TECHNICAL SPECIFICATIONS

(Volume-II)

Insulators,Transformers,Breakers,Conductors CR Panels

उत्तराखण्ड पावर कारपोरेशन लि०

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Technical Specifications

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1. Technical Specification for 33kV & 11kV Disc Insulators

1.1. Scope

This specification covers minimum technical requirements for design, engineering, manufacture, inspection, supply and performance of 33 kV and 11 kV Disc Insulators.

1.2. Service Conditions

Equipment/material to be supplied against this specification shall be suitable for satisfactory continuous operation under the tropical conditions as follows:

Table 1-1: Service Conditions

S.No.	Particulars	Value
1	Maximum ambient temperature (Deg. Celsius)	50
2	Minimum temperature (Deg. Celsius)	-5
3	Relative humidity range (%)	10 to 100
4	Maximum annual rainfall (mm)	1500
5	Maximum wind pressure (kg/sq. m)	195
6	Wind speed zones (m/s)	47 & 39
7	Maximum altitude above mean sea level (m)	3000
8	Isoceraunic level (days/year)	50
9	Seismic level (Horizontal acceleration) (g)	0.13

1.3. Standards

The insulators shall comply with latest revision of the following Indian Standards (IS) unless otherwise stipulated in the specification.
All references to Indian Standards shall be deemed to be complying with latest amendments to the respective IS, if any.

Table 1-2: Standards

S.No.	Standard no.	Title
1	IS:731-1971	Specifications for porcelain Insulators for overhead power lines with nominal voltage greater than1000V
2	IS: 2486 Part-1 19193	Metal fittings of insulators for overhead lines. IS: 2486 Part -1 / 1993
3	IS: 2486 Part-2 1989	Dimensional Requirements for insulators fittings
4	IS: 2486 Part-3	Locking devices
5	IS: 2486 Part-4	Test for locking devices
6	IS: 2071 Part -1 ,2 & 3	Method of High Voltage Testing
7	IS: 3188	Characteristics of Disc Insulators
8	IS: 2633 / 1986	Testing of uniformity of coating of zinc coated articles
9	IS: 209	Zinc ingot specification

1.4. General Technical Requirements

a) Material used for insulators shall be of best quality complying with the requirements of relevant Standards. Insulators shall be suitable for installation free in air and shall be capable of withstanding the normal stress associated with transportation erection operations without getting deformed.
b) All insulators shall confirm to "Type – B" of IS: 731.
c) The tension (strain) insulators shall be of Ball and socket type or Tong and Clevis type.
d) The suspension (string) insulators shall be only of ball and socket type with ball shank diameter of 16 mm.
e) Insulators shall have minimum failing load of 45 kN for 11 kV lines and 70 kN for 33 kV lines.
f) Diameter of porcelain disc shall be 255 mm for moderately polluted atmosphere and 280 mm for heavily polluted atmosphere.
g) Insulators and Hardware fittings should be ordered separately as hardware fitting will differ for each conductor type.
h) The Centre to Centre distance between ball and socket shall be 145 mm.
i) Total minimum creepage distances shall be as follows:

Table 1-3: Minimum Creepage Distance

Working voltage (kV)	Highest system Voltage (kV)	Minimum Creepage distance (mm)
11	12	320
33	36	900

1.4.1. Basic insulation levels & Test Voltages:

a) The Basic insulation levels test voltages of insulators shall be as under:

Table 1-4: Basic insulation levels

Highest System Voltage	Visible Discharge Test	Dry one-minute power frequency withstand test	Wet Power Frequency withstand Test	Power Frequency puncture withstand test	Impulse voltage withstand Test
				Strain/string Insulators	
kV(rms)	kV(rms)	kV(rms)	kV(rms)	kV(rms)	kV(rms)
12	9	35	35	1.3 times the actual dry flash over voltage of the insulator	75
36	27	75	75	1.3 times the actual dry flash over voltage of the insulator	170

The porcelain used in the manufacture of shells shall be sound, free from defects thoroughly vitrified and smoothly glazed.

The finished porcelain shall be glazed in brown colour. The glaze shall cover all exposed parts of the insulator except those areas which serve as supports during firing or left unglazed for the purpose of assembly. Glaze shall have a good luster, smooth surface and good performance under the extreme weather conditions of a tropical climate. It shall not crack or chip by ageing under the normal Service Conditions. The glaze shall have the same co-efficient of expansion as of the porcelain body throughout the working temperature range.

The design of the insulator shall be such that stresses due to expansion and contraction in any part of the insulator shall not lead to deterioration.

Cement used in the manufacture of the insulator shall not cause fracture by expansion or loosening by contraction. The cement shall not give rise to chemical reaction with metal fittings and its thickness shall be as small and uniform as possible. Proper care shall be taken to correctly center and locate individual parts during cementing.

1.4.2. Pin and Cap

a) Pins shall be made of drop forged steel and caps shall be made of malleable cast iron / spheroidal graphite iron/drop forged steel, duly hot dip galvanized and shall not be made by jointing, welding, shrink fitting or any other process from more than one piece of material.
b) Pin and Cap shall be designed to transmit the mechanical stresses to the shell by compression and develop uniform mechanical strength in the insulator. The cap shall be circular with the inner and outer surfaces concentric, of such design that it will not yield or distort under load conditions.
c) The pin ball shall move freely in the cap socket but without danger of accidental uncoupling during erection or in position. The design of the disc should be such that stresses due to expansion or contraction in any part of the insulator shall not lead to deterioration.

1.4.3. Security clip

(a) Security clip for use with ball and socket coupling shall be of W clip / R-shaped hump type which shall provide positive locking of the coupling as per IS:2486-(Part-Ill)/ IEC:372. The legs of the security clips shall be spread after installation to prevent complete withdrawal from the socket. The locking device should be resilient, corrosion resistant and of suitable mechanical strength. There shall be no risk of the locking device being displaced accidentally or being rotated when in position- under no circumstances shall locking device allow separation of insulator units or fittings.

(b) Security clips shall be made of good quality stainless steel or phosphor bronze as per IS: 1385-1968. 2.5% extra Security clip shall be provided.

1.4.4. Interchange ability

The disc insulators inclusive of fittings shall be of standard design suitable for use with the hardware fittings of any make conforming to relevant Indian/International Standards.

1.4.5. Maintenance

The insulators offered shall be suitable for employment of hot line maintenance techniques so that the usual hot line operations can be carried out with ease, speed and safety.

1.4.6. Workmanship

All the material shall be of the latest design and conform to the best modern practices adopted in the distribution voltage field. Contractors shall offer only such insulators as are guaranteed by him to be satisfactory and suitable for specified voltage level and will give continued good service.

The design, manufacturing process and material control at various stages shall be such as to give maximum working load, highest mobility, best resistance to corrosion, good finish and elimination of sharp edges and corners.

In disc insulators, metal caps shall be free from cracks, seams, shrinks, air holes, burrs and rough edges. All surfaces of the metal parts shall be perfectly smooth with no projecting points or irregularities. All load bearing surfaces shall be smooth and uniform so as to distribute the loading stresses uniformly.

All ferrous parts shall be hot dip galvanized to give a minimum average coating of Zinc equivalent to 600 mg/sq.mm. And shall be in accordance with the requirement of IS: 2629-1985 and shall satisfy the Tests mentioned in IS: 2633 1986. The zinc used for galvanizing shall be of Grade Zn 99.95 as per IS: 209-1979. The zinc coating shall be uniform, adherent, smooth, reasonably bright, continuous and free from imperfections such as flux, ash, rust stains, bulky white deposits and blisters. The galvanized metal parts shall be guaranteed to withstand at least six successive dips each lasting for one (1) minute duration under the standard preece test.

Before ball fittings are galvanized, all die flashing on the shank surface of the ball shall be carefully removed without reducing the dimensions below the design requirements.

In disc insulators, the design of the insulators shall be such that the shell shall not engage directly with hard metal. The design shall also be such that when units are coupled together there is no contact between the shell of one unit and metal of the next adjacent unit. The design of the shell ribs shall be such that the security clip of the insulator can be engaged and disengaged easily with hot stick without damaging the shell ribs.

Insulator units after assembly shall be concentric and co-axial within limits as permitted by the relevant Indian Standards.

The marking shall be on porcelain, and shall be printed, not impressed and shall be applied before firing.

1.4.7. Type Test Reports

Type Test Reports (less than five years old as on the due date of tender) of Tests carried out at NABL accredited laboratory along with certified drawings shall be furnished by the bidder with offer otherwise offer shall be rejected.

1.4.8. ISI Certification Mark

The insulators with ISI marking only are required against this tender specification. A copy of BIS license valid on the due date of the tender should be submitted with the offer failing which, the offer shall be rejected. The BIS (ISI) license shall be valid on the date of supply & material supplied shall have ISI marking. If the material received at site is found without ISI marking, the lot shall be rejected and no further correspondence shall be entertained in this regard.

1.5. Tests

All Tests shall be conducted on individual insulator unit, components and complete strings.

1.5.1. Type Tests

The following shall constitute 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) Electro-mechanical failing load test
h) 24 hour hour's mechanical strength test
i) Puncture Test
j) Porosity test
k) Galvanizing test
l) Thermal Mechanical Performance Test

1.5.2. Acceptance Tests

a) Verification of dimensions
b) Temperature cycle test
c) 24 hour hours mechanical strength test
d) Electro-mechanical failing load test
e) Porosity test
f) Puncture test
g) Galvanizing test
h) Test on locking device for ball and socket coupling

Sampling procedure, size and criteria of conformity shall be as per IS: 731-1971.

1.5.3. Routine Tests

a) Visual Inspection
b) Mechanical routine text
c) Electrical routine test

Routine Tests shall be carried out on each insulator.

1.5.4. Testing Equipment / Meter Calibration

All testing equipment / meters used shall be calibrated within valid time limit at NABL accredited laboratory. Calibration seals provided by the calibrating agency on testing equipment / meters shall be in good condition.

1.6. Pre-Delivery Inspection at Manufacturer's Work

a. All acceptance Tests shall be witnessed and certified by purchaser's representative at manufacturer's works. The vendor shall give at least 10 days advance intimation to the purchaser to enable them to depute their representative for witnessing the Tests. The said representative shall have full facilities for unrestricted inspection of supplier's works, raw materials, manufacturing processes and conducting necessary Tests.
b. The said representative shall verify the calibration seals provided by the calibrating agency on testing equipment/ meters.
c. Test reports of routine Tests carried out by the manufacturer shall be submitted to the inspecting authority at the time of inspection for his approval.
d. Acceptance of any quantity of materials shall in no way relieve the supplier of his responsibility for meeting all requirements of the specification and shall not prevent subsequent rejection, if such materials are later found to be defective.

e. In case of waiver of inspection, vendor shall carry out all (i) routine and (ii) acceptance Tests and submit test reports for approval of the purchaser, before dispatch of material.
f. The entire cost of testing for acceptance & routine rests and checking of length etc. shall be borne by the supplier.
g. The purchaser reserves the right to select sample from any material offered for inspection /inspected and dispatched, which will be got type tested at any NABL accredited laboratory. The results of this type-tested sample shall be applicable for the entire quantity of the particular lot offered or supplied by the supplier. The Purchaser shall bear the testing charges, if sample passes all the Tests and if sample fails in any one of the Tests, supplier shall have to bear testing charges, same are recoverable from the supplier's any pending bill, security deposit, Bank Guarantee or by any suitable means, whichever deem fit by the Purchaser. In case of sample failing in aforesaid type Tests, supplier shall have to replace the whole lot materials, which should pass through the type Tests, the re-testing charges will have to be paid by supplier. If any quantity against the particular lot is consumed by the Purchaser, the supplier will agree for any penalty/deduction in price as may be mutually agreed.

1.7. Guarantee

The equipment/material shall be guaranteed for a period of 24 months from the date of commissioning or 30 months from the date of dispatch whichever is earlier.

1.8. Quality Assurance Plan & Material Quality Plan

Following quality plans shall be submitted within 30 days from the date of placement of contract.

a) Quality Assurance Plan (QAP) to be adopted by manufacturer in respect of raw materials and bought out items, including source and test reports of (i) important raw materials and (ii) bought out items.
b) Material Quality Plan (MQP) to be adopted by manufacturer in respect of manufacturing process.

The QAP & MQP shall be approved by the purchaser within 15 days from the receipt of compliance, if any. The vendor shall follow the approved QAP & MQP in true spirit. If desired by the purchaser, he shall give access to all the documents and materials to satisfy the purchaser that QAP & MQP are being properly followed.

1.9. Packing & Marketing

1.9.1. Packing

a) All insulators shall be packed in strong seasoned wooden crates. The gross weight of the crates along with the material shall not normally exceed 200 kg to avoid handling problem. For marine transportation, crates shall be palette.
b) The packing shall be of sufficient strength to withstand rough handling during transit, storage at site and subsequent handling in the field.
c) Suitable cushioning, protective padding or spacers shall be provided to prevent damage or deformation during transit and handling.
d) All packing cases shall be marked legibly and correctly so as to ensure safe arrival at their destination and to avoid the possibility of goods being lost or wrongly dispatched on account of faulty packing and faulty or illegible markings. Each wooden case/crate shall have all the markings stenciled on it in indelible ink.

1.9.2. Marking

Each insulator shall be legibly and indelibly marked with the following.

a) Name or trademark of the manufacturer
b) Month & year of manufacture
c) Minimum failing load (kN)
d) ISI mark
e) UPCL

1.10. Engineering Data and Manual

The Bidder shall furnish catalogues, literature and detailed dimensional drawing of insulators offered showing section of the insulator to show the method of construction, connecting arrangement, length and type of threads etc. The drawing shall include but not limited to the following information:

(a) Dimensions with manufacturing tolerances
(b) Minimum Creepage distance with positive tolerance
(c) Protected creepage distance
(d) Eccentricity of the disc
    i. Axial run out
    ii. Radial run out

Unit mechanical and electrical characteristics

(e) Size and weight of pin ball shank / ball and socket parts
(f) Weight of unit insulator disc
(g) Materials used
(h) Identification mark

Executive Engineer (Stores), UPCL will be the final authority for approving the drawings submitted by the tenderer.

1.11. Schedules

1.11.1. Schedule – I [Guaranteed Technical Particulars (I/II): 45 KN Disc insulators]

(To be confirmed by the vendor)

Table 1-5: Guaranteed Technical Particulars (I/II): 45 KN Disc insulators

S.No.	Particulars	Confirmation
1	Disc insulators shall be manufactured and supplied confirming to IS:731 and UPCL specifications	
2	Disc insulators shall bear ISI mark	
3	Material used for insulator housing shall be porcelain	
4	Colour of disc insulator shall be brown	
5	Diameter of disc insulator shall be 255 mm/ 280mm for normal and moderately polluted atmosphere / heavily polluted atmosphere	
6	Diameter of pin ball shank shall be 16 mm	
7	Centre to center distance between ball and socket shall be 145 mm	
8	Minimum failing load shall be 45 kN	
9	Minimum total creepage distance shall be 320 mm	
10	Working voltage shall be 11 kV	
11	Highest system voltage shall be 12 kV	
12	Impulse Withstand Voltage shall be 75 kV (Peak)	
13	Visible discharge voltage shall be 9 kV (rms)	
14	Power frequency puncture withstand voltage shall be 105 kV (rms)	
15	Dry one minute power frequency withstand voltage shall be 35 kV (rms)	
16	Wet power frequency withstand voltage shall be 35 kV (rms)	

1.11.2. Schedule – I [Guaranteed Technical Particulars (II/II) for Item: Disc Insulators 45 KN]

(Information not covered in IS)

Sr. No.	Item	Value
1	Weight of single disc (kg)	
2	No. of insulators per crate	
3	Packed wt. of each crate (kg)	

1.11.3. Schedule – II [Guaranteed Technical Particulars (I/II): 70 kN Disc insulators]

(To be confirmed by the vendor)

Table 1-6: Guaranteed Technical Particulars (I/II): 70 kN Disc insulators

S.No.	Particulars	Confirmation
1	Disc insulators shall be manufactured and supplied confirming to IS:731 and UPCL specifications	
2	Disc insulators shall bear ISI mark	
3	Material used for insulator housing shall be porcelain	
4	Colour of disc insulator shall be brown	
5	Diameter of disc insulator shall be 255 mm/ 280mm for normal and moderately polluted atmosphere / heavily polluted atmosphere	
6	Diameter of pin ball shank shall be 16 mm	
7	Center to center distance between ball and socket shall be 145 mm	
8	Minimum failing load shall be 70 kN	
9	Minimum total creepage distance shall be 900 mm	
10	Working voltage shall be 33 kV	
11	Highest system voltage shall be 36 kV	
12	Impulse Withstand Voltage shall be 170 kV (Peak)	
13	Visible discharge voltage shall be 27 kV (rms)	
14	Power frequency puncture withstand voltage shall be 180 kV (rms)	
15	Dry one minute power frequency withstand voltage shall be 75 kV (rms)	
16	Wet power frequency withstand voltage shall be 75 kV (rms)	

1.11.4. Schedule I [Guaranteed Technical Particulars (II/II) for Item: Disc Insulators 70 KN]

(Information not covered in IS)

Table 1-7: Guaranteed Technical Particulars (II/II) for Item: Disc Insulators 70 KN

S.No.	Item	Value
1	Weight of single disc (kg)	
2	No. of insulators per crate	
3	Packed wt. of each crate 70 kN (kg)	

1.11.5. Schedule – III [Information regarding BIS license]

Table 1-8: Information regarding BIS license

S.No.	Particulars	Information
1	Name of manufacturer and address	
2	Trade mark, if any	
3	ISI license number for IS: 731	
4	ISI license for IS: 731 is valid up to	

1.11.6. Schedule – IV [Information regarding manufacturing and testing facilities]

(Vendor to enclose following documents and to confirm the same)

Table 1-9: Information regarding manufacturing and testing facilities

S.No.	Particulars	Confirmation
1	Type test report from NABL accredited lab (less than 5 years old as on date of opening of offer)	
2	ISI license	
3	Proof if applied for renewal of ISI license	
4	List of plant and machinery	
5	List of testing facility available	
6	List of orders pending and executed	
6 (a)	With UPCL	
6 (b)	With other agencies, other than 6 (a)	

2. Technical Specification for 33kV & 11kV Pin Insulators

2.1. Scope

This specification covers minimum technical requirements for design, engineering, manufacture, inspection, supply and performance of 33 kV and 11 kV Pin Insulators.

2.2. Service Conditions

Equipment/material to be supplied against this specification shall be suitable for satisfactory continuous operation under the tropical conditions as follows:

Table 2-1: Service Conditions

S.No.	Particulars	Value
1	Maximum ambient temperature (Deg. Celsius)	50
2	Minimum temperature (Deg. Celsius)	-5
3	Relative humidity range (%)	10 to 100
4	Maximum annual rainfall (mm)	1500
5	Maximum wind pressure (kg/sq. m)	195
6	Wind speed zones (m/s)	47 & 39
7	Maximum altitude above mean sea level (m)	3000
8	Isoceraunic level (days/year)	50
9	Seismic level (Horizontal acceleration) (g)	0.13

1.1.

2.3. Standards

The insulators shall comply with latest revision of the following Indian Standards (IS) unless otherwise stipulated in the specification.

All references to Indian Standards shall be deemed to be complying with latest amendments to the respective IS, if any.

Table 2-2: Standards

S.No.	Standard no.	Title
1	IS:731-1971	Specifications for porcelain Insulators for overhead power lines with nominal voltage greater than 1000V
2	IS : 2486 Part-1, 1993	Metal fittings of insulators for overhead lines.
3	IS : 2486 Part-2, 1989	Dimensional Requirements for insulators fittings
4	IS : 2071 Part -1 ,2 & 3	Method of High Voltage Testing

2.4. General Technical Requirements

a) Material used for insulators shall be of best quality complying with the requirements of relevant Standards. Insulators shall be suitable for installation free in air and shall be capable of withstanding the normal stress associated with transportation erection operations without getting deformed.
b) All insulators shall confirm to IS: 731.
c) Insulators shall have minimum failing load of 5 kN for 11 kV lines and 10 kN for 33 kV lines.
d) Total minimum creepage distance shall be as follows:

Working voltage (kV)	Highest system VOLTAGE (kV)	Minimum Creepage Distance (mm)
11	12	230
33	36	580

2.4.1. Basic insulation levels & Test Voltages:

a) The Basic insulation levels test voltages of insulators shall be as under:

Table 2-3: Basic insulation Levels

Highest System Voltage	Visible Discharge Test	Dry one minute Power Frequency withstand Test	Wet Power Frequency withstand Test	Power Frequency puncture withstand test	Impulse voltage withstand Test
				Strain/string Insulators	
kV(rms)	kV(rms)	kV(rms)	kV(rms)	kV(rms)	kV(rms)
12	9	35	35	1.3 times the actual dry flash over voltage of the insulator	75
36	27	75	75	1.3 times the actual dry flash over voltage of the insulator	170

The porcelain used in the manufacture of shells shall be sound, free from defects thoroughly vitrified and smoothly glazed.

The finished porcelain shall be glazed in brown color. The glaze shall cover all exposed parts of the insulator except those areas which serve as supports during firing or left unglazed for the purpose of assembly. Glaze shall have a good luster, smooth surface and good performance under the extreme weather conditions of a tropical climate. It shall not crack or chip by ageing under the normal Service Conditions. The glaze shall have the same co-efficient of expansion as of the porcelain body throughout the working temperature range.

2.4.2. Maintenance

The insulators offered shall be suitable for employment of hot line maintenance techniques so that the usual hot line operations can be carried out with ease, speed and safety.

2.4.3. Workmanship

All the material shall be of the latest design and conform to the best modern practices adopted in the distribution voltage field. Contractors shall offer only such insulators as are guaranteed by him to be satisfactory and suitable for specified voltage level and will give continued good service.

2.4.4. Type Test Reports

Type Test Reports (less than five years old as on the due date of tender) of Tests carried out at NABL accredited laboratory along with certified drawings shall be furnished by the bidder with offer otherwise offer shall be rejected.

2.4.5. ISI Certification Mark

a) The insulators with ISI marking only are required against this tender specification. A copy of BIS license valid on the due date of the tender should be submitted with the offer failing which, the offer shall be rejected.
b) The BIS (ISI) license shall be valid on the date of supply & material supplied shall have ISI marking. If the material received at site is found without ISI marking, the lot shall be rejected and no further correspondence shall be entertained in this regard.

2.5. Tests

2.5.1. Type Tests

The following shall constitute 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
h. Puncture Test
i. Porosity test

2.5.2. Acceptance Tests

a. Verification of dimensions
b. Temperature cycle test
c. Mechanical failing load test
d. Porosity test

Sampling procedure, size and criteria of conformity shall be as per IS: 731-1971.

2.5.3. Routine Tests

a. Visual Inspection
b. Electrical routine test

Routine Tests shall be carried out on each insulator.

2.5.4. Testing Equipment / Meter Calibration

All testing equipment / meters used shall be calibrated within valid time limit at NABL accredited laboratory. Calibration seals provided by the calibrating agency on testing equipment / meters shall be in good condition.

2.6. Pre-Delivery Inspection at Manufacturer's Work

a) All acceptance Tests shall be witnessed and certified by purchaser's representative at manufacturer's works. The vendor shall give at least 10 days advance intimation to the purchaser to enable them to depute their representative for witnessing the Tests. The said representative shall have full facilities for unrestricted inspection of supplier's works, raw materials, manufacturing processes and conducting necessary Tests.
b) The said representative shall verify the calibration seals provided by the calibrating agency on testing equipment/ meters.
c) Test reports of routine Tests carried out by the manufacturer shall be submitted to the inspecting authority at the time of inspection for his approval.
d) Acceptance of any quantity of materials shall in no way relieve the supplier of his responsibility for meeting all requirements of the specification and shall not prevent subsequent rejection, if such materials are later found to be defective.

e) In case of waiver of inspection, vendor shall carry out all (i) routine and (ii) acceptance Tests and submit test reports for approval of the purchaser, before dispatch of material.
f) The entire cost of testing for acceptance & routine rests and checking of length etc shall be borne by the supplier.
g) The purchaser reserves the right to select sample from any material offered for inspection /inspected and dispatched, which will be got type tested at any NABL accredited laboratory. The results of this type-tested sample shall be applicable for the entire quantity of the particular lot offered or supplied by the supplier. The Purchaser shall bear the testing charges, if sample passes all the Tests and if sample fails in any one of the Tests, supplier shall have to bear testing charges, same are recoverable from the supplier's any pending bill, security deposit, Bank Guarantee or by any suitable means, whichever deem fit by the Purchaser. In case of sample failing in aforesaid type Tests, supplier shall have to replace the whole lot materials, which should pass through the type Tests, the re-testing charges will have to be paid by supplier. If any quantity against the particular lot is consumed by the Purchaser, the supplier will agree for any penalty/deduction in price as may be mutually agreed.

2.7. Quality Assurance Plan & Material Quality Plan

Following quality plans shall be submitted within 30 days from the date of placement of contract.

a) Quality Assurance Plan (QAP) to be adopted by manufacturer in respect of raw materials and bought out items, including source and test reports of (i) important raw materials and (ii) bought out items.
b) Material Quality Plan (MQP) to be adopted by manufacturer in respect of manufacturing process.

The QAP & MQP shall be approved by the purchaser within 15 days from the receipt of compliance, if any. The vendor shall follow the approved QAP & MQP in true spirit. If desired by the purchaser, he shall give access to all the documents and materials to satisfy the purchaser that QAP & MQP are being properly followed.

2.8. Guarantee

The equipment/material shall be guaranteed for a period of 24 months from the date of commissioning or 30 months from the date of dispatch whichever is earlier.

2.9. Packing & Marking

2.9.1. Packing

a) All insulators shall be packed in strong seasoned wooden crates. The gross weight of the crates along with the material shall not normally exceed 200 kg to avoid handling problem. For marine transportation, crates shall be palette.
b) The packing shall be of sufficient strength to withstand rough handling during transit, storage at site and subsequent handling in the field.
c) Suitable cushioning, protective padding, or spacers shall be provided to prevent damage or deformation during transit and handling.
d) All packing cases shall be marked legibly and correctly so as to ensure safe arrival at their destination and to avoid the possibility of goods being lost or wrongly dispatched on account of faulty packing and faulty or illegible markings. Each wooden case/crate shall have all the markings stenciled on it in indelible ink.

2.9.2. Marking

Each insulator shall be legibly and indelibly marked with the following.

a) Name or trademark of the manufacturer
b) Month & year of manufacture
c) Minimum failing load (kN)
d) ISI mark
e) UPCL

Marking on porcelain shall be applied before firing.

2.10. Engineering Data and Manual

The Bidder shall furnish catalogues, literature and detailed dimensional drawing of insulators offered showing section of the insulator to show the method of construction, length and type of threads etc.

Executive Engineer (Stores), UPCL will be the final authority for approving the drawings submitted by the tenderer.

2.11. Schedules

2.11.1. Schedule – I [Guaranteed Technical Particulars (I/II) for Item: 11 kV Pin insulators]

(To be confirmed by the vendor)

S.No.	Particulars	Confirmation
1	Pin insulators shall be manufactured and supplied confirming to IS:731 and UPCL specifications	
2	Pin insulators shall bear ISI mark	
3	Material used for insulator housing shall be porcelain	
4	Colour of pin insulator shall be brown	
5	Minimum failing load shall be 5 kN for 11 kV	
6	Minimum creepage distance shall be 230mm	
7	Working voltage shall be 11 kV	
8	Highest system voltage shall be 12 kV	
9	Impulse Withstand Voltage shall be 75 kV (Peak)	
10	Visible discharge voltage shall be 9 kV (rms)	
11	Power frequency puncture withstand voltage shall be 105 kV (rms)	
12	Wet one minute power frequency withstand voltage shall be 35 kV (rms)	
13	Wet power frequency withstand voltage shall be 35 kV (rms)	

2.11.2. Schedule I [Guaranteed Technical Particulars (II/II) for Item: Pin Insulators 11 kV]

(Information not covered in IS)

Table 2-4: Guaranteed Technical Particulars (II/II) for Item: Pin Insulators 11 kV

S.No.	Item	Value
1	Weight of single Pin Insulator 11 kV (kg)	
2	No. of insulators per crate	
3	Packed wt. of each crate (kg)	

2.11.3. Schedule – II [Guaranteed Technical Particulars (I/II) for Item: 33 kV Pin insulators]

(To be confirmed by the vendor)

Table 2-5: Guaranteed Technical Particulars (I/II) for Item: 33 kV Pin insulators

Sr. No.	Particulars	Confirmation
1	Pin insulators shall be manufactured and supplied confirming to IS:731 and UPCL specifications	
2	Pin insulators shall bear ISI mark	
3	Material used for insulator housing shall be porcelain	
4	Colour of pin insulator shall be brown	
5	Minimum failing load shall be 10 kN for 33 kV	
6	Minimum total creepage distance shall be 580 mm for 33 kV	
7	Working voltage shall be 33 kV	
8	Highest system voltage shall be 36 kV	
9	Impulse Withstand Voltage shall be 170 kV (Peak)	
10	Visible discharge voltage shall be 27 kV (rms)	
11	Power frequency puncture withstand voltage shall be 180 kV (rms)	
12	Dry one minute power frequency withstand voltage shall be 75 kV (rms)	
13	Wet power frequency withstand voltage shall be 75 kV (rms)	

2.11.4. Schedule II [Guaranteed Technical Particulars (II/II) for Item: Pin Insulators 33 kV]

(Information not covered in IS)

Table 2-6: Guaranteed Technical Particulars (II/II) for Item: Pin Insulators 33 kV

S.No.	Item	Value
1	Weight of single insulator (kg)	
2	No. of insulators per crate	
3	Packed wt. of each crate (kg)	

2.11.5. Schedule – III [Information regarding BIS license]

Table 2-7: Information regarding BIS license

S.No.	Particulars	Information
1	Name of manufacturer and address	
2	Trade mark, if any	

S.No.	Particulars	Information
3	ISI license for IS: 731 - number	
4	ISI license for IS: 731 is valid up to	

2.11.6. Schedule – IV [Information regarding manufacturing and testing facilities etc]

(Vendor to enclose following documents and to confirm the same)

Table 2-8: Information regarding manufacturing and testing facilities etc

Sr. No.	Particulars	Confirmation
1	Type test report from NABL accredited lab (less than 5 years old as on date of opening of offer)	
2	ISI license	
3	Proof if applied for renewal of ISI license	
4	List of plant and machinery	
5	List of testing facility available	
6	List of orders pending and executed	
6 (a)	With UPCL	
6 (b)	With other agencies, other than 6 (a)	

3. Technical Specification for Porcelain Insulators for use on 415/240-volt overhead power lines

3.1. Scope

This specification covers minimum technical requirements for design, engineering, manufacture, inspection, supply and performance of porcelain LT Pin and Shackle insulators for use on 415/240-volt overhead power lines.

3.2. Service Conditions

Equipment/material to be supplied against this specification shall be suitable for satisfactory continuous operation under the tropical conditions as follows:

Table 3-1: Service Conditions

S.No.	Particulars	Value
1	Maximum ambient temperature (Deg. Celsius)	50
2	Minimum temperature (Deg. Celsius)	-5
3	Relative humidity range (%)	10 to 100
4	Maximum annual rainfall (mm)	1500
5	Maximum wind pressure (kg/sq. m)	195
6	Wind speed zones (m/s)	47 & 39
7	Maximum altitude above mean sea level (m)	3000
8	Isoceraunic level (days/year)	50
9	Seismic level (Horizontal acceleration) (g)	0.13

3.3. Standards

The insulators shall comply with latest revision of the following Indian Standards (IS) unless otherwise stipulated in the specification.
All references to Indian Standards shall be deemed to be complying with latest amendments to the respective IS, if any.

Table 3-2: Standards

S.No.	Standard no.	Title
1.	IS: 1445 -1997	Specifications for porcelain Insulators for overhead power lines with nominal voltage up to and including 1000V
2.	IS : 7935- 1975	Metal fittings of insulators for overhead power lines with nominal voltage up to and including 1000V

3.4. Type of Insulators

3.4.1. Pin Insulator

Pin Insulator is an insulator consisting of a single piece of porcelain and intended to be mounted rigidly on a supporting structure by a pin, which passes up inside the insulator.

3.4.2. Shackle Insulators

Shackle insulator is an insulator consisting of a single piece of porcelain and intended to be mounted vertically or horizontally , between and in contact with the two ends of a 'u' strap or a pair of straps with its axis vertical and intended to secure a line conductor in tension.

3.5. System Conditions

a) Frequency: 50 Hz
b) Nominal System Voltage: 400/230 V
c) Maximum System Voltage LT System: 440/250 V
d) Minimum LT Voltage: 370 V
e) Neutral Earthing arrangement LT System: Solidly Earthed

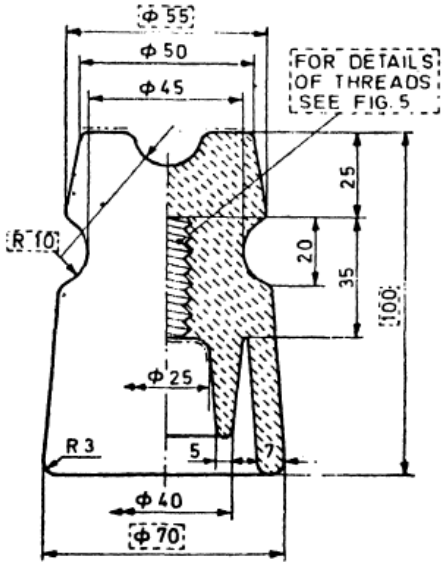
3.6. General Technical Requirements

a) The porcelain shall be sound, free from defects, thoroughly vitrified and smoothly glazed.
b) The glaze, unless otherwise specified, shall be white in colour. Except for the screw threads and the parts on which the porcelain is supported during firing, which may be left unglazed, all other surfaces of the insulator shall be effectively glazed.
c) The design of the insulator shall be such that stresses due to expansion and contraction in any part of the insulator shall not lead to its deterioration.
d) The insulator shall be in one piece.
e) The insulators shall be installed on three-phase, 433 volts AC & 50 Hz system in which the neutral is effectively grounded. The insulators shall be designed to work continuously at a voltage 10% in excess of the normal rated voltage.
f) The insulators shall conform to provisions under IS: 1445/1977. The Pin insulators shall be threaded to take mild Steel Pin of dimensions given below.

Pin Insulator	Suitable for head shank	Dia. (mm)	Remark
Type – 1	Steel Head threads as per profile of threads as insulators as given in Fig.5 of IS : 1445 /1977	16	Pin insulators Threads as per profile given in Fig.5 of IS:1445/1977

The pin type insulator shall have a top groove and shall be threaded to take mild steel pins, the profile of threads being as given in fig. 5 of is:1445-1977.

The dimensions of the insulators are as per fig. 1 – type 1 of is: 1445 –amendment no. 2: 1981.



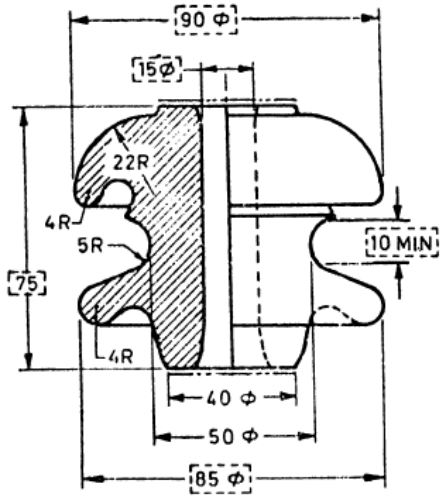
NOTE 1 — The upper groove of the pin insulators should be slightly slanting so that the possibility of damage to the conductor on the sharp edge is avoided.

NOTE 2 — Threads and portions marked ---- shall be unglazed.

All dimensions in millimetres.

FIG. 1 PIN INSULATOR — TYPE 1

The dimensions of shackle insulator shall be as shown in fig. 3 & 4 of IS: 1445.

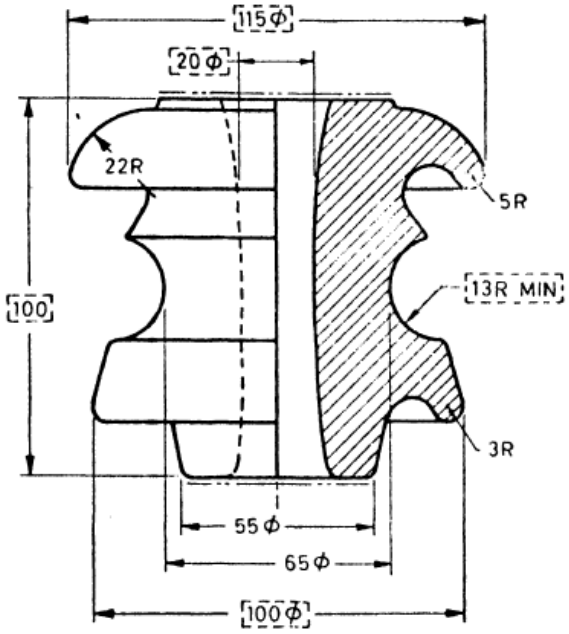


NOTE 1 — The portions marked ---- shall be unglazed.

NOTE 2 — The unglazed portion marked at the top and bottom of the insulators is meant for supporting the insulators during firing. While determining the areas for glaze faults, only one portion should be permitted as unglazed as only one portion (that is, top or bottom) would be required for supporting during firing.

All dimensions in millimetres.

FIG. 3 SHACKLE INSULATOR — TYPE 1



NOTE 1 — The portions marked ---- shall be unglazed.

NOTE 2 — The unglazed portion marked at the top and bottom of the insulators is meant for supporting the insulators during firing. While determining the areas for glaze faults, only one portion should be permitted as unglazed as only one portion (that is, top or bottom) would be required for supporting during firing.

All dimensions in millimetres.

FIG. 4 SHACKLE INSULATOR — TYPE 2

The insulators shall be suitable for use with all Aluminium Conductor or Aluminium Conductor Steel Reinforced (ACSR) up to 100 sq.mm. The insulators should withstand the conductor tension the reversible wind load as well as the high frequency vibrations set due to wind.

3.6.1. Insulation Characteristics

The insulators shall have the electrical and mechanical characteristic given in the table below:

Table 3-3: Insulator's Characteristics

Type of insulator	Power frequency flashover voltage in kV (rms)		One minute power frequency withstand voltage in kV(rms)		Power frequency puncture withstand voltage kV (rms)	Min. failing load (kN)
	Dry	Wet	Dry	Wet		
Pin	25	10	23	10	1.3 x the actual flashover voltage	3.5
Shackle Type 1 (115 x 100 mm2)	25	10	23	10	1.3 x the actual flashover voltage	11.50

Type of insulator	Power frequency flashover voltage in kV (rms)		One minute power frequency withstand voltage in kV(rms)		Power frequency puncture withstand voltage kV (rms)	Min. failing load (kN)
	Dry	Wet	Dry	Wet		
Shackle Type 2 (90 x 75 mm2)	25	10	23	10	1.3 x the actual flashover voltage	16.00

Shackle insulator "type – 2" shall be used for low tension lines.

3.6.2. Workmanship

All the material shall be of the latest design and conform to the best modern practices adopted in the distribution voltage field. Contractors shall offer only such insulators as are guaranteed by him to be satisfactory and suitable for specified voltage level and will give continued good service.

3.6.3. ISI Certification Mark

- The insulators with ISI marking only are required against this tender specification. A copy of BIS license valid on the due date of the tender should be submitted with the offer failing which, the offer shall be rejected.
- The BIS (ISI) license shall be valid on the date of supply & material supplied shall have ISI marking. If the material received at site is found without ISI marking, the lot shall be rejected and no further correspondence shall be entertained in this regard.

3.6.4. Type Test Reports

Type Test Reports (less than five years old as on the due date of tender) of Tests carried out at NABL accredited laboratory along with certified drawings shall be furnished by the bidder with offer otherwise offer shall be rejected.

3.7. Tests

3.7.1. Type Tests

The following shall constitute type Tests:

a) Visual examination
b) Verification of dimensions
c) Dry power-frequency voltage withstand test
d) Wet power-frequency voltage withstand test
e) Temperature cycle test
f) Mechanical failing load test

g) Power frequency puncture withstand test
h) Porosity test

3.7.2. Acceptance Tests

a) Verification of dimensions
b) Temperature cycle test
c) Mechanical failing load test
d) Porosity test

3.7.3. Routine Tests

a) Visual Inspection
b) Acceptance Tests: Sampling procedure, size and criteria of conformity shall be as per IS: 1445-1977.
c) Routine Tests: Routine Tests shall be carried out on each insulator.

3.7.4. Testing Equipment / Meter Calibration

All testing equipment / meters used shall be calibrated within valid time limit at NABL accredited laboratory. Calibration seals provided by the calibrating agency on testing equipment / meters shall be in good condition.

3.8. Pre-Delivery Inspection at Manufacturer's Work

a) All acceptance Tests shall be witnessed and certified by purchaser's representative at manufacturer's works. The vendor shall give at least 10 days advance intimation to the purchaser to enable them to depute their representative for witnessing the Tests. The said representative shall have full facilities for unrestricted inspection of supplier's works, raw materials, manufacturing processes and conducting necessary Tests.
b) The said representative shall verify the calibration seals provided by the calibrating agency on testing equipment/ meters.
c) Test reports of routine Tests carried out by the manufacturer shall be submitted to the inspecting authority at the time of inspection for his approval.
d) Acceptance of any quantity of materials shall in no way relieve the supplier of his responsibility for meeting all requirements of the specification and shall not prevent subsequent rejection, if such materials are later found to be defective.
e) In case of waiver of inspection, vendor shall carry out all (i) routine and (ii) acceptance Tests and submit test reports for approval of the purchaser, before dispatch of material.
f) The entire cost of testing for acceptance & routine rests and checking of length etc shall be borne by the supplier.

g) The purchaser reserves the right to select sample from any material offered for inspection /inspected and dispatched, which will be got type tested at any NABL accredited laboratory. The results of this type-tested sample shall be applicable for the entire quantity of the particular lot offered or supplied by the supplier. The Purchaser shall bear the testing charges, if sample passes all the Tests and if sample fails in any one of the Tests, supplier shall have to bear testing charges, same are recoverable from the supplier's any pending bill, security deposit, Bank Guarantee or by any suitable means, whichever deem fit by the Purchaser. In case of sample failing in aforesaid type Tests, supplier shall have to replace the whole lot materials, which should pass through the type Tests, the re-testing charges will have to be paid by supplier. If any quantity against the particular lot is consumed by the Purchaser, the supplier will agree for any penalty/deduction in price as may be mutually agreed.

3.9. Quality Assurance Plan & Material Quality Plan

Following quality plans shall be submitted within 30 days from the date of placement of contract.

a) Quality Assurance Plan (QAP) to be adopted by manufacturer in respect of raw materials and bought out items, including source and test reports of (i) important raw materials and (ii) bought out items.
b) Material Quality Plan (MQP) to be adopted by manufacturer in respect of manufacturing process.

The QAP & MQP shall be approved by the purchaser within 15 days from the receipt of compliance, if any. The vendor shall follow the approved QAP & MQP in true spirit. If desired by the purchaser, he shall give access to all the documents and materials to satisfy the purchaser that QAP & MQP are being properly followed.

3.10. Guarantee

The equipment/material shall be guaranteed for a period of 24 months from the date of commissioning or 30 months from the date of dispatch whichever is earlier.

3.11. Packing & marking

3.11.1. Packing

All insulators shall be packed in suitable double gunny bags.

3.11.2. Marking

Each insulator shall be legibly and indelibly marked with the following.

a) Name or trademark of the manufacturer

b) Month & year of manufacture
c) ISI mark
d) UPCL

3.12. Engineering Data and Manual

Following Information Shall be furnished along with the offer.
The Bidder shall furnish detailed dimensional drawing of insulators offered showing section of the insulator to show the method of construction, length and type of threads etc.

Executive Engineer (Stores), UPCL will be the final authority for approving the drawings submitted by the tenderer.

3.13. Schedules

3.13.1. Schedule – I [Guaranteed Technical Particulars (I/II) for Item: LT Pin insulators]

(To be confirmed by the vendor)

Table 3-4: Guaranteed Technical Particulars (I/II) for Item: LT Pin insulators

S.No.	Particulars	Confirmation
1	Pin insulators shall be manufactured and supplied confirming to Type 1 of IS:1554 and UPCL specifications	
2	Insulators shall bear ISI mark	
	Material used for insulator housing shall be porcelain	
3	Colour of insulator shall be white	
4	The dimensions of the pin insulators are as per fig. 1 – type 1 of IS: 1445 – amendment no. 2 1981 (Height -100 MM, dia-70mm).	
5	Minimum failing load of pin insulator shall be 3.5 kN	
6	Wet one minute power frequency withstand voltage shall be 10 kV (rms)	
7	Dry one minute power frequency withstand voltage shall be 23 kV (rms)	
8	Wet power frequency flashover voltage shall be 10 kV (rms)	
9	Dry power frequency flashover voltage shall be 25 kV (rms)	
10	Power frequency withstand voltage kV (rms) shall be 1.3 times the actual flashover voltage	
11	Marking on insulator shall be as per specifications	

3.13.2. Schedule I [Guaranteed Technical Particulars (II/II) Item: LT Pin Insulators]

(Information not covered in IS)

Table 3-5: Guaranteed Technical Particulars (II/II) Item: LT Pin Insulators

S.No.	Item	Value
1	Weight of Pin Insulator (kg)	
2	No. of insulators per crate	
3	Packed wt. of each crate (kg)	

3.13.3. Schedule – II [Guaranteed Technical Particulars (I/II) for Item: LT Shackle insulators]

(To be confirmed by the vendor)

Table 3-6: Guaranteed Technical Particulars (I/II) for Item: LT Shackle insulators

S.No.	Particulars	Confirmation
1	Shackle insulators shall be manufactured and supplied confirming to Type 2 of IS:1554 and UPCL specifications	
2	Insulators shall bear ISI mark	
	Material used for insulator housing shall be porcelain	
3	Colour of insulator shall be white	
4	The dimensions of shackle insulator shall be as shown in fig. 4 of IS : 1445 (Type-2) (height-100mm x dia 115 mm)	
5	Minimum failing load of insulator shall be 16 kN (Type 2)	
6	Wet one minute power frequency withstand voltage shall be 10 kV (rms)	
7	Dry one minute power frequency withstand voltage shall be 23 kV (rms)	
8	Wet power frequency flashover voltage shall be 10 kV (rms)	
9	Dry power frequency flashover voltage shall be 25 kV (rms)	
10	Power frequency withstand voltage kV (rms) shall be 1.3 times the actual flashover voltage	
11	Marking on insulator shall be as per specifications	

3.13.4. Schedule II [Guaranteed Technical Particulars (II/II) Item: LT Shackle Insulators]

(Information not covered in IS)

Table 3-7: Guaranteed Technical Particulars (II/II) Item: LT Shackle Insulators

S.No.	Item	Value
1	Weight of Shackle Insulator (kg)	
2	No. of insulators per crate	
3	Packed wt. of each crate (kg)	

3.13.5. Schedule – III [Information regarding BIS license]

Table 3-8: Information regarding BIS license

S. No.	Particulars	Information
1	Name of manufacturer and address	
2	Trade mark, if any	
3	ISI license number for IS: 1445	
4	ISI license for IS: 1445 is valid up to	

3.13.6. Schedule – IV [Information regarding manufacturing and testing facilities]

(Vendor to enclose following documents and to confirm the same)

Table 3-9: Information regarding manufacturing and testing facilities

S. No.	Particulars	Confirmation
1	Type test report from NABL accredited lab (less than 5 years old as on date of opening of offer)	
2	ISI license	
3	Proof if applied for renewal of ISI license	
4	List of plant and machinery	
5	List of testing facility available	
6	List of orders pending and executed	
6 (a)	With UPCL	
6 (b)	With other agencies, other than 6(a)	

4. Technical Specification for Stay Insulators

4.1. Scope

This specification covers minimum technical requirements for design, engineering, manufacture, inspection, supply and performance of porcelain stay insulators for use on LT and HT lines.

4.2. Service Conditions

Equipment/material to be supplied against this specification shall be suitable for satisfactory continuous operation under the tropical conditions as follows:

Table 4-1: Service Conditions

S.No.	Particulars	Value
1	Maximum ambient temperature (Deg. Celsius)	50
2	Minimum temperature (Deg. Celsius)	-5
3	Relative humidity range (%)	10 to 100
4	Maximum annual rainfall (mm)	1500
5	Maximum wind pressure (kg/sq m)	195
6	Wind speed zones (m/s)	47 & 39
7	Maximum altitude above mean sea level (m)	3000
8	Isoceraunic level (days/year)	50
9	Seismic level (Horizontal acceleration) (g)	0.13

4.3. Standards

- The insulators shall comply with latest revision of the following Indian Standards (IS) unless otherwise stipulated in the specification.
- All references to Indian Standards shall be deemed to be complying with latest amendments to the respective IS, if any.

Table 4-2: References Indian Standards

Sr. No.	Standard no.	Title
1.	IS: 5300 -1969	Specifications for porcelain Insulators for overhead power lines with nominal voltage up to and including 1000V

4.4. General Technical Requirements

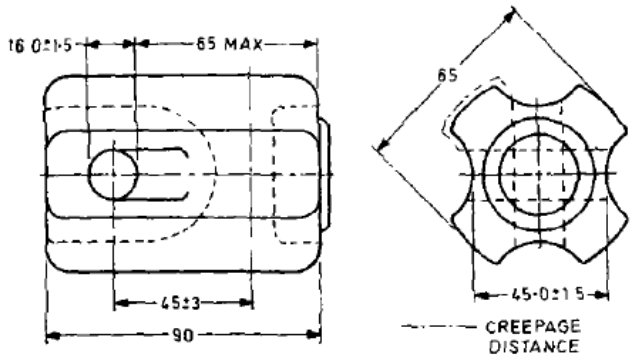
a) The porcelain shall be sound, free from defects, thoroughly vitrified and smoothly glazed.
b) The glaze, unless otherwise specified, shall be white in colour.
c) The design of the insulator shall be such that stresses due to expansion and contraction in any part of the insulator shall not lead to its deterioration.

4.4.1. System Parameters

Table 4-3: System Parameters

Nominal system voltage	33 kV	11 kV	LT
Highest system voltage	36 kV	12kV	400/230 V
System earthing	Solidly earthed system	Solidly earthed system	Solidly earthed system
Frequency (Hz)	50	50	50
Lightning Impulse withstand Voltage (kVP)	170	75	
Power frequency withstand Voltage (kV rms)	70	28	

The dimensions of the stay insulators shall be as per Fig. 1 Guy Insulator, Designation A of IS: 5300, as follows:



All dimensions in millimetres.

FIG. 1 GUY STRAIN INSULATOR, DESIGNATION A

4.4.2. Insulation Characteristics

The insulators shall have the electrical and mechanical characteristic given in the table below:

Table 4-4: Insulator's Characteristics

Type of insulator	Length (mm)	Diameter (mm)	Cable hole dia. (mm)	Min. Creepage distance (mm)	Min. Failing load (kN)	Dry one minute power frequency withstand voltage in kV(rms)	Wet one minute power frequency withstand voltage in kV(rms)
Type A	90	65	16	41	44	18	8
Type B	110	75	22	48	53	22	9
Type C	140	85	25	57	88	27	13

4.4.3. Workmanship

All the material shall be of the latest design and conform to the best modern practices adopted in the distribution voltage field. Contractors shall offer only such insulators as are guaranteed by him to be satisfactory and suitable for specified voltage level and will give continued good service.

4.4.4. Type Test Reports

Type Test Reports (less than five years old as on the due date of tender) of Tests carried out at NABL accredited laboratory along with certified drawings shall be furnished by the bidder with offer otherwise offer shall be rejected.

4.4.5. ISI Certification Mark

The insulators with ISI marking only are required against this tender specification. A copy of BIS license valid on the due date of the tender should be submitted with the offer failing which, the offer shall be rejected. The BIS (ISI) license shall be valid on the date of supply & material supplied shall have ISI marking. If the material received at site is found without ISI marking, the lot shall be rejected and no further correspondence shall be entertained in this regard.

4.5. Tests

4.5.1. Type Tests

The following shall constitute type Tests:

(a) Visual examination
(b) Verification of dimensions
(c) Dry power-frequency voltage withstand test
(d) Wet power-frequency voltage withstand test

(e) Temperature cycle test
(f) Mechanical failing load test
(g) Porosity test

4.5.2. Acceptance Tests

(a) Verification of dimensions
(b) Temperature cycle test
(c) Mechanical failing load test
(d) Porosity test

4.5.3. Routine Tests

(a) Visual Inspection
(b) Acceptance Tests: Sampling procedure, size and criteria of conformity shall be as per IS: 5300.
(c) Routine Tests: Routine Tests shall be carried out on each insulator.

4.5.4. Testing Equipment/Meter Calibration

All testing equipment / meters used shall be calibrated within valid time limit at NABL accredited laboratory. Calibration seals provided by the calibrating agency on testing equipment / meters shall be in good condition.

4.6. Pre-Delivery Inspection at Manufacturer's Works

a) All acceptance Tests shall be witnessed and certified by purchaser's representative at manufacturer's works. The vendor shall give at least 10 days advance intimation to the purchaser to enable them to depute their representative for witnessing the Tests. The said representative shall have full facilities for unrestricted inspection of supplier's works, raw materials, manufacturing processes and conducting necessary Tests.
b) The said representative shall verify the calibration seals provided by the calibrating agency on testing equipment's/ meters.
c) Test reports of routine Tests carried out by the manufacturer shall be submitted to the inspecting authority at the time of inspection for his approval.
d) Acceptance of any quantity of materials shall in no way relieve the supplier of his responsibility for meeting all requirements of the specification and shall not prevent subsequent rejection, if such materials are later found to be defective.
e) In case of waiver of inspection, vendor shall carry out all (i) routine and (ii) acceptance Tests and submit test reports for approval of the purchaser, before dispatch of material.
f) The entire cost of testing for acceptance & routine rests and checking of length etc shall be borne by the supplier.

The purchaser reserves the right to select sample from any material offered for inspection /inspected and dispatched, which will be got type tested at any NABL accredited laboratory. The results of this type-tested sample shall be applicable for the entire quantity of the particular lot offered or supplied by the supplier. The Purchaser shall bear the testing charges, if sample passes all the Tests and if sample fails in any one of the Tests, supplier shall have to bear testing charges, same are recoverable from the supplier's any pending bill, security deposit, Bank Guarantee or by any suitable means, whichever deem fit by the Purchaser. In case of sample failing in aforesaid type Tests, supplier shall have to replace the whole lot materials, which should pass through the type Tests, the re-testing charges will have to be paid by supplier. If any quantity against the particular lot is consumed by the Purchaser, the supplier will agree for any penalty/deduction in price as may be mutually agreed.

4.7. Quality Assurance Plan & Material Quality

Following quality plans shall be submitted within 30 days from the date of placement of contract.

a) Quality Assurance Plan (QAP) to be adopted by manufacturer in respect of raw materials and bought out items, including source and test reports of (i) important raw materials and (ii) bought out items.
b) Material Quality Plan (MQP) to be adopted by manufacturer in respect of manufacturing process.

The QAP & MQP shall be approved by the purchaser within 15 days from the receipt of compliance, if any. The vendor shall follow the approved QAP & MQP in true spirit. If desired by the purchaser, he shall give access to all the documents and materials to satisfy the purchaser that QAP & MQP are being properly followed.

4.8. Guarantee

The equipment/material shall be guaranteed for a period of 24 months from the date of commissioning or 30 months from the date of dispatch whichever is earlier.

4.9. Packing & Marketing

4.9.1. Packing

All insulators shall be packed in suitable double gunny bags.

4.9.2. Marking

a) Each insulator shall be legibly and indelibly marked with the following.
b) Name or trademark of the manufacturer
c) Month & year of manufacture
d) ISI mark
e) UPCL

4.10. Engineering Data and Manual

The Bidder shall furnish detailed dimensional drawing of insulators offered showing section of the insulator to show the method of construction, length and type of threads etc.

Executive Engineer (Stores), UPCL will be the final authority for approving the drawings submitted by the tenderer.

4.11. Schedules

4.11.1. Schedule – I [Guaranteed Technical Particulars (I/II): LT stay insulators (Type – B)]

(To be confirmed by the vendor)

Table 4-5: Guaranteed Technical Particulars (I/II): LT stay insulators

S.No.	Particulars	Confirmation
1	Stay insulators shall be manufactured and supplied confirming to Type A or Type- C of IS:5300 and UPCL specifications	
2	Insulators shall bear ISI mark	
	Material used for insulator housing shall be porcelain	
3	Colour of insulator shall be white	
4	The dimensions of the pin insulators are as per fig. 1 – type A of IS: 5300	
5	Minimum creepage distance shall be 48 mm	
6	Length of insulator shall be 110 mm	
7	Minimum failing load of insulator shall be 53 kN	
8	Wet one minute power frequency withstand voltage shall be 9 kV (rms)	
9	Dry one minute power frequency withstand voltage shall be 22 kV (rms)	
10	Marking on insulator shall be as per specifications	

4.11.2. Schedule I [Guaranteed Technical Particulars (II/II): LT Stay Insulators]

(Information not covered in IS)

Table 4-6: Guaranteed Technical Particulars (II/II): LT Stay Insulators

S.No.	Item	Value
1	Weight of stay Insulator (kg)	
2	No. of insulators per crate	
3	Packed wt. of each crate (kg)	

4.11.3. Schedule –II [Guaranteed Technical Particulars: LT stay insulators (Type – C)]

(To be confirmed by the vendor)

Table 4-7: Guaranteed Technical Particulars: LT stay insulators (Type – C)

S.No.	Particulars	Confirmation
1	Stay insulators shall be manufactured and supplied confirming to Type- C of IS:5300 and UPCL specifications	
2	Insulators shall bear ISI mark	
3	Material used for insulator housing shall be porcelain	
4	Colour of insulator shall be white	
5	The Dimensions Of The Pin Insulators Are As Per Fig. 3 – Type C Of Is: 5300.	
6	Length Of Insulator Shall Be 140 mm	
7	Minimum creepage distance shall be 57 mm	
8	Minimum failing load of insulator shall be 88 kN	
9	Wet one minute power frequency withstand voltage shall be 13 kV (rms)	
10	Dry one minute power frequency withstand voltage shall be 27 kV (rms)	
11	Marking on insulator shall be as per specifications	

4.11.4. Schedule II [Guaranteed Technical Particulars (II/II): LT Stay Insulators]

(Information not covered in IS)

Table 4-8: Guaranteed Technical Particulars (II/II): LT Stay Insulators

S. No.	Item	Value
1	Weight of stay Insulator (kg)	
2	No. of insulators per crate	
3	Packed wt. of each crate (kg)	

4.11.5. Schedule – III [Information regarding BIS license]

Table 4-9: Information regarding BIS license

S.No.	Particulars	Information
1	Name of manufacturer and address	
2	Trade mark, if any	
3	ISI license number for IS: 5300	
4	ISI license for IS: 5300 is valid up to	

4.11.6. Schedule – IV [Information regarding manufacturing and testing facilities]

(Vendor to enclose following documents and to confirm the same)

Table 4-10: Information regarding manufacturing and testing facilities

S. No.	Particulars	Confirmation
1	Type test report from NABL accredited lab (less than 5 years old as on date of opening of offer)	
2	ISI license	
3	Proof if applied for renewal of ISI license	
4	List of plant and machinery	
5	List of testing facility available	
6	List of orders pending and executed	
6 (a)	With UPCL	
6 (b)	With other agencies, other than 6 (a)	

5. Polymer Type (Composite) System

5.1. Scope

This specification covers the design, manufacture, testing and supply of 11kV / 33 kV Composite Insulators. The composite insulators shall be of the following type:

i. Long rod insulators for conductors in tension application at angle / cut points the insulators shall be of tongue & clevis type.
ii. Line post insulators or pin insulators for straight line locations

5.2. Service conditions

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

Table 5-1 Service Conditions

S.No.	Particulars	Value
1	Maximum ambient temperature (Deg. Celsius)	50
2	Minimum temperature (Deg. Celsius)	-5
3	Relative humidity range (%)	10 to 100
4	Maximum annual rainfall (mm)	1500
5	Maximum wind pressure (kg/sq m)	195
6	Wind speed zones (m/s)	47 & 39
7	Maximum altitude above mean sea level (m)	3000
8	Isoceraunic level (days/year)	50
9	Seismic level (Horizontal acceleration) (g)	0.13

5.3. System Particulars

a) Nominal System Voltage: 11 kV / 33 kV
b) Corresponding highest system Voltage: 12 kV / 36 kV
c) Frequency: 50 Hz with 3% tolerance
d) Number of phase: 3
e) Neutral earthing: Effectively grounded

5.4. Standards

Unless otherwise specified elsewhere in the specifications insulators shall confirm to the latest revisions of all relevant standards available at the time of placement of the order. The standards are listed in Annexure 'A'.

Table 5-2 Relevant Standards

S.no	Standard	Title	International
1	-	Definition, test methods and acceptance criteria for composite insulators for A.C. overhead lines above 1000V	IEC: 61109
2	IS: 731	Porcelain insulators for overhead power lines with a nominal voltage greater than 1000V	IEC: 60383
3	IS: 2071	Methods of High Voltage Testing	IEC: 60060-1
4	IS: 2486	Specification for Insulator fittings for Overhead power Lines with a nominal voltage greater than 1000V General Requirements and Tests Dimensional Requirements Locking Devices	IEC: 60120 IEC: 60372
5.	-	Thermal Mechanical Performance test and mechanical performance test on string insulator units	IEC: 60575
6.	IS: 13134	Guide for the selection of insulators in respect of polluted condition	IEC: 60815
7.	-	Characteristics of string insulator units of the long rod type	IEC: 60433
8.	-	Hydrophobicity Classification Guide	STRI guide 1.92/1
9.	-	Radio interference characteristics of overhead power lines and high-voltage equipment.	CISPR: 18-2 Part 2
10.	IS: 8263	Methods of RI Test of HV insulators	IEC: 60437
11.		Standard for Insulators- Composite- Distribution Dead-end Type	ANSI C29.13-2000
12.	IS: 4759	Hot dip zinc coatings on structural steel & other allied products	ISO: 1459 ISO: 1461
13.	IS: 2629	Recommended Practice for Hot, Dip Galvanization for iron and steel	ISO: 1461 (E)
14.	IS: 6745	Determination of Weight of Zinc Coating on Zinc coated iron and steel articles	ISO: 1460
15.	IS: 3203	Methods of testing of local thickness of electroplated coatings	ISO: 2173

S.no	Standard	Title	International
16.	IS: 2633	Testing of Uniformity of Coating of zinc coated articles	
17.	-	Standard specification for glass fiber strands	ASTM D 578-05
18.	-	Standard test method for compositional analysis by Thermogravimetry	ASTM E 1131-03
19.	IS:4699	Specification for refined secondary Zinc	

5.5. General Requirements

1) The Composite Insulators will be used on lines on which the conductors will be ACSR of any size up to Panther (0.2 sq. inch copper equivalent). The insulators should withstand the conductor tension, the reversible wind load as well as the high frequency vibrations due to wind.
2) Bidder must be an indigenous manufacturer and supplier of composite insulators of rating 33 kV or above OR must have proven in house technology and manufacturing process for composite insulators of above rating OR possess technical collaboration /association with a manufacturer of composite insulators of rating 33kV or above. The Bidder shall furnish necessary evidence in support of the above along with the bid, which can be in the form of certification from the utilities concerned, or any other documents to the satisfaction of the owner.
3) Insulator shall be suitable for both the suspension and strain type of load & shall be of tongue & clevis type. The diameter of Composite Insulator shall be less than 200 mm. The center-to-center distance between tongue & clevis shall be max. 300 mm for 11 kV & 550 mm for 33 kV composite Insulator.
4) Insulators shall have sheds with good self-cleaning properties. Insulator shed profile, spacing, projection etc. and selection in respect of polluted conditions shall be generally in accordance with the recommendation of IEC-60815/IS: 13134.
5) The size of Composite insulator, minimum creepage distance and mechanical strength along with hardware fittings shall be as follows:

Table 5-3 General Requirements

Sr. No.	Type of composite insulators	Nominal System voltage kV	Highest System voltage	Visible discharge test voltage	Wet Power Frequency Withstand	RImpulse Withstand voltage kV(rms	Minimum Creepage Distance (mm)	Center to center distance betwe	Min. failing load kN	Shed Diameter (mm) (\min)
i.	Long rod insulator	11	12	9	35	75	320	300	45	100
		33	36	27	75	170	900	550	70	100
ii.	Post/Pin Insulato	11	12	9	35	75	320		5	
		33	36	27	75	170	900		10	

6) Dimensional Tolerance of Composite Insulators: The tolerances on all dimensions e.g. diameter, length and creepage distance shall be allowed as follows in line with-IEC 61109:

± (0.04d+1.5) mm when d≤300mm.

± (0.025d+6) mm when d>300 mm.

Where, 'd' being the dimensions in millimeters for diameter, length or creepage distance as the case may be. However, no negative tolerance shall be applicable to creepage distance.

7) Interchangeability: The composite insulator together with the tongue & clevis fittings shall be of standard design suitable for use with the hardware of any other indigenous make conforming to relevant standards referred above.
8) Corona and RI Performance: All surfaces shall be clean, smooth, without cuts, abrasions or projections. No part shall be subjected to excessive localized pressure. The insulator and metal parts shall be so designed and manufactured that it shall avoid local corona formation and not generate any radio interference beyond specified limit under the operating conditions

5.6. General Technical Requirements:

Polymeric Insulators shall be designed to meet the high quality, safety and reliability and are capable of withstanding a wide range of environmental conditions.

Polymeric Insulators shall consist of THREE parts, at least two of which are insulating parts:-

(a) Core: the internal insulating part

(b) Housing: the external insulating part

(c) Metal end fittings.

5.6.1. Core:

It shall be a glass-fiber reinforced epoxy resin rod of high strength (FRP rod). Glass fibers and resin shall be optimized in the FRP rod. Glass fibers shall be Boron free electrically corrosion resistant (ECR) glass fiber or Boron free E-Glass and shall exhibit both high electrical integrity and high resistance to acid corrosion. The matrix of the FRP rod shall be Hydrolysis resistant. The FRP rod shall be manufactured through Pultrusion process. The FRP rod shall be void free.

5.6.2. Housing:

The FRP rod shall be covered by a seamless sheath of a silicone elastomeric compound or silicone alloy compound of a thickness of 3mm minimum. It shall be one- piece housing using Injection Molding Principle to cover the core. The elastomer housing shall be designed to provide the necessary creepage distance and protection against environmental influences. Housing shall conform to the requirements of IEC 61109/92-93 with latest amendments.

5.6.3. Weather sheds:

The composite polymer weather sheds made of a silicone elastometric compound or silicone alloy compound shall be firmly bonded to the sheath, vulcanized to the sheath or molded as part of the sheath and shall be free from imperfections It should protect the FRP rod against environmental influences, external pollution and humidity. The weather sheds should have silicon content of minimum 30% by weight. The strength of the weather shed to sheath interface shall be greater than the tearing strength of the polymer. The interface, if any, between sheds and sheath (housing) shall be free from voids.

5.6.4. Metal end Fittings

End fitting transmit the mechanical load to the core. They shall be made of spheroidal graphite cast iron, malleable cast iron or forged steel or aluminum alloy. They shall be connected to the rod by means of a controlled compression technique. Metal end fittings shall be suitable for tongue & clevis hard wares of respective specified mechanical load and shall be hot dip galvanized after, all fittings have been completed. The material used in fittings shall be corrosion resistant. As the main duty of the end fittings is the transfer of mechanical loads to the core the fittings should be properly attached to the core by a coaxial or hexagonal compression process & should not damage the individual fibers or crack the core. The gap between fitting and sheath shall be sealed by a flexible silicone elastomeric compound or silicone alloy compound sealant. System of attachment of end fitting to the rod shall provide superior sealing performance between housing, i.e. seamless sheath and metal connection. The sealing must be moisture proof. The dimensions of end fittings of insulators shall be in accordance with the standard dimensions stated in IEC: 60120/ IS: 2486 - Part-II /1989.

5.7. Workmanship

a) All the materials shall be of latest design and conform to the best engineering practices adopted in the high voltage field. Bidders shall offer only such insulators as are guaranteed by them to be satisfactory and suitable for continued good service in power transmission lines.
b) The design, manufacturing process and material control at various stages shall be such as to give maximum working load, highest mobility, best resistance to corrosion, good finish and elimination of sharp edges and corners.
c) The design of the insulators shall be such that stresses due to expansion and contraction in any part of the insulator shall not lead to deterioration.
d) The core shall be sound and free of cracks and voids that may adversely affect the insulators.
e) Weather sheds shall be uniform in quality. They shall be clean, sound, smooth and shall be free from defects and excessive flashing at parting lines.
f) End fittings shall be free from cracks, seams, shrinks, air holes and rough edges. End fittings should be effectively sealed to prevent moisture ingress; effectiveness of sealing system must be supported by test documents. All surfaces of the metal parts shall be perfectly smooth without projecting points or irregularities, which may cause corona.

g) All load bearing surfaces shall be sooth and uniform so as to distribute the loading stresses uniformly.
h) All ferrous parts shall be hot dip galvanized to give a minimum average coating of zinc equivalent to 610 gm/sq.m. or 87 microm thickness and shall be in accordance with the requirement of IS:4759. The zinc used for galvanizing shall be of purity 99.5% as per IS:4699. The zinc coating shall be uniform, adherent, smooth, reasonably bright continuous and free from imperfections such as flux, ash rust stains, bulky white deposits and blisters. The galvanized metal parts shall be guaranteed to withstand at least four successive dips each lasting for one (1) minute duration under the standard preece test. The galvanizing shall be carried out only after any machining.

5.8. Tests and Standards

Insulators offered shall be manufactured with the same configuration & raw materials as used in the insulators for which design & type test reports are submitted. The manufacturer shall submit a certificate for the same. The design & type test reports submitted shall not be more than five years old.

5.8.1. Design Tests:

For polymeric insulators it is essential to carry out design test as per clause 4.1 of IEC 61109 / 92-93 with latest amendments. The design tests are intended to verify the suitability of the design, materials and method of manufacture (technology). When a composite insulator is submitted to the design tests, the result shall be considered valid for the whole class of insulators, which are represented by the one tested and having the following characteristics:

- Same materials for the core, and sheds and same manufacturing method;
- Same material of the fittings, the same design, the same method of attachment;
- Same or greater layer thickness of the shed material over the core (including a sheath where used);
- Same or smaller ratio of the highest system voltage to insulation length;
- Same or smaller ratio of all mechanical loads to the smallest core diameter between fittings
- Same or greater diameter of the core.

The tested composite insulators shall be identified by a drawing giving all the dimensions with the manufacturing tolerances.

Manufacturer should submit test reports for Design Tests as per IEC – 61109 along with the bid. Additionally following tests shall be carried out or reports for the tests shall be submitted after award of contract:

UV test: the test shall be carried out in line with clause 7.2 of ANSI C29.13.

5.8.2. Type tests:

The type tests are intended to verify the main characteristics of a composite insulator. The type tests shall be applied to composite insulators, the class of which has passed the design tests.

Following Type test shall be conducted on a suitable number of individual insulator units, components, materials or complete strings:

Table 5-4 Tests and their Applicable standards

SI. No	Description of type test	Test procedure / standard
1	Dry lightning impulse withstand voltage test	As per IEC 61109(Clause 6.1)
2	Wet power frequency test	As per IEC 61109(Clause 6.2)
3	Mechanical load-time test	As per IEC 61109(Clause 6.4)
4	Radio interference test	As per IEC 61109(Clause 6.5) revised
5	Recovery of Hydrophobicity test	This test may be repeated every 3 years by the manufacturer
6	Chemical composition test for silicon content	Or any other test method acceptable to the owner
7	Brittle fracture resistance test	

The bidder shall submit type test reports as per IEC 61109 along with the bid. Additional type tests required if any shall be carried out by the manufacturer, after award of contract for which no additional charges shall be payable. In case, the tests have already been carried out, the manufacturer shall submit reports for the same.

5.8.3. Acceptance Tests:

The test samples after having withstood the routine test shall be subject to the following acceptance tests in order indicated below:

Table 5-5 Acceptance Tests

	Particular	Clause
(a)	Verification of dimensions	: Clause 7.2 IEC: 61109,
(b)	Verification of the locking system	: Clause 7.3 IEC: 61109, (if applicable)
(c)	Verification of tightness of the interface between end fittings & Insulator housing	: Clause 7.4 IEC: 61109 amendment 1of 1995
(d)	Verification of the specified mechanical load	: Clause 7.4 IEC: 61109, amendment 1of 1995
(e)	Galvanizing test : IS:2633/IS:6745	

5.8.4. Routine tests:

Table 5-6 Routine tests

S. No.	Description	Standard
1	Identification of marking	As per IEC: 61109 Clause 8.1
2	Visual Inspection	As per IEC: 61109 Clause 8.2
3	Mechanical routine test	As per IEC: 61109 Clause 8.3

Every polymeric insulator shall withstand mechanical routine test at ambient temperature tensile load at RTL corresponding to at least 50 % of the SML for at least 10 sec.

5.8.5. Tests during manufacture:

Following tests shall also be carried out on all components as applicable

a) Chemical analysis of zinc used for galvanizing
b) Chemical analysis, mechanical, metallographic test and magnetic particle inspection for malleable castings.
c) Chemical analysis, hardness tests and magnetic particle inspection for forgings.

5.9. Pre-Delivery Inspection at Manufacturer's Works

a) All acceptance Tests shall be witnessed and certified by purchaser's representative at manufacturer's works. The vendor shall give at least 10 days advance intimation to the purchaser to enable them to depute their representative for witnessing the Tests. The said representative shall have full facilities for unrestricted inspection of supplier's works, raw materials, manufacturing processes and conducting necessary Tests.
b) The said representative shall verify the calibration seals provided by the calibrating agency on testing equipment's/ meters.
c) Test reports of routine Tests carried out by the manufacturer shall be submitted to the inspecting authority at the time of inspection for his approval.
d) Acceptance of any quantity of materials shall in no way relieve the supplier of his responsibility for meeting all requirements of the specification and shall not prevent subsequent rejection, if such materials are later found to be defective.
e) In case of waiver of inspection, vendor shall carry out all (i) routine and (ii) acceptance Tests and submit test reports for approval of the purchaser, before dispatch of material.
f) The entire cost of testing for acceptance & routine rests and checking of length etc shall be borne by the supplier.

The purchaser reserves the right to select sample from any material offered for inspection /inspected and dispatched, which will be got type tested at any NABL accredited laboratory. The results of this type-tested sample shall be applicable for the entire quantity of the particular lot offered or supplied by the supplier. The Purchaser shall bear the testing charges, if sample passes all the Tests and if sample fails in any one of the Tests, supplier shall have to bear testing charges, same are recoverable from the supplier's any pending bill, security deposit, Bank Guarantee or by any suitable means, whichever deem fit by the Purchaser. In case of sample failing in aforesaid type Tests, supplier shall have to replace the whole lot materials, which should pass through the type Tests, the re-testing charges will have to be paid by supplier. If any quantity against the particular lot is consumed by the Purchaser, the supplier will agree for any penalty/deduction in price as may be mutually agreed.

5.10. Quality Assurance Plan & Material Quality

Following quality plans shall be submitted within 30 days from the date of placement of contract.

a) Quality Assurance Plan (QAP) to be adopted by manufacturer in respect of raw materials and bought out items, including source and test reports of (i) important raw materials and (ii) bought out items.
b) Material Quality Plan (MQP) to be adopted by manufacturer in respect of manufacturing process.

The QAP & MQP shall be approved by the purchaser within 15 days from the receipt of compliance, if any. The vendor shall follow the approved QAP & MQP in true spirit. If desired by the purchaser, he shall give access to all the documents and materials to satisfy the purchaser that QAP & MQP are being properly followed.

5.11. Guarantee

The equipment/material shall be guaranteed for a period of 24 months from the date of commissioning or 30 months from the date of dispatch whichever is earlier.

5.12. Packing & Marketing

5.12.1. Packing

All insulators shall be packed in suitable double gunny bags.

5.12.2. Marking

Each insulator shall be legibly and indelibly marked with the following.

a) Name or trademark of the manufacturer
b) Month & year of manufacture
c) ISI mark
d) UPCL

5.13. Engineering Data and Manual

The Bidder shall furnish detailed dimensional drawing of insulators offered showing section of the insulator to show the method of construction, length and type of threads etc.

Executive Engineer (Stores), UPCL will be the final authority for approving the drawings submitted by the tenderer.

5.14. Schedules

5.14.1. Schedule 1: Guaranteed Technical Parameters

Sr. No.	Parameter Name	Confirmation
1.	Type of insulator	
2.	Standard according to which the insulators manufactured and tested	
3.	Name of material used in manufacture of the insulator with class/grade	
3.1	Material of core (FRP rod) E-glass or ECR-glass Boron content	
3.2	Material of housing & weather sheds (Silicon content by weight)	
3.3	Material of end fittings	
3.4	Sealing compound for end fitting	
4.0	Color	
5.	Electrical characteristics	
5.1.	Nominal system voltage kV (rms)	
5.2	Highest system voltage kV (rms)	
5.3	Dry Power frequency withstand voltage kV (rms)	
5.4	Wet Power frequency withstand voltage kV (rms)	
5.5	Dry flashover voltage kV (rms)	
5.6	Wet flash over voltage kV (rms)	

Sr. No.	Parameter Name	Confirmation
5.7	Dry lighting impulse withstand voltage Positive kV (peak) Negative kV (peak)	
5.8	Dry lighting impulse flashover voltage Positive kV (peak) Negative kV (peak)	
5.9	RIV at 1 MHz when energized at 10 kV/ 30 kV (rms) under dry condition Micro volts	
6.0	Creepage distance (Min.) (320mm) (mm)	
6.1	Center to center distance between tongue & clevis) (300mm) (mm)	
6.2	Shed diameter (100mm) (mm)	
7.0	Mechanical characteristics: KN Minimum failing load	
8.0	Dimensions of insulator	
8.1	Weight Kg	
8.2	Dia. of FRP rod: mm	
8.3	Length of FRP rod mm	
8.4	Dia. of weather sheds (100mm) mm	
8.5	Thickness of housing mm	
8.6	Dry arc distancemm	
8.7	Dimensioned drawings of insulator (including weight with tolerances in weight) enclosed.	
9.0.	Method of fixing of sheds to housing (Specify): Single mould or Modular construction (Injection molding / compression molding)	
10.0	No of weather sheds	
11.0	Type of sheds	
11.1	Aerodynamic	
11.2	With underribs	
12.	Packing details	
12.1	Type of packing	

Sr. No.	Parameter Name	Confirmation
12.2	No. of insulators in each pack	
12.3	Gross weight of package	
13.0	Design Test Report, Type Test Report of insulator enclosed.	
14.0	Any other particulars which the bidder may like to give	

6. Technical Specification for 33 and 11 kV Surge Arresters

6.1. Scope

This specification covers minimum technical requirements for design, engineering, manufacture, inspection, supply and performance of Gap-less, metal oxide type 33 and 11 kV Surge Arresters for protection of transformers, substation equipment and overhead lines.

