Annexure ‘B’

**TECHNICAL SPECIFICATION OF  
100 KVA, 250 KVA & 500 KVA 11/0.433 KV, BIS ENERGY LEVEL-II RATING DISTRIBUTION TRANSFORMER**

**1.0 SCOPE**

**1.1** The specification covers the design, engineering, manufacture, stage inspection, testing, pre-delivery inspection, supply, delivery, loading, unloading and performance requirements of nominal system voltages 11/0.433 KV non-sealed type copper wound Distribution Transformers of **500 KVA rating** for outdoor use in the networks of JBVNL. The transformers shall be double wound, three phases, CRGO Electrical Steel,oil immersed with ONAN cooling with Oil filled up to maximum permissible level.

**1.2** The equipment offered should have been successfully type tested within three years from date of opening of the tender and the designs should have been in **satisfactory operation for a period not less than one year as on the date of bid opening**. Compliance shall be demonstrated by submitting with the bid. **Type test certificate for BIS Energy Level-II distribution transformer offered is mandatory for participation.**

(i) **Authenticated copies of the type test reports**

**1.3** Type test certificate for BIS Energy Level-II distribution transformer offered is mandatory for participation**.**

**1.4** The 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 owner shall have the power to reject any work or material, which, in his judgment, is not in full accordance therewith.

1. **CODES & STANDARDS**

**2.1** Except where modified by this specification, the Transformers shall be designed, manufactured and tested in accordance with the **latest editions of the following standards**. The Bidder may propose alternative standards, provided it is demonstrated that they give a degree of quality and performance equivalent to or better than the referenced standards. Whether to accept or reject any alternative standard shall be adjudged by the owner. The Bidder shall furnish a copy of the alternative standard proposed along with the bid. If the alternative standard is in a language other than English, an English translation shall be submitted with the standard. In the case of conflict the order of precedence shall be 1) Indian Standards IS 1180 (Part-I), 2014. Latest revision. 2) IEC or ISO Standards, 3) other alternative standards.