6.2. Services Conditions

Equipment/material to be supplied against this specification shall be suitable for satisfactory continuous operation under the tropical conditions as follows:

Table 6-1: Service Conditions

S.No.	Particulars	Value
1	Maximum ambient temperature (Deg. Celsius)	50
2	Minimum temperature (Deg. Celsius)	-5
3	Relative humidity range (%)	10 to 100
4	Maximum annual rainfall (mm)	1500
5	Maximum wind pressure (kg/sq m)	195
6	Wind speed zones (m/s)	47 & 39
7	Maximum altitude above mean sea level (m)	3000
8	Isoceraunic level (days/year)	50
9	Seismic level (Horizontal acceleration) (g)	0.13

6.3. Standards

- The insulators shall comply with latest revision of the following Indian Standards (IS) unless otherwise stipulated in the specification.
- All references to Indian Standards shall be deemed to be complying with latest amendments to the respective IS, if any.

Table 6-2: Standards

IS:3070-1993 (Part – 3)	Specification for surge arrestor for alternating current systems. Metal-Oxide lightening arresters without gaps.

IEC 60099-4	Surge Arresters
IS:5621-1980	Hollow Insulators for use in electrical equipment.
IS:2071-1993 (Part-1)	Methods of high voltage testing general definitions & test requirements
IS:2629-1985	Recommended practice for hot dip galvanizing on Iron & Steel
IS:2633-1986	Method for testing uniformity of coating of zinc Coated articles.
IS:4759-1996	Specification for hot dip zinc coating on structural Steel and other allied products.
IS:6745	Method for determination of mass of zinc coating on zinc coated iron and steel articles

6.4. General Technical Requirement

a) The metal oxide gap less Surge Arrestor shall be heavy duty station class suitable for protection of switchgear, transformers, associated equipment and lines from voltage surges resulting from natural disturbance like lightning as well as system disturbances including switching surges. They shall be single phase units suitable for outdoor duty.
b) The surge arrestor shall draw negligible current at operating voltage and at the same time offer least resistance during the flow of surge current.
c) The surge arrestor shall consist of non-linear resistor elements placed in series and housed in electrical grade porcelain housing of creepage distance of 300 mm for 11 kV and 900 mm for 33 kV. The protected creepage distance shall not be less than 50% of total creepage.
d) The assembly shall be hermetically sealed with suitable rubber gaskets with effective sealing system arrangement to prevent ingress of moisture.
e) The surge arrestor shall be provided with one line and two earth terminals of suitable size. The ground side terminal of surge arrestor shall be connected with 25x6 mm galvanized strip, one end connected to the surge arrestor and second end to a separate ground electrode. The bidder shall also recommend the procedure which shall be followed in providing the earthing / system to the Surge Arrestor.
f) The surge arrestor shall not operate under power frequency and temporary over voltage conditions but under surge conditions, the surge arrestor shall change over to the conducting mode.
g) The surge arrestor shall be suitable for circuit breaker performing O-0.3 sec. – CO - 3 min – CO - duty in the system.
h) Surge arresters shall have a suitable pressure relief system to avoid damage to the porcelain housing and providing path for flow of rated fault currents in the event of arrestor failure.
i) The reference current of the arrestor shall be high enough to eliminate the influence of grading and stray capacitance on the measured reference voltage.
j) The Surge Arrestor shall be thermally stable.
k) The arresters for shall be suitable for mounting on transformers, bus, line. The arrester shall be provided with line and earth terminals of suitable size.

l) The arrestor shall be capable of handling terminal energy for high surges, external pollution and transient over voltage and have low losses at operating voltages.

6.4.1. Arrestor Housing

a) The arrestor housing shall be made up of porcelain or polymer housing and shall be homogenous, free from laminations, cavities and other flaws of imperfections that might affect the mechanical and dielectric quality. The housing shall be of uniform brown colour (for porcelain)/grey (for polymer), free from blisters, burrs and other similar defects.
b) Arresters shall be complete with terminal connectors.
c) The housing shall be so coordinated that external flashover shall not occur due to application of any impulse or switching surge voltage up to the maximum design value for arrestor. The arresters shall not fail due to contamination. 33 kV surge arresters housing shall be designed for pressure relief class 40.
d) Surge arresters at grid substations shall be station class type and those at lines shall be of distribution class type.
e) Sealed housings shall exhibit no measurable leakage.
f) The Arrester housing shall conform to the requirements of relevant IEC specification.

6.4.2. Arrestor Mounting

The 11 kV arresters shall be suitable for mounting on 4 pole/2 pole structure used for pole/plinth mounted transformer and for incoming and outgoing lines.

The 33 kV arrester shall be suitable for mounting on a bracket on the HT side of 33/11 kV transformer or on a lattice steel supporting structure.

6.4.3. Fittings & Accessories

a) The surge arrestor shall be complete provided with fasteners for stacking units, terminal connectors.
b) The terminals shall be non-magnetic, corrosion proof, robust and of adequate size and shall be so located that incoming and outgoing connections are made with minimum possible bends. The top metal cap and base of surge arrestor shall be galvanized. The line terminal shall have a built in clamping device which can be adjusted for both horizontal and vertical take-off. It should be suitable for ACSR conductor. Conductor shall be given during detail engineering.
c) All metal parts exposed to weather and likely to be subjected to corrosion shall be hot dip galvanized as per IS: 2629. Bolts, nuts and washers shall be electro zinc plated. The conducting parts shall have adequate current density to have satisfactory performance during service life.

6.4.4. Name Plate

Each arrester shall have non-corrosive name plate, legibly and indelibly marked and securely fixed to it. They shall be provided with following information.

- Name of the manufacture

- Manufacturers trade mark
- Year of manufacturer
- Rated voltage
- Continuous operation voltage
- Normal discharge current
- Pressure relief rated current
- Property of UPCL
- Purchase order number along with date

6.4.5. Technical Particulars

The surge arresters shall conform to the following standard technical requirements. The Insulation values shall be enhanced considering the altitude of operation & other atmospheric conditions.

Table 6-3: Nominal System Voltage

Nominal system voltage	33 kV	11 kV
Highest system voltage	36 kV	12kV
System earthing	Solidly earthed system	Solidly earthed system
Frequency (Hz)	50	50
Lightning Impulse withstand Voltage (kVP)	170	75
Power frequency withstand Voltage (kV rms)	70	28
Connection to system	Phase to earth	Phase to earth

Table 6-4: Surge Arrestor

Type of Surge Arrestor	Gapless Metal oxide outdoor	Gapless Metal oxide outdoor
Arrestor rating (kV rms)	30	9
Continuous Operating voltage (kV rms)	25	7.65
Standard Nominal Discharge Current Rating (kA) (8x20 micro impulse shape)	10	10 for station class 5 for distribution class
Line discharge class	2	2
Degree of protection	IP-55	IP -55
Lightning Impulse at 10 kA	85	40
Partial discharge at 1.05 COV not greater than	50 (PC)	
Energy capability corresponding to		
a) Arrestor rating (kj/kV)	4.5	4
b) COV (kJ/kV)	4.9	4.9
Peak current for high current impulse operating duty of arrestor classification 10 kA	100	100

Table 6-5: Insulator Housing

Power frequency withstand test voltage (wet) (kV rms)	70	28
Lightning impulse withstand/Tests voltage (kVP)	170	75
Pressure Relief Class	40	40
Creepage distance not less than	900 mm	300

Table 6-6: Galvanisation

Fabricated Steel Articles	
-- 5 mm thick cover	610 g/m2
-- Under 5 mm but not less than 2 mm thickness	460 g/m2
-- Under 2 mm but not less than 1.2 mm thickness	340 g/m2
Castings	
-- Grey Iron, malleable iron	610 g/m2
Threaded works other than tubes & tube fittings	
-- Under 10 mm dia.	270 g/m2
-- 10 mm dia. & above	300 g/m2

6.4.6. Type Test Reports

Type Test Reports (less than five years old as on the due date of tender) of Tests carried out at NABL accredited laboratory along with certified drawings shall be furnished by the bidder with offer otherwise offer shall be rejected.

6.5. Tests

6.5.1. Type Tests

Following shall be type test as per IS 3070 (Part 3): 1993 or its latest amendment.

1) Insulation Withstand test
   a) Lightning Impulse
   b) Power Frequency (Dry/Wet)
2) Residual Voltage Test
   a) Steep current impulse residual voltage test
   b) Lightning impulse residual voltage test
   c) Switching Impulse Residual voltage test
3) Long duration current impulse withstand test

4) Switching surge operating duty test
5) Power frequency voltage Vs. Time characteristics
6) Reference voltage test
7) Accelerated Ageing test
8) Pressure relief test
   a) High Current
   b) Low Current
9) Artificial pollution test (for porcelain housing)
10) Seismic Test
11) Partial Discharge test
12) Bending test
   a) Temperature cycle test (for porcelain housing)
   b) Porosity test (for porcelain housing)
13) Galvanizing test on metal parts
14) Seal Leakage test (for porcelain housing)
15) Seal leak test and operation Tests (for surge monitor)
16) Weather ageing test (for polymer housing)

6.5.2. Acceptance Tests

a. Measurement of power frequency reference voltage of arrester units.
b. Lightning impulse residual voltage on arrester units (IEC clause 6.3.2)
c. Internal ionization or partial discharge test

6.5.3. Special Acceptance Tests

a. Thermal stability test (IEC 99-4clause 7.2.2)
b. Watt loss test.

6.5.4. Routine Tests

a. Measurement of reference voltage
b. Residual voltage test of arrester unit
c. Internal ionization or partial discharge test
d. Sealing test

All Ferrous parts exposed to atmospheric condition shall have passed the type Tests and be subjected to routine and acceptance Tests in accordance with IS:2633 & IS 6745.

Acceptance Tests: Sampling procedure, size and criteria of conformity shall be as per IS: 731-1971.

Routine Tests: Routine Tests shall be carried out on each insulator.

6.5.5. Testing Equipment/Meter Calibration

All testing equipment / meters used shall be calibrated within valid time limit at NABL accredited laboratory. Calibration seals provided by the calibrating agency on testing equipment / meters shall be in good condition.

6.6. Pre-Delivery Inspection at Manufacturer's Works

a) All acceptance Tests shall be witnessed and certified by purchaser's representative at manufacturer's works. The vendor shall give at least 10 days advance intimation to the purchaser to enable them to depute their representative for witnessing the Tests. The said representative shall have full facilities for unrestricted inspection of supplier's works, raw materials, manufacturing processes and conducting necessary Tests.
b) The said representative shall verify the calibration seals provided by the calibrating agency on testing equipment/ meters.
c) Test reports of routine Tests carried out by the manufacturer shall be submitted to the inspecting authority at the time of inspection for his approval.
d) Acceptance of any quantity of materials shall in no way relieve the supplier of his responsibility for meeting all requirements of the specification and shall not prevent subsequent rejection, if such materials are later found to be defective.
e) In case of waiver of inspection, vendor shall carry out all (i) routine and (ii) acceptance Tests and submit test reports for approval of the purchaser, before dispatch of material.
f) The entire cost of testing for acceptance & routine rests and checking of length etc. shall be borne by the supplier.

The purchaser reserves the right to select sample from any material offered for inspection /inspected and dispatched, which will be got type tested at any NABL accredited laboratory. The results of this type-tested sample shall be applicable for the entire quantity of the particular lot offered or supplied by the supplier. The Purchaser shall bear the testing charges, if sample passes all the Tests and if sample fails in any one of the Tests, supplier shall have to bear testing charges, same are recoverable from the supplier's any pending bill, security deposit, Bank Guarantee or by any suitable means, whichever deem fit by the Purchaser. In case of sample failing in aforesaid type Tests, supplier shall have to replace the whole lot materials, which should pass through the type Tests, the re-testing charges will have to be paid by supplier. If any quantity against the particular lot is consumed by the Purchaser, the supplier will agree for any penalty/deduction in price as may be mutually agreed.

6.7. Quality Assurance & Material Quality Plan

Following quality plans shall be submitted within 30 days from the date of placement of contract:

a) Quality Assurance Plan (QAP) to be adopted by manufacturer in respect of raw materials and bought out items, including source and test reports of (i) important raw materials and (ii) bought out items.
b) Material Quality Plan (MQP) to be adopted by manufacturer in respect of manufacturing process.

The QAP & MQP shall be approved by the purchaser within 15 days from the receipt of compliance, if any. The vendor shall follow the approved QAP & MQP in true spirit. If desired by the purchaser, he shall give access to all the documents and materials to satisfy the purchaser that QAP & MQP are being properly followed.

6.8. Guarantee

The equipment/material shall be guaranteed for a period of 24 months from the date of commissioning or 30 months from the date of dispatch whichever is earlier.

6.9. Packing & Marketing

a) All surge arresters shall be packed in strong seasoned wooden crates. The gross weight of the crates along with the material shall not normally exceed 200 kg to avoid handling problem.
b) The packing shall be of sufficient strength to withstand rough handling during transit, storage at site and subsequent handling in the field.
c) Suitable cushioning, protective padding or spacers shall be provided to prevent damage or deformation during transit and handling.
d) All packing cases shall be marked legibly and correctly so as to ensure safe arrival at their destination and to avoid the possibility of goods being lost or wrongly dispatched on account of faulty packing and faulty or illegible markings. Each wooden case/crate shall have all the markings stenciled on it in indelible ink.

6.10. Engineering Data and Manual

The Bidder shall furnish catalogues, literature and detailed dimensional, assembly drawing, name plate, clearances, PRD, creepage distance, weights of surge arresters and accessories.

Executive Engineer (Stores), UPCL will be the final authority for approving the drawings submitted by the tenderer.

6.11. Schedules

6.11.1. Schedule – I [Guaranteed Technical Particulars (I/II): 33 kV Surge Arresters]

(To be confirmed by the vendor)

Table 6-7: Guaranteed Technical Particulars (I/II): 33 kV Surge Arresters

S.No.	Particulars	Confirmation
1	Disc insulators shall be manufactured and supplied confirming to IS:3070 and UPCL specifications	
2	Type of surge arrester shall be Gapless Metal oxide type.	
3	Material used for insulator housing shall be porcelain	
4	Colour of insulator shall be brown	
5	Rated voltage shall be 30 kV	
6	Rated maximum continuous nominal system voltage shall be 33 kV	
7	Nominal discharge current (8/20 micro impulse wave) shall be 10 kA	
8	Long duration discharge class shall be – class -III	
9	Energy capability corresponding to arrester rating shall be 4.5 kJ/kV	
10	Energy capability corresponding to COV shall be 4.9 kJ/kV	
11	Peak current for high current operating duty shall be 100 kA	
12	Wet power frequency withstand voltage shall be 70 kV	
13	Lightning impulse withstand voltage shall be 170 kVP	
14	Pressure relief class shall be 40	
15	Creepage distance shall not be less than 900 mm	
16	Galvanization Tests shall confirm to IS: 2633 and IS:6475	

6.11.2. Schedule I [Guaranteed Technical Particulars (II/II): 33 kV Surge Arrester]

(Information not covered in IS)

Table 6-8: Guaranteed Technical Particulars (II/II): 33 kV Surge Arrester

S.No.	Item	Value
1	Model no. if any	
2	Weight of surge arrester (complete unit) (kg)	

S.No.	Item	Value
3	No. of arresters per crate	
4	Packed wt. of each crate (kg)	

6.11.3. Schedule – II [Guaranteed Technical Particulars (I/II): 11 kV Surge Arresters]

(To be confirmed by the vendor)

Table 6-9: Guaranteed Technical Particulars (I/II): 11 kV Surge Arresters

S.No.	Particulars	Confirmation
1	Disc insulators shall be manufactured and supplied confirming to IS:3070 and UPCL specifications	
2	Type of surge arrester shall be Gapless Metal oxide type.	
3	Material used for insulator housing shall be porcelain	
4	Colour of insulator shall be brown	
5	Rated voltage shall be 9 kV	
6	Rated maximum continuous nominal system voltage shall be 11 kV	
7	Nominal discharge current (8/20 micro impulse wave) shall be 10 kA	
8	Long duration discharge class shall be – class -III	
9	Energy capability corresponding to arrester rating shall be 4.0 kJ/kV	
10	Energy capability corresponding to COV shall be 4.9 kJ/kV	
11	Peak current for high current operating duty shall be 100 kA	
12	Wet power frequency withstand voltage shall be 28 kV	
13	Lightning impulse withstand voltage shall be 75 kVP	
14	Pressure relief class shall be 40	
15	Creepage distance shall not be less than 300 mm	
16	Galvanization Tests shall confirm to IS: 2633 and IS:6475	
17	Degree of protection shall be IP 55	

6.11.4. Schedule II [Guaranteed Technical Particulars (II/II): 11 kV Surge Arrester]

(Information not covered in IS)

Table 6-10: Guaranteed Technical Particulars (II/II): 11 kV Surge Arrester

S.No.	Item	Value
1	Model no. if any	
2	Weight of surge arrester (complete unit) (kg)	
3	No. of arresters per crate	
4	Packed wt. of each crate (kg)	

6.11.5. Schedule – III [Information regarding BIS license]

Table 6-11: Information regarding BIS license

S.No.	Particulars	Information
1	Name of manufacturer and address	
2	Trade mark, if any	

6.11.6. Schedule – IV [Information regarding manufacturing and testing facilities]

(Vendor to enclose following documents and to confirm the same)

Table 6-12: Information regarding manufacturing and testing facilities

S.No.	Particulars	Confirmation
1	Type test report from NABL accredited lab (less than 5 years old as on date of opening of offer)	
2	List of plant and machinery	
3	List of testing facility available	
4	List of orders pending and executed	
4 (a)	With UPCL	
4 (b)	With other agencies, other than 4 (a)	

7.Technical Specification for ACSR Conductors

7.1. Scope

This specification covers minimum technical requirements for design, engineering, manufacture, inspection, supply and performance of ACSR conductors. Following sizes of conductors used for overhead power distribution lines are covered here.

- ***ACSR - 20 sq mm, 30 sq mm, 50 sq mm, 80 sq mm, 100 sq mm and 150 sq mm***

7.2. Service Conditions

Equipment/material to be supplied against this specification shall be suitable for satisfactory continuous operation under the tropical conditions as follows:

Table 7-1: Service Conditions

S.No.	Particulars	Value
1	Maximum ambient temperature (Deg. Celsius)	50
2	Minimum temperature (Deg. Celsius)	-5
3	Relative humidity range (%)	10 to 100
4	Maximum annual rainfall (mm)	1500
5	Maximum wind pressure (kg/sq m)	195
6	Wind speed zones (m/s)	47 & 39
7	Maximum altitude above mean sea level (m)	3000
8	Isoceraunic level (days/year)	50
9	Seismic level (Horizontal acceleration) (g)	0.13

7.3. Standards

The conductors shall comply with latest revision of the following Indian Standards unless otherwise stipulated in the specification.

All references to Indian Standards shall be deemed to be complying with latest amendments to the respective IS, if any.

Table 7-2: Standards

S.No.	Indian Standard	Title
1	IS : 398 Part – I	Specification for Aluminum conductors for overhead transmission purposes
2	IS:398 Part-II	Specification for Aluminium conductor galvanized-steel reinforced for overhead transmission purposes
3	IS : 209	Specification for zinc
4	IS : 1778	Reels and drums for bare conductors
5	IS : 1521	Method of tensile testing of Steel wire
6	IS : 2629	Recommended practice for hot dip galvanizing of Iron and Steel
7	IS : 2633	Method of testing uniformity of coating on Zinc coated articles
8	IS : 4826	Galvanized coating on round Steel wires
9	IS : 6745	Methods of determination of mass of Zinc coating of Zinc coated Iron and Steel articles.
10	IS : 9997	Aluminium Alloy redraw rods
11	IS : 5484-1978	EC Grade Aluminium Rods produced by continuous casting and rolling

7.4. General Technical Requirements

7.4.1. Sizes and Properties

The sizes and properties of Steel core Aluminum conductors shall be as under:

Table 7-3: ACSR Conductors Technical Requirements

Nominal Aluminium area (Code)	Stranding & wire diameter		Sectional area of Aluminium	Total sectional area	Approx. overall diameter	Approx. mass	Calculated D.C. Resistance at 20^0 C max.	Approx. calculate breaking load
	Aluminium	Steel						
1	2	3	4	5	6	7	8	9
mm sq	Mm	mm	mm sq	mm sq	mm	kg/km	Ohm/km	kN
20(Squirrel)	6/2.11	1/2.11	20.98	24.48	6.33	85	1.394	7.61
30(Weasel)	6/2.59	1/2.59	31.61	36.88	7.77	128	0.9289	11.12

Nominal Aluminium area (Code)	Stranding & wire diameter		Sectional area of Aluminium	Total sectional area	Approx. overall diameter	Approx. mass	Calculated D.C. Resistance at 20^0 C max.	Approx. calculate breaking load
	Aluminium	Steel						
50(Rabbit)	6/3.35	1/3.35	52.88	61.7	10.05	214	0.5524	18.25
80(Raccoon)	6/4.09	1/4.09	78.83	91.97	12.27	319	0.3712	26.91
100(Dog)	6/4.72	7/1.57	105	118.5	14.15	394	0.2792	32.41
150(Wolf)	30/2.59	7/2.59	158.1	194.9	18.13	726	0.1871	67.34
200 (Panther)	30/3.00	7/3.00	212.1	261.5	21.00	974	0.139	89.67
250 (Bear)	30/3.35	7/3.35	264.4	326.1	23.45	1213	0.1093	111.2
400 (Zebra)	54/3.18	7/3.18	428.9	484.5	28.62	1621	0.0674	131.9

Note: sectional area is the sum of cross sectional area of the relevant individual wires.

7.4.2. Aluminum Wires

The Aluminum strands shall be hard drawn from electrolytic Aluminum rods of EC grade having purity not less than 99.5% and a copper content not exceeds 0.04%. They shall have the same properties and characteristics as prescribed in IEC: 889-1987.The properties and manufacturing tolerances of Aluminum wires to be used in the construction of the stranded conductors shall be as under:

Table 7-4: Solid Aluminium Wires Used In the Construction of Stranded ACSR Conductors

Diameter			Cross sectional area of nominal diameter wire	Mass	Resistance at 200 C	Breaking load min.	
Nominal	Min.	Max.				Before stranding	After stranding
1	2	3	4	5	6	7	8
mm	Mm	mm	mm sq	kg/km	Ohm/km	kN	kN
2.11	2.09	2.13	3.497	9.45	8.237	0.63	0.6
2.59	2.56	2.62	5.269	14.24	5.49	0.89	0.85
3.00	2.97	3.03	7.069	19.11	4.079	1.17	1.11
3.35	3.32	3.38	8.814	23.82	3.265	1.43	1.36

Diameter			Cross sectional area of nominal diameter wire	Mass	Resistance at 200 C	Breaking load min.	
Nominal	Min.	Max.				Before stranding	After stranding
4.09	4.05	4.13	13.14	35.51	2.194	2.08	1.98

Note: The resistance has been calculated from the maximum value of resistivity and the cross sectional area based on the minimum diameter.

7.4.3. Steel Wires

The steel wire strands shall be drawn from high carbon steel wire rods produced by either the acid or the basic open-hearth process, or the electric furnace process, or the basic oxygen process and shall conform to the following requirements as to the chemical composition as prescribed in IS 398 (Pt. II) – 1996.

Table 7-5: Chemical Composition of Steel wire strands

Element	% Composition
Carbon	0.50 to 0.85
Manganese	0.50 to 1.10
Phosphorous	Not more than 0.035
Sulphur	Not more than 0.045
Silicon	0.35

The properties and manufacturing tolerances of steel wires to be used in the construction of the stranded ACSR conductors shall be as under.

Table 7-6: Solid Steel Wires Used In the Construction of Stranded ACSR Conductors

Diameter			Cross sectional area of nominal diameter wire	Mass	Breaking load min.	
Nominal	Min.	Max.			Before stranding	After stranding
1	2	3	4	5	6	7
Mm	mm	mm	mm sq	kg/km	kN	kN
1.57	1.54	1.60	1.936	15.10	2.70	2.57
2.11	2.07	2.15	3.497	27.27	4.60	4.37
2.59	2.54	2.64	5.269	41.09	6.92	6.57
3.35	3.28	3.42	8.814	68.75	11.58	11.00

Diameter			Cross sectional area of nominal diameter wire	Mass	Breaking load min.	
Nominal	Min.	Max.			Before stranding	After stranding
4.09	4.01	417	13.140	102.48	17.27	16.40

The coating of the galvanized steel wires may be applied by the hot dip galvanized process.

Zinc coating shall confirm to mass of zinc coating and uniformity of zinc coating parameters for heavily coated hard wire in accordance with latest amendment of IS :4826-1979, as follows:

Table 7-7: Zinc coating Specifications

S.No.	Steel wire nominal dia. (mm)	Zinc coating after stranding (g/m2)	Minimum no. of dips that the galv. strand can withstand in the standard pressure test (Nos.)
1	1.57	190	2 of 1 minute
2	2.11	210	2 of 1 minute
3	2.59	230	2 of 1 minute and 1 of half minute
4	3.35	250	3 of 1 minute
5	4.09	275	3 of 1 minute and 1 of half minute

The conductor shall meet or exceed the requirements of this specification in all respects.

7.4.4. Workmanship

All Aluminium and steel 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.

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, material inclusions, white rust, powder formation or black spot (on account of reaction with trapped rain water etc.), dirt, grit etc.

The zinc coating shall be smooth, continuous, of uniform thickness, free from imperfections. The steel wire rods shall be of such quality and purity that, when drawn to the size of the strands specified and coated with zinc, the finished strands and the individual wires shall be of uniform quality and have the same properties and characteristics as required in the specification.

The steel strands shall be pre-formed and post formed in order to prevent spreading of strands in the event of cutting of composite core wire. Care shall be taken to avoid, damages to galvanization during pre-forming and post-forming operation.

7.4.5. Joints in Wires

Joint in any wire shall not be permitted in any wire of stranded conductor containing seven wires.

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.

No joint shall be permitted in the individual Aluminum wires in the outer most layer of the finished conductor.

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

Wires shall be smooth and free form all imperfections, such as spills & splits.

7.4.6. Stranding

The wires used in construction of stranded conductors shall, before stranding, satisfy all relevant requirements of IS: 398/ 1976 (Part-I & II).

In all constructions, the successive layers shall have opposite directions of lay and the outer most layers being right handed. The wires in each layer shall be evenly and closely stranded.

In conductor having multiple layers of Aluminum wires, the lay ratio of any Aluminum layers shall be not greater than the lay ratio of the Aluminum layer immediately beneath it.

7.4.7. Lay Ratio

The lay ratio (ratio of the aerial length of a complete turn of the helix formed by an individual wire in a stranded conductor to the external diameter of the helix) shall be within the limits given below:

Table 7-8: Lay ratio for ACSR conductors

No. of wires		Lay ratio for steel core		Lay ratio for outside core		Aluminium wires inner most layer	
Al.	Steel	Max.	Min.	Max.	Min.	Max.	Min.
6	1	-	-	14	10	-	-
6	7	28	13	14	10	-	-
30	7	28	13	14	10	16	10
54	7	28	13	14	10	17	10

Note: For the purpose of calculation, the mean lay ratio shall be taken as the arithmetic mean of the relevant minimum and maximum values given in this table

7.4.8. Gross Mass

The gross mass per conductor drum for various conductors shall not exceed by more than 10% of the values given in the following table:

Table 7-9: Gross Mass per conductor drum

ACSR conductor size / Standard / dia. (mm)	Gross Mass (kg)
20mm2 Al. area (7/2.11mm)	1000
30mm2 Al. area (7/2.59 mm)	1000
50mm2 Al. area (7/3.35mm)	1500
80mm2 Al. area (7/4.09 mm)	1500
100mm2 Al. area (6/4.72mm + 7/1.57mm)	2000

7.4.9. Standard Length

a) The standard lengths shall be as follows:
   - ACSR conductor (up to 50 sq mm) 2 km
   - ACSR conductor (80 sq mm and above) 1.5 km

b) Short length shall not be less than 80% of the standard length specified as above, up to 10 % of ordered quantity.

c) Tolerance in standard length shall be +/- 5 %.

7.4.10. ISI Certification mark

Material with ISI marking only is required against this tender specification. A copy of BIS license valid on the due date of the tender should be submitted with the offer failing which, the offer shall be rejected.

The BIS (ISI) license shall be valid on the date of supply & material supplied shall have ISI marking. If the material received at site is found without ISI marking, the lot shall be rejected.

7.5. Tests

7.5.1. Type Tests

Type Test Reports (less than five years old as on due date of tender) of Tests carried out on conductors at NABL accredited laboratory shall be furnished by the bidder along with offer otherwise offer shall be rejected.

Following shall constitute Type Tests:

- Visual examination
- Measurement of diameters of individual Aluminium and steel wires
- Measurement of lay ratio of each layer
- Breaking load test

- Ductility tests (i)Torsion Test (ii) Elongation Test
- Wrapping test
- Resistance test on Aluminium wires
- Galvanizing test
- Surface condition test (applicable to conductors of nominal Aluminium area 100 sq mm and above)
- Stress Strain test (applicable to conductors of nominal Aluminium area 100 sq mm and above)
- 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.

7.5.2. Acceptance Tests and Routine Tests

- Visual and dimensional check on drum and conductor
- Visual Examination
- Measurement of diameters of individual Aluminium and steel wires
- Measurement of lay ratio of each layer
- Breaking load test
- Ductility test (i) Torsion Test (ii) Elongation Test
- Wrapping test
- Resistance test on Aluminium wires
- Galvanizing test
- DC resistance Test on composite conductor.

Procedure for conducting Tests on conductors shall be as per applicable IS.

7.5.3. Breaking load test

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.

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.

7.5.4. Ductility Test

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

7.5.5. 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.

7.5.6. 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 or 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.

7.5.7. Wrapping Test

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

7.5.8. 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.

7.5.9. 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.

7.5.10. 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.

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

Where, R20 = Resistance corrected at 20 degrees C.

R_T = Resistance measured at T degrees C.

α = 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 section-II.

7.5.11. 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.

7.5.12. 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.

7.5.13. 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.

7.5.14. Selection of samples

- Acceptance Tests: Samples taken after stranding 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.
- Routine Tests: Routine tests shall be same as acceptance test and shall be carried out on each coil.

7.5.15. Testing equipment/meter calibration:

All testing equipment/ meter used shall be calibrated within valid time limit at NABL accredited lab. Seals provided by Calibrating agency on testing equipment's/meters shall be in good condition.

7.6. Pre-Delivery Inspection at Manufacturer's Works

7.6.1. Inspection

a) All acceptance Tests, length and mass verification etc. shall be witnessed and certified by purchaser's representative at manufacturer's works. The vendor shall give at least 10 days advance intimation to the purchaser to enable them to depute their representative for witnessing the Tests. The said representative shall have full facilities for unrestricted inspection of supplier's works, raw materials, manufacturing processes and conducting necessary Tests.
b) The said representative shall verify the calibration seals provided by the calibrating agency on testing equipment's/ meters.
c) Test reports of routine Tests carried out by the manufacturer shall be submitted to the inspecting authority at the time of inspection for his approval.
d) Acceptance of any quantity of materials shall in no way relieve the supplier of his responsibility for meeting all requirements of the specification and shall not prevent subsequent rejection, if such materials are later found to be defective.
e) In case of waiver of inspection, vendor shall carry out all (i) routine and (ii) acceptance Tests and submit test reports for approval of the purchaser, before dispatch of material.
f) The entire cost of testing for acceptance & routine rests and checking of length etc. shall be borne by the supplier.
g) The purchaser reserves the right to select sample from any material offered for inspection /inspected and dispatched, which will be got type tested at any NABL accredited laboratory. The results of this type-tested sample shall be applicable for the entire quantity of the particular lot offered or supplied by the supplier. The Purchaser shall bear the testing charges, if sample passes all the Tests and if sample fails in any one of the Tests, supplier shall have to bear testing charges, same are recoverable from the supplier's any pending bill, security deposit, Bank Guarantee or by any suitable means, whichever deem fit by the Purchaser. In case of sample failing in aforesaid type Tests, supplier shall have to replace the whole lot materials, which should pass through the type Tests, the re-testing

charges will have to be paid by supplier. If any quantity against the particular lot is consumed by the Purchaser, the supplier will agree for any penalty/deduction in price as may be mutually agreed.

7.6.2. Verification of Length & Mass

Out of each lot offered for testing, maximum number of drums to the extent of 10% shall be rewound for checking the surface of conductor, declared length and mass of conductor in drum. Mass with and without conductor of sample drum shall be checked before and after length measurement respectively. Values so obtained shall be checked with the declared values. In case, any excess length that mentioned in offered packing list is found in drum during length checking, no benefit shall be given to the manufacturer for the same. However, in case any shortage of conductor is found in one or more drums, the maximum value of each shortage, in percent(s) shall be deducted from all the drums offered for inspection.

The supplier should ensure that length measuring machine is available for measurement of the length by the inspecting officer.

Both ends of the ACSR conductor may be sealed by supplier and the seals shall be contained in the drum and not exposed out of drum. The declared length shall be measured between manufacturer's seals at both ends of ACSR conductor.

7.7. Quality Assurance Plan & Material Quality Plan:

Following quality plans shall be submitted within 30 days from the date of placement of contract:

- Quality Assurance Plan (QAP) to be adopted by manufacturer in respect of raw materials and bought out items, including source and test reports of (i) important raw materials and (ii) bought out items.
- Material Quality Plan (MQP) to be adopted by manufacturer in respect of manufacturing process.

The QAP & MQP shall be approved by the purchaser within 15 days from the receipt of compliance, if any. The vendor shall follow the approved QAP & MQP in true spirit. If desired by the purchaser, he shall give access to all the documents and materials to satisfy the purchaser that QAP & MQP are being properly followed.

7.8. Guarantee

The equipment/material shall be guaranteed for a period of 24 months from the date of commissioning or 30 months from the date of dispatch whichever is earlier.

7.9. Packing & Marking

7.9.1. Packing

The conductor shall be supplied in strong, non-returnable, wooden drums provided with lagging of adequate strength. Drums shall be constructed to protect the conductor against any damage and displacement during transit, storage and subsequent handling and stringing operations in the field. The vendor 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, except as otherwise specified hereinafter.

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.

More than two lengths in one conductor drum shall not be accepted.

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.

Before reeling, card board or double corrugated or thick bituminized water-proof bamboo paper 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. Medium grade craft paper shall be used in between the layers of the conductor. After reeling the conductor, the exposed surface of the outer layer of conductor shall be wrapped with water proof thick bituminized bamboo paper to preserve the conductor from dirt, grit and damage during transport and handling.

A minimum space of 75 mm for conductor shall be provided between the inner surface of the external protective tagging and outer layer of the conductor.

As an alternative to wooden drum Vendor may also supply the conductors in 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 shall be treated at par for evaluation purpose and the vendor should quote accordingly.

7.9.2. Marking

Each drum shall have the following information stenciled on it, in indelible ink.

- Contract no.
- Specification number
- Name and address of the consignee
- Manufacturer's name or trade mark
- Lot & Drum number
- Code name and size of the conductor
- Length of the conductor
- Gross mass of the drum
- Mass of empty drum

- Net mass of the conductor
- Arrow marking for unwinding
- Position of the conductor end
- ISI mark
- Identification mark 'Property of UPCL'

7.10. Rejection and Retests

Rejection and retests shall be as per the provisions of relevant Indian Standard.

7.11. Schedule

7.11.1. Schedule – I [Guaranteed Technical Particulars (I/II) for ACSR Conductor]

(To be confirmed by the vendor)

Table 7-10: Schedule I

S.No.	Particulars			Confirmation
1	ACSR conductor shall be manufactured and supplied confirming to IS:398 Part-II and UPCL specifications			
2	Conductor drum shall bear ISI mark			
3	ACSR conductor confirms to size –			
	Nominal Area(sq mm)	Al.Strand (No./Dia. mm)	St. Strand (No./ Dia. mm)	
	20	6 / 2.21	1 / 2.21	
	30	6 / 2.59	1 / 2.59	
	50	6 / 3.35	1 /3.35	
	80	6/4.09	1 /4. 09	
	100	6/4.72	7 / 1.57	
	150	30/2.59	7/2.59	
4	Whether following parameters confirm to IS 398 (Part II)			
	Minimum breaking load of Aluminium wire, after stranding (kN)			
	Minimum breaking load of Steel wire (kN)			
	Minimum breaking load of completed conductor (kN)			
	Mass of conductor (kg / km)			
	Resistance of Al. wire at 20^0 C (ohm/km)			

S.No.	Particulars	Confirmation
	Resistance of conductor at 200 C(ohm/km)	
	Modulus of elasticity of conductor (GN/m2)	
	Co-efficient of linear expansion (per degree c)	
5	Uniformity of galvanizing and mass of Zinc coating confirms to Tests as per IS : 4826/1979	
6	Standard length of conductor shall be as per this specification	
7	Non-standard length shall not be less than 80 %, up to 10% of ordered quantity	
8	Wooden packing drums shall confirm to IS:1778	
9	Wooden drums shall have markings as per this specification	

7.11.2. Schedule- II [Guaranteed Technical Particulars (II/II) for ACSR Conductor]

(Items not covered in IS)

Table 7-11: Schedule II

S.No.	Item	20 Sq. mm	30 Sq. mm	50 Sq. mm	80 Sq. mm	100 Sq. mm	150 Sq. mm	200 Sq. mm	250 Sq. mm	400 Sq. mm
1	Continuous current rating of conductor at 75^0 C temperature (Amp)									
2	Approx. gross mass of the drum including mass of the conductor (kg)									

7.11.3. Schedule – III [Information regarding BIS license]

Table 7-12: Schedule III

S.No.	Particulars	Data
1	Name of manufacturer and address	
2	Trade mark, if any	
3	ISI license no. for product manufactured as per IS: 398 Part 2	

S.No.	Particulars	Data
4	Validity of ISI license (date)	

7.11.4. Schedule – IV [Information regarding manufacturing and testing facilities]

(Vendor to enclose following documents and to confirm the same)

Table 7-13: Schedule IV

S. No.	Particulars	Confirmation
1	Type test report from NABL accredited lab (less than 5 years old as on due date of tender)	
2	ISI license	
3	Proof if applied for renewal of ISI license	
4	List of plant and machinery	
5	List of testing facility available	
6	List of orders pending and executed	
A	With UPCL	
B	With other agencies, other than 6-A	

8. Technical Specification of 33/11Kv, 8 MVA, ONAN Power Transformer

8.1. Scope

This specification covers design, engineering, manufacture, assembly, testing, inspection before dispatch, forwarding, packing, transportation to site of three phase, 50 Hz, 8 MVA 33/11kV step-down outdoor ONAN Power Transformers complete with all accessories/fittings and spare parts as specified herein, for use in sub-stations in Uttarakhand state.

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 purchaser 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.

It is not the intent to specify herein complete details of design and construction. The equipment offered shall conform to the relevant standards and be of high quality, sturdy, robust and of good design and workmanship complete in all respects and capable to perform continuous and satisfactory operations in the actual service conditions at site and shall have sufficiently long life in service as per statutory requirements. In actual practice, notwithstanding any anomalies, discrepancies, omissions, incompleteness, etc. in these specifications and attached drawings, the design and constructional aspects, including materials and dimensions, will be subject to good engineering practice in conformity with the required quality of the product, and to such tolerances, allowances and requirements for clearances etc. as are necessary by virtue of various stipulations in that respect in the relevant Indian Standards, IEC standards, CEA Regulations , Electricity Act and other statutory provisions.

8.2. Service Condition

Equipment/material to be supplied against this specification shall be suitable for satisfactory continuous operation under the tropical conditions as follows:

Table 8-1: Service Conditions

S.No.	Particulars	Value
1	Maximum ambient temperature (Deg. Celsius)	50
2	Minimum temperature (Deg. Celsius)	-5
3	Relative humidity range (%)	10 to 100
4	Maximum annual rainfall (mm)	1500
5	Maximum wind pressure (kg/sq m)	195

S.No.	Particulars	Value
6	Maximum altitude above mean sea level (m)	3000
7	Isoceraunic level (days/year)	50
8	Seismic level (Horizontal acceleration) (g)	0.13

8.3. Standards

The equipment shall comply with latest revision of the following Indian Standards (IS) unless otherwise stipulated in the specification.

All references to Indian Standards shall be deemed to be complying with latest amendments to the respective IS, if any.

Table 8-2: Standards

Indian Standard	Particulars	International standard
IS: 2026 (Part- 1 to 4)	Power transformers	IEC 76 (1-5)
IS:1271	Classification of insulating materials for electrical machinery and apparatus	
IS:335	New insulating oil for transformers, Switchgears	IEC 296
IS:2071	Method of high voltage testing	
IS:2099	High voltage porcelain bushings	IEC 137
IS:2147	Degree of protection	IEC 529
IS:2705	Current transformers	
IS:3347	Dimensions for porcelain transformer bushings	
IS:3637	Gas operated relays	
IS:3639	Fittings and accessories for power transformers	
IS: 6600	Guide for loading of oil immersed transformers	IEC 354
IS:5561	Electric Power Connectors	
IS: 10028	Code of practice for selection, installation and maintenance of transformers, Part I, II and III	
IS:3202	Code of practice for climate proofing of electrical equipment	
IS:5	Colour for ready mixed paints	
IS : 325	Three Phase Induction Motors	

Indian Standard	Particulars	International standard
C.B.I.P. Publication	Manual on Transformers	
	Insulation Co-ordination	IEC 71
	Radio influence voltage measurement	IEC 437
	Measurement of transformer and reactor sound levels	IEC 551

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; and if the IS mentioned is upgraded then the latest version of IS shall be applicable

8.4. Specific Technical Requirements

Specific technical requirements shall be as follows:

Table 8-3: Specific Technical Requirements

S.No.	Parameter	Particulars
1	Rated MVA (ONAN rating)	8 MVA
2	No. of phases	3
3	Type of installation	Outdoor
4	Frequency	50 Hz
5	Cooling medium	Insulating oil
6	Rated voltage	
	High voltage winding	33kV
	Low voltage winding	11kV
7	Highest continuous system voltage	
	a) HV side	36kV
	b) LV Side	12kV
8	No. of windings	Two
9	Range of tapings	Plus 5% to minus 10% of 2.5% each on HV winding
10	Neutral terminal to be brought out	On LV side only
11	Impedance on rated MVA base at 75^0 C, on normal tap	8.35% for 8 MVA

S.No.	Parameter	Particulars
		(Tolerance plus 10%, negative tolerance shall not be allowed)
12	Type of winding insulation	Uniform both for HV and LV
13	Over voltage operating capacity & duration	112.5 % of rated voltage (continuous)
14	Anticipated unbalanced loading	Around 10 %
15	Anticipated continuous loading of windings (HV/LV)	110 % of rated current
16	Maximum Flux Density in any part of the core and yoke at rated MVA, rated voltage i.e. 33kV / 11kV and system frequency of 50Hz.	1.5 Tesla
18	Impulse withstand test voltage (kV peak)	170 (HV) , 75 (LV)
19	Withstand time for three phase short circuit	2 seconds
20	Winding connection	
21	LV Side	Star
22	HV Side	Delta
	Winding material (HV & LV)	Electrolytic Copper
	Vector group	Dyn 11
23	Type of cooling	Insulating oil (ONAN)
24	Neutral earthing	LV neutral shall be solidly earthed
25	Winding temperature Indicator	One
26	Provision for Differential Protection arrangement	Not required
27	Oil Temperature indicator	One
28	Maximum temperature rise on top of oil over an ambient temperature of 50^0 C (measured by thermometer)	45^0 C
29	Maximum temperature rise of winding over an ambient temperature of 50^0 C (measured by resistance)	50^0 C
30	Over load capacity	As per IS:6600
31	Degree of protection for marshaling box	IP 55
32	Noise level at rated voltage and frequency	As per NEMA publication no. TR-1

S.No.	Parameter	Particulars
33	Minimum clearances in air (mm)	
	Phase to phase	HV - 350, LV – 280
	Phase to ground	HV- 320, LV – 205
34	Terminals (Bushings)	
	HV winding line end	36 kV oil filled communicating type porcelain bushing (Anti fog type)
	LV winding (for outdoor type 11 kV breakers)	12 kV porcelain type bushing (Anti fog type)
35	Minimum creepage distance	900 mm (HV), 300 mm (LV)
36	Maximum current density for HV, LV windings for rated current	2.8 Amp/sq. mm
37	Core material	High grade, non-ageing Cold Rolled Grain Oriented (CRGO) silicon steel, confirming to HIB grade
38	Core assembly	Boltless Core type
39	Type of mounting	On wheels, mounted on rails
40	Maximum permissible no load loss at rated voltage and rated frequency	7.0 kW for 8 MVA
41	Maximum permissible load loss at rated current at 75^0 C	48 kW for 8 MVA

8.5. General Technical Requirements

8.5.1. General

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 MVA, voltage and frequency shall be such that the flux density under 12.5% over voltage condition shall not exceed 1.9 Tesla.
c) With combined voltage variation of +12.5% and frequency variation of -5%, the flux density shall not exceed 1.9 Tesla.
d) Transformer shall be able to withstand without injurious heating, combined voltage and frequency fluctuation which produce the 125% over fluxing condition for one minute and 140 % for 5 seconds.
e) The transformer shall be capable of operating continuously without danger on any particular tapping at the rated MVA ±12.5% of the voltage corresponding to the tapping.

f) Transformer shall be capable of withstanding thermal and mechanical stress caused by any symmetrical and asymmetrical faults on any winding. This shall be demonstrated through calculation as per IS:2026.
g) The thermal ability withstand short circuit shall be demonstrated by calculation.
h) 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.
i) Transformer noise level, when energised at normal voltage and frequency shall be as per NEMA TR -1 stipulations.
j) 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.
k) The transformer shall be capable of being operated without danger on any tapping at the rated kVA with voltage variation of + 10% corresponding to the voltage of the tapping.

8.5.2. Construction Features

a) 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.
b) Similar parts, particularly removable ones, shall be interchangeable.
c) 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.
d) Nuts, bolts and pins used inside the transformers and tap changer compartments shall be provided with lock washers or locknuts.
e) Exposed parts shall not have pockets where water can collect.
f) Internal design of transformer shall ensure that air is not trapped in any location.
g) Material in contact with oil shall be such as not to contribute to the formation of acid in oil.
h) Surface in contact with oil shall not be galvanized or cadmium plated.
i) 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.
j) All internal connections and fastenings shall be capable of operating under overloads and over-excitation, allowed as per specified standards without injury.
k) Transformer and accessories shall be designed to facilitate proper operation, inspection, maintenance and repairs.
l) No patching, plugging, shimming or other such means of overcoming defects, discrepancies or errors will be accepted.
m) Schematic Drawing of the wiring, including external cables shall be put under the prospane sheet on the inside door of the transformer marshalling box.

8.5.3. Core

a) Stage level inspection for core construction shall be carried out by the owner.
b) Each lamination shall be insulated such that it will not deteriorate due to mechanical pressure and the action of hot transformer oil.
c) 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 0.23 mm to 0.27 mm or better.
d) The maximum flux density in any part of the cores and yoke at normal voltage and frequency shall be such that the flux density with + 12.5 % voltage variation from rated voltage or frequency variation of -5% shall not exceed 1.5 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.
e) Following documents shall be submitted during stage inspection as proof towards use of prime core material:
   - Purchase order
   - Invoice of the supplier
   - Mills test certificate
   - Packing list
   - Bill of lading
   - Bill of entry certificate to customs
f) Core material shall be directly procured either from the manufacturer or through their accredited marketing organization of repute and not through any agent.
g) The laminations shall be free of all burrs and sharp projections. Each sheet shall have an insulating coating resistant to the action of hot oil.
h) The insulation structure for the core to bolts and core to clamp plates, shall be such as to withstand 2000 Volt DC voltage for one minute.
i) The completed core and coil shall be so assembled that the axis and the plane of the outer surface of the core assembly shall not deviate from the vertical plane by more than 25 mm.
j) All steel sections used for supporting the core shall be thoroughly shot or sand blasted, after cutting, drilling and welding.
k) The finally assembled core with all the clamping structures shall be free from deformation and shall not vibrate during operation.
l) The core clamping structure shall be designed to minimize eddy current loss.
m) The framework and clamping arrangements shall be securely earthed.
n) The core shall be carefully assembled and rigidly clamped to ensure adequate mechanical strength.
o) 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.
p) The design of magnetic circuit shall be such as to avoid static discharges, development of short circuit paths within itself or to the earthed 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.

q) 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 assembly shall be so fixed in the tank that shifting will not occur during transport or short circuits.

r) The temperature gradient between core & surrounding oil shall be maintained less than 20 ^{0}C. The manufacturer shall demonstrate this either through test (to be mutually agreed) or by calculation.

8.5.4. Windings

a) 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.

b) 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.

c) 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.

d) 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.

e) Varnish application on coil windings may be given only for mechanical protection and not for improvement in dielectric properties. In no case varnish or other adhesive be used which will seal the coil and prevent evacuation of air and moisture and impregnation by oil.

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

g) 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.

h) All the insulating materials to be used in the transformer shall preferably be of class- A insulation as specified in Indian Standards. The test certificate of the raw materials shall be made available by the Transformer manufacturer on request during inspection and testing.

i) The coil clamping arrangement and the finished dimensions of any oil ducts shall be such that it will not impede the free circulation of oil through the ducts.

j) Coil clamping rings, if provided shall be of steel or suitable insulating material. Axially laminated material other than backlisted paper shall not be used.

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

l) The completed core and coil assembly 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.

m) The winding shall be so designed that all coil assemblies 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.

n) 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.
o) Adequate barriers shall be provided between coils and core and between high and low voltage coil. End turns shall have additional protection against abnormal line disturbances.
p) 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.
q) Tapings 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 the transformer at all voltage ratios.
r) Magnitude of impulse surges transferred from HV to LV windings by electromagnetic induction and capacitance coupling shall be limited to B.I.L. of LV winding.
s) The current density adopted in all windings shall not exceed **2.8** A/ sq mm . The total net cross sectional area of strip conductors for calculating current density for each winding shall be obtained after deducting the copper area lost due to rounding up of the sharp edges of the rectangular conductors.

8.5.5. Insulating Oil

a) The insulating oil for the transformers shall be of EHV grade, conforming to IS: 335/1983. No inhibitors shall be used in the oil.
b) Transformer shall be shipped with oil filled at least to cover the core and coil assembly.
c) The quantity of oil required for the first filling of the transformer and its full specification shall be stated in the bid. The bidder shall quote the price of transformer complete with first filling of oil plus 10% extra. However, the rate of transformer oil in Rupee per litre shall be quoted separately also. The transformer oil shall be supplied in non-returnable drums.
d) 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.
e) The Supplier shall warrant that oil furnished is in accordance with the following specifications. Supplier shall submit the test certificate accordingly.

Table 8-4: Insulating Oil specifications

S.No.	Characteristic	Requirement	Method of Test
1	Appearance	The oil shall be clear & transparent & free from suspended matter or sediment	A representative sample of oil shall be examined in a 100 mm thick layer at ambient temp.
2	Density at 20oC	0.89g/cm3 Max.	IS: 1448
3	Kinematic Viscosity at	27 CST	IS: 1448

S.No.	Characteristic	Requirement	Method of Test
	27 deg. C Max		
4	Interfacial tension at 27 deg. C Min.	0.03N/m	IS: 6104
5	Flash Point	140 deg. C	IS: 1448
6	Pour Point Max.	-6 deg. C	IS: 1448
7	Neutralization Value (Total acidity) Max.	0.04 mg KOH/gm	IS: 335
8	Electric strength Break Down (voltage) Min.	60 kV	IS: 6792
9	Dielectric dissipation factor tan delta at 900 C	0.002 Max	IS:6262
10	Min. Specific resistance(resistivity) at 90 deg. C	35 x 1012 ohm cm (min.)	IS: 6103
	Min. Specific resistance(resistivity) at 27 deg. C	1500x1012	
11	Neutralisation value after Oxidation	0.40 mg KOH/g	
12	Total sludge after Oxidation	0.10% by weight max.	
13	Presence of oxidation Inhibitor	The oil shall not contain anti-oxidant additives	IS:335
14	Water content Max:	Less than 25 ppm	IS: 2362

8.5.6. Internal Earthing

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

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

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

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.

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.

8.5.7. Tank

The Transformer tank and cover shall be fabricated from high grade low carbon plate steel of tested quality of adequate thickness. The tank and the cover shall be of welded construction. All welds shall be stress relieved. Stiffener shall be provided for general rigidity. Tank surface shall be designed to prevent retention of water.

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

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

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

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.

All bolted connections to the tank shall be fitted with suitable oil-tight gaskets which shall give satisfactory service under the operating conditions for complete life of the transformer. Special attention shall be given to the methods of making the hot oil-tight joints between the tank and the cover as also between the tank cover and the bushings and all outlets to ensure that the joint can be remade satisfactorily and with ease, with the help of semi-skilled labour. Where compressible gaskets are used, steps shall be provided to prevent over-compression.

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

8.5.8. 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 suitably sloped so that it does not retain rain water.

8.5.9. Under Carriage

The transformer tank shall be supported on steel structure with detachable plain rollers completely filled with oil. Suitable channels for movement of roller with transformer shall be spaced accordingly. Rollers wheels

shall be provided with suitable rollers bearings, which will resist rust and corrosion and shall be equipped with fittings for lubrication. It shall be possible to swivel the wheels in two directions, at right angle to or parallel to the main axis of the transformers.

Jacking pads shall be provided on the transformer. It shall be possible to change the direction of the wheels through 90 degree when the transformer is lifted on jacks to permit movement of the transformer both in longitudinal and transverse directions.

8.5.10. Valves

Valves shall be of forged carbon steel up to 50 mm size and of gun metal or of cast iron bodies with gun metal fittings for sizes above 50 mm. 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.

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 supplier shall supply the same.

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

- Drain valve so located as to completely drain the tank.
- Two filter valves on diagonally opposite corners, of 50 mm size.
- Oil sampling valves not less than 8 mm at top and bottom of main tank.
- One 15 mm air release plug.
- Valves between radiators and tank.

Drain and filter valves shall be suitable for applying vacuum as specified in the specifications.

8.5.11. Painting, Surface Preparation for tank, pipes, etc.

- All surfaces of transformer tank, pipes, etc. shall be thoroughly blast cleaned with sand or shot or grit in accordance with ISO 8501 Part 1 to a minimum standard of "Sa2½" to make the surface free from visible oil, grease & dirt, mill scale, rust, paint coatings and foreign matter. Machined areas and threaded components etc. are to be covered during blasting to prevent damage.
- The air that is used for blasting should be dry and free from oil. The flanges, angles, tank curbs and other such areas shall be preferably blast cleaned prior to fabrication and paint these with one coat of primer. After adequate blast cleaning of each large surface where blasting time is more than three hours, an overall blast cleaning is to be done on the entire surface once more so that entire surface areas is exposed as fresh for first coat of primer paint. The first coat of primer paint should be applied not later than 3-4 hours after preparation of surface to avoid oxidation.

a) Surface Preparation for radiator

All internal and external surfaces of radiator shall be thoroughly cleaned either by chemical cleaning or by blast with sand or shot or grit in accordance with ISO 8501 Part 1 to make the surface free from visible oil, grease & dirt, mill scale, rust, paint coatings and foreign matter. Suitable chemical should be used for chemical cleaning, if required. The air that is used for blasting should be dry and free from oil. After adequate surface cleaning, the first coat of primer paint/varnish should be applied not later than 3-4 hours after preparation of surface to avoid oxidation.

b) Surface Preparation for Control cabinets/Marshaling Boxes

Surface Preparation for all Transformer Control cabinets/Marshaling Boxes shall be carried out confirming to following Indian standard in dust free area:

- IS: 3618: Degreasing by solvent wiping: Phosphate Treatment of Iron &Steel for Protection against corrosion.
- IS: 6005: Code of Practice for phosphating of Iron & Steel.

c) Chemicals

Suitable chemicals should be used and concentration of chemicals /weight of Phosphate coating should be checked regularly as per recommendation of the chemical manufacturer and applicable IS.

d) Inspection

The surface for application of paint should be dry, free from oil, dirt, acid & loose adhering powder and reasonably smooth in finish without uncovered areas, rusty surfaces and roughness.

e) Painting

Control cabinets/Marshalling Boxes -Enamel paint shall be used with total paint thickness as minimum 80 microns.

f) Painting- external & internal surfaces

Painting shall be carried out in closed and dust free area. The external surface shall be coated with suitable layers of paint and to form an impermeable layer so that air and water cannot reach the substrate. The paint selected shall be stable in outdoor condition such as rain, sunlight, pollution etc. Paint used for primer, under coat and top or finish coat should be from the same manufacturer and compatible to each other. In case in the rare event, paint used for primer, under coat and finish coat are not from the same manufacturer the compatibility test of the paint from different source shall be carried out. Painting shall be applied as per the recommendation of the paint manufacturer. The number of coats shall be such that the minimum dry film thickness (DFT) specified is achieved. The DFT of painted surface shall be checked with a measuring gauge to ensure specified DFT. Complete painting scheme for the transformer is tabulated below:

g) Painting-Transformer tank, pipes, radiator etc.:

Table 8-5: Painting Specifications

	Surface Preparation	Prime Coat	Intermediate Undercoat	Finish Coat	Total DFT	Colour Shade
Tank, pipes, etc. (External surfaces)	Blast cleaning Sa2½	Epoxy base Zinc primer (30-40 μm)	Epoxy HB MIO (30-40 μm)	Aliphatic Polyurethane (min 50 μm)	Min 155 μm	697 shade as per IS 5

	Surface Preparation	Prime Coat	Intermediate Undercoat	Finish Coat	Total DFT	Colour Shade
Tank (Internal surfaces)	Blast cleaning Sa2½	Hot oil resistant, non-corrosive varnish or paint or epoxy	--	--	Min 30 μm	Glossy white for paint
Radiator (External surfaces)	Chemical / blast cleaning (Sa2½)	Epoxy base zinc primer (30-40μm)	Epoxy base zinc primer (30-40μm)	PU paint (min 50μm)	Min 110 μm	Matching shade of tank/ different shade aesthetically matching to tank
Radiator and pipes (Internal surfaces)	Chemical cleaning if required	Hot oil proof, low viscosity varnish, flushing with transformer oil.	--	--	--	--

8.5.12. Bushing

Transformer shall be provided with bushing insulators on both H.V and L.V. sides. H.V and L.V. bushings shall be located on opposite side.

The electrical characteristics of bushing insulator shall be in accordance with IS: 2099. Dimensions and type of bushing shall conform to IS: 3347 and shall be as follows: -

H.V. Bushing (33kV)	36kV Class	Porcelain bushing with plain sheds for heavily polluted atmosphere
L.V. Bushing (11kV)	12 kV Class	Porcelain bushing with plain sheds for heavily polluted atmosphere
Neutral Bushing	Neutral	Neutral of L.V. winding shall be brought out through porcelain bushing similar to L.V. Bushing for connection with earth terminal in line with LV bushing.

a) All porcelain used in bushings shall be homogeneous, non-porous, uniformly glazed to brown colour and free from blisters, burns and other defects.
b) Stress due to expansion and contraction in any part of the bushing shall not lead to deterioration.
c) Each bushing shall be capable to carry at least 200% of current of Continuous Maximum Rating (CMR) of transformer and the short time current shall be of the same as of transformer.

d) Fittings made of steel or malleable iron shall be galvanized.
e) Bushing shall be so located on the transformers that full flashover strength will be utilized.
f) All applicable routine and type tests certificates of the bushings shall be furnished for approval.
g) Bushing shall be supplied with bi-metallic/terminal connector/clamp/washers suitable for fixing to bushing terminal and the purchaser's specified conductors. The connector/clamp shall be rated to carry the bushing rated current without exceeding a temperature rise of 550° C over an ambient of 500o C. The connector/clamp shall be designed to be corona free at the maximum rated line to ground voltage.
h) Bushing of identical voltage rating shall be interchangeable.
i) Each bushing shall be so coordinated with the transformer insulation that all flashover will occur outside the tank.
   - The creepage distance shall be not less than 25 mm/kV and protected creepage distance shall be not less than 50% of total.
   - Arcing horns are to be provided with adjustable horn gap except the neutral bushing.
   - Each terminal, including the neutral, shall be distinctly marked on both primary and secondary in accordance with the connection diagram fixed upon the transformer which shall conform to latest IS 2026 (Part IV).
j) Insulation Level: The transformer and bushing shall be capable to withstand test voltage as specified below:

Table 8-6: Insulation level

Particulars	Bushings	
Nominal voltage (in kV rms)	11 kV	33 kV
Highest voltage for equipment (in kV rms)	12	36
1.2/50 micro sec. impulse withstand voltage (in kV peak)	75	170
1 minute power frequency withstand voltage (in kV rms)	35	75
Minimum creepage distance (mm)	300	900
Minimum clearance (mm) : Phase to phase	280	350
Minimum clearance (mm) : Phase to earth	205	320

8.5.13. Protection & Measuring Devices

Oil Conservator Tank

- The conservator shall be of capacity to meet the requirement of expansion of the total cold oil volume in the transformer & cooling equipment and it should be such that the oil level will always be visible through the plain oil level gauge.

- A conservator will have volumetric capacity of at least 10 % of the total volume of oil in tank. Moreover the oil in conservator up to minimum level mark on the oil gauge shall be at least 3 % of the total volume of oil in transformer excluding oil in OLTC.
- The conservator tank shall be bolted into position so that it can be removed for cleaning purposes.
- The conservator shall be fitted with magnetic oil level gauge with low level electrically insulated alarm contact
- Plain conservator fitted with silica gel breather.
- It shall be provided with oil filling hole with cap on top and a drain valve at the bottom.

Oil Preservation Equipment (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.

Breather

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

- Passage of air is through a dust filter & Silica gel
- Silica gel is isolated from atmosphere by an oil seal.
- Moisture absorption indicated by a change in colour of the crystals of the silica gel can be easily observed from a distance.
- Breather is mounted not more than 1400 mm above rail top level.

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 contacts shall be provided for tripping when the device operates.

Buchholz Relay

Each transformer shall be provided with gas and oil actuated Relay (Buchholz Relay) equipment conforming of IS: 3637 double float type with one set of alarm contacts, one set of trip contacts and a testing pet cock. The contacts shall be wired with a P.V.C. armoured cable. A machined surface shall be provided on the top of Relay to facilitate the setting of Relay and to check the mounting angle in the pipe and cross level of the Relay. The pipe work shall be so arranged that all gas arising from the Transformer shall pass into the gas and oil actuated Relay. The oil circuit through the Relay shall not form a delivery path in parallel with any circulating oil pipe. A copper tube shall be connected from the gas collector to a valve located at about 1200 mm above ground level to facilitate sampling with the transformer in service.

Oil Temperature Indicator (OTI)

The transformers shall be provided with a 150 mm dial type thermometer 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 5A AC at 230 Volt supply.

Winding Temperature Indicator (WTI)

a) A device for measuring the hot spot temperature of the winding shall be provided. It shall comprise the following.
b) Temperature sensing element
c) Image Coil.
d) Auxiliary CTS, if required to match the image coil, shall be furnished and mounted in the local control panel.
e) 150 mm 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 one for trip.
f) Calibration device.
g) Two number NO electrical contact each capable of operating at 5 A ac, 230 Volt supply.
h) The scale on the dial of the thermometer should be 0 Deg.C to 150 Deg.C. The angular displacement of thermometer should be 270 Deg. The signaling contact of WTI & OTI shall be set to operate at the following temperature:
   - OIL : Alarm-80 deg. C, Trip – 90 deg. C
   - WINDING : Alarm-85 deg. C, Trip – 95 deg. C

Marshalling Box

Sheet steel (not less than 2 mm thick), weather, vermin and dust proof marshaling box fitted with required glands, locks, glass door, terminal Board, 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 sloping 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. The temperature indicators shall be so mounted that the dials are visible by standing at the ground level.

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

The marshaling box shall accommodate the following equipment:

- Temperature indicators
- Terminal blocks and gland plates for incoming and outgoing cables.
- Space heater with thermostat and MCB

All the above equipment except (b) 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.

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 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.

8.5.14. On Load Tap Changer

The transformers shall be provided with an On-Load Tap Changer (OLTC) of well reputed and of proven make as per technical requirement for varying the effective transformation ratio while the transformer is ON load and without providing phase displacement. The salient features of the OLTC shall be as under:

The tap changing mechanism should be suitable for automatic, remote control operation from remote control panel in the control room in addition to being capable of local manual as well as local electrical operation.

The **On Load Tap Changer (OLTC)** shall include the following:

a) An oil immersed tap selector and arcing switch on arc suppressing tap selector provided with ohmic or resistor type high speed diverter switch, for reduction of make and break arcing voltages, overloads and short circuits.

b) Diverter switch should be with snap action mechanism with energy accumulator mounted directly on the diverter switch.

c) Separate oil compartment

d) Easy removable diverter switch unit.

i) Motor driven mechanism

ii) Control and protection devices

iii) Local tap changer position indicator

iv) Manual operation device

v) Make of OLTC – Indigenous make (type test certificates from (CPRI).

Control voltage – Any of the auxiliary power supply voltage.

The on-load tap changer shall be designed so that the contacts do not interrupt are within the main tank of transformer. The tap changer selector and arcing switch on arc suppressing tap selector switch shall be located in one or more oil filled compartments. The diverter switch should be provided with gas vent and Buchholz relay. It shall be designed as to prevent the oil in tap selector and diverter switch compartments from mixing with the oil in transformer. The barrier board between OLTC and the transformer tank shall be made of Silicon Bonded Resin Paper (SBRP)

The tap changer shall be capable of permitting parallel operation with other transformers of the same type. The transformer shall give full load output on all taps without exceeding the limit of permissible temperature

rise in oil and winding. The manual operation device shall be so located on the transformer that it can be operated by a man standing at the level of transformer track. It shall be of robust construction and shall be capable of frequent operations. It shall not be possible to operate the electric drive when the manual operating gear is in use.

Necessary interlocks blocking independent control when the units are in parallel shall be provided.

The controls shall be so arranged as to ensure that when a tap change operation has commenced, it shall be completed independently of the operation of control relays or switches. Local or remote control switch shall cause one tap movement only, until the control switch has returned to the off position between successive operations. Under abnormal conditions such as may occur when the contractor controlling one tap change sticks, the arrangement must be such as to switch off supply to the motor so that an out of step condition is limited to one tap difference between the units./ Limit switches shall be provided to prevent over running of mechanism.

The transformer and the tap changing equipment shall be designed to permit full rated operation with tap changing equipment temporarily installed in any intermediate position. Details of out of step protection provided for the taps should be furnished in the tender.

The control scheme for the tap changer shall be provided for independent auto/non-auto control of the tap changer when the transformers are in independent service. Voltage relating relay should be designed for maximum operational simplicity for regulating the secondary voltage of power transformer with OLTC. The required EAD band settings are set by setting the nominal value and lower and upper levels independently.

In addition, provisions shall be made to enable non-auto/automatic parallel control also so that the tap changers of two or more transformers will be operated simultaneously when one unit is in parallel with another so that under normal conditions the tap changer will not become out of step and this will eliminate circulating current. Additional features like "Master / Follower" and visual indication, during the operation of motor shall also be incorporated.

A mechanical tap position indicator shall be provided on the tap changer in addition to remote indication equipment in the control room on remote control cubicle of OLTC. Necessary interlocks, for independent control when the units are in parallel shall be provided.

The whole of motor drive unit comprising the motor and its control gear including contractors, indicator, local electrical push buttons, five digit operation counter, handle for manual control etc. as well as terminals for the control and indication wiring shall be housed in a dust proof kiosk mounted on tap changer, A heating element with thermostat and MCB shall also be provided in kiosk for ensuring trouble free operation of the drive in cold weather. Arrangement shall be made for padlocking the kiosk. Tap position indication shall be visible by a number appearing in a small glass window on the front of the kiosk. For remote indication, an indication type instrument or digital type shall be provided on a panel on the 415 volts, 3 phase, 50 c/s external supply.

Any enclosed compartment not oil filled shall be adequately ventilated. All contractors, relay coils or other parts shall be suitably protected against corrosion or deterioration due to condensation, fungi etc.

The oil in the compartments of the main tap changing apparatus which do not contain contacts used for making or breaking current shall be maintained under conservator head by means of a pipe connection from

the highest point of the chamber to the conservator. This connection shall be controlled by a suitable valve and shall be arranged so that any gas leaving the chamber will pass into the gas and oil actuated relay. A separate oil Buchholz relay with trip contacts shall be provided for the On-Load Tap Changer chamber. Each tap changer shall also be provided with a pressure relief valve outside OLTC to protect against sudden pressure development on OLTC.

Each compartment in which the oil is not maintained under conservator head shall be provided with a suitable direct reading oil level gauge.

A permanently legible lubrication chart shall be fitted with the driving mechanism chamber.

Local electrical control switches and the local operating gear shall be clearly labeled in suitable manner to indicate the direction of operation of tap changer.

The remote control panel of OLTC gear to be installed in the control room should match in colour and dimensions sheet steel size etc. with the purchaser's transformer control panel for which details would be furnished to the successful contractor.

In addition to the fittings, auxiliaries and accessories considered necessary by the contractor the following shall be provided:

A. **FOR LOCAL ELECTRICAL CONTROL**

i) Raise lower selector switch with a intermediate 'OFF' position.

ii) Auxiliary transformer (if necessary) along with MCBs and links.

iii) Step by step contractor

iv) Thermal over load relay for the motor

v) Reversing contractor

vi) ON/OFF automatic trip air circuit breaker for motor supply

vii) Local/Remote change over selector switch.

B. **FOR REMOTE ELECTRICAL INDEPENDENT / AUTO-CONTROL**

i) All equipment listed in (A) above.

ii) Tap position indicator for mounting on control panel in the control room.

iii) Signal lamp and buzzer, for indicating "Tap Change in Progress".

iv) Raise lower switch push button type with intermediate off/position for remote control.

v) Emergency stop button (push button type) with visual indication.

vi) Visual and alarm indication for non completion of operation within pre-set time

vii) Provision of interlocking system for blocking independent control when the units are to run in parallel by providing interlock able phase sequence selector switch.

viii) All audo-visual indications should be brought to the Remote Tap Changer Cubicle (RTCC) panel.

ix) DC supply isolators, DC supply 'ON' indicator & DC failure, both alongwith cancellations.

x) All equipment and their connections in RTCC panel should be properly marked. The buzzer/bell (industrial type) should be provided.

C. **FOR SIMULTANEOUS PARALLEL OPERATION OF TRANSFORMER**

i) All equipment listed in (B) above.

ii) Out of step relay alongwith auxiliary relays, contractors and other equipment including a buzzer and signal lamp to indicate the out of step indication when transformers in one of pair of group of rating in parallel are one tap out of step and also to trip the circuit breaker.

iii) Control selector switch to enable to run a transformer as Master/Follower or independent in a group.

iv) Selection switches for individual/parallel operation.

DC supply, Isolators, DC supply, 'ON' indication & DC failure, hooter alongwith cancellation

8.5.15. Fittings

The following fittings shall be provided on the transformers:

a) Conservator with oil filling hole with cap and drain valve.
b) Magnetic type oil level gauge (150 mm dia.) with low oil level alarm contacts.
c) Prismatic/toughened glass oil level gauge.
d) Silica gel breather with oil seal and connecting pipe complete with first fill of activated silica gel.
e) A double float type Buchholz relay with isolating valve, bleeding pipe and a testing cock. The relay shall be provided with shut off valve on the conservator side as well as on the tank side.
f) Pressure relief devices (including pressure relief valve) and necessary air equalizer connection between this and the conservator with necessary trip contacts.
g) Air release plugs in the top cover.
h) Inspection covers, access holes with bolted covers for access and inspection of inner ends of bushing, core/coil assembly etc.
i) Winding temperature indicating device for local mounting complete in all respects.
j) Dial thermometer with pocket for oil temperature indicator.
k) Lifting lugs for the top cover, core and coils and for the complete transformer.
l) Jacking pads.
m) Haulage lugs.
n) Protected type mercury/alcohol in glass thermometer and a pocket to house the same.
o) Top and bottom filter valves on diagonally opposite ends with pad locking arrangement on both valves.
p) Top and bottom sampling valves.
q) Drain valve with pad locking arrangement and blanking plate.
r) Rating and connection diagram plate valve schedule plate.
s) Two numbers tank earthing terminals with associated nuts and bolts for connections to purchaser's grounding strip.

t) Bidirectional flanged rollers.
u) Marshalling Box (MB)
v) Cooling Accessories :
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.
- Air release device and oil drain plug on oil pipe connectors.

w) Terminal marking plates for Main Transformer.
x) Off-Load Tap Changer.
y) HV Bushing with terminal connector and arcing horn.
z) LV Bushing with terminal connector.
aa) LV Neutral Bushing for ground connection.

Note: 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.

The contacts of various devices required for alarm and trip shall be potential free and shall be adequately rated (minimum 230V and 5 amp) for regular making and breaking current duties as specified.

8.5.16. Auxiliary Power Supplies

The following power supplies shall be available at site

a) AC 3 phase, 400 volts, 50 Hz earthed
b) AC 1 phase, 230 volts, 50 Hz earthed
c) 30V DC and/or 110 V DC

8.5.17. 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 Purchaser name-UPCL.

8.5.18. Control Connections and Wiring Terminal, Board and Fuses

a) Normally no fuses shall be used anywhere. Instead of fuses MCBs (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.
b) All wiring connections, terminal boards, fuses, MCBs 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.

c) Panel connections shall be neatly and squarely fixed to the panel. All instruments and panel wiring shall be run in PVC. All wiring to a panel shall be taken from suitable terminal boards.
d) When 400 volt connections are taken through junction boxes or marshalling boxes, they shall be adequately screened and 400 volts Danger Notice must be affixed to the outside of the junction boxes or marshalling box. Proper colour code for Red, Yellow, Blue phases wires shall be followed. 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.
e) All box wiring shall be in accordance with relevant IS. All wiring shall be of stranded single core copper (48 strands) of 1100 Volt grade and size as under:
    - CT circuits – 2x2.5 sq.mm.
    - AC/DC Power circuit – 1x2.5 sq.mm.
    - All other circuit - 1x2.5 sq.mm.
f) 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.
g) The same ferrule number shall not be used on wires in different circuits on the same panels.
h) 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.
i) Stranded wires shall be terminated with tinned 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.
j) Where apparatus is mounted on panels, all metal cases shall be separately earthed by means of stranded (48 No.) copper wire or strip having a cross section of not less than 2.5 sq. mm. Where strip is used, the joints shall be sweated.
k) The wiring diagram for marshalling box shall preferably be drawn as viewed from the back and shall show the terminal boards arranged as in services.
l) Terminal blocks shall be 1100 volts 10 Amp grade moulded material complete with stud type brass terminal, washers, nuts and identification strips.
m) Terminal block rows should be spaced adequately not less than 100 mm apart to permit convenient access to external cables and terminations.
n) Terminal blocks shall be placed with respect to the cable gland (at a minimum distance of 200 mm) as to permit satisfactory arrangement of multi-core cable tails.
o) Terminal blocks shall have separate 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.

p) All interconnecting wiring, as per the final approved scheme between accessories of transformer and marshalling box is included in the scope of this specification and shall be done by the Transformer supplier.
q) The schematic diagram shall be drawn and fixed under a transparent prospane sheet on the inner side of the marshalling box cover.
r) All marking of terminals shall follow IS 11953

8.5.19. Inspection and Testing during manufacturing

General

- The supplier shall carry out a comprehensive inspection and testing during manufacture of the transformer. An indicative of checks to be carried out during manufacturing are given below.
- This is, however, not intended to form a comprehensive program as it is supplier's responsibility to draw up and carry out such a program duly approved by the purchaser.
- The supplier shall carry out type tests, special tests and routine tests on the transformers.
- Only one no. transformer of each rating will be subjected to type test.
- All type, special and routine tests shall be carried out at supplier cost.
- The pre-shipment checks shall also be carried out by the supplier.
- The requirements of onsite tests are as listed in the specifications.
- Certified test report and oscillographs shall be furnished to the purchaser/consultants for evaluation. The Supplier shall also evaluate the test results and rectify the defects in the equipment based on his and the Purchaser's evaluations of the tests without any extra charges to the Purchaser. Manufacturer's Test Certificates in respect of all associated auxiliary and ancillary equipment shall be furnished.
- 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.

Checks during Manufacturing

a) Tank and Conservator
   - Inspection of major weld.
   - Crack detection of major strength weld seams by dye penetration test.
   - Check correct dimensions between wheels, demonstrate turning of wheels, through 90o and further dimensional check.
   - Leakage test of the conservator.
b) Core
   - Sample testing of core materials for checking specific loss properties, magnetization characteristics and thickness.
   - Check on the quality of varnish if used on the stampings.
   - Check on the amount of burrs.
   - Visual and dimensional check during assembly stage.
   - Check on completed core for measurement of iron loss.

- Visual and dimensional checks for straightness and roundness of core, thickness of limbs and suitability of clamps.
- High voltage DC test (2 kV for one minute) between core and clamps.

c) Insulating Material
- Sample check for physical properties of materials.
- Check for dielectric strength
- Check for the reaction of hot oil on insulating materials.

d) Winding
- Sample check on winding conductor for mechanical continuity and electrical conductivity.
- Visual and dimensional checks on conductor for scratches, dent mark etc.
- Sample check on insulating paper for PH value, electric strength.
- Check for the bonding of the insulating paper with conductor.
- Check for the reaction of hot oil and insulating paper.
- Check and ensure that physical condition of all materials taken for windings is satisfactory and free of dust.
- Check for absence of short circuit between parallel strands.

e) Checks Before Drying Process
- Check condition of insulation on the conductor and between the windings.
- Check insulation distance between high voltage connections, between high voltage connection cables and earth and other live parts.
- Check insulating distances between low voltage connections and earth and other parts.
- Insulating test for core earthing.

f) Checks during Drying Process
- Measurement and recording of temperature and drying time during vacuum treatment. Check for completeness of drying.

g) Assembled Transformer
- Check completed transformer against approved outline drawing, provision for all fittings, finish level etc.
- Jacking test on the assembled Transformer.
- All standard test in accordance with IS: 335 shall be carried out on Transformer oil sample before filling in the transformer.
- 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 equipment is purchased by the supplier on a sub-contract, he shall have them tested to comply with relevant requirements.

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

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

j) Gas tightness test to conform tightness.

8.5.20. Losses

Transformers with lower losses shall be preferred. The bidder shall indicate the values of load and no-load losses of the transformer in his bid. Maximum allowable losses shall be as follows:

Table 8-7: Losses

kVA rating	No load loss (kW)	Load loss at 75 ^{0}C (kW)
8000	7.0	48.0

There would not be any positive tolerance in losses. The manufacturer can offer losses less than above.

8.5.21. Capitalization of Losses

For total cost evaluation, the capitalized cost of losses will be taken into account as per the following:

Capitalised cost of Transformer = Initial cost of Transformer + Rs. A x WI + Rs. B x Wc

Where: WI = Iron loss in kW & A = 137408 Rupees for iron loss

WC = Copper loss in kW & B = 41222 Rupees for copper loss

In the event of either the iron or copper loss exceeding its guaranteed value as stated in the technical data schedule, the relevant rate above shall be applied to the excess and the resulting amount shall be deducted from the contract price.

8.5.22. Stage Inspection

The purchaser reserves the right to carry out stage inspection of power transformers. During stage Inspection compliance of following particulars shall be checked.

- Core assembly - diameter, window height, leg centre, stack width, stack thickness, thickness of laminations, proof towards prime source of laminations
- Windings - conductor size, I.D., O.D & height of winding, major and minor insulations for both H.V and L.V windings
- Tank - length, breadth, height and thickness of plates of transformer tank, quality of fittings and accessories.

The supplier shall offer for final inspection of the transformers subject to clearance of the stage inspection report by the purchaser.

8.5.23. 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 plant, shall be deemed to be included in the specification and shall be furnished by the contractor 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 purchaser under any circumstances.

8.5.24. Spare parts

The Bidder shall provide a list of mandatory & recommended spare parts together with their individual prices. The prices of mandatory spares will be taken into account in the evaluation of tenders. This list shall identify all essential spares and consumable items for any recommended maintenance for a period of five years after commissioning.

The Purchaser may order all or any of the spare parts listed at the time of contract award and the spare parts so ordered shall be supplied as part of the definite works. The Purchaser may order additional spares at any time during the contract period at the rates stated in the contract document. A spare parts catalogue with price list shall be provided and this shall form part of the drawings and literature to be supplied.

The Bidder shall give an assurance that spare parts and consumable items will continue to be available through the life of the equipment, which shall be 25 years minimum. However, the supplier shall give a minimum of 12 months' notice in the event that the supplier or any sub-suppliers plan to discontinue manufacture of any component used in this equipment.

Any spare apparatus, parts or tools shall be subject to the same specification, tests and conditions as similar material supplied under the definite work section of the contract.

They shall be strictly interchangeable and suitable for use in place of the corresponding parts supplied with the plant and must be suitably marked and numbered for identification.

Spare parts shall be delivered suitably packed and treated for long periods in storage. Each pack shall be clearly and indelibly marked with its contents, including a designation number corresponding to the spare parts list in the operation and maintenance instructions.

A complete set of all the special tools, devices, slings or tackles required for the adjustment and maintenance of the equipment shall be supplied in the quantity listed in the Price Schedule. Each set of tools shall be mounted in a lockable cabinet. These shall also be provided under this contract. Eye bolts which have to be removed after use shall be accommodated in the cabinet.

8.6. Tests

8.6.1. Type Tests

The following shall constitute type tests. Special tests shall also constitute part of type tests:

a) Measurement of winding resistance
b) Measurement of voltage radio and check of voltage vector relationship
c) Measurement of impedance voltage/short-circuit impedance (principal tapping) and load loss
d) Measurement of no-load loss and current
e) Measurement of insulation resistance
f) Dielectric tests
g) Temperature-rise test, on tap having maximum losses
h) Off load tap changer tests (as per BS:4571 / BS EN 60214)

i) Tank Vacuum test
j) Tank Pressure test

8.6.2. Special Tests

a) Short circuit test
b) Measurement of zero sequence impedance
c) Measurement of acoustic noise level

Type test reports (less than five years old as on the due date of tender) of tests carried out at CPRI /NABL accredited laboratory along with certified drawings shall be furnished by the bidder with offer otherwise offer shall be rejected. The offered transformer must be manufactured as per type tested design.

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

8.6.3. Routine Tests

The following shall constitute routine tests:

a) Visual examination and checking the dimensions
b) Winding DC resistance.
c) Voltage ratio on each tapping and
d) Check of voltage vector relationship and polarity.
e) Impedance voltage / short circuit impedance (principle tapping , maximum and minimum tapping)
f) Magnetic balance test -
g) Load loss.
h) No-load loss and current
i) Insulation resistance
j) Separate source AC voltage withstand test
k) Induced over voltage withstand test
l) Measurement of Zero sequence impedance
m) Absorption index i.e. insulation resistance for 15 seconds and 60 seconds (R60/R15) and polarization index i.e. Insulation Resistance for 10 minutes and one minute (R10 mt/R1 mt)
n) Oil leakage test of transformer tank at a pressure equal to normal pressure plus 35 kN per sq mtr measured at the base of tank.
o) Measurement of neutral unbalance current (not to exceed 2% of full rated current of transformer)
p) High voltage withstand test on auxiliary equipment and wiring.

In case of Temperature Rise test, if it is not feasible to carry out this test at CPRI /ERDA, bidder may hire services of the laboratories and carry out Temperature Rise test at supplier's works with testing equipment of CPRI /NABL. Test has to be carried out by testing engineer of CPRI/NABL and certification of the same have to be given on CPRI/NABL's letter head.

8.6.4. Test Procedures

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 for oil and one hour for air and during that time no leak shall occur.

Pressure Test

Where required by the Purchaser, 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.

Vacuum Test

One transformer tank of each size shall be subjected to the vacuum pressure of 760 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.

8.6.5. Testing Equipment/Meter Calibration

All testing equipment / meters used shall be calibrated within valid time limit at ERDA / NABL accredited laboratory. Calibration seals provided by the calibrating agency on testing equipments / meters shall be in good condition.

8.7. Pre-Delivery Inspection at Manufacturer's Works

All routine & acceptance tests shall be witnessed and certified by purchaser's representative at manufacturer's works. The vendor shall give at least 10 days advance intimation to the purchaser to enable them to depute their representative for witnessing the tests. The said representative shall have full facilities for unrestricted inspection of supplier's works, raw materials, manufacturing processes and conducting necessary tests.

The said representative shall verify the calibration seals provided by the calibrating agency on testing equipments/ meters.

Test reports of routine tests carried out by the manufacturer shall be submitted to the inspecting authority at the time of inspection for his approval.

Acceptance of any quantity of materials shall in no way relieve the supplier of his responsibility for meeting all requirements of the specification and shall not prevent subsequent rejection, if such materials are later found to be defective.

In case of waiver of inspection, vendor shall carry out all (i) routine and (ii) acceptance tests and submit test reports for approval of the purchaser, before dispatch of material.

The entire cost of testing for acceptance & routine rests and checking of length etc shall be borne by the supplier.

8.8. Quality Assurance

Following quality plans shall be submitted within 30 days from the date of placement of contract:

a. Quality Assurance Plan (QAP) to be adopted by manufacturer in respect of raw materials and bought out items, including source and test reports of (i) important raw materials and (ii) bought out items.

b. Material Quality Plan (MQP) to be adopted by manufacturer in respect of manufacturing process.

The QAP & MQP shall be approved by the purchaser within 15 days from the receipt of compliance, if any. The vendor shall follow the approved QAP & MQP in true spirit. If desired by the purchaser, he shall give access to all the documents and materials to satisfy the purchaser that QAP & MQP are being properly followed.

8.9. Guarantee

The manufacturers of the transformer shall provide a guarantee of 54 months from the date of commissioning or 60 months from the date of dispatch whichever is earlier.

8.10. Drawing / Documents

8.10.1. Test reports for bought out items

The Supplier shall submit the test reports for all bought out/sub supplier items for approval.

- Buchholz relay
- Sudden pressure rise relay in OLTC
- Sudden pressure rise relay on main tank
- Winding temperature indicators
- Oil temperature indicators
- Bushings
- Bushing current transformers in neutral (if provided)
- Marshaling box

- Any other item required to complete the works.

The supplier shall furnish following drawings/documents for approval of purchaser within 4 weeks from the order.

a) Detailed overall general outline 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, bushing lifting height, clearances between HV and LV terminals and ground, quantity of insulating oil etc.
b) Foundation plan showing loading on each wheel and jacking points with respect to centre line of transformer.
c) GA drawings/details of bushing.
d) Name plate drawing with terminal marking and connection diagrams.
e) Wheel locking arrangement drawing.
f) Transportation dimensions drawings.
g) GA drawing of marshalling box.
h) Control scheme/wiring diagram of marshalling box.
i) Technical leaflets of major components and fittings.
j) Oil temperature indicator and winding temperature indicator settings
k) Completed technical data sheets.
l) Details including write-up of tap changing gear.
m) Bi- metallic connector for connection to conductor/cable.
n) Maintenance and Operating Instructions.
o) As built version of the drawings and documents.

Executive Engineer (Stores), UPCL will be the final authority for approving the drawings submitted by the tenderer.

8.10.2. Instructions Manual

Three 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 others, the following particulars:

- Marked erection prints identifying the components, parts of the transformer as dispatched with assembly drawings.
- Detailed dimensions, assembly and description of all auxiliaries.
- 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.
- Salient technical particulars of the transformer.
- Copies of all final approved drawings.
- Detailed O&M instructions with periodical check lists and format etc.

8.11. Onsite inspection testing

8.11.1. Installation Checks

- Inspection and operational checking of accessories like tap changers, etc.
- 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.
- Check the whole assembly for tightness etc.
- Oil leakage tests.

8.11.2. Pre-Commissioning Tests

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

- Dry out test
- Megger Test
- DC Resistance measurement of windings
- Ratio test on all taps
- Phase relationship test (Vector grouping test)
- Buchholz relay alarm operation test
- Low oil level (in conservator) alarm
- Temperature Indicators
- Marshalling kiosk
- Magnetising current

The following additional checks shall be made:

- All oil valves are in correct position closed or opened as required.
- Thermometer pockets are filled with oil.
- Oil is at correct level in the conservator.
- Earthing connections are made.
- Colour of Silica gel is blue.
- Bushing arcing horn is set correctly and gap distance is recorded.

8.12. Commissioning

The equipment shall be commissioned as per CBIP manual, IS: 10028 and manufacturer's recommendations. All the related drawings and manuals shall be pre-requisite for release of final payment.

8.13. Packing & forwarding

8.13.1. Packing

Supplier shall pack or shall cause to be packed all items in such a manner as shall be reasonably suitable for shipment by road to UPCL without any risk of damage in transit. The packing shall be sufficient to withstand, without limitation, rough handling during transit and exposure to extreme temperatures, salt and precipitation during transit, and open storage.

8.13.2. Packing List

One copy of the packing list shall be enclosed in each package delivered. There shall also be enclosed in one package a master packing list identifying each individual package, which is part of the shipment. If, on any package, it is not possible to place packing list inside the container, all pertinent information shall be stenciled on the outside and will thus constitute a packing list.

8.14. Rejection

The Purchaser may reject any transformer if during tests or service any of the following conditions arise:

a) No load loss exceeds the guaranteed value.
b) Load loss exceeds the guaranteed value.
c) Impedance value exceeds the guaranteed value by + 10% or more.
d) The difference in impedance values of any two phases during single phase short circuit impedance test exceeds 2% of the average value guaranteed by the vendor.
e) Oil or winding temperature rise exceeds the specified value.
f) Transformer fails on impulse test.
g) Transformer fails on power frequency voltage withstand test.
h) Transformer is proved to have been manufactured not in accordance with the agreed specification.

8.15. Schedules

8.15.1. Schedule – I [Guaranteed Technical Particulars for 33/11 kV, 5 MVA Power Transformer]

Table 8-8: Guaranteed Technical Particulars for 33/11 kV, 5 MVA Power Transformer

S.No.	Description	Unit	Specified
1	Name and address of the Manufacturer		
	a) Transformer		
	b) HV & LV Bushings		
	c) Bimetallic connectors		

S.No.	Description	Unit	Specified
	d) Transformer Oil		
	e) Off Load/ On load tap changer		
	f) Instruments		
2	Service (Indoor / Outdoor)		Outdoor
3	Normal continuous rating in kVA under site conditions at all taps :	kVA	
	a) HV winding	kVA	8000
	b) LV winding	kVA	8000
4	Rated Voltage		
	a) HV winding	kV	33
	b) LV winding	kV	11
5	Rated frequency	Hz	50(+ - 5%)
6	No. of phases		3
7	Type of transformer		Conventional Power Transformer
8	Connections		
	a) HV winding		Delta
	b) LV winding		Star
9	Connections symbols		
	a) HV – LV		Dyn11
10	Tapings		
	a) Range		+ 0% to - 15% (in steps of 2.5%)
	b) Number of steps		9
	c) Position of tapping on HT winding for high voltage variation		
11	Reference ambient temperatures		
	a) Maximum ambient air temperature.	°C	50°C
	b) Maximum daily average ambient temperature	°C	35°C
	c) Minimum ambient air temperature.	°C	10°C
	d) Maximum yearly weighted average ambient air temperature.	°C	35°C

S.No.	Description	Unit	Specified
12	Maximum temperature rise over ambient temperature		
	a) In oil by thermometer	°C	35°C
	b) In winding by resistance measurement	°C	40°C
	c) Limit for hot spot temperature for which the transformer is designed	°C	90°C (as per IS 2026)
	d) Type and details of winding hot spot temperature detector	°C	WTI with 150 mm dia. dial type instrument temp. Sensing element image coil, auxiliary CT, 2 nos. of contacts of high winding temperature alarm and trip, calibration devices.
	e) Temperature gradient between windings and oil	°C	
	f) Type of maximum winding temperature	°C	
13	Voltage to earth for which the star point will be insulated	kV	
14	Cooling type		ONAN
15	Losses		
	a) Fixed (Iron) losses of 3 phase Transformer (kW) at rated voltage & rated frequency	kW	7.0 kW (Max)
	b) Load losses at rated current at principal	kW	48.0 kW (Max)
16	Max. Current density in winding at rated current for normal tap position		
	a) HV winding (Amps/ sq.mm.)	A/mm2	2.8 (Amps/ sq.mm)
	b) LV winding (Amps / sq.mm.)	A/mm2	2.8 (Amps/ sq.mm)
17	Impedance voltage at rated current ,frequency and at 75 °C expressed as percentage of rated voltage at :-		
	a) Principal (normal) tap	%	7.15% + 10% Tolerance
	b) Highest tap	%	

S.No.	Description	Unit	Specified
	c) Lowest tap	%	
18	Reactance at rated current & frequency as percentage of rated voltage at:		
	a) Principal (normal) tap	%	
	b) Highest tap	%	
	c) Lowest tap	%	
19	Resistance at 75 ºC		
	a) H.V. winding at normal tap position	Ohms	
	b) L.V. winding	Ohms	
	c) Resistance voltage drop at 75ºC winding temperature expressed as percent of rated voltage	%	
	i) Principal/ normal tap	%	
	ii) Highest tap	%	
	iii) Lowest tap	%	
20	Capacitance on open circuit conditions		1800 pF(Approximately)
21	Insulation level		
	a) Separate source power frequency voltage withstand		
	i) HV winding	kV rms	70
	ii) LV winding	kV rms	28
	b) Induced over voltage withstand		
	i) HV winding	kV rms	--- Double Voltage & Double Frequency -
	ii) LV winding	kV rms	--- Double Voltage & Double Frequency -
	c) Full wave lightning impulse withstand		
	i) HV winding	kV peak	

S.No.	Description	Unit	Specified
	ii) LV winding	kV peak	
	d) Power frequency high voltage tests		
	i) Test voltage for one minute withstand test on high voltage windings (induced)	kV rms	
	ii) Test voltage for one minute withstand test on low voltage windings	kV rms	
	iii) Test voltage for one minute withstand test on neutral end of low voltage windings	kV rms	
	e) Lightning impulse withstand tests		
	i) Impulse test on high voltage winding 1.2/50 µ sec full wave withstand	kV peak	
	ii) Impulse test on low voltage winding 1.2/50 µ sec full wave withstand	kV peak	
	iii) Wave form for impulse test	kV peak	
22	No load current, no load loss, no load power factor at normal ratio and frequency	Amp/ kW/P.F	
	a) 10 percent of rated voltage		Will be furnished by Bidders Offer
	b) 25 percent of rated voltage		
	c) 50 percent of rated voltage		
	d) 85 percent of rated voltage		
	e) 100 percent of rated voltage		
	f) 105 percent of rated voltage		
	g) 110 percent of rated voltage		
	h) 112.5 percent of rated voltage		
	i) 115 percent of rated voltage		
	j) 120 percent of rated voltage		
	k) 125 percent of rated voltage		

S.No.	Description	Unit	Specified
23	Efficiency at 75ºC at unity power factor		
	a) Full load	%	
	b) 75% load	%	
	c) 50% load	%	
	d) 25% load	%	
24	a) The minimum % of load at which the transformer will run at maximum efficiency (%)	%	
	b) Maximum efficiency of the transformer	%	
25	Regulation at full load at 75ºC		
	a) At unity power factor	%	
	b) At 0.8 power factor (lagging)	%	
26	Core data		
	a) Grade of core material used		CRGO HIB, M3 or better
	b) Thickness of core plate lamination	Mm	≤ 0.23 mm for M3 and ≤ 0.27 mm for CRGO HIB
	c) Whether core laminations are of cold rolled grain oriented		CRGO HIB, M3 or better
	d) Details of oil ducts in core		
	i) Whether in the plane & at right angle to the plane of winding		
	ii) Across the plane of lamination		
	e) i) Insulation of core lamination		
	ii) Insulation of core plates		
	iii) Type of core joints		
27	Flux density		
	a) Designed maximum flux density at normal tap at rated voltage and rated frequency	Tesla	1.5 Tesla
	b) Operating continuous flux density	Tesla	1.5 Tesla
	i) at normal tap	Tesla	

S.No.	Description	Unit	Specified
	ii) at maximum tap	Tesla	
	iii) at minimum tap	Tesla	
	c) Designed maximum operating flux density which the transformer can withstand for one minute at normal tap	Tesla	1.5 Tesla for all Tap
	d) Designed maximum operating flux density which the transformer can withstand for five seconds at normal tap	Tesla	
28	Inter-Tap insulation		
	a) Extent of extreme end turns reinforcement		
	b) Extent of end turns reinforcement		
	c) Extent of turn adjacent to tapping reinforced		
	d) Test voltage for 10 seconds 50Hz inter- turn insulation test on (a)		
	e) Test voltage for 10 seconds 50Hz inter-turn insulation test on (b)		
	f) Test voltage for 10 seconds 50Hz inter-turn insulation test on (c)		
29	Windings:		
	a) Material		
	b) Type of windings:		
	i) HV windings		
	ii) LV windings		
	c) Insulation of HV windings		
	d) Insulation of LV windings		
	e) Insulation between HV & LV windings		
31	Transformer Tank		
	a) Material		
	b) Thickness		

S.No.	Description	Unit	Specified
	- Top	mm	10 mm
	- Sides	mm	10 mm
	- Bottom	mm	12 mm
	c) Details of painting (inner / outer surface)		
32	Dimensions of 3 phase transformers:		
	a) Max. Height to top of bushings	mm	
	b) Over-all length	mm	
	c) Over-all breadth	mm	
33	Weight data of transformer components (Tolerance + 5%) (approximate values not allowed)		
	a) Core excluding clamping	Kg	
	b) Core with clamping	Kg	
	c) HV winding insulated conductor	Kg	
	d) LV winding Insulated conductor	Kg	
	e) Coils with insulation	Kg	
	f) Core and windings	Kg	
	g) Weight of steel	Kg	
	h) Fittings and accessories	Kg	
	i) Oil required for first filling including 10% extra	Ltr/Kg	
	1. Oil in main tank	Ltr	
	2. Oil in the conservator	Ltr	
	3. Oil in the radiators	Ltr	
	4. Oil in the OLTC	Ltr	
	5. Overall total quantity of oil with 10% extra oil for first filling	ltr/Kg	
	j) 1. Transportation weight excluding accessories	Kg	
	2. Shipping details		
	i) Weight of heaviest package	Kg	

S.No.	Description		Unit	Specified
		ii) Dimension of largest package (L x Wx H)	mm	
	k)	Un-tanking weight	Kg	
	l)	Total weight of transformer with oil and fittings	Kg	
34	Bushing data :			
	a)	Type of bushing insulator		
		i) HV		Outdoor type highly polluted a (as per Is-8603, 2099 & 3347)
		ii) LV		-do-
		iii) Neutral		-do-
	b)	Material of bushing (inner part / outer part)		Porcelain (as per IS-8603)
	c)	Weight of bushing insulator (Kg.)		
		i) HV	Kg	
		ii) LV	Kg	
		iii) Neutral	Kg	
	d)	Quantity of oil in one bushing (lt.)		
		i) HV	ltr.	
		ii) LV	ltr.	
		iii) Neutral	ltr.	
	e)	Minimum dry withstand & flash over power frequency voltage of bushing	kV	
	f)	Minimum wet withstand & flash over power frequency voltage of bushing	kV	
	g)	Minimum withstand & flashover impulse level	kV	
	h)	Voltage rating	kV	
		i) HV	kV	
		ii) LV	kV	
		iii) Neutral	kV	
	i)	Current rating (Amps.)		

S.No.	Description	Unit	Specified
	i) HV	Amp	
	ii) LV	Amp	
	iii) Neutral	Amp	
j)	Thermal Short Time current & Duration	Sec	2 Sec
	i) HV	kA	
	ii) LV	kA	
	iii) Neutral	kA	
k)	Rated Dynamic current & its duration	Sec	As per Is-2026 & 2029
	i) HV	kA	
	ii) LV	kA	
	iii) Neutral	kA	
l)	Cantilever with stand loading		
m)	Clearance in oil		
	phase to phase		
	i) HV	mm	
	ii) LV	mm	
	iii) Neutral	mm	
	phase to earth (mm)		
	i) HV	mm	
	ii) LV	mm	
	iii) Neutral	mm	
n)	Creepage distance in oil & air (mm)	mm/kV	
	i) In oil		
	a) HV	mm	
	b) LV	mm	
	c) Neutral	mm	
	ii) In air	mm	
	a) HV	mm	
	b) LV	mm	

S.No.	Description		Unit	Specified
		c) Neutral	mm	
	o)	Minimum level of immersing / medium (oil)	mm	
	p)	Maximum pressure of immersing medium (oil)	kg/cm^2	
	q)	Free space required at top for removal of bushings	mm	
	r)	Angle of mounting		
35	Conservator (Main Transformer and OLTC)			
	a)	Total volume of the Conservator	M3	
	b)	Volume of the conservator between the highest and lowest level	M3	
36	Calculated time constants for natural cooling		Hrs	
37	Type of axial coil supports :			
	a)	HV winding		
	b)	LV winding		
38	Details of On load / off-circuit tap changer			
	a)	Make		
	b)	Type		
	c)	Rating		
		i) Rated Voltage	kV	
		ii) Rated current	Amp	
		iii) Step voltage	V	
		iv) Number of steps		
	d)	Whether Diverter switch provided with gas vent and Buchholz relay (Yes / No)	Yes/No	
	e)	Whether a separate oil surge relay with trip contracts provided (Yes / No)		
	f)	Whether Remote control panel provided with Control scheme for simultaneous operation of Tap changer when transformers running in		

S.No.	Description		Unit	Specified
		Parallel and independent control when in independent operation		
	g)	Details of motor device unit housed in kiosk mounted on tap changer		
	h)	Pressure relief valve		
39	Dispatch details :			
	a)	Approx. mass of heaviest Package	Kg	
	b)	Approx. dimensions of largest Package		
		i) Length	mm	
		ii) Breadth	mm	
		iii) Height	mm	
40	Un-tanking height		mm	
41	Bimetallic connectors: HV / LV			
	a)	Normal current rating (A)	Amp	
	b)	Short time current rating (A)	Amp	
	c)	Tensile strength	Kg	
	d)	Maximum temperature limit		
	e)	Dimensional sketch enclosed indicating tolerances (Yes/No)		
	f)	Minimum clearance		
		Phase to phase	mm	
		Phase to Earth	mm	
42	CORE ASSEMBLY:			
	a)	Core diameter	mm	
	b)	Core window height	mm	
	c)	Core leg Centre	mm	
	d)	Gross core cross - sectional area	m^2	Will be furnished by Bidder Offer
	e)	Total height of core	mm	
	f)	Details of top end frame		
	g)	Details of Bottom end frame		

S.No.	Description		Unit	Specified
	h)	Details of clamp plate (material, thickness, insulation)		
	i)	Total core weight	Kg	
	j)	Core loss, basing on core loss graph at operating flux density (rated voltage and rated frequency)	kW	
	k)	Core stacking factor		
	l)	Net core area (Sq. M.)	M2	
	m)	Margin towards corner joints, cross-fluxing, dielectric loss	kW	
	n)	Total core loss at rated voltage and rated frequency	kW	
	o)	Describe location/ method of core grounding		
	p)	Details of core- belting		
		i) Material , grade and type		
		ii) Width	mm	
		iii) Thickness	mm	
		iv) Fixing method		
43	DETAILS OF WINDING:			
	a)	Type of winding		
	b)	Material of the winding conductor		Electrolytic Copper
	c)	Maximum current density of windings at rated current and conductor area (HV/LV)	A/mm2	2.8 Amps /mm2 (at all taps)
	d)	Whether windings are pre-shrunk?		
	e)	Whether adjustable coil clamps are provided for HV and LV windings?		
	f)	Whether steel rings are used for the windings? If so, whether these are split?		

S.No.	Description		Unit	Specified
	g)	Whether electrostatic shields are provided to obtain uniform voltage distribution in the windings?		
	h)	Winding Insulation (Type & Class)		
	i)	Insulating material , used for		
		i) H.V winding		
		ii) LV winding		
		iii) Tapping connection		
	j)	Insulating material used between		
		i) L.V and H.V winding		
		ii) Core & L.V winding		
	k)	H.V to H.V winding between phases		
	l)	Type of axial supports		
		i) H.V winding		
		ii) L.V winding		
	m)	Type of radial supports		
		i) H.V winding		
		ii) L.V winding		
	n)	Maximum allowable torque on coil clamping bolts		
	o)	Clamping ring details		
		i) Thickness of ring mm	Mm	
		ii) Diameter of ring mm	Mm	
		iii) No. & size of pressure screw		
	p)	Bare conductor size		
		i) HV	mm^2	
		ii) LV	mm^2	
	q)	Inside diameter		
		i) HV	mm	
		ii) LV	mm	
	x)	Outside diameter		

S.No.	Description	Unit	Specified
	i) HV	mm	
	ii) LV	mm	
	y) Axial height after shrinkage		
	i) HV	mm	
	ii) LV	mm	
	z) D.C Resistance		
	i) L.V winding at 75°C	Ohm	
	ii) H.V winding at normal tap at 75°C	Ohm	
	iii) H.V winding at highest tap at 75°C	Ohm	
	iv) H.V winding at lowest tap at 75°C	Ohm	
	v)Total I2R losses at 75°C for normal tap	kW	
	vi)Total I2R losses at 75°C for highest tap	kW	
	vii) Total I2R losses at 75°C for lowest tap	kW	
	viii) Stray losses including eddy current losses in winding at 75°C	kW	
	a) Normal tap position	kW	
	b) Highest tap position	kW	
	c) Lowest tap position	kW	
	d) Any special measures, taken to reduce eddy current losses and stray losses mention in details		
	ix)Load losses at 75°C (I2 R + Stray)		
	a) Normal tap position	kW	
	b) Highest tap position	kW	
	c) Lowest tap position	kW	
	x) Details of special arrangement, provided to improve surge voltage distribution in the windings.		
44	DETAILS OF TANK:		

S.No.	Description		Unit	Specified
	a)	Material of Transformer tank		
	b)	Type of tank		
	c)	Thickness of sheet (No approximate value to be mentioned)		
		i) Sides (mm)	mm	10 mm
		ii) Bottom (mm)	mm	12 mm
		iii) Cover (mm)	mm	10 mm
		iv) Radiators (mm)	mm	1. 2 mm
	d)	Inside dimensions of main tank (No approximation in dimensions to be used)		
		i) Length (mm)	mm	As per CBIP
		ii) Breadth (mm)	mm	As per CBIP
		iii) Height (mm)	mm	As per CBIP
	e)	Outside dimensions of main tank approximation in dimensions to be used)	(No	
		i) Length (mm)	mm	
		ii) Breadth (mm)	mm	
		iii) Height (mm)	mm	
	f)	Vacuum recommended for hot oil circulation (Torr / mm of Hg)	Kg/cm2	
	g)	Vacuum to be maintained during oil filling in transformer tank (Torr / mm of Hg)	Kg/cm2	
	h)	Vacuum to which the tank can be subjected without distortion ((Torr / mm of Hg)	Kg/cm2	
	i)	No. of bi-directional wheels provided		
	j)	Track gauge required for the wheels		
		i) Transverse axis	mm	
		ii) Longitudinal axis	mm	

S.No.	Description	Unit	Specified
	k) Type and make of pressure relief device and minimum pressure at which it operates (kpa)		
45	CONSERVATOR:		
	a) Thickness of sheet (mm)	mm	
	b) Size (Dia. x length) (mm)	mm	
	c) Total volume (Litres)	Ltr	
	d) Volume between the highest and lowest visible oil levels (Litres)	Ltr	

8.15.2. Schedule – II [Information regarding manufacturing and testing facilities etc.]

(Vendor to enclose following documents and to confirm the same)

Table 8-9: Information regarding manufacturing and testing facilities etc.

S.No.	Particulars	Confirmation
1	Type test report from CPRI/ NABL accredited lab (less than 5 years old as on date of opening of offer)	Yes
2	List of plant and machinery	Yes
3	List of testing facility available	Yes
4	List of orders pending and executed	
	a) With UPCL	Yes
	b) With other agencies, other than 4.A	Yes

9. Technical Specification of 33/11Kv, 5 MVA, ONAN Power Transformer with On- Load Tap Changer

9.1. Scope

This specification covers design, engineering, manufacture, assembly, testing, inspection before dispatch, forwarding, packing, transportation to site of three phase, 50 Hz, 5 MVA 33/11kV step-down outdoor ONAN Power Transformers with on-load tap changer complete with all accessories/fittings and spare parts as specified herein, for use in sub-stations in Uttarakhand state.

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 purchaser 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.

It is not the intent to specify herein complete details of design and construction. The equipment offered shall conform to the relevant standards and be of high quality, sturdy, robust and of good design and workmanship complete in all respects and capable to perform continuous and satisfactory operations in the actual service conditions at site and shall have sufficiently long life in service as per statutory requirements. In actual practice, notwithstanding any anomalies, discrepancies, omissions, incompleteness, etc. in these specifications and attached drawings, the design and constructional aspects, including materials and dimensions, will be subject to good engineering practice in conformity with the required quality of the product, and to such tolerances, allowances and requirements for clearances etc. as are necessary by virtue of various stipulations in that respect in the relevant Indian Standards, IEC standards, CEA Regulations , Electricity Act and other statutory provisions.

9.2. Service Condition

Equipment/material to be supplied against this specification shall be suitable for satisfactory continuous operation under the tropical conditions as follows:

Table 9-1: Service Conditions

S.No.	Particulars	Value
1	Maximum ambient temperature (Deg. Celsius)	50
2	Minimum temperature (Deg. Celsius)	-5
3	Relative humidity range (%)	10 to 100

S.No.	Particulars	Value
4	Maximum annual rainfall (mm)	1500
5	Maximum wind pressure (kg/sq m)	195
6	Wind speed zones (m/s)	47 & 39
7	Maximum altitude above mean sea level (m)	3000
8	Isoceraunic level (days/year)	50
9	Seismic level (Horizontal acceleration) (g)	0.13

9.3. Standards

The equipment shall comply with latest revision of the following Indian Standards (IS) unless otherwise stipulated in the specification.

All references to Indian Standards shall be deemed to be complying with latest amendments to the respective IS, if any.

Table 9-2: Standards

Indian Standard	Particulars	International standard
IS: 2026 (Part- 1 to 4)	Power transformers	IEC 76 (1-5)
IS:1271	Classification of insulating materials for electrical machinery and apparatus	
IS:335	New insulating oil for transformers, Switchgears	IEC 296
IS:2071	Method of high voltage testing	
IS:2099	High voltage porcelain bushings	IEC 137
IS:2147	Degree of protection	IEC 529
IS:2705	Current transformers	
IS:3347	Dimensions for porcelain transformer bushings	
IS:3637	Gas operated relays	
IS:3639	Fittings and accessories for power transformers	
IS: 6600	Guide for loading of oil immersed transformers	IEC 354
IS:5561	Electric Power Connectors	
IS: 10028	Code of practice for selection, installation and maintenance of transformers, Part I, II and III	

Indian Standard	Particulars	International standard
IS:3202	Code of practice for climate proofing of electrical equipment	
IS:5	Colour for ready mixed paints	
IS : 325	Three Phase Induction Motors	
C.B.I.P. Publication	Manual on Transformers	
	Insulation Co-ordination	IEC 71
	Radio influence voltage measurement	IEC 437
	Measurement of transformer and reactor sound levels	IEC 551

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; and if the IS mentioned is upgraded then the latest version of IS shall be applicable

9.4. Specific Technical Requirements

Specific technical requirements shall be as follows:

Table 9-3: Specific Technical Requirements

S.No.	Parameter	Particulars
1	Rated MVA (ONAN rating)	10 MVA
2	No. of phases	3
3	Type of installation	Outdoor
4	Frequency	50 Hz
5	Cooling medium	Insulating oil
6	Rated voltage	
7	High voltage winding	33kV
8	Low voltage winding	11kV
9	Highest continuous system voltage	
10	a) HV side	36kV
	b) HV Side	12kV
11	Type of tap changer	On-load tap changer on HV winding
12	No. of windings	Two

S.No.	Parameter	Particulars
13	Range of tapings	Plus 5% to minus 10% of 2.5% each on HV winding
14	Neutral terminal to be brought out	On LV side only
15	Impedance on rated MVA base at 75^0 C, on normal tap	7.15% for 5 MVA (Tolerance plus 10%, negative tolerance shall not be allowed)
16	Type of winding insulation	Uniform both for HV and LV
17	Over voltage operating capacity & duration	112.5 % of rated voltage (continuous)
18	Anticipated unbalanced loading	Around 10 %
19	Anticipated continuous loading of windings (HV/LV)	110 % of rated current
20	Maximum Flux Density in any part of the core and yoke at rated MVA, rated voltage i.e. 33kV / 11kV and system frequency of 50Hz.	1.9 Tesla
21	Power frequency withstand test voltage (kV rms)	70 kV (HV), 28 kV (LV)
22	Impulse withstand test voltage (kV peak)	170 (HV) , 95 (LV)
23	Withstand time for three phase short circuit	2 seconds
24	Winding connection	
25	LV Side	Star
26	HV Side	Delta
	Winding material (HV & LV)	Electrolytic Copper
	Vector group	Dyn 11
27	Type of cooling	Insulating oil (ONAN)
28	Neutral earthing	LV neutral shall be solidly earthed
29	Winding temperature Indicator	One
30	Provision for Differential Protection arrangement	Not required
31	Oil Temperature indicator	One
32	Maximum temperature rise on top of oil over an ambient temperature of 50^0 C (measured by thermometer)	45^0 C

S.No.	Parameter	Particulars
33	Maximum temperature rise of winding over an ambient temperature of 50^0 C (measured by resistance)	50^0 C
34	Over load capacity	As per IS:6600
35	Degree of protection for marshaling box	IP 55
36	Noise level at rated voltage and frequency	As per NEMA publication no. TR-1
37	Minimum clearances in air (mm)	
	Phase to phase	HV - 400, LV – 280
	Phase to ground	HV- 320, LV – 140
38	Terminals (Bushings)	
	HV winding line end	36 kV oil filled communicating type porcelain bushing (Anti fog type)
	LV winding (for outdoor type 11 kV breakers)	12 kV porcelain type bushing (Anti fog type)
39	Minimum creepage distance	900 mm (HV), 300 mm (LV)
40	Maximum current density for HV, LV windings for rated current	2.4 Amp/sq mm
41	Core material	High grade, non-ageing Cold Rolled Grain Oriented (CRGO) silicon steel, confirming to HIB grade
42	Core assembly	Boltless Core type
43	Type of mounting	On wheels, mounted on rails
44	Maximum permissible no load loss at rated voltage and rated frequency	6.0 kW for 5 MVA
45	Maximum permissible load loss at rated current at 75^0 C	34 kW for 5 MVA

9.5. General Technical Requirements

9.5.1. General

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 MVA, voltage and frequency shall be such that the flux density under 12.5% over voltage condition shall not exceed 1.9 Tesla.
c) With combined voltage variation of +12.5% and frequency variation of -5%, the flux density shall not exceed 1.9 Tesla.
d) Transformer shall be able to withstand without injurious heating, combined voltage and frequency fluctuation which produce the 125% over fluxing condition for one minute and 140 % for 5 seconds.
e) The transformer shall be capable of operating continuously without danger on any particular tapping at the rated MVA ±12.5% of the voltage corresponding to the tapping.
f) Transformer shall be capable of withstanding thermal and mechanical stress caused by any symmetrical and asymmetrical faults on any winding. This shall be demonstrated through calculation as per IS:2026.
g) The thermal ability withstand short circuit shall be demonstrated by calculation.
h) 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.
i) Transformer noise level, when energised at normal voltage and frequency shall be as per NEMA TR -1 stipulations.
j) 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.
k) The transformer shall be capable of being operated without danger on any tapping at the rated kVA with voltage variation of + 10% corresponding to the voltage of the tapping.

9.5.2. Construction Features

a) 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.
b) Similar parts, particularly removable ones, shall be interchangeable.
c) 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.
d) Nuts, bolts and pins used inside the transformers and tap changer compartments shall be provided with lock washers or locknuts.
e) Exposed parts shall not have pockets where water can collect.
f) Internal design of transformer shall ensure that air is not trapped in any location.
g) Material in contact with oil shall be such as not to contribute to the formation of acid in oil.
h) Surface in contact with oil shall not be galvanized or cadmium plated.
i) 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.
j) All internal connections and fastenings shall be capable of operating under overloads and over-excitation, allowed as per specified standards without injury.
k) Transformer and accessories shall be designed to facilitate proper operation, inspection, maintenance and repairs.

l) No patching, plugging, shimming or other such means of overcoming defects, discrepancies or errors will be accepted.
m) Schematic Drawing of the wiring, including external cables shall be put under the prospane sheet on the inside door of the transformer marshalling box.

9.5.3. Core

a) Stage level inspection for core construction shall be carried out by the owner.
b) Each lamination shall be insulated such that it will not deteriorate due to mechanical pressure and the action of hot transformer oil.
c) 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 0.23 mm to 0.27 mm or better.
d) The maximum flux density in any part of the cores and yoke at normal voltage and frequency shall be such that the flux density with + 12.5 % voltage variation from rated voltage or frequency variation of -5% shall not exceed 1.9 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.
e) Following documents shall be submitted during stage inspection as proof towards use of prime core material:
   - Purchase order
   - Invoice of the supplier
   - Mills test certificate
   - Packing list
   - Bill of lading
   - Bill of entry certificate to customs
f) Core material shall be directly procured either from the manufacturer or through their accredited marketing organization of repute and not through any agent.
g) The laminations shall be free of all burrs and sharp projections. Each sheet shall have an insulating coating resistant to the action of hot oil.
h) The insulation structure for the core to bolts and core to clamp plates, shall be such as to withstand 2000 Volt DC voltage for one minute.
i) The completed core and coil shall be so assembled that the axis and the plane of the outer surface of the core assembly shall not deviate from the vertical plane by more than 25 mm.
j) All steel sections used for supporting the core shall be thoroughly shot or sand blasted, after cutting, drilling and welding.
k) The finally assembled core with all the clamping structures shall be free from deformation and shall not vibrate during operation.
l) The core clamping structure shall be designed to minimize eddy current loss.
m) The framework and clamping arrangements shall be securely earthed.
n) The core shall be carefully assembled and rigidly clamped to ensure adequate mechanical strength.

o) 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.
p) The design of magnetic circuit shall be such as to avoid static discharges, development of short circuit paths within itself or to the earthed 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.
q) 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 assembly shall be so fixed in the tank that shifting will not occur during transport or short circuits.
r) The temperature gradient between core & surrounding oil shall be maintained less than 20 ^{0}C. The manufacturer shall demonstrate this either through test (to be mutually agreed) or by calculation.

9.5.4. Windings

a) 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.
b) 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.
c) 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.
d) 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.
e) Varnish application on coil windings may be given only for mechanical protection and not for improvement in dielectric properties. In no case varnish or other adhesive be used which will seal the coil and prevent evacuation of air and moisture and impregnation by oil.
f) Winding and connections shall be braced to withstand shocks during transport or short circuit.
g) 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.
h) All the insulating materials to be used in the transformer shall preferably be of class- A insulation as specified in Indian Standards. The test certificate of the raw materials shall be made available by the Transformer manufacturer on request during inspection and testing.
i) The coil clamping arrangement and the finished dimensions of any oil ducts shall be such that it will not impede the free circulation of oil through the ducts.
j) Coil clamping rings, if provided shall be of steel or suitable insulating material. Axially laminated material other than backlisted paper shall not be used.
k) Terminals of all windings shall be brought out of the tank through bushings for external connections.
l) The completed core and coil assembly 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.

m) The winding shall be so designed that all coil assemblies 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.
n) 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.
o) Adequate barriers shall be provided between coils and core and between high and low voltage coil. End turns shall have additional protection against abnormal line disturbances.
p) 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.
q) Tapings 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 the transformer at all voltage ratios.
r) Magnitude of impulse surges transferred from HV to LV windings by electromagnetic induction and capacitance coupling shall be limited to B.I.L. of LV winding.
s) The current density adopted in all windings shall not exceed 2.4 A/ sq mm . The total net cross sectional area of strip conductors for calculating current density for each winding shall be obtained after deducting the copper area lost due to rounding up of the sharp edges of the rectangular conductors.

9.5.5. Insulating Oil

a) The insulating oil for the transformers shall be of EHV grade, conforming to IS: 335. No inhibitors shall be used in the oil.
b) Transformer shall be shipped with oil filled at least to cover the core and coil assembly.
c) The quantity of oil required for the first filling of the transformer and its full specification shall be stated in the bid. The bidder shall quote the price of transformer complete with first filling of oil plus 10% extra. However, the rate of transformer oil in Rupee per litre shall be quoted separately also. The transformer oil shall be supplied in non-returnable drums.
d) 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.
e) The Supplier shall warrant that oil furnished is in accordance with the following specifications. Supplier shall submit the test certificate accordingly.

Table 9-4: Insulating Oil specifications

S.No.	Characteristic	Requirement	Method of Test
1	Appearance	The oil shall be clear & transparent & free from	A representative sample of oil shall be examined in a 100

S.No.	Characteristic	Requirement	Method of Test
		suspended matter or sediment	mm thick layer at ambient temp.
2	Density at 20 deg. C	0.89g/cm3 Max.	IS: 1448
3	Kinematic Viscosity at 27 deg. C Max	27 CST	IS: 1448
4	Interfacial tension at 27 deg. C Min.	0.03N/m	IS: 6104
5	Flash Point	140 deg. C	IS: 1448
6	Pour Point Max.	-6 deg. C	IS: 1448
7	Neutralization Value (Total acidity) Max.	0.04 mg KOH/gm	IS: 335
8	Electric strength Break Down (voltage) Min.	60 kV	IS: 6792
9	Dielectric dissipation factor tan delta at 900 C	0.002 Max	IS:6262
10	Min. Specific resistance(resistivity) at 90 deg. C	35 x 1012 ohm cm (min.)	IS: 6103
	Min. Specific resistance(resistivity) at 27 deg. C	1500x1012	
11	Neutralisation value after Oxidation	0.40 mg KOH/g	
12	Total sludge after Oxidation	0.10% by weight max.	
13	Presence of oxidation Inhibitor	The oil shall not contain anti-oxidant additives	IS:335
14	Water content Max:	Less than 25 ppm	IS: 2362

9.5.6. Internal Earthing

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

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

- By connection through vertical tie-rods to the top structure.

- By direct metal to metal contact with the tank base.
- By a connection to the top structure on the same side of the core as the main earth connection to the tank.

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.

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.

9.5.7. Tank

The Transformer tank and cover shall be fabricated from high grade low carbon plate steel of tested quality of adequate thickness. The tank and the cover shall be of welded construction. All welds shall be stress relieved. Stiffener shall be provided for general rigidity. Tank surface shall be designed to prevent retention of water.

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

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

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

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.

All bolted connections to the tank shall be fitted with suitable oil-tight gaskets which shall give satisfactory service under the operating conditions for complete life of the transformer. Special attention shall be given to the methods of making the hot oil-tight joints between the tank and the cover as also between the tank cover and the bushings and all outlets to ensure that the joint can be remade satisfactorily and with ease, with the help of semi-skilled labour. Where compressible gaskets are used, steps shall be provided to prevent over-compression.

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

9.5.8. 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 suitably sloped so that it does not retain rain water.

9.5.9. Under Carriage

The transformer tank shall be supported on steel structure with detachable plain rollers completely filled with oil. Suitable channels for movement of roller with transformer shall be spaced accordingly. Rollers wheels shall be provided with suitable rollers bearings, which will resist rust and corrosion and shall be equipped with fittings for lubrication. It shall be possible to swivel the wheels in two directions, at right angle to or parallel to the main axis of the transformers.

Jacking pads shall be provided on the transformer. It shall be possible to change the direction of the wheels through 90 degree when the transformer is lifted on jacks to permit movement of the transformer both in longitudinal and transverse directions.

9.5.10. Valves

Valves shall be of forged carbon steel up to 50 mm size and of gun metal or of cast iron bodies with gun metal fittings for sizes above 50 mm. 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.

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 supplier shall supply the same.

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

- Drain valve so located as to completely drain the tank.
- Two filter valves on diagonally opposite corners, of 50 mm size.
- Oil sampling valves not less than 8 mm at top and bottom of main tank.
- One 15 mm air release plug.
- Valves between radiators and tank.

Drain and filter valves shall be suitable for applying vacuum as specified in the specifications.

9.5.11. Painting, Surface Preparation for tank, pipes, etc.

- All surfaces of transformer tank, pipes, etc. shall be thoroughly blast cleaned with sand or shot or grit in accordance with ISO 8501 Part 1 to a minimum standard of "Sa2½" to make the surface free from visible oil, grease & dirt, mill scale, rust, paint coatings and foreign matter. Machined areas and threaded components etc. are to be covered during blasting to prevent damage.
- The air that is used for blasting should be dry and free from oil. The flanges, angles, tank curbs and other such areas shall be preferably blast cleaned prior to fabrication and paint these with one coat

of primer. After adequate blast cleaning of each large surface where blasting time is more than three hours, an overall blast cleaning is to be done on the entire surface once more so that entire surface areas is exposed as fresh for first coat of primer paint. The first coat of primer paint should be applied not later than 3-4 hours after preparation of surface to avoid oxidation.

- Surface Preparation for radiator:
  All internal and external surfaces of radiator shall be thoroughly cleaned either by chemical cleaning or by blast with sand or shot or grit in accordance with ISO 8501 Part 1 to make the surface free from visible oil, grease & dirt, mill scale, rust, paint coatings and foreign matter. Suitable chemical should be used for chemical cleaning, if required. The air that is used for blasting should be dry and free from oil. After adequate surface cleaning, the first coat of primer paint/varnish should be applied not later than 3-4 hours after preparation of surface to avoid oxidation.
- Surface Preparation for Control cabinets/Marshaling Boxes:
  Surface Preparation for all Transformer Control cabinets/Marshaling Boxes shall be carried out confirming to following Indian standard in dust free area:
- IS: 3618: Degreasing by solvent wiping: Phosphate Treatment of Iron &Steel for Protection against corrosion.
- IS: 6005: Code of Practice for phosphating of Iron & Steel.

a) Chemicals:
   Suitable chemicals should be used and concentration of chemicals /weight of Phosphate coating should be checked regularly as per recommendation of the chemical manufacturer and applicable IS.
b) Inspection:
   The surface for application of paint should be dry, free from oil, dirt, acid & loose adhering powder and reasonably smooth in finish without uncovered areas, rusty surfaces and roughness.
c) Painting:
   Control cabinets/Marshalling Boxes -Enamel paint shall be used with total paint thickness as minimum 80 microns.

Painting- external & internal surfaces:

Painting shall be carried out in closed and dust free area. The external surface shall be coated with suitable layers of paint and to form an impermeable layer so that air and water cannot reach the substrate. The paint selected shall be stable in outdoor condition such as rain, sunlight, pollution etc. Paint used for primer, under coat and top or finish coat should be from the same manufacturer and compatible to each other. In case in the rare event, paint used for primer, under coat and finish coat are not from the same manufacturer the compatibility test of the paint from different source shall be carried out. Painting shall be applied as per the recommendation of the paint manufacturer. The number of coats shall be such that the minimum dry film thickness (DFT) specified is achieved. The DFT of painted surface shall be checked with a measuring gauge to ensure specified DFT. Complete painting scheme for the transformer is tabulated below:

Painting-Transformer tank, pipes, radiator etc.:

Table 9-5: Painting Specifications

	Surface Preparation	Prime Coat	Intermediate Undercoat	Finish Coat	Total DFT	Colour Shade
Tank, pipes, etc. (External surfaces)	Blast cleaning Sa2½	Epoxy base Zinc primer (30-40 μm)	Epoxy HB MIO (30-40 μm)	Aliphatic Polyurethane (min 50 μm)	Min 155 μm	697 shade as per IS 5
Tank (Internal surfaces)	Blast cleaning Sa2½	Hot oil resistant, non-corrosive varnish or paint or epoxy	--	--	Min 30 μm	Glossy white for paint
Radiator (External surfaces)	Chemical / blast cleaning (Sa2½)	Epoxy base zinc primer (30-40μm)	Epoxy base zinc primer (30-40μm)	PU paint (min 50μm)	Min 110 μm	Matching shade of tank/ different shade aesthetically matching to tank
Radiator and pipes (Internal surfaces)	Chemical cleaning if required	Hot oil proof, low viscosity varnish, flushing with transformer oil.	--	--	--	--

9.5.12. Bushing

Transformer shall be provided with bushing insulators on both H.V and L.V. sides. H.V and L.V. bushings shall be located on opposite side.

The electrical characteristics of bushing insulator shall be in accordance with IS: 2099. Dimensions and type of bushing shall conform to IS: 3347 and shall be as follows: -

H.V. Bushing (33kV)	36kV Class	Porcelain bushing with plain sheds for heavily polluted atmosphere
L.V. Bushing (11kV)	12 kV Class	Porcelain bushing with plain sheds for heavily polluted atmosphere
Neutral Bushing	Neutral	Neutral of L.V. winding shall be brought out through porcelain bushing similar to L.V. Bushing for connection with earth terminal in line with LV bushing.

a) All porcelain used in bushings shall be homogeneous, non-porous, uniformly glazed to brown colour and free from blisters, burns and other defects.
b) Stress due to expansion and contraction in any part of the bushing shall not lead to deterioration.
c) Each bushing shall be capable to carry at least 200% of current of Continuous Maximum Rating (CMR) of transformer and the short time current shall be of the same as of transformer.
d) Fittings made of steel or malleable iron shall be galvanized.
e) Bushing shall be so located on the transformers that full flashover strength will be utilized.
f) All applicable routine and type tests certificates of the bushings shall be furnished for approval.
g) Bushing shall be supplied with bi-metallic/terminal connector/clamp/washers suitable for fixing to bushing terminal and the purchaser's specified conductors. The connector/clamp shall be rated to carry the bushing rated current without exceeding a temperature rise of 550° C over an ambient of 500o C. The connector/clamp shall be designed to be corona free at the maximum rated line to ground voltage.
h) Bushing of identical voltage rating shall be interchangeable.
i) Each bushing shall be so coordinated with the transformer insulation that all flashover will occur outside the tank.

- The creepage distance shall be not less than 25 mm/kV and protected creepage distance shall be not less than 50% of total.
- Arcing horns are to be provided with adjustable horn gap except the neutral bushing.
- Each terminal, including the neutral, shall be distinctly marked on both primary and secondary in accordance with the connection diagram fixed upon the transformer which shall conform to latest IS 2026 (Part IV).

j) Insulation Level: The transformer and bushing shall be capable to withstand test voltage as specified below:

Table 9-6: Insulation level

Particulars	Bushings	
Nominal voltage (in kV rms)	11 kV	33 kV
Highest voltage for equipment (in kV rms)	12	36
1.2/50 micro sec. impulse withstand voltage (in kV peak)	95	170
1 minute power frequency withstand voltage (in kV rms)	28	70
Minimum creepage distance (mm)	300	900
Minimum clearance (mm) : Phase to phase	280	400
Minimum clearance (mm) : Phase to earth	140	320

9.5.13. Protection & Measuring Devices

Oil Conservator Tank

- The conservator shall be of capacity to meet the requirement of expansion of the total cold oil volume in the transformer & cooling equipment and it should be such that the oil level will always be visible through the plain oil level gauge.
- A conservator will have volumetric capacity of at least 10 % of the total volume of oil in tank. Moreover the oil in conservator up to minimum level mark on the oil gauge shall be at least 3 % of the total volume of oil in transformer excluding oil in OLTC.
- The conservator tank shall be bolted into position so that it can be removed for cleaning purposes.
- The conservator shall be fitted with magnetic oil level gauge with low level electrically insulated alarm contact
- Plain conservator fitted with silica gel breather.
- It shall be provided with oil filling hole with cap on top and a drain valve at the bottom.

Oil Preservation Equipment (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.

Breather

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

- Passage of air is through a dust filter & Silica gel
- Silica gel is isolated from atmosphere by an oil seal.
- Moisture absorption indicated by a change in colour of the crystals of the silica gel can be easily observed from a distance.
- Breather is mounted not more than 1400 mm above rail top level.

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 contacts shall be provided for tripping when the device operates.

Buchholz Relay

Each transformer shall be provided with gas and oil actuated Relay (Buchholz Relay) equipment conforming of IS: 3637 double float type with one set of alarm contacts, one set of trip contacts and a testing pet cock. The contacts shall be wired with a P.V.C. armoured cable. A machined surface shall be provided on the top of Relay to facilitate the setting of Relay and to check the mounting angle in the pipe and cross level of the Relay. The pipe work shall be so arranged that all gas arising from the Transformer shall pass into the gas and oil actuated Relay. The oil circuit through the Relay shall not form a delivery path in parallel with any circulating oil pipe. A copper tube shall be connected from the gas collector to a valve located at about 1200 mm above ground level to facilitate sampling with the transformer in service.

Oil Temperature Indicator (OTI)

The transformers shall be provided with a 150 mm dial type thermometer 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 5A AC at 230 Volt supply.

Winding Temperature Indicator (WTI)

a) A device for measuring the hot spot temperature of the winding shall be provided. It shall comprise the following.
b) Temperature sensing element
c) Image Coil.
d) Auxiliary CTS, if required to match the image coil, shall be furnished and mounted in the local control panel.
e) 150 mm 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 one for trip.
f) Calibration device.
g) Two number NO electrical contact each capable of operating at 5 A ac, 230 Volt supply.
h) The scale on the dial of the thermometer should be 0 Deg.C to 150 Deg.C. The angular displacement of thermometer should be 270 Deg. The signaling contact of WTI & OTI shall be set to operate at the following temperature:

- OIL : Alarm-80 deg. C, Trip – 90 deg. C
- WINDING : Alarm-85 deg. C, Trip – 95 deg. C

Marshalling Box

Sheet steel (not less than 2 mm thick), weather, vermin and dust proof marshaling box fitted with required glands, locks, glass door, terminal Board, 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 sloping 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. The temperature indicators shall be so mounted that the dials are visible by standing at the ground level.

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

The marshaling box shall accommodate the following equipment:

- Temperature indicators
- Terminal blocks and gland plates for incoming and outgoing cables.
- Space heater with thermostat and MCB

All the above equipment except (b) 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.

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 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.

9.5.14. On- Load tap Changer

The transformers shall be provided with an On-Load Tap Changer (OLTC) of well reputed and of proven make as per technical requirement for varying the effective transformation ratio while the transformer is ON load and without providing phase displacement. The salient features of the OLTC shall be as under:

The tap changing mechanism should be suitable for automatic, remote control operation from remote control panel in the control room in addition to being capable of local manual as well as local electrical operation.

The **On Load Tap Changer (OLTC)** shall include the following:

e) An oil immersed tap selector and arcing switch on arc suppressing tap selector provided with ohmic or resistor type high speed diverter switch, for reduction of make and break arcing voltages, overloads and short circuits.

f) Diverter switch should be with snap action mechanism with energy accumulator mounted directly on the diverter switch.

g) Separate oil compartment

h) Easy removable diverter switch unit.

vi) Motor driven mechanism

vii) Control and protection devices

viii) Local tap changer position indicator

ix) Manual operation device

x) Make of OLTC – Indigenous make (type test certificates from (CPRI).

Control voltage – Any of the auxiliary power supply voltage.

The on-load tap changer shall be designed so that the contacts do not interrupt are within the main tank of transformer. The tap changer selector and arcing switch on arc suppressing tap selector switch shall be located in one or more oil filled compartments. The diverter switch should be provided with gas vent and Buchholz relay. It shall be designed as to prevent the oil in tap selector and diverter switch compartments from mixing with the oil in transformer. The barrier board between OLTC and the transformer tank shall be made of Silicon Bonded Resin Paper (SBRP)

The tap changer shall be capable of permitting parallel operation with other transformers of the same type. The transformer shall give full load output on all taps without exceeding the limit of permissible temperature rise in oil and winding. The manual operation device shall be so located on the transformer that it can be operated by a man standing at the level of transformer track. It shall be of robust construction and shall be capable of frequent operations. It shall not be possible to operate the electric drive when the manual operating gear is in use.

Necessary interlocks blocking independent control when the units are in parallel shall be provided.

The controls shall be so arranged as to ensure that when a tap change operation has commenced, it shall be completed independently of the operation of control relays or switches. Local or remote control switch shall cause one tap movement only, until the control switch has returned to the off position between successive operations. Under abnormal conditions such as may occur when the contractor controlling one tap change sticks, the arrangement must be such as to switch off supply to the motor so that an out of step condition is limited to one tap difference between the units./ Limit switches shall be provided to prevent over running of mechanism.

The transformer and the tap changing equipment shall be designed to permit full rated operation with tap changing equipment temporarily installed in any intermediate position. Details of out of step protection provided for the taps should be furnished in the tender.

The control scheme for the tap changer shall be provided for independent auto/non-auto control of the tap changer when the transformers are in independent service. Voltage relating relay should be designed for maximum operational simplicity for regulating the secondary voltage of power transformer with OLTC. The required EAD band settings are set by setting the nominal value and lower and upper levels independently.

In addition, provisions shall be made to enable non-auto/automatic parallel control also so that the tap changers of two or more transformers will be operated simultaneously when one unit is in parallel with another so that under normal conditions the tap changer will not become out of step and this will eliminate circulating current. Additional features like "Master / Follower" and visual indication, during the operation of motor shall also be incorporated.

A mechanical tap position indicator shall be provided on the tap changer in addition to remote indication equipment in the control room on remote control cubicle of OLTC. Necessary interlocks, for independent control when the units are in parallel shall be provided.

The whole of motor drive unit comprising the motor and its control gear including contractors, indicator, local electrical push buttons, five digit operation counter, handle for manual control etc. as well as terminals for the control and indication wiring shall be housed in a dust proof kiosk mounted on tap changer, A heating element with thermostat and MCB shall also be provided in kiosk for ensuring trouble free operation of the drive in cold weather. Arrangement shall be made for padlocking the kiosk. Tap position indication shall be visible by a number appearing in a small glass window on the front of the kiosk. For remote indication, an indication type instrument or digital type shall be provided on a panel on the 415 volts, 3 phase, 50 c/s external supply.

Any enclosed compartment not oil filled shall be adequately ventilated. All contractors, relay coils or other parts shall be suitably protected against corrosion or deterioration due to condensation, fungi etc.

The oil in the compartments of the main tap changing apparatus which do not contain contacts used for making or breaking current shall be maintained under conservator head by means of a pipe connection from the highest point of the chamber to the conservator. This connection shall be controlled by a suitable valve and shall be arranged so that any gas leaving the chamber will pass into the gas and oil actuated relay. A separate oil Buchholz relay with trip contacts shall be provided for the On-Load Tap Changer chamber. Each tap changer shall also be provided with a pressure relief valve outside OLTC to protect against sudden pressure development on OLTC.

Each compartment in which the oil is not maintained under conservator head shall be provided with a suitable direct reading oil level gauge.

A permanently legible lubrication chart shall be fitted with the driving mechanism chamber.

Local electrical control switches and the local operating gear shall be clearly labeled in suitable manner to indicate the direction of operation of tap changer.

The remote control panel of OLTC gear to be installed in the control room should match in colour and dimensions sheet steel size etc. with the purchaser's transformer control panel for which details would be furnished to the successful contractor.

In addition to the fittings, auxiliaries and accessories considered necessary by the contractor the following shall be provided:

A. **FOR LOCAL ELECTRICAL CONTROL**

viii) Raise lower selector switch with a intermediate 'OFF' position.

ix) Auxiliary transformer (if necessary) along with MCBs and links.

x) Step by step contractor

xi) Thermal over load relay for the motor

xii) Reversing contractor

xiii) ON/OFF automatic trip air circuit breaker for motor supply

xiv) Local/Remote change over selector switch.

B. **FOR REMOTE ELECTRICAL INDEPENDENT / AUTO-CONTROL**

ix) All equipment listed in (A) above.

x) Tap position indicator for mounting on control panel in the control room.

xi) Signal lamp and buzzer, for indicating "Tap Change in Progress".

xii) Raise lower switch push button type with intermediate off/position for remote control.

xiii) Emergency stop button (push button type) with visual indication.

xiv) Visual and alarm indication for non completion of operation within pre-set time

xv) Provision of interlocking system for blocking independent control when the units are to run in parallel by providing interlock able phase sequence selector switch.

xvi) All audo-visual indications should be brought to the Remote Tap Changer Cubicle (RTCC) panel.

xi) DC supply isolators, DC supply 'ON' indicator & DC failure, both alongwith cancellations.

xii) All equipment and their connections in RTCC panel should be properly marked. The buzzer/bell (industrial type) should be provided.

C. **FOR SIMULTANEOUS PARALLEL OPERATION OF TRANSFORMER**

v) All equipment listed in (B) above.

vi) Out of step relay alongwith auxiliary relays, contractors and other equipment including a buzzer and signal lamp to indicate the out of step indication when transformers in one of pair of group of rating in parallel are one tap out of step and also to trip the circuit breaker.

vii) Control selector switch to enable to run a transformer as Master/Follower or independent in a group.

viii) Selection switches for individual/parallel operation.

DC supply, Isolators, DC supply, 'ON' indication & DC failure, hooter alongwith cancellation.

9.5.15. Fitting

The following fittings shall be provided on the transformers:

a) Conservator with oil filling hole with cap and drain valve.
b) Magnetic type oil level gauge (150 mm dia.) with low oil level alarm contacts.
c) Prismatic/toughened glass oil level gauge.
d) Silica gel breather with oil seal and connecting pipe complete with first fill of activated silica gel.
e) A double float type Buchholz relay with isolating valve, bleeding pipe and a testing cock. The relay shall be provided with shut off valve on the conservator side as well as on the tank side.
f) Pressure relief devices (including pressure relief valve) and necessary air equalizer connection between this and the conservator with necessary trip contacts.
g) Air release plugs in the top cover.
h) Inspection covers, access holes with bolted covers for access and inspection of inner ends of bushing, core/coil assembly etc.
i) Winding temperature indicating device for local mounting complete in all respects.
j) Dial thermometer with pocket for oil temperature indicator.
k) Lifting lugs for the top cover, core and coils and for the complete transformer.
l) Jacking pads.
m) Haulage lugs.
n) Protected type mercury/alcohol in glass thermometer and a pocket to house the same.
o) Top and bottom filter valves on diagonally opposite ends with pad locking arrangement on both valves.
p) Top and bottom sampling valves.

q) Drain valve with pad locking arrangement and blanking plate.
r) Rating and connection diagram plate valve schedule plate.
s) Two numbers tank earthing terminals with associated nuts and bolts for connections to purchaser's grounding strip.
t) Bidirectional flanged rollers.
u) Marshalling Box (MB)
v) Cooling Accessories :
    - 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.
    - Air release device and oil drain plug on oil pipe connectors.
w) Terminal marking plates for Main Transformer.
x) On -Load Tap Changer.
y) HV Bushing with terminal connector and arcing horn.
z) LV Bushing with terminal connector.
aa) LV Neutral Bushing for ground connection

Note: 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.

The contacts of various devices required for alarm and trip shall be potential free and shall be adequately rated (minimum 230V and 5 amp) for regular making and breaking current duties as specified.

9.5.16. Auxiliary Power Supplies

The following power supplies shall be available at site

a) AC 3 phase, 400 volts, 50 Hz earthed
b) AC 1 phase, 230 volts, 50 Hz earthed
c) 30V DC and/or 110 V DC

9.5.17. 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 Purchaser name-UPCL.

9.5.18. Control Connections and Wiring Terminal, Board and Fuses

a) Normally no fuses shall be used anywhere. Instead of fuses MCBs (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.
b) All wiring connections, terminal boards, fuses, MCBs 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.
c) Panel connections shall be neatly and squarely fixed to the panel. All instruments and panel wiring shall be run in PVC. All wiring to a panel shall be taken from suitable terminal boards.
d) When 400 volt connections are taken through junction boxes or marshalling boxes, they shall be adequately screened and 400 volts Danger Notice must be affixed to the outside of the junction boxes or marshalling box. Proper colour code for Red, Yellow, Blue phases wires shall be followed. 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.
e) All box wiring shall be in accordance with relevant IS. All wiring shall be of stranded single core copper (48 strands) of 1100 Volt grade and size as under:
    a. CT circuits – 2x2.5 sq.mm.
    b. AC/DC Power circuit – 1x2.5 sq.mm.
    c. All other circuit - 1x2.5 sq.mm.
f) 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.
g) The same ferrule number shall not be used on wires in different circuits on the same panels.
h) 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.
i) Stranded wires shall be terminated with tinned 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.
j) Where apparatus is mounted on panels, all metal cases shall be separately earthed by means of stranded (48 No.) copper wire or strip having a cross section of not less than 2.5 sq. mm. Where strip is used, the joints shall be sweated.
k) The wiring diagram for marshalling box shall preferably be drawn as viewed from the back and shall show the terminal boards arranged as in services.
l) Terminal blocks shall be 1100 volts 10 Amp grade moulded material complete with stud type brass terminal, washers, nuts and identification strips.
m) Terminal block rows should be spaced adequately not less than 100 mm apart to permit convenient access to external cables and terminations.
n) Terminal blocks shall be placed with respect to the cable gland (at a minimum distance of 200 mm) as to permit satisfactory arrangement of multi-core cable tails.

o) Terminal blocks shall have separate 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.
p) All interconnecting wiring, as per the final approved scheme between accessories of transformer and marshalling box is included in the scope of this specification and shall be done by the Transformer supplier.
q) The schematic diagram shall be drawn and fixed under a transparent prospane sheet on the inner side of the marshalling box cover.
r) All marking of terminals shall follow IS 11953

9.5.19. Inspection and Testing during manufacturing

General

- The supplier shall carry out a comprehensive inspection and testing during manufacture of the transformer. An indicative of checks to be carried out during manufacturing are given below.
- This is, however, not intended to form a comprehensive program as it is supplier's responsibility to draw up and carry out such a program duly approved by the purchaser.
- The supplier shall carry out type tests, special tests and routine tests on the transformers.
- Only one no. transformer of each rating will be subjected to type test.
- All type, special and routine tests shall be carried out at supplier cost.
- The pre-shipment checks shall also be carried out by the supplier.
- The requirements of onsite tests are as listed in the specifications.
- Certified test report and oscillographs shall be furnished to the purchaser/consultants for evaluation. The Supplier shall also evaluate the test results and rectify the defects in the equipment based on his and the Purchaser's evaluations of the tests without any extra charges to the Purchaser. Manufacturer's Test Certificates in respect of all associated auxiliary and ancillary equipment shall be furnished.
- 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.

Checks during Manufacturing

a) Tank and Conservator
   - Inspection of major weld.
   - Crack detection of major strength weld seams by dye penetration test.
   - Check correct dimensions between wheels, demonstrate turning of wheels, through 90o and further dimensional check.
   - Leakage test of the conservator.
b) Core

- Sample testing of core materials for checking specific loss properties, magnetization characteristics and thickness.
- Check on the quality of varnish if used on the stampings.
- Check on the amount of burrs.
- Visual and dimensional check during assembly stage.
- Check on completed core for measurement of iron loss.
- Visual and dimensional checks for straightness and roundness of core, thickness of limbs and suitability of clamps.
- High voltage DC test (2 kV for one minute) between core and clamps.

c) Insulating Material
- Sample check for physical properties of materials.
- Check for dielectric strength
- Check for the reaction of hot oil on insulating materials.

d) Winding
- Sample check on winding conductor for mechanical continuity and electrical conductivity.
- Visual and dimensional checks on conductor for scratches, dent mark etc.
- Sample check on insulating paper for PH value, electric strength.
- Check for the bonding of the insulating paper with conductor.
- Check for the reaction of hot oil and insulating paper.
- Check and ensure that physical condition of all materials taken for windings is satisfactory and free of dust.
- Check for absence of short circuit between parallel strands.

e) Checks Before Drying Process
- Check condition of insulation on the conductor and between the windings.
- Check insulation distance between high voltage connections, between high voltage connection cables and earth and other live parts.
- Check insulating distances between low voltage connections and earth and other parts.
- Insulating test for core earthing.

f) Checks during Drying Process
- Measurement and recording of temperature and drying time during vacuum treatment. Check for completeness of drying.

g) Assembled Transformer
- Check completed transformer against approved outline drawing, provision for all fittings, finish level etc.
- Jacking test on the assembled Transformer.
- All standard test in accordance with IS: 335 shall be carried out on Transformer oil sample before filling in the transformer.
- 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 equipment is purchased by the supplier on a sub-contract, he shall have them tested to comply with relevant requirements.

h) Check for proper packing and preservation of accessories like radiators, bushings, explosions vent, dehydrating breather, rollers, Buchholz relay, control cubicle connecting pipes & conservator etc.
i) Check for proper provision of bracing to arrest the movement of core and winding assembly inside the tank.
j) Gas tightness test to conform tightness.

9.5.20. Losses

Transformers with lower losses shall be preferred. The bidder shall indicate the values of load and no load losses of the transformer in his bid. Maximum allowable losses shall be as follows:

Table 9-7: Losses

kVA rating	No load loss (kW)	Load loss at 75 ^{0}C (kW)
5000	6	34

There would not be any positive tolerance in losses. The manufacturer can offer losses less than above.

9.5.21. Capitalization of Losses

For total cost evaluation, the capitalized cost of losses will be taken into account as per the following:

Capitalised cost of Transformer = Initial cost of Transformer + Rs.A x WI + Rs. B x Wc

Where: WI = Iron loss in kW & A = 137408 Rupees for iron loss

WC = Copper loss in kW & B = 41222 Rupees for copper loss

In the event of either the iron or copper loss exceeding its guaranteed value as stated in the technical data schedule, the relevant rate above shall be applied to the excess and the resulting amount shall be deducted from the contract price.

9.5.22. Stage Inspection

The purchaser reserves the right to carry out stage inspection of power transformers. During stage Inspection compliance of following particulars shall be checked.

- Core assembly - diameter, window height, leg centre, stack width, stack thickness, thickness of laminations, proof towards prime source of laminations
- Windings - conductor size, I.D., O.D & height of winding, major and minor insulations for both H.V and L.V windings
- Tank - length, breadth, height and thickness of plates of transformer tank, quality of fittings and accessories.

The supplier shall offer for final inspection of the transformers subject to clearance of the stage inspection report by the purchaser.

9.5.23. 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 plant, shall be deemed to be included in the specification and shall be furnished by the contractor 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 purchaser under any circumstances.

9.5.24. Spare parts

The Bidder shall provide a list of mandatory & recommended spare parts together with their individual prices. The prices of mandatory spares will be taken into account in the evaluation of tenders. This list shall identify all essential spares and consumable items for any recommended maintenance for a period of five years after commissioning

The Purchaser may order all or any of the spare parts listed at the time of contract award and the spare parts so ordered shall be supplied as part of the definite works. The Purchaser may order additional spares at any time during the contract period at the rates stated in the contract document. A spare parts catalogue with price list shall be provided and this shall form part of the drawings and literature to be supplied.

The Bidder shall give an assurance that spare parts and consumable items will continue to be available through the life of the equipment, which shall be 25 years minimum. However, the supplier shall give a minimum of 12 months' notice in the event that the supplier or any sub-suppliers plan to discontinue manufacture of any component used in this equipment.

Any spare apparatus, parts or tools shall be subject to the same specification, tests and conditions as similar material supplied under the definite work section of the contract.

They shall be strictly interchangeable and suitable for use in place of the corresponding parts supplied with the plant and must be suitably marked and numbered for identification.

Spare parts shall be delivered suitably packed and treated for long periods in storage. Each pack shall be clearly and indelibly marked with its contents, including a designation number corresponding to the spare parts list in the operation and maintenance instructions.

A complete set of all the special tools, devices, slings or tackles required for the adjustment and maintenance of the equipment shall be supplied in the quantity listed in the Price Schedule. Each set of tools shall be mounted in a lockable cabinet. These shall also be provided under this contract. Eye bolts which have to be removed after use shall be accommodated in the cabinet.

9.6. Tests

9.6.1. Type Tests

The following shall constitute type tests. Special tests shall also constitute part of type tests.

a) Measurement of winding resistance
b) Measurement of voltage radio and check of voltage vector relationship

c) Measurement of impedance voltage/short-circuit impedance (principal tapping) and load loss
d) Measurement of no-load loss and current
e) Measurement of insulation resistance
f) Dielectric tests
g) Temperature-rise test, on tap having maximum losses
h) Off load tap changer tests (as per BS:4571 / BS EN 60214)
i) Tank Vacuum test
j) Tank Pressure test

9.6.2. Special Tests

a) Short circuit test
b) Measurement of zero sequence impedance
c) Measurement of acoustic noise level

Type test reports (less than five years old as on the due date of tender) of tests carried out at CPRI /NABL accredited laboratory along with certified drawings shall be furnished by the bidder with offer otherwise offer shall be rejected. The offered transformer must be manufactured as per type tested design.

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

9.6.3. Routine Tests

The following shall constitute routine tests:

a) Visual examination and checking the dimensions
b) Winding DC resistance.
c) Voltage ratio on each tapping and
d) Check of voltage vector relationship and polarity.
e) Impedance voltage / short circuit impedance (principle tapping , maximum and minimum tapping)
f) Magnetic balance test -
g) Load loss.
h) No-load loss and current
i) Insulation resistance
j) Separate source AC voltage withstand test
k) Induced over voltage withstand test
l) Measurement of Zero sequence impedance
m) Absorption index i.e. insulation resistance for 15 seconds and 60 seconds (R60/R15) and polarization index i.e. Insulation Resistance for 10 minutes and one minute (R10 mt/R1 mt)
n) Oil leakage test of transformer tank at a pressure equal to normal pressure plus 35 kN per sq mtr measured at the base of tank.
o) Measurement of neutral unbalance current (not to exceed 2% of full rated current of transformer)
p) High voltage withstand test on auxiliary equipment and wiring.

In case of Temperature Rise test, if it is not feasible to carry out this test at CPRI /NABL, bidder may hire services of the laboratories and carry out Temperature Rise test at supplier's works with testing equipment of CPRI /NABL. Test has to be carried out by testing engineer of CPRI/NABL and certification of the same have to be given on CPRI/NABL's letter head.

9.6.4. Test Procedures

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 for oil and one hour for air and during that time no leak shall occur.

Pressure Test

Where required by the Purchaser, 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.

Vacuum Test

One transformer tank of each size shall be subjected to the vacuum pressure of 760 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.

9.6.5. Testing Equipment/Meter Calibration

All testing equipment / meters used shall be calibrated within valid time limit at ERDA / NABL accredited laboratory. Calibration seals provided by the calibrating agency on testing equipments / meters shall be in good condition.

9.7. Pre-Delivery Inspection at Manufacturer's Works

All routine & acceptance tests shall be witnessed and certified by purchaser's representative at manufacturer's works. The vendor shall give at least 10 days advance intimation to the purchaser to enable them to depute their representative for witnessing the tests. The said representative shall have full facilities for unrestricted inspection of supplier's works, raw materials, manufacturing processes and conducting necessary tests.

The said representative shall verify the calibration seals provided by the calibrating agency on testing equipments/ meters.

Test reports of routine tests carried out by the manufacturer shall be submitted to the inspecting authority at the time of inspection for his approval.

Acceptance of any quantity of materials shall in no way relieve the supplier of his responsibility for meeting all requirements of the specification and shall not prevent subsequent rejection, if such materials are later found to be defective.

In case of waiver of inspection, vendor shall carry out all (i) routine and (ii) acceptance tests and submit test reports for approval of the purchaser, before dispatch of material.

The entire cost of testing for acceptance & routine rests and checking of length etc shall be borne by the supplier.

9.8. Quality Assurance

Following quality plans shall be submitted within 30 days from the date of placement of contract:

- Quality Assurance Plan (QAP) to be adopted by manufacturer in respect of raw materials and bought out items, including source and test reports of (i) important raw materials and (ii) bought out items.
- Material Quality Plan (MQP) to be adopted by manufacturer in respect of manufacturing process.

The QAP & MQP shall be approved by the purchaser within 15 days from the receipt of compliance, if any. The vendor shall follow the approved QAP & MQP in true spirit. If desired by the purchaser, he shall give access to all the documents and materials to satisfy the purchaser that QAP & MQP are being properly followed.

9.9. Guarantee

The manufacturers of the transformer shall provide a guarantee of 54 months from the date of commissioning or 60 months from the date of dispatch whichever is earlier.

9.10. Drawing / Documents

9.10.1. Test reports for bought out items

The Supplier shall submit the test reports for all bought out/sub supplier items for approval.

- Buchholz relay
- Sudden pressure rise relay in OLTC
- Sudden pressure rise relay on main tank
- Winding temperature indicators
- Oil temperature indicators
- Bushings
- Bushing current transformers in neutral (if provided)

- Marshaling box
- Any other item required to complete the works.

The supplier shall furnish following drawings/documents for approval of purchaser within 4 weeks from the order.

a) Detailed overall general outline 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, bushing lifting height, clearances between HV and LV terminals and ground, quantity of insulating oil etc.
b) Foundation plan showing loading on each wheel and jacking points with respect to centre line of transformer.
c) GA drawings/details of bushing.
d) Name plate drawing with terminal marking and connection diagrams.
e) Wheel locking arrangement drawing.
f) Transportation dimensions drawings.
g) GA drawing of marshalling box.
h) Control scheme/wiring diagram of marshalling box.
i) Technical leaflets of major components and fittings.
j) Oil temperature indicator and winding temperature indicator settings
k) Completed technical data sheets.
l) Details including write-up of tap changing gear.
m) Bi- metallic connector for connection to conductor/cable.
n) Maintenance and Operating Instructions.
o) As built version of the drawings and documents.

Executive Engineer (Stores), UPCL will be the final authority for approving the drawings submitted by the tenderer.

9.10.2. Instructions Manual

Three 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 others, the following particulars:

- Marked erection prints identifying the components, parts of the transformer as dispatched with assembly drawings.
- Detailed dimensions, assembly and description of all auxiliaries.
- 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.
- Salient technical particulars of the transformer.
- Copies of all final approved drawings.

- Detailed O&M instructions with periodical check lists and format etc.

9.11. Onsite inspection testing

9.11.1. Installation Checks

- Inspection and operational checking of accessories like tap changers, etc.
- 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.
- Check the whole assembly for tightness etc.
- Oil leakage tests.

9.11.2. Pre-Commissioning Tests

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

- Dry out test
- Megger Test
- DC Resistance measurement of windings
- Ratio test on all taps
- Phase relationship test (Vector grouping test)
- Buchholz relay alarm operation test
- Low oil level (in conservator) alarm
- Temperature Indicators
- Marshalling kiosk
- Magnetising current

The following additional checks shall be made:

- All oil valves are in correct position closed or opened as required.
- Thermometer pockets are filled with oil.
- Oil is at correct level in the conservator.
- Earthing connections are made.
- Colour of Silica gel is blue.
- Bushing arcing horn is set correctly and gap distance is recorded.

9.12. Commissioning

The equipment shall be commissioned as per CBIP manual, IS: 10028 and manufacturer's recommendations. All the related drawings and manuals shall be pre-requisite for release of final payment.

9.13. Packing & forwarding

9.13.1. Packing

Supplier shall pack or shall cause to be packed all items in such a manner as shall be reasonably suitable for shipment by road to UPCL without any risk of damage in transit. The packing shall be sufficient to withstand, without limitation, rough handling during transit and exposure to extreme temperatures, salt and precipitation during transit, and open storage.

9.13.2. Packing List

One copy of the packing list shall be enclosed in each package delivered. There shall also be enclosed in one package a master packing list identifying each individual package, which is part of the shipment. If, on any package, it is not possible to place packing list inside the container, all pertinent information shall be stenciled on the outside and will thus constitute a packing list.

9.14. Rejection

The Purchaser may reject any transformer if during tests or service any of the following conditions arise:

i) No load loss exceeds the guaranteed value.
j) Load loss exceeds the guaranteed value.
k) Impedance value exceeds the guaranteed value by + 10% or more.
l) The difference in impedance values of any two phases during single phase short circuit impedance test exceeds 2% of the average value guaranteed by the vendor.
m) Oil or winding temperature rise exceeds the specified value.
n) Transformer fails on impulse test.
o) Transformer fails on power frequency voltage withstand test.
p) Transformer is proved to have been manufactured not in accordance with the agreed specification.

9.15. Schedules

9.15.1. Schedule – I [Guaranteed Technical Particulars for 33/11 kV, 5 MVA Power Transformer]

Table 9-8: Guaranteed Technical Particulars for 33/11 kV, 5 MVA Power Transformer

S.No.	Description	Unit	Specified
1	Name and address of the Manufacturer		
	a) Transformer		
	b) HV & LV Bushings		
	c) Bimetallic connectors		
	d) Transformer Oil		
	e) Off Load/ On load tap changer		
	f) Instruments		
2	Service (Indoor / Outdoor)		Outdoor
3	Normal continuous rating in kVA under site conditions at all taps :	kVA	
	a) HV winding	kVA	5000
	b) LV winding	kVA	5000
4	Rated Voltage		
	a) HV winding	kV	33
	b) LV winding	kV	11
5	Rated frequency	Hz	50(+ - 5%)
6	No. of phases		3
7	Type of transformer		Conventional Power Transformer
8	Connections		
	a) HV winding		Delta
	b) LV winding		Star
9	Connections symbols		
	a) HV - LV		Dyn11
10	Tapings		
	a) Range		+ 5% to - 10% (in steps of 2.5%)

S.No.	Description	Unit	Specified
	b) Number of steps		9
	c) Position of tapping on HT winding for high voltage variation		
11	Reference ambient temperatures		
	a) Maximum ambient air temperature.	°C	50°C
	b) Maximum daily average ambient temperature	°C	35°C
	c) Minimum ambient air temperature.	°C	10°C
	d) Maximum yearly weighted average ambient air temperature.	°C	35°C
12	Maximum temperature rise over ambient temperature		
	a) In oil by thermometer	°C	35°C
	b) In winding by resistance measurement	°C	40°C
	c) Limit for hot spot temperature for which the transformer is designed	°C	90°C (as per IS 2026)
	d) Type and details of winding hot spot temperature detector	°C	WTI with 150 mm dia. dial type instrument temp. Sensing element image coil, auxiliary CT, 2 nos. of contacts of high winding temperature alarm and trip, calibration devices.
	e) Temperature gradient between windings and oil	°C	
	f) Type of maximum winding temperature	°C	
13	Voltage to earth for which the star point will be insulated	kV	
14	Cooling type		ONAN
15	Losses		
	a) Fixed (Iron) losses of 3 phase Transformer (kW) at rated voltage & rated frequency	kW	3.6 kW (Max)

S.No.	Description	Unit	Specified
	b) Load losses at rated current at principal	kW	21 kW (Max)
16	Max. Current density in winding at rated current for normal tap position		
	a) HV winding (Amps/ sq.mm.)	A/mm2	2.4 (Amps/ sq.mm)
	b) LV winding (Amps / sq.mm.)	A/mm2	2.4 (Amps/ sq.mm)
17	Impedance voltage at rated current ,frequency and at 75°C expressed as percentage of rated voltage at :-		
	a) Principal (normal) tap	%	7.15% + 10% Tolerance
	b) Highest tap	%	
	c) Lowest tap	%	
18	Reactance at rated current & frequency as percentage of rated voltage at:		
	a) Principal (normal) tap	%	
	b) Highest tap	%	
	c) Lowest tap	%	
19	Resistance at 75ºC		
	a) H.V. winding at normal tap position	Ohms	
	b) L.V. winding	Ohms	
	c) Resistance voltage drop at 75ºC winding temperature expressed as percent of rated voltage	%	
	i) Principal/ normal tap	%	
	ii) Highest tap	%	
	iii) Lowest tap	%	
20	Capacitance on open circuit conditions		1800 pF(Approximately)
21	Insulation level		
	a) Separate source power frequency voltage withstand		
	i) HV winding	kV rms	70

S.No.	Description		Unit	Specified
		ii) LV winding	kV rms	28
	b)	Induced over voltage withstand		
		i) HV winding	kV rms	--- Double Voltage & Double Frequency -
		ii) LV winding	kV rms	--- Double Voltage & Double Frequency -
	c)	Full wave lightning impulse withstand		
		i) HV winding	kV peak	
		ii) LV winding	kV peak	
	d)	Power frequency high voltage tests		
		i) Test voltage for one minute withstand test on high voltage windings (induced)	kV rms	
		ii) Test voltage for one minute withstand test on low voltage windings	kV rms	
		iii) Test voltage for one minute withstand test on neutral end of low voltage windings	kV rms	
	e)	Lightning impulse withstand tests		
		i) Impulse test on high voltage winding 1.2/50 µ sec full wave withstand	kV peak	
		ii) Impulse test on low voltage winding 1.2/50 µ sec full wave withstand	kV peak	
		iii) Wave form for impulse test	kV peak	
22	No load current, no load loss, no load power factor at normal ratio and frequency		Amp/ kW/P.F	
	a)	10 percent of rated voltage		Will be furnished by Bidders Offer
	b)	25 percent of rated voltage		

S.No.	Description		Unit	Specified
	c)	50 percent of rated voltage		
	d)	85 percent of rated voltage		
	e)	100 percent of rated voltage		
	f)	105 percent of rated voltage		
	g)	110 percent of rated voltage		
	h)	112.5 percent of rated voltage		
	i)	115 percent of rated voltage		
	j)	120 percent of rated voltage		
	k)	125 percent of rated voltage		
23	Efficiency at 75ºC at unity power factor			
	a)	Full load	%	
	b)	75% load	%	
	c)	50% load	%	
	d)	25% load	%	
24	a)	The minimum % of load at which the transformer will run at maximum efficiency (%)	%	
	b)	Maximum efficiency of the transformer	%	
25	Regulation at full load at 75ºC			
	a)	At unity power factor	%	
	b)	At 0.8 power factor (lagging)	%	
26	Core data			
	a)	Grade of core material used		CRGO HIB, M3 or better
	b)	Thickness of core plate lamination	mm	≤ 0.23 mm for M3 and ≤ 0.27 mm for CRGO HIB
	c)	Whether core laminations are of cold rolled grain oriented		CRGO HIB, M3 or better
	d)	Details of oil ducts in core		
		i) Whether in the plane & at right angle to the plane of winding		
		ii) Across the plane of lamination		

S.No.	Description		Unit	Specified
	e)	i) Insulation of core lamination		
		ii) Insulation of core plates		
		iii) Type of core joints		
27	Flux density			
	a)	Designed maximum flux density at normal tap at rated voltage and rated frequency	Tesla	1.9 Tesla
	b)	Operating continuous flux density	Tesla	1.9 Tesla
		i) at normal tap	Tesla	
		ii) at maximum tap	Tesla	
		iii) at minimum tap	Tesla	
	c)	Designed maximum operating flux density which the transformer can withstand for one minute at normal tap	Tesla	1.9 Tesla for all Tap
	d)	Designed maximum operating flux density which the transformer can withstand for five seconds at normal tap	Tesla	
28	Inter-Tap insulation			
	a)	Extent of extreme end turns reinforcement		
	b)	Extent of end turns reinforcement		
	c)	Extent of turn adjacent to tapping reinforced		
	d)	Test voltage for 10 seconds 50Hz inter- turn insulation test on (a)		
	e)	Test voltage for 10 seconds 50Hz inter-turn insulation test on (b)		
	f)	Test voltage for 10 seconds 50Hz inter-turn insulation test on (c)		
29	Windings:			
	a)	Material		

S.No.	Description	Unit	Specified
	b) Type of windings:		
	i) HV windings		
	ii) LV windings		
	c) Insulation of HV windings		
	d) Insulation of LV windings		
	e) Insulation between HV & LV windings		
30	Continuous rating under following conditions:		
	a) At 40°C ambient air temp. at site	kVA	5000
	b) At 30°C ambient air temp. at site	kVA	5500
	c) At 20°C ambient air temp. at site	kVA	6000
31	Transformer Tank		
	a) Material		
	b) Thickness		
	- Top	mm	10 mm
	- Sides	mm	10 mm
	- Bottom	mm	12 mm
	c) Details of painting (inner / outer surface)		
32	Dimensions of 3 phase transformers:		
	a) Max. Height to top of bushings	mm	
	b) Over-all length	mm	
	c) Over-all breadth	mm	
33	Weight data of transformer components (Tolerance + 5%) (approximate values not allowed)		
	a) Core excluding clamping	Kg	
	b) Core with clamping	Kg	
	c) HV winding insulated conductor	Kg	
	d) LV winding Insulated conductor	Kg	
	e) Coils with insulation	Kg	

S.No.	Description		Unit	Specified
	f)	Core and windings	Kg	
	g)	Weight of steel	Kg	
	h)	Fittings and accessories	Kg	
	i)	Oil required for first filling including 10% extra	Ltr/Kg	
		1. Oil in main tank	Ltr	
		2. Oil in the conservator	Ltr	
		3. Oil in the radiators	Ltr	
		4. Oil in the OLTC	Ltr	
		5. Overall total quantity of oil with 10% extra oil for first filling	ltr/Kg	
	j)	1. Transportation weight excluding accessories	Kg	
		2. Shipping details		
		i) Weight of heaviest package	Kg	
		ii) Dimension of largest package (L x Wx H)	mm	
	k)	Un-tanking weight	Kg	
	l)	Total weight of transformer with oil and fittings	Kg	
34	Bushing data :			
	a)	Type of bushing insulator		
		i) HV		Outdoor type highly polluted (as per Is-8603, 2099 & 3347)
		ii) LV		-do-
		iii) Neutral		-do-
	b)	Material of bushing (inner part / outer part)		Porcelain (as per IS-8603)
	c)	Weight of bushing insulator (Kg.)		
		i) HV	Kg	
		ii) LV	Kg	
		iii) Neutral	Kg	

S.No.	Description		Unit	Specified
	d)	Quantity of oil in one bushing (lt.)		
		i) HV	ltr.	
		ii) LV	ltr.	
		iii) Neutral	ltr.	
	e)	Minimum dry withstand & flash over power frequency voltage of bushing	kV	
	f)	Minimum wet withstand & flash over power frequency voltage of bushing	kV	
	g)	Minimum withstand & flashover impulse level	kV	
	h)	Voltage rating	kV	
		i) HV	kV	
		ii) LV	kV	
		iii) Neutral	kV	
	i)	Current rating (Amps.)		
		i) HV	Amp	
		ii) LV	Amp	
		iii) Neutral	Amp	
	j)	Thermal Short Time current & Duration	Sec	2 Sec
		i) HV	kA	
		ii) LV	kA	
		iii) Neutral	kA	
	k)	Rated Dynamic current & its duration	Sec	As per IS-2026 & 2029
		i) HV	kA	
		ii) LV	kA	
		iii) Neutral	kA	
	l)	Cantilever with stand loading		
	m)	Clearance in oil		
		phase to phase		
		i) HV	mm	

S.No.	Description		Unit	Specified
		ii) LV	mm	
		iii) Neutral	mm	
		phase to earth (mm)		
		i) HV	mm	
		ii) LV	mm	
		iii) Neutral	mm	
	n)	Creepage distance in oil & air (mm)	mm/kV	
		i) In oil		
		a) HV	mm	
		b) LV	mm	
		c) Neutral	mm	
		ii) In air	mm	
		a) HV	mm	
		b) LV	mm	
		c) Neutral	mm	
	o)	Minimum level of immersing / medium (oil)	mm	
	p)	Maximum pressure of immersing medium (oil)	kg/cm2	
	q)	Free space required at top for removal of bushings	mm	
	r)	Angle of mounting		
35	Conservator (Main Transformer and OLTC)			
	a)	Total volume of the Conservator	M^3	
	b)	Volume of the conservator between the highest and lowest level	M^3	
36	Calculated time constants for natural cooling		Hrs	
37	Type of axial coil supports :			
	a)	HV winding		
	b)	LV winding		
38	Details of On load / off-circuit tap changer			

S.No.	Description		Unit	Specified
	a)	Make		
	b)	Type		
	c)	Rating		
		i) Rated Voltage	kV	
		ii) Rated current	Amp	
		iii) Step voltage	V	
		iv) Number of steps		
	d)	Whether Diverter switch provided with gas vent and Buchholz relay (Yes / No)	Yes/No	
	e)	Whether a separate oil surge relay with trip contracts provided (Yes / No)		
	f)	Whether Remote control panel provided with Control scheme for simultaneous operation of Tap changer when transformers running in Parallel and independent control when in independent operation		
	g)	Details of motor device unit housed in kiosk mounted on tap changer		
	h)	Pressure relief valve		
39	Dispatch details :			
	a)	Approx. mass of heaviest Package	Kg	
	b)	Approx. dimensions of largest Package		
		i) Length	mm	
		ii) Breadth	mm	
		iii) Height	mm	
40	Un-tanking height		mm	
41	Bimetallic connectors: HV / LV			
	a)	Normal current rating (A)	Amp	
	b)	Short time current rating (A)	Amp	

S.No.	Description		Unit	Specified
	c)	Tensile strength	Kg	
	d)	Maximum temperature limit		
	e)	Dimensional sketch enclosed indicating tolerances (Yes/No)		
	f)	Minimum clearance		
		Phase to phase	mm	
		Phase to Earth	mm	
42	CORE ASSEMBLY:			
	a)	Core diameter	mm	
	b)	Core window height	mm	
	c)	Core leg Centre	mm	
	d)	Gross core cross - sectional area	M^2	Will be furnished by Bidder Offer
	e)	Total height of core	mm	
	f)	Details of top end frame		
	g)	Details of Bottom end frame		
	h)	Details of clamp plate (material, thickness, insulation)		
	i)	Total core weight	Kg	
	j)	Core loss, basing on core loss graph at operating flux density (rated voltage and rated frequency)	kW	
	k)	Core stacking factor		
	l)	Net core area (Sq. M.)	M^2	
	m)	Margin towards corner joints, cross-fluxing, dielectric loss	kW	
	n)	Total core loss at rated voltage and rated frequency	kW	
	o)	Describe location/ method of core grounding		
	p)	Details of core- belting		
		i) Material , grade and type		
		ii) Width	mm	

S.No.	Description		Unit	Specified
		iii) Thickness	mm	
		iv) Fixing method		
43	DETAILS OF WINDING:			
	a)	Type of winding		
	b)	Material of the winding conductor		Electrolytic Copper
	c)	Maximum current density of windings at rated current and conductor area (HV/LV)	A/mm2	2.4 Amps /mm2 (at all taps)
	d)	Whether windings are pre-shrunk?		
	e)	Whether adjustable coil clamps are provided for HV and LV windings?		
	f)	Whether steel rings are used for the windings? If so, whether these are split?		
	g)	Whether electrostatic shields are provided to obtain uniform voltage distribution in the windings?		
	h)	Winding Insulation (Type & Class)		
	i)	Insulating material , used for		
		i) H.V winding		
		ii) LV winding		
		iii) Tapping connection		
	j)	Insulating material used between		
		i) L.V and H.V winding		
		ii) Core & L.V winding		
	k)	H.V to H.V winding between phases		
	l)	Type of axial supports		
		i) H.V winding		
		ii) L.V winding		
	m)	Type of radial supports		
		i) H.V winding		
		ii) L.V winding		

S.No.	Description	Unit	Specified
	n) Maximum allowable torque on coil clamping bolts		
	o) Clamping ring details		
	i) Thickness of ring mm	mm	
	ii) Diameter of ring mm	mm	
	iii) No. & size of pressure screw		
	p) Bare conductor size		
	i) HV	mm^2	
	ii) LV	mm^2	
	q) Inside diameter		
	i) HV	mm	
	ii) LV	mm	
	x) Outside diameter		
	i) HV	mm	
	ii) LV	mm	
	y) Axial height after shrinkage		
	i) HV	mm	
	ii) LV	mm	
	z) D.C Resistance		
	i) L.V winding at 75°C	Ohm	
	ii) H.V winding at normal tap at 75°C	Ohm	
	iii) H.V winding at highest tap at 75°C	Ohm	
	iv) H.V winding at lowest tap at 75°C	Ohm	
	v)Total I2R losses at 75°C for normal tap	kW	
	vi)Total I2R losses at 75°C for highest tap	kW	
	vii) Total I2R losses at 75°C for lowest tap	kW	
	viii) Stray losses including eddy current losses in winding at 75°C	kW	

S.No.	Description	Unit	Specified
	a) Normal tap position	kW	
	b) Highest tap position	kW	
	c) Lowest tap position	kW	
	d) Any special measures, taken to reduce eddy current losses and stray losses mention in details		
	ix)Load losses at 75°C (I2 R + Stray)		
	a) Normal tap position	kW	
	b) Highest tap position	kW	
	c) Lowest tap position	kW	
	x) Details of special arrangement, provided to improve surge voltage distribution in the windings.		
44	DETAILS OF TANK:		
	a) Material of Transformer tank		
	b) Type of tank		
	c) Thickness of sheet (No approximate value to be mentioned)		
	i) Sides (mm)	mm	10 mm
	ii) Bottom (mm)	mm	12 mm
	iii) Cover (mm)	mm	10 mm
	iv) Radiators (mm)	mm	1. 2 mm
	d) Inside dimensions of main tank (No approximation in dimensions to be used)		
	i) Length (mm)	mm	As per CBIP
	ii) Breadth (mm)	mm	As per CBIP
	iii) Height (mm)	mm	As per CBIP
	e) Outside dimensions of main tank (No approximation in dimensions to be used)		
	i) Length (mm)	mm	

S.No.	Description		Unit	Specified
		ii) Breadth (mm)	mm	
		iii) Height (mm)	mm	
	f)	Vacuum recommended for hot oil circulation (Torr / mm of Hg)	Kg/cm^2	
	g)	Vacuum to be maintained during oil filling in transformer tank (Torr / mm of Hg)	Kg/cm^2	
	h)	Vacuum to which the tank can be subjected without distortion ((Torr / mm of Hg)	Kg/cm^2	
	i)	No. of bi-directional wheels provided		
	j)	Track gauge required for the wheels		
		i) Transverse axis	mm	
		ii) Longitudinal axis	mm	
	k)	Type and make of pressure relief device and minimum pressure at which it operates (kpa)		
45	CONSERVATOR:			
	a)	Thickness of sheet (mm)	mm	
	b)	Size (Dia. x length) (mm)	mm	
	c)	Total volume (Litres)	Ltr	
	d)	Volume between the highest and lowest visible oil levels (Litres)	Ltr	

9.15.2. Schedule – II [Information regarding manufacturing and testing facilities etc.]

(Vendor to enclose following documents and to confirm the same)

Table 9-9: Information regarding manufacturing and testing facilities etc.

S.No.	Particulars	Confirmation
1	Type test report from CPRI/ NABL accredited lab (less than 5 years old as on date of opening of offer)	Yes
2	List of plant and machinery	Yes
3	List of testing facility available	Yes

S.No.	Particulars	Confirmation
4	List of orders pending and executed	
	a) With UPCL	Yes
	b) With other agencies, other than 4.A	Yes

10. Technical Specifications for 33/11 kV, 12.5 MVA ONAN Power Transformers with On Load Tap Changer

10.1. Scope

This specification covers design, engineering, manufacture, assembly, testing, inspection before dispatch, forwarding, packing, transportation to site of three phase, 50 Hz, 12.5 MVA 33/11kV step-down outdoor ONAN Power Transformers with off-load tap changer complete with all accessories/fittings and spare parts as specified herein, for use in sub-stations in Uttarakhand state.

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 purchaser 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.

It is not the intent to specify herein complete details of design and construction. The equipment offered shall conform to the relevant standards and be of high quality, sturdy, robust and of good design and workmanship complete in all respects and capable to perform continuous and satisfactory operations in the actual service conditions at site and shall have sufficiently long life in service as per statutory requirements. In actual practice, notwithstanding any anomalies, discrepancies, omissions, incompleteness, etc. in these specifications and attached drawings, the design and constructional aspects, including materials and dimensions, will be subject to good engineering practice in conformity with the required quality of the product, and to such tolerances, allowances and requirements for clearances etc. as are necessary by virtue of various stipulations in that respect in the relevant Indian Standards, IEC standards, CEA Regulations , Electricity Act and other statutory provisions.

10.2. Service Conditions

Equipment/material to be supplied against this specification shall be suitable for satisfactory continuous operation under the tropical conditions as follows:

Table 10-1: Service Conditions

S.No.	Particulars	Value
1	Maximum ambient temperature (Deg. Celsius)	50
2	Minimum temperature (Deg. Celsius)	-5
3	Relative humidity range (%)	10 to 100

S.No.	Particulars	Value
4	Maximum annual rainfall (mm)	1500
5	Maximum wind pressure (kg/sq m)	195
6	Wind speed zones (m/s)	47 & 39
7	Maximum altitude above mean sea level (m)	3000
8	Isoceraunic level (days/year)	50
9	Seismic level (Horizontal acceleration) (g)	0.13

10.3. Specific technical requirements

Specific technical requirements shall be as follows:

Table 10-2: Specific Technical Requirements

Sr. No.	Parameter	Particulars
1	Rated MVA (ONAN rating)	12.5 MVA
2	No. of phases	3
3	Type of installation	Outdoor
4	Frequency	50 Hz
5	Cooling medium	Insulating oil
6	Rated voltage	
6 (a)	High voltage winding	33kV
6 (b)	Low voltage winding	11kV
7	Highest continuous system voltage	
7 (a)	a) HV side	36kV
7 (b)	b) HV Side	12kV
8	Nominal short circuit level 33 kV (Basing on apparent power)	31.5 kA
9	Nominal short circuit level 11 kV (Basing on apparent power)	13.1 kA
10	Type of tap changer	Off-load tap changer on HV winding
11	No. of windings	Two
12	Range of tapings	Plus 5% to minus 10 % of 1.25% each on HV winding

Sr. No.	Parameter	Particulars
13	Neutral terminal to be brought out	On LV side only
14	Impedance on rated MVA base at 75^0 C, on normal tap	8.35% (Tolerance plus 10%, negative tolerance shall not be allowed)
15	Type of winding insulation	Uniform both for HV and LV
16	Over voltage operating capacity & duration	112.5 % of rated voltage (continuous)
17	Anticipated unbalanced loading	Around 10 %
18	Anticipated continuous loading of windings (HV/LV)	110 % of rated current
19	Maximum Flux Density in any part of the core and yoke at rated MVA, rated voltage i.e. 33kV /11kV and system frequency of 50Hz.	1.9 Tesla
20	Power frequency withstand test voltage (kV rms)	70 kV (HV), 28 kV (LV)
21	Impulse withstand test voltage (kV peak)	170 (HV) , 75 (LV)
22	Withstand time for three phase short circuit	2 seconds
23	Winding connection	
23 (a)	LV Side	Delta
23 (b)	HV Side	Star
24	Winding material (HV & LV)	Electrolytic Copper
25	Vector group	Dyn 11
26	Type of cooling	Insulating oil (ONAN)
27	Neutral earthing	LV neutral shall be solidly earthed
28	Winding temperature Indicator	One
29	Provision for Differential Protection arrangement	Not required
30	Oil Temperature indicator	One
31	Maximum temperature rise on top of oil over an ambient temperature of 50^0 C (measured by thermometer)	45^0 C

Sr. No.	Parameter	Particulars
32	Maximum temperature rise of winding over an ambient temperature of 50^0 C (measured by resistance)	55^0 C
33	Over load capacity	As per IS:6600
34	Degree of protection for marshalling box	IP 55
35	Noise level at rated voltage and frequency	As per NEMA publication no. TR-1
36	Minimum clearances in air (mm)	
36 (a)	Phase to phase	HV - 400, LV – 280
36 (b)	Phase to ground	HV- 320, LV – 140
37	Terminals (Bushings)	
37 (a)	HV winding line end	36 kV oil filled communicating type porcelain bushing (Anti fog type)
37 (b)	LV winding (for outdoor type 11 kV breakers)	12 kV porcelain type bushing (Anti fog type)
38	Insulation level of bushings	
38 (a)	One minute power frequency withstand test voltage (kVrms)	70 kV (HV), 28 kV (LV)
38 (b)	Impulse withstand test voltage (kV peak) 1.2/50 micro second	170 (HV) , 75 (LV)
39	Minimum creepage distance	900 mm (HV), 300 mm (LV)
40	Maximum current density for HV, LV windings for rated current	2.4 Amp/sq mm
41	Core material	High grade, non ageing Cold Rolled Grain Oriented (CRGO) silicon steel, confirming to HIB grade
42	Core assembly	Boltless Core type
43	Type of mounting	On wheels, mounted on rails
44	Maximum permissible no load loss at rated voltage and rated frequency	11 kW
45	Maximum permissible load loss at rated current at 75^0 C	72 kW

10.4. General Technical Requirements

10.4.1. 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 MVA, voltage and frequency shall be such that the flux density under 12.5% over voltage condition shall not exceed 1.9 Tesla.
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.
d) The transformer shall be capable of operating continuously without danger on any particular tapping at the rated MVA ±12.5% of the voltage corresponding to the tapping.
e) Transformer shall be capable of withstanding thermal and mechanical stress caused by any symmetrical and asymmetrical faults on any winding. This shall be demonstrated through calculation as per IS:2026.
f) The thermal ability withstand short circuit shall be demonstrated by calculation.
g) 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.
h) Transformer noise level, when energised at normal voltage and frequency shall be as per NEMA TR -1 stipulations.
i) 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.
j) The transformer shall be capable of being operated without danger on any tapping at the rated kVA with voltage variation of + 10% corresponding to the voltage of the tapping.

10.5. Standards

The equipment shall comply with latest revision of the following Indian Standards (IS) unless otherwise stipulated in the specification.

All references to Indian Standards shall be deemed to be complying with latest amendments to the respective IS, if any.

Table 10-3: Standards

Indian Standard	Particulars	International standard
IS: 2026 (Part- 1 to 4)	Power transformers	IEC 76 (1-5)
IS:1271	Classification of insulating materials for electrical machinery and apparatus	
IS:335	New insulating oil for transformers, Switchgears	IEC 296

Indian Standard	Particulars	International standard
IS:2071	Method of high voltage testing	
IS:2099	High voltage porcelain bushings	IEC 137
IS:2147	Degree of protection	IEC 529
IS:2705	Current transformers	
IS:3347	Dimensions for porcelain transformer bushings	
IS:3637	Gas operated relays	
IS:3639	Fittings and accessories for power transformers	
IS: 6600	Guide for loading of oil immersed transformers	IEC 354
IS:5561	Electric Power Connectors	
IS: 10028	Code of practice for selection, installation and maintenance of transformers, Part I, II and III	
IS:3202	Code of practice for climate proofing of electrical equipment	
IS:5	Colour for ready mixed paints	
IS : 325	Three Phase Induction Motors	
C.B.I.P. Publication	Manual on Transformers	
	Insulation Co-ordination	IEC 71
	Radio influence voltage measurement	IEC 437
	Measurement of transformer and reactor sound levels	IEC 551

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; and if the IS mentioned is upgraded then the latest version of IS shall be applicable

10.5.1. General Construction Features

a) 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.
b) Similar parts, particularly removable ones, shall be interchangeable.
c) 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.
d) Nuts, bolts and pins used inside the transformers and tap changer compartments shall be provided with lock washers or locknuts.

e) Exposed parts shall not have pockets where water can collect.
f) Internal design of transformer shall ensure that air is not trapped in any location.
g) Material in contact with oil shall be such as not to contribute to the formation of acid in oil.
h) Surface in contact with oil shall not be galvanized or cadmium plated.
i) 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.
j) All internal connections and fastenings shall be capable of operating under overloads and over-excitation, allowed as per specified standards without injury.
k) Transformer and accessories shall be designed to facilitate proper operation, inspection, maintenance and repairs.
l) No patching, plugging, shimming or other such means of overcoming defects, discrepancies or errors will be accepted.
m) Schematic Drawing of the wiring, including external cables shall be put under the propane sheet on the inside door of the transformer marshalling box.

10.5.2. Core

a) The core shall be stack type with ABC type construction.
b) Stage level inspection for core construction shall be carried out by the owner.
c) Each lamination shall be insulated such that it will not deteriorate due to mechanical pressure and the action of hot transformer oil.
d) 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 0.23 mm to 0.27 mm or better. The maximum flux density in any part of the core and yoke at rated MVA, voltage and frequency shall be such that the flux density under 12.5% over voltage condition shall not exceed 1.9 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.
e) Following documents shall be submitted during stage inspection as proof towards use of prime core material:
    - Purchase order
    - Invoice of the supplier
    - Mills test certificate
    - Packing list
    - Bill of lading
    - Bill of entry certificate to customs
f) Core material shall be directly procured either from the manufacturer or through their accredited marketing organization of repute and not through any agent.
g) The laminations shall be free of all burrs and sharp projections. Each sheet shall have an insulating coating resistant to the action of hot oil.
h) The insulation structure for the core to bolts and core to clamp plates, shall be such as to withstand 2000 Volt DC voltage for one minute.

i) The completed core and coil shall be so assembled that the axis and the plane of the outer surface of the core assembly shall not deviate from the vertical plane by more than 25 mm.
j) All steel sections used for supporting the core shall be thoroughly shot or sand blasted, after cutting, drilling and welding.
k) The finally assembled core with all the clamping structures shall be free from deformation and shall not vibrate during operation.
l) The core clamping structure shall be designed to minimize eddy current loss.
m) The framework and clamping arrangements shall be securely earthed.
n) The core shall be carefully assembled and rigidly clamped to ensure adequate mechanical strength.
o) 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.
p) The design of magnetic circuit shall be such as to avoid static discharges, development of short circuit paths within itself or to the earthed 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.
q) 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 assembly shall be so fixed in the tank that shifting will not occur during transport or short circuits.
r) The temperature gradient between core & surrounding oil shall be maintained less than 20^0 C. The manufacturer shall demonstrate this either through test (to be mutually agreed) or by calculation.

10.5.3. Windings

a) 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.
b) 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.
c) 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.
d) 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.
e) Varnish application on coil windings may be given only for mechanical protection and not for improvement in dielectric properties. In no case varnish or other adhesive be used which will seal the coil and prevent evacuation of air and moisture and impregnation by oil.
f) Winding and connections shall be braced to withstand shocks during transport or short circuit.
g) 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.

h) All the insulating materials to be used in the transformer shall preferably be of class- A insulation as specified in Indian Standards. The test certificate of the raw materials shall be made available by the Transformer manufacturer on request during inspection and testing.
i) The coil clamping arrangement and the finished dimensions of any oil ducts shall be such that it will not impede the free circulation of oil through the ducts.
j) Coil clamping rings, if provided shall be of steel or suitable insulating material. Axially laminated material other than backlisted paper shall not be used.
k) Terminals of all windings shall be brought out of the tank through bushings for external connections.
l) The completed core and coil assembly 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.
m) The winding shall be so designed that all coil assemblies 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.
n) 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.
o) Adequate barriers shall be provided between coils and core and between high and low voltage coil. End turns shall have additional protection against abnormal line disturbances.
p) 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.
q) Tapings 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 the transformer at all voltage ratios.
r) Magnitude of impulse surges transferred from HV to LV windings by electromagnetic induction and capacitance coupling shall be limited to B.I.L. of LV winding.
s) The current density adopted in all windings shall not exceed 2.4 A/ sq mm . The total net cross sectional area of strip conductors for calculating current density for each winding shall be obtained after deducting the copper area lost due to rounding up of the sharp edges of the rectangular conductors.

10.5.4. Insulating Oil

a) The insulating oil for the transformers shall be of EHV grade, conforming to IS: 335. No inhibitors shall be used in the oil.
b) Transformer shall be shipped with oil filled at least to cover the core and coil assembly.
c) The quantity of oil required for the first filling of the transformer and its full specification shall be stated in the bid. The bidder shall quote the price of transformer complete with first filling of oil plus 10% extra. However, the rate of transformer oil in Rupee per litre shall be quoted separately also. The transformer oil shall be supplied in non-returnable drums.
d) 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.

e) The Supplier shall warrant that oil furnished is in accordance with the following specifications. Supplier shall submit the test certificate accordingly.

Table 10-4: Insulating Oil Specifications

S.No.	Characteristic	Requirement	Method of Test
1	Appearance	The oil shall be clear & transparent & free from suspended matter or sediment	A representative sample of oil shall be examined in a 100 mm thick layer at ambient temp.
2	Density at 20^0 C	0.89g/cm3 Max.	IS: 1448
3	Kinematic Viscosity at 27 deg. C Max	27 CST	IS: 1448
4	Interfacial tension at 27 deg. C Min.	0.03N/m	IS: 6104
5	Flash Point	140 deg. C	IS: 1448
6	Pour Point Max.	-6 deg. C	IS: 1448
7	Neutralisation Value (Total acidity) Max.	0.04 mg KOH/gm	IS: 335
8	Electric strength Break Down (voltage) Min.	60 kV	IS: 6792
9	Dielectric dissipation factor tan delta at 900 C	0.002 Max	IS:6262
10.a	Min. specific resistance(resistivity) at 90 deg. C	35 x 1012 ohm cm (min.)	IS: 6103
10.b	Min. specific Resistance (resistivity) at 27 deg. C	1500 x 1012 ohm cm (min.)	IS: 6103
11	Neutralisation value after Oxidation	0.40 mg KOH/g	
12	Total sludge after Oxidation	0.10% by weight max.	
13	Presence of oxidation Inhibitor	The oil shall not contain anti- oxidant additives	IS:335
14	Water content Max:	Less than 25 ppm	IS: 2362

10.5.5. Internal Earthing

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

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

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

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.

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.

10.5.6. Tank

- The Transformer tank and cover shall be fabricated from high grade low carbon plate steel of tested quality of adequate thickness. The tank and the cover shall be of welded construction. All welds shall be stress relieved. Stiffener shall be provided for general rigidity. Tank surface shall be designed to prevent retention of water.
- Tank shall be designed to permit lifting by crane or jacks of the complete transformer assembly filled with oil. Suitable lugs and bosses shall be provided for this purpose.
- All beams, flanges, lifting lugs, braces and permanent parts attached to the tank, shall be welded and where practicable, they shall be double welded.
- The main tank body of the transformer, excluding tap changing compartments and radiators, shall be capable of withstanding pressure of 760 mm of Hg.
- 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.
- All bolted connections to the tank shall be fitted with suitable oil-tight gaskets which shall give satisfactory service under the operating conditions for complete life of the transformer. Special attention shall be given to the methods of making the hot oil-tight joints between the tank and the cover as also between the tank cover and the bushings and all outlets to ensure that the joint can be remade satisfactorily and with ease, with the help of semi-skilled labour. Where compressible gaskets are used, steps shall be provided to prevent over-compression.
- Suitable guides shall be provided for positioning the various parts during assembly or dismantling. Adequate space shall be provided between the cores and windings and the bottom of the tank for collection of any sediment.

10.5.7. 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 suitably sloped so that it does not retain rain water.

10.5.8. Under Carriage

The transformer tank shall be supported on steel structure with detachable plain rollers completely filled with oil. Suitable channels for movement of roller with transformer shall be spaced accordingly. Rollers wheels shall be provided with suitable rollers bearings, which will resist rust and corrosion and shall be equipped with fittings for lubrication. It shall be possible to swivel the wheels in two directions, at right angle to or parallel to the main axis of the transformers.

Jacking pads shall be provided on the transformer. It shall be possible to change the direction of the wheels through 90 degree when the transformer is lifted on jacks to permit movement of the transformer both in longitudinal and transverse directions.

10.5.9. Valves

a) Valves shall be of forged carbon steel up to 50 mm size and of gun metal or of cast iron bodies with gun metal fittings for sizes above 50 mm. 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.
b) 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.
c) 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 supplier shall supply the same.
d) Each transformer shall be provided with following valves on the tank:
    - Drain valve so located as to completely drain the tank.
    - Two filter valves on diagonally opposite corners, of 50 mm size.
    - Oil sampling valves not less than 8 mm at top and bottom of main tank.
    - One 15 mm air release plug.
    - Valves between radiators and tank.
e) Drain and filter valves shall be suitable for applying vacuum as specified in the specifications.

10.5.10. Painting

Surface Preparation for tank, pipes, etc

All surfaces of transformer tank, pipes, etc shall be thoroughly blast cleaned with sand or shot or grit in accordance with ISO 8501 Part 1 to a minimum standard of "Sa2½" to make the surface free from visible oil, grease & dirt, mill scale, rust, paint coatings and foreign matter. Machined areas and threaded components etc are to be covered during blasting to prevent damage.

The air that is used for blasting should be dry and free from oil. The flanges, angles, tank curbs and other such areas shall be preferably blast cleaned prior to fabrication and paint these with one coat of primer. After adequate blast cleaning of each large surface where blasting time is more than three hours, an overall blast cleaning is to be done on the entire surface once more so that entire surface areas is exposed as fresh for first coat of primer paint. The first coat of primer paint should be applied not later than 3-4 hours after preparation of surface to avoid oxidation.

Surface Preparation for radiator

All internal and external surfaces of radiator shall be thoroughly cleaned either by chemical cleaning or by blast with sand or shot or grit in accordance with ISO 8501 Part 1 to make the surface free from visible oil, grease & dirt, mill scale, rust, paint coatings and foreign matter. Suitable chemical should be used for chemical cleaning, if required. The air that is used for blasting should be dry and free from oil. After adequate surface cleaning, the first coat of primer paint/varnish should be applied not later than 3-4 hours after preparation of surface to avoid oxidation.

Surface Preparation for Control cabinets/Marshalling Boxes

Surface Preparation for all Transformer Control cabinets/Marshalling Boxes shall be carried out confirming to following Indian standard in dust free area:

- IS: 3618: Degreasing by solvent wiping: Phosphate Treatment of Iron &Steel for Protection against corrosion.
- IS: 6005: Code of Practice for phosphating of Iron & Steel.

Chemicals: Suitable chemicals should be used and concentration of chemicals /weight of Phosphate coating should be checked regularly as per recommendation of the chemical manufacturer and applicable IS.

Inspection: The surface for application of paint should be dry, free from oil, dirt, acid & loose adhering powder and reasonably smooth in finish without uncovered areas, rusty surfaces and roughness.

Painting: Control cabinets/Marshalling Boxes -Enamel paint shall be used with total paint thickness as minimum 80 microns.

Painting- external & internal surfaces

Painting shall be carried out in closed and dust free area. The external surface shall be coated with suitable layers of paint and to form an impermeable layer so that air and water cannot reach the substrate. The paint selected shall be stable in outdoor condition such as rain, sunlight, pollution etc. Paint used for primer, under coat and top or finish coat should be from the same manufacturer and compatible to each other. In case in the rare event, paint used for primer, under coat and finish coat are not from the same manufacturer the compatibility test of the paint from different source shall be carried out. Painting shall be applied as per the recommendation of the paint manufacturer. The number of coats shall be such that the minimum dry film

thickness (DFT) specified is achieved. The DFT of painted surface shall be checked with a measuring gauge to ensure specified DFT. Complete painting scheme for the transformer is tabulated below:

Painting-Transformer tank, pipes, radiator etc.:

Table 10-5: Painting specifications

	Surface Preparation	Primer Coat	Intermediate Undercoat	Finish Coat	Total DFT	Colour Shade
Tank, pipes, etc. (External surfaces)	Blast cleaning Sa2½	Epoxy base Zinc primer (30-40 μm)	Epoxy HB MIO (30-40 μm)	Aliphatic Polyurethane (min 50 μm)	Min 155 μm	697 shade as per IS 5
Tank (Internal surfaces)	Blast cleaning Sa2½	Hot oil resistant, non-corrosive varnish or paint or epoxy	--	--	Min 30 μm	Glossy white for paint
Radiator (External surfaces)	Chemical / blast cleaning (Sa2½)	Epoxy base zinc primer (30-40μm)	Epoxy base zinc primer (30-40μm)	PU paint (min 50μm)	Min 110μm	Matching shade of tank/ different shade aesthetically matching to tank
Radiator and pipes (Internal surfaces)	Chemical cleaning if required	Hot oil proof, low viscosity varnish, flushing with transformer oil.	--	--	--	--

10.5.11. Bushing

Transformer shall be provided with bushing insulators on both H.V and L.V. sides. H.V and L.V. bushings shall be located on opposite side.

The electrical characteristics of bushing insulator shall be in accordance with IS: 2099. Dimensions and type of bushing shall conform to IS: 3347 and shall be as follows:

H.V. Bushing (33kV)	**36kV Class**	**Porcelain bushing with plain sheds for heavily polluted atmosphere.**
L.V. Bushing (11kV)	12 kV Class	Porcelain bushing with plain sheds for heavily polluted atmosphere.
Neutral Bushing	Neutral of L.V. winding shall be brought out through porcelain bushing similar to L.V. Bushing for connection with earth terminal in line with LV 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. Each bushing shall be capable to carry at least 200% of current of Continuous Maximum Rating (CMR) of transformer and the short time current shall be of the same as of transformer.
iv. Fittings made of steel or malleable iron shall be galvanized.
v. Bushing shall be so located on the transformers that full flashover strength will be utilized.
vi. All applicable routine and type tests certificates of the bushings shall be furnished for approval.
vii. Bushing shall be supplied with bi-metallic/terminal connector/clamp/washers suitable for fixing to bushing terminal and the purchaser's specified conductors. The connector/clamp shall be rated to carry the bushing rated current without exceeding a temperature rise of 550 C over an ambient of 500 C. The connector/clamp shall be designed to be corona free at the maximum rated line to ground voltage.
viii. Bushing of identical voltage rating shall be interchangeable.
ix. Each bushing shall be so coordinated with the transformer insulation that all flashover will occur outside the tank.
x. The creepage distance shall be not less than 25 mm/kV and protected creepage distance shall be not less than 50% of total.
xi. Arcing horns are to be provided with adjustable horn gap except the neutral bushing.
xii. Each terminal, including the neutral, shall be distinctly marked on both primary and secondary in accordance with the connection diagram fixed upon the transformer which shall conform to latest IS 2026 (Part IV).
xiii. Insulation Level: The transformer and bushing shall be capable to withstand test voltage as specified below:

Table 10-6: Insulation Level

Particulars	**Bushings**	
Nominal voltage (in kV rms)	11	33
Highest voltage for equipment (in kV rms)	12	36
1.2/50 micro sec. impulse withstand voltage (in kV peak)	95	170

Particulars	Bushings	
1 minute power frequency withstand voltage (in kV rms)	28	70
Minimum creepage distance (mm)	300	900
Minimum clearance (mm) : Phase to phase	280	400
Minimum clearance (mm) : Phase to earth	140	320

10.5.12. Oil Conservator Tank

a) The conservator shall be of capacity to meet the requirement of expansion of the total cold oil volume in the transformer & cooling equipment and it should be such that the oil level will always be visible through the plain oil level guage.
b) A conservator will have volumetric capacity of at least 10 % of the total volume of oil in tank. Moreover the oil in conservator up to minimum level mark on the oil gauge shall be at least 3 % of the total volume of oil in transformer excluding oil in OLTC.
c) The conservator tank shall be bolted into position so that it can be removed for cleaning purposes.
d) The conservator shall be fitted with magnetic oil level gauge with low level electrically insulated alarm contact.
e) Plain conservator fitted with silica gel breather.
f) It shall be provided with oil filling hole with cap on top and a drain valve at the bottom.

10.5.13. Oil Preservation Equipment

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 and silica gel.

ii) Silica gel is isolated 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.

Breather:

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

- Passage of air is through a dust filter & Silica gel

- Silica gel is isolated from atmosphere by an oil seal.
- Moisture absorption indicated by a change in colour of the crystals of the silica gel can be easily observed from a distance.
- Breather is mounted not more than 1400 mm above rail top level.

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 contacts shall be provided for tripping when the device operates.

Buchholz Relay:

Each transformer shall be provided with gas and oil actuated Relay (Buchholz Relay) equipment conforming of IS: 3637 double float type with one set of alarm contacts, one set of trip contacts and a testing pet cock. The contacts shall be wired with a P.V.C. armoured cable. A machined surface shall be provided on the top of Relay to facilitate the setting of Relay and to check the mounting angle in the pipe and cross level of the Relay. The pipe work shall be so arranged that all gas arising from the Transformer shall pass into the gas and oil actuated Relay. The oil circuit through the Relay shall not form a delivery path in parallel with any circulating oil pipe. A copper tube shall be connected from the gas collector to a valve located at about 1200 mm above ground level to facilitate sampling with the transformer in service.

Oil Temperature Indicator (OTI):

The transformers shall be provided with a 150 mm dial type thermometer 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.

a) Temperature sensing element
b) Image Coil.

- Auxiliary CTS, if required to match the image coil, shall be furnished and mounted in the local control panel.
- 150 mm 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 one for trip.

c) Calibration device.

- Two number NO electrical contact each capable of operating at 5 A ac, 230 Volt supply.

d) The scale on the dial of the thermometer should be 0 Deg. C to 150 Deg. C. The angular displacement of thermometer should be 270 Deg. The signaling contact of WTI & OTI shall be set to operate at the following temperature:

OIL:	Alarm-80 deg. C, Trip – 90 deg. C
WINDING:	Alarm-85 deg. C, Trip – 95 deg. C

Marshaling Box

Sheet steel (not less than 2 mm thick), weather, vermin and dust proof marshalling box fitted with required glands, locks, glass door, terminal Board, 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 sloping roof and the interior and exterior painting shall be in accordance with the specification. Padlock along with duplicate keys shall be supplied for marshalling box. The degree of protection shall be IP-55. The temperature indicators shall be so mounted that the dials are visible by standing at the ground level.

The schematic diagram of the circuitry inside the marshalling box be prepared and fixed inside the door under a prospone sheet.

The marshalling box shall accommodate the following equipment:

- Temperature indicators
- Terminal blocks and gland plates for incoming and outgoing cables.
- Space heater with thermostat and MCB
- All the above equipment except (b) 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.

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 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.

10.5.14. On Load Tap Changer

The transformers shall be provided with an On-Load Tap Changer (OLTC) of well reputed and of proven make as per technical requirement for varying the effective transformation ratio while the transformer is ON load and without providing phase displacement. The salient features of the OLTC shall be as under:

The tap changing mechanism should be suitable for automatic, remote control operation from remote control panel in the control room in addition to being capable of local manual as well as local electrical operation.

The **On Load Tap Changer (OLTC)** shall include the following:

i) An oil immersed tap selector and arcing switch on arc suppressing tap selector provided with ohmic or resistor type high speed diverter switch, for reduction of make and break arcing voltages, overloads and short circuits.

j) Diverter switch should be with snap action mechanism with energy accumulator mounted directly on the diverter switch.

k) Separate oil compartment

l) Easy removable diverter switch unit.

xi) Motor driven mechanism

xii) Control and protection devices

xiii) Local tap changer position indicator

xiv) Manual operation device

xv) Make of OLTC – Indigenous make (type test certificates from (CPRI).

Control voltage – Any of the auxiliary power supply voltage.

The on-load tap changer shall be designed so that the contacts do not interrupt are within the main tank of transformer. The tap changer selector and arcing switch on arc suppressing tap selector switch shall be located in one or more oil filled compartments. The diverter switch should be provided with gas vent and Buchholz relay. It shall be designed as to prevent the oil in tap selector and diverter switch compartments from mixing with the oil in transformer. The barrier board between OLTC and the transformer tank shall be made of Silicon Bonded Resin Paper (SBRP)

The tap changer shall be capable of permitting parallel operation with other transformers of the same type. The transformer shall give full load output on all taps without exceeding the limit of permissible temperature rise in oil and winding. The manual operation device shall be so located on the transformer that it can be operated by a man standing at the level of transformer track. It shall be of robust construction and shall be capable of frequent operations. It shall not be possible to operate the electric drive when the manual operating gear is in use.

Necessary interlocks blocking independent control when the units are in parallel shall be provided.

The controls shall be so arranged as to ensure that when a tap change operation has commenced, it shall be completed independently of the operation of control relays or switches. Local or remote control switch shall cause one tap movement only, until the control switch has returned to the off position between successive operations. Under abnormal conditions such as may occur when the contractor controlling one tap change sticks, the arrangement must be such as to switch off supply to the motor so that an out of step condition is limited to one tap difference between the units./ Limit switches shall be provided to prevent over running of mechanism.

The transformer and the tap changing equipment shall be designed to permit full rated operation with tap changing equipment temporarily installed in any intermediate position. Details of out of step protection provided for the taps should be furnished in the tender.

The control scheme for the tap changer shall be provided for independent auto/non-auto control of the tap changer when the transformers are in independent service. Voltage relating relay should be designed for maximum operational simplicity for regulating the secondary voltage of power transformer with OLTC. The required EAD band settings are set by setting the nominal value and lower and upper levels independently.

In addition, provisions shall be made to enable non-auto/automatic parallel control also so that the tap changers of two or more transformers will be operated simultaneously when one unit is in parallel with another so that under normal conditions the tap changer will not become out of step and this will eliminate circulating current. Additional features like "Master / Follower" and visual indication, during the operation of motor shall also be incorporated.

A mechanical tap position indicator shall be provided on the tap changer in addition to remote indication equipment in the control room on remote control cubicle of OLTC. Necessary interlocks, for independent control when the units are in parallel shall be provided.

The whole of motor drive unit comprising the motor and its control gear including contractors, indicator, local electrical push buttons, five digit operation counter, handle for manual control etc. as well as terminals for the control and indication wiring shall be housed in a dust proof kiosk mounted on tap changer, A heating element with thermostat and MCB shall also be provided in kiosk for ensuring trouble free operation of the drive in cold weather. Arrangement shall be made for padlocking the kiosk. Tap position indication shall be visible by a number appearing in a small glass window on the front of the kiosk. For remote indication, an indication type instrument or digital type shall be provided on a panel on the 415 volts, 3 phase, 50 c/s external supply.

Any enclosed compartment not oil filled shall be adequately ventilated. All contractors, relay coils or other parts shall be suitably protected against corrosion or deterioration due to condensation, fungi etc.

The oil in the compartments of the main tap changing apparatus which do not contain contacts used for making or breaking current shall be maintained under conservator head by means of a pipe connection from the highest point of the chamber to the conservator. This connection shall be controlled by a suitable valve and shall be arranged so that any gas leaving the chamber will pass into the gas and oil actuated relay. A separate oil Buchholz relay with trip contacts shall be provided for the On-Load Tap Changer chamber. Each tap changer shall also be provided with a pressure relief valve outside OLTC to protect against sudden pressure development on OLTC.

Each compartment in which the oil is not maintained under conservator head shall be provided with a suitable direct reading oil level gauge.

A permanently legible lubrication chart shall be fitted with the driving mechanism chamber.

Local electrical control switches and the local operating gear shall be clearly labeled in suitable manner to indicate the direction of operation of tap changer.

The remote control panel of OLTC gear to be installed in the control room should match in colour and dimensions sheet steel size etc. with the purchaser's transformer control panel for which details would be furnished to the successful contractor.

In addition to the fittings, auxiliaries and accessories considered necessary by the contractor the following shall be provided:

A. **FOR LOCAL ELECTRICAL CONTROL**

xv) Raise lower selector switch with a intermediate 'OFF' position.

xvi) Auxiliary transformer (if necessary) along with MCBs and links.

xvii) Step by step contractor

xviii) Thermal over load relay for the motor

xix) Reversing contractor

xx) ON/OFF automatic trip air circuit breaker for motor supply

xxi) Local/Remote change over selector switch.

B. **FOR REMOTE ELECTRICAL INDEPENDENT / AUTO-CONTROL**

xvii) All equipment listed in (A) above.

xviii) Tap position indicator for mounting on control panel in the control room.

xix) Signal lamp and buzzer, for indicating "Tap Change in Progress".

xx) Raise lower switch push button type with intermediate off/position for remote control.

xxi) Emergency stop button (push button type) with visual indication.

xxii) Visual and alarm indication for non completion of operation within pre-set time

xxiii) Provision of interlocking system for blocking independent control when the units are to run in parallel by providing interlock able phase sequence selector switch.

xxiv) All audo-visual indications should be brought to the Remote Tap Changer Cubicle (RTCC) panel.

xiii) DC supply isolators, DC supply 'ON' indicator & DC failure, both alongwith cancellations.

xiv) All equipment and their connections in RTCC panel should be properly marked. The buzzer/bell (industrial type) should be provided.

C. **FOR SIMULTANEOUS PARALLEL OPERATION OF TRANSFORMER**

ix) All equipment listed in (B) above.

x) Out of step relay alongwith auxiliary relays, contractors and other equipment including a buzzer and signal lamp to indicate the out of step indication when transformers in one of pair of group of rating in parallel are one tap out of step and also to trip the circuit breaker.

xi) Control selector switch to enable to run a transformer as Master/Follower or independent in a group.

xii) Selection switches for individual/parallel operation.

DC supply, Isolators, DC supply, 'ON' indication & DC failure, hooter alongwith cancellation

10.5.15. Fitting

The following fittings shall be provided on the transformers:

a) Conservator with oil filling hole with cap and drain valve.
b) Magnetic type oil level gauge (150 mm dia.) with low oil level alarm contacts.
c) Prismatic/toughened glass oil level gauge.
d) Silica gel breather with oil seal and connecting pipe complete with first fill of activated silica gel.
e) A double float type Buchholz relay with isolating valve, bleeding pipe and a testing cock. The relay shall be provided with shut off valve on the conservator side as well as on the tank side.
f) Pressure relief devices (including pressure relief valve) and necessary air equalizer connection between this and the conservator with necessary trip contacts.
g) Air release plugs in the top cover.
h) Inspection covers, access holes with bolted covers for access and inspection of inner ends of bushing, core/coil assembly etc.
i) Winding temperature indicating device for local mounting complete in all respects.
j) Dial thermometer with pocket for oil temperature indicator.
k) Lifting lugs for the top cover, core and coils and for the complete transformer.
l) Jacking pads.
m) Haulage lugs.
n) Protected type mercury/alcohol in glass thermometer and a pocket to house the same.
o) Top and bottom filter valves on diagonally opposite ends with pad locking arrangement on both valves.
p) Top and bottom sampling valves.
q) Drain valve with pad locking arrangement and blanking plate.
r) Rating and connection diagram plate valve schedule plate.
s) Two numbers tank earthing terminals with associated nuts and bolts for connections to purchaser's grounding strip.
t) Bidirectional flanged rollers.
u) Marshalling Box (MB)
v) Cooling Accessories :

i. 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
- Air release device and oil drain plug on oil pipe connectors.

w) Terminal marking plates for Main Transformer.
x) On Load Tap Changer.
y) HV Bushing with terminal connector and arcing horn.
z) LV Bushing with terminal connector.

aa) LV Neutral Bushing for ground connection

Note: 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.

The contacts of various devices required for alarm and trip shall be potential free and shall be adequately rated (minimum 230V and 5 amp) for regular making and breaking current duties as specified.

10.5.16. Auxiliary Power Supplies

The following power supplies shall be available at site:

- AC 3 phase, 400 volts, 50 Hz earthed
- AC 1 phase, 230 volts, 50 Hz earthed
- 30V DC and/or 110 V DC

10.5.17. 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 Purchaser name UPCL.

10.5.18. Control Connections and Wiring Terminal, Board and Fuses

a) Normally no fuses shall be used anywhere. Instead of fuses MCBs (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.
b) All wiring connections, terminal boards, fuses, MCBs 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.
c) Panel connections shall be neatly and squarely fixed to the panel. All instruments and panel wiring shall be run in PVC. All wiring to a panel shall be taken from suitable terminal boards.
d) When 400 volt connections are taken through junction boxes or marshalling boxes, they shall be adequately screened and 400 volts Danger Notice must be affixed to the outside of the junction boxes or marshalling box. Proper colour code for Red, Yellow, Blue phases wires shall be followed. 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.
e) All box wiring shall be in accordance with relevant IS. All wiring shall be of stranded single core copper (48 strands) of 1100 Volt grade and size as under:
    - CT circuits – 2x2.5 sq.mm.
    - AC/DC Power circuit – 1x2.5 sq.mm.
    - All other circuit - 1x2.5 sq.mm.
f) 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.

g) The same ferrule number shall not be used on wires in different circuits on the same panels.
h) 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.
i) Stranded wires shall be terminated with tinned 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.
j) Where apparatus is mounted on panels, all metal cases shall be separately earthed by means of stranded (48 No.) copper wire or strip having a cross section of not less than 2.5 sq. mm. Where strip is used, the joints shall be sweated.
k) The wiring diagram for marshalling box shall preferably be drawn as viewed from the back and shall show the terminal boards arranged as in services.
l) Terminal blocks shall be 1100 volts 10 Amp grade moulded material complete with stud type brass terminal, washers, nuts and identification strips.
m) Terminal block rows should be spaced adequately not less than 100 mm apart to permit convenient access to external cables and terminations.
n) Terminal blocks shall be placed with respect to the cable gland (at a minimum distance of 200 mm) as to permit satisfactory arrangement of multi-core cable tails.
o) Terminal blocks shall have separate 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.
p) All interconnecting wiring, as per the final approved scheme between accessories of transformer and marshalling box is included in the scope of this specification and shall be done by the Transformer supplier.
q) The schematic diagram shall be drawn and fixed under a transparent prospane sheet on the inner side of the marshalling box cover.
r) All marking of terminals shall follow IS 11953

10.5.19. In house Inspection and Testing

a) The supplier shall carry out a comprehensive inspection and testing during manufacture of the transformer. An indicative of checks to be carried out during manufacturing are given below.
b) This is, however, not intended to form a comprehensive program as it is supplier's responsibility to draw up and carry out such a program duly approved by the purchaser.
c) The supplier shall carry out type tests, special tests and routine tests on the transformers.
d) Only one no. transformer of each rating will be subjected to type test.
e) All type , special and routine tests shall be carried out at supplier cost.
f) The pre-shipment checks shall also be carried out by the supplier.

g) The requirements of onsite tests are as listed in the specifications.
h) Certified test report and oscillographs shall be furnished to the purchaser/consultants for evaluation. The Supplier shall also evaluate the test results and rectify the defects in the equipment based on his and the Purchaser's evaluations of the tests without any extra charges to the Purchaser. Manufacturer's Test Certificates in respect of all associated auxiliary and ancillary equipment shall be furnished.
i) 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.

10.5.20. Checks during Manufacturing

Tank and conservator:

- Inspection of major weld.
- Crack detection of major strength weld seams by dye penetration test.
- Check correct dimensions between wheels, demonstrate turning of wheels, through 90o and further dimensional check.
- Leakage test of the conservator.

Core:

- Sample testing of core materials for checking specific loss properties, magnetization characteristics and thickness.
- Check on the quality of varnish if used on the stampings.
- Check on the amount of burrs.
- Visual and dimensional check during assembly stage.
- Check on completed core for measurement of iron loss.
- Visual and dimensional checks for straightness and roundness of core, thickness of limbs and suitability of clamps.
- High voltage DC test (2 kV for one minute) between core and clamps.

Insulating Material:

- Sample check for physical properties of materials.
- Check for dielectric strength
- Check for the reaction of hot oil on insulating materials.

Winding:

- Sample check on winding conductor for mechanical continuity and electrical conductivity.
- Visual and dimensional checks on conductor for scratches, dent mark etc.
- Sample check on insulating paper for PH value, electric strength.
- Check for the bonding of the insulating paper with conductor.
- Check for the reaction of hot oil and insulating paper.

- Check and ensure that physical condition of all materials taken for windings is satisfactory and free of dust.
- Check for absence of short circuit between parallel strands.

Checks before Drying Process:

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

Checks during Drying Process:

- Measurement and recording of temperature and drying time during vacuum treatment.
- Check for completeness of drying.

Assembled Transformer:

- Check completed transformer against approved outline drawing, provision for all fittings, finish level etc.
- Jacking test on the assembled Transformer.
- Check for proper packing and preservation of accessories like radiators, bushings, explosions vent, dehydrating breather, rollers, Buchholz relay, control cubicle connecting pipes, Off Load Tap Changing & conservator etc.
- Check for proper provision of bracing to arrest the movement of core and winding assembly inside the tank.
- Gas tightness test to conform tightness.

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 plant, shall be deemed to be included in the specification and shall be furnished by the contractor 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 purchaser under any circumstances.

Oil:

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

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 equipment is purchased by the supplier on a sub-contract, he shall have them tested to comply with relevant requirements.

Stage Inspection:

The purchaser reserves the right to carry out stage inspection. The purchaser reserves the right to carry out stage inspection of power transformers. During stage Inspection compliance of following particulars shall be checked.

- Core assembly - diameter, window height, leg centre, stack width, stack thickness, thickness of laminations, proof towards prime source of laminations
- Windings - conductor size, I.D., O.D & height of winding, major and minor insulations for both H.V and L.V windings
- Tank - length, breadth, height and thickness of plates of transformer tank, quality of fittings and accessories.

The supplier shall offer for final inspection of the transformers subject to clearance of the stage inspection report by the purchaser.

10.5.21. Losses

Transformers with lower losses shall be preferred. The bidder shall indicate the values of load and no load losses of the transformer in his bid. Maximum allowable losses shall be as follows:

- No load losses = 8 kW
- Load losses at 75 ^{0}C = 50 kW

There would not be any positive tolerance in losses. The manufacturer can offer losses less than above.

10.5.22. Capitalization of Losses

For total cost evaluation, the capitalized cost of losses will be taken into account as per the following:
Capitalized cost of Transformer = Initial cost of Transformer + Rs. A x WI + Rs. B x W_C

Where: WI = Iron loss in kW & A = 137408 Rupees for iron loss

WC = Copper loss in kW & B = 41222 Rupees for copper loss

In the event of either the iron or copper loss exceeding its guaranteed value as stated in the technical data schedule, the relevant rate above shall be applied to the excess and the resulting amount shall be deducted from the contract price.

10.5.23. Spare Parts

The Bidder shall provide a list of mandatory & recommended spare parts together with their individual prices. The prices of mandatory spares will be taken into account in the evaluation of tenders. This list shall identify all essential spares and consumable items for any recommended maintenance for a period of five years after commissioning

The Purchaser may order all or any of the spare parts listed at the time of contract award and the spare parts so ordered shall be supplied as part of the definite works. The Purchaser may order additional spares at any time during the contract period at the rates stated in the contract document. A spare parts catalogue with price list shall be provided and this shall form part of the drawings and literature to be supplied.

The Bidder shall give an assurance that spare parts and consumable items will continue to be available through the life of the equipment, which shall be 25 years minimum. However, the supplier shall give a minimum of 12 months' notice in the event that the supplier or any sub-suppliers plan to discontinue manufacture of any component used in this equipment.

Any spare apparatus, parts or tools shall be subject to the same specification, tests and conditions as similar material supplied under the definite work section of the contract.

They shall be strictly interchangeable and suitable for use in place of the corresponding parts supplied with the plant and must be suitably marked and numbered for identification.

Spare parts shall be delivered suitably packed and treated for long periods in storage. Each pack shall be clearly and indelibly marked with its contents, including a designation number corresponding to the spare parts list in the operation and maintenance instructions.

A complete set of all the special tools, devices, slings or tackles required for the adjustment and maintenance of the equipment shall be supplied in the quantity listed in the Price Schedule. Each set of tools shall be mounted in a lockable cabinet. These shall also be provided under this contract. Eye bolts which have to be removed after use shall be accommodated in the cabinet.

10.6. Tests

10.6.1. Type Tests

The following shall constitute type tests. Special tests shall also constitute part of type tests.

- Measurement of winding resistance Measurement of voltage radio and check of voltage vector relationship
- Measurement of impedance voltage/short-circuit impedance (principal tapping) and load loss
- Measurement of no-load loss and current
- Measurement of insulation resistance
- Dielectric tests
- Temperature-rise test, on tap having maximum losses
- Off load tap changer tests (as per IEC 60214-1 :2003)
- Tank Vacuum test
- Tank Pressure test

10.6.2. Special Tests

- Short circuit test
- Measurement of zero sequence impedance
- Measurement of acoustic noise level

Type test reports (less than five years old as on the due date of tender) of tests carried out at CPRI/ NABL accredited laboratory along with certified drawings shall be furnished by the bidder with offer otherwise offer shall be rejected. The offered transformer must be manufactured as per type tested design.

10.6.3. Routine Tests

The following shall constitute routine tests:

a) Visual examination and checking the dimensions
b) Winding DC resistance.
c) Voltage ratio on each tapping and
d) Check of voltage vector relationship and polarity.
e) Impedance voltage / short circuit impedance (principle tapping, maximum and minimum tapping.
f) Magnetic balance test -
   - Load loss.
   - No-load loss and current
g) Insulation resistance
h) Separate source AC voltage withstand test
i) Induced over voltage withstand test
j) Measurement of Zero sequence impedance
k) Absorption index i.e. insulation resistance for 15 seconds and 60 seconds (R60/R15) and polarization index i.e. Insulation Resistance for 10 minutes and one minute (R10 mt/R1 mt)
l) Oil leakage test of transformer tank at a pressure equal to normal pressure plus 35 kN per sq mtr measured at the base of tank.
m) Measurement of neutral unbalance current (not to exceed 2% of full rated current of transformer)
n) High voltage withstand test on auxiliary equipment and wiring.

In case of Temperature Rise test, if it is not feasible to carry out this test at CPRI/ NABL laboratories, bidder may hire services of the laboratories and carry out Temperature Rise test at supplier's works with testing equipment of CPRI/ NABL. Test has to be carried out by testing engineer of CPRI/ NABL and certification of the same have to be given on CPRI / NABL's letter head.

10.6.4. Test Procedure

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 for oil and one hour for air and during that time no leak shall occur.

Pressure Test

Where required by the Purchaser, 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.

Vacuum Test

One transformer tank of each size shall be subjected to the vacuum pressure of 760 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.

10.6.5. Testing Equipment/Meter Calibration

All testing equipments / meters used shall be calibrated within valid time limit at NABL accredited laboratory. Calibration seals provided by the calibrating agency on testing equipments / meters shall be in good condition.

10.7. Pre-Delivery Inspection at Manufacturer's Works

All routine & acceptance tests shall be witnessed and certified by purchaser's representative at manufacturer's works. The vendor shall give at least 10 days advance intimation to the purchaser to enable them to depute their representative for witnessing the tests. The said representative shall have full facilities for unrestricted inspection of supplier's works, raw materials, manufacturing processes and conducting necessary tests.

The said representative shall verify the calibration seals provided by the calibrating agency on testing equipments/ meters.

Test reports of routine tests carried out by the manufacturer shall be submitted to the inspecting authority at the time of inspection for his approval.

Acceptance of any quantity of materials shall in no way relieve the supplier of his responsibility for meeting all requirements of the specification and shall not prevent subsequent rejection, if such materials are later found to be defective.

In case of waiver of inspection, vendor shall carry out all (i) routine and (ii) acceptance tests and submit test reports for approval of the purchaser, before dispatch of material.

The entire cost of testing for acceptance & routine rests and checking of length etc shall be borne by the supplier.

10.8. Quality Assurance

Following quality plans shall be submitted within 30 days from the date of placement of contract:

- Quality Assurance Plan (QAP) to be adopted by manufacturer in respect of raw materials and bought out items, including source and test reports of (i) important raw materials and (ii) bought out items.
- Material Quality Plan (MQP) to be adopted by manufacturer in respect of manufacturing process.

The QAP & MQP shall be approved by the purchaser within 15 days from the receipt of compliance, if any. The vendor shall follow the approved QAP & MQP in true spirit. If desired by the purchaser, he shall give access to all the documents and materials to satisfy the purchaser that QAP & MQP are being properly followed.

10.9. Guarantee

The manufacturers of the transformer shall provide a guarantee of 54 months from the date of commissioning or 60 months from the date of dispatch whichever is earlier.

10.10. Drawing / Documents

10.10.1. Test reports for bought out items

The Supplier shall submit the test reports for all bought out/sub supplier items for approval:

- Buchholz relay
- Sudden pressure rise relay in OLTC
- Sudden pressure rise relay on main tank
- Winding temperature indicators
- Oil temperature indicators
- Bushings
- Bushing current transformers in neutral (if provided)
- Marshaling box
- Any other item required to complete the works.

The supplier shall furnish following drawings/documents for approval of purchaser within 4 weeks from the order:

a) Detailed overall general outline 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, bushing lifting height, clearances between HV and LV terminals and ground, quantity of insulating oil etc.
b) Foundation plan showing loading on each wheel and jacking points with respect to centre line of transformer.
c) GA drawings/details of bushing.
d) Name plate drawing with terminal marking and connection diagrams.
e) Wheel locking arrangement drawing.
f) Transportation dimensions drawings.

g) GA drawing of marshalling box.
h) Control scheme/wiring diagram of marshalling box.
i) Technical leaflets of major components and fittings.
j) Oil temperature indicator and winding temperature indicator settings
k) Completed technical data sheets.
l) Details including write-up of tap changing gear.
m) Bi- metallic connector for connection to conductor/cable.
n) Maintenance and Operating Instructions.
o) As built version of the drawings and documents.

Executive Engineer (Stores), UPCL will be the final authority for approving the drawings submitted by the tenderer.

10.10.2. Instructions Manual

Three 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 others, the following particulars:

- Marked erection prints identifying the components, parts of the transformer as dispatched with assembly drawings.
- Detailed dimensions, assembly and description of all auxiliaries.
- 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.
- Salient technical particulars of the transformer.
- Copies of all final approved drawings.
- Detailed O&M instructions with periodical check lists and format etc.

10.11. Onsite inspection testing

10.11.1. Installation Checks

- Inspection and operational checking of accessories like tap changers, etc.
- 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.
- Check the whole assembly for tightness etc.
- Oil leakage tests.

10.11.2. Pre-Commissioning Tests

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

- Dry out test
- Megger Test
- DC Resistance measurement of windings
- Ratio test on all taps
- Phase relationship test (Vector grouping test)
- Buchholz relay alarm operation test
- Low oil level (in conservator) alarm
- Temperature Indicators
- Marshalling kiosk
- Magnetising current

The following additional checks shall be made:

- All oil valves are in correct position closed or opened as required.
- Thermometer pockets are filled with oil.
- Oil is at correct level in the conservator.
- Earthing connections are made.
- Colour of Silica gel is blue.
- Bushing arcing horn is set correctly and gap distance is recorded.

10.12. Packing & forwarding

10.12.1. Packing

Supplier shall pack or shall cause to be packed all items in such a manner as shall be reasonably suitable for shipment by road to UPCL without any risk of damage in transit. The packing shall be sufficient to withstand, without limitation, rough handling during transit and exposure to extreme temperatures, salt and precipitation during transit, and open storage.

10.12.2. Packing List

One copy of the packing list shall be enclosed in each package delivered. There shall also be enclosed in one package a master packing list identifying each individual package, which is part of the shipment. If, on any package, it is not possible to place packing list inside the container, all pertinent information shall be stenciled on the outside and will thus constitute a packing list.

10.13. Rejection

The Purchaser may reject any transformer if during tests or service any of the following conditions arise:

a) No load loss exceeds the guaranteed value.
b) Load loss exceeds the guaranteed value.
c) Impedance value exceeds the guaranteed value by + 10% or more.

d) The difference in impedance values of any two phases during single phase short circuit impedance test exceeds 2% of the average value guaranteed by the vendor.
e) Oil or winding temperature rise exceeds the specified value.
f) Transformer fails on impulse test.
g) Transformer fails on power frequency voltage withstand test.

Transformer is proved to have been manufactured not in accordance with the agreed specification.

10.14. Schedules

10.14.1. Schedule – I [Guaranteed Technical Particulars for – 33/11 kV, 10 MVA Power Transformer with Off Load Tap Changer]

Table 10-7: Guaranteed Technical Particulars for – 33/11 kV, 10 MVA Power Transformer with Off Load Tap Changer

S.No.	Description	Unit	Specified
1	Name and address of the Manufacturer		
	a) Transformer		
	b) HV & LV Bushings		
	c) Bimetallic connectors		
	d) Transformer Oil		
	e) Off Load/ On load tap changer		
	f) Instruments		
2	Service (Indoor / Outdoor)		Outdoor
3	Normal continuous rating in kVA under site conditions at all taps :	kVA	
	a) HV winding	kVA	12500
	b) LV winding	kVA	12500
4	Rated Voltage		
	a) HV winding	kV	33
	b) LV winding	kV	11
5	Rated frequency	Hz	50(+ - 5%)
6	No. of phases		3
7	Type of transformer		Conventional Power Transformer

S.No.	Description	Unit	Specified
8	Connections		
	a) HV winding		Delta
	b) LV winding		Star
9	Connections symbols		
	a) HV - LV		Dyn11
10	Tapings		
	a) Range		+ 5% to - 10% (in steps of 2.5%)
	b) Number of steps		9
	c) Position of tapping on HT winding for high voltage variation		
11	Reference ambient temperatures		
	a) Maximum ambient air temperature.	°C	50°C
	b) Maximum daily average ambient temperature	°C	35°C
	c) Minimum ambient air temperature.	°C	10°C
	d) Maximum yearly weighted average ambient air temperature.	°C	35°C
12	Maximum temperature rise over ambient temperature		
	a) In oil by thermometer	°C	35°C
	b) In winding by resistance measurement	°C	40°C
	c) Limit for hot spot temperature for which the transformer is designed	°C	90°C (as per IS 2026)
	d) Type and details of winding hot spot temperature detector	°C	WTI with 150 mm dia. dial type instrument temp. sensing element image coil , auxiliary CT, 2 nos. of contacts of high winding temperature alarm and trip, calibration devices.
	e) Temperature gradient between windings and oil	°C	
	f) Type of maximum winding temperature	°C	

S.No.	Description	Unit	Specified
13	Voltage to earth for which the star point will be insulated	kV	
14	Cooling type		ONAN
15	Losses		
	a) Fixed (Iron) losses of 3 phase Transformer (kW) at rated voltage & rated frequency	kW	11 kW (Max)
	b) Load losses at rated current at principal	kW	72 kW (Max)
16	Max. Current density in winding at rated current for normal tap position		
	a) HV winding (Amps/ sq.mm.)	A/mm2	2.4 (Amps/ sq.mm)
	b) LV winding (Amps / sq.mm.)	A/mm2	2.4 (Amps/ sq.mm)
17	Impedance voltage at rated current ,frequency and at 75°C expressed as percentage of rated voltage at :-		
	a) Principal (normal) tap	%	7.15% + 10% Tolerance
	b) Highest tap	%	
	c) Lowest tap	%	
18	Reactance at rated current & frequency as percentage of rated voltage at:		
	a) Principal (normal) tap	%	
	b) Highest tap	%	
	c) Lowest tap	%	
19	Resistance at 75ºC		
	a) H.V. winding at normal tap position	Ohms	
	b) L.V. winding	Ohms	
	c) Resistance voltage drop at 75ºC winding temperature expressed as percent of rated voltage	%	
	i) Principal/ normal tap	%	
	ii) Highest tap	%	
	iii) Lowest tap	%	

S.No.	Description	Unit	Specified
20	Capacitance on open circuit conditions		1800 pF(Approximately)
21	Insulation level		
	a) Separate source power frequency voltage withstand		
	i) HV winding	kV rms	70
	ii) LV winding	kV rms	28
	b) Induced over voltage withstand		
	i) HV winding	kV rms	--- Double Voltage & Double Frequency -
	ii) LV winding	kV rms	--- Double Voltage & Double Frequency -
	c) Full wave lightning impulse withstand		
	i) HV winding	kV peak	
	ii) LV winding	kV peak	
	d) Power frequency high voltage tests		
	i) Test voltage for one minute withstand test on high voltage windings (induced)	kV rms	
	ii) Test voltage for one minute withstand test on low voltage windings	kV r ms	
	iii) Test voltage for one minute withstand test on neutral end of low voltage windings	kV rms	
	e) Lightning impulse withstand tests		
	i) Impulse test on high voltage winding 1.2/50 µ sec full wave withstand	kV peak	
	ii) Impulse test on low voltage winding 1.2/50 µ sec full wave withstand	kV peak	

S.No.	Description	Unit	Specified
	iii) Wave form for impulse test	kV peak	
22	No load current, no load loss, no load power factor at normal ratio and frequency	Amp/kW/P.F	
	a) 10 percent of rated voltage		Will be furnished by Bidders Offer
	b) 25 percent of rated voltage		
	c) 50 percent of rated voltage		
	d) 85 percent of rated voltage		
	e) 100 percent of rated voltage		
	f) 105 percent of rated voltage		
	g) 110 percent of rated voltage		
	h) 112.5 percent of rated voltage		
	i) 115 percent of rated voltage		
	j) 120 percent of rated voltage		
	k) 125 percent of rated voltage		
23	Efficiency at 75ºC at unity power factor		
	a) Full load	%	
	b) 75% load	%	
	c) 50% load	%	
	d) 25% load	%	
24	a) The minimum % of load at which the transformer will run at maximum efficiency (%)	%	
	b) Maximum efficiency of the transformer	%	
25	Regulation at full load at 75ºC		
	a) At unity power factor	%	
	b) At 0.8 power factor (lagging)	%	
26	Core data		
	a) Grade of core material used		CRGO HIB, M3 or better
	b) Thickness of core plate lamination	Mm	≤ 0.23 mm for M3 and ≤ 0.27 mm for CRGO HIB

S.No.	Description	Unit	Specified
	c) Whether core laminations are of cold rolled grain oriented		CRGO HIB, M3 or better
	d) Details of oil ducts in core		
	i) Whether in the plane & at right angle to the plane of winding		
	ii) Across the plane of lamination		
	e) i) Insulation of core lamination		
	ii) Insulation of core plates		
	iii) Type of core joints		
27	Flux density		
	a) Designed maximum flux density at normal tap at rated voltage and rated frequency	Tesla	1.9 Tesla
	b) Operating continuous flux density	Tesla	1.9 Tesla
	i) at normal tap	Tesla	
	ii) at maximum tap	Tesla	
	iii) at minimum tap	Tesla	
	c) Designed maximum operating flux density which the transformer can withstand for one minute at normal tap	Tesla	1.9 Tesla for all Tap
	d) Designed maximum operating flux density which the transformer can withstand for five seconds at normal tap	Tesla	
28	Inter-Tap insulation		
	a) Extent of extreme end turns reinforcement		
	b) Extent of end turns reinforcement		
	c) Extent of turn adjacent to tapping reinforced		
	d) Test voltage for 10 seconds 50Hz inter-turn insulation test on (a)		

S.No.	Description	Unit	Specified
	e) Test voltage for 10 seconds 50Hz inter-turn insulation test on (b)		
	f) Test voltage for 10 seconds 50Hz inter-turn insulation test on (c)		
29	Windings:		
	a) Material		
	b) Type of windings:		
	i) HV windings		
	ii) LV windings		
	c) Insulation of HV windings		
	d) Insulation of LV windings		
	e) Insulation between HV & LV windings		
30	Transformer Tank		
	a) Material		
	b) Thickness		
	- Top	Mm	10 mm
	- Sides	Mm	10 mm
	- Bottom	Mm	12 mm
	c) Details of painting (inner / outer surface)		
31	Dimensions of 3 phase transformers:		
	a) Max. Height to top of bushings	Mm	
	b) Over-all length	Mm	
	c) Over-all breadth	Mm	
32	Weight data of transformer components (Tolerance + 5%) (approximate values not allowed)		
	a) Core excluding clamping	Kg	
	b) Core with clamping	Kg	
	c) HV winding insulated conductor	Kg	
	d) LV winding Insulated conductor	Kg	

S.No.	Description		Unit	Specified
	e)	Coils with insulation	Kg	
	f)	Core and windings	Kg	
	g)	Weight of steel	Kg	
	h)	Fittings and accessories	Kg	
	i)	Oil required for first filling including 10% extra	Ltr/kg	
		1. Oil in main tank	Ltr	
		2. Oil in the conservator	Ltr	
		3. Oil in the radiators	Ltr	
		4. Oil in the OLTC	Ltr	
		5. Overall total quantity of oil with 10% extra oil for first filling	ltr/kg	
	j)	1. Transportation weight excluding accessories	Kg	
		2. Shipping details		
		i) Weight of heaviest package	Kg	
		ii) Dimension of largest package (L x Wx H)	Mm	
	k)	Untanking weight	Kg	
	l)	Total weight of transformer with oil and fittings	Kg	
33	Bushing data :			
	a)	Type of bushing insulator		
		i) HV		Out door type highly polluted a (as per Is-8603, 2099 & 3347)
		ii) LV		-do-
		iii) Neutral		-do-
	b)	Material of bushing (inner part / outer part)		Porcelain (as per IS-8603)
	c)	Weight of bushing insulator (Kg.)		
		i) HV	Kg	
		ii) LV	Kg	

S.No.	Description		Unit	Specified
		iii) Neutral	Kg	
	d)	Quantity of oil in one bushing (lt.)		
		i) HV	ltr.	
		ii) LV	ltr.	
		iii) Neutral	ltr.	
	e)	Minimum dry withstand & flash over power frequency voltage of bushing	kV	
	f)	Minimum wet withstand & flash over power frequency voltage of bushing	kV	
	g)	Minimum withstand & flashover impulse level	kV	
	h)	Voltage rating	kV	
		i) HV	kV	
		ii) LV	kV	
		iii) Neutral	kV	
	i)	Current rating (Amps.)		
		i) HV	Amp	
		ii) LV	Amp	
		iii) Neutral	Amp	
	j)	Thermal Short Time current & Duration	Sec	2 Sec
		i) HV	kA	
		ii) LV	kA	
		iii) Neutral	kA	
	k)	Rated Dynamic current & its duration	Sec	As per Is-2026 & 2029
		i) HV	kA	
		ii) LV	kA	
		iii) Neutral	kA	
	l)	Cantilever with stand loading		
	m)	Clearance in oil		
		phase to phase		

S.No.	Description		Unit	Specified
		i) HV	Mm	
		ii) LV	Mm	
		iii) Neutral	Mm	
		phase to earth (mm)		
		i) HV	Mm	
		ii) LV	Mm	
		iii) Neutral	Mm	
	n)	Creepage distance in oil & air (mm)	mm/kV	
		i) In oil		
		a) HV	Mm	
		b) LV	Mm	
		c) Neutral	Mm	
		ii) In air	Mm	
		a) HV	Mm	
		b) LV	Mm	
		c) Neutral	Mm	
	o)	Minimum level of immersing / medium (oil)	Mm	
	p)	Maximum pressure of immersing medium (oil)	Kg/cm2	
	q)	Free space required at top for removal of bushings	Mm	
	r)	Angle of mounting		
34	Conservator (Main Transformer and OLTC)			
	a)	Total volume of the Conservator	M3	
	b)	Volume of the conservator between the highest and lowest level	M3	
35	Calculated time constants for natural cooling		Hrs	
36	Type of axial coil supports :			
	a)	HV winding		
	b)	LV winding		

S.No.	Description		Unit	Specified
37	Details of On load / off-circuit tap changer			
	a)	Make		
	b)	Type		
	c)	Rating		
		i) Rated Voltage	kV	
		ii) Rated current	Amp	
		iii) Step voltage	V	
		iv) Number of steps		
	d)	Whether Diverter switch provided with gas vent and Buchholz relay (Yes / No)	Yes/No	
	e)	Whether a separate oil surge relay with trip contracts provided (Yes / No)		
	f)	Whether Remote control panel provided with Control scheme for simultaneous operation of Tap changer when transformers running in Parallel and independent control when in independent operation		
	g)	Details of motor device unit housed in kiosk mounted on tap changer		
	h)	Pressure relief valve		
38	Dispatch details :			
	a)	Approx. mass of heaviest Package	Kg	
	b)	Approx. dimensions of largest Package		
		i) Length	Mm	
		ii) Breadth	Mm	
		iii) Height	Mm	
39	Un-tanking height		Mm	
40	Bimetallic connectors: HV / LV			
	a)	Normal current rating (A)	Amp	
	b)	Short time current rating (A)	Amp	

S.No.	Description		Unit	Specified
	c)	Tensile strength	Kg	
	d)	Maximum temperature limit		
	e)	Dimensional sketch enclosed indicating tolerances (Yes/No)		
	f)	Minimum clearance		
		Phase to phase	Mm	
		Phase to Earth	Mm	
41	CORE ASSEMBLY :-			
	a)	Core diameter	Mm	
	b)	Core window height	Mm	
	c)	Core leg centre	Mm	
	d)	Gross core cross - sectional area	M2	Will be furnished by Bidder Offer
	e)	Total height of core	Mm	
	f)	Details of top end frame		
	g)	Details of Bottom end frame		
	h)	Details of clamp plate (material, thickness, insulation)		
	i)	Total core weight	Kg	
	j)	Core loss, basing on core loss graph at operating flux density (rated voltage and rated frequency)	kW	
	k)	Core stacking factor		
	l)	Net core area (Sq. M.)	M2	
	m)	Margin towards corner joints, cross-fluxing, dielectric loss	kW	
	n)	Total core loss at rated voltage and rated frequency	kW	
	o)	Describe location/ method of core grounding		
	p)	Details of core- belting		
		i) Material , grade and type		
		ii) Width	Mm	

S.No.	Description		Unit	Specified
		iii) Thickness	Mm	
		iv) Fixing method		
42	DETAILS OF WINDING			
	a)	Type of winding		
	b)	Material of the winding conductor		Electrolytic Copper
	c)	Maximum current density of windings at rated current and conductor area (HV / LV)	A/mm2	2.4 Amps /mm2 (at all taps)
	d)	Whether windings are pre-shrunk?		
	e)	Whether adjustable coil clamps are provided for HV and LV windings?		
	f)	Whether steel rings are used for the windings? If so, whether these are split?		
	g)	Whether electrostatic shields are provided to obtain uniform voltage distribution in the windings?		
	h)	Winding Insulation (Type & Class)		
	i)	Insulating material , used for		
		i) H.V winding		
		ii) LV winding		
		iii) Tapping connection		
	j)	Insulating material used between		
		i) L.V and H.V winding		
		ii) Core & L.V winding		
	k)	H.V to H.V winding between phases		
	l)	Type of axial supports		
		i) H.V winding		
		ii) L.V winding		
	m)	Type of radial supports		
		i) H.V winding		
		ii) L.V winding		

S.No.	Description	Unit	Specified
	n) Maximum allowable torque on coil clamping bolts		
	o) Clamping ring details		
	i) Thickness of ring mm	Mm	
	ii) Diameter of ring mm	Mm	
	iii) No. & size of pressure screw		
	p) Bare conductor size		
	i) HV	mm2	
	ii) LV	mm2	
	q) Inside diameter		
	i) HV	Mm	
	ii) LV	Mm	
	x) Outside diameter		
	i) HV	Mm	
	ii) LV	Mm	
	y) Axial height after shrinkage		
	i) HV	Mm	
	ii) LV	Mm	
	z) D.C Resistance		
	i) L.V winding at 75°C	Ohm	
	ii) H.V winding at normal tap at 75°C	Ohm	
	iii) H.V winding at highest tap at 75°C	Ohm	
	iv) H.V winding at lowest tap at 75°C	Ohm	
	v)Total I2R losses at 75°C for normal tap	kW	
	vi)Total I2R losses at 75°C for highest tap	kW	
	vii) Total I2R losses at 75°C for lowest tap	kW	
	viii) Stray losses including eddy current losses in winding at 75°C	kW	

S.No.	Description	Unit	Specified
	a) Normal tap position	kW	
	b) Highest tap position	kW	
	c) Lowest tap position	kW	
	d) Any special measures, taken to reduce eddy current losses and stray losses mention in details		
	ix)Load losses at 75°C (I2 R + Stray)		
	a) Normal tap position	kW	
	b) Highest tap position	kW	
	c) Lowest tap position	kW	
	x) Details of special arrangement, provided to improve surge voltage distribution in the windings.		
43	DETAILS OF TANK :		
	a) Material of Transformer tank		
	b) Type of tank		
	c) Thickness of sheet (No approximate value to be mentioned)		
	i) Sides (mm)	Mm	10 mm
	ii) Bottom (mm)	Mm	12 mm
	iii) Cover (mm)	Mm	10 mm
	iv) Radiators (mm)	Mm	1. 2 mm
	d) Inside dimensions of main tank (No approximation in dimensions to be used)		
	i) Length (mm)	Mm	As per CBIP
	ii) Breadth (mm)	Mm	As per CBIP
	iii) Height (mm)	Mm	As per CBIP
	e) Outside dimensions of main tank (No approximation in dimensions to be used)		
	i) Length (mm)	Mm	

S.No.	Description		Unit	Specified
		ii) Breadth (mm)	Mm	
		iii) Height (mm)	Mm	
	f)	Vacuum recommended for hot oil circulation (Torr / mm of Hg)	Kg/cm2	
	g)	Vacuum to be maintained during oil filling in transformer tank (Torr / mm of Hg)	Kg/cm2	
	h)	Vacuum to which the tank can be subjected without distortion ((Torr / mm of Hg)	Kg/cm2	
	i)	No. of bi-directional wheels provided		
	j)	Track gauge required for the wheels		
		i) Transverse axis	Mm	
		ii) Longitudinal axis	Mm	
	k)	Type and make of pressure relief device and minimum pressure at which it operates (Kpa)		
44	CONSERVATOR :-			
	a)	Thickness of sheet (mm)	Mm	
	b)	Size (Dia x length) (mm)	Mm	
	c)	Total volume (Litres)	Ltrs	
	d)	Volume between the highest and lowest visible oil levels (Litres)	Ltrs	

10.14.2. Schedule – II [Information regarding manufacturing and testing facilities]

(Vendor to enclose following documents and to confirm the same)

Table 10-8: Information regarding manufacturing and testing facilities

S.No.	Particulars	Confirmation
1	Type test report from NABL accredited lab (less than 5 years old as on date of opening of offer)	
2	List of plant and machinery	
3	List of testing facility available	

S.No.	Particulars	Confirmation
4	List of orders pending and executed	
4 (a)	With UPCL	
4 (b)	With other agencies, other than 4.a	

11. Technical Specifications for 33/11 kV, 10 MVA ONAN Power Transformers with On Load Tap Changer (OLTC)

11.1. Scope

This specification covers design, engineering, manufacture, assembly, testing, inspection before dispatch, forwarding, packing, transportation to site of three phase, 50 Hz, 10 MVA 33/11kV step-down outdoor ONAN Power Transformers with On-load tap changer complete with all accessories/fittings and spare parts as specified herein, for use in sub-stations in Uttarakhand state.

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 purchaser 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.

It is not the intent to specify herein complete details of design and construction. The equipment offered shall conform to the relevant standards and be of high quality, sturdy, robust and of good design and workmanship complete in all respects and capable to perform continuous and satisfactory operations in the actual service conditions at site and shall have sufficiently long life in service as per statutory requirements. In actual practice, notwithstanding any anomalies, discrepancies, omissions, incompleteness, etc. in these specifications and attached drawings, the design and constructional aspects, including materials and dimensions, will be subject to good engineering practice in conformity with the required quality of the product, and to such tolerances, allowances and requirements for clearances etc. as are necessary by virtue of various stipulations in that respect in the relevant Indian Standards, IEC standards, CEA Regulations , Electricity Act and other statutory provisions.

11.2. Service Conditions

Equipment/material to be supplied against this specification shall be suitable for satisfactory continuous operation under the tropical conditions as follows:

Table 11-1: Service Conditions

S.No.	Particulars	Value
1	Maximum ambient temperature (Deg. Celsius)	50
2	Minimum temperature (Deg. Celsius)	-5
3	Relative humidity range (%)	10 to 100

S.No.	Particulars	Value
4	Maximum annual rainfall (mm)	1500
5	Maximum wind pressure (kg/sq m)	195
6	Maximum altitude above mean sea level (m)	3000
7	Isoceraunic level (days/year)	50
8	Seismic level (Horizontal acceleration) (g)	0.13

11.3. Standards

The equipment shall comply with latest revision of the following Indian Standards (IS) unless otherwise stipulated in the specification.

All references to Indian Standards shall be deemed to be complying with latest amendments to the respective IS, if any.

Table 11-2: Standards

Indian Standard	Particulars	International standard
IS: 2026 (Part- 1 to 4)	Power transformers	IEC 76 (1-5)
IS:1271	Classification of insulating materials for electrical machinery and apparatus	
IS:335	New insulating oil for transformers, Switchgears	IEC 296
IS:2071	Method of high voltage testing	
IS:2099	High voltage porcelain bushings	IEC 137
IS:2147	Degree of protection	IEC 529
IS:2705	Current transformers	
IS:3347	Dimensions for porcelain transformer bushings	
IS:3637	Gas operated relays	
IS:3639	Fittings and accessories for power transformers	
IS: 6600	Guide for loading of oil immersed transformers	IEC 354
IS:5561	Electric Power Connectors	
IS: 10028	Code of practice for selection, installation and maintenance of transformers, Part I, II and III	
IS:3202	Code of practice for climate proofing of electrical equipment	

Indian Standard	Particulars	International standard
IS:5	Colour for ready mixed paints	
IS : 325	Three Phase Induction Motors	
C.B.I.P. Publication	Manual on Transformers	
	Insulation Co-ordination	IEC 71
	Radio influence voltage measurement	IEC 437
	Measurement of transformer and reactor sound levels	IEC 551

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. and if the IS mentioned is upgraded then the latest version of IS shall be applicable.

11.4. Specific Technical Requirements

Specific technical requirements shall be as follows:

Table 11-3: Specific Technical Requirements

S.No.	Parameter	Particulars
1	Rated MVA (ONAN rating)	10 MVA
2	No. of phases	3
3	Type of installation	Outdoor
4	Frequency	50 Hz
5	Cooling medium	Insulating oil
6	Rated voltage	
6 (a)	High voltage winding	33kV
6 (b)	Low voltage winding	11kV
7	Highest continuous system voltage	
7 (a)	a) HV side	36kV
7 (b)	b) HV Side	12kV
8	Nominal short circuit level 33 kV (Based on apparent power)	31.5 kA
9	Nominal short circuit level 11 kV (Based on apparent power)	13.1 kA

S.No.	Parameter	Particulars
10	Type of tap changer	On-load tap changer on HV winding
11	No. of windings	Two
12	Range of tapings	Plus 5% to minus 10 % of 1.25% each on HV winding
13	Neutral terminal to be brought out	On LV side only
14	Impedance on rated MVA base at 75^0 C, on normal tap	8.35% (Tolerance plus 10%, negative tolerance shall not be allowed)
15	Type of winding insulation	Uniform both for HV and LV
16	Over voltage operating capacity & duration	112.5 % of rated voltage (continuous)
17	Anticipated unbalanced loading	Around 10 %
18	Anticipated continuous loading of windings (HV/LV)	110 % of rated current
19	Maximum Flux Density in any part of the core and yoke at rated MVA, rated voltage i.e. 33kV /11kV and system frequency of 50Hz.	1.9 Tesla
20	Power frequency withstand test voltage (kV rms)	70 kV (HV), 28 kV (LV)
21	Impulse withstand test voltage (kV peak)	170 (HV) , 75 (LV)
22	Withstand time for three phase short circuit	2 seconds
23	Winding connection	
23 (a)	LV Side	Delta
23 (b)	HV Side	Star
24	Winding material (HV & LV)	Electrolytic Copper
25	Vector group	Dyn 11
26	Type of cooling	Insulating oil (ONAN)
27	Neutral earthing	LV neutral shall be solidly earthed
28	Winding temperature Indicator	One
29	Provision for Differential Protection arrangement	Not required
30	Oil Temperature indicator	One

S.No.	Parameter	Particulars
31	Maximum temperature rise on top of oil over an ambient temperature of 50^0 C (measured by thermometer)	45^0 C
32	Maximum temperature rise of winding over an ambient temperature of 50^0 C (measured by resistance)	55^oC
33	Over load capacity	As per IS:6600
34	Degree of protection for marshaling box	IP 55
35	Noise level at rated voltage and frequency	As per NEMA publication no. TR-1
36	Minimum clearances in air (mm)	
36 (a)	Phase to phase	HV - 400, LV – 280
36 (b)	Phase to ground	HV- 320, LV – 140
37	Terminals (Bushings)	
37 (a)	HV winding line end	36 kV oil filled communicating type porcelain bushing (Anti fog type)
37 (b)	LV winding (for outdoor type 11 kV breakers)	12 kV porcelain type bushing (Anti fog type)
38	Insulation level of bushings	
38 (a)	One minute power frequency withstand test voltage (kV rms)	70 kV (HV), 28 kV (LV)
38 (b)	Impulse withstand test voltage (kV peak) 1.2/50 micro second	170 (HV) , 75 (LV)
39	Minimum creepage distance	900 mm (HV), 300 mm (LV)
40	Maximum current density for HV, LV windings for rated current	2.4 Amp/sq mm
41	Core material	High grade, non-ageing Cold Rolled Grain Oriented (CRGO) silicon steel, confirming to HIB grade
42	Core assembly	Boltless Core type
43	Type of mounting	On wheels, mounted on rails
44	Maximum permissible no load loss at rated voltage and rated frequency	7 kW

S.No.	Parameter	Particulars
45	Maximum permissible load loss at rated current at 750 C	50 kW

11.5. General Technical Requirements

11.5.1. Performance

- 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.
- The maximum flux density in any part of the core and yoke at rated MVA, voltage and frequency shall be such that the flux density under 12.5% over voltage condition shall not exceed 1.9 Tesla.
- The maximum FLUX DENSITY in any part of the core and yoke at rated voltage and frequency shall not exceed 1.5 Tesla
- 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.
- The transformer shall be capable of operating continuously without danger on any particular tapping at the rated MVA ±12.5% of the voltage corresponding to the tapping.
- Transformer shall be capable of withstanding thermal and mechanical stress caused by any symmetrical and asymmetrical faults on any winding. This shall be demonstrated through calculation as per IS: 2026.
- The thermal ability withstand short circuit shall be demonstrated by calculation.
- 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 energised at normal voltage and frequency shall be as per NEMA TR -1 stipulation.
- 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.
- The transformer shall be capable of being operated without danger on any tapping at
- The rated kVA with voltage variation of + 10% corresponding to the voltage of the tapping.

11.5.2. General Construction Features

- 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.
- Similar parts, particularly removable ones, shall be interchangeable.
- 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.

- Nuts, bolts and pins used inside the transformers and tap changer compartments shall be provided with lock washers or locknuts.
- Exposed parts shall not have pockets where water can collect.
- Internal design of transformer shall ensure that air is not trapped in any location.
- 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.
- 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.
- All internal connections and fastenings shall be capable of operating under overloads and over-excitation, allowed as per specified standards without injury.
- Transformer and accessories shall be designed to facilitate proper operation, inspection, maintenance and repairs.
- No patching, plugging, shimming or other such means of overcoming defects; discrepancies or errors will be accepted.
- Schematic Drawing of the wiring, including external cables shall be put under the prospane sheet on the inside door of the transformer marshalling box.

11.5.3. Core

- Stage level inspection for core construction shall be carried out by the owner.
- Each lamination shall be insulated such that it will not deteriorate due to mechanical pressure and the action of hot transformer oil.
- 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 0.23 mm to 0.27 mm or better. The maximum flux density in any part of the core and yoke at rated MVA, voltage and frequency shall be such that the flux density under 12.5% over voltage condition shall not exceed 1.9 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.
- Following documents shall be submitted during stage inspection as proof towards use of prime core material:
  a) Purchase order
  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 and not through any agent.
- The laminations shall be free of all burrs and sharp projections. Each sheet shall have an insulating coating resistant to the action of hot oil.

- The insulation structure for the core to bolts and core to clamp plates shall be such as to withstand 2000 Volt DC voltage for one minute.
- The completed core and coil shall be so assembled that the axis and the plane of the outer surface of the core assembly shall not deviate from the vertical plane by more than 25 mm.
- All steel sections used for supporting the core shall be thoroughly shot or sand blasted, after cutting, drilling and welding.
- The finally assembled core with all the clamping structures shall be free from deformation and shall not vibrate during operation.
- The core clamping structure shall be designed to minimize eddy current loss.
- The framework and clamping arrangements shall be securely earthed.
- The core shall be carefully assembled and rigidly clamped to ensure adequate mechanical strength.
- 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.
- The design of magnetic circuit shall be such as to avoid static discharges, development of short circuit paths within itself or to the earthed 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.
- 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 assembly shall be so fixed in the tank that shifting will not occur during transport or short circuits.
- The temperature gradient between core & surrounding oil shall be maintained less than 20^0C. The manufacturer shall demonstrate this either through test (to be mutually agreed) or by calculation.

11.5.4. Windings

- 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.
- 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.
- 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.
- 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.
- Varnish application on coil windings may be given only for mechanical protection and not for improvement in dielectric properties. In no case varnish or other adhesive be used which will seal the coil and prevent evacuation of air and moisture and impregnation by oil.
- Winding and connections shall be braced to withstand shocks during transport or short circuit.
- 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.

- All the insulating materials to be used in the transformer shall preferably be of class- insulation as specified in Indian Standards. The test certificate of the raw materials shall be made available by the Transformer manufacturer on request during inspection and testing.
- The coil clamping arrangement and the finished dimensions of any oil ducts shall be such that it will not impede the free circulation of oil through the ducts.
- Coil clamping rings, if provided shall be of steel or suitable insulating material. Axially laminated material other than backlisted paper shall not be used.
- Terminals of all windings shall be brought out of the tank through bushings for external connections.
- The completed core and coil assembly 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.
- The winding shall be so designed that all coil assemblies 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.
- 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.
- Adequate barriers shall be provided between coils and core and between high and low voltage coil. End turns shall have additional protection against abnormal line disturbances.
- 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.
- Tapings 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 the transformer at all voltage ratios.
- Magnitude of impulse surges transferred from HV to LV windings by electromagnetic induction and capacitance coupling shall be limited to B.I.L. of LV winding.
- The current density adopted in all windings shall not exceed 2.4 A/ sq mm . The total net cross sectional area of strip conductors for calculating current density for each winding shall be obtained after deducting the copper area lost due to rounding up of the sharp edges of the rectangular conductors.

11.5.5. Insulating Oil

- The insulating oil for the transformers shall be of EHV grade, conforming to IS: 335. No inhibitors shall be used in the oil.
- Transformer shall be shipped with oil filled at least to cover the core and coil assembly.
- The quantity of oil required for the first filling of the transformer and its full specification shall be stated in the bid. The bidder shall quote the price of transformer complete with first filling of oil plus 10% extra. However, the rate of transformer oil in Rupee per litre shall be quoted separately also. The transformer oil shall be supplied in non-returnable drums.
- 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.

- The Supplier shall warrant that oil furnished is in accordance with the following specifications. Supplier shall submit the test certificate accordingly.

Table 11-4: Insulating oil specifications

S.No.	Characteristic	Requirement	Method of Test
1	Appearance	The oil shall be clear & transparent & free from suspended matter or sediment	A representative sample of oil shall be examined in a 100 mm thick layer at ambient temp.
2	Density at 20^0 C	0.89g/cm3 Max.	IS: 1448
3	Kinematic Viscosity at 27 deg. C Max	27 CST	IS: 1448
4	Interfacial tension at 27 deg. C Min.	0.03N/m	IS: 6104
5	Flash Point	140 deg. C	IS: 1448
6	Pour Point Max.	-6 deg. C	IS: 1448
7	Neutralisation Value (Total acidity) Max.	0.04 mg KOH/gm	IS: 335
8	Electric strength Break Down (voltage) Min.	60 kV	IS: 6792
9	Dielectric dissipation factor tan delta at 900 C	0.002 Max	IS:6262
10.a	Min. specific resistance (resistivity) at 90 deg. C	35 x 1012 ohm cm (min.)	IS: 6103
10.b	Min. specific resistance (resistivity) at 27 deg. C	1500 x 1012 ohm cm (min.)	IS: 6103
11	Neutralisation value after Oxidation	0.40 mg KOH/g	
12	Total sludge after Oxidation	0.10% by weight max.	
13	Presence of oxidation Inhibitor	The oil shall not contain anti-oxidant additives	IS:335
14	Water content Max:	Less than 25 ppm	IS: 2362

11.5.6. Internal Earthing

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

b) The top clamping structure shall be connected to the tank by a copper strip. The bottom clamping structure shall be earthed by one or more of the following methods:
   - By connection through vertical tie-rods to the top structure.
   - By direct metal to metal contact with the tank base.
   - By a connection to the top structure on the same side of the core as the main earth connection to the tank.

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.

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.

11.5.7. Tank

a) The Transformer tank and cover shall be fabricated from high grade low carbon plate steel of tested quality of adequate thickness. The tank and the cover shall be of welded construction. All welds shall be stress relieved. Stiffener shall be provided for general rigidity. Tank surface shall be designed to prevent retention of water.
b) Tank shall be designed to permit lifting by crane or jacks of the complete transformer assembly filled with oil. Suitable lugs and bosses shall be provided for this purpose.
c) All beams, flanges, lifting lugs, braces and permanent parts attached to the tank, shall be welded and where practicable, they shall be double welded.
d) The main tank body of the transformer, excluding tap changing compartments and radiators, shall be capable of withstanding pressure of 760 mm of Hg.
e) 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.
f) All bolted connections to the tank shall be fitted with suitable oil-tight gaskets which shall give satisfactory service under the operating conditions for complete life of the transformer. Special attention shall be given to the methods of making the hot oil-tight joints between the tank and the cover as also between the tank cover and the bushings and all outlets to ensure that the joint can be remade satisfactorily and with ease, with the help of semi-skilled labour. Where compressible gaskets are used, steps shall be provided to prevent over-compression.
g) Suitable guides shall be provided for positioning the various parts during assembly or dismantling. Adequate space shall be provided between the cores and windings and the bottom of the tank for collection of any sediment.

11.5.8. 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 suitably sloped so that it does not retain rain water.

11.5.9. Under Carriage

The transformer tank shall be supported on steel structure with detachable plain rollers completely filled with oil. Suitable channels for movement of roller with transformer shall be spaced accordingly. Rollers wheels shall be provided with suitable rollers bearings, which will resist rust and corrosion and shall be equipped with fittings for lubrication. It shall be possible to swivel the wheels in two directions, at right angle to or parallel to the main axis of the transformers.

Jacking pads shall be provided on the transformer. It shall be possible to change the direction of the wheels through 90 degree when the transformer is lifted on jacks to permit movement of the transformer both in longitudinal and transverse directions.

11.5.10. Valves

a) Valves shall be of forged carbon steel up to 50 mm size and of gun metal or of cast iron bodies with gun metal fittings for sizes above 50 mm. 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.
b) 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.
c) 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 supplier shall supply the same.
d) Each transformer shall be provided with following valves on the tank:
    - Drain valve so located as to completely drain the tank.
    - Two filter valves on diagonally opposite corners, of 50 mm size.
    - Oil sampling valves not less than 8 mm at top and bottom of main tank.
    - One 15 mm air release plug.
    - Valves between radiators and tank.
e) Drain and filter valves shall be suitable for applying vacuum as specified in the specifications.

11.5.11. Painting

Surface Preparation for tank, pipes, etc

All surfaces of transformer tank, pipes, etc shall be thoroughly blast cleaned with sand or shot or grit in accordance with ISO 8501 Part 1 to a minimum standard of "Sa2½" to make the surface free from visible oil, grease & dirt, mill scale, rust, paint coatings and foreign matter. Machined areas and threaded components etc are to be covered during blasting to prevent damage.

The air that is used for blasting should be dry and free from oil. The flanges, angles, tank curbs and other such areas shall be preferably blast cleaned prior to fabrication and paint these with one coat of primer. After adequate blast cleaning of each large surface where blasting time is more than three hours, an overall blast cleaning is to be done on the entire surface once more so that entire surface areas is exposed as fresh for first coat of primer paint. The first coat of primer paint should be applied not later than 3-4 hours after preparation of surface to avoid oxidation.

Surface Preparation for radiator

All internal and external surfaces of radiator shall be thoroughly cleaned either by chemical cleaning or by blast with sand or shot or grit in accordance with ISO 8501 Part 1 to make the surface free from visible oil, grease & dirt, mill scale, rust, paint coatings and foreign matter. Suitable chemical should be used for chemical cleaning, if required. The air that is used for blasting should be dry and free from oil. After adequate surface cleaning, the first coat of primer paint/varnish should be applied not later than 3-4 hours after preparation of surface to avoid oxidation.

Surface Preparation for Control cabinets/Marshalling Boxes

Surface Preparation for all Transformer Control cabinets/Marshalling Boxes shall be carried out confirming to following Indian standard in dust free area:

- IS: 3618: Degreasing by solvent wiping: Phosphate Treatment of Iron &Steel for Protection against corrosion.
- IS: 6005: Code of Practice for phosphating of Iron & Steel.

Chemicals: Suitable chemicals should be used and concentration of chemicals /weight of Phosphate coating should be checked regularly as per recommendation of the chemical manufacturer and applicable IS.

Inspection: The surface for application of paint should be dry, free from oil, dirt, acid & loose adhering powder and reasonably smooth in finish without uncovered areas, rusty surfaces and roughness.

Painting- Control cabinets/Marshalling Boxes

Enamel paint shall be used with total paint thickness as minimum 80 microns.

Painting- External & Internal surfaces

Painting shall be carried out in closed and dust free area. The external surface shall be coated with suitable layers of paint and to form an impermeable layer so that air and water cannot reach the substrate. The paint selected shall be stable in outdoor condition such as rain, sunlight, pollution etc. Paint used for primer, under coat and top or finish coat should be from the same manufacturer and compatible to each other. In case in the rare event, paint used for primer, under coat and finish coat are not from the same manufacturer the compatibility test of the paint from different source shall be carried out. Painting shall be applied as per the recommendation of the paint manufacturer. The number of coats shall be such that the minimum dry film

thickness (DFT) specified is achieved. The DFT of painted surface shall be checked with a measuring gauge to ensure specified DFT. Complete painting scheme for the transformer is tabulated below:

Table 11-5: Painting Specifications

	Surface Preparation	Primer Coat	Intermediate Undercoat	Finish Coat	Total DFT	Colour Shade
Tank, pipes, etc. (External surfaces)	Blast cleaning Sa2½	Epoxy base Zinc primer (30-40 μm)	Epoxy HB MIO (30-40 μm)	Aliphatic Polyurethane (min 50 μm)	Min 155 μm	697 shade as per IS 5
Tank (Internal surfaces)	Blast cleaning Sa2½	Hot oil resistant, non-corrosive varnish or paint or epoxy	--	--	Min 30 μm	Glossy white for paint
Radiator (External surfaces)	Chemical / blast cleaning (Sa2½)	Epoxy base zinc primer (30-40μm)	Epoxy base zinc primer (30-40μm)	PU paint (min 50μm)	Min 110μm	Matching shade of tank/ different shade aesthetically matching to tank
Radiator and pipes (Internal surfaces)	Chemical cleaning if required	Hot oil proof, low viscosity varnish, flushing with transformer oil.	--	--	--	--

11.5.12. Bushing

- Transformer shall be provided with bushing insulators on both H.V and L.V. sides. H.V and L.V. bushings shall be located on opposite side.
- The electrical characteristics of bushing insulator shall be in accordance with IS: 2099. Dimensions and type of bushing shall conform to IS:3347 and shall be as follows:

H.V. Bushing (33kV)	**36kV Class**	**Porcelain bushing with plain sheds for heavily polluted atmosphere**
L.V. Bushing (11kV)	12 kV Class	Porcelain bushing with plain sheds for heavily polluted atmosphere
Neutral Bushing	Neutral of L.V. winding shall be brought out through porcelain bushing similar to L.V. Bushing for connection with earth terminal in line with LV bushing.	

- All porcelain used in bushings shall be homogeneous, non-porous, uniformly glazed to brown colour and free from blisters, burns and other defects.
- Stress due to expansion and contraction in any part of the bushing shall not lead to deterioration.
- Each bushing shall be capable to carry at least 200% of current of Continuous Maximum Rating (CMR) of transformer and the short time current shall be of the same as of transformer.
- Fittings made of steel or malleable iron shall be galvanized.
- Bushing shall be so located on the transformers that full flashover strength will be utilized.
- All applicable routine and type tests certificates of the bushings shall be furnished for approval.
- Bushing shall be supplied with bi-metallic/terminal connector/clamp/washers suitable for fixing to bushing terminal and the purchaser's specified conductors. The connector/clamp shall be rated to carry the bushing rated current without exceeding a temperature rise of 550 C over an ambient of 500 C. The connector/clamp shall be designed to be corona free at the maximum rated line to ground voltage.
- Bushing of identical voltage rating shall be interchangeable.
- Each bushing shall be so coordinated with the transformer insulation that all flashover will occur outside the tank.
- The creepage distance shall be not less than 25 mm/kV and protected creepage distance shall be not less than 50% of total.
- Arcing horns are to be provided with adjustable horn gap except the neutral bushing.
- Each terminal, including the neutral, shall be distinctly marked on both primary and secondary in accordance with the connection diagram fixed upon the transformer which shall conform to latest IS 2026 (Part IV).
- Insulation Level: The transformer and bushing shall be capable to withstand test voltage as specified below:

Table 11-6: Insulations Level

Particulars	Bushings	
Nominal voltage (in kV rms)	11	33
Highest voltage for equipment (in kV rms)	12	36
1.2/50 micro sec. impulse withstand voltage (in kV peak)	95	170
1 minute power frequency withstand voltage (in kV rms)	28	70

Particulars	Bushings	
Minimum creepage distance (mm)	300	900
Minimum clearance (mm) : Phase to phase	280	400
Minimum clearance (mm) : Phase to earth	140	320

11.5.13. Oil Conservator Tank

- The conservator shall be of capacity to meet the requirement of expansion of the total cold oil volume in the transformer & cooling equipment and it should be such that the oil level will always be visible through the plain oil level gauge.
- A conservator will have volumetric capacity of at least 10 % of the total volume of oil in tank. Moreover the oil in conservator up to minimum level mark on the oil gauge shall be at least 3 % of the total volume of oil in transformer excluding oil in OLTC.
- The conservator tank shall be bolted into position so that it can be removed for cleaning purposes.
- The conservator shall be fitted with magnetic oil level gauge with low level electrically insulated alarm contact.
- Plain conservator fitted with silica gel breather.
- It shall be provided with oil filling hole with cap on top and a drain valve at the bottom.

11.5.14. Oil Preservation Equipment

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.

Breather

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

- Passage of air is through a dust filter & Silica gel
- Silica gel is isolated from atmosphere by an oil seal.
- Moisture absorption indicated by a change in colour of the crystals of the silica gel can be easily observed from a distance.
- Breather is mounted not more than 1400 mm above rail top level.

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 contacts shall be provided for tripping when the device operates.

Buchholz Relay

Each transformer shall be provided with gas and oil actuated Relay (Buchholz Relay) equipment conforming of IS:3637 double float type with one set of alarm contacts, one set of trip contacts and a testing pet cock. The contacts shall be wired with a P.V.C. armoured cable. A machined surface shall be provided on the top of Relay to facilitate the setting of Relay and to check the mounting angle in the pipe and cross level of the Relay. The pipe work shall be so arranged that all gas arising from the Transformer shall pass into the gas and oil actuated Relay. The oil circuit through the Relay shall not form a delivery path in parallel with any circulating oil pipe. A copper tube shall be connected from the gas collector to a valve located at about 1200 mm above ground level to facilitate sampling with the transformer in service.

Oil Temperature Indicator (OTI)

The transformers shall be provided with a 150 mm dial type thermometer 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 $\pm$ 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.

- Temperature sensing element
- Image Coil.
- Auxiliary CTS, if required to match the image coil, shall be furnished and mounted in the local control panel.
- 150 mm 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 one for trip.

- Calibration device.
- Two number NO electrical contact each capable of operating at 5 A ac, 230 Volt supply.

The scale on the dial of the thermometer should be 0 Deg. C to 150 Deg. C. The angular displacement of thermometer should be 270 Deg. The signaling contact of WTI & OTI shall be set to operate at the following temperature:

- OIL : Alarm-80 deg. C, Trip – 90 deg. C
- WINDING : Alarm-85 deg. C, Trip – 95 deg. C

Marshalling Box

Sheet steel (not less than 2 mm thick), weather, vermin and dust proof marshalling box fitted with required glands, locks, glass door, terminal Board, 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 sloping roof and the interior and exterior painting shall be in accordance with the specification. Padlock along with duplicate keys shall be supplied for marshalling box. The degree of protection shall be IP-55. The temperature indicators shall be so mounted that the dials are visible by standing at the ground level.

a) The schematic diagram of the circuitry inside the marshalling box be prepared and fixed inside the door under a prospane sheet.
b) The marshalling box shall accommodate the following equipment:
   - Temperature indicators
   - Terminal blocks and gland plates for incoming and outgoing cables.
   - Space heater with thermostat and MCB
   - All the above equipment except (b) 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.
c) 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.
d) 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.

11.5.15. On Load Tap Changer

The transformers shall be provided with an On-Load Tap Changer (OLTC) of well reputed and of proven make as per technical requirement for varying the effective transformation ratio while the transformer is ON load and without providing phase displacement. The salient features of the OLTC shall be as under:

The tap changing mechanism should be suitable for automatic, remote control operation from remote control panel in the control room in addition to being capable of local manual as well as local electrical operation.

The **On Load Tap Changer (OLTC)** shall include the following:

m) An oil immersed tap selector and arcing switch on arc suppressing tap selector provided with ohmic or resistor type high speed diverter switch, for reduction of make and break arcing voltages, overloads and short circuits.

n) Diverter switch should be with snap action mechanism with energy accumulator mounted directly on the diverter switch.

o) Separate oil compartment

p) Easy removable diverter switch unit.

xvi) Motor driven mechanism

xvii) Control and protection devices

xviii) Local tap changer position indicator

xix) Manual operation device

xx) Make of OLTC – Indigenous make (type test certificates from (CPRI).

Control voltage – Any of the auxiliary power supply voltage.

The on-load tap changer shall be designed so that the contacts do not interrupt are within the main tank of transformer. The tap changer selector and arcing switch on arc suppressing tap selector switch shall be located in one or more oil filled compartments. The diverter switch should be provided with gas vent and Buchholz relay. It shall be designed as to prevent the oil in tap selector and diverter switch compartments from mixing with the oil in transformer. The barrier board between OLTC and the transformer tank shall be made of Silicon Bonded Resin Paper (SBRP)

The tap changer shall be capable of permitting parallel operation with other transformers of the same type. The transformer shall give full load output on all taps without exceeding the limit of permissible temperature rise in oil and winding. The manual operation device shall be so located on the transformer that it can be operated by a man standing at the level of transformer track. It shall be of robust construction and shall be capable of frequent operations. It shall not be possible to operate the electric drive when the manual operating gear is in use.

Necessary interlocks blocking independent control when the units are in parallel shall be provided.

The controls shall be so arranged as to ensure that when a tap change operation has commenced, it shall be completed independently of the operation of control relays or switches. Local or remote control switch shall cause one tap movement only, until the control switch has returned to the off position between successive operations. Under abnormal conditions such as may occur when the contractor controlling one tap change sticks, the arrangement must be such as to switch off supply to the motor so that an out of step condition is limited to one tap difference between the units./ Limit switches shall be provided to prevent over running of mechanism.

The transformer and the tap changing equipment shall be designed to permit full rated operation with tap changing equipment temporarily installed in any intermediate position. Details of out of step protection provided for the taps should be furnished in the tender.

The control scheme for the tap changer shall be provided for independent auto/non-auto control of the tap changer when the transformers are in independent service. Voltage relating relay should be designed for maximum operational simplicity for regulating the secondary voltage of power transformer with OLTC. The required EAD band settings are set by setting the nominal value and lower and upper levels independently.

In addition, provisions shall be made to enable non-auto/automatic parallel control also so that the tap changers of two or more transformers will be operated simultaneously when one unit is in parallel with another so that under normal conditions the tap changer will not become out of step and this will eliminate circulating current. Additional features like "Master / Follower" and visual indication, during the operation of motor shall also be incorporated.

A mechanical tap position indicator shall be provided on the tap changer in addition to remote indication equipment in the control room on remote control cubicle of OLTC. Necessary interlocks, for independent control when the units are in parallel shall be provided.

The whole of motor drive unit comprising the motor and its control gear including contractors, indicator, local electrical push buttons, five digit operation counter, handle for manual control etc. as well as terminals for the control and indication wiring shall be housed in a dust proof kiosk mounted on tap changer, A heating element with thermostat and MCB shall also be provided in kiosk for ensuring trouble free operation of the drive in cold weather. Arrangement shall be made for padlocking the kiosk. Tap position indication shall be visible by a number appearing in a small glass window on the front of the kiosk. For remote indication, an indication type instrument or digital type shall be provided on a panel on the 415 volts, 3 phase, 50 c/s external supply.

Any enclosed compartment not oil filled shall be adequately ventilated. All contractors, relay coils or other parts shall be suitably protected against corrosion or deterioration due to condensation, fungi etc.

The oil in the compartments of the main tap changing apparatus which do not contain contacts used for making or breaking current shall be maintained under conservator head by means of a pipe connection from the highest point of the chamber to the conservator. This connection shall be controlled by a suitable valve and shall be arranged so that any gas leaving the chamber will pass into the gas and oil actuated relay. A separate oil Buchholz relay with trip contacts shall be provided for the On-Load Tap Changer chamber. Each tap changer shall also be provided with a pressure relief valve outside OLTC to protect against sudden pressure development on OLTC.

Each compartment in which the oil is not maintained under conservator head shall be provided with a suitable direct reading oil level gauge.

A permanently legible lubrication chart shall be fitted with the driving mechanism chamber.

Local electrical control switches and the local operating gear shall be clearly labeled in suitable manner to indicate the direction of operation of tap changer.

The remote control panel of OLTC gear to be installed in the control room should match in colour and dimensions sheet steel size etc. with the purchaser's transformer control panel for which details would be furnished to the successful contractor.

In addition to the fittings, auxiliaries and accessories considered necessary by the contractor the following shall be provided:

A. **FOR LOCAL ELECTRICAL CONTROL**

xxii) Raise lower selector switch with a intermediate 'OFF' position.

xxiii) Auxiliary transformer (if necessary) along with MCBs and links.

xxiv) Step by step contractor

xxv) Thermal over load relay for the motor

xxvi) Reversing contractor

xxvii) ON/OFF automatic trip air circuit breaker for motor supply

xxviii) Local/Remote change over selector switch.

B. **FOR REMOTE ELECTRICAL INDEPENDENT / AUTO-CONTROL**

xxv) All equipment listed in (A) above.

xxvi) Tap position indicator for mounting on control panel in the control room.

xxvii) Signal lamp and buzzer, for indicating "Tap Change in Progress".

xxviii) Raise lower switch push button type with intermediate off/position for remote control.

xxix) Emergency stop button (push button type) with visual indication.

xxx) Visual and alarm indication for non completion of operation within pre-set time

xxxi) Provision of interlocking system for blocking independent control when the units are to run in parallel by providing interlock able phase sequence selector switch.

xxxii) All audo-visual indications should be brought to the Remote Tap Changer Cubicle (RTCC) panel.

xv) DC supply isolators, DC supply 'ON' indicator & DC failure, both alongwith cancellations.

xvi) All equipment and their connections in RTCC panel should be properly marked. The buzzer/bell (industrial type) should be provided.

C. **FOR SIMULTANEOUS PARALLEL OPERATION OF TRANSFORMER**

xiii) All equipment listed in (B) above.

xiv) Out of step relay alongwith auxiliary relays, contractors and other equipment including a buzzer and signal lamp to indicate the out of step indication when transformers in one of pair of group of rating in parallel are one tap out of step and also to trip the circuit breaker.

xv) Control selector switch to enable to run a transformer as Master/Follower or independent in a group.

xvi) Selection switches for individual/parallel operation.

DC supply, Isolators, DC supply, 'ON' indication & DC failure, hooter alongwith cancellation

11.5.16. In house Inspection and Testing

General

- The supplier shall carry out a comprehensive inspection and testing during manufacture of the transformer. An indicative of checks to be carried out during manufacturing are given below.
- This is, however, not intended to form a comprehensive program as it is supplier's responsibility to draw up and carry out such a program duly approved by the purchaser.
- The supplier shall carry out type tests, special tests and routine tests on the transformers.
- Only one no. transformer of each rating will be subjected to type test.
- All type, special and routine tests shall be carried out at supplier cost.
- The pre-shipment checks shall also be carried out by the supplier.
- The requirements of onsite tests are as listed in the specifications.
- Certified test report and oscillographs shall be furnished to the purchaser/consultants for evaluation. The Supplier shall also evaluate the test results and rectify the defects in the equipment based on his and the Purchaser's evaluations of the tests without any extra charges to the Purchaser. Manufacturer's Test Certificates in respect of all associated auxiliary and ancillary equipment shall be furnished.
- 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.

Checks during Manufacturing

a) Tank and Conservator
   - Inspection of major weld.
   - Crack detection of major strength weld seams by dye penetration test.
   - Check correct dimensions between wheels, demonstrate turning of wheels, through 90o and further dimensional check.
   - Leakage test of the conservator.

b) Core
   - Sample testing of core materials for checking specific loss properties, magnetization characteristics and thickness.
   - Check on the quality of varnish if used on the stampings.
   - Check on the amount of burrs.
   - Visual and dimensional check during assembly stage.
   - Check on completed core for measurement of iron loss.
   - Visual and dimensional checks for straightness and roundness of core, thickness of limbs and suitability of clamps.

- High voltage DC tests (2 kV for one minute) between core and clamps.

c) Insulating Material
   - Sample check for physical properties of materials.
   - Check for dielectric strength
   - Check for the reaction of hot oil on insulating materials.

d) Winding
   - Sample check on winding conductor for mechanical continuity and electrical conductivity.
   - Visual and dimensional checks on conductor for scratches, dent mark etc.
   - Sample check on insulating paper for PH value, electric strength.
   - Check for the bonding of the insulating paper with conductor.
   - Check for the reaction of hot oil and insulating paper.
   - Check and ensure that physical condition of all materials taken for windings is satisfactory and free of dust.
   - Check for absence of short circuit between parallel strands.

e) Checks Before Drying Process
   - Check condition of insulation on the conductor and between the windings.
   - Check insulation distance between high voltage connections, between high voltage connection cables and earth and other live parts.
   - Check insulating distances between low voltage connections and earth and other parts.
   - Insulating test for core earthing.

f) Checks during Drying Process
   - Measurement and recording of temperature and drying time during vacuum treatment.
   - Check for completeness of drying.

g) Assembled Transformer
   - Check completed transformer against approved outline drawing, provision for all fittings, finish level etc.
   - Jacking test on the assembled Transformer.
   - Check for proper packing and preservation of accessories like radiators, bushings, explosions vent, dehydrating breather, rollers, buchholz relay, control cubicle connecting pipes, On Load Tap Changing & conservator etc.
   - Check for proper provision of bracing to arrest the movement of core and winding assembly inside the tank.
   - Gas tightness test to conform tightness.

h) Completeness of Equipments
   - All fittings and accessories, which may not be specifically mentioned in the specification but which are necessary for the satisfactory operation of the plant, shall be deemed to be included in the specification and shall be furnished by the contractor 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 purchaser under any circumstances.

i) Oil

- All standard tests in accordance with IS: 335 shall be carried out on Transformer oil sample before filling in the transformer.
- 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 equipment is purchased by the supplier on a sub-contract, he shall have them tested to comply with relevant requirements.

11.5.17. Stage Inspection

The purchaser reserves the right to carry out stage inspection. The purchaser reserves the right to carry out stage inspection of power transformers. During stage Inspection compliance of following particulars shall be checked.

- Core assembly - diameter, window height, leg centre, stack width, stack thickness, thickness of laminations, proof towards prime source of laminations
- Windings - conductor size, I.D., O.D & height of winding, major and minor insulations for both H.V and L.V windings
- Tank - length, breadth, height and thickness of plates of transformer tank, quality of fittings and accessories.

The supplier shall offer for final inspection of the transformers subject to clearance of the stage inspection report by the purchaser.

11.5.18. Losses

Transformers with lower losses shall be preferred. The bidder shall indicate the values of load and no load losses of the transformer in his bid. Maximum allowable losses shall be as follows:

- No load losses = 7 kW
- Load losses at 75 ^{0}C = 50 kW

There would not be any positive tolerance in losses. The manufacturer can offer losses less than above.

11.5.19. Capitalization of Losses

For total cost evaluation, the capitalized cost of losses will be taken into account as per the following:

Capitalized cost of Transformer = Initial cost of Transformer + Rs.A x WI + Rs. B x Wc

Where: WI = Iron loss in kW & A = 137408 Rupees for iron loss

WC = Copper loss in kW & B = 41222 Rupees for copper loss

In the event of either the iron or copper loss exceeding its guaranteed value as stated in the technical data schedule, the relevant rate above shall be applied to the excess and the resulting amount shall be deducted from the contract price.

11.6. Tests

11.6.1. Type Tests

The following shall constitute type tests. Special tests shall also constitute part of type tests:

- Measurement of winding resistance Measurement of voltage radio and check of voltage vector relationship
- Measurement of impedance voltage/short-circuit impedance (principal tapping) and load loss
- Measurement of no-load loss and current
- Measurement of insulation resistance
- Dielectric tests
- Temperature-rise test, on tap having maximum losses
- On load tap changer tests (as per IEC 60214-1 :2003)
- Tank Vacuum test
- Tank Pressure test

11.6.2. Special Tests

- Short circuit test
- Measurement of zero sequence impedance
- Measurement of acoustic noise level

Type test reports (less than five years old as on the due date of tender) of tests carried out at CPRI/ NABL accredited laboratory along with certified drawings shall be furnished by the bidder with offer otherwise offer shall be rejected. The offered transformer must be manufactured as per type tested design.

11.6.3. Routine Tests

The following shall constitute routine tests:

- Visual examination and checking the dimensions
- Winding DC resistance.
- Voltage ratio on each tapping and
- Check of voltage vector relationship and polarity.
- Impedance voltage / short circuit impedance (principle tapping, maximum and minimum tapping)
- Magnetic balance test
- Load loss.
- No-load loss and current
- Insulation resistance
- Separate source AC voltage withstand test
- Induced over voltage withstand test
- Measurement of Zero sequence impedance

- Absorption index i.e. insulation resistance for 15 seconds and 60 seconds (R60/R15) and polarization index i.e. Insulation Resistance for 10 minutes and one minute (R10 mt/R1 mt)
- Oil leakage test of transformer tank at a pressure equal to normal pressure plus 35 kN per sq mtr measured at the base of tank.
- Measurement of neutral unbalance current (not to exceed 2% of full rated current of transformer)
- High voltage withstand test on auxiliary equipment and wiring.

In case of Temperature Rise test, if it is not feasible to carry out this test at CPRI/ NABL laboratories, bidder may hire services of the laboratories and carry out Temperature Rise test at supplier's works with testing equipment of CPRI/NABL. Test has to be carried out by testing engineer of CPRI/ NABL and certification of the same have to be given on CPRI/ NABL's letter head.

11.6.4. Test Procedure

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 for oil and one hour for air and during that time no leak shall occur.

Pressure Test

Where required by the Purchaser, 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.

Vacuum Test

One transformer tank of each size shall be subjected to the vacuum pressure of 760 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.

Testing Equipment/Meter Calibration

All testing equipments / meters used shall be calibrated within valid time limit at NABL accredited laboratory. Calibration seals provided by the calibrating agency on testing equipments / meters shall be in good condition.

11.7. Pre-Delivery Inspection at Manufacturer's Works

All routine & acceptance tests shall be witnessed and certified by purchaser's representative at manufacturer's works. The vendor shall give at least 10 days advance intimation to the purchaser to enable them to depute their representative for witnessing the tests. The said representative shall have full facilities for unrestricted inspection of supplier's works, raw materials, manufacturing processes and conducting necessary tests.

The said representative shall verify the calibration seals provided by the calibrating agency on testing equipments/ meters.

Test reports of routine tests carried out by the manufacturer shall be submitted to the inspecting authority at the time of inspection for his approval.

Acceptance of any quantity of materials shall in no way relieve the supplier of his responsibility for meeting all requirements of the specification and shall not prevent subsequent rejection, if such materials are later found to be defective.

In case of waiver of inspection, vendor shall carry out all (i) routine and (ii) acceptance tests and submit test reports for approval of the purchaser, before dispatch of material.

The entire cost of testing for acceptance & routine rests and checking of length etc shall be borne by the supplier.

11.8. Quality Assurance

Following quality plans shall be submitted within 30 days from the date of placement of contract.

- Quality Assurance Plan (QAP) to be adopted by manufacturer in respect of raw materials and bought out items, including source and test reports of (i) important raw materials and (ii) bought out items.
- Material Quality Plan (MQP) to be adopted by manufacturer in respect of manufacturing process.

The QAP & MQP shall be approved by the purchaser within 15 days from the receipt of compliance, if any. The vendor shall follow the approved QAP & MQP in true spirit. If desired by the purchaser, he shall give access to all the documents and materials to satisfy the purchaser that QAP & MQP are being properly followed.

11.9. Guarantee

The manufacturers of the transformer shall provide a guarantee of 54 months from the date of commissioning or 60 months from the date of dispatch whichever is earlier.

11.10. Drawing / Documents

11.10.1. Test reports for bought out items

The Supplier shall submit the test reports for all bought out/sub supplier items for approval.

- Buchholz relay
- Sudden pressure rise relay in OLTC
- Sudden pressure rise relay on main tank
- Winding temperature indicators
- Oil temperature indicators
- Bushings
- Bushing current transformers in neutral (if provided)
- Marshaling box
- Any other item required to complete the works.

The supplier shall furnish following drawings/documents for approval of purchaser within 4 weeks from the order:

a) Detailed overall general outline 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, bushing lifting height, clearances between HV and LV terminals and ground, quantity of insulating oil etc.
b) Foundation plan showing loading on each wheel and jacking points with respect to centre line of transformer.
c) GA drawings/details of bushing.
d) Name plate drawing with terminal marking and connection diagrams.
e) Wheel locking arrangement drawing.
f) Transportation dimensions drawings.
g) GA drawing of marshalling box.
h) Control scheme/wiring diagram of marshalling box.
i) Technical leaflets of major components and fittings.
j) Oil temperature indicator and winding temperature indicator settings
k) Completed technical data sheets.
l) Details including write-up of tap changing gear.
m) Bi- metallic connector for connection to conductor/cable.
n) Maintenance and Operating Instructions.
o) As built version of the drawings and documents.

Executive Engineer (Stores), UPCL will be the final authority for approving the drawings submitted by the tenderer.

11.10.2. Instructions Manual

Three 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 others, the following particulars:

- Marked erection prints identifying the components, parts of the transformer as dispatched with assembly drawings.
- Detailed dimensions, assembly and description of all auxiliaries.
- 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.
- Salient technical particulars of the transformer.
- Copies of all final approved drawings.
- Detailed O&M instructions with periodical check lists and format etc.

11.11. Onsite inspection testing

11.11.1. Installation Checks

- Inspection and operational checking of accessories like tap changers, etc.
- 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.
- Check the whole assembly for tightness etc.
- Oil leakage tests.

11.11.2. Pre-Commissioning Tests

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

- Dry out test
- Megger Test
- DC Resistance measurement of windings
- Ratio test on all taps
- Phase relationship test (Vector grouping test)
- Buchholz relay alarm operation test
- Low oil level (in conservator) alarm
- Temperature Indicators
- Marshalling kiosk
- Magnetising current

The following additional checks shall be made:

- All oil valves are in correct position closed or opened as required.
- Thermometer pockets are filled with oil.
- Oil is at correct level in the conservator.
- Earthing connections are made.
- Colour of Silica gel is blue.
- Bushing arcing horn is set correctly and gap distance is recorded.

11.12. Packing & forwarding

11.12.1. Packing

Supplier shall pack or shall cause to be packed all items in such a manner as shall be reasonably suitable for shipment by road to UPCL without any risk of damage in transit. The packing shall be sufficient to withstand, without limitation, rough handling during transit and exposure to extreme temperatures, salt and precipitation during transit, and open storage.

11.12.2. Packing List

One copy of the packing list shall be enclosed in each package delivered. There shall also be enclosed in one package a master packing list identifying each individual package, which is part of the shipment. If, on any package, it is not possible to place packing list inside the container, all pertinent information shall be stenciled on the outside and will thus constitute a packing list.

11.13. Rejection

The Purchaser may reject any transformer if during tests or service any of the following conditions arise:

a) No load loss exceeds the guaranteed value.
b) Load loss exceeds the guaranteed value.
c) Impedance value exceeds the guaranteed value by + 10% or more.
d) The difference in impedance values of any two phases during single phase short circuit impedance test exceeds 2% of the average value guaranteed by the vendor.
e) Oil or winding temperature rise exceeds the specified value.
f) Transformer fails on impulse test.
g) Transformer fails on power frequency voltage withstand test.
h) Transformer is proved to have been manufactured not in accordance with the agreed specification.

11.14. Schedules

11.14.1. Schedule – I [Guaranteed Technical Particulars for – 33/11 kV, 10 MVA Power Transformer with ON Load Tap Changer]

Table 11-7: Guaranteed Technical Particulars for – 33/11 kV, 10 MVA Power Transformer with ON Load Tap Changer

S.No.	DESCRIPTION	Unit	Specified
1	Name and address of the Manufacturer		
	a) Transformer		
	b) HV & LV Bushings		

S.No.	DESCRIPTION	Unit	Specified
	c) Bimetallic connectors		
	d) Transformer Oil		
	e) Off Load/ On load tap changer		
	f) Instruments		
2	Service (Indoor / Outdoor)		Outdoor
3	Normal continuous rating in kVA under site conditions at all taps :	kVA	
	a) HV winding	kVA	10000
	b) LV winding	kVA	10000
4	Rated Voltage		
	a) HV winding	kV	33
	b) LV winding	kV	11
5	Rated frequency	Hz	50(+ - 5%)
6	No. of phases		3
7	Type of transformer		Conventional Power Transformer
8	Connections		
	a) HV winding		Delta
	b) LV winding		Star
9	Connections symbols		
	a) HV - LV		Dyn11
10	Tapings		
	a) Range		+ 5% to – 10 %(in steps of 2.5%)
	b) Number of steps		9
	c) Position of tapping on HT winding for high voltage variation		
11	Reference ambient temperatures		
	a) Maximum ambient air temperature.	°C	50°C
	b) Maximum daily average ambient temperature	°C	35°C

S.No.	DESCRIPTION	Unit	Specified
	c) Minimum ambient air temperature.	°C	10°C
	d) Maximum yearly weighted average ambient air temperature.	°C	35°C
12	Maximum temperature rise over ambient temperature		
	a) In oil by thermometer	°C	35°C
	b) In winding by resistance measurement	°C	40°C
	c) Limit for hot spot temperature for which the transformer is designed	°C	90°C (as per IS 2026)
	d) Type and details of winding hot spot temperature detector	°C	WTI with 150 mm dia. dial type instrument .temp. sensing element image coil , auxiliary CT, 2 nos. of contacts of high winding temperature alarm and trip, calibration devices.
	e) Temperature gradient between windings and oil	°C	
	f) Type of maximum winding temperature	°C	
13	Voltage to earth for which the star point will be insulated	kV	
14	Cooling type		ONAN
15	Losses		
	a) Fixed (Iron) losses of 3 phase Transformer (kW) at rated voltage & rated frequency	kW	7 kW (Max)
	b) Load losses at rated current at principal	kW	50 kW (Max)
16	Max. Current density in winding at rated current for normal tap position		
	a) HV winding (Amps/ sq.mm.)	A/mm2	2.4 (Amps/ sq.mm)
	b) LV winding (Amps / sq.mm.)	A/mm2	2.4 (Amps/ sq.mm)

S.No.	DESCRIPTION	Unit	Specified
17	Impedance voltage at rated current ,frequency and at 75°C expressed as percentage of rated voltage at :-		
	a) Principal (normal) tap	%	7.15% + 10% Tolerance
	b) Highest tap	%	
	c) Lowest tap	%	
18	Reactance at rated current & frequency as percentage of rated voltage at:		
	a) Principal (normal) tap	%	
	b) Highest tap	%	
	c) Lowest tap	%	
19	Resistance at 75ºC		
	a) H.V. winding at normal tap position	Ohms	
	b) L.V. winding	Ohms	
	c) Resistance voltage drop at 75ºC winding temperature expressed as percent of rated voltage	%	
	i) Principal/ normal tap	%	
	ii) Highest tap	%	
	iii) Lowest tap	%	
20	Capacitance on open circuit conditions		1800 pF(Approximately)
21	Insulation level		
	a) Separate source power frequency voltage withstand		
	i) HV winding	kV rms	70
	ii) LV winding	kV rms	28
	b) Induced over voltage withstand		
	i) HV winding	kV rms	--- Double Voltage & Double Frequency -

S.No.	DESCRIPTION		Unit	Specified
		ii) LV winding	kV rms	--- Double Voltage & Double Frequency -
	c)	Full wave lightning impulse withstand		
		i) HV winding	kV peak	
		ii) LV winding	kV peak	
	d)	Power frequency high voltage tests		
		i) Test voltage for one minute withstand test on high voltage windings (induced)	kV rms	
		ii) Test voltage for one minute withstand test on low voltage windings	kV rms	
		iii) Test voltage for one minute withstand test on neutral end of low voltage windings	kV rms	
	e)	Lightning impulse withstand tests		
		i) Impulse test on high voltage winding 1.2/50 µ sec full wave withstand	kV peak	
		ii) Impulse test on low voltage winding 1.2/50 µ sec full wave withstand	kV peak	
		iii) Wave form for impulse test	kV peak	
22	No load current, no load loss, no load power factor at normal ratio and frequency		Amp/kW/P.F	
	a)	10 percent of rated voltage		Will be furnished by Bidders Offer
	b)	25 percent of rated voltage		
	c)	50 percent of rated voltage		
	d)	85 percent of rated voltage		
	e)	100 percent of rated voltage		
	f)	105 percent of rated voltage		

S.No.	DESCRIPTION		Unit	Specified
	g)	110 percent of rated voltage		
	h)	112.5 percent of rated voltage		
	i)	115 percent of rated voltage		
	j)	120 percent of rated voltage		
	k)	125 percent of rated voltage		
23	Efficiency at 75ºC at unity power factor			
	a)	Full load	%	
	b)	75% load	%	
	c)	50% load	%	
	d)	25% load	%	
24	a)	The minimum % of load at which the transformer will run at maximum efficiency (%)	%	
	b)	Maximum efficiency of the transformer	%	
25	Regulation at full load at 75ºC			
	a)	At unity power factor	%	
	b)	At 0.8 power factor (lagging)	%	
26	Core data			
	a)	Grade of core material used		CRGO HIB, M3 or better
	b)	Thickness of core plate lamination	mm	≤ 0.23 mm for M3 and ≤ 0.27 mm for CRGO HIB
	c)	Whether core laminations are of cold rolled grain oriented		CRGO HIB, M3 or better
	d)	Details of oil ducts in core		
		i) Whether in the plane & at right angle to the plane of winding		
		ii) Across the plane of lamination		
	e)	i) Insulation of core lamination		
		ii) Insulation of core plates		
		iii) Type of core joints		
27	Flux density			

S.No.	DESCRIPTION		Unit	Specified
	a)	Designed maximum flux density at normal tap at rated voltage and rated frequency	Tesla	1.9 Tesla
	b)	Operating continuous flux density	Tesla	1.9 Tesla
		i) at normal tap	Tesla	
		ii) at maximum tap	Tesla	
		iii) at minimum tap	Tesla	
	c)	Designed maximum operating flux density which the transformer can withstand for one minute at normal tap	Tesla	1.9 Tesla for all Tap
	d)	Designed maximum operating flux density which the transformer can withstand for five seconds at normal tap	Tesla	
28	Inter-Tap insulation			
	a)	Extent of extreme end turns reinforcement		
	b)	Extent of end turns reinforcement		
	c)	Extent of turn adjacent to tapping reinforced		
	d)	Test voltage for 10 seconds 50Hz inter- turn insulation test on (a)		
	e)	Test voltage for 10 seconds 50Hz inter-turn insulation test on (b)		
	f)	Test voltage for 10 seconds 50Hz inter-turn insulation test on (c)		
29	Windings:			
	a)	Material		
	b)	Type of windings:		
		i) HV windings		
		ii) LV windings		
	c)	Insulation of HV windings		

S.No.	DESCRIPTION	Unit	Specified
	d) Insulation of LV windings		
	e) Insulation between HV & LV windings		
30	Continuous rating under following conditions:		
	a) At 40°C ambient air temp. at site	kVA	10000
	b) At 30°C ambient air temp. at site	kVA	10500
	c) At 20°C ambient air temp. at site	kVA	11000
31	Transformer Tank		
	a) Material		
	b) Thickness		
	- Top	mm	10 mm
	- Sides	mm	10 mm
	- Bottom	mm	12 mm
	c) Details of painting (inner / outer surface)		
32	Dimensions of 3 phase transformers:		
	a) Max. Height to top of bushings	mm	
	b) Over-all length	mm	
	c) Over-all breadth	mm	
33	Weight data of transformer components (Tolerance + 5%) (approximate values not allowed)		
	a) Core excluding clamping	Kg	
	b) Core with clamping	Kg	
	c) HV winding insulated conductor	Kg	
	d) LV winding Insulated conductor	Kg	
	e) Coils with insulation	Kg	
	f) Core and windings	Kg	
	g) Weight of steel	Kg	
	h) Fittings and accessories	Kg	
	i) Oil required for first filling including 10% extra	Ltr/Kg	

S.No.	DESCRIPTION		Unit	Specified
		1. Oil in main tank	Ltr	
		2. Oil in the conservator	Ltr	
		3. Oil in the radiators	Ltr	
		4. Oil in the OLTC	Ltr	
		5. Overall total quantity of oil with 10% extra oil for first filling	ltr/Kg	
	j)	1. Transportation weight excluding accessories	Kg	
		2. Shipping details		
		i) Weight of heaviest package	Kg	
		ii) Dimension of largest package (L x Wx H)	mm	
	k)	Untanking weight	Kg	
	l)	Total weight of transformer with oil and fittings	Kg	
34	Bushing data :			
	a)	Type of bushing insulator		
		i) HV		Out door type highly polluted a (as per Is-8603, 2099 & 3347)
		ii) LV		-do-
		iii) Neutral		-do-
	b)	Material of bushing (inner part / outer part)		Porcelain (as per IS-8603)
	c)	Weight of bushing insulator (Kg.)		
		i) HV	Kg	
		ii) LV	Kg	
		iii) Neutral	Kg	
	d)	Quantity of oil in one bushing (lt.)		
		i) HV	ltr.	
		ii) LV	ltr.	
		iii) Neutral	ltr.	

S.No.	DESCRIPTION		Unit	Specified
	e)	Minimum dry withstand & flash over power frequency voltage of bushing	kV	
	f)	Minimum wet withstand & flash over power frequency voltage of bushing	kV	
	g)	Minimum withstand & flashover impulse level	kV	
	h)	Voltage rating	kV	
		i) HV	kV	
		ii) LV	kV	
		iii) Neutral	kV	
	i)	Current rating (Amps.)		
		i) HV	Amp	
		ii) LV	Amp	
		iii) Neutral	Amp	
	j)	Thermal Short Time current & Duration	Sec	2 Sec
		i) HV	KA	
		ii) LV	KA	
		iii) Neutral	KA	
	k)	Rated Dynamic current & its duration	Sec	As per Is-2026 & 2029
		i) HV	KA	
		ii) LV	KA	
		iii) Neutral	KA	
	l)	Cantilever with stand loading		
	m)	Clearance in oil		
		phase to phase		
		i) HV	mm	
		ii) LV	mm	
		iii) Neutral	mm	
		phase to earth (mm)		
		i) HV	mm	

S.No.	DESCRIPTION		Unit	Specified
		ii) LV	mm	
		iii) Neutral	mm	
	n)	Creepage distance in oil & air (mm)	mm/kV	
		i) In oil		
		a) HV	mm	
		b) LV	mm	
		c) Neutral	mm	
		ii) In air	mm	
		a) HV	mm	
		b) LV	mm	
		c) Neutral	mm	
	o)	Minimum level of immersing / medium (oil)	mm	
	p)	Maximum pressure of immersing medium (oil)	Kg/cm2	
	q)	Free space required at top for removal of bushings	mm	
	r)	Angle of mounting		
35	Conservator (Main Transformer and OLTC)			
	a)	Total volume of the Conservator	m^3	
	b)	Volume of the conservator between the highest and lowest level	m^3	
36	Calculated time constants for natural cooling		Hrs	
37	Type of axial coil supports :			
	a)	HV winding		
	b)	LV winding		
38	Details of On load / off-circuit tap changer			
	a)	Make		
	b)	Type		
	c)	Rating		
		i) Rated Voltage	kV	

S.No.	DESCRIPTION		Unit	Specified
		ii) Rated current	Amp	
		iii) Step voltage	V	
		iv) Number of steps		
	d)	Whether Diverter switch provided with gas vent and buchholz relay (Yes / No)	Yes/No	
	e)	Whether a separate oil surge relay with trip contracts provided (Yes / No)		
	f)	Whether Remote control panel provided with Control scheme for simultaneous operation of Tap changer when transformers running in Parallel and independent control when in independent operation		
	g)	Details of motor device unit housed in kiosk mounted on tap changer		
	h)	Pressure relief valve		
39	Dispatch details :			
	a)	Approx. mass of heaviest Package	Kg	
	b)	Approx. dimensions of largest Package		
		i) Length	mm	
		ii) Breadth	mm	
		iii) Height	mm	
40	Untanking height		mm	
41	Bimetallic connectors: HV / LV			
	a)	Normal current rating (A)	Amp	
	b)	Short time current rating (A)	Amp	
	c)	Tensile strength	Kg	
	d)	Maximum temperature limit		
	e)	Dimensional sketch enclosed indicating tolerances (Yes/No)		
	f)	Minimum clearance		

S.No.	DESCRIPTION		Unit	Specified
		Phase to phase	mm	
		Phase to Earth	mm	
42	CORE ASSEMBLY :-			
	a)	Core diameter	Mm	
	b)	Core window height	Mm	
	c)	Core leg centre	Mm	
	d)	Gross core cross - sectional area	M^2	Will be furnished by Bidder Offer
	e)	Total height of core	Mm	
	f)	Details of top end frame		
	g)	Details of Bottom end frame		
	h)	Details of clamp plate (material, thickness, insulation)		
	i)	Total core weight	Kg	
	j)	Core loss, basing on core loss graph at operating flux density (rated voltage and rated frequency)	kW	
	k)	Core stacking factor		
	l)	Net core area (Sq.m)	M^2	
	m)	Margin towards corner joints, cross-fluxing, dielectric loss	kW	
	n)	Total core loss at rated voltage and rated frequency	kW	
	o)	Describe location/ method of core grounding		
	p)	Details of core- belting		
		i) Material , grade and type		
		ii) Width	Mm	
		iii) Thickness	Mm	
		iv) Fixing method		
43	DETAILS OF WINDING			
	a)	Type of winding		

S.No.	DESCRIPTION		Unit	Specified
	b)	Material of the winding conductor		Electrolytic Copper
	c)	Maximum current density of windings at rated current and conductor area (HV / LV)	A/mm^2	2.4 Amps /mm^2 (at all taps)
	d)	Whether windings are pre-shrunk?		
	e)	Whether adjustable coil clamps are provided for HV and LV windings?		
	f)	Whether steel rings are used for the windings? If so, whether these are split?		
	g)	Whether electrostatic shields are provided to obtain uniform voltage distribution in the windings?		
	h)	Winding Insulation (Type & Class)		
	i)	Insulating material , used for		
		i) H.V winding		
		ii) LV winding		
		iii) Tapping connection		
	j)	Insulating material used between		
		i) L.V and H.V winding		
		ii) Core & L.V winding		
	k)	H.V to H.V winding between phases		
	l)	Type of axial supports		
		i) H.V winding		
		ii) L.V winding		
	m)	Type of radial supports		
		i) H.V winding		
		ii) L.V winding		
	n)	Maximum allowable torque on coil clamping bolts		
	o)	Clamping ring details		
		i) Thickness of ring mm	Mm	

S.No.	DESCRIPTION		Unit	Specified
		ii) Diameter of ring mm	Mm	
		iii) No. & size of pressure screw		
	p)	Bare conductor size		
		i) HV	mm^2	
		ii) LV	mm^2	
	q)	Inside diameter		
		i) HV	Mm	
		ii) LV	Mm	
	x)	Outside diameter		
		i) HV	Mm	
		ii) LV	Mm	
	y)	Axial height after shrinkage		
		i) HV	Mm	
		ii) LV	Mm	
	z)	D.C Resistance		
		i) L.V winding at 75°C	Ohm	
		ii) H.V winding at normal tap at 75°C	Ohm	
		iii) H.V winding at highest tap at 75°C	Ohm	
		iv) H.V winding at lowest tap at 75°C	Ohm	
		v)Total I2R losses at 75°C for normal tap	kW	
		vi)Total I2R losses at 75°C for highest tap	kW	
		vii) Total I2R losses at 75°C for lowest tap	kW	
		viii) Stray losses including eddy current losses in winding at 75°C	kW	
		a) Normal tap position	kW	
		b) Highest tap position	kW	
		c) Lowest tap position	kW	

S.No.	DESCRIPTION	Unit	Specified
	d) Any special measures, taken to reduce eddy current losses and stray losses mention in details		
	ix)Load losses at 75°C (I2 R + Stray)		
	a) Normal tap position	kW	
	b) Highest tap position	kW	
	c) Lowest tap position	kW	
	x) Details of special arrangement, provided to improve surge voltage distribution in the windings.		
44	DETAILS OF TANK :		
	a) Material of Transformer tank		
	b) Type of tank		
	c) Thickness of sheet (No approximate value to be mentioned)		
	i) Sides (mm)	Mm	10 mm
	ii) Bottom (mm)	Mm	12 mm
	iii) Cover (mm)	Mm	10 mm
	iv) Radiators (mm)	Mm	1. 2 mm
	d) Inside dimensions of main tank (No approximation in dimensions to be used)		
	i) Length (mm)	Mm	As per CBIP
	ii) Breadth (mm)	Mm	As per CBIP
	iii) Height (mm)	Mm	As per CBIP
	e) Outside dimensions of main tank approximation in dimensions to be used)	(No	
	i) Length (mm)	Mm	
	ii) Breadth (mm)	Mm	
	iii) Height (mm)	Mm	

S.No.	DESCRIPTION		Unit	Specified
	f)	Vacuum recommended for hot oil circulation (torr / mm of Hg)	Kg/cm2	
	g)	Vacuum to be maintained during oil filling in transformer tank (torr / mm of Hg)	Kg/cm2	
	h)	Vacuum to which the tank can be subjected without distortion ((torr / mm of Hg)	Kg/cm2	
	i)	No. of bi-directional wheels provided		
	j)	Track gauge required for the wheels		
		i) Transverse axis	Mm	
		ii) Longitudinal axis	Mm	
	k)	Type and make of pressure relief device and minimum pressure at which it operates (Kpa)		
45	CONSERVATOR :-			
	a)	Thickness of sheet (mm)	Mm	
	b)	Size (Dia x length) (mm)	Mm	
	c)	Total volume (Litres)	Ltrs	
	d)	Volume between the highest and lowest visible oil levels (Litres)	Ltrs	

11.14.2. Schedule – II [Information regarding manufacturing and testing facilities etc]

(Vendor to enclose following documents and to confirm the same)

Table 11-8: Information regarding manufacturing and testing facilities etc

S.No.	Particulars	Confirmation
1	Type test report from NABL accredited lab (less than 5 years old as on date of opening of offer)	Yes
2	List of plant and machinery	Yes
3	List of testing facility available	Yes
4	List of orders pending and executed	
4 (a)	With UPCL	Yes
4 (b)	With other agencies, other than 4 (a)	Yes

12. Technical Specification for 11 /0.433 kV and 33/0.433 kV, 3 phase, Outdoor type Distribution Transformers

12.1. Scope

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, 11/0.433 kV and 33/0.433 kV, Aluminum wound transformers for outdoor use.

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

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.

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

12.2. Service Conditions

Equipment/material to be supplied against this specification shall be suitable for satisfactory continuous operation under the tropical conditions as follows:

Table 12-1: Service Conditions

S.No.	Particulars	Value
1	Maximum ambient temperature (Deg. Celsius)	50
2	Minimum temperature (Deg. Celsius)	-10
3	Relative humidity range (%)	10 to 100
4	Maximum annual rainfall (mm)	1500
5	Maximum wind pressure (kg/sq m)	195
6	Maximum altitude above mean sea level (m)	3000

S.No.	Particulars	Value
7	Isoceraunic level (days/year)	50
8	Seismic level (Horizontal acceleration) (g)	0.3

12.3. Standards

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

Table 12-2: Standards

Indian Standard	Title	Internationally recognized standards
IS-2026	Specification for Distribution Transformers	IEC76
IS- 1180	Specification for Distribution Transformers up to 100 kVA	
IS-335	Specification for Transformer Oil	BS 148, D-1473, D-1 533-1934 IEC Pub 296
IS-5	Specification for colors for ready mixed paints	
IS-104	Ready mixed paint, brushing zinc chromate, Priming	
IS-2099	Specification for high voltage porcelain Bushing	
IS-649	Testing for steel sheets and strips and magnetic circuits	
IS-4257	Dimensions for clamping 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	

Indian Standard	Title	Internationally recognized standards
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-20028	Installation and maintenance of transformers	

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

12.4. Specific Technical Requirements

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

Table 12-3: Highest Continuous System Voltage

Maximum system voltage ratio (HV / LV)	12 kV / 0.476 kV	36 kV / 0.476 kV
Rated voltage ratio (HV / LV)	11 kV / 0.433 kV	33 kV / 0.433 kV

The transformers shall conform to the following specific parameters:

Table 12-4: Specific Technical Requirements

S.No.	Parameter	Particulars
1	Rated kVA (ONAN rating)	11 kV: 25, 63, 100, 200,250, 315, 400, 500 33 kV: 100
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 Channels (25, 63, 100, 200, 315 kVA) On Plinth (400, 500 kVA)

S.No.	Parameter	Particulars
7	Rated voltage	
8	High voltage winding	11 kV, 33 kV
9	Low voltage winding	0.433 kV
10	Highest continuous system voltage	
11	Maximum system voltage ratio (HV / LV)	12 kV / 0.476 kV, 36 kV / 0.476 kV
	Rated voltage ratio (HV / LV)	11 kV / 0.433 kV, 33 kV / 0.433 kV
12	No. of windings	Two winding Transformers
13	Type of cooling	ONAN (Oil natural / Air natural)
14	kVA Rating corresponding to ONAN cooling system	100%
15	Method of connection:	
	HV:	Delta
	LV:	Star (Neutral brought out)
16	Connection symbol	Dyn 11
17	System earthing	Neutral of LV side to be solidly earthed.
18	Percentage impedance voltage on normal tap and kVA base at 750 C corresponding to HV/ LV rating and applicable tolerances :	% Impedance + Tolerance % 4.5 + 10% (No negative tolerance will be allowed)
19	Intended regular cyclic overloading of windings	As per IEC –76-1, Clause 4.2
	Anticipated unbalanced loading	Around 10%
	Anticipated continuous loading of windings (HV / LV)	110 % of rated current
20	Type of tap changer	NA
21	Range of taping	No Tap
22	Neutral terminal to be brought out	On LV side only
23	Over Voltage operating capability and duration	112.5 % of rated voltage (continuous)
24	Maximum Flux Density in any part of the core and yoke at rated kVA, rated voltage i.e 11 kV / 0.433 kV and system frequency of 50 HZ	1.5 Tesla
25	Insulation levels for windings :-	

S.No.	Parameter	Particulars
	1.2 / 50 microsecond wave shape Impulse withstand (kVP)	HV: 95 LV: N.A.
	Power frequency voltage withstand (kV- rms)	HV: 28 LV: 03
26	Type of winding insulation	
	HV winding	Uniform
	LV winding	Uniform
27	Withstand time for three phase short circuit	2 Seconds
28	Creepage distance (mm) (minimum)	25 mm/ kV
29	Material of HV & LV Conductor	EC grade Aluminum
30	Maximum current density for HV and LV winding for rated current	1.6 Amp/ mm2.
31	Polarisation index i.e. ratio of megger values at 600 sec. to 60 sec for HV to earth, L.V to earth and HV to LV.	Shall be greater than or equal to 1.5, but less than or equal to 5
32	Core Assembly	Boltless type

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

12.5. General Technical Requirements

12.5.1. Core

- The core shall be stack type of high grade Cold Rolled Grain Oriented (CRGO) annealed Silicon steel lamination having low loss and good grain properties, coated with hot oil proof insulation, and bolted together and to the frames firmly to prevent vibration or noise. The grade of core laminations shall be M4 or better. 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 bidder should offer the core for inspection and approval by the purchaser during manufacturing state.
- The flux density at rated voltage & rated frequency shall not exceed. 1.5 Tesla. The transformer must be capable of operating at 12.5% 10% over voltage and at frequency of 48.5 Hz without saturation.
- For transformers till 200 kVA rating No-load current shall not exceed 3% of full load current and will be measured by energizing the transformer at 430 volts, 50 Hz on the secondary. Increase of voltage of 430 volts by 12.5% shall not increase the no-load current by 6%(maximum of full load current
- For transformers above 200 kVA rating No load current shall not exceed two percent of the full load current and shall be measured by energizing the transformer at rated voltage and frequency. Increase of 12.5 percent of rated voltage shall not increase the no load current by 5 percent of full load current.
- The assembled core shall be securely clamped with uniform pressure to minimize noise.
- The M.S. Core clamping frame shall be provided with lifting holes for Tanking & de-tanking and the core is to be electrically connected by tinned copper strip of adequate section to the core frame for earthing through the tank at two different points to drain off electrostatic potential that may build up.
- The supporting framework of the core shall be so designed, so as to avoid the presence of pocket which would prevent complete emptying of tank or cause trapping of air during filling.
- Adequate provision shall be made to prevent movement of core and winding relative to the task during transport and installation or while in service.

12.5.2. Internal Earthing

- All internal metal parts of the transformer, with the exception of individual laminations and their individual clamping plates shall be earthed.
- 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:
- By connection through vertical tie-rods to the top structure.
- By direct metal to metal contact with the tank base.
- By a connection to the structure on the same side of the core as the main earth connection to the tank.

- 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.

12.5.3. Windings

- HV and LV windings shall be wound from Double Paper covered (DPC), Aluminium conductor wire / strip.
- LV winding shall be such that neutral formation will be at top.
- Inter layer insulation shall be Nomex / Epoxy dotted Kraft Paper.
- Current density for HV and LV winding should not be more than 1.6 Ampere per sq. mm for Aluminium Conductor.
- The core/coil assembly shall be securely held in position to avoid any movement under short circuit conditions.
- 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.
- The Transformer shall be provided with requisite number of windings and shall be so designed to withstand the electro mechanical stress exerted under short circuit conditions as per ISS : 2026 - 1977
- The winding shall be so designed to reduce to a minimum out of balance forces in the transformer.
- The winding shall be so designed that all coil assemblies of identical voltage rating shall be interchangeable. The winding shall be assembled on the core centrally for magnetic balance & symmetrically for electrical balance. Ducts shall be provided for oil circulation and lowering hot spot temperature in the winding.
- The paper insulation shall be dry and free form puncture and other defects. Solid insulation shall be of best quality. Wooden support, if used, shall be well seasoned and compatible with hot transformer oil.
- The test certificate of the raw materials shall be made available by the Transformer manufacturer on request during Inspection & Testing.
- The insulation of Transformer winding & connections shall be free from Insulating materials liable to soften, ooze out , shrink or collapse and shall be non-catalytic & chemically inactive to transformer oil during service.
- The Interleaved Insulating paper between the layers of the winding, shall be Kraft Paper. The clearance between the coils shall be adequate and well co - coordinated.
- The stacks of windings shall receive adequate pre shrinkage treatment before assembly. No tapping are to be provided on the winding.
- HV / LV lead termination to the stud should be made either by method of brazing / soldering or the free end of The lead wire having considerable length should be bent to form a ring & the ring should be fixed to the bushing stud with suitable nut, bolt and washer.

12.5.4. Taps

- No tapping shall be provided for transformers up to 500 kVA rating.
- For ratings above 500 kVA, tappings shall be provided, if required by the purchaser, on the higher voltage winding for variation of HV voltage within range of (+) 5.0 % to (-) 7.5% in steps of 2.5%.
- For ratings higher than 200 kVA, tapping shall be provided on the higher voltage winding for variation of HV voltage within range of (+) 5.0 % to (-) 15.0 % in steps of 2.5%.
- Tap changing shall be carried out by means of an externally operated self-position switch and when the transformer is in de-energised condition. Switch position No.1 shall correspond to the maximum plus tapping. Each tap change shall result in variation of 2.5% in voltage. Provision shall be made for locking the taping switch handle in position. Suitable aluminum anodized plate shall be fixed for tap changing switch to know the position number of tap.

12.5.5. Oil

- The insulating oil shall comply with the requirements of IS 335 or BS 148.
- Use of recycled oil is not acceptable. The specific resistance of the oil shall not be less than 2.5 x 10 12 ohm-cm at 27 °C when tested as per IS 6103
- Oil shall be filtered and tested for break down voltage (BDV) and moisture content before filling.
- The oil shall be filled under vacuum.
- 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.
- The Transformer shall be supplied complete with first filling of oil and 10 % extra insulating oil.

12.5.6. Losses

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

The maximum allowable losses at rated voltage and rated frequency permitted at 75°C for 11/0.433 kV transformers can be chosen by the utility from the values of Energy Efficiency Level 1,2 and 3 rating for transformers up to rating of 200 kVA as indicated below:

Table 12-5 Maximum Allowable losses- 11/0.433 kV transformers (Up to 200 kVA)

Rating (kVA)	Energy Efficiency Level 1		Energy Efficiency Level 2		Energy Efficiency Level	
	Max. Losses at 50% Loading (Watts)	Max. Losses at 100% Loading (Watts)	Max. Losses at 50% Loading (Watts)	Max. Losses at 100% Loading (Watts)	Max. Losses at 50% Loading (Watts)	Max. Losses at 100% Loading (Watts)
16	150	480	135	440	120	400
25	210	695	190	635	175	595
63	380	1250	340	1140	300	1050
100	520	1800	475	1650	435	1500
200	890	2700	780	2300	670	2100

As per the Bureau of Indian Standards (BIS) the maximum allowable losses for transformers higher than 200kVA is given below:

Table 12-6 Maximum Allowable losses- 11/0.433 kV transformers (Above 200 kVA)

Rating (kVA)	Energy Efficiency Level 1		Energy Efficiency Level 2		Energy Efficiency Level	
	Max. Losses at 50% Loading (Watts)	Max. Losses at 100% Loading (Watts)	Max. Losses at 50% Loading (Watts)	Max. Losses at 100% Loading (Watts)	Max. Losses at 50% Loading (Watts)	Max. Losses at 100% Loading (Watts)
250	1050	3150	980	2930	920	2700
315	1100	3275	1025	3100	955	2750
400	1300	3875	1225	3450	1150	3330
500	1600	4750	1510	4300	1430	4100

For transformers of the ratings **33/.433(Substation Transformers)** the following maximum allowable losses at rated voltage and frequency and at 75°C shall be taken:

Table 12-6 Maximum Allowable losses- 33/0.433 kV transformers

Rating (kVA)	Energy Efficiency Level 1		Energy Efficiency Level 2		Energy Efficiency Level	
	Max. Losses at 50% Loading (Watts)	Max. Losses at 100% Loading (Watts)	Max. Losses at 50% Loading (Watts)	Max. Losses at 100% Loading (Watts)	Max. Losses at 50% Loading (Watts)	Max. Losses at 100% Loading (Watts)
25	226	747	204	683	188	640
63	409	1344	366	1226	323	1129
100	559	1935	511	1774	468	1613

Bids with higher losses than the above specified values would be treated as non- responsive.

However, the manufacturer can offer losses less than above.

12.5.7. Tolerances

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

12.5.8. Percentage Impedance

The value of impedance of transformers at 75 °C shall be 4.5%.

12.5.9. Temperature rise:

The temperature rise over design ambient temperature of 50 Degree centigrade shall not exceed the limits given below:

- Top oil temperature rise measured by thermometer: 35 °C
- Winding temperature rise measured by resistance method: 40 °C

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

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.

12.5.10. Internal Connections

HV Winding:

- In case of H.V. winding all jumpers from winding to bushing shall have cross section larger than winding conductor.
- Inter coil connection shall be by crimping and brazing.
- In case of Copper Winding Delta joints shall be with crimping and Brazing only.

- Lead from delta joint shall be connected to bushing rod by brazing only.

LV Winding:

- L.T. Star point shall be formed of Aluminum/Copper flat of sufficient length. Lead from winding shall be connected to the flat by crimping and brazing.
- Firm connections of L.T. winding to bushing shall be made of adequate size of `L' shaped flat. Connection of L.T. Coil lead to `L' shape flat shall be by crimping and brazing. Alternatively, `L' shape lug of adequate capacity effectively crimped shall be acceptable.
- `L' shape flat/lug shall be clamped to L.V. Bushing metal part by using nut, locknut and washers.
- For Aluminum windings, L&T Alkapee aluminum brazing rods with suitable flux shall be used. For copper winding crimping and silver brazing alloy shall be used.

12.5.11. Penalty for Non-Performance

- 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.
- Purchaser shall reject the entire lot during the test at supplier's works, if the temperature rise exceeds the specified values.
- Purchaser shall reject any transformer during the test at supplier's works, if the impedance values differ from the guaranteed values including tolerance.

12.5.12. Insulation Material

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.

All spacers, axial wedges / runners used in windings shall be made of pre- compressed Press board 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.

Insulation Level at Various Voltages

Table 12-7: Insulation Level

S.No.	Voltage (kV)	Impulse Voltage (kV Peak)	Power Frequency Voltage (kV)
1	0.433	-	3
2	11	95	28
3	33	170	70

12.5.13. Tank

- 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. Tank cover should have 900 downward bent edges on all sides to protect the gasket under the top cover from direct exposure to weather.
- 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.
- 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.
- The transformer tank shall be of robust construction rectangular elliptical in shape and shall be built up of electrically tested welded mild steel plates of thickness of 5.00 mm for the bottom and top and not less than 3.15 for the sides for 100 kVA sub-station transformers. No negative tolerance than the above prescribed limits in the tank thickness shall be allowed.
- In case of rectangular tanks there shall be no joints at corners and there shall not be more than two joints in total.
- 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.
- The tank shall be reinforced by welded flats on all the outside walls on the edge of the tank.
- 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:

Horizontal length of flat Plate (mm)	Permanent Deflection (mm)
Up to and including 750	5.0
751 to 1250	6.5

- The tank shall further be capable of withstanding a pressure of 0.8 kg/ sq.cm (g) and a vacuum of 0.7 kg/sq.cm (g) without any deformation.
- The radiators can be tube type or fin type or pressed steel type to achieve the desired cooling to limit the specified temperature rise.
- The under carriage of the tank shall be made of channel of suitable size and design.
- All nut bolts and washers provided for outside use on tank cover and accessories shall be galvanized.
- All sealing washers/gaskets shall be made of oil and heat resistant Nitrile rubber or neoprene bonded cork seals suitable for temperature as stipulated in this specification. Surfaces at gasketed joints shall be such that an even face is presented to the gasket, thereby eliminating the necessity for the gasket to take up surface irregularities.

- All pipes, radiators, stiffeners or corrugations which are welded to the tank wall shall be welded externally and shall be double welded wherever possible. All welds shall be stress relieved.
- The clearance between top yoke or top of core and tank cover shall not be less than 125 mm.
- Lifting & pulling lugs shall be provided.

12.5.14. Conservator

- The conservator shall be provided on transformers.
- Oil gauge and the weather proof Silica Gel breathing device with oil seal at the bottom shall be fitted to the conservator which shall also be provided with a drain plug and a filling hole [32 mm (1%")] normal size thread with cover. In addition, the cover of the main tank shall be provided with an air release plug.
- 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.
- 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 contain 10% quantity of the oil. Normally 3% quantity the oil shall be contained in the conservator.
- 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.
- 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 °C) should be above the sump level.

12.5.15. Painting

General

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

ll 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 manufacturers recommendations. However, where ever airless spray is not possible, conventional spray be used with proper approval of purchaser.

Clearing and Surface Preparation

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 (IS9954) to grade Sq. 2.5 of ISO 8501 -1 or chemical cleaning including phosphating of the appropriate quality (IS 3618).

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.

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.

Paint Material

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 & Oil resisting varnish for inside surface

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

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.

Painting Procedure

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.

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%.

Damaged Paintwork

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.

Any damaged paint work shall be made good as follows:

- The damaged area, together with an area extending 25 mm around its boundary, shall be cleaned down to bare metal.
- 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.
- The repainted surface shall present a smooth surface. This shall be obtained by carefully chamfering the paint edges before and after priming.

Dry Film Thickness

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 color.

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

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

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

Table 12-8: Dry Film Thickness

S.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)	Outside	01	30
	b) P.U. Paint (Finish coat)	Outside	02	25 each
	c) Hot oil paint/ Varnish	Inside	01	35/10

Tests for Painted Surface:

- The painted surface shall be tested for paint thickness.
- 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 year.

12.5.16. Bushings

- The bushings shall conform to IS: 2099 and shall be of outdoor type. The bushing rods and nuts shall be made of brass material of the following diameters :

For 25, 63,100 kVA:

- *LT : 12 mm*
- *HT : 12 mm*

For 200, 315 kVA

- *LT : 16 mm*
- *HT : 12 mm*

For 500, 630 kVA

- *LT : 20 mm*
- *HT : 12 mm*

The bushings shall be fixed to the transformers on side with straight pockets and in the same plane or the top cover for transformers above 100 kVA. The tests as per latest IS 2099 and IS 7421' shall be conducted on the transformer bushings.

- For 33 kV, 52 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, 17.5 kV class bushings and for Bushing can be of porcelain/epoxy material. Polymer insulator bushings conforming to relevant IEC can also be used.
- Bushings of plain shades as per IS 3347 shall be mounted on the side of the Tank / on top cover.
- 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.
- Minimum external phase to phase and phase to earth clearances of bushing terminals shall be as follows:

Table 12-9: Minimum Clearance

Voltage	Clearance	
	Phase to phase	Phase to earth
33 kV	400 mm	320 mm
11 kV	255 mm	205 mm
LV	75mm	55 mm

- Arcing horns shall be provided on HV bushings.
- Brazing of all inter connections.
- Jumpers from winding to bushing shall have cross section larger than the winding conductor.
- The bushings shall be of reputed make supplied by those manufacturers who are having manufacturing and testing facilities for insulators.
- The terminal arrangement shall not require a separate oil chamber not connected to oil in the main tank.

12.5.17. Earthing Terminals

All transformers shall be provided with two earthing terminals comprising an M12 isometric bolt and nut which shall be non-ferrous. It shall include a spring washer and a lock washer.

12.5.18. Terminal Connectors

The LV and HV bushing stems shall be provided with suitable bi-metallic 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. The 11 kV bushings of transformers shall be provided with a bi-metallic terminal connector or suitable device to receive 25 - 100 sq.mm. AAAC or ACSR conductor directly without any bi-metallic action.

12.5.19. Terminal Markings

High voltage phase windings shall be marked both in the terminal boards inside

the tank and on the outside with capital letter 1 U, 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 N. marking letters shall be at least 12mm high.

The means of marking shall be either; engraved metal plate or, etched anodized Aluminum.

Phase identification by adhesive stickers shall not be acceptable.

If labeling is to be carried out on the tank, it is preferred that one plate be used rather than individual markings for each phase, in order to prevent incorrect phase markings.

Neutral terminal is to be brought out and connected to local grounding terminal by an earthing strip.

12.5.20. Suppression of Harmonics

The transformer shall be designed with attention to the suppression of harmonic voltages, especially the 3rd (third) and 5th (fifth).

12.5.21. Fittings

The following standard fittings shall be provided:

- Rating and terminal marking plates, non-detachable.
- Earthing terminals with lugs - 2 Nos.
- Lifting lugs for main tank and top cover
- Terminal connectors on the HV/LV bushings (For bare terminations only).
- Thermometer pocket with cap -1 no.
- Air release plug
- HV bushings - 3 Nos.
- LV bushings - 4 Nos
- Pulling lugs
- Stiffener (minimum 35 X 35 X 5 mm)
- Radiators - No. and length may be mentioned (as per heat dissipation calculations)/ corrugations.
- Prismatic oil level gauge,
- Drain cum sampling valve,
- Top filter valve
- Oil filling hole having thread with plug and drain plug on the conservator.
- Silica gel breather (minimum capacity of 500 gm)
- Base channel 100 mmx50 mm above 100 kVA, 460 mm long with holes to make them suitable for fixing on a platform or plinth.
- 4 No. rollers for transformers of 100 kVA.
- Pressure relief device or explosion vent.

12.5.22. Fasteners

- 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.
- Bolts or studs shall not be less than 6 mm in diameter except when used for small wiring terminals.
- All nuts and pins shall be adequately locked.
- 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.
- All ferrous bolts, nuts and washers placed in outdoor positions shall be treated to prevent corrosion, by hot dip Galvanising, except high tensile steel bolts and spring washers which shall be electro-galvanised / plated. Appropriate precautions shall be taken to prevent electrolytic action between dissimilar metals.
- 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.
- 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.
- Taper washers shall be provided where necessary.
- Protective washers of suitable material shall be provided front and back of the securing screws.

12.5.23. Stage Inspection

The purchaser reserves the right to carry out stage inspection of power transformers.

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 (only in case of CRGO material) to ensure that the CRGO laminations used are of good quality.

Compliance of following particulars shall also be checked during stage Inspection.

- Core assembly - diameter, window height, leg centre, stack width, stack thickness, thickness of laminations, proof towards prime source of laminations
- Windings - conductor size, I.D., O.D & height of winding, major and minor insulations for both H.V and L.V windings
- Tank - length, breadth, height and thickness of plates of transformer tank, quality of fittings and accessories.
- Calculation of flux density of the transformer.

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 supplier shall furnish following documents along with their offer in respect of the raw materials:

- Invoice of supplier.
- Mill's certificate
- Packing list.
- Bill of landing,
- Bill of entry certificate by custom.

12.5.24. Inspection and Testing of Transformer Oil

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

12.5.25. Label design, manner of display of Star rating in the Sub-station Transformer

Material of the label shall be non-detachable weather proof type. The Design of the Label, manner of display of label and its color scheme will be in accordance with the notification of Bureau of Energy Efficiency, New Delhi.

12.5.26. Overload Capacity

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

12.6. Tests

12.6.1. Type Tests

Tenderers must submit attested / certified copy of complete volume of type test certificates as per relevant ISS issued from CPRI / NABL accredited laboratory failing which the tender may be rejected. The copy of test certificates must, contain approved drawings, test report no & date, name of test, name of material, rating transformer serial no etc.

The submitted type-test reports must be in conformity to these technical specifications, failing which, offer will be rejected.

Specification of the offered transformer (GTP) must conform the specification of the NIT, failing which the offer will be rejected.

The type test must be conducted on a transformer of same design during last 5 years on date of submission of bid.

The following shall constitute type tests:

- Measurement of winding resistance as per IS 2026 (part 1); 1977

- Measurement of impedance voltage and load loss as per IS 2026 (part 1):1977
- Measurement of no-load loss and current as per IS 2026 (part 1) : 1977
- Temperature-rise as per IS 2026 (part 2): 1977
- Short circuit test as per IS 2026 (part 1): 1977
- Lightning impulse test
- Tank air pressure test
- Induced voltage
- Measurement of insulation resistance
- Measurement of voltage radio and check of voltage vector relationship
- Flux density test
- Separate source voltage withstand
- Measurement of the harmonics of the no-load current

In addition to the above type tests of following additional tests may be conducted, at the cost of the supplier.

- Magnetic Balance Test.
- Un-balanced current test: The value of unbalanced current indicated by the ammeter shall not be more than 2% of the full load current noise-level measurement.
- Measurement of zero-phase sequence impedance

Vacuum test shall be carried out at an internal pressure of 0.35 kg per sq cm absolute (250 mm of Hg) for one hour. The permanent deflection of flat plates after the vacuum has been released shall not exceed the values specified below:

Table 12-10: Permanent Deflection of Flat Plates

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

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.

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.

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.

12.6.2. Acceptance Tests

- At least 10% transformers of the offered lot (minimum of one) shall be subjected to the 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 and IS:2026.
- Checking of weights, dimensions, fitting and accessories, tank sheet thickness, oil quality, material, finish and workmanship as per GTP and contract drawings.
- 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.
- Purchaser reserves the right to carry out Temperature rise test on at least one unit of the every lot offered for final inspection.

12.6.3. Routine Tests

Following routine tests shall be carried out by the supplier on each and every transformer manufactured.

- Ratio, polarity, phase sequence and vector group.
- No Load current and losses at service voltage and normal frequency.
- Load losses at rated current and normal frequency at 75^0C
- Impedance voltage test.
- Resistance of windings at each tap, cold (at or near the test bed temperature).
- Insulation resistance.
- Induced over voltage withstand test.
- Separate source voltage withstand test.
- 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.
- Oil samples (one sample per lot) to comply with IS 1866.
- Measurement of no load losses and magnetizing current at rated frequency and 90%, 100% and 110% rated voltage.

12.6.4. Pre-delivery inspection at manufacturer’s works

- All acceptance tests shall be witnessed and certified by purchaser’s representative at manufacturer’s works. The vendor shall give at least 10 days advance intimation to the purchaser to enable them to depute their representative for witnessing the tests. The said representative shall have full facilities for unrestricted inspection of supplier’s works, raw materials, manufacturing processes and conducting necessary tests.
- The said representative shall verify the calibration seals provided by the calibrating agency on testing equipments/ meters.

- Test reports of routine tests carried out by the manufacturer shall be submitted to the inspecting authority at the time of inspection for his approval.
- Acceptance of any quantity of materials shall in no way relieve the supplier of his responsibility for meeting all requirements of the specification and shall not prevent subsequent rejection, if such materials are later found to be defective.
- In case of waiver of inspection, vendor shall carry out all (i) routine and (ii) acceptance tests and submit test reports for approval of the purchaser, before dispatch of material.
- The entire cost of testing for acceptance & routine rests and checking of length etc shall be borne by the supplier.
- The purchaser reserves the right to select sample from any material offered for inspection /inspected and dispatched, which will be get type tested at the accredited laboratory. The results of this type-tested sample shall be applicable for the entire quantity of the particular lot offered or supplied by the supplier.
- The Purchaser shall bear the testing charges, if sample passes all the tests and if sample fails in any one of the tests, supplier shall have to bear testing charges, same are recoverable from the supplier's any pending bill, security deposit, Bank Guarantee or by any suitable means, whichever deem fit by the Purchaser. In case of sample failing in aforesaid type tests, supplier shall have to replace the whole lot materials, which should pass through the type tests, the re-testing charges will have to be paid by supplier. If any quantity against the particular lot is consumed by the Purchaser, the supplier will agree for any penalty/deduction in price as may be mutually agreed.
- 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.
- 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 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**.
- 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 supplied. Purchaser has right to test 1 % of the supply (minimum one unit) 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.

12.6.5. Testing Equipment/Meter Calibration

"All testing equipment/ meter used shall be calibrated within valid time limit at ERDA/NABL accredited laboratory. Calibration seals provided by the calibrating agency on testing equipment / meters shall be in good condition."

12.6.6. Tests at Site

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

12.6.7. BIS Certification Mark

Every Distribution transformer being sold by the bidder must carry the Bureau of Indian Standards Certification mark.

12.7. Pre-Delivery Inspection at Manufacturer's Work

All routine & acceptance tests shall be witnessed and certified by purchaser's representative at manufacturer's works. The vendor shall give at least 10 days advance intimation to the purchaser to enable them to depute their representative for witnessing the tests. The said representative shall have full facilities for unrestricted inspection of supplier's works, raw materials, manufacturing processes and conducting necessary tests.

The said representative shall verify the calibration seals provided by the calibrating agency on testing equipment / meters.

Test reports of routine tests carried out by the manufacturer shall be submitted to the inspecting authority at the time of inspection for his approval.

Acceptance of any quantity of materials shall in no way relieve the supplier of his responsibility for meeting all requirements of the specification and shall not prevent subsequent rejection, if such materials are later found to be defective.

In case of waiver of inspection, vendor shall carry out all (i) routine and (ii) acceptance tests and submit test reports for approval of the purchaser, before dispatch of material.

The entire cost of testing for acceptance & routine rests and checking of length etc shall be borne by the supplier.

12.8. Quality Assurance Plan

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.

- 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.
- Information and copies of test certificates as above in respect of bought out accessories.
- List of manufacturing facilities available.

- Level of automation achieved and list of areas where manual processing exists.
- List of areas in manufacturing process, where stage inspections are normally carried out for quality control and details of such tests and inspection.
- 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.
- Quality Assurance Plan (QAP) withholds points for purchaser's inspection.
- The successful bidder shall within 30 days of placement of order, submit following information to the purchaser:
- List of raw materials as well as bought out accessories and the names of sub- suppliers selected from those furnished along with offer.
- Type test certificates of the raw materials and bought out accessories.
- 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.

12.9. Drawings/Documentation

- The bidder shall furnish along with the bid the dimensional drawings of the items offered indicating all the fittings.
- Overall Dimensional tolerances.
- Weight of individual components and total weight.
- 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.
- Typical general arrangement drawings of the windings with the details of the insulation at each point and core construction of transformer.
- Typical general arrangement drawing showing both primary and secondary sides and end-elevation and plan of the transformer.

12.10. Identification Plate

Manufacturer shall also provide a separate plate of size (20.0cm. x 10.0cm. x 0.3cm)on the transformer. The plate should contain the following details punched on the plate:

UNIQUE NO.

PROPERTY OF "UPCL"

DATE OF FINAL INSPECTION OFFER

GUARANTEE PERIOD:

GAURANTEED UP TO (MONTH/YEAR)

TOLL FREE NUMBER: 1912 (for any complaints)

Unique Number shall be provided by SE (MM), UPCL and it has to be punched on Guarantee and Identification plate provided on the tank transformer in visible condition. Other details as above shall also to be punched

below unique number. Manufacturer shall request to SE (MM) for unique no. after awarded of supply to them as soon as they will receive the LOI/counter offers. Above plate should be welded on the tank of each transformer and guarantee period should be clearly visible on it .Inspecting agency deputed by UPCL shall ensure the compliance of same at the time of inspection.

12.11. Guarantee

- The manufacturers of the transformer shall provide a guarantee of 60 months from the date of commissioning or 66 months from the date of dispatch whichever is earlier. In case the transformer fails within the guarantee period the purchaser will immediately inform the supplier who shall take back the failed DT within 15 days from the date of the intimation at his own cost and replace/repair the transformer within forty five days of date of intimation with a roll over guarantee.
- 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.
- 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.

12.12. On Site inspection testing

12.12.1. Installation Checks

- Inspection and operational checking of accessories like tap changers, etc.
- 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.
- Check the whole assembly for tightness etc.
- Oil leakage tests.

12.12.2. Pre-Commissioning Tests

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

- Dry out test
- Megger Test
- DC Resistance measurement of windings
- Ratio test on all taps
- Phase relationship test (Vector grouping test)
- Buchholz relay alarm operation test
- Low oil level (in conservator) alarm
- Temperature Indicators
- Marshalling kiosk
- Magnetising current

The following additional checks shall be made:

- All oil valves are in correct position closed or opened as required.
- Thermometer pockets are filled with oil.
- Oil is at correct level in the conservator.
- Earthing connections are made.
- Colour of Silica gel is blue.
- Bushing arcing horn is set correctly and gap distance is recorded.

12.13. Packing & forwarding

12.13.1. Packing

Supplier shall pack or shall cause to be packed all items in such a manner as shall be reasonably suitable for shipment by road to UPCL without any risk of damage in transit. The packing shall be sufficient to withstand, without limitation, rough handling during transit and exposure to extreme temperatures, salt and precipitation during transit, and open storage.

12.13.2. Packing List

One copy of the packing list shall be enclosed in each package delivered. There shall also be enclosed in one package a master packing list identifying each individual package, which is part of the shipment. If, on any package, it is not possible to place packing list inside the container, all pertinent information shall be stenciled on the outside and will thus constitute a packing list.

12.14. Rejection

The Purchaser may reject any transformer if during tests or service any of the following conditions arise:

a) No load loss exceeds the guaranteed value.
b) Load loss exceeds the guaranteed value.
c) Impedance value exceeds the guaranteed value by + 10% or more.
d) The difference in impedance values of any two phases during single phase short circuit impedance test exceeds 2% of the average value guaranteed by the vendor.
e) Oil or winding temperature rise exceeds the specified value.
f) Transformer fails on impulse test.
g) Transformer fails on power frequency voltage withstand test.
h) Transformer is proved to have been manufactured not in accordance with the agreed specification.

12.15. Schedules

12.15.1. Schedule – I [Guaranteed Technical Particulars for Distribution Transformer]

Table 12-11: Guaranteed Technical Particulars for Distribution Transformer

S.No	Description	As Specified	Bidder's Offer
1	Make		
2	Name of the Manufacturer		
3	Place of Manufacture		
	Type of BIS Specified Energy Efficiency Level to be fixed near Name Plate.		
4	Voltage Ratio	11000/430V 33000/430V	
5	Rating in kVA		
6	Core Material used and Grade:	CRGO M4 or Better	
	a) Flux density	1.5 Tesla (Max.)	
	b) Over fluxing without saturation (Curve to be furnished by the Manufacturer in support of his claim)		
7	Maximum temperature rise of:		
	a) windings by resistance method	40°Cover an ambient of 50°C	
	b) Oil by thermometer	35°Cover an ambient of 50°C	
8	Magnetizing (no-load) current at:		
	a) 90% Voltage		
	b) 100% Voltage		
	c) 112.5% Voltage		
9	Core loss in watts:		
	a) Normal voltage		
	b) Maximum voltage		
10	Resistance of windings at 20°C (with 5% tolerance)		
	a) HV Winding (ohms)		
	b) LV Winding (ohms)		
11	Full load losses (watts) at 75°C		

S.No	Description	As Specified	Bidder's Offer
12	Total losses at 100% load at 75°C		
13	Total losses at 50% load at 75°C		
14	Current density used for : (Ampere/ Sq mm)		
	a) HV Winding		
	b) LV Winding		
15	Clearances : (mm)		
	a) Core and LV		
	b) LV and HV		
	c) HV Phase to Phase		
	d) End insulation clearance to earth		
	e) Any point of winding to tank		
16	Efficiency at 75°C :		
	a) Unity P. F. and		
	b) 0.8 P.F		
	1) 125% load		
	2) 100% load		
	3) 75% load		
	4) 50% load		
	5) 25% load		
17	Regulation at:		
	a) Unity P.F.		
	b) 0.8 P.F. at 75°C		
18	% Impedance at 75°C	4.5+tolerance as per IS-1180	
19	Separate Source Voltage withstand Test:		
	(I) HV 28kV/50 HZ for 1 minute	Yes	
	(ii) LV 3kV/50 HZ for 1 minute	Yes	
20	Induced Over Voltage withstand Test (Double Voltage and Double frequency for 1 minute)	22kV for HV winding by applying 0.866 kV on LV at 100Hz for the duration of 1 minute.	

S.No	Description	As Specified	Bidder's Offer
21	Impulse test	HV-95kV peak, LV- NA	
22	Mass of : (kg)		
	a) Core lamination (minimum)		
	b) Windings (minimum)		
	c) Tank and fittings		
	d) Oil		
	e) Oil quantity (minimum) (litre)		
	f) Total weight		
23	Oil Data:		
	1. Quantity for first filling (minimum) (litre)		
	2. Grade of oil used		
	3. Maker's name		
	4. BDV at the time of filling (kV)		
24	Transformer:		
	1) Overall length x breadth x height (mm x mm x mm)		
	2) Tank length x breadth x height		
	3) Thickness of plates for		
	a) Side plate (min)		
	b) Top and bottom plate (min)		
	4) Conservator Dimensions.		
25	Radiation		
	1) Heat dissipation by tank walls excluding top and bottom		
	2) Heat dissipation by cooling tube.		
	3) Diameter and thickness of cooling tube.		
	4) Whether calculation sheet for selecting cooling area to ensure that the transformer is capable of giving continuous rated output without exceeding temperature rise is enclosed.		
26	Inter layer insulation provided in design for:		

S.No	Description	As Specified	Bidder's Offer
	1) Top and bottom layer	Epoxy Dotted Kraft Paper	
	2) In between all layer	Epoxy Dotted Kraft Paper	
	3) Details of end insulation.	Press Board	
	4) Whether wedges are provided at 50% turns of the HV coil		
27	Insulation materials provided		
	a) For conductors		
	(1) HV	DPC	
	(2) LV	DPC	
	b) For Core	Carlite	
28	Material and Size of the wire used.		
	1) HV Dia. (mm) (SWG)		
	2) LV		
	a) Strip size		
	b) No. of Conductors in parallel		
	c) Total area of cross section (sq mm)		
29	Whether the name plate gives all particulars as required in Tender	Yes	
30	Particulars of bushings HV/LV		
	1) Maker's name		
	2) Type IS-3347/ IS-2099/ IS- 7421		
	3) Rating as per IS		
	4) Dry power frequency voltage withstand test	HV-28kV, LV-3kV	
	5) Wet power frequency voltage withstand test	HV-28kV, LV-3kV	

13. Technical Specification for 33kV Outdoor Vacuum Circuit Breakers

13.1. Scope

This specification covers design, engineering, manufacture, testing, inspection before dispatch packing, forwarding, transportation, insurance during transit, delivery to site/ stores of 33kV Outdoor Vacuum Circuit Breakers for outdoor use.

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

13.2. Service Conditions

Equipment/Material to be supplied against this specification shall be suitable for satisfactory continuous operation under the Tropical Conditions given below:

Table 13-1: Tropical conditions for continuous operation

S.No.	Particulars	Value
1	Maximum ambient temperature (Deg. Celsius)	50
2	Minimum temperature (Deg. Celsius)	-5
3	Relative humidity range (%)	10 to 100
4	Maximum annual rainfall (mm)	1500
5	Maximum wind pressure (kg/sq m)	195
6	Wind speed zones (m/s)	47 & 39
7	Maximum altitude above mean sea level (m)	3000
8	Isoceraunic level (days/year)	50
9	Seismic level (Horizontal acceleration) (g)	0.13

13.3. Standards

Expect where modified by this specification, the circuit breakers and the accessories shall be designed, manufactured and tested in accordance with latest editions of the following standards.

Table 13-2: Standards of compliance

S.No.	IEC / ISO / BS	Indian Standard	Title
1	IEC56 IEC 62271-100 & 200	IS 13118	High voltage alternating current circuit breakers general requirement
2	IEC 694	IS 12729	Common clauses of high voltage switch-gear and control gear standards (for voltage exceeding 1000 V)
3	IEC 60	IS 9135	High Voltage testing techniques
4	IEC 427	IS13516	Method of synthetic testing of HV AC circuit breakers
5	IEC 1233		HV. AC. Circuit breakers- inductive load switching
6	IEC 17A/CD 474		HV. AC. Circuit breakers- capacitive switching
7	IEC 529	IS 13947	Degree of protection provided by enclosure
8	IEC137	IS 2099	Insulating bushing for A.C. voltages above 1000V
9	IEC233	IS 5621	Hollow insulators for use in electrical equipment & testing
10	IEC273	IS 5350	Characteristics of indoor and outdoor post insulators for systems with nominal voltages greater than 1000V
11	IEC815	IS 13134	Guide for selection of insulators in respect of polluted conditions
12	IEC 34	IS 996	A.C motors
13	ISO1460 BS729	IS2629	Hot dip galvanizing
14		IS2633	Method of testing uniformity of zinc coated articles
15		IS 5	Colour for ready missed paints and enamels
16		IS 6005	Code of practice for phosphating or iron and steel
17	IEC 227	IS1554	P.V.C Insulated cables for voltages up to and including 1100 Volt
18	IEC269	IS13703	Low voltage fuses for voltages not exceeding 1000 volt
19	ISO800	IS1300	Phenolic molding materials
20		IS13118	Guide for uniform marking and identification of conductors and apparatus terminals
21	IEC 185	IS 2705	Current transformers

S.No.	IEC / ISO / BS	Indian Standard	Title
22	IEC 296	IS 335	Specification for unused insulating oil for transformer and switchgear
23	IEC186	IS 3156	Potential transformers
24	CBIP Technical Report No. 88 revised July, 1996 read with amendment issued (April, 99, September, 99 and also any other amendment thereafter)		Specification for AC Static Electrical Energy Meter

This list is not to be considered exhaustive and reference to a particular standard or recommendation in this specification does not relieve the Supplier of the necessity of providing the goods and services complying with other relevant standards or recommendations.

13.4. Basic Technical Requirements

The circuit breakers to be supplied against this specification shall be required for Feeder Protection and Transformer Protection.

The circuit breakers shall be suitable for 3 phase 50Hz solidly grounded neutral system and shall have normal current carrying capacity and symmetrical short circuit current breaking capability as mentioned hereunder.

The supplier should be an OEM (Original Equipment manufacturers) of the relay, make and break pot and VCB.

The vacuum circuit breakers are required to meet the following basic technical requirements. (Reference standards IEC56, IEC 62271 – 100, IS13118 and associated standards listed in this Specification).

Table 13-3: Basic Technical Requirements

S.No.	Particulars	Requirements
1	Service type	Outdoor
2	No. of Poles	3
3	Mechanical Endurance Class (as per relevant IEC)	M2
4	Electrical Endurance Class (as per relevant IEC)	C2
5	Nominal system voltage	33kV
6	Highest system voltage	36kV
7	Interrupting Capacity at nominal system voltage	1500 MVA
8	Rated normal current at 50^0 C	1250 A

S.No.	Particulars	Requirements
9	Rated short circuit breaking current (rms)	25 kA
10	Rated short circuit making current (peak)	62.5 kA
11	Rated short time current withstand capability	25 kA for 3 sec
12	No of Interruptions	50,000
13	Rated insulation level	
14	One minute power frequency withstand voltage to earth (wet and dry) rms	70 kV
15	Impulse withstand voltage to earth with 1.2/50µsec, wave of +ve and -ve polarity (Peak)	170kV
16	First - pole - to clear factor	1.5
17	Rated operating duty cycle	O-0.3 Sec- CO-3 min- CO
18	Rated operating sequence (for auto reclosing)	3 cycles (60 ms)
19	Maximum break time	3 cycles (60 ms)
20	Rated out of phase breaking current	25% of the symmetrical short circuit breaking current
21	Rated Auxiliary supply for spring charge motor, lamp & heater circuit	230V A.C.
22	Rated supply voltage for trip/close coil	30V or 110 V DC
23	Minimum creepage distance (mm)	900mm
24	Minimum protected creepage distance	300mm

13.4.1. General

The circuit breakers shall be structure mounted open type with vacuum as interrupting media, incorporating separate interrupters for each phase mounted on single frame. There shall be a common drive mechanism actuating the interrupters, which must work in synchronism. These breakers shall be provided with suitable local control while provision shall be made for remote control. The Design life of the circuit breaker should be 100 nos. operation at rated short circuit level.

The circuit breakers shall be fitted with spring mechanism type.

The design of the circuit breakers shall be such that inspection and replacement of contracts, coils, vacuum bottles and any worn or damaged components can be carried out quickly and this ease. The contract gaps shall be adjustable to allow for wear.

The mechanism and the connected interrupters shall satisfy the mechanical endurance requirements of IEC56, IEC 62271 – 100, IS13118 and all additional requirements specified herein.

13.4.2. Porcelain Insulator

External parts of the circuit breakers, which are under continuous electrical stress, shall be of hollow porcelain. The creepage and flashover distance of the insulators shall be dimensioned and the type and profile designed in accordance with IEC815 or IS 13134 and shall be suitable for the worst environmental conditions specified in this specification. The creepage distance across the interrupting chambers shall suite the outdoor service conditions mentioned in the relevant standards for heavily polluted atmosphere and shall be not less than 900 mm with protected creepage distance 50 percent of the total. Internal surfaces of hollow insulators shall also be glazed. The insulators shall comply with IS5621 and tested in accordance with IEC233.

All porcelain whether, used on the interrupting chamber or on the support insulator shall have the following properties

Higher strength, homogeneity, uniform glaze, free from cavities and other flaws and high quality uniform finish porcelain components and shall withstand the maximum expected static and dynamic loads to which the circuit breakers may be subjected during their service life.

13.4.3. Interrupting Media- Vacuum

In vacuum circuit breakers, facilities shall be provided for monitoring the contract erosion and any change in contact gap. The vacuum bottles shall be easily replaceable on site and the mechanism shall be conveniently adjustable to permit resetting the contact gap.

The vacuum circuit breaker poles shall be sealed to prevent contamination of the spaces surrounding the interrupters. The Bidder shall demonstrate how this is achieved by supplying technical details with the bid.

13.4.4. Auxiliary Contacts

20 auxiliary contacts (10N.O.+ 10N.C.) of 30 or 110 Volt D.C grade and 10 amps DC rating shall be provided in each circuit breaker. and if the IS mentioned is upgraded then the latest version of IS shall be applicable

13.4.5. Indication

A mechanically operated circuit breaker position indicator of non-corroding material shall be provided in a location visible from the operating side of the breaker without the necessity to open the mechanism door. The word "OFF" in white letter on green background shall be used to indicate that the breaker is in the opening position and the word "ON" in white letters on a red background to indicate that the breaker is in the closed position. The drive for the device shall be positive in both directions and provision shall be made for local and remote electrical indication.

Indication of spring charging condition shall be provided as mentioned in this specification. Mechanical counters to record the number of closing operations shall be provided for each circuit breaker mechanism.

13.4.6. Take Off Terminal Pads

Terminal pads shall be provided with silver plating of at least 25 microns thickness if these are made of metal other than Aluminium. No such plating shall be required if the terminal pad is made out of Aluminiium. The pads shall be suitably designed to take the approximate terminal loads, specified below.

The breaker shall be designed to withstand the rated terminal load, wind load/Earth quake load and short circuit forces. The short circuit forces to be considered for the design shall be based on length of bus bars consisting of conductors and phase to phase spacing.

The current density adopted for the design of the terminal pad shall in no case exceed 1.6A/sq.mm for copper pad and 1.0 A/ sq. Mm for pad made of other material.

13.4.7. Operating Mechanism

General

The operating mechanism of the circuit breaker shall be motor wound spring charged type. It shall be electrically and mechanically trip free with anti-pumping device (as per IEC694 definition). All working parts in the mechanism shall be of corrosion resistant material. Self-lubricating, wearing resistant bearings shall be provided in the mechanism.

The mechanism shall fully close the circuit breaker and sustain it in the closed position against the forces of the rated making current and shall fully open the circuit breaker without undue contact bounce at a speed commensurate with that shown by tests to be necessary to achieve the rated breaking capacity in accordance with IEC56 / IEC 62271 – 100 or IS13118. The mechanism shall be capable of being locked in either the open or closed position. The mechanism shall be capable of fully closing and opening again after the auto-reclose time interval specified as 0.3 second in this specification.

Spring Mechanism

The spring operating mechanism shall be with spring charging motor, opening and closing springs with limit switches and all accessories necessary for automatic charging. In normal operation, recharging of the operating springs shall commence immediately and automatically upon completion of the closing operation so that a complete sequence of closing and opening operation should be possible.

It shall be possible to hand charge the operating spring with the circuit breaker in either the open or closed position conveniently from the ground level. Closure whilst a spring charging operation is in progress shall be prevented and release of the springs shall not be possible until they are fully charged.

The state of charge of the operating springs shall be indicated by a mechanical device showing 'SPRING CHARGED' when closing spring is fully charged and operation is permissible and 'SPRING FREE' when closing spring is not fully charged and the operation is not possible. Provision shall be made for remote electrical indication of "Spring Charged" and "Spring Free" conditions.

The operating mechanism shall be such that the failure of any auxiliary spring shall not cause tripping or closing the circuit breaker but shall not prevent tripping against trip command.

Closing action of the circuit breaker shall charge the opening spring ready for tripping. From the close position with spring charged, one open-close-open operation shall be possible without recharging the spring.

13.4.8. Motor

The motor for spring charging shall be single phase 230 Volt A. C motor. Continuous motor rating shall be at least ten percent above the maximum load demand of the driven equipment. It shall remain within its rated capacity at all operating points that will arise in service. It shall be protected by H.R.C cartridge fuses or MCB. The motor shall comply with IEC34 or IS996.

13.4.9. Interlocks

The circuit breaker shall be capable of being mechanically and electrically interlocked with the associated line isolator so that the isolator cannot be operated with the breaker in the closed position.

All doors or shutters which give access to live parts shall be interlocked in such a way that these cannot be opened unless the circuit breaker is in the open position.

Other interlocks shall be provided as deemed necessary for safety.

13.4.10. Terminal Connectors

Suitable terminal connectors of bi-metallic type suitable for both horizontal and vertical connection shall be provided on the terminal pad both on the incoming and the outgoing side for connection of jumpers of ACSR or AAAC conductor. The size of the conductor may vary between 50mm^2 and 232mm^2 depending upon the location of the circuit breaker. The terminal connection drawing and details are to be approved by the Purchaser before fabrication. The terminal connectors shall be bi-metallic type to avoid bi-metallic corrosion.

13.4.11. Insulation and Clearance

- The insulation to ground, the insulation between open contacts and insulation between phases of the circuit breaker shall be capable of satisfactorily withstanding dielectric test voltages.
- The minimum clearance in open air shall be as follows:

Between poles- 400 mm

Ground clearance for live part- 3700 mm

13.4.12. Temperature Rise

The maximum temperature attained by any part of the equipment when in service at site and under continuous full load conditions and exposed to the direct rays of the sun shall not exceed the permissible limits fixed by IEC. When the standards specify the limits of temperature rise these shall not be exceeded when corrected for the difference between ambient temperatures specified in the approved specification.

The limits of temperature rise shall also be corrected for altitude as per IEC and stated in the bid.

13.4.13. Local Control Cabinet of VCB

The operating mechanism, local controls and monitoring shall be provided in a metal clad control cabinet fitted to the same structure supporting the breaker and mounted at a convenient height for safe operation from ground level or from platform to be supplied under the contract.

13.4.14. Cabinet

The cabinet shall be made of minimum 3 mm sheet steel and shall be constructed as a dust, weather and vermin proof outdoor housing with protection of IP-55 class. It shall have single door and transparent windows for reading the circuit breaker ON or OFF position and spring charge position without opening the door. The door and any removable covers shall be gasket all round with neoprene bonded gaskets. A ventilating louver shall be provided with fine wire non-ferrous metal or stainless steel screen and filter. A 230V AC heather with auto temperature control shall be provided in the cabinet to prevent moisture condensation and also a 230 volt lamp for internal illumination with door operated switch. The local control cabinet shall be subjected to surface treatment and painting as per clause on surface treatment of this specification.

13.4.15. Wiring and Cabling

a) Unless otherwise specified control wire shall be stranded tinned copper switchboard wire with 1.1 kV PVC insulation conforming to the requirements of IS-1554.
b) All the control circuit and secondary wiring shall be wired completely and brought out preferably to a vertical terminal block ready for external connections in the control cabinet. The control wire shall not be of cross- section less than 2.5 mm^2 copper.
c) All spare auxiliary contacts of the circuit breaker shall be supplied wired up to terminal block. Each terminal in terminal block shall be suitable for at least 2 x 2.5 mm copper conductor.
d) At least 20 number spare terminals shall be provided over and above the number required.
e) All wiring termination on terminal blocks shall be made through lugs. For current and DC supply circuits disconnecting stud type terminal blocks will be provided. For other control circuits, non-disconnecting snap on type terminal blocks shall be provided.
f) All wires shall be identified with non-metallic sleeve or tube type markers at each termination.
g) Terminal blocks shall be made up of moulded non-inflammable plastic material with blocks and barriers moulded integrally have white marking strips for circuit identification and moulded plastic covers.

13.4.16. Grounding

A ground bus of copper bar not less than 6 mm by 25 mm shall be provided along the inside of the front or rear of the each cubicle and equipment rack. The ground bus shall be bolted to the frame of each panel in such a way as to make good electrical contact with each panel or section. Earth terminals at two ends of the cabinet shall be provided for connection of the ground bus to the station earth mat.

13.4.17. Tripping/Closing Coils

The circuit breakers shall be provided with two trip coils and one closing coil per breaker. First trip coil shall be utilized for tripping the breaker on main protection fault detection. Second trip coil shall be used to trip the breaker when first trip coil fails to trip the breaker and backup protection comes into operation and shall also be used to trip the breaker on command. The trip coils shall be suitable for pre-closing and after closing trip circuit supervision.

All the breakers shall have provision for independent electrical operation of trip coils from local as well as remote through local/remote selector switch. The breaker shall be provided with suitable protection device against discrepancies in the operation of individual pole.

13.4.18. Trip Free and Anti Pumping Features

The trip free mechanism shall permit the circuit breaker to be tripped by the protective relay even if it is under the process of closing. An anti- pumping device to prevent the circuit breaker from reclosing after an automatic opening shall be provided to avoid the breaker from pumping i.e., anti-pumping relay should interrupt the closing coil circuit.

13.4.19. Controls

a) The circuit breaker shall be controlled by a control switch located in the control room. The control arrangement shall be such as to disconnect the remote control circuits of the breaker, when it is under test. Local/remote selector switch shall be provided for all breakers for selection of "Local" control/remote control.
b) Provision shall be made for local manual, closing, tripping and spring charging controls. Necessary equipment's for local controls shall be housed in the circuit breaker cabinet of weather-proof construction.
c) Each circuit breaker shall have a mechanical open/closed and spring charge indicator Lamps for indicating, 'close, open and spring charged' position of the breaker shall also be provided.
d) Mechanical indicator, to show the `open' and `close' position of the breaker shall be provided in a position where it will be visible to a man standing on ground with mechanism housing open. An operation counter, visible from the ground even with the mechanism housing closed, shall be provided. Electrical tripping of the breaker shall be performed by shunt trip coils.
e) Closing coil shall operate correctly at all value of supply voltage between 85% and 110% of the rated voltage. Shunt trip coils shall operate correctly under all operating conditions of circuit breaker up to the rated breaking capacity and at all values of supply voltage between 85% and 110% of rated voltage. Bearings which require grease shall be equipped with pressure type fillings.
f) Bearing pins, bolts, nuts and other parts shall be adequately pinned or locked to prevent loosening or changing adjustment with repeated operation of the circuit breaker. It shall be possible to trip the circuit breaker even in the event of failure of power supply.

g) Operating mechanism and all accessories shall be enclosed in control cabinet. A common marshalling box for the three poles of the breaker shall be provided, along with supply of tubing, cables from individual pole operating boxes to the common marshalling box, local.
h) The circuit breaker shall be able to perform 10,000 operating cycles at no load in accordance with IEC17A/474/CD for circuit breakers for auto reclosing duties.

13.4.20. Supporting Structure

The circuit breakers shall be supplied complete with hot dip galvanized steel supporting structures, foundation and fixing bolts, etc. The structure shall be made of steel MS angle section conforming to IS 226. The galvanizing shall be as per IS. The mounting of the breaker shall be such as to ensure the safety of the operating staff and should conform to Indian Electricity Rules, 1956. Minimum ground clearance of live part from ground level shall be 3700 mm.

The bidder shall submit detailed design calculations and detailed drawings in respect of supporting structures suitable for the equipment offered. The tenders shall specify the loads which shall be transmitted to the equipment foundation under most adverse operating conditions of the breaker.

All material for making connections between the circuit breaker and its control shall also be included in the scope of supply. Facility to earth the circuit breaker structure at two points shall be provided.

13.4.21. Surface Finish

All interiors and exteriors of control cubicles and other metal parts shall be thoroughly cleaned to remove all rust, scales, corrosion, greases or other adhering foreign matter.

All metal surfaces exposed to atmosphere shall be phosphated as per IS 6005 and thereafter given two primer coats of zinc chromate and then two coats of epoxy paint with epoxy base thinner. All metal parts not accessible for painting shall be made of corrosion resisting material. All machine finished or bright surfaces shall be coated with a suitable preventive compound and suitably wrapped on otherwise protected. All paints shall be carefully selected to withstand tropical heat and extremes of weather within the limits specified. The paint shall not scale off or wrinkle or be removed by abrasion due to normal handling.

All external paintings shall be as per shade No.631 of IS5.

All ferrous hardware, exposed to atmosphere, shall be hot dip galvanized.

13.4.22. Performance Requirements

The supplier shall declare the circuit breaker opening and closing times at 120 percent, 100 percent and 70 per cent of the rated voltage of the opening and closing devices when measured at the terminals of the trip and closing coils. The minimum make break time at rated voltage and total break time of the CB shall be stated. The total break time must not exceed 60 m sec.

13.4.23. Earthing

All metal parts not intended for carrying current or not alive shall be connected to duplicate earthing system and suitable electroplated brass earthing terminals shall be provided on each circuit breaker in conformity with IEC56 / IEC 62271 – 100 or IS13118. Suitable identification mark for the earth terminals shall be provided adjacent to the terminal.

Earth continuity conductors shall be provided down to the ground level for earth connection to purchaser's earthing grid. It shall have sufficient cross sectional area to afford a low resistance path for the full fault current envisaged. Such conductor shall also be provided for the cts up to the ground level.

The size of the earth continuity conductor shall be large enough to reduce the potential rise of the metal frame of the breaker in the event of fault to minimum but in any case not more than 10V. The size of the conductor shall also be adequate to restrict the temperature rise without causing any damage to the earth connection in the case of fault. No riveted joints in the earth conducting path shall be permissible and only bolted joints of adequate size shall be provided with nuts, bolts and plain and spring washers. The surfaces to be jointed shall be perfectly flat without any unevenness to ensure that there is no contact resistance.

13.4.24. Galvanizing

All ferrous parts including all sizes of nuts, bolts, plain and spring washers, support channels, structures, shall be hot dip galvanized conforming to latest version of IS2629 or any other equivalent authoritative standard.

13.4.25. Auxiliary Power Supply

The operating mechanism shall be suitable to operate with the following auxiliary power supplies.

a) 230V, 50Hz Single phase A.C- For spring charging motor
b) DC supply 30 Volts- For close and open coils, indication & Alarm

The DC supply shall be provided by UPCL at substation.

c) Voltage and frequency variation
   - AC supply (Voltage) :From 110% to 85% of normal voltage
   - Frequency :From plus/minus 3% of normal frequency
   - Combined :From 115% to 85% of normal
   - DC supply (Voltage) :From 110% to 85% of normal voltage

13.4.26. Name Plate

Equipment should be provided with name plate giving full details of manufacture, capacities and other details as specified in the relevant IS.

13.4.27. Site Tests on Control and Auxiliary Circuit

The following tests shall be conducted at site before commissioning.

(i) Voltage tests on control and auxiliary circuit.
(ii) Measurements of resistance of the main circuit.
(iii) Mechanical operation tests.
(iv) Insulation Resistance test

13.4.28. Spares for 33kV VCB

Manufacturer shall furnish list of (a) mandatory and (b) recommended spares for VCB's indicating quantity and unit rate. Value of mandatory spares would be considered for the purpose of bid evaluation. Quantity of recommended spares to be procured would be decided before placement of order.

In addition to above, the manufacturer shall supply following list of spares free of cost:

- Trip coil and closing coil (1 no.)
- Spring charging motor (1 no.)
- Interrupters (1 set for supply of every 4 sets of VCB)
- Supporting insulators (2 sets for supply of every 10 sets of VCB)
- Good quality tools & plants suitable to dismantle the breaker (1 set)

13.4.29. Training to Utility Staff

The supplier shall provide training to utility staff on operation and maintenance of VCB's free of cost at manufacturer's facility. Duration of training and number of staff to be trained shall be decided mutually.

13.4.30. Commissioning of VCB's

The supplier shall commission at least xxx numbers (quantity to be decided based on order quantity) of VCB's at purchaser's site free cost, so as to demonstrate the pre-commissioning tests to be carried out etc.

13.4.31. Interconnection Drawings

The VCB supplier shall provide five copies of interconnection drawings for interconnection between VCB and Control and Relay (CR) Panel. Technical specifications for CR Panel shall be provided to the VCB supplier.

13.5. Tests

13.5.1. Type Tests

Type test reports (less than five years old as on due date of tender) of tests carried out on 33 kV breakers at CPRI/ NABL accredited laboratory shall be furnished by the bidder along with offer otherwise offer shall

be rejected. Provisional report will not be acceptable. Type test carried out at the factory/ in house premises will not be accepted.

The circuit breakers shall be subjected to routine and type tests in accordance with the following standards with the latest amendments

(i) Circuit breaker IEC56 and IS13118 and relevant other standards
(ii) Porcelain insulator IEC233 and IS5621 and relevant other standards

The tests shall include but not limited to the following:

1) Short Circuit Tests

The circuit breaker shall satisfactorily perform the out of phase and short circuit duties [T10, T30, T60, T100a, T100s & single phase] specified in IEC 62271-100.

2) Capacitive Current Switching

Capacitive current switching shall be performed on following duties in accordance with IEC 62771 -100.

a. Single Capacitor bank switching test
b. Cable charging current breaking test.

3) Dielectric Tests

At zero gauge loss of vacuum inside the interrupter chamber, the open contracts shall withstand continuously, the rated phase to ground voltage and it shall be possible to break normal current in these conditions. During the dielectric type tests, no flashover external or internal shall be acceptable.

The circuit breakers shall be subjected to a power frequency AC voltage test for one minute in dry and wet conditions and lightening impulse voltage withstand test and there shall be no external flash over to earth.

4) Mechanical Endurance

In addition to the requirements of IEC56 / IEC 62271 – 100, an extended mechanical endurance test is required to show that the circuit breaker is capable of at least 10,000 operations at no load in accordance with IEC17A/474/CD. Between the specified test series in IEC17A/474/CD, some maintenance such as lubrication and mechanical adjustment is allowed and shall be performed in accordance with manufacturer's instructions. Change of contracts is not permitted.

5) Duty Requirement Tests

Apart from auto-reclosing and the other duties mentioned above, the breakers shall be able to perform the following duties for which type tests are to be conducted as per IEC56 or IS13118.

a) Short time withstand current test and peak withstand test
b) Degree of protection test [IP 55]
c) Cable charging breaking current.

Test for the resistance of the main circuit shall also be conducted.

6) Temperature Rise Test

Temperature rise test is to be conducted on the circuit breaker and the accessories in accordance with IEC56 or IS13118. The temperature rise shall be limited as per this specification.

7) Routine Tests

Following shall constitute routine tests:

a) Power frequency voltage withstand dry tests on the main circuit
b) Voltage withstand tests on control and auxiliary circuits
c) Measurement of the resistance of the main circuit
d) Mechanical operating tests
e) Design and visual checks

13.6. Pre-Delivery Inspection at Manufacturer's Works

a) All acceptance Tests, length and mass verification etc shall be witnessed and certified by purchaser's representative at manufacturer's works. The vendor shall give at least 10 days advance intimation to the purchaser to enable them to depute their representative for witnessing the Tests. The said representative shall have full facilities for unrestricted inspection of supplier's works, raw materials, manufacturing processes and conducting necessary Tests.
b) The said representative shall verify the calibration seals provided by the calibrating agency on testing equipments/ meters.
c) Test reports of routine Tests carried out by the manufacturer shall be submitted to the inspecting authority at the time of inspection for his approval.
d) Acceptance of any quantity of materials shall in no way relieve the supplier of his responsibility for meeting all requirements of the specification and shall not prevent subsequent rejection, if such materials are later found to be defective.
e) In case of waiver of inspection, vendor shall carry out all (i) routine and (ii) acceptance Tests and submit test reports for approval of the purchaser, before dispatch of material.
f) The entire cost of testing for acceptance & routine rests and checking of length etc shall be borne by the supplier.
g) The purchaser reserves the right to select sample from any material offered for inspection /inspected and dispatched, which will be got type tested at any NABL accredited laboratory. The results of this

type-tested sample shall be applicable for the entire quantity of the particular lot offered or supplied by the supplier. The Purchaser shall bear the testing charges, if sample passes all the Tests and if sample fails in any one of the Tests, supplier shall have to bear testing charges, same are recoverable from the supplier's any pending bill, security deposit, Bank Guarantee or by any suitable means, whichever deem fit by the Purchaser. In case of sample failing in aforesaid type Tests, supplier shall have to replace the whole lot materials, which should pass through the type Tests, the re-testing charges will have to be paid by supplier. If any quantity against the particular lot is consumed by the Purchaser, the supplier will agree for any penalty/deduction in price as may be mutually agreed.

13.7. Quality Assurance Plan & Material Quality Plan

Following quality plans shall be submitted within 30 days from the date of placement of contract:

a) Quality Assurance Plan (QAP) to be adopted by manufacturer in respect of raw materials and bought out items, including source and test reports of (i) important raw materials and (ii) bought out items.
b) Material Quality Plan (MQP) to be adopted by manufacturer in respect of manufacturing process.

The QAP & MQP shall be approved by the purchaser within 15 days from the receipt of compliance, if any. The vendor shall follow the approved QAP & MQP in true spirit. If desired by the purchaser, he shall give access to all the documents and materials to satisfy the purchaser that QAP & MQP are being properly followed.

13.8. Guarantee

The equipment/material shall be guaranteed for a period of 24 months from the date of commissioning or 30 months from the date of dispatch whichever is earlier.

13.9. Drawings and Instruction Manuals

Within 30 days after the award of the contract, the contractor shall supply six sets of drawings which will describe the equipment in details, for the approval of Purchaser. All the drawings and manuals should be in English Language and dimensions and weights shall be in MKS units.

Following drawings and documents for each item are to be supplied as part of the contract.

a) General outline drawings, showing dimensions, front and side elevations and plan of the circuit breaker and its local control panel.
b) Outline drawing of support insulators showing dimensions and number of sheds and creepage distance.
c) Assembly and sub-assembly drawings with numbered parts.
d) Sectional views showing the general constructional features, operating mechanism and are extinguishing chamber, etc.
e) Dimension and assembly of important auxiliaries.
f) Detailed drawings of operating mechanism.
g) Test certificates and oscillographs.
h) Detailed drawings of mounting structure.
i) Spare parts and catalogue
j) Wiring diagram showing the local and remote-control scheme of breaker.
k) Write up on working of control schematic of breaker.
l) Foundation plan including weights of various components and impact loadings for working foundation design.

m) Three copies for each sub-station of the above drawings and instruction manuals covering instructions for installations, operation and maintenance shall be supplied by the contractor(s) without any extra cost.

13.10. Packing & Forwarding

13.10.1. Packing

Supplier shall pack or shall cause to be packed all items in such a manner as shall be reasonably suitable for shipment by road to UPCL without any risk of damage in transit. The packing shall be sufficient to withstand, without limitation, rough handling during transit and exposure to extreme temperatures, salt and precipitation during transit, and open storage.

13.10.2. Packing List

One copy of the packing list shall be enclosed in each package delivered. There shall also be enclosed in one package a master packing list identifying each individual package, which is part of the shipment. If, on any package, it is not possible to place packing list inside the container, all pertinent information shall be stenciled on the outside and will thus constitute a packing list.

13.11. Schedules

13.11.1. Schedule - I [Guaranteed Technical Particulars 36 kV Out Door Vacuum CIRCUIT BREAKERS]

Table 13-4: Schedule I

S.	Description	Desired Values	Offered
1	Rate voltage (kV rms)	36 kV	
2	Rated frequency (Hz)	50	
3	System neutral earthing	Solidly grounded system	
4	Type of arc quenching medium	Vacuum	
5	Rated normal current at site conditions	1250 Amps	
6	Number of poles	3	
7	Installation	Outdoor type	
8	Temperature rise	As per IEC 62271 - 100	
9	Rated short circuit		

S.	Description	Desired Values	Offered
10	A) Interrupting capacity at 36 kV	25 kA	
11	B) The percentage DC components	As per IEC 62271 - 100	
12	Rated short circuit making	62.5 kA	
13	First pole to clear factor	1.5	
14	Rated short time current	25 kA	
15	Rated duration of short circuit	3 Seconds	
16	Total break time for any current up to the rated breaking current with Limiting condition of operating and quenching media. Pressure (ms)	< 60 ms	
17	Closing time (ms)	< 150 ms	
18	No. of interruptions	50,000	
19	Mounting	Hot dip galvanized lattices steel support structured bolted type	
20	Phase to phase spacing in the switch yard i.e. Inter-pole spacing for breaker (Min)	400	
21	Required ground clearance from the lowest line terminal if both the Terminals are not in same horizontal plane (cum)	3700	
22	Height of concrete plinth (mm)	150	
23	Minimum creepage distance of support insulator (mm)	900	
24	Standard value of rated transient recovery voltage for terminal fault	As per IEC-56	
25	Standard value of rated line	RRRV	
26	Characteristics	Surge peak factor K=1.6 A For short line faults kV /ms=0.214 Impedance Factor Z(ohms) = 450	
27	Rated operating		
	A) Duty cycle	0-0.3s- CO – 3min- CO	

S.	Description	Desired Values	Offered
	B) Auto reclosing	Suitable for three phase Auto reclosing duty	
28	Rated insulation level under heavy Pollution condition 1.2/50 micro second lightening Impulse withstand voltage (kV peak)to earth	170 kV	
29	Power frequency withstand voltage (rms) to earth (kV rms)	70 kV	
30	Rated characteristic for out of Phase Breaking		
	A) Out of phase breaking capacity	25% of rated breaking capacity	
	B) Standard values of transient	As per IEC-56 recovery	
	C) Operating mechanism	Spring operated, Anti pumping and Trip free mechanism	
31	A) Rated supply voltage of closing & operating devices and auxiliary circuits	1) 110 V DC/30 V DC 2) Series Trip Type system requiring no DC supply. Closing in this case shall be operating on 240 Volts AC 50 C/S single phase 3) 430 volts 50 Hz three phase	
	B) Permissible voltage variation	1) In case of DC Power supply voltage variation shall be Between 85% & 110% of normal voltage. 2) In case of AC power supply voltage variation shall be of the normal voltage as per IS-15% to +10%.	
	C) Permissible frequency	± 3% from normal 50 Hz as per IS 2026 part-I 1977 Para 4.4	
	D) Combined variation of frequency and voltage	± 15%	

S.	Description	Desired Values	Offered
32	Number of auxiliary contacts	10 NO and 10 NC on each pole Continuous current Rating 10 Amps, DC at 110/30 volts DC or 240 V AC	
33	Number of coils	2 (Two) trip coils and 1 close coil	
34	Rated terminal load	100 kg. Static The breaker shall be designed to withstand the rated terminal load, wind, load, earthquake load and short circuit forces	

14. Technical Specification for 11kV Indoor Vacuum Circuit Breaker

14.1. Scope

This specification covers design, engineering, manufacture, testing, inspection before dispatch packing, forwarding, transportation, insurance during transit, delivery to site/ stores of 11kV Indoor Vacuum Circuit Breakers for outdoor use.

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

14.2. Service Conditions

Equipment/material to be supplied against this specification shall be suitable for satisfactory continuous operation under the tropical conditions as follows:

Table 14-1: Tropical conditions for continuous operation

S.No.	Particulars	Value
1	Maximum ambient temperature (Deg. Celsius)	50
2	Minimum temperature (Deg. Celsius)	-5
3	Relative humidity range (%)	10 to 100

S.No.	Particulars	Value
4	Maximum annual rainfall (mm)	1500
5	Maximum wind pressure (kg/sq m)	195
6	Wind Speed Zones (m/s)	47 & 39
7	Maximum altitude above mean sea level (m)	3000
8	Isoceraunic level (days/year)	50
9	Seismic level (Horizontal acceleration) (g)	0.13

14.3. Standards

The cables shall comply with latest revision of the following Indian Standards unless otherwise stipulated in the specification.

All references to Indian Standards shall be deemed to be complying with latest amendments to the respective IS, if any.

Table 14-2: Standards of compliance

S.No.	IEC / ISO / BS	Indian Standard	Title
1	IEC56 IEC 62271-100 & 200	IS 13118	High voltage alternating current circuit breakers general requirement
2	IEC 694	IS 12729	Common clauses of high voltage switch-gear and control gear standards (for voltage exceeding 1000 V)
3	IEC 60	IS 9135	High Voltage testing techniques
4	IEC 427	IS13516	Method of synthetic testing of HV AC circuit breakers
5	IEC 1233		HV. AC. Circuit breakers- inductive load switching
6	IEC 17A/CD 474		HV. AC. Circuit breakers- capacitive switching
7	IEC 529	IS 13947	Degree of protection provided by enclosure
8	IEC137	IS 2099	Insulating bushing for A.C. voltages above 1000V
9	IEC233	IS 5621	Hollow insulators for use in electrical equipment & testing

S.No.	IEC / ISO / BS	Indian Standard	Title
10	IEC273	IS 5350	Characteristics of indoor and outdoor post insulators for systems with nominal voltages greater than 1000V
11	IEC815	IS 13134	Guide for selection of insulators in respect of polluted conditions
12	IEC 34	IS 996	A.C motors
13	ISO1460 BS729	IS2629	Hot dip galvanizing
14		IS2633	Method of testing uniformity of zinc coated articles
15		IS 5	Colour for ready missed paints and enamels
16		IS 6005	Code of practice for phosphating or iron and steel
17	IEC 227	IS1554	P.V.C Insulated cables for voltages up to and including 1100 Volt
18	IEC269	IS13703	Low voltage fuses for voltages not exceeding 1000 volt
19	ISO800	IS1300	Phenolic molding materials
20		IS13118	Guide for uniform marking and identification of conductors and apparatus terminals
21	IEC 185	IS 2705	Current transformers
22	IEC 296	IS 335	Specification for unused insulating oil for transformer and switchgear
23	IEC186	IS 3156	Potential transformers
24	CBIP Technical Report No. 88 revised July, 1996 read with amendment issued (April, 99, September, 99 and also any other amendment thereafter)		Specification for AC Static Electrical Energy Meter

This list is not to be considered exhaustive and reference to a particular standard or recommendation in this specification does not relieve the Supplier of the necessity of providing the goods and services complying with other relevant standards or recommendations.

14.4. Basic Technical Requirements

The circuit breakers to be supplied against this specification shall be required for Feeder Protection and Transformer Protection.

The supplier should be an OEM (Original Equipment manufacturers) of the relay, make and break pot and VCB.

The circuit breakers shall be suitable for 3 phase 50Hz solidly grounded neutral system and shall have normal current carrying capacity and symmetrical short circuit current breaking capability as mentioned hereunder.

The vacuum circuit breakers are required to meet the following basic technical requirements. (Reference standards IEC56, IS13118 and associated standards listed in this Specification).

Table 14-3: Basic Technical Requirements are being provided separately

S.No.	Particulars	Requirements
1	Service type	Indoor
2	No. of Poles	3
3	Mechanical Endurance Class	M2
4	Electricial Endurance Class	C1 / C2
5	Nominal system voltage	11 kV
6	Highest system voltage	12 kV
7	Interrupting Capacity at nominal system voltage/Short circuit breaking capacity	500 MVA
8	Rated normal current at 50^0 C	1000 A
9	Rated short circuit breaking current (rms)	26.3 kA
10	Rated short circuit making current (peak)	62.5 kA
11	Rated short time current withstand capability	26.3 kA
12	No of Interruptions	50,000
13	Rated insulation level	
14	One minute power frequency withstand voltage to earth (wet and dry) rms	28 kV
15	Impulse withstand voltage to earth with 1.2/50µsec, wave of +ve and -ve polarity (Peak)	75 kV
16	First - pole - to clear factor	1.5
17	Rated operating duty cycle	0-0.3 Sec- CO-3 min-CO
18	Rated operating sequence (for auto reclosing)	0-0.3 Sec- CO-3 min-CO
19	Maximum break time	3 cycles (60 ms)

S.No.	Particulars	Requirements
20	Rated out of phase breaking current	25% of the symmetrical short circuit breaking current
21	Rated Auxiliary supply for spring charge motor, lamp & heater circuit	230 V A.C.
22	Rated supply voltage for trip/close coil	30 or 110 V D.C (as per station DC)
23	Minimum creepage distance (mm)	300mm
24	Minimum protected creepage distance	100mm

14.4.1. General

The circuit breakers shall be structure mounted open type with vacuum as interrupting media. Incorporating separate interrupters for each phase mounted on single frame. There shall be a common drive mechanism actuating the interrupters, which must work in synchronism. These breakers shall be provided with suitable local control while provision shall be made for remote control. The Design life of the circuit breaker should be 100 nos. operation at rated short circuit level.

The circuit breakers shall be fitted with spring mechanism type.

The design of the circuit breakers shall be such that inspection and replacement of contracts, coils, vacuum bottles and any worn or damaged components can be carried out quickly and this ease. The contract gaps shall be adjustable to allow for wear.

The mechanism and the connected interrupters shall satisfy the mechanical endurance requirements of IEC 62271 – 100, IS13118 and all additional requirements specified herein.

14.4.2. Construction

The Switchgear panel shall be of sheet Steel construction and shall be dust and vermin proof complying with degree of protection of not less than IP-4X as per IS-3427 (1997). The panels shall be of Metal Clad compartmentalized design with all the High voltage compartments viz. Circuit Breaker, Bus Bar, Current Transformers and Voltage transformers separated by metallic partitions. The switchgear panels shall be rigid without using any external bracing. The switchboard panels should comply with relevant ISS/IEC and revision thereof and shall be designed for easy operation maintenance and further extension. Bus bar, metering, circuit breaker chamber, cables and cable box chamber should have proper access for maintenance, proper interlocks should be provided. All instruments shall be non draw-out type and safeguard in every respect from damages. The switchgear shall be completed with all necessary wiring fuses, auxiliary contacts terminal boards etc.

For indoor panels SWITCHGEAR (circuit breakers, CTs, PTs etc.) and control gear (relays, C&R panels meters etc.) shall be mounted on the same panel. A set of air insulated copper bus bars with PVC sleeves are to be provided for all indoor switchgear panels. The switchgear panels shall be provided with the arrangement for extending the bus bar and inter connecting bus bars. Their supports, nuts and bolts etc will be supplied loose. The region of such inter connection shall normally be blanked on panels. The bus bars should be of copper with permissible limits of current density. Size of the bus bar and current density should be specified in the tender. The bus bar conductor shall conform to IS:8034.

The panels shall be pre treated using 7-tank process and then Epoxy Powder Coated. The paint shade of indoor panels shall be shade 631 as per IS-5 light gray.

The Circuit Breakers and bus-bars should be rated for 500MVA, 26.3KA for 3 sec. The bus-bars shall be extensible on both sides.

The Circuit breakers shall be draw out type in horizontal position. The circuit breaker chamber shall have Metallic safety shutters which will close in the event of breaker withdrawal and ensure that no live components inside the 11 kV switchgear panels should be accessible. The switchgear shall have complete interlocking arrangement at the fully inserted and fully drawn out position of the breaker. Withdrawal of the breaker should not be possible in ON position.

It shall be possible to test the circuit breaker in "TEST" position inside the panel with all the auxiliary and control circuit connected and Power contacts isolated.

All the High Voltage compartments i.e Circuit Breaker, Bus-Bar, and Cable Compartments shall be separated from each other by metallic partitions in line with IEC-600298. These compartments must have pressure relief flaps for the exit of gas due to internal arc to ensure operators safety. All the HV design must ensure conformity to IEC-600298 and must be Type tested for Internal Arc Test of one second. The supplier shall submit Type Test report from CPRI or other independent agency to prove the above

14.4.3. Bus Bars and Connectors

a) Bus bars and all other electrical connections between various components shall be made of electrolytic copper of rectangular cross-section. The bus bar section shall be of ample capacity to carry the rated current of 1000A continuously without excessive heating and for adequately meeting the thermal and dynamic stresses in the case of short circuit in the system up to 500 MVA specified above.
b) All bus bars shall be rigidly and firmly mounted and shall be capable of withstanding short circuit stresses and vibrations.
c) Adequate clearance between 11 kV point and Earth and between phases shall be provided to ensure safety as per provision in Indian electricity rule 1956 and its amendment thereof and also in accordance with the relevant Indian standard specification. The same shall be capable of withstanding the specified High Voltage tests as per ISS –13118 / IEC-62271-100, IEC-62271-200 and its amendments thereof.

d) Sharp edges and bends either in bus bars or bus bar connections shall be avoided as far as possible. Wherever such bends or edges are un-avoidable, suitable compound or any other insulation shall be supplied to prevent local ionization and consequent flashover.

14.4.4. Characteristics of the Operating Mechanism of the Circuit Breaker and Associated Equipment

(i) The circuit breakers shall be provided with manual and motorized operated spring closing mechanism. The circuit breaker shall be electrically and mechanically trip free under various conditions.

(ii) Adequate number of spare auxiliary switches/ contacts both of normally open and normally close type but not less than 4 each shall be provided on the circuit breaker for use in the indication and controlling scheme of the circuit breaker.

(iii) The rated voltage for auxiliary supply shall be 240 V, 50 Hz, AC or 24 V DC supply as the case may be.

(iv) The three phase vaccum circuit breakers will have three interrupters (one interrupter per phase) mounted on same carriage. The interrupters shall be air insulated in epoxy resin tank with epoxy resin phase barriers. Each interrupter shall have fixed and moving contacts in sealed envelope having vaccum below 10^{-6} torr. The metallic below shall permit axial movement of moving contact and act as vaccum seal. The contacts shall have requisite mechanical strength and good electrical and thermal conductivity and shall be made of copper chromium alloy. **Complete literature of vaccum bottles shall be furnished with the tender.**

(v) The Breakers shall be capable of Making & Breaking the short time current in accordance with the requirement of ISS 13118 (1991) / IEC-62271-100, IEC-62271-200 and latest amendment thereof and shall have 3 phase rupturing capacity of 500 MVA at 11 kV. The continuous current rating of breaker shall not be less than 1000 A for all items.

Comprehensive interlocking system to prevent any dangerous or inadvertent operation shall be provided. Isolation of circuit breaker from bus bar or insertion into bus bar shall only be possible when the breaker is in the open position

14.4.5. Interrupting Media. - Vacuum

In vacuum circuit breakers, facilities shall be provided for monitoring the contract erosion and any change in contact gap. The vacuum bottles shall be easily replaceable on site and the mechanism shall be conveniently adjustable to permit resetting the contact gap.

The vacuum circuit breaker poles shall be sealed to prevent contamination of the spaces surrounding the interrupters. The Bidder shall demonstrate how this is achieved by supplying technical details with the bid.

14.4.6. Auxiliary Contracts

20 auxiliary contacts (10 N.O. + 10 N.C.) of 30 or 110 Volt D.C grade and 10 amps DC rating shall be provided in each circuit breaker.

14.4.7. Indication

A mechanically operated circuit breaker position indicator of non-corroding material shall be provided in a location visible from the operating side of the breaker without the necessity to open the mechanism door. The word "OFF" in white letter on green background shall be used to indicate that the breaker is in the opening position and the word "ON" in white letters on a red background to indicate that the breaker is in the closed position. The drive for the device shall be positive in both directions and provision shall be made for local and remote electrical indication.

Indication of spring charging condition shall be provided as mentioned in this specification. Mechanical counters to record the number of closing operations shall be provided for each circuit breaker mechanism.

14.4.8. Take Off Terminal Pads

Terminal pads shall be provided with silver plating of at least 25 microns thickness if these are made of metal other than Aluminium. No such plating shall be required if the terminal pad is made out of Aluminium. The pads shall be suitably designed to take the approximate terminal loads, specified below.

The breaker shall be designed to withstand the rated terminal load, wind load/Earth quake load and short circuit forces. The short circuit forces to be considered for the design shall be based on length of bus bars consisting of conductors and phase to phase spacing.

The current density adopted for the design of the terminal pad shall in no case exceed 1.6A/sq.mm for copper pad and 1.0 A/ sq. Mm for pad made of other material.

14.4.9. Current Transformers & Potential Transformers

PTs shall be provided with HRC type fuses on the secondary side. The HT fuses on primary side shall also be provided with all safety precautions. One of the secondary terminals of the HTs shall be solidly earthed. Only one number three phase voltage transformer of this rated output will be required for each incoming indoor panels. No voltage transformers shall be required for outgoing indoor panels.

i)	Highest equipment voltage	12 kV
ii)	No. of phases	3
iii)	Insulation level	
	a) Impulse withstand voltage	95kVp
	b) One minute power frequency withstand voltage on:	
	i) Primary winding	35 kV rms
	ii) Secondary winding	2 kV rms
iv)	Frequency	50 Hz

v)	Transformation ratio	11000/ 110 V
vi)	Rated output	100 VA / phase
vii)	Accuracy class	0.5
viii)	Winding connection	Star / Star
ix)	Rated voltage factor	1.2 continuous and 1.5 for 30 seconds.
x)	Type of insulation	Resin cast

12 kV current transformers shall be single phase. The core shall be of high grade non ageing laminated silicon steel of low hysteresis loss and high permeability to ensure high accuracy for both normal and fault current.

a. The rating of secondary winding shall be 5 Amps. Required transformations ratio can be achieved in any manner. However, the current transformers will have to satisfy the requirement of rated VA burden, class of accuracy, accuracy limit factor and short time thermal rating as have been specified in this specification at all transformation ratio. In case tapping are provided on secondary side of current transformer, magnetization curves corresponding to all secondary taps must be submitted with the tender.
b. The ratings of current transformers of all classes regarding ratio error, knee voltage, resistance of secondary winding etc. shall have to be co-ordinate with the requirements of protective relays and protection scheme, without any extra cost.
c. Before commencement of supplies one panel of each type with circuit breaker, CT, PT etc will have to be subjected to temperature rise test without extra charges in the presence of our Inspector. All the type certificates are also needed to be furnished without which tender is likely to be ignored.

The tenderer shall also furnish alongwith the tender, complete general arrangement, schematic and outline diagrams indicating the mounting arrangement and position of current transformers, potential transformer terminal blocks etc. Type of current transformer and potential transformer employed shall also be clearly stated.

1.	Rated voltage	:	12 kV
2.	Insulation level		
a)	Impulse withstand voltage	:	95kVP
b)	One minute power frequency withstand voltage on		
i)	Primary winding	:	35 kV rms
ii)	Secondary winding	:	2 kV rms
3.	Frequency	:	50 Hz.

4.	Rated continuous thermal current		:	120% of rated primary current.
5.	Short time thermal rating		:	26.3 KA for 3 sec.
6.	Transformer CTs of ratio 600-300/5-5A			
	for incoming type indoor panel			
	400-200/ 5-5A for outgoing type indoor panel			
7.	Rated out put / accuracy etc. for both type of CTs.			
			Core – I	Core – II
	a)	Rated out put However VA burden should not be less than suitable for tripping requirement	10 VA (Min)	10 VA (Min.)
	b)	Class of accuracy	5 P	0.5
	c)	Accuracy limit factor	10	-
	d)	Purpose	Relaying	Metering
8.	Instrument Security factor :			5

14.4.10. Ferrules

Ferrules engraved with the same numbers, letters or symbols as indicated in the connection and wiring diagram shall be provided on the terminal ends of all wires for identification of circuits for inspection and maintenance. Ferrules shall be of strong and flexible insulating material with glossy finish to prevent adhesion. They shall be engraved and clearly marked and shall not be affected by dampness. Ferrule numbering shall be in accordance with IS:375. The same ferrule numbering shall be in accordance with IS:375. The same ferrule number shall not be used on wires in different circuits on a panel.

14.4.11. Relays

The relay should be a comprehensive numerical microprocessor based consisting of multifunction modules of ABB / Alstom / Easun Reyrolle / Schneider / Ashida/Siemens/CGL make designed to disconnect fault circuits with speed and discrimination. Relays shall be suitable for flush mounting on the front with connections from the rear. The relay should be completely numerical microprocessor based. The measurement principle should be based on sampling of energized currents, analog to digital conversion and numerical handling. Relay should have 4 CT input 3 nos. for over current and 1 CT input for Earth fault.

The low set stage of over current protection should be having setting starting from 10% to 250% and high set stage from 20% to 2000%.The low set stage of earth fault protection should be having setting starting from 1% to 200% and high set stage from 5% to 1200%. The relays shall have at least four programmable

stages which can be set for any of the protection functions of the relay such as normal inverse, very inverse, extremely inverse, long time inverse etc as per relevant standard. The circuit breaker shall be fitted with AC Series/DC Shunt tripping device for operation on over load and earth fault by relays. The relay shall be suitable to accept both AC/DC supplies with wide range supporting low as well high voltage 24-240V AC / DC. The relay should have alpha numeric LCD display for displaying parameters like measurement, settings, event logs etc. The relay shall have LEDs for providing indications like fault trip, protection start, relay healthy / unhealthy / control supply on, phase over current trip, earth fault trip and trip circuit unhealthy conditions etc. Relay should also have one rear communication port RS 485 for remote communication and should have retrofit compatibility as well

The relay should incorporate a non-volatile memory with a capacity of storing at least 50 events. The non-volatile memory should retain its data also in case the relay temporarily loses its auxiliary supply. Additionally relay should have facility of recording sufficient analogue fault data.

The relay should have in built trip circuit supervision to continuously monitor the availability and operability of the trip circuit of the CB connected to the relay. It should provide open circuit monitoring both when the circuit breaker is in its closed and in its open position.

The relays offered by the supplier shall fully conform to the requirement of IS: 3231 and shall be suitable for operation under the climatic conditions specified in this specification. The relay front shall be dust tight having degree of protection as IP54. All fault detecting relays shall be equipped with operation indicators. The relays shall have an auxiliary unit fitted with two parts of hand reset contacts. The relays shall be rated for 5 Amps. Suitable arrangement shall also be provided for adjustment of the operating time of relays. The tenders shall furnish details in this regard alongwith the offer

14.4.12. Wiring

All wiring shall be of switch board type consisting of multi-core copper conductor of 2.5 sq.mm. cross section insulated with polyvinyl chloride insulation suitable for 660V service and in according with relevant IS:732. Polyvinyle chloride used shall have excellent resistance against burning, moisture, oil and vermin and shall be finished with clear colour, Rubber insulated wiring shall not be acceptable. Tenderers shall furnish the details of method being adopted by them for joint / connections.

All instruments and panel wiring shall be of heat resisting and self extinguishing type in compliance with British Standard Practice / IS. Plastic or porcelain cleats of the limited compression type shall be used for holding wiring runs. All wires shall be suitable for bending to meet the terminal studs at right angles. Metal cases of all apparatus mounted on panels shall be separately earthed by means of copper wire or strips. The following colour scheme of the wiring shall be used as per IS:375.

1.0	AC three phase circuits		
i.	No. 1 phase	:	Red
ii.	No. 2 phase	:	Yellow
iii.	No. 3 phase	:	Blue
iv.	Neutral conductor	:	Black
v.	Connection to earth	:	Green
2.0	D.C. Circuits	:	Gray

14.4.13. Operating Mechanism

General

The operating mechanism of the circuit breaker shall be motor wound spring charged type. It shall be electrically and mechanically trip free with anti-pumping device (as per IEC694 definition). All working parts in the mechanism shall be of corrosion resistant material. Self-lubricating, wearing resistant bearings shall be provided in the mechanism.

The mechanism shall fully close the circuit breaker and sustain it in the closed position against the forces of the rated making current and shall fully open the circuit breaker without undue contact bounce at a speed commensurate with that shown by tests to be necessary to achieve the rated breaking capacity in accordance with IEC56 or IS13118. The mechanism shall be capable of being locked in either the open or closed position. The mechanism shall be capable of fully closing and opening again after the auto-reclose time interval specified as 0.3 second in this specification.

Spring Mechanism

The spring operating mechanism shall be with spring charging motor, opening and closing springs with limit switches and all accessories necessary for automatic charging. In normal operation, recharging of the operating springs shall commence immediately and automatically upon completion of the closing operation so that a complete sequence of closing and opening operation should be possible.

It shall be possible to hand charge the operating spring with the circuit breaker in either the open or closed position conveniently from the ground level. Closure whilst a spring charging operation is in progress shall be prevented and release of the springs shall not be possible until they are fully charged.

The state of charge of the operating springs shall be indicated by a mechanical device showing 'SPRING CHARGED' when closing spring is fully charged and operation is permissible and 'SPRING FREE' when closing spring is not fully charged and the operation is not possible. Provision shall be made for remote electrical indication of "Spring Charged" and "Spring Free" conditions.

The operating mechanism shall be such that the failure of any auxiliary spring shall not cause tripping or closing the circuit breaker but shall not prevent tripping against trip command.

Closing action of the circuit breaker shall charge the opening spring ready for tripping. From the close position with spring charged, one open-close-open operation shall be possible without recharging the spring.

Motor

The motor for spring charging shall be single phase 230 Volt A. C motor. Continuous motor rating shall be at least ten percent above the maximum load demand of the driven equipment. It shall remain within its rated capacity at all operating points that will arise in service. It shall be protected by H.R.C cartridge fuses or MCB. The motor shall comply with IEC34 or IS996.

Interlocks

The circuit breaker shall be capable of being mechanically and electrically interlocked with the associated line isolator so that the isolator cannot be operated with the breaker in the closed position.

All doors or shutters which give access to live parts shall be interlocked in such a way that these cannot be opened unless the circuit breaker is in the open position.

Other interlocks shall be provided as deemed necessary for safety.

14.4.14. Terminal Connector

Suitable terminal connectors of bi-metallic type suitable for both horizontal and vertical connection shall be provided on the terminal pad both on the incoming and the outgoing side for connection of jumpers of ACSR or AAAC conductor. The size of the conductor may vary between 50mm^2 and 232mm^2 depending upon the location of the circuit breaker. The terminal connection drawing and details are to be approved by the Purchaser before fabrication. The terminal connectors shall be bi-metallic type to avoid bi-metallic corrosion.

14.4.15. Insulation and Clearance

a) The insulation to ground, the insulation between open contacts and insulation between phases of the circuit breaker shall be capable of satisfactorily withstanding dielectric test voltages.
b) The minimum clearance in open air shall be as per CEA Safety Regulations.

14.4.16. Temperature Rise

The maximum temperature attained by any part of the equipment when in service at site and under continuous full load conditions and exposed to the direct rays of the sun shall not exceed the permissible limits fixed by IEC. When the standards specify the limits of temperature rise these shall not be exceeded when corrected for the difference between ambient temperature specified in the approved specification.

The limits of temperature rise shall also be corrected for altitude as per IEC and stated in the bid.

14.4.17. Local Control Cabinet of VCB

The operating mechanism, local controls and monitoring shall be provided in a metal clad control cabinet fitted to the same structure supporting the breaker and mounted at a convenient height for safe operation from ground level or from platform to be supplied under the contract.

The cabinet shall be made of minimum 3 mm sheet steel and shall be constructed as a dust, weather and vermin proof outdoor housing with protection of IP-55 class. It shall have single door and transparent

windows for reading the circuit breaker ON or OFF position and spring charge position without opening the door. The door and any removable covers shall be gasketed all round with neoprene bonded gaskets. A ventilating louver shall be provided with fine wire non- ferrous metal or stainless steel screen and filter. A 230V AC heather with auto temperature control shall be provided in the cabinet to prevent moisture condensation and also a 230 volt lamp for internal illumination with door operated switch.

The local control cabinet shall be subjected to surface treatment and painting as per clause on surface treatment of this specification.

14.4.18. Wiring and Cabling

a) Unless otherwise specified control wire shall be stranded tinned copper switchboard wire with 1.1 kV PVC insulation conforming to the requirements of IS-1554.
b) All the control circuit and secondary wiring shall be wired completely and brought out preferably to a vertical terminal block ready for external connections in the control cabinet. The control wire shall not be of cross- section less than 2.5 mm^2 copper.
c) All spare auxiliary contacts of the circuit breaker shall be supplied wired up to terminal block. Each terminal in terminal block shall be suitable for at least 2 x 2.5 mm copper conductor.
d) At least 20 number spare terminals shall be provided over and above the number required.
e) All wiring termination on terminal blocks shall be made through lugs. For current and DC supply circuits disconnecting stud type terminal blocks will be provided. For other control circuits, non-disconnecting snap on type terminal blocks shall be provided.
f) All wires shall be identified with non-metallic sleeve or tube type markers at each terminations.
g) Terminal blocks shall be made up of moulded non-inflammable plastic material with blocks and barriers moulded integrally have white marking strips for circuit identification and moulded plastic covers.

14.4.19. Grounding

A ground bus of copper bar not less than 6 mm by 25 mm shall be provided along the inside of the front or rear of the each cubicle and equipment rack. The ground bus shall be bolted to the frame of each panel in such a way as to make good electrical contact with each panel or section. Earth terminals at two ends of the cabinet shall be provided for connection of the ground bus to the station earth mat.

14.4.20. Tripping/Closing Coils

The circuit breakers shall be provided with two trip coils and one closing coil per breaker. First trip coil shall be utilized for tripping the breaker on main protection fault detection. Second trip coil shall be used to trip the breaker when first trip coil fails to trip the breaker and backup protection comes into operation and shall also be used to trip the breaker on command. The trip coils shall be suitable for pre-closing and after closing trip circuit supervision. All the breakers shall have provision for independent electrical operation of trip coils from local as well as remote through local/remote selector switch. The breaker shall be provided with suitable protection device against discrepancies in the operation of individual pole.

14.4.21. Trip Free and Anti Pumping Features

The trip free mechanism shall permit the circuit breaker to be tripped by the protective relay even if it is under the process of closing. An anti- pumping device to prevent the circuit breaker from reclosing after an automatic opening shall be provided to avoid the breaker from pumping i.e., anti pumping relay should interrupt the closing coil circuit.

14.4.22. Controls

The circuit breaker shall be controlled by a control switch located in the control room. The control arrangement shall be such as to disconnect the remote control circuits of the breaker, when it is under test. Local/remote selector switch shall be provided for all breakers for selection of "Local" control/remote control.

Provision shall be made for local manual, closing, tripping and spring charging controls. Necessary equipment's for local controls shall be housed in the circuit breaker cabinet of weather-proof construction.

Each circuit breaker shall have a mechanical open/closed and spring charge indicator Lamps for indicating, 'close, open and spring charged' position of the breaker shall also be provided.

Mechanical indicator, to show the `open' and `close' position of the breaker shall be provided in a position where it will be visible to a man standing on ground with mechanism housing open. An operation counter, visible from the ground even with the mechanism housing closed, shall be provided. Electrical tripping of the breaker shall be performed by shunt trip coils.

Closing coil shall operate correctly at all value of supply voltage between 85% and 110% of the rated voltage. Shunt trip coils shall operate correctly under all operating conditions of circuit breaker up to the rated breaking capacity and at all values of supply voltage between 85% and 110% of rated voltage. Bearings which require grease shall be equipped with pressure type fillings.

Bearing pins, bolts, nuts and other parts shall be adequately pinned or locked to prevent loosening or changing adjustment with repeated operation of the circuit breaker. It shall be possible to trip the circuit breaker even in the event of failure of power supply.

Operating mechanism and all accessories shall be enclosed in control cabinet. A common marshalling box for the three poles of the breaker shall be provided, along with supply of tubing, cables from individual pole operating boxes to the common marshalling box, local.

The circuit breaker shall be able to perform 10,000 operating cycles at no load in accordance with IEC17A/474/CD for circuit breakers for auto reclosing duties.

14.4.23. Supporting Structure

The circuit breakers shall be supplied complete with hot dip galvanized steel supporting structures, foundation and fixing bolts, etc. The structure shall be made of steel MS angle section conforming to IS 226. The galvanizing shall be as per IS. The mounting of the breaker shall be such as to ensure the safety of the operating staff and should conform to Indian Electricity Rules, 1956. Minimum ground clearance of live part from ground level shall be 2750 mm.

The bidder shall submit detailed design calculations and detailed drawings in respect of supporting structures suitable for the equipment offered. The tenders shall specify the loads which shall be transmitted to the equipment foundation under most adverse operating conditions of the breaker.

All material for making connections between the circuit breaker and its control shall also be included in the scope of supply. Facility to earth the circuit breaker structure at two points shall be provided.

14.4.24. Surface Finish

All interiors and exteriors of control cubicles and other metal parts shall be thoroughly cleaned to remove all rust, scales, corrosion, greases or other adhering foreign matter.

All metal surfaces exposed to atmosphere shall be phosphated as per IS 6005 and there after given two primer coats of zinc chromate and then two coats of epoxy paint with epoxy base thinner. All metal parts not accessible for painting shall be made of corrosion resisting material. All machine finished or bright surfaces shall be coated with a suitable preventive compound and suitably wrapped on otherwise protected. All paints shall be carefully selected to withstand tropical heat and extremes of weather within the limits specified. The paint shall not scale off or wrinkle or be removed by abrasion due to normal handling.

All external paintings shall be as per shade No.631 of IS5.

All ferrous hardware, exposed to atmosphere, shall be hot dip galvanized.

14.4.25. Earthing

All metal parts not intended for carrying current or not alive shall be connected to duplicate earthing system and suitable electroplated brass earthing terminals shall be provided on each circuit breaker in conformity with IEC56, IEC 62271 – 100 or IS13118. Suitable identification mark for the earth terminals shall be provided adjacent to the terminal.

Earth continuity conductors shall be provided down to the ground level for earth connection to purchaser's earthing grid. It shall have sufficient cross sectional area to afford a low resistance path for the full fault current envisaged. Such conductor shall also be provided for the cts up to the ground level.

The size of the earth continuity conductor shall be large enough to reduce the potential rise of the metal frame of the breaker in the event of fault to minimum but in any case not more than 10V. The size of the conductor shall also be adequate to restrict the temperature rise without causing any damage to the earth connection in the case of fault. No riveted joints in the earth conducting path shall be permissible and only bolted joints of adequate size shall be provided with nuts, bolts and plain and spring washers. The surfaces to be jointed shall be perfectly flat without any unevenness to ensure that there is no contact resistance.

14.4.26. Galvanising

All ferrous parts including all sizes of nuts, bolts, plain and spring washers, support channels, structures, shall be hot dip galvanized conforming to latest version of IS2629 or any other equivalent authoritative standard.

14.4.27. Auxiliary Power Supply

The operating mechanism shall be suitable to operate with the following auxiliary power supplies.

- 230V, 50Hz Single phase A.C

For spring charging motor

- DC supply 30 Volts

For close and open coils, indication & Alarm

The DC supply shall be provided by UPCL at sub-station.

- AC supply (Voltage) : From 110% to 85% of normal voltage
- Frequency : From plus/minus 3% of normal frequency
- Combined : From 115% to 85% of normal voltage and frequency variation
- DC supply (Voltage) : From 110% to 85% of normal voltage

14.4.28. Performance Requirements

The supplier shall declare the circuit breaker opening and closing times at 120 percent, 100 percent and 70 per cent of the rated voltage of the opening and closing devices when measured at the terminals of the trip and closing coils. The minimum make break time at rated voltage and total break time of the CB shall be stated. The total break time must not exceed 60m sec.

14.4.29. Site Tests on Control and Auxiliary Circuit

The following tests shall be conducted at site before commissioning.

- Voltage tests on control and auxiliary circuit.
- Measurements of resistance of the main circuit.
- Mechanical Operation Tests.
- Insulation Resistance test

14.4.30. Name Plate

Equipment should be provided with name plate giving full details of manufacture, capacities and other details as specified in the relevant IS.

14.4.31. Spares for 11 kV VCB

Manufacturer shall furnish list of (a) mandatory and (b) recommended spares for VCB's indicating quantity and unit rate. Value of mandatory spares would be considered for the purpose of bid evaluation. Quantity of recommended spares to be procured would be decided before placement of order.

In addition to above, the manufacturer shall supply following list of spares free of cost:

- Trip coil and closing coil (1 no.)
- Spring charging motor (1 no.)

- Interrupters (1 set for supply of every 4 sets of VCB)
- Supporting insulators (2 sets for supply of every 10 sets of VCB)
- Good quality tools & plants suitable to dismantle the breaker (1 set)

14.4.32. Training to Utility Staff

The supplier shall provide training to utility staff on operation and maintenance of VCB's free of cost at manufacturer's facility. Duration of training and number of staff to be trained shall be decided mutually.

14.4.33. Commissioning of VCB's

The supplier shall commission at least xxx numbers (quantity to be decided based on order quantity) of VCB's at purchaser's site free cost, so as to demonstrate the pre-commissioning tests to be carried out etc.

14.4.34. Interconnection Drawings

The VCB supplier shall provide five copies of interconnection drawings for interconnection between VCB and Control and Relay (CR) Panel. Technical specifications for CR Panel shall be provided to the VCB supplier.

14.5. Tests

14.5.1. Type Tests

Type test reports (less than five years old as on due date of tender) of tests carried out on 11 kV VCB's at CPRI/ NABL accredited laboratory shall be furnished by the bidder along with offer otherwise offer shall be rejected. Provisional report will not be acceptable. Type test carried out at the factory / in house premises will not be accepted.

The circuit breakers shall be subjected to routine and type tests in accordance with the following standards with the latest amendments

- Circuit breaker : IEC56 and IS13118 and relevant other standards
- Porcelain insulator: IEC211 and IS5621 and relevant other standards

The tests shall include but not limited to the following

1) Short Circuit Tests

The circuit breaker shall satisfactorily perform the out of phase and short circuit duties [T10, T30, T60, T100a, T100s & single phase] specified in IEC 62271-100.

2) Capacitive Current Switching

Capacitive current switching shall be performed on following duties in accordance with IEC 62771 -100.

a. Single Capacitor bank switching test
b. Cable charging current breaking test

3) Dielectric Tests

At zero gauge loss of vacuum inside the interrupter chamber, the open contracts shall withstand continuously, the rated phase to ground voltage and it shall be possible to break normal current in these conditions. During the dielectric type tests, no flashover external or internal shall be acceptable.

The circuit breakers shall be subjected to a power frequency AC voltage test for one minute in dry and wet conditions and lightening impulse voltage withstand test and there shall be no external flash over to earth.

4) Mechanical Endurance

In addition to the requirements of IEC56 / IEC 62271 – 100, an extended mechanical endurance test is required to show that the circuit breaker is capable of at least 10,000 operations at no load in accordance with IEC17A/474/CD. Between the specified test series in IEC17A/474/CD, some maintenance such as lubrication and mechanical adjustment is allowed and shall be performed in accordance with manufacturer's instructions. Change of contracts is not permitted.

5) Duty Requirement Tests

Apart from auto-reclosing and the other duties mentioned above, the breakers shall be able to perform the following duties for which type tests are to be conducted as per IEC56 or IS13118.

- Short time withstand current test and peak withstand test
- Degree of protection test [IP 55]
- Cable charging breaking current.
- Back-to-back capacitor bank breaking current.

Test for the resistance of the main circuit shall also be conducted.

6) Temperature Rise Test

Temperature rise test is to be conducted on the circuit breaker and the accessories in accordance with IEC56 or IS13118. The temperature rise shall be limited as per this specification.

7) Routine Tests

Following shall constitute routine tests.

- Power frequency voltage withstand dry tests on the main circuit
- Voltage withstand tests on control and auxiliary circuits
- Measurement of the resistance of the main circuit
- Mechanical operating tests
- Design and visual checks

14.6. Pre-Delivery Inspection at Manufacturer's Works

a) All acceptance Tests, length and mass verification etc shall be witnessed and certified by purchaser's representative at manufacturer's works. The vendor shall give at least 10 days advance intimation to the purchaser to enable them to depute their representative for witnessing the Tests. The said representative shall have full facilities for unrestricted inspection of supplier's works, raw materials, manufacturing processes and conducting necessary Tests.
b) The said representative shall verify the calibration seals provided by the calibrating agency on testing equipments/ meters.
c) Test reports of routine Tests carried out by the manufacturer shall be submitted to the inspecting authority at the time of inspection for his approval.
d) Acceptance of any quantity of materials shall in no way relieve the supplier of his responsibility for meeting all requirements of the specification and shall not prevent subsequent rejection, if such materials are later found to be defective.
e) In case of waiver of inspection, vendor shall carry out all (i) routine and (ii) acceptance Tests and submit test reports for approval of the purchaser, before dispatch of material.
f) The entire cost of testing for acceptance & routine rests and checking of length etc shall be borne by the supplier.
g) The purchaser reserves the right to select sample from any material offered for inspection /inspected and dispatched, which will be got type tested at any NABL accredited laboratory. The results of this type-tested sample shall be applicable for the entire quantity of the particular lot offered or supplied by the supplier. The Purchaser shall bear the testing charges, if sample passes all the Tests and if sample fails in any one of the Tests, supplier shall have to bear testing charges, same are recoverable from the supplier's any pending bill, security deposit, Bank Guarantee or by any suitable means, whichever deem fit by the Purchaser. In case of sample failing in aforesaid type Tests, supplier shall have to replace the whole lot materials, which should pass through the type Tests, the re-testing charges will have to be paid by supplier. If any quantity against the particular lot is consumed by the Purchaser, the supplier will agree for any penalty/deduction in price as may be mutually agreed.

14.7. Quality Assurance Plan & Material Quality Plan

Following quality plans shall be submitted within 30 days from the date of placement of contract.

a) Quality Assurance Plan (QAP) to be adopted by manufacturer in respect of raw materials and bought out items, including source and test reports of (i) important raw materials and (ii) bought out items.
b) Material Quality Plan (MQP) to be adopted by manufacturer in respect of manufacturing process.

The QAP & MQP shall be approved by the purchaser within 15 days from the receipt of compliance, if any. The vendor shall follow the approved QAP & MQP in true spirit. If desired by the purchaser, he shall give

access to all the documents and materials to satisfy the purchaser that QAP & MQP are being properly followed.

14.8. Guarantee

The equipment/material shall be guaranteed for a period of 24 months from the date of commissioning or 30 months from the date of dispatch whichever is earlier.

14.9. Drawings and Instruction Manuals

Within 30 days after the award of the contract, the contractor shall supply six sets of drawings which will describe the equipment in details, for the approval of Purchaser. All the drawings and manuals should be in English Language and dimensions and weights shall be in MKS units.

Following drawings and documents for each item are to be supplied as part of the contract.

(i) General outline drawings, showing dimensions, front and side elevations and plan of the circuit breaker and its local control panel.
(ii) Outline drawing of support insulators showing dimensions and number of sheds and creepage distance.
(iii) Assembly and sub-assembly drawings with numbered parts.
(iv) Sectional views showing the general constructional features, operating mechanism and are extinguishing chamber, etc.
(v) Dimension and assembly of important auxiliaries.
(vi) Detailed drawings of operating mechanism.
(vii) Test certificates and oscillographs.
(viii) Detailed drawings of mounting structure.
(ix) Spare parts and catalogue
(x) Wiring diagram showing the local and remote control scheme of breaker.
(xi) Write up on working of control schematic of breaker.
(xii) Foundation plan including weights of various components and impact loadings for working foundation design.

Executive Engineer (Stores), UPCL will be the final authority for approving the drawings submitted by the tenderer.

Seven copies for each sub-station of the above drawings and instruction manuals covering instructions for installations, operation and maintenance shall be supplied by the contractor(s) without any extra cost.

14.10. Packing & Forwarding

14.10.1. Packing

Supplier shall pack or shall cause to be packed all items in such a manner as shall be reasonably suitable for shipment by road to UPCL without any risk of damage in transit. The packing shall be sufficient to withstand, without limitation, rough handling during transit and exposure to extreme temperatures, salt and precipitation during transit, and open storage.

14.10.2. Packing List

One copy of the packing list shall be enclosed in each package delivered. There shall also be enclosed in one package a master packing list identifying each individual package, which is part of the shipment. If, on any package, it is not possible to place packing list inside the container, all pertinent information shall be stencilled on the outside and will thus constitute a packing list.

14.11.Schedules

14.11.1. Schedule – I [Equipments]

Sl.No	Description	Quantity
1.	11 kV, 1000 A circuit breaker vacuum type drawout with provision of manual tripping by means of a control switch / push button.	1 No.
2.	Manually and motorized charged spring operated closing mechanism	1 No.
3.	240V AC Series/24V DC shunt tripping arrangement	1No.
4.	Single phase 11 kV current transformers of ratio 800-400/ 5-5A suitable for metering and protection. The class of accuracy shall be 0.5 for metering and 5P 15 for protection. Rated burden (output) shall be 10VA (Min.) for each secondary windings. Instrument security factor for metering core shall not exceed 5. However burden should not be less than suitable for tripping arrangement.	Nos.
5.	11000 / 110 volts three phase voltage transformer having 100VA / phase burden and class of accuracy 0.5. The transformer shall be star-star connected.	1 No.
6.	Flush type switchboard mounting pattern 96x96 sq.mm moving iron AC voltmeter of class 1.5 accuracy suitable for 110 Volts phase to phase secondary scaled for 0-15 kV.	1 No.
7.	Voltmeter phase selector switch to indicate phase to phase to neutral voltage of all the three phases.	1 No.
8.	Indicating lamps coloured red, amber and blue for PT supply indication.	3 Nos.

Sl.No	Description	Quantity
9.	Arrangement for reception of incoming and outgoing cable connection along with cable termination and sealing kits for 3Cx400 mm sq. XPLE power cables.	2 Nos.
10.	Set of three phase air insulated main copper bus bars of 1000A continuous current rating with PVC insulation or sleeves. STC rating 26.3KA for 3 seconds.	1 No.
11.	Mechanical ON/ OFF indicator	1 No.
12.	Operating handle for independent manual closing mechanism.	1 No.
13.	Red indicating lamp for ON indication.	1 No.
14.	Green indicating lamp for OFF indication.	1 No.
15.	Auxiliary switch having minimum of 8 contacts, 4 normally open and 4 normally closed.	1 No.
16.	Flush mounting pattern 96x96 sq.mm M.I. Ammeter of class 1.5 accuracy for 5 Amps. CT secondary scale 0-400/ 800A.	1 No.
17.	Ammeter selector switch to indicate phase current in all three phases and with OFF position.	1 No.
18.	Triple pole IDMTL type protection relay with high set (instantaneous feature) and with enabling / disabling option of high set. Three elements for over current protection suitable for matching A.C. series/DC shunt tripping arrangement. The current setting range of the over-current elements shall be from 10% and that of earth fault element from 1%.	1 No.
19.	Automatic door illuminating lamps with switch	1 No.
20.	3 phase 4 wire Electronic tri vector meter with Meter reading instruments (MRI) facility suitable for unbalance load mounted in flush pattern with accuracy class 0.5 as per relevant IS (equivalent to IEC 62056 & DLMS compliant) having all billing parameters & AMR compatible also (make L&T / Secure).	1 No.
21.	240 V, 100 W, AC single phase anti / condensation heaters, with thermostat (0-60 deg.C) and switch.	2 Nos.
22.	Anti pumping relay	1 No.
23.	Operation counter	1 No.
24.	Test terminal blocks for metering and relays.	2 Nos.
25.	Fault trip yellow lamp.	1 No.
26.	Trip circuit healthy indication.	1 No.

14.11.2. Schedule – II [Guaranteed Technical Particulars for 11 kV Out Door Circuit Breakers]

Table 14-4: Guaranteed Technical Particulars for 11 kV Out Door Circuit Breakers

S. No.	Description	Desired Values	Offered
1	Rated/ Highest voltage (kV rms)	11 kV / 12kV	
2	Rated frequency (Hz)	50	
3	System neutral earthing	Solidly grounded system	
4	Type of arc quenching medium	Vacuum	
5	Rated normal current at site conditions	1250 A (For both feeder and Transformer)	
6	Number of poles	3	
7	Installation	Outdoor type	
8	Temperature rise	As per IEC 62271- 100	
9	Rated short circuit		
10	A) Interrupting capacity at 36 kV	25 kA	
11	B) The percentage DC components	As per IEC 62271 – 100	
12	Rated short circuit making	62.5 kA	
13	First pole to clear factor	1.5	
14	Rated short time current	25 kA	
15	Rated duration of short circuit	3 Seconds	
16	Total break time for any current up to the rated breaking current with Limiting condition of operating and quenching media. Pressure (ms)	< 60 ms	
17	Closing time (ms)	< 130 ms	
18	No. of Interruptions	50,000	
19	Mounting	Hot dip galvanized lattices steel support structured bolted type	
20	Phase to phase spacing in the switch yard i.e. Inter-pole spacing for breaker (Min)	280	

S. No.	Description	Desired Values	Offered
21	Required ground clearance from the lowest line terminal if both the Terminals are not in same horizontal plane (cum)	2750	
22	Height of concrete plinth (mm)	300	
23	Minimum creepage distance of support insulator (mm)	300	
24	Standard value of rated transient recovery voltage for terminal fault	As per IEC 62271 - 100	
25	Standard value of rated line	RRRV	
26	Characteristics	surge peak factor K=1.6 A	
		For short line faults kV /ms=0.214	
		Impedence Factor Z(ohms) = 450	
27	Rated operating		
	A) duty cycle	0-0.3 s-CO-3 min-CO	
	B) Auto reclosing	Suitable for three phase Auto reclosing duty	
28	Rated insulation level under heavy Pollution condition 1.2/50 micro second lightening Impulse withstand voltage (kV peak)to earth	75 kV	
29	Power frequency withstand voltage (rms) to earth (kV rms)	28 kV to earth	
30	Rated characteristic for out of Phase Breaking		
	A) Out of phase breaking capacity	25% of rated breaking capacity	
	B) Standard values of transient	As per IEC-56 recovery	
	C) Operating mechanism	Spring operated, Anti pumping and Trip free mechanism	
31	A) Rated supply voltage of closing & operating devices and auxiliary circuits	1) 110 V DC/30 VDC	
		2) Series Trip Type system requiring no DC supply. Closing in this case shall be operating on 240 Volts AC 50 C/S single phase	

S. No.	Description	Desired Values	Offered
		3) 430 volts 50 Hz three phase	
	B) Permissible voltage variation	1) In case of DC Power supply voltage variation shall be Between 85% & 110% of normal voltage.	
		2) In case of AC power supply voltage variation shall be of the normal voltage as per IS (-15% to +10%)	
	C) Permissible frequency	± 3% from normal 50 Hz as per IS 2026 part-I 1977 Para 4.4	
	D) Combined variation of frequency and voltage	± 15%	
32	Number of auxiliary contacts	10 NO and 10 NC on each pole Continuous current Rating 10 Amps, DC at 110/30 volts DC or 240 V AC	
33	Number of coils	2 (Two) trip coils and 1 close coil	
34	Rated terminal load	100 kg. Static	
		The breaker shall be designed to withstand the rated terminal load, wind, load, earthquake load and short circuit forces	

15. Technical Specification for 11 kV Outdoor Type Current Transformers

15.1. Scope

The specification covers the design, manufacture, testing at manufacturer's works and supply of 11 kV Current Transformers complete with all accessories and spares suitable for outdoor use. Single phase, Outdoor, oil filled hermetically sealed with dead tank.

15.2. Service Conditions

Equipment/material to be supplied against this specification shall be suitable for satisfactory continuous operation under the tropical conditions as follows:

Table 15-1: Tropical conditions for continuous operation

S.No.	Particulars	Value
1	Maximum ambient temperature (Deg. Celsius)	50
2	Minimum temperature (Deg. Celsius)	0
3	Relative humidity range (%)	10 to 95
4	Maximum annual rainfall (mm)	1450
5	Maximum wind pressure (kg/sq m)	150
6	Wind speed zones (m/s)	47 & 39
7	Maximum altitude above mean sea level (m)	1000
8	Isoceraunic level (days/year)	50
9	Seismic level (Horizontal acceleration) (g)	0.3

15.3. Standards

The Current Transformers shall conform in all respects to IEC-185 & IS 2705 part-I, II, III & IV (amended up to date) except where specified otherwise. The equipment meeting any other authoritative standard which ensures equal or better quality than the standard mentioned above shall also be acceptable. Where the equipment offered conforms to any other standard the salient features of difference between the standards adopted and specified shall be clearly brought out in the tender.

15.4. Specific Technical Requirements

S.No.	Item	Specification	
1	Reference standard	IS 2705 (Part I to IV)/IEC 185	
2	System voltage		
	A. Normal	11 kV	
	B. Highest	12 kV	
3	Supply frequency	50 Hz	
4	System Neutral earth	Solidly earthed	
5	Insulation level		
	A. Impulse	75 kV peak	
	B. 1 min power frequency voltage	28 kV rms	
6	CT installation	Outdoor, single phase unit	
7	Type	Oil insulated or dry type	
8	Current		
	A. Normal	600 amp / 400 amp	
	B. Short time rating	12.5 kA rms for 3 sec (for current above 150 Amp)	
		12.5 kA rms for 1 sec (for current below 150 Amp)	
9 **10** **11**	One minute power frequency Withstand voltage between Secondary terminal & earth	3kV	
	Installation safety factor	Less than 5	
	Clear height of bushing	370 mm (Bird clearance)	
12	Minimum creepage	25 mm/kV	
13	CT details	Incomer	Outgoing
14	I) Ratio	600-300-150/5-5-5 a	400-200-100/5-5 a
		600-300-150/5-5 a	
15	II) Class of accuracy		

S.No.	Item	Specification	
16	A) Core I (Metering)	0.5	0.5
17	B) Core II (O/C protection)	5P10	5P10
18	C) Core III (Protection)	5P10	
19	III) Burden (every core)	15 VA	15 VA

15.5. General Technical Requirements

Current transformers, three per circuit breaker, shall be of outdoor, single phase oil immersed dead tank type and shall comply with IEC185 and IS2705, suitable for operation in hot and humid atmospheric conditions described in service condition. They shall be mounted on the bracket. The CT tank should be Hot Dip galvanized as per relevant ISS to prevent corrosion of all exposed metal parts.

3 core CTs will be provided for 10 MVA Power Transformers having differential protection and 2 core CTs will be provided for 11kV Feeder, incomer & 5MVA Power Transformers where differential protection is not provided.

15.5.1. Core

a) High grade non- ageing cold rolled grain oriented silicon steel of low hysteresis loss and permeability shall be used for the core so as to ensure specified accuracy at both normal and over currents. The flux density shall be limited to ensure that there is no saturation during normal service.
b) The instrument security factor of the metering core shall be low enough so as not to cause damage to the instruments in the event of maximum short circuit current.
c) The protection core to be used for earth fault and over current protection shall be designed for minimum saturation factor of 20 for the highest setting. The magnetizing curves for the core shall be furnished.
d) CT core to be used for differential protection shall be of PS class.

15.5.2. Windings

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 continuous current rating of the primary winding shall be one hundred and fifty Percent of the normal rated current.

Secondary Winding

The secondary windings shall be made of electrolytic copper with suitable insulation. The conductor shall be of adequate cross- section so as to limit the temperature rise even during short circuit conditions. The insulation of windings and connections shall be free from composition liable to soften, shrink or collapse during service.

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.

Secondary windings of current transformers shall be used for metering, instrumentation and protection and shall be rated for continuous current of one hundred and fifty percent of normal rated current of primary winding.

15.5.3. Marking

Polarity shall be indelibly marked on each current transformer and at the lead and termination at associated terminal blocks. CTs with multi ratio winding shall be clearly tabulated to show the connections required for different ratios. Similar numbers shall be marked on terminal block arrangement and wiring diagram. Apart from the above marking and those to be provided as per IEC 185 or IS 2705, other markings shall be provided in consultation with owner.

15.5.4. Construction

The current transformer enclosures shall be made of high quality steel and shall be hot dip galvanized and shall be able to withstand and stresses occurring during transportation and the terminal and mechanical stresses resulting from maximum short circuit current in service. The primary winding and terminals shall be in a tank and supported by a hollow porcelain insulator. The secondary connection shall be conducted through the hollow insulator and terminated in a terminal box mounted on the base plate.

15.5.5. Sealing

Each current transformer shall be supplied filled with insulating oil complying with IEC296 or IS115 and shall be hermetically sealed to prevent atmosphere coming in contact with oil, avoiding frequent filtration and change of oil.

The current transformers shall have provision for draining and re-filling insulation oil after drying.

15.5.6. Insulating Oil

The current transformer shall be complete with new insulating oil. The quantity of insulating oil for first filling of the equipment and complete specification of oil proposed to be used shall be stated in the bid. The oil shall conform to the requirements of latest issue of IEC296 or IS115.

To ensure prevention of oil leakage, the manufacturer will give following details supported by drawings:

- Location of emergence of Primary & Secondary terminals
- Interface between porcelain & metal tanks
- 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

15.5.7. Fittings and Accessories

Fittings and accessories listed below shall be supplied with each current transformer

- Oil level gauge
- Oil filling hole and cap;
- Pressure relief device;
- HV terminal connectors;
- Two earthing terminals and strips with necessary nut, bolts and washers;
- Name and rating plate;
- Terminal box with LV terminal connections;
- Mounting nuts, bolts and washers;

Any other fittings deemed essential by the Supplier shall also be supplied with each current transformer.

The oil level gauge shall be mounted in such a way that the oil level can be clearly seen from ground level.

A dust, vermin and weather proof terminal box shall be provided at the lower end of the current transformer for terminating the secondary windings. The box shall have a bolted cover plate complete with gaskets. The terminal box shall have terminal blocks, cable gland plate and cable glands with shrouds suitable for different sizes of PVC insulated control cables 650/1100V grade as per IEC227 or IS1554. The terminal blocks shall have covering of moulded insulation materials complete with brass studs, washers, nuts and lock nuts suitable for termination of 2X2.5 sq mm wires. The termination shall be made by crimping lugs or bare wire with insulating sleeves at ends.

The terminal box enclosure shall have protection as per class IP 55 as defined in IEC529 or IS13947.

15.5.8. CT Junction Box/Console Box

Each set of 3 current transformers for three phase shall be provided with a common junction box mounted on the circuit breaker supporting structure at a convenient position to accommodate the secondary wire of CT and other control cables of Purchaser. Separate terminals for testing the relays and instruments and short

circuiting of each current transformer secondary wires shall be provided in it. The junction box enclosure shall have the same protection features as for the terminal box. It shall be provided with terminal blocks, gland plates and glands suitable for different sizes of cables. Facilities shall be provided for earthing the CT secondary wires in the junction box.

15.5.9. Bushings

Oil filled/condenser type, porcelain bushing shall be used on the current transformers. The porcelain shall be homogenous thoroughly verified and impervious to moisture. The blazing of porcelain shall be uniform brown colour free from blisters, burns and other similar defects. Bushing shall have ample insulation, mechanical strength and rigidity for the purpose for which they will be used. There shall be no undue stressing of any part of bushings due to temperature changes and adequate means shall be provided to accommodate conductor expansion. The bushings shall be so designed that when operated at highest system voltage specified in clause 3.3, there will be no electric discharge in between the conductors and the bushings. No corrosion or injury shall be caused to conductor insulation or supports by the formation of substances produced by chemical action. The insulation on bushings shall be co-coordinated with that of the current transformer such that the flash over if any, will occur only external to the current transformers. The bushings should not cause radio interference when operated at rated voltage .In general the bushings shall conform to the latest issue of IS 2099 or equivalent.

15.5.10. Hollow Porcelain Insulators

The insulators of the current transformers shall conform to latest edition of IS5621 and shall be subjected to and successfully pass the tests listed in this standard and in IEC211. The hollow porcelain insulators shall be brown glazed and shall meet the requirements indicated in this specification. The insulators shall be cemented with Portland cement to the flanges resulting in high mechanical, tensile and breaking strength.

Each of the bushings shall be complete with the following-

- Bio-metallic expansion type terminal connector
- Oil level side gauge and convenient means of filling, sampling and draining of oil.
- Adjustable arcing horns.

15.5.11. Insulation Level

The current transformers shall be designed to withstand impulse test voltages and power frequency test voltages as specified in this specification.

15.5.12. Terminal Connections

The CTs shall be provided with bi-metallic solder less clamp and rigid type terminal connectors on the top tank for connection to the HV terminals. They shall be universal type suitable for both horizontal and vertical connections.

Two earthing terminals complete with necessary hardware shall be provided on each CT for connecting to earth continuity conductor to be provided. The earthing terminals shall be identified by means of appropriate symbol marked in a legible and indelible manner adjacent to the terminals. The terminals shall be adequately sized to meet the full earth fault current envisaged. Suitable terminal connector for earth connection shall also be supplied size of Terminal connectors however shall be confirmed at the time of approval of drawing.

15.5.13. CT Mounting Bracket

The supporting structure shall be fitted with a bracket for supporting the three oil filled 11kV single phase current transformers. The support bracket shall be provided opposite the circuit breaker poles and shall ensure adequate clearance between the breaker poles and the CTs. The drawings of the structure with bracket shall be subject to Purchaser's approval before fabrication.

15.5.14. Galvanization

All the ferrous parts including nuts bolts etc shall be hot dip galvanized as per IS 2629-1966 (As amended up to date).

15.5.15. Spare Parts

The tenderer shall quote separately for spares recommended by them for five years operation of equipment covered by this specification. The purchaser will decide the actual quantity of spare parts to be ordered on the basis of the list and the item wise prices for spares called for in the price schedule.

15.5.16. Completeness of Equipment

Any fitting accessories or apparatus which may not have been specifically mentioned in this specification but are usual or necessary in the equipment for satisfactory functioning shall be deemed to be included in the contract and shall be supplied without any extra cost. All plant and equipment shall be complete in all details whether such details are mentioned in the specification or not.

15.6. Tests and Inspection

The CTs shall be tested in accordance with the requirements of the type tests and routine tests as per the latest issues IEC185 or IS2705.

15.6.1. Type Tests

Type test reports (less than five years old as on due date of tender) of tests carried out on 11 kV CT's at CPRI/ NABL accredited laboratory shall be furnished by the bidder along with offer otherwise offer shall be rejected.

The tests to be conducted shall include;

- Lightning impulse voltage;

- Power frequency wet withstand voltage ;
- Temperature rise;
- Short time current; o Composite error;
- Accuracy test (for measuring core);
- Instrument security current (for measuring core);
- Current error and phase displacement (for protection core)

15.6.2. Routine Tests

- Verification of terminal marking and polarity;
- Power frequency dry withstand test on primary windings;
- Power frequency dry withstand test on secondary windings;
- Power frequency dry withstand test between sections;
- Over voltage inter-turn test;
- Composite error;
- Turn ratio;
- Accuracy test (for measuring core);
- Current error and phase displacement (for protection core);
- Knee point voltage and magnetizing current test (for PS class); xi. Secondary winding resistance (for PS class).
- Insulation Resistance Test.

15.7. Guarantee

The material will be guaranteed against defective materials, bad workmanship and unsatisfactory performance for a period of 30 months from the date of delivery. If during the guarantee period, the materials are found defective or sub-standard, the same will have to be replaced/repaired free of cost by the supplier within 30 days of intimation.

15.8. Drawings and Instructions Manual

The tenderer shall submit with the tender the following drawings to enable the purchaser to assess the suitability of the equipment.

- General layout and assembly drawings of the equipment
- Arrangement of terminal equipment
- Schematic drawings of electric power to control circuit
- Graph showing the performance of the equipment

Drawings necessary to demonstrate compliance with any critical, dimensional requirements such as for transportation, fitting within the restricted space, clearance required etc.

These drawings shall show sufficiently over all dimensions clearance and space requirements of all apparatus to be furnished to enable the purchaser to determine the design and layout of the installation.

Soon after the award of the contract the manufacturer shall submit the drawing duly describing the equipment in detail for approval.

The following drawings are to be supplied as part of the contract-

- Outline dimension drawings
- Assembly drawings
- Cross sectional view of the instrument transformer
- Foundation diagram
- Wiring diagram with polarity marks
- Magnetization curves

Executive Engineer (Stores), UPCL will be the final authority for approving the drawings submitted by the tenderer.

Seven copies of the instructions manual covering instructions for installation and maintenance check test shall be supplied by the contractor as a part of the contract.

15.9. Schedule

15.9.1. Schedule – I [Guaranteed Technical Particulars for 12 kV out Door Current Transformers]

S.No.	Particulars of GTP Parameter	Offered
1	Manufacturers name & Type	
2	Manufacturer's type Designation.	
3	Whether Conforming to standards	
4	Rated Voltage in kV	
5	Rated primary current (Amps)	
6	Rated Secondary current (Amp)	
7	Whether conforming to Details of Cores	
8	Secondary resistance corrected to 75ºc (in Ohm)	
9	Magnetizing current (in ma)	
10	Rated dynamic withstand current (kap) as per Annexure- I at	
11	Rated short time withstands current for 1 sec. Duration	
12	One minute dry power frequency withstand voltage	
13	One minute wet power frequency withstand voltage	
14	1.2/50 micro-second impulse withstand voltage (kV P)	
15	The die-electric withstand values(kV p) of external and internal insulation	

S.No.	Particulars of GTP Parameter	Offered
16	One minute power frequency withstands voltage of secondary winding (kV rms)	
17	Minimum creepage distance in mm	
18	Weight of oil (kg).	
19	Total Weight (kg).	
20	Mounting details	
21	Overall dimension.	
22	Magnetization curves	
23	Type of winding	
24	Cross section area of primary winding	
25	Cross section area of secondary winding	
26	No. Of Primary turns	
27	No. Of secondary turns	
28	Current density of primary winding	
29	Primary terminal	
30	Type of insulation & Temperature rise limits applicable	
31	Whether Current transformer conforms to the Temperature rise limits	
32	Whether Type test reports (within five years) are submitted along with the offer?	
33	Type of oil compensation	
34	Whether Experience sheet is submitted along with the offer?	
35	Whether Two year continuous servicing performance certificate is submitted along with the offer?	
36	Whether Turn over sheet is submitted along with the offer?	
37	Whether Drawings are submitted along with the offer?	
38	Whether Test tap is provided?	
39	Type of Pressure release device provided?	
40	Partial discharge level	
41	Rated continuous thermal current	
42	Current security factor	
43	Type of insulation material used	

16. Technical Specifications for 11 kV Outdoor Type Potential Transformer

16.1. Scope

The scope of this specification covers design, manufacturing, testing, supply, transportation, insurance (transit and storage), erection, site testing & commissioning of 11 kV Potential Transformer suitable for outdoor service.

16.2. Service Conditions

Equipment/Material to be supplied against this specification shall be suitable for satisfactory continuous operation under the Tropical Conditions given below:

Table 16-1: Tropical conditions for continuous operation

Sr. No.	Particulars	Value
1	Maximum ambient temperature (Deg. Celsius)	50
2	Minimum temperature (Deg. Celsius)	-5
3	Relative humidity range (%)	10 to 100
4	Maximum annual rainfall (mm)	1500
5	Maximum wind pressure (kg/sq m)	195
6	Wind speed zones (m/s)	47 & 39
7	Maximum altitude above mean sea level (m)	3000
8	Isoceraunic level (days/year)	50
9	Seismic level (Horizontal acceleration) (g)	0.13

16.3. Standards

The cables shall comply with latest revision of the following Indian Standards unless otherwise stipulated in the specification.

All references to Indian Standards shall be deemed to be complying with latest amendments to the respective IS, if any.

Table 16-2: Standards

S. No.	IS	IEC	Item
1	Is 3156	IEC 186	Voltage transformers
2	Is 2099		Bushings for alternating voltages above 1000 Volts
3	Is 1147		Dimensions for Porcelain Transformer Bushings
4	Is 115		New insulating oils
5	Is 13947(part I)		Glossary of terms relating to metal containers
6	Indian electricity Rules 1956/ CEA regulations, 2010		Indian electricity Rules 1956/ CEA regulations, 2010
7		IEC 815	Guide for the selection of insulators in respect of polluted condition

16.4. Basic Technical requirements

The 11kV outdoor voltage transformers are required to meet the following basic technical requirements (Reference standards IEC186, IS3156 and associated standards listed in the specification).

Table 16-3: Basic Technical requirements

Sr. No	Particulars	Requirements
1	Type	Single phase
2	Nominal/ Highest system voltage, phase to phase	11kV / 12kV
3	Instrumentation, Metering and Protection Application	
4	Number of secondary windings	1
5	Rated normal burden (minimum acceptable)	200 VA
6	Rated primary voltage	11 kV
7	Rated secondary voltage	110 V
8	System neutral earthing	Solidly earthed
9	Class of accuracy	0.5
10	Rated insulation level (Primary winding) (Phase to earth)	
11	One minute power frequency withstand voltage to earth (wet and dry) rms	28kV

Sr. No	Particulars	Requirements
12	Impulse withstand voltage to earth with 1.2/50 sec wave of +ve and -ve polarity (peak)	75kV
13	One minute power frequency withstand voltage of secondary winding (rms)	
14	Between phase to earth	3kV
15	Between sections	3kV
16	Rated voltage factor	
17	Continuous	1.2
18	For 30 seconds	1.5
19	Creepage distance to earth in mm per kV of highest phase to phase system voltage	25

16.5. General Technical Requirements

The voltage transformers to be supplied under this specification shall be of outdoor, single phase dead tank double wound, oil immersed type, complying with IEC185 and IS3156 suitable for operation in hot and humid atmospheric conditions described in this document. To prevent corrosion of the exposed surfaces, the tank should be hot dip galvanized. They shall have separate HV and LV windings and shall be suitable for use as bus VTs in 33/11kV substations.

16.5.1. Duty Requirement

11kV Voltage transformer for all the indicating instruments and measuring meters in the primary substation on 11kV side.

16.5.2. Porcelain Insulator

External parts of the voltage transformers which are under continuous electrical stress shall be of hollow porcelain insulators complying with latest edition of IS6521 tested as per IEC211. The creepage and flashover distance of the insulators shall be dimensioned and the type and profile designed in accordance with IEC815 or IS13134 and shall be suitable for the worst environmental conditions for heavily polluted atmosphere and shall be not less than 25mm per kV of highest phase to phase system voltage with protected creepage distance minimum 50 percent of the total. Internal surfaces of hollow insulators shall also be glazed.

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

All porcelain used on the voltage transformers shall have the following properties high strength, homogeneity, uniform glaze, free from cavities and other flaws and a high quality uniform finish porcelain

components shall withstand the maximum expected static and dynamic loads to which the voltage transformers may be subjected during their service life. The clear height of porcelain housing shall be at least 430 mm.

The insulation of the hollow porcelain insulators shall be coordinated with that of the voltage transformers to ensure that any flash over occurs only externally.

16.5.3. Core

High grade non-ageing cold rolled grain oriented silicone steel of low hysteresis loss and permeability shall be used for core so as to ensure accuracy at both normal and or over Voltages. There shall be no saturation at any stage during operation.

The instrument security factor of the core shall be low enough so as not to cause damage to the instruments in the event of maximum short circuit current or over voltages.

16.5.4. Windings

Primary Winding

It shall be made of insulated electrolytic copper wire and covered with double paper insulation. The insulation of windings and connections shall be free from composition liable to soften, looze, shrink or collapse during service. The neutral end of the winding shall be brought outside for earthing.

The conductor shall be of adequate cross-section so as to limit the temperature rise even during maximum over voltages.

The current rating of the primary winding shall be one hundred and fifty percent of the normal rated burden and the windings shall be suitable to withstand continuously the maximum system voltage.

Secondary Winding

It shall be made of insulated copper wire of electrolytic grade and covered with double paper insulation. 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 winding of the voltage transformers shall also be suitable for continuous over voltage corresponding to the maximum system voltage at the primary winding. The winding supports shall be suitably reinforced to withstand normal handling and the thermal and dynamic stresses during operation without damage.

The voltage transformer secondary circuits will be taken out to form the star point and earthed at one point outside the voltage transformers.

16.5.5. Marking

Both primary and secondary winding terminals shall be clearly and indelibly marked to show polarity in accordance with IEC186. The connections required for different secondary windings in case of multi- winding voltage transformers shall be clearly indicated in terminal blocks and the wiring diagrams.

16.5.6. Tank

Both expansion chamber and tank of the voltage transformers shall be made of high quality steel and shall be hot dip galvanized and shall be able to withstand the stress occurring during transit and all thermal and mechanical stresses resulting from maximum short circuit current during operation. It shall be fabricated of MS steel sheet of min. 3.15 mm thickness for sides & 5 mm for top & bottom.

16.5.7. Insulating Oil

The voltage transformers shall be supplied filled with new insulating oil. The oil shall conform to the requirements of latest issue of IEC296 of IS115. The quantity of insulating oil for first filling of the equipment and complete specification of oil proposed to be used shall be stated in the bid.

The manufacturer will give following details supported by drawings:

- Location of emergence of Primary & Secondary terminals
- Interface between porcelain & metal tanks
- 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 clamped to the bushings & not on the porcelain directly.

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.

16.5.8. Sealing

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 voltage transformers shall be supplied filled with insulating oil and shall be hermetically sealed to prevent atmosphere coming in contact with oil, avoiding filtration and change of oil.

16.5.9. Fitting and Accessories

Fittings and accessories listed below shall be supplied with each voltage transformer

- Oil level gauge.
- Oil drain, sampling and filling hole with cap;
- Pressure relief device;
- HV terminals;
- Two earthing terminals with necessary nuts, bolts and washers; vi. Name and rating plate;
- Secondary terminal box with LV terminal connections; viii. Mounting nuts, bolts and washers;
- L.V HRC cartridge fuses for the protection of secondary winding;

- Any other fitting deemed essential by the contractor shall also be supplied along with each voltage transformer
- The oil level gauge shall be mounted in such a way that the oil level can be clearly seen from the ground level.

The name and rating plate shall contain all the particulars as provided in IEC186 and also the name of the employer and year of manufacture. They shall comply with the clause termed label in this specification.

16.5.10. Secondary Terminal Box

A dust, vermin and weather proof terminal box shall be provided at the lower end of each voltage transformer for terminating the secondary windings. The box shall have a bolted removable cover plate complete with gaskets. The terminal box shall have cable gland plate and cable glands with shrouds suitable for entry of 4 core x2.5mm2 PVC insulated control cables as per IEC227 or IS1554.

The terminal box enclosure shall have protection of class IP 55 as defined in IEC529 or IS13947 and shall be painted or galvanized in accordance with specification of Surface Treatment.

16.5.11. Terminal Blocks

Terminal blocks of brass studs rated for 10 Amps continuous current, 650 Volt grade enclosed in moulded insulating materials shall be provided with adequate electrical clearance for terminating the secondary wiring and outgoing connections. The terminal blocks shall be suitable for termination of 2.5mm^2 wires. The termination shall be made by crimping Jugs or bare wire with insulating sleeves at ends. All terminals must be marked with numbers and wire termination provided with numbered ferrules for identification.

16.5.12. Fuse Protection

The secondary windings shall be protected by HRC cartridge fuses in fuse holder consisting of carriers and bases. The carriers and bases shall be of high grade flame retarding and non-hygroscopic moulded insulating materials with hard glass surface. Each fuse shall be identified with engraved plastic label.

16.5.13. Circuit Diagram

A durable copy of the circuit wiring diagram shall be affixed to the inner side of the terminal box cover. Labels shall be provided inside the cover to describe the functions of various items of equipments.

16.5.14. Termination

The equipment shall be supplied with HV electrical connection terminals of a size and rating appropriate for all the duties, including overload duty specified for the equipment. The terminals shall be of the bi-metallic type, suitable for connection of all aluminium alloy conductor (AAAC) or aluminium conductor steel reinforced (ACSR). In general connections using palm type solder-less sockets shall be preferred. The proposed method of connections shall be stated in the offer and shall be subject to approval by the Purchaser. Where the

terminals are of the clamp type, they shall be suitable for taking a range of conductors appropriate to the rating of the equipment.

All nuts, bolts, washers and spring washers required to complete the connection shall be supplied with the equipment.

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 99.99 % conductivity.

The secondary terminals studs shall be provided with at least 3 nuts and two plain washers, these shall be made of brass duly nickeled. The min. Stud outer dia. shall be 10 mm & length 15 mm. The min spacing between the centres of the adjacent studs shall be 1.5 times the outer dia. Of the stud.

16.5.15. Polarity

The polarity shall be marked on each PT at the secondary terminals in the terminal box. There shall be MCB of suitable rating at secondary terminals.

16.5.16. Earthing Terminal

Two earthing terminals complete with necessary hardware shall be provided on each voltage transformer for connecting to earth continuity conductors of the Employer. They shall be of electroplated brass and of adequate size to carry the earth fault current.

Two earthing 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. The earthing terminals shall be identified by means of appropriate symbol marked in a legible and indelible manner adjacent to the terminals.

16.6. Test and Inspections

The voltage transformers shall be tested in accordance with the requirements of the type tests and routine tests as provided in the latest issues of IEC186 or IS3516.

16.6.1. Type Tests

Type test reports (less than five years old as on due date of tender) of tests carried out on 11 kV PT's at CPRI/ NABL accredited laboratory shall be furnished by the bidder along with offer otherwise offer shall be rejected.

The tests to be conducted shall include;

- Lightning impulse voltage test;
- High voltage power frequency wet withstand voltage;
- Temperature rise test;
- Short circuit withstand capability test; Determination of limits of voltage error and phase displacement

16.6.2. Routine Tests

- Verification of terminal marking and polarity;
- Power frequency withstand tests on primary winding;
- Power frequency dry withstand tests on secondary winding;
- Power frequency withstand tests between sections;
- Determination of limits of voltage errors and phase displacement; Partial discharge measurement.
- Insulating Resistance measurement.

16.6.3. Temperature Rise

The temperature rise of any part of the voltage transformer under continuous operating and exposed in the direct rays of the sun shall not exceed the permissible limits as provided in IEC publication 186 or IS3156. These shall not be exceeded when corrected for the difference between the ambient temperature at site and the ambient temperature specified in the standard. The correction proposed shall be stated in the bid.

16.7. Drawings and Instructions Manual

The tenderer shall submit with the tender the following drawings to enable the purchaser to assess the suitability of the equipment.

a) General layout and assembly drawings of the equipment
b) Arrangement of terminal equipment
c) Schematic drawings of electric power to control circuit
d) Graph showing the performance of the equipment
e) Drawings necessary to demonstrate compliance with any critical, dimensional requirements such as for transportation, fitting with in the restricted space, clearance required etc.

These drawings shall show sufficiently over all dimensions clearance and space requirements of all apparatus to be furnished to enable the purchaser to determine the design and layout of the installation.

Soon after the award of the contract the manufacturer shall submit the drawing duly describing the equipment in detail for approval.

The following drawings are to be supplied as part of the contract:

- Outline dimension drawings
- Assembly drawings
- Cross sectional view of the instrument transformer
- Foundation diagram
- Wiring diagram with polarity marks
- Magnetization curves

Executive Engineer (Stores), UPCL will be the final authority for approving the drawings submitted by the tenderer.

Seven copies of the instructions manual covering instructions for installation and maintenance check test shall be supplied by the contractor as a part of the contract.

16.8. Schedules

16.8.1. Schedule – I [Guaranteed Technical Particulars for 12 kV out Door Potential Transformers]

Table 16-4: Guaranteed Technical Particulars for 12 kV out Door Potential Transformers

S.No.	Particulars of GTP Parameter	Offered
1	Manufacturers name & Type of PT	
2	Manufacturer's type Designation.	
3	Whether Conforming to standards	
4	Rated Primary Voltage in kV	
5	Number of secondary windings	
6	Rated secondary voltage (Volts)	
7	Rated burden (VA)	
8	Accuracy class	
9	Highest system voltage (kV)	
10	Quantity of oil (Liters)	
11	Type of insulation & Temperature rise limits applicable	
12	Whether Potential transformer conforms to the Temperature rise limits	
13	Rated voltage factor & time	
14	One minute power frequency withstand voltage test (dry) (kV rms)	
15	One minute power frequency withstand voltage test (wet) (kV rms)	
16	1.2/50 microsecond impulse wave withstand test voltage (kV P)	
17	One minute power frequency withstand voltage on secondary (kV rms)	
18	Minimum Creepage distance (mm)	
19	Weight of oil (kg)	
20	Total weight (kg)	
21	Overall dimensions	
22	Mounting details	

S.No.	Particulars of GTP Parameter	Offered
23	Primary terminals	
24	Whether Type test reports (within 5 years) are submitted along with the offer?	
25	Type of oil compensation	
26	Whether experience sheet is submitted along with the offer?	
27	Whether two year continuous servicing performance certificate is submitted along with the offer?	
28	Whether Turn over sheet is submitted along with the offer?	
29	Whether Drawings are submitted along with the offer?	
30	Whether Pressure release device is provided?	
31	Type of insulation material used for PT	
32	Actual Clearance between live part and ground (mm)	

17. Technical Specification for 11 kV 25 kA Indoor Switchgear integrated with associated C & R Panels and Control Desk for Remote Operation

17.1. Scope

This Specification covers the basic requirements in respect of 11 kV, 25 kA (with highest system voltage of 12 kV) indoor switchgear integrated with associated indoor control and relay panels for installation at various sub-stations in UPCL. Clause 5 of the Specification covers the requirements of indoor switchgear with relays & controls. The control and relay panel should form integral part of the switchgear (i.e. should be physically integrated into one unit). In addition to this an operator's supervisory control desk with interconnecting equipment viz. Control cables, connectors etc. Should be provided having facility of remote closing, tripping of every switchgear panel and a repeat annunciation and indication system showing status of the circuit breaker.

The equipment offered shall be complete with all parts necessary for their effective and trouble-free operation. Such parts will be deemed to be within the scope of the supply irrespective of whether they are specifically indicated in the commercial order or not.

The respective drawing along with notes and specification attached hereto form an integral part of this specification for all purposes.

It is not the intent to specify herein complete details of design and construction. The equipment offered shall conform to the relevant standards and be of high quality, sturdy, robust and of good design and workmanship complete in all respects and capable to perform continuous and satisfactory operations in the actual service conditions at site and shall have sufficiently long life in service as per statutory requirements. In actual practice, notwithstanding any anomalies, discrepancies, omissions, in-completeness, etc. In these specifications and attached drawings, the design and constructional aspects, including materials and dimensions, will be subject to good engineering practice in conformity with the required quality of the product, and to such tolerances, allowances and requirements for clearances etc. As are necessary by virtue of various stipulations in that respect in the relevant Indian Standards, IEC standards, I.E. Rules, I.E. Act and other statutory provisions.

The Tenderer/supplier shall bind himself to abide by these considerations to the entire satisfaction of the purchaser and will be required to adjust such details at no extra cost to the purchaser over and above the tendered rates and prices.

17.2. Codes and Standards

The design, manufacture and performance of the equipment shall comply with all currently applicable statutes, regulations and safety codes. Nothing in this specification shall be construed to relieve the tenderer of this responsibility.

Unless otherwise specified, the equipment offered shall confirm to the latest applicable Indian, IEC, British or USA standards and in particular, to the following-

Table 17-1: Codes and Standards

S.No.	IS / IEC	Particulars
1	IS 13118/1991	High Voltage Alternative current circuit breaker
2	IS12729/2004	High-Voltage Switchgear and Control gear Standards
3	IEC 694	Common clauses for switchgear
4	3427/1997	A.C. Metal Enclosed Switchgear and Control gear
5	IS 3156/1992	Voltage transformers
6	IS 2705/1992	Current transformers.
7	IS 56211980	Hollow Insulators for use in electrical equipment
8	IS2544/1973	Porcelain post insulators
9	8828/1996	MCB
10	IS 12063/1987	Degree of protection provided for enclosures for electrical equipment.
11	IS 5/2005	Colour for ready mixed paints and enamels.
12	IS 55781984	Marking of insulated conductor.
13	11353/1985	Guide for Uniform System of Marking and Identification of Conductors and Apparatus Terminals
14	IS 1248/2003	Indicating instruments.
15	IS 14697/1999 amended up to date	HT Static tri vector TOD Energy meters
16	IS 6875 amended up to date	Control switches.
17	IS 3231/1986 & 87 amended up to date	Electrical Relays for Power System Protection.
18	IEC 60255 amended up to date,	Numerical biased protection relays.
19	IS 8686/1977	Static protective relays.

S.No.	IS / IEC	Particulars
20	IS 4794/68 & 86	Push button.
21	IS9385/1979	High voltage fuses
22	IS 9431/1979	Indoor post insulator of organic material

In the event of offered equipment confirming to standards other than the above, the salient points of comparison between the standard(s) adopted and the relevant IS shall be indicated in the technical offer. Copies of the standard adopted shall be invariably furnished with the offer.

17.3. General Technical Requirements

17.3.1. General

Switchgear for Indoor installation shall be metal clad, draw-out type and fully compartmentalized having 25 kA short time current rating. All panels shall be of unitized construction providing facility for extensions on both sides. Three types of switchgear panels are required, viz. The incomer panel, the bus section panel and the feeder (outgoing) panel.

The switchgear will be installed in a separate switchgear room, but the controls under normal conditions will be from the 11 kV remote supervisory control desk installed in the main control room.

The supplier should be an OEM (Original Equipment manufacturers) of the relay, make and break pot and VCB. Suppliers providing assembled relay and make and break parts will not be entertained.

Circuit Breakers used shall be VCBs of specified rating for the various types. The design of the breaker truck shall be such that there will be flexibility of interchanging between incomer, bus-section and feeder trucks, where similar rated breakers are offered.

17.3.2. System Particulars

Table 17-2: System Particulars

S. No.	Item	Particulars
1	Nominal System Voltage	11 kV
2	Highest System Voltage	12 kV
3	Frequency	50 Hz±3%
4	Number of phases	3
5	Neutral earthing	Solidly grounded
6	Short current rating	25 kA

17.3.3. Auxiliary Supplies Available at the Various Sub-Stations

I	A. C. Supply	240 volts with ± 10% variation
II	D.C. supply	30 V DC with +10% to – 15% variation
III	Frequency	50 Hz with ± 3% variation

17.3.4. Bill of Materials

There will be 2 sets of indoor panels comprising of one incomers, and four outgoing feeders. It will be coupled with bus coupler. (2 IC + 1 BC + 8 OG). The bill of materials for the incomer, bus section and feeder panels (for one set) shall be as follows:

17.3.5. Incomer Panel

a) One draw out type Vacuum circuit breaker having 1250 Amps. Continuous current rating and 25 ka for 3 sec. Short time current rating, complete with operating mechanism and accessories.
b) 3 nos. Current transformers of ratio 600-300-150 /5-5-5 a.
c) 3 nos. Single phase pts of ratio 11/√3 kV /110/√3v connected to the incomer
d) With proper fuse protection arrangement.
e) One mechanical ON/OFF indicator
f) One mechanical 'spring charged' indicator.
g) One T-N-C control switch for circuit breaker. Vii. Remote-Local switch for circuit Breaker
h) Relay instruments etc.
i) Set of MCBs, stud type terminals and control wiring.
j) Fuse and link for Motor Starter
k) Three nos. Of space heaters with thermostat control, one each for the breaker chamber, bus bar chamber and the CT/cable chamber along with a common MCB mounted inside LT control wiring.

17.3.6. Bus-Section Panel

a) One draw-out type vacuum circuit breaker having 1250 Amps continuous current rating and 25 ka for 3 sec. Short time current rating, complete with operating mechanism and accessories.
b) 3 nos. CTs of ratio -600-300-150 /5-5-5 a.
c) One T-N-C control switch for circuit breaker.
d) Remote-local switch for circuit Breaker.
e) One mechanical ON/OFF indicator
f) One mechanical 'spring charged' indicator
g) Three nos. Space heaters with thermostat control, one each for the breaker chamber, bus bar chamber and the CT/cable chamber along with a common MCB mounted inside the L.T. control cubicle.
h) Set of MCBs, stud type terminals, and control wiring. Ix. Fuse and link for Motor Starter

i) All Relay and instruments etc.

17.3.7. Feeder (Outgoing) Panel

a) One draw-out type vacuum circuit breaker having 630 Amps continuous current rating and 25 ka for 3 sec. Short time current rating, complete with operating mechanism and accessories.
b) 3 nos. CTs of ratio 200-100/5-5a
c) One T-N-C control switch for circuit breaker.
d) Remote-local switch for circuit Breaker.
e) One mechanical ON/OFF indicator
f) One mechanical 'spring charged' indicator
g) Three nos. Space heaters with thermostat control, one each for the breaker chamber, bus bar chamber and the CT/cable chamber along with a common MCB mounted inside the L.T. control cubicle.
h) Set of MCBs, stud type terminals, and control wiring.
i) Fuse and link for Motor Starter
j) All Relay and instruments etc.

17.3.8. Bus bar

11 kV bus bars shall be of electrolytic copper and shall be rated for 2000 Amps continuous current. Cross sectional area shall not be less than 1250 sq.mm. Current density of 1.6Amps/sq. Mm shall be considered for the bus bars. The bus bar edges/ends shall be rounded off/chamfered so that there will not be any sharp edges/projections.

11 kV bus support insulators and other equipment insulators shall have a minimum creepage distance of 127 mm. These insulators shall be of solid core porcelain or epoxy resin cast, with suitable petticoat design. Insulators shall have a cantilever strength of not less than 1200 kgf.

All fasteners (Nuts Bolts) used for bus bar connections shall be of non magnetic stainless steel. Only Belle-ville type washers shall be provided for each nut bolt. If the fasteners used are not of stainless steel the tenderer shall state in their offer the material used and confirm that the same is non-magnetic and is superior to stainless steel.

The bus bars along with their supporting insulators etc. Shall have a short time current rating of 25 KA for 3 sec. This shall be confirmed by the tenderer's in their technical offer.

Clearances between phases and between phase and earth shall be kept liberally so as to obtain high reliability. However, minimum clearances as shown below shall be kept.

Table 17-3 Minimum clearance between phase and earth

S. No.	Minimum Clearance	For bus bar Chamber	For breaker Chamber
1	Phase to Phase	127 mm	127 mm

S. No.	Minimum Clearance	For bus bar Chamber	For breaker Chamber
2	Phase to earth	77 mm	77 mm

If any special insulating material is proposed to achieve the effect of above clearances details of the same shall be furnished in the technical offer.

Test certificate of bus bar for rated STC rating shall be submitted, along with offer, otherwise necessary confirmation shall be given in the offer for submitting the same for approval of competent authority prior to commencement delivery.

17.3.9. Circuit Breakers

a) The circuit breakers offered shall be Vacuum Circuit Breakers and of horizontal draw out Horizontal Isolation type. Breakers shall be of 3 pole design for use in 11 kV indoor switchgear.
b) The circuit breaker shall have 25 kA for 3 sec. short time current rating. The circuit breaker for incomer and bus section shall have 1250 Amps continuous current rating and for feeders shall have 630 Amps continuous rating. Circuit breaker shall be suitable for rapid reclosing cycle i.e. O-0.3 sec.-CO-30 sec.-CO.
c) The circuit breaker shall be provided with motor operated spring charged closing. Spring charging motor shall be suitable for 240V, 50 Hz, single phase AC. Suitable rating starter shall be provided for Motor protection. Spring release coil for closing shall be suitable for 30V DC. Provision shall be available for charging the springs manually as well, and to close CB mechanically.
d) Tripping of the circuit breakers shall be through "Shunt trip" coils rated for 30V DC auxiliary supply. It shall be possible to trip the breaker manually in case of necessity.
e) All circuit breakers shall have mechanical ON/OFF indicator and spring charge indicator. These shall be visible from the front without opening the panel door. Also there shall be provision for mechanical (manual) tripping and also for manual charging of the springs.
f) Each operating mechanism of the circuit breaker shall be provided with adequate number of Cam/Snap type auxiliary switches of normally open and normally closed contacts for the control and operation of the equipment with continuous current rating of 10 Amp. The Breaking capacity of the contacts shall be minimum 2 A with circuit time constant less than 20 mili-seconds at the rated D.C. voltage. Normal position of auxiliary switches refers to contact position when circuit breaker is open.
g) Adequate numbers of "NO/NC" contacts of the C.B. shall be wired up to the terminal block for connection to the remote supervisory desk for indication, interlocks, etc., as described under this specification. Following contacts shall be wired up to the terminals and clearly marked up in the relevant drawings.
    - Terminal for remote indication of breaker ON/OFF.
    - Terminal for remote indication of spring charge.
    - Terminal for remote indication of trip circuit healthy (Pre close and post close)

Minimum 4 pair each of "NO/NC" contacts shall be available as spare for use in the remote control desk for various/interlocks, voltage selection etc.

h) Insulation level of auxiliary contacts shall be 1100 volts, 2.5 kV for 1 min.
i) Safety shutters which close automatically to prevent accidental contact with the live bus after withdrawal of the C.B. shall be provided.
j) The tenderer shall offer suitable earthing trolleys to facilitate earthing of out-going feeder circuits. Unit prices of earthing trolleys shall be quoted, per set two earthing trolleys are required.
k) Electrical anti pumping device shall be provided for breaker.
l) Principal parameter for the circuit breaker will be

1	Rated voltage	12 kV
2	Rated insulation level	28 kV
3	T.R.V peak value	20.6 kV
4	Rated symmetrical current breaking	25 kA
5	Rated making current(Peak)	62.5 kA
6	Short time current rating	25 ka for 3 second

17.3.10. Circuit Breaker Control Switch

a) Circuit Breakers Control 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.
b) Terminal screws must be captive to avoid misplace during maintenance.
c) Switch shall be with 48 mm x 48 mm escutcheon plate marked with Trip & Close.
d) Circuit Breakers control switch shall be Non- discrepancy type
e) 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.
f) One contact to close in each position of Trip and Close. Contact not required in Neutral position. Contact rating shall be 12 A at 30 V DC

17.3.11. Protective Relays

a) Numerical biased protection relays (principle requirements are given in annexure- II B) shall be suitable for auxiliary supply (30 V D.C.) and shall have a reset push button and a test push button to test the relay function with provision to trip bypass push button.
b) The Non directional 2 O/C & 1 E/F relay with High set Relay should be provided.
c) For each Incomer and feeder, non-directional, 2 Over current and 1 earth fault relays shall be provided. All these relays shall be of 3 seconds IDMT characteristics, the O/C elements having current

setting variable from 50% to 200 % in steps of 10%, and the E/F elements having current setting variable from 5% to 80% in steps of 5%.

d) For each incomer and feeder, high speed tripping relay shall be provided. Over current & Earth fault relay shall be connected to trip coil through high speed trip relay.
e) All relays should be suitable for flush mounting on C & R panel and all connections should be on backside. The relay should be draw –out type preferably with automatic shorting of CT circuit at a time of removal of relay from the casing.
f) LCD Display Relay should have 12 mm LCD backlit display.
g) 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
h) Test terminal blocks used in metering circuit shall be suitable for 3 phase 4 wire type connections.
i) Numerical biased protection relay for current differential protection shall be provided.

17.3.12. Current Transformers

a) The C.Ts. being prone to failure due to various reasons, the quality and reliability of the CTs are of vital importance. C.T. shall be rated for 25 kA for 3 sec. short time current. Insulation used shall be of very high quality, details of which shall be furnished in the technical offer.
b) The instrument security factor for metering core shall be low enough but not greater than 5 at lower ratio. This shall be demonstrated on metering core in accordance with the procedure specified in relevant IS/IEC
c) Primaries shall be wound or bar type, rigid, high conductivity grade copper conductor. Unavoidable joints on the primary conductor shall be welded type, preferably lap type. The current density at any point shall not exceed 1.6 A/sq. mm.
d) Suitable insulated copper wire of electrolytic grade shall be used for CT secondary winding. Multi ratio in CT shall be achieved by reconnection of secondary winding tapping.
e) Secondary terminal studs shall be provided with at least three nuts, two plain and two spring washers for fixing leads. The stud, nut and washer shall be of brass, duly nickel plated. The minimum outside diameter of the studs shall be 6 mm. The length of at least 15 mm shall be available on the studs for inserting the leads. The space clearance between nuts on adjacent studs when fitted shall be at least 10 mm.
f) The CTs shall be resin/epoxy cast. Contact tips on primary terminals shall be silver plated. Correct polarity shall be invariably marked on each primary and secondary terminals.

17.3.13. Details of CT's

a)	IS applicable:	IS 2705 or IEC 185
b)	Insulation level:	28 kV
c)	Class of Insulation:	E

d) Short time current: 25 ka for 3 sec.
e) CT details
   - Incomer 600-300-150/5-5-5 A
   - Bus coupler 600-300-150/5-5-5 a
   - Feeder 200-100/5-5A
f) Class of accuracy
   - Core I 0.5
   - Core II 5p10
   - Core III ps
g) Purpose of each core
   - Core I metering
   - Core II protection
   - Core III diff. Protection

   (Core III - To be ordered for 10MVA and above Transformers with Differential protection)
h) Burden
   - Core I 20VA
   - Core II 20VA
   - Core III NA

17.3.14. Potential Transformer

Potential transformers shall be single phase units connected to the line side in the respective incomer. H.V side shall be connected in star formation and L.V. side in star/open delta formation. Three numbers of HRC fuses of suitable rating shall be provided for HV side.

PT may be provided in a separate compartment. The primary and secondary contacts (moving & fixed type) shall have firm grip while in service. Service position locking mechanism shall be provided and indicated by bidder in relevant drawing. Rigidity of primary stud point with earth bus in service position shall be confirmed.

P.T. shall be epoxy/resign cast. Contact tips of primary/secondary contacts shall be silver plated. Correct polarity shall be distinctly marked on primary and secondary terminal

Secondary terminal studs shall be provided with at least three nuts, two plain and two spring washers for fixing leads. The stud, nut and washer shall be of brass, duly nickel plated. The minimum outside diameter of the studs shall be 6 mm. The length of at least 15 mm shall be available on the studs for inserting the leads. The space clearance between nuts on adjacent studs when fitted shall be at least 10 mm.

17.3.15. Details of PTs

- Standard: IS 3156 or IEC 186
- Insulation level: 28 kV
- Class of insulation: Class E
- Rated voltage factor: 1.2 continuous & 1.5 for 30 sec.
- Ratio: 11kV /√3 / 110v/ √3

- Burden core I: 50 VA
- Class of accuracy core I: Class 0.5
- Purpose core I: Metering
- Connection: star/star

Each secondary core will be protected by suitable MCB.

17.3.16. Cubicle

The switchgear cubicle (panel) shall be made of sheet steel of thickness not less than 2 mm and shall be free standing floor mounting indoor type. There shall be sufficient reinforcement to have level surfaces resistance to vibration and rigidity during transportation & installation. The compactness of the C.B shall be made use of by the designer to make the switchgear panels as compact as possible. Cubicle shall be dust, moisture & vermin proof, and shall provide degree of protection not less than IP4X in accordance with IS 12063/1987. The cubicle shall be designed such that in both the test and isolated position of the C.B truck, the front cover of the cubicle shall remain closed.

Design & construction of the switchgear panel shall be of the highest order. All sheet steel work shall be treated as per the seven tank process before applying primary coating. For the final coat (stowed) epoxy paint colour shade of dove grey to shade No.694 as per IS5 shall be used. Alternatively powder coating may also be accepted. The panels after final painting shall present an aesthetically pleasing appearance, free of any dent or uneven surface.

Two separate earthing terminals shall be provided in each panel and shall be connected to the earth bus within the panel. The earth bus shall be of copper and shall have adequate cross sectional area.

Each of the Switchgear panel shall be of unitised construction with all necessary accessories like end covers etc. However the design shall allow for extension on both sides without limit. Bus bar design shall be such that panel to panel interconnection can be carried out without difficulty as and when required.

Explosion vents of suitable design shall be provided on the roof sheet of the bus-bar/cable/CT's chambers so as to enable discharge of explosive gases from inside during a flashover. However the provision of explosion vent shall not affect the degree of protection/vermin proofing of the panel.

17.3.17. Power cable Compartment

Power cable compartment shall be provided at the rear of the switchgear panels and shall be suitable for cable entry from the bottom cable trenches. Rear bottom plates of the cable compartment shall be fitted with removable gland plates of adequate size for fixing the cable glands.

Cable compartments for the incomer shall be suitable for terminating 3nos. Of 3x400 sq.mm XLPE cables and that for feeder shall be suitable to accommodate 2 nos. O f 3x400 sq.mm. XLPE cables. Copper terminator strip of suitable size shall be provided for termination of cables and shall have adequate height inside to accommodate the heat shrinkable type indoor cable termination. Cable compartment shall be robust enough & self-supporting. The design shall be such that the weight of the power cable within the

compartment shall not cause direct pressure on the C.T. studs. Suitable clamping arrangement shall be provided at the bottom of the cable compartment. Each power cable shall be terminated independently.

17.3.18. Control Wiring

All wiring shall be carried out with 1100 volts grade single core, multi-strand flexible tinned copper wires with PVC insulation. The conductor size shall 2.5 sq mm (minimum) for circuits. Wiring trough may be used for routing the cables. Wire numberings and colour code for wiring shall be as per IS5578/1984. The wiring diagram for various schematics shall be made on thick and durable white paper in permanent black ink and same should be encased in plastic cover, thermally sealed. It should be kept visibly in a pocket of size 350 x 400 mm of MS sheet of 1 mm thickness, on the interior surface of the door of C & R Panel.

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.

Further it shall be ensured that any control wiring if at all routed through the H.T chamber is properly insulated and provided with metallic barriers to prevent damages due to heat.

17.3.19. Wiring and Control Wiring Terminals

Terminal blocks shall be of clip-on design made out of non-track able 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.

The terminal connector/blocks shall be disconnecting type terminal connectors 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.

At least 20% spare terminals 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.

All front mounted as well as internally mounted items 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.

All fuses used shall be of HRC type. The fuse base and carrier shall be plug-in type moulded case kit-kat of Bakelite/DMC. All current carrying and live parts shall be of tinned/nickel plated copper. No fuse shall be provided on DC negatives and AC neutrals. Tinned copper links shall, however, be provided on DC negatives and AC neutrals.

All MCBs as per IS8828/1993 (amended up to date) of adequate rating shall be used

17.3.20. Control and Relay

Bill of Materials

The relays, meters and equipment as described below should be provided on the switchgear for each for incomer, bus-section, and feeder as follows:

Table 17-4: Bill of Material

S.No.	Description	Quantity		
		Incomer	Bus-sect.	Feeder
1	Circuit label / Name plate	1 no.	1 no	1 no
2	Vacuum Circuit Breaker 12 kV , 1250 Amps, 25 ka	1 no.	1 no.	
3	Vacuum Circuit Breaker 12 kV , 630 Amps, 25 ka	--		1 no.
4	Motor for spring charge	1 no.	1 no	1 no
5	Starter with fuse and link for Motor	1 no.	1 no	1 no
6	Ammeter, 48x96 sq. Mm	1 no.	1 no	1 no
7	Ammeter selector switch	1 no.	1 no.	1 no
8	Voltmeter, 48x96 sq. Mm	1 no.	-	-
9	Voltmeter selector switch	1 no.	-	-
10	Digital frequency meter	1 no.	1 no.	1 no
11	Control switch for circuit breaker	1 no.	1 no.	1 no
12	Local/Remote selector switch.	1 no.	1 no.	1 no
13	Auto/Manual selector Switch.	1 no.	1 no.	1 no
14	Indicating LED (Amber colour) for 'Trip	1 no.	1 no.	1 no
15	Circuit healthy'			
16	Push button for 'Trip circuit Healthy Test'	1 no.	1 no.	1 no
17	Indicating LED (White colour) for 'spring	1 no.	1 no.	1 no
18	Charged'			
19	Indicating LED (Red colour) for C.B. 'ON"	1 no.	1 no.	1 no
20	Indicating LED (Green colour) for C.B. 'OFF"	1 no.	1 no.	1 no
21	Indicating LED for Auto Trip	1 no.	1 no.	1 no
22	Mimic diagram section	1 set	1 set	1 set

S.No.	Description	Quantity		
		Incomer	Bus-sect.	Feeder
23	Numerical non-directional combined 2	1 set	1 set	1 set
24	O/C+1E/F relays (IDMT 3-sec relays.)			
25	Numerical high speed master trip relay	1 set	1 set	1 set
26	Panel Mounted HT Static Tri-vector TOD energy Meter with RS 485 port	1 no	-	1 no
27	Single phase Current Transformer 1250 - 600-300/1-1-1 Amp	3 nos.	3 nos.	--
28	Single phase Current Transformer 600-300-150/5-5 Amp	--	--	3 nos.
29	Single phase Potential Transformer	3 nos.	--	--
30	Alarm scheme consisting of alarm relay(s),indicating LED and Accept/Reset push button(s)	-	1 set	-
31	Alarm bell	-	1 no	-
32	Voltage selection Scheme consisting of auxiliary relays and PT-1/PT-2 fail indicating leds.-	-	1 set	-
33	Space heater along with MCB	1 set	1 set	1 set
34	Thermostat	1 no.	1 no.	1 no
35	Toggle switch for Heater	1 no.	1 no.	1 no
36	Cubicle illumination lamp along with door operated control switch.	1 set	1 set	1 set
37	Power plug along with control switch.	1 set	1 set	1 set
38	Wiring along with mcbs, terminal blocks and terminal connectors	1 set	1 set	1 set

17.3.21. Scheme Features

Trip circuit supervision scheme as per clause no. 5.3.14.7 shall be provided for each circuit breaker.

When two or more incomers are required at one station, suitable voltage selection scheme to select the correct PT supply will be essential. Voltage selection scheme offered shall be suitable to select (automatically) the PT supply as follows:

- Both incomers 'ON' and both pts healthy- PT supply from respective incomer shall feed all circuits in that section.
- Both incomers 'ON' and one PT fails PT supply shall change over, provided the bus-section breaker is closed.

One incomer out, P.T. supply shall change over, provided the bus-section breaker is closed.

PT supply to all the panels including the incomer shall be routed through the voltage selection scheme. When one of the pts fails, the same shall be indicated automatically by the respective PT fail indicating LED. All necessary relays/contacts for above schemes shall be accommodated in empty chamber of adopter panel inside front door.

17.3.22. Supervisory Control Desk

The operator's supervisory control desk generally conforming to the configuration and dimension shown in the diagram enclosed along with two revolving chairs (Godrej make or equivalent) and one side rack of steel drawers (Godrej make or equivalent) for storage of record etc. Should be provided.

- The desk should include following facilities.
- Mimic diagram depicting the bus and positions of breakers for all the panels on the Switchgear Board.
- Discrepancy switches for remote closing and tripping of all the breakers on the Board.
- Flasher relay for discrepancy switch suitable for 30 V DC.
- Repeat annunciation system both visual and audio i.e. Alarm bell with accept, reset & LED test push buttons.
- Indication for 'spring charged' status.
- HT Static tri-vector TOD Energy meter (single unit) for measurement of voltage, current, PF, kw, kV A, kV, kwh, kVah, Maximum demand in kV A for 15/30 minutes interval- one for each circuit breaker. (Metering equipment is not required for bus coupler)
- Test Terminal Block for each metering equipment.
- All the control cables, connectors, accessories, etc. For connecting the control desk to the switchgear Board for ready connection and commissioning (distance between the switchgear board and control desk should be 50 meters approx.)
- Space heater with thermostat and toggle switch.

17.3.23. Annunciation

a) Nos. Of 8 Window annunciators suitable for the visual and audible alarm annunciation shall be provided on the supervisory control desk for following. These shall be microprocessor based units using bright LEDs.
   - One number for Incomers and Bus Coupler
   - Two numbers for outgoing feeders.

b) Annunciator fascia units shall have translucent plastic windows for each alarm point.

c) Annunciator fascia 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 fascia LED are glow.

d) Annunciator fascia units shall be suitable for flush mounting on panels. Replacement of individual fascia inscription plate and LED shall be possible from front of the panel.

e) Each annunciator shall be provided with 'Accept', 'Reset' and 'Test' push buttons, colored red, yellow and blue respectively.

f) Special precaution shall be taken by the supplier 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 neighboring circuits within the panels.

g) In case 'RESET' push button is pressed before abnormality is cleared, the leds shall continue to glow steady and shall go out only when normal condition is restored.

h) Any new annunciation appearing after the operation of 'Accept' for previous annunciation, shall provide a fresh audible alarm with accompanied visual, even if the process of "acknowledging" or "resetting" of previous alarm is going on or is yet to be carried out.

i) Provision for testing healthiness of visual and audible alarm circuits of annunciator shall be available.

S. No.	Mounting	Flush
1	No. Of fascia windows	8
2	No. Of windows per row	4
3	Supply voltage	30 v dc
4	No. Of LEDs per window	2
5	Lettering on fascia plate	Properly engraved

j) 8 Window Annunciation Scheme to indicate following functions for Incomer 1, Incomer 2 and Bus coupler

1	Main protection (O/C) Trip for incomer 1	1 no.
2	Main protection (E/F) Trip for incomer 1	1 no.
3	Main protection (O/C) Trip for incomer 2	1 no.
4	Main protection (E/F) Trip for incomer 2	1 no.
5	Main protection (O/C) Trip for Bus coupler	1 no.
6	Main protection (E/F) Trip for Bus coupler	1 no.
7	Spare	1 no.
8	Spare	1 no.

k) 8 Window Annunciation Scheme to indicate following functions for Outgoing Feeder 1,2,3 & 4

1	Main protection (O/C) Trip for feeder 1.	1 no.
2	Main protection (E/F) Trip for feeder 1.	1 no.
3	Main protection (O/C) Trip for feeder 2.	1 no.

4	Main protection (E/F) Trip for feeder 2.	1 no.
5	Main protection (O/C) Trip for feeder 3.	1 no.
6	Main protection (E/F) Trip for feeder 3.	1 no.
7	Main protection (O/C) Trip for feeder 4.	1 no.
8	Main protection (E/F) Trip for feeder 4.	1 no.

l) 8 Window Annunciation Scheme to indicate following functions for Outgoing Feeder 5,6,7 & 8

1	Main protection (O/C) Trip for feeder 5.	1 no.
2	Main protection (E/F) Trip for feeder 5.	1 no.
3	Main protection (O/C) Trip for feeder 6.	1 no.
4	Main protection (E/F) Trip for feeder 6.	1 no.
5	Main protection (O/C) Trip for feeder 7.	1 no.
6	Main protection (E/F) Trip for feeder 7.	1 no.
7	Main protection (O/C) Trip for feeder 8	1 no.
8	Main protection (E/F) Trip for feeder 8.	1 no.

17.3.24. Operator's Desk

The operator's desk be made of sheet steel of thickness not less than 2 mm. And shall be free standing floor mounting indoor type. The desk should be dust moisture and vermin proof. It should be elegant in appearance and should be treated and painted as detailed in clause No.5.1.8.2.

The desk should be modular in construction. Each module should be about 800 mm. Wide and should accommodate controls, indications and metering equipment for four feeder breakers and one module for the incomer & one B.C. The desk for the 11 panels switchgear Board (viz. 2 I/C + 1 B.C. + 8 O/G) shall have three such modules (Total length about 2.4 m). And the desk for the 7 panels switchgear Board (viz. 2 I/C + 1 B.C. + 8 O/G) shall have two such modules (Total length about 1.6 m).

The two modules for 7 panel board and three modules for 11 panel Board should be assembled in such a way that the complete desk has a semi-circular/ arc-link configuration for easy and convenient operations.

17.3.25. Tolerances

Tolerances on all the dimensions shall be in accordance with provisions made in the relevant Indian/IEC standards and in these specifications. Otherwise the same will be governed by good engineering practice in conformity with required quality of the product.

17.4. Tests

17.4.1. Type Tests

The equipment offered in the tender should have been successfully type tested at NABL accredited laboratories for following tests in line with the relevant standard and technical specification, within the last 5 (five) years from the date of offer. The bidder shall be required to submit complete set of the following type test reports along with the offer.

Switchgear Panel (with circuit breaker installed)

- Lightning impulse voltage withstand test
- Out of phase making & breaking test
- H.V. dry 1 min power frequency withstand test
- Short time and peak withstand current test
- Short circuit test with basic duties
- Single phase breaking capacity test.
- Cable charging breaking current test
- Temperature rise test

Circuit Breaker

- Mechanical endurance test
- Current transformer
- Short time current test
- Impulse voltage withstand test
- Temperature rise test
- Potential transformer
- Impulse voltage withstand test
- Temperature rise test
- Switchgear panel
- IP 4x

17.4.2. Acceptance and Routine Tests

All acceptance and routine tests as stipulated in relevant IS/IEC shall be carried out by the supplier in the presence of purchaser's representative without any extra cost to the purchaser.

After finalization of the program of type/acceptance/routine testing, the supplier shall give three weeks advance intimation to the purchaser, to enable him to depute his representatives for witnessing the tests.

17.5. Quality Assurance Plan

The tenderer shall invariably furnish following information along with his offer, failing which his offer shall be liable for rejection. Information shall be separately given for individual type and current rating of circuit breaker/CTs/pts/Panel mounting & accessories.

a) Statement giving information about names of sub-suppliers, list of testing standards, list of tests normally carried out for bought out item.
b) Copies of test certificates in respect of following bought out items.
   - Vacuum interrupter
   - Insulators
   - Bus bar material
   - Instrument transformers
   - Terminal connectors
c) List of areas in manufacturing process, where stage inspection are normally carried out by the tenderer for quality control and details of such tests and inspections.
d) List of testing equipment available with the tenderer for final testing of breakers vis- a-vis the type, special, acceptance and routine tests specified herein. The limitations in testing facilities shall be very clearly brought out in schedule-e i.e. Schedule of deviation from specified test requirements.

The successful tender shall submit the routine test certificates of bought out accessories at the time of routine testing of the fully assembled breaker for the goods manufactured within purchaser's country. The supplier shall also submit the central excise passes for the raw material at the time of routine testing of the fully assembled breaker.

17.6. Performance Guarantee

All equipment supplied against this specification shall be guaranteed for a period of 60 months from the date of dispatch. However, any engineering error, omission, wrong provision, etc. Which do not have any effect on the time period shall be attended to as and when observed/pointed out without any price implication.

17.7. Drawings/ Documentation

After receipt of letter of Award, the successful tenderer's shall submit 3 sets of complete drawings along with detailed bill of materials for approval to the purchaser. Space for stamp and signature of approving authority shall be kept at right hand bottom corner above name block. If any modifications are required on these, the same will be conveyed to the supplier who shall modify the drawings accordingly and furnish final drawings for approval. In no case delivery extension will be granted for any delay in drawing approval.

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

After approval of the drawings and bills of materials, the suppliers shall submit detailed packing lists for approval. After approval, copies of these packing lists shall be forwarded to the respective consignees. Copies of packing lists shall also be submitted to the purchase, along with the bills for payment.

Six set of final drawings, bill of materials, wiring schedules, technical literature and commissioning manuals shall invariably be forwarded to the consignee along with the each panel consignment, and shall be listed out in the packing list when submitted for approval. All drawings shall preferably be of A3 size. No drawing of width more than 35 cm will be acceptable.

In case the supplier fails to furnish contractual drawings and manuals even at the time of supply of equipment, the date of furnishing of drawings/manuals will be considered as the date of supply of equipment for the purpose of computing penalties for late delivery.

List of drawings to be submitted along with the offer are as under:

- G. A. of indoor 11 panel switchgear.
- Typical single line diagram for 11 panel switchgear.
- Sectional view of incomer, bus coupler & feeder panels.
- G. A. of circuit breaker truck.
- G. A. of current transformer
- G. A. of potential transformer.
- G. A. Drawing for control desk.
- Bill of material for complete switchgear.
- Technical particulars of switchgears.

Successful tenderer shall furnish all above drawings and following additional drawings for approval before commencement of supply.

- Foundation details for 11 panel switchgear
- Equipment door layout for incomer, bus coupler & feeder panels
- Schematic diagram for incomer bus coupler & feeder section of switchgear
- Protection circuit for incomer bus coupler & feeder section of switchgear
- DC control circuit for incomer, bus coupler & feeder section
- Metering circuit for incomers, bus coupler & feeder section
- Annunciator and alarm scheme
- P.T. supply change over scheme
- Terminal block details for incomer, bus coupler & feeder section.
- Cross section view for CTs
- Name plate & connection diagram for CTs
- Cross section view for PTs
- Name plate & connection diagram for PTs

- Schematic diagram for control desk
- G. A. Drawing for chair
- G. A. Drawing for sliding door unit

Executive Engineer (Stores), UPCL will be the final authority for approving the drawings submitted by the tenderer.

17.8. Packing and Forwarding

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

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

- Name of the consignee
- Details of consignment
- Destination
- Total weight of consignment
- Sign showing upper/lower side of the crate
- Handling and unpacking instructions
- Bill of material indicating contents of each package

All the equipment covered in this specification shall be delivered to the various stores centres of the UPCL as will be intimated to the successful tenderer's. The equipment shall be delivered to these stores centres only by road transport, and shall be suitably packed to avoid damages during transit in the case of indigenous supplies.

The tenderer's shall quote delivery periods for various equipment, and shall stick-on to the committed delivery. The delivery period will be counted from the date of issue of detailed purchase order. It may clearly be noted that the delivery periods will under no circumstances be linked up with other formalities like drawing approval, etc. It is therefore the responsibility of the successful tenders to submit the drawings, bill of materials, packing lists, etc. In time and get these approved by UPCL.

17.8.1. Supervisory Erection & Commissioning

Erection and commissioning of the equipment covered in this specification may be asked to be carried out by the selected bidder. The tenderer's may quote their terms and conditions for deputing their Engineers/Technicians to the various sites for carrying out the erection and commissioning work.

17.8.2. Information to be filled in & furnished invariably by the Tenderers.

The offers shall be complete in all respects, failing which the same are liable for rejection. In the bill of materials for each items, the tenderer shall state the type designation and make of each item/equipment. Unit prices of all items and sub-components shall be quoted. The list of items for which unit prices are quoted (without the price part) shall be submitted along with the technical offer. Guaranteed technical particulars for various equipment shall be elaborate and complete in all respects. It may be noted that the technical evaluation of the tender is made mainly based on the guaranteed technical particulars furnished along with the technical offer. Technical offer shall be submitted in triplicate, and each set shall include all the necessary particulars including the technical literature on various equipment.

17.8.3. Documents to be submitted along with offer

1) Test certificates of Bus Bar for STC rating or undertaking in this respect
2) Quality assurance plan
3) Names of sub-suppliers
4) List of testing equipment available with the tenderer for final testing of breakers
5) Following type test reports:
   i. Switchgear panel (with circuit breaker installed)
      - Lightning impulse voltage withstand test
      - Out of phase making & breaking test
      - H.V. dry 1 min power frequency withstand test
      - Short time and peak withstand current test
      - Short circuit test with basic duties
      - Single phase breaking capacity test.
      - Cable charging breaking current test
      - Temperature rise test
   ii. Circuit breaker
      - Mechanical endurance test
   iii. Current transformer
      - Short time current test
      - Impulse voltage withstand test
      - Temperature rise test
   iv. Potential transformer
      - Impulse voltage withstand test
      - Temperature rise test
   v. Control & relay panel
   vi. IP test
6) Copies of test certificates in respect of following bought out items:
   - Vacuum interrupter
   - Insulators
   - Bus bar material

- Instrument transformers
- Terminal connectors

17.8.4. General Requirements for Protective, Measuring & Control Equipment

Principal requirements of protective relays, metering equipment, auxiliary relays breaker control switches etc. Are as follows:

Numerical Non Directional, 2 O/C + 1 E/F Relay With High Set Relay:

Elements	2 O/C + 1 E/F + High set for both O/C & E/F separately
CT Secondary input current to relay	1A / 5 Amp selectable
Operating Characteristics selectable	1. IDMT - 3 sec 2. IDMT - 1.3 sec 3. Very inverse 4. Extremely inverse 5. Definite time
Auxiliary supply	30 v DC
Setting for O/C	50% to 200% in steps of 10%
Setting for E/F	10% to 40% in steps of 5 %
HF setting for over current	100 % to 3000 % in steps of 100%
HF setting for earth fault	100 % to 1200 % in steps of 100%
Time multiplier setting for O/C & E/F	0.05 to 1.5 in steps of 0.01
Memory storage for fault information	Storing of latest five faults with date & time stamping, fault amplitude , type of fault with FIFO feature
Mounting	Flush & all connections should be on back side. The relay should be draw out type preferably with automatic shorting of CT circuit at a time of removal of relay from casing.
LED indications	1. Power ON – green colour

	2. Pick up – yellow colour 3. Trip- red colour 4. HF – Red colour
Push buttons	Reset push button for resetting the relay manually. Test push button for trip test of relay with provision of trip bypass push button
Output contacts	2 trip & 2 alarm contacts
Communication port	The relay should have RS 232/ RS 485 communication port compatibility to SCADA with provision for four digital input & four digital output contacts
Contact rating	1. Make & carry Ac 1250VA, 5A, 660V DC 1250W, 5A, 660V 2. Contact breaking AC 1250VA,5A,660V DC 100W resistive , 50 W inductive
Self diagnosis feature	Relay should have self diagnosis for its healthiness of functioning & should show indication in case of its failure
Password protection	The relay should have provision f password protection for the applied settings
Selectivity of primary CT Current	The relay should have facility to select the primary CT current from 50A to 1600A in steps of 50A. The relay should display the CT primary current.
Operational indicator	Flags
IS reference	IEC 60255 , IS 3231 amended up to date

High Speed Master Trip Relay Hand Reset Type Conforming IS 3231:

Aux. Voltage	30 V, DC
Coil rating	30 V DC, Voltage band for satisfactory operation – 50 to 120 % of rated voltage.
Operating time	10 m sec nominal at rated voltage
Burdon of relay coil	Low burden 40 watt at rated voltage
Contact configuration	3 NO + 2 NC combination with additional hand reset coil cut of contact (seal in intact)
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 , 50 Hs for 1 min. 2.5 kV / 1 sec between all terminals & case as per IS 3231 1 kV RMS , 50 Hz for 1 min. Across open contact
Operating temp	10-degree C to 55 dg C
Operation indication	Mechanical red colour flag

Ammeter:

Each circuit one ammeter and associated selector switch shall be provided.

Mounting	Flush
Size	48 x 96 sq. Mm. Case
Response time	1 second
Operating temperature	Up to 55°C
Dielectric strength	2 kV RMS for 1 minute
Frequency	50 Hz
Operating current	5 A from CT Secondary.
Type	Panel Mounting with 31/2 Digital Display

Ammeter Selector Switch:

Ammeter Selector switch shall be a four-position (3 way with off) rotary type with R, Y, B and 'OFF' positions marked clearly on 48x48 mm brushed aluminium plate with black handle. Switch should be single hole mounting and not screw mounting. Switches should have finger touch proof terminals. Terminal wire should be inserted from the side of the switch terminal. Terminal screw must be captive to avoid misplace during maintenance.

Rated insulation voltage	1100 V
Rated Impulse withstand voltage	6 kV
Rated operational current	12 A

Volt Meter:

Mounting	Flush
Size	48 x 96 sq. Mm. Case
Response time	1 second

Operating temperature	Up to 55°C
Dielectric strength	2 kV RMS for 1 minute
Auxiliary supply	110 V
Frequency	50 Hz
Operating voltage	110 V from PT Secondary.
Type	Panel Mounting with 31/2 Digital Display

Volt Meter Selector Switch:

Voltmeter Selector Switch shall be seven position type (6 way & off) with 3 phase to phase and 3 phase to neutral position marked clearly on 48x48 brushed aluminium plate with black handle. Switch should be single hole mounting and not screw mounting. Switches should have finger touch proof terminals. Terminal wire should be inserted from the side of the switch terminal. Terminal screw must be captive to avoid misplace during maintenance.

Rated insulation voltage	1100 V
Rated Impulse withstand voltage	6 kV
Rated operational current	12 A

HT Static Tri-Vector TOD Meter:

3 Phase 4 wire HT Static Tri-vector TOD Meter having kwh element of class 0.5 accuracy with following parameters.

Class of accuracy	0.5
Is	14697/1999 amended up to date
C.t. ratio	I) - /5A for feeder panels ii) - /5A for Incomer Panels
V.t. ratio	11000/110V
Type	Static
Mounting	Flush
Measuring parameters	Kwh, kVArh, kVAh, instantaneous P.F., kW, kV A, supply frequency, phase voltages and phase currents.
Make	Secure/L&T/L&G/Elster or equivalent
Display	Customised backlit liquid crystal display

Space Heater:

Capacity	80 watts
Voltage	240 V AC
Type	Strip type

Thermostat:

Voltage	240 V AC
Range	30-90 deg. C

Contactor for Antidumping Duty:

Contacts	2 n/o + n/c
Coil voltage	30V DC.

L/R Switch:

- 4 way, 2 positions stay put handle
- Contacts 2 contacts to close in each position

Auxiliary Contactor:

Contacts	Arr 2 n/o+2 n/c
Auxiliary voltage	30 V DC

Auto Manual Selector Switch:

- Stay put type, pistol grip handle, 2 contacts to close in each position
- Auxiliary voltage 30 V DC

Micro Switch:

Voltage	240 V AC
Contacts	1 n/c

D.C. Snapper Switch with Blow out Magnet:

Type	EX 110 of Elmex or equivalent
Current	5 amps.

Discrepancy type Control Switch suitable for remote control of Circuit Breaker:

- Bulb voltage 30 V DC

Digital Frequency Meter:

Mounting	Flush in 96 sq.mm. Case
Size	96 mm x 96 mm x 70 mm
Range	45 Hz to 55 Hz
Dielectric strength	2 kV RMS for 1 minute
Power consumption	Less than 6 VA
Type	Electronic 4 Digit Digital frequency meter.
Display	Seven segments red color LED Display with 0.5" height
Is reference	Is1248

Terminal Connector:

Material	Nickel plated Brass
Size of Stud	Minimum 4 mm dia.
Current capacity	
Normal	10 amps
Breaking	4 amps
Insulation	1100 V/3 kV of 1 min

18. Technical Specification for Control & Relay Panel 33kV and 11 kV

18.1. 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 lines, 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 in Uttarakhand. The Control and Relay Panel Boards shall consist of Simplex panel, vertical independent, floor mounted with equipment mounted on front and having wiring access from rear.

18.2. Applicable Standards

The control & Relay Panels and various sub-units/components mounted on the panels shall conform to the latest revisions of the following standards.

Table 18-1: Applicable Standards

IS 12063/1987	Degree of Protection provided for enclosure of electrical equipment
IS 5/2004	Colour for ready mixed paints & enamels.
IS 3231 / 1986 & 1987	Electrical relays for power system protection
IEC 60255 amended up to date	Numerical biased protection relay
IS 8686/1977	Static protective relays
IS 1248/2003	Indicating instruments
IS 14697/1999	HT Static Tri vector TOD Energy meter
IS 6875 amended up to date	Control switches
IS 4794/1968 & 1986	Push buttons
IS 5578/1984	Marking of insulated conductors.

18.3. General Technical Requirements

The supplier should be an OEM of relay, make and break pot and VCB.

18.3.1. Auxiliary Supplies

Auxiliary supplies available at the various sub-stations are as follows-

A.C. Supply	240 volts with ± 10% variation
D.C. supply	30 V DC with +10% to – 15% variation
Frequency	50 Hz with ±3%

18.3.2. Constructional Features

1) It is the responsibility of the Contractor to ensure that the equipment specified and such unspecified complementary equipment required for completeness of the protective/control schemes be properly accommodated in the panels without congestion. However, the width of panels that are being offered to be placed in existing switchyard control rooms, should be in conformity with the space availability in the control room.
2) Panels shall be completely sheet metal clad and shall be dust, moisture and vermin proof. The enclosure shall provide a degree of protection not less than IP-4X in accordance with IS 13947.
3) Panels shall be free standing, floor mounting type and shall comprise structural frames completely enclosed with specially selected smooth finished, cold rolled sheet steel of thickness not less than 3 mm for weight bearing members of the panels such as base frame, front sheet and door frames, and 2.0mm for sides, door, top and bottom portions. There shall be sufficient reinforcement to provide level transportation and installation.
4) All doors, removable covers and panels shall be gasketed all around with neoprene gaskets. Ventilating louvers to be if provided shall have screens and filters. The screens shall be made of either brass or GI wire mesh.
5) Design, materials selection and workmanship shall be such as to result in neat appearance, inside and outside with no welds, rivets or bolt head apparent from outside, with all exterior surfaces tune and smooth.
6) Panels shall have base frame with smooth bearing surface, which shall be fixed on the embedded foundation channels/insert plates. Anti vibration strips made of shock absorbing materials that shall be supplied by the contractor, shall be placed between panel and base frame.
7) Cable entries to the panels shall be from the bottom. Cable gland plate fitted on the bottom of the panel shall be connected to earthing of the panel/station through a flexible braided copper conductor rigidly. The gland shall confirm to IS 12943. Gland plates shall be suitable for fixing the cable glands at an elevated height of at least 100 mm above the ground level.
8) Terminal Connectors and Test terminal blocks for cables shall be fixed at an elevated height of at least 200 mm above the Bottom plate.
9) The panels shall be of overall dimensions 700 x 750 x 2310 (W x D x H) mm. The height 2310 mm is inclusive of the height of base frame. The height of base frame is generally 100 mm , and shall be painted black.
10) The wiring diagram for various schematics shall be made on thick and durable white paper in permanent black ink and same should be encased in plastic cover thermally sealed. It should be kept

visibly in a pocket of size 350 x 400 mm of MS sheet of 1 mm thickness, on the interior surface of rear door marked.

18.3.3. Mounting

All equipment on and in panels shall be mounted and completely wired to the terminal blocks ready for external connections. The equipment on front of panel shall be mounted flush. No equipment shall be mounted on the doors.

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 on the equipment shall be clearly visible.

Contractor shall carry out cut out, mounting and wiring of the items supplied by others, which are to be mounted in his panel in accordance with the corresponding equipment manufacturer's drawings. Cut outs if any, provided for future mounting of equipment shall be properly blanked off with blanking plate.

The centre lines of switches, push buttons and indicating lamps shall be not less than 750mm from the bottom of the panel. The centre lines of relays, meters and recorders shall be not less than 450mm from the bottom of the panel

The centre lines of switches, push buttons and indicating lamps shall be matched to give a neat and uniform appearance. Likewise the top lines of all meters, relays and recorders etc. Shall be matched.

18.3.4. Panel Internal Wiring

Panels shall be supplied complete with interconnecting wiring provided between all electrical devices mounted and wired in the panels and between the devices and terminal blocks for the devices to be connected to equipment outside the panels. When panels are arranged to be located adjacent to each other all inter panel wiring and connections between the panels shall be furnished and the wiring shall be carried out internally

All wiring shall be carried out with 1100V grade, single core, stranded FRLS tinned copper conductor wires with PVC insulation conforming to IS 1554. The minimum size of the multi-stranded copper conductor used for internal wiring shall be as follows:

- All circuits except current transformer circuits and voltage transformer circuits meant for energy metering and AC & DC power circuit- one no 2.5 sq. Mm. Per lead.
- All current transformer circuits two nos. 2.5 sq. Mm. Per lead.
- Voltage transformer circuit (for energy meters) Two 2.5 sq.mm. Per lead.
- AC/DC Power Circuit – One 4 Sq.mm. Per lead

All internal wiring shall be securely supported, neatly arranged, readily accessible and connected to equipment terminals and terminal blocks. Wiring gutters and troughs shall be used for this purpose.

Auxiliary bus wiring for AC and DC supplies, voltage transformer circuits, annunciation circuits and other common services shall be provided near the top of the panels running throughout the entire length of the panels.

Wire termination shall be made with solder less crimping type and tinned copper lugs, which firmly grip the conductor. Insulated sleeves shall be provided at 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 from terminal blocks. All wires directly connected to trip circuit of breaker or device shall be distinguished by the addition of red coloured unlettered ferrule.

Longitudinal troughs extending throughout the full length of the panel shall be preferred for inter panel wiring. Inter-connections to adjacent panel shall be brought out to a separate set of terminal blocks located near the slots of holes meant for taking the inter-connecting wires.

Contractor shall be solely responsible for the completeness and correctness of the internal wiring and for the proper functioning of the connected equipment's

18.3.5. Terminal Blocks

1) All internal wiring to be connected to external equipment shall terminate on terminal blocks. Terminal blocks shall be 1100 V grade and have 10 Amps continuous rating, moulded piece, complete with insulated barriers, stud type brass terminals of minimum 4 mm dia. All washers, nuts, lock nuts used for terminal connectors shall be of tin plated brass. Markings on the terminal blocks shall be on marking strips and shall correspond to wire number and terminal numbers on the wiring diagrams. All terminal blocks shall have shrouding with transparent unbreakable material. All Marking shall confirm to IS 11353.
2) Disconnecting type terminal blocks for voltage transformer secondary leads shall be provided. Current transformer secondary leads shall be provided with automatic short circuiting and earthing facilities. These leads should have testing facilities.
3) At least 20% spare terminals shall be provided on each panel and these spare terminals shall be uniformly distributed on all terminal blocks.
4) Unless otherwise specified, terminal blocks shall be suitable for connecting the following conductors of external cable on each side
   - All CT & PT circuits minimum of two of 2.5mm Sq. Copper.
   - AC/DC Power Supply Circuits One of 4mm Sq. Copper.
   - All other circuits minimum of one of 2.5mm Sq. Copper.
5) There shall be a minimum clearance of 250mm between the first row of terminal blocks and the associated cable gland plate or panel side wall. Also, the clearance between two rows of terminal blocks edges shall be minimum of 150mm.
6) Arrangement of the terminal block assemblies and the wiring channel within the enclosure shall be such that a row of terminal blocks is run in parallel and close proximity along each side of the wiring-duct to provide for convenient attachment of internal panel wiring. The side of the terminal block opposite the wiring duct shall be reserved for the external cable connections. All adjacent terminal blocks shall also share this field wiring corridor. All wiring shall be provided with adequate support inside the panels to hold them firmly and to enable free and flexible termination without causing strain on terminals.

7) All necessary cable terminating accessories such as gland plates, supporting clamps & brackets, wiring troughs and gutters etc. for external cables shall be included in the scope of supply.

18.3.6. Painting

All sheet steel work shall be phosphate in accordance with the IS6005 "Code of Practice for Phosphating Iron and Steel".

Rust, scale, oil, grease, dirt and swarf shall be removed by 7 tank process.

After phosphating, thorough rinsing shall be carried out with clean water followed by final rinsing with dilute dichromate solution and oven drying.

The phosphate coating shall be sealed with application of two coats of ready mixed, stoved type zinc chromate primer. The first coat may be "flash dried" while the second coat shall be stoved.

After application of the primer, two coats of finishing synthetic enamel paint shall be applied, each coat followed by stoving. The second finishing coat shall be applied after inspection of first coat of painting. The exterior colour of paint shall be of a slightly different shade to enable inspection of the painting. The final coat should present a hard glass finish.

A small quantity of finished paint shall be supplied for minor touching up required at site after installation of the panels.

In case the bidder proposes to follow any other established painting procedure like electrostatic painting or powder coating, the procedure shall be submitted for 's review and approval.

18.3.7. Mimic Diagram

Coloured mimic diagram and symbols showing the exact representation of the system shall be provided in the front of control panels.

Mimic diagram shall be made preferably of anodised aluminium or plastic of approved fast colour material, which shall be screwed on to the panel and can be easily cleaned. Painted overlaid mimic is also acceptable. The mimic bus shall be 2 mm thick. The width of the mimic bus shall be 10mm for bus bars and 7 mm for other connections.

Mimic bus colour will be decided by the UPCL and shall be furnished to the successful Bidder during Engineering.

When semaphore indicators are used for equipment position they shall be so mounted in the mimic that the equipment close position shall complete the continuity of mimic.

Indicating lamp, one for each phase, for each bus shall be provided on the mimic to indicate bus charged condition.

18.3.8. Name Plates and Markings

All equipment mounted on front and rear side as well as equipment mounted inside the panels shall be provided with individual name plates with equipment designation engraved. Also on the top of each panel on front as well as rear side, large and bold name plates shall be provided for circuit/feeder designation.

All front mounted equipment shall also be provided at the rear with individual name plates engraved with tag numbers corresponding to the one shown in the panel internal wiring to facilitate easy tracing of the wiring.

Each instrument and meter shall be prominently marked with the quantity measured e.g. kV A, MW, etc. All relays and other devices shall be clearly marked with manufacturer's name, manufacturer's type, serial number and electrical rating data.

Name Plates shall be made of non-rusting metal or 3 ply lamicoid.

Nameplates shall be black with white engraving lettering.

All the panels shall be provided with nameplate mounted inside the panel bearing LOA No & Date, Name of the Substation & feeder and reference drawing number.

18.3.9. Miscellaneous Accessories

Plug Point

A 240V, Single phase 50Hz, 15Amp AC socket with 15 Amps standard Indian plug, shall be provided in the interior of each cubicle with ON-OFF switch.

Interior Lighting

Each panel shall be provided with a 20 W fluorescent lighting fixture rated for 240 Volts, single phase, 50 Hz supply for the interior illumination of the panel controlled by the respective panel door switch.

Switches and Fuses

Each panel shall be provided with necessary arrangements for receiving, distributing, protecting and isolating DC and AC supplies for various control, signalling, lighting and space heater circuits. The incoming and sub-circuits shall be separately provided with miniature circuit breakers (MCB). Selection of the main and sub-circuit MCB rating shall be such as to ensure selective clearance of sub-circuit faults. MCBs shall confirm to IS 13947. Each MCB shall be provided with one potential free contact and the same shall be wired for annunciation purpose. However voltage transformer circuits for relaying and metering shall be protected by fuses. All fuses shall be HRC cartridge type conforming to IS 13703 mounted on moulded structure plug-in type fuse carriers fitted to bases as per IS 1300 bases. Fuse carrier base as well as MCBs shall have imprints of the fuse 'rating' and 'voltage'.

Space Heater

Each panel shall be provided with a space heater rated for 240V, 80 watt, single phase, 50 Hz AC supply for the internal heating of the panel to prevent condensation of moisture. The heater shall be complete with thermostat controlled and a switch unit.

Test Terminal Block

Test terminal blocks to be provided in metering circuit shall be suitable for 3 phase 4 wire type connections.

18.3.10. Earthing

All panels shall be equipped with an earth bus securely fixed. The material and the sizes of the bus bar shall be at least 25 X 6 sq.mm perforated copper strip with threaded holes at a gap of 50mm with a provision of bolts and nuts for connection with cable armours and mounted equipment etc. for effective earthing suitable connectors for this purpose shall be provided. When several panels are mounted adjoining each other, the earth bus shall be made continuous and necessary connectors and clamps for this purpose shall be included in the scope of supply of Contractor. Provision shall be made for extending the earth bus bars to future adjoining panels on either side.

All metallic cases of relays, instruments and other panel mounted equipment including gland plate, shall be connected to the earth bus by copper wires of size not less than 2.5 sq. Mm. The colour code of earthing wires shall be green.

Looping of earth connections which would result in loss of earth connection to other devices when the loop is broken, shall not be permitted. However, looping of earth connections between equipment to provide alternative paths to earth bus shall be provided.

VT and CT secondary neutral or common lead shall be earthed at one place only at the terminal blocks where they enter the panel. Such earthing shall be made through links so that earthing may be removed from one group without disturbing continuity of earthing system for other groups.

The earth bar shall be terminated into two earthling terminals of adequate size with nuts and washer for connecting to the station earthing system.

18.3.11. Indicating Instruments

All instruments and meters shall be enclosed in dust proof, moisture resistant, black finished cases and shall be suitable for tropical use. Frequency meters shall be provided with individual transducers and these shall be calibrated along with transducers to read directly the primary quantities. They shall be accurately adjusted and calibrated at works and shall have means of calibration check and adjustment at site.

Unless otherwise specified, all electrical indicating instruments shall have circular 240 degree scale and with a dial of 96mm x 96mm. They shall be suitable for flush mounting.

Instruments dial shall be with white circular scale and black pointer and with black numerals and lettering. The dial shall be free from warping, fading, and decolouring. The dial shall also be free from parallax error.

Instruments shall conform to IS1248 and shall have accuracy class of 1.0 or better. The design of the scales shall be such as to have resolution suitable for the application. All indicating instruments shall be of digital type.

Digital frequency meters shall be of class 0.5 and shall have digital display of 5 and 4 digits respectively, with display size, not less than 25mm (height).

18.3.12. Transducers

Transducers (for use with Indicating Instruments) shall in general conform to IEC 688-1

The energy meter capability shall be used for measurement of active power, reactive power, voltage, current and frequency in three phase four wire unbalanced system.

One 33 kV C&R panel shall be installed for each incomer of 33 kV (Line incomer and 33 kV side of transformer). Each panel shall consist of energy meter, protection schemes, indication and control etc. One 11kV C&R panel shall be provided for each 11kV outdoor type VCB for incomer and feeder.

Voltage signal (440 Volt ac L-L) for voltmeter, PF meter, frequency meter, kW meter etc to be provided in the C&R panel and shall be tapped from the respective pts through a separate / independent copper cable.

18.3.13. Energy Meter

Contractor shall provide Static TVM energy meter as per the technical specification covered in the chapter of technical specification of TVM energy meter

18.3.14. Annunciation System

1) Alarm annunciation system shall be provided in the control board by means of visual and audible alarm. The microprocessor-based annunciation equipment shall be suitable for operation on the voltages specified in this specification.
2) The visual annunciation shall be provided by annunciation fascia windows mounted flush on the top of the control panels.
3) The annunciator fascia shall be provided with translucent plastic window for alarm point with approximate size of 35mm x 50mm. The fascia plates shall be engraved in black lettering with respective inscriptions. Alarm inscriptions shall be engraved on each window in not more than three lines and size of the lettering shall not be less than 5 mm.
4) Each annunciation window shall be provided with two bright LED lamps in parallel to provide safety against lamp failure. Long life lamps shall be used. The transparency of cover plates and wattage of the lamps provided in the fascia windows shall be adequate to ensure clear visibility of the inscriptions in the control room having high illumination intensity (350 Lux), from the location of the operator's desk.
5) All Trip fascia shall have red colour and all Non-trip fascia shall have white colour. Each annunciator shall be provided with 'Accept', 'Reset' and 'Test' push buttons, coloured red, yellow and blue respectively.
6) The annunciation system shall work in co-ordination with the existing annunciation system (hooter or bell) in the substation for R&M scheme. If the same is not provided, hooter shall be supplied for above purpose.

18.3.15. Sequence of operation of the annunciator

Table 18-2: Sequence of Operation of the annunciator

S.No.	Alarm condition	Fault contact	Visual annunciation	Audible Annunciation (by hooter)
1	Normal	Open	Off	Off
2	Abnormal	Close	Flashing	On
3	Accept push button pressed	Close	Steady on	Off
		Open	Steady on	Off
4	Reset push button is pressed	Close	On	Off
		Open	Off	Off
5	Lamp test Push button pressed	Open	Steady on	Off
6	Alarm test	Open	Flashing	On

Audible annunciation for the failure of DC supply to the annunciation system shall be provided and this annunciation shall operate on 240 Volts AC supply. On failure of the DC to the annunciation system for more than 2 or 3 seconds. (adjustable setting), a bell shall sound. A separate push button shall be provided for the cancellation of this audible alarm alone but the fascia window shall remain steadily lighted till the DC supply to annunciation system is restored.

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). Self-resetting buzzer should sound for fixed time of 60 seconds interval and stop automatically.

A separate voltage check relay shall be provided to monitor the failure of supply (240V AC). If the failure of supply exists for more than 2 to 3 seconds, this relay shall initiate visual and audible annunciation. This annunciation shall operate on DC and buzzer shall sound.

The total number of windows shall be 16 and the matter for engraving shall be indicated to the contractor in due course.

18.3.16. Switches

Control and instrument switches shall be rotary operated type with escutcheon plates clearly marked to show operating position and circuit designation plates and suitable for flush mounting with only switch front plate and operating handle projecting out.

The selection of operating handles for the different types of switches shall be as follows:

- Breaker :Pistol grip, black control switches
- Selector switches :Oval or knob, black
- Instrument switches :Round, knurled, black

The control switch of breaker shall be of spring return to neutral type. The switch shall have spring return from close and trip positions to "after close" and "after trip" positions respectively. It shall be necessary to press the switch before turning to close or command position.

Instrument selection switches shall be of maintained contact (stay put) type.

The contacts of all switches shall preferably open and close with snap action to minimise arcing. Contacts of switches shall be spring assisted and contact faces shall be with rivets of pure silver or silver alloy. Springs shall not be used as current carrying parts

The contact rating of the switches shall be as follows:

- Description :Contact rating in Amps
- Continuous :30/110 V DC or 240 volts AC
- Supply :10 Amp
- Make and carry :30/110 V DC or 240 volts AC
- Supply :30 Amp
- Break for Resistive load :30/110 V DC or 240 volts AC
- Supply 20 Amp

18.3.17. Indicating Lamps

1) Indicating lamps shall be of multiple LED, panel mounting type with rear terminal connections. LED shall be provided with series connected resistors preferably built-in in the LED assembly. Conventional bulbs are not acceptable. Lamps shall have translucent lamp covers to diffuse lights coloured red, green, amber, clear white or blue as specified. The lamp cover shall be preferably of screwed type, unbreakable and moulded from heat resisting material.
2) Lamps and its parts shall be interchangeable and easily replaceable from the front of the panel.
3) The indicating lamps shall withstand 120% of rated voltage on a continuous basis.

18.3.18. Semaphore Indicators

1) Position indicators of "SEMAPHORE" type shall be provided as part of the mimic diagrams on panels for indicating the position of circuit breakers, isolating/earthing switches etc. The indicator shall be suitable for semi-flush mounting with only the front disc projecting out and with terminal connection from the rear. Their strips shall be of the same colour as the associated mimic.
2) Position indicator shall be suitable for DC Voltage as specified. When the supervised object is in the closed position, the pointer of the indicator shall take up a position in line with the mimic bus-bars, and at right angles to them when the object is in the open position. When the supply failure to the indicator occurs, the pointer shall take up an intermediate position to indicate the supply failure.
3) The rating of the indicator shall not exceed 2.5 W.
4) The position indicators shall withstand 120 percent of rated voltage on a continuous basis.

18.3.19. Relays

1) All relays shall conform to the requirements of IS 3231 or IEC-60255 or other applicable standards. Relay shall be suitable for flush or semi-flush mounting on the front with connections from the rear. All protection and control relays shall be Digital / Numerical type. Relays shall have a reset push button and a test push button to test the relay function with provision to trip bypass push button. Relays to be suitable for auxiliary supply of 30 V DC.
2) All protective relays shall be in draw out type in modular cases with proper testing facilities in the form of blocks. Necessary test plugs shall be supplied loose and shall be included in Contractor's scope of supply.
3) All DC operated relays and timers shall be designed for the DC voltage specified, and shall operate satisfactorily between 80 percent and 110 percent of rated voltage. All relays shall have adequate thermal capacity for continuous operation.
4) The protective relays shall be suitable for efficient and reliable operation of the protection scheme described in the specification. Necessary auxiliary relays, timers, lockout relay etc. Required for the complete protection schemes described in the specification shall be provided. All protective relays shall be provided with at least two pairs of potential free isolated output contacts. Auxiliary relays and timers shall have pairs of contacts as required to complete the scheme. Contacts shall be silver faced with spring action. Relay case shall have adequate number of terminals for making potential free external connections.
5) All protective relays, auxiliary relays and timers shall be provided with hand reset type contacts. They shall also be provided with hand reset type external operation indicators with suitable inscription to be informed in due course of time.
6) No control relay which shall trip the power circuit breaker when the relay is de-energised shall be employed in the circuits.
7) Provision shall be made for easy isolation of trip circuits of each relay for the purpose of testing and maintenance.
8) All protective relays and alarm relays shall be provided with one extra isolated pair of contacts wired to terminals.
9) The setting ranges of the relays offered, if different from the ones specified shall also be acceptable if they meet the functional requirements.
10) Any alternative or additional protections or relays considered necessary for providing complete effective and reliable protection should also be offered separately. The acceptance of this alternative/ additional equipment shall lie with the UPCL.
11) All relays shall have capability to withstand test voltage of 2 kV rms for one minute.
12) All relays and their drawings shall have phase indications as R-Red, Y- yellow, and B-blue
13) In case the protective relays offered are not manufactured by the tenderer, an undertaking from the respective relay manufacturer indicating his readiness to extend necessary
14) Technical support and back-up guarantee for the satisfactory operation of the relay shall be furnished by the tenderer in his offer. The tenderer shall also furnish an undertaking (from the relay manufacturers) confirming that the relay offered is in the current range of manufacture and will not be phased out for at least 10 years from the date of supply.

18.3.20. Protections

Transformer Protection Panel

- Two over current (IDMT characteristic with a definite minimum time of 3.0 seconds at 10 times setting and have a variable setting range of 50-200% of rated current in steps of 10%) and one earth fault relay (having current setting variable from 5% to 8% in steps of 5 %). Contractor may offer a composite unit also having these features as separate elements.
- One auxiliary relay which shall receive inputs from all transformer protections and send command to trip coil of the circuit breaker through master trip relay.
- One high speed master trip relay

18.3.21. 33 kV Line Panels

- Two over current (IDMT characteristic with a definite minimum time of 3.0 seconds at 10 times setting and have a variable setting range of 50-200% of rated current in steps of 10%) and one earth fault relay (having current setting variable from 5% to 8% in steps of 5 %). The 33 kV lines are envisaged to operate in a synchronous ring having feed at multiple points.
- There shall be high speed master trip hand reset lock out relay which shall receive inputs from above relay and send command to trip coil of the circuit breaker directly.

18.3.22. 11 kV Panels Incoming and Outgoing

- Two over current(IDMT characteristic with a definite minimum time of 3.0 seconds at 10 times setting and have a variable setting range of 50-200% of rated current in steps of 10%) and one earth fault relay (having current setting variable from 5% to 8% in steps of 5 %).
- There shall be high speed master trip hand reset lock out relay which shall receive inputs from above relay and send command to trip coil of the circuit breaker directly.

18.3.23. Trip Circuit 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.

18.3.24. Supervision Relay

Following supervision relay shall be provided having adequate contacts for providing alarm.

- Trip circuit supervision
- DC supply supervision
- AC supply supervision

18.3.25. Principal Parameters

Principal parameters of protective relays, metering equipments, auxiliary relays breaker control switches etc. are as follows:

Ammeter:

Each circuit one ammeter and associated selector switch shall be provided.

Mounting	Flush
Size	48 x 96 sq. Mm. Case
Response time	1 second
Operating temperature	Up to 55°C
Dielectric strength	2 kV RMS for 1 minute
Frequency	50 Hz
Operating current	1 A from CT Secondary.
Type	Panel Mounting with 31/2 Digital Display

Ammeter Selector Switch:

Rated insulation voltage	1100 V
Rated Impulse withstand voltage	6 kV
Rated operational current	12 A

Volt Meter:

Mounting	Flush
Size	48 x 96 sq. Mm. Case
Response time	1 second
Operating temperature	Up to 55°C
Dielectric strength	2 kV RMS for 1 minute
Frequency	50 Hz
Operating current	1 A from CT Secondary.
Type	Panel Mounting with 31/2 Digital Display

Volt Meter Selector Switch:

Rated insulation voltage	1100 V

Rated Impulse withstand voltage	6 kV
Rated operational current	12 A

Frequency Meter:

Mounting	Flush in 96 sq.mm. Case
Size	96 mm x 96 mm x 70 mm
Range	45 Hz to 55 Hz
Dielectric strength	2 kV RMS for 1 minute
Power consumption	Less than 6 VA
Type	Electronic 4 Digit Digital frequency meter.
Display	Seven segments red colour LED Display with 0.5" height
Is reference	IS1248

Heater:

Capacity	80 watts
Voltage	240 V AC
Type	Strip type

Semaphore Indicator:

Type	3 Position type or Equivalent
Mounting	Flush
Coil rating	30 V DC
Burden	Less than 2 VA
Terminals	3 nos, central terminal is common for negative, positive is connected to 1 or/and 2.

Numerical Non Directional 2 O/C + 1 E/F with High Set Relay for Lines:

Elements	2 O/C + 1 E/F + High set for both O/C & E/F separately
CT Secondary input Current to relay	1A / 5 Amp selectable.

Operating characteristics Selectable	1. Idmt - 3 sec. 2. IDMT- 1.3 sec. 3. Very inverse 4. Extremely inverse 5. Definite time
Auxiliary supply	30 V DC
Setting for O/C	50% to 200% in steps of 10%
Setting for E/F	10% to 40% in steps of 5 %
HF setting for over current	100 % to 3000 % in steps of 100%
HF setting for earth fault	100 % to 1200 % in steps of 100%
Time multiplier setting for O/c & e/f	0.05 to 1.5 in steps of 0.01
Memory storage for fault Information	Storing of latest five faults with date & time stamping, fault Amplitude , type of fault with FIFO feature
Mounting	Flush & all connections should be on back side. The relay should Be draw out type preferably with automatic shorting of CT circuit at a time of removal of relay from casing.
LED indications	1. Power ON – green colour 2. Pick up – yellow colour 3. Trip- red colour 4. HF – Red colour
Push buttons	Reset push button for resetting the relay manually. Test push button for trip test of relay with provision of trip bypass push button
Output contacts	2 trip & 2 alarm contacts
Communication port	The relay should have RS 232 communication port compatibility to SCADA with provision for four digital input & four digital output contacts
Contact rating	1. Make & carry AC 1250VA, 5A, 660V DC 1250W, 5A, 660V. 2. Contact breaking AC 1250VA,5A,660V DC 100W resistive , 50 W inductive

Self-diagnosis feature	Relay should have self-diagnosis for its healthiness of functioning & should show indication in case of its failure
Password protection	The relay should have provision f password protection for the applied settings
Selectivity of primary CT Current	The relay should have facility to select the primary CT current from 50A to 1600A in steps of 50A. The relay should display the CT primary current.
Operational indicator	Flags
IS reference	IEC 60255 , IS 3231 amended up to date

Three elements Auxiliary Relay hand reset type conforming IS 3231 for Transformer:

Aux. Voltage	30 V D.C
Coil rating	30V D.C., voltage band for satisfactory operation 50 to 120% of Rated voltage
Operating time	25 m. Seconds nominal at rated voltage
Burden of relay coil Watts (Max)	40 Watt at rated voltage for each coil
Operating temp	-10 deg C to 55 deg C .
Operational indication For each element	Mechanical red colour Flag Hand Reset Type
Contact configuration	2 NO + 2 NC for each element
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

High Speed Tripping Relay Hand Resetting Type Confirming To IS – 3231:

Aux. Voltage	30 V D.C.
Coil rating	30V D.C., voltage band for satisfactory operation 50 to 120% of Rated voltage
Operating time	10 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 Hand Reset Type
Contact configuration	3 NO + 2 NC combination with additional hand 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

Numerical based differential protection relay with inbuilt current amplitude & vector group compensation feature & also with differential high set element for two winding power transformer to IEC 60255

Aux. Voltage	24 to 110 V D.C.
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 / drawout type	

Communication port for compatibility to SCADA

HT Static Tri-Vector TOD Energy Meter

Class of accuracy	0.5
Is	14697 / 1999 up to date
C.T. ratio	I) 100/1A for feeder panels ii)100/1A for Transformer Panels
V.T. ratio	33000/110V
Type	Static
Mounting	Flush
Measuring Parameters	Kwh, kVArh, kVAh, instantaneous P.F., kw, kV A, supply frequency, phase voltages and phase currents.
Make	Secure Meters/L&T/L&G/Elster or Equivalent.
Display	Customized backlit liquid crystal display

18.4. Documentation

After issue of letter of Award, the successful tenderer's shall submit 3 sets of complete drawings along with detailed bill of materials for approval to the owner. If any modifications are required on these, the same will be conveyed to the supplier who shall modify the drawings accordingly and furnish final drawings for approval. In normal practice, the documents submitted for approval will be commented upon or approved if in order, within 30 days from the date of receipt of the same in the designated office of the owner. The period of commencement of delivery shall include submission and approval of drawings/BOM. The manufacturing of the equipments shall be strictly in accordance with the approved drawings and no deviation will be permitted without the written approval of the owner. All manufacturing and fabrication work in connection with the equipments prior to the approval of the drawings shall be at the supplier's risk.

After approval of the drawings and bills of materials, the suppliers shall submit detailed packing lists for approval.

In case the supplier fails to furnish the required drawings and manuals even at the time of supply of equipment, the date of furnishing of drawings/manuals will be considered as the date of supply of equipment for the purpose of computing penalties for late delivery.

18.4.1. List of Drawings to be submitted along with the offer

- GA drawing for C & R panel.
- Schematic drawing.
- Typical single line diagram.
- Bill of material for complete C & R panel.

- Terminal block details

Executive Engineer (Stores), UPCL will be the final authority for approving the drawings submitted by the tenderer

The drawings, technical literature and manuals submitted by the tenderer along with his offer shall be treated as purely and generally informative in nature and unless the details incorporated in them are clearly and specifically brought out in the various Schedules for Guaranteed Technical Particulars and Schedules of Deviations, the same shall not be binding upon the purchaser (a) for evaluation of the offer and (b) for the order, if placed.

18.5. Packing and Forwarding

Duly wired-up C & R panel with all relays and equipments mounted, shall be packed in crates suitable for vertical/horizontal transport as the case may be and the packing shall be suitable to withstand handling during the transport and outdoor storage during transit. The supplier shall be responsible for any damage to the equipment during transit due to improper and inadequate packing. The easily damageable materials shall be carefully packed and marked with the appropriate caution symbols. Wherever necessary, proper arrangement for lifting, such as lifting hooks etc. Shall be provided. Any material found short inside the packing cases shall be supplied by the supplier within 7 days without any extra cost.

18.5.1. Configuration of C&R Panels (33kV & 11kV)

Each panel shall consist of the following:

Table 18-3: Configuration of C&R Panels

S.No.	Description of Relays	Quantity		
		Transformer Panel	Bus Coupler	Feeder panel
1	Ammeter with selector switch	1	-	1
2	Wattmeter	1	-	1
3	Pistol grip CB control switch	1	1	1
4	Red indicating lamp for indicating close position of CB	1	1	1
5	Red indicating lamp for indicating close position of Isolator	1 no for each Isolator	1 no for each Isolator	1 no for each Isolator
6	Red indicating lamp for indicating close position of Earth switch	1 no for each Earth switch	1 no for each Earth switch	1 no for each Earth switch

S.No.	Description of Relays	Quantity		
		Transformer Panel	Bus Coupler	Feeder panel
7	Green indicating lamp for indicating open position of CB	1	1	1
8	Green indicating lamp for indicating open position of Isolator	1 no for each Isolator	1 no for each Isolator	1 no for each Isolator
9	Green indicating lamp for indicating open position of Earth switch	1 no for each Earth switch	1 no for each Earth switch	1 no for each Earth switch
10	Yellow indicating lamp for auto trip	1	1	1
11	Blue indicating lamp for spring charging	1	1	1
12	Annunciation windows with associated annunciation relay	1	1	1
13	Push buttons for Alarm accept/Reset/Lamp Test	1	1	1
14	Mimic to represent SLD with Semaphore Indication	1 lot	1 lot	1 lot
15	Voltmeter with selector switch	1	-	-
16	Cut out mounting and wiring for WTI and Selector switch	1 lot	-	-
17	Energy meter TVM	-	-	1
18	Trip Circuit supervision relays	1	1	1
19	DC supply supervision relay	1	1	1
20	AC supply supervision relay	1	1	1
21	Flag relays, aux relays, timers trip relays etc as per scheme requirement	1 set	1 set	1 set
22	Bus frequency meter(Digital)	1	-	-
23	Bus Healthy indication lamps	3	-	-
24	Auxiliary relay for Buchholz	1	-	-
25	2 O/C 1 E/F relay	1	-	1
26	Static, instantaneous 3 phase PT Fuse Failure Relays. Rated Voltage-110VAC	1	-	-

S.No.	Description of Relays	Quantity		
		Transformer Panel	Bus Coupler	Feeder panel
27	Master Trip Relays suitable for operation at 110 VDC with sufficient number and configuration of contacts.	1	1	1
28	Auxiliary Relays for Anti-pumping, Density switch, Contact multiplier etc. As may be required.	1 lot	1 lot	1 lot
29	Power Factor meter (Digital)	1	-	-

Note:

- For transformer feeders, all equipments of control panel shall be provided separately for HV and LV sides.
- The above list of equipments mentioned for control panel is generally applicable unless it is defined elsewhere and in case of bay extension in existing substations, necessary equipments for matching the existing control panel shall be supplied

18.6. Test

18.6.1. Type Test

The bidder has to furnish the type test report, including functional tests for all protective relays from CPRI/NABL accredited, Govt. Recognized Test House carried out within five years.

The following type tests shall be conducted on the Protective relays.

1) Insulation tests as per IEC 60255-5
2) High frequency disturbance test as per IEC 60255-4 (Appendix -E) -Class III (not applicable for electromechanical relays)
3) Fast transient test as per IEC 1000-4, Level III (not applicable for electromechanical relays)
4) Relay characteristics , performance and accuracy test as per IEC 60255
   - Steady state Characteristics and operating time
   - Dynamic
5) Tests for thermal and mechanical requirements as per IEC 60255-
6) Tests for rated burden as per IEC 60255-6
7) Contact performance test as per IEC 60255-0-20
8) Steady state & Dynamic characteristics tests on the relays (current differential protection relays), as type test, shall be carried out based on general guide lines specified in CIGRE Committee 34 report on simulator/network analyzer/PTL.

18.6.2. Acceptance & Routine Test

The following shall constitute acceptance & routine tests:

- Checking of wiring of Circuits and the continuity.
- One minute applied voltage test. All equipment on Panel and small Wiring shall be tested for a withstand voltage of 2000 Volts to earth & between different Voltage Circuits.

Insulation resistance of the complete wiring, circuit by circuit with all equipment mounted on the Board before and after H.V. test mentioned under 2 above.