**LIST OF REFERRED INDIAN STANDARDS**

|  |  |  |
| --- | --- | --- |
| **Sl. No.** | **IS No.** | **Title** |
| 1 | 191 : 2007 | Copper |
| 2 | 335 : 1993 | New Insulating Oils |
| 3 | 554 : 1999 | Pipe threads where pressure- tight joints are made on the threads-Dimensions, tolerances and designation |
| 4 | 1576 : 1992 | Solid pressboard for electrical purpose |
| 5 | 1608 : 2005 | Mechanical testing of metals-Tensile testing |
| 6 | 1747 : 1972 | Nitrogen |
| 7 | 1885 (Part-38) : 1993 | Electro technical vocabulary : Part 38 Power transformers and rectors |
| 8 | 1897 : 2008 | Copper strip for electrical purpose |
| 9 | 2026 | Power Transformers : |
| 10 | (Part-1) : 2011 | General |
| 11 | (Part-2) : 2010 | Temperature rise |
| 12 | (Part -3) : 2009 | Insulation levels, dielectric tests and external clearances in air |
| 13 | (Part-5) : 2011 | Ability to withstand short circuit |
| 14 | (Part-8) : 2009 | Application guide |
| 15 | (Part-10) : 2009 | Determination of sound levels |
| 16 | 2099 : 1986 | Bushings for alternative voltages above 1000 volts |
| 17 | 3024 : 2006 | Grain oriented electrical steel sheets and strips |
| 18 | 3347 | Dimensions for porcelain transformer bushings for use in lightly polluted atmospheres |
| 19 | (Part-1 / Sec-1) : 1979 | Up to and including 1 KV, Section 1 Porcelain parts |
| 20 | (Part-1 / Sec-2) : 1979 | Up to and including 1 KV, Section 2 Metal parts |
| 21 | (Part-2 / Sec-1) : 1979 | 3.6 KV Bushings, Section 1 Porcelain parts |
| 22 | (Part-2 / Sec-2) : 1979 | 3.6 KV Bushings, Section 2 Metal parts |
| 23 | (Part-3 / Sec-1) : 1988 | 17.5 KV Bushings, Section 1 Porcelain parts |
| 24 | (Part-3 / Sec-2) : 1988 | 17.5 KV Bushings, Section 2 Metal parts |
| 25 | (Part-4 / Sec-1) : 1988 | 24 KV Bushings, Section 1 Porcelain parts |
| 26 | (Part-4 / Sec-2) : 1982 | 24 KV Bushings, Section 2 Metal parts |
| 27 | (Part-5 / Sec-1) : 1979 | 36 KV Bushings, Section 1 Porcelain parts |
| 28 | (Part-5 / Sec-2) : 1979 | 36 KV Bushings, Section 2 Metal parts |
| 29 | 3639 : 1966 | Fittings and accessories for power transformers |
| 30 | 4253 (Part-2) 2008 | Cork composition sheet : Part 2 Cork and rubber |
| 31 | 6162 | Paper-covered aluminium conductors : |
| 32 | (Part-1) : 1971 | Round conductors |
| 33 | (Part-2) : 1971 | Rectangular conductors |
| 34 | 7404 (part-1) : 1991 | Paper covered copper conductors : Part 1 Round conductors |
| 35 | 7421 : 1988 | Porcelain bushings for alternating voltages up to and including 1000 V |
| 36 | 8999 : 2003 | Pipe threads where pressure tight joints are made on the threads- Verification by means of limit gauges |
| 37 | 9335 (Part-1) : 1979 | Cellulosic papers for electrical purpose : Definitions and general requirements |
| 38 | (Part-2) : 1998 | Methods of test |
| 39 | (Part -3 / Sec-1) : 1984 | Specifications for individual materials, Section 1 General purposes electrical paper |
| 40 | (Part -3 / Sec-3) : 1984 | Specifications for individual materials, Section 3 Crepe paper |
| 41 | (Part -3 / Sec-5) : 1985 | Specifications for individual materials, Section 5 Special papers |
| 42 | 11149 : 1984 | Specification for rubber gaskets |
|  | 12444 : 1988 | Continuously cast and rolled electrolytic copper wire rods for electrical conductors |
| 43 | 13730 | Specification of particular types of winding wires |
| 44 | (Part-0 /Sec-3) : 2012 | General requirements, Section 3 Enamelled round copper wire |
| 45 | (Part-17) : 1996 | Polywiny1 actual enamelled rectangular copper wire, Class 105 |
| 46 | (Part-27) : 1996 | Paper covered rectangular copper wire |
| 47 | 16081 : 2013 | Insulating liquids – Specification for unused synthetic organic esters for electrical purposes |

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 complying with other relevant standards or recommendations.

**3.0** The service conditions shall be as follows:

**Provisions of IS 2026 (Part-I) shall apply.**

|  |  |  |
| --- | --- | --- |
|  |  | SERVICE CONDITIONS |
| [a] | Maximum altitude above sea level | 1000 m |
| [b] | Maximum ambient temperature | 50 0C |
| [c] | Maximum daily average ambient air temperature | 40 0C |
| [d] | Minimum ambient air temperature | -5° C |
| [e] | Maximum temperature attainable by an object exposed to the sun | 60 ° C |
| [f] | Maximum yearly weighted average ambient temperature | 32° C |
| [g] | Maximum relative humidity | 100% |
| [h] | Average no. of rainy days in a year. | 120 days |
| [i] | Average annual rainfall | 150 cm |
| [j] | Maximum wind pressure | 260 Kg/Sq.m |
| [k] | Average number of thunderstorm days per annum (isokeraunic level) | 70 |

Environmentally, the region where the equipment will be installed includes coastal areas, subject to high relative humidity, which can give rise to condensation. Onshore winds will frequently be salt laden. On occasions, the combination of salt and condensation may create pollution conditions for outdoor insulators.

Therefore, outdoor material and equipment shall be designed and protected for use in exposed, heavily polluted, salty, corrosive, tropical and humid coastal atmosphere.

1. **SYSTEM CONDITIONS:**

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

|  |  |  |
| --- | --- | --- |
| Frequency |  | 50 Hz ± 5% |
| Nominal system voltages | 11 KV System | 11 KV |
|  | LV System | 433/250 V |
| Maximum system voltages | 11 KV System | 12 KV |
|  | LV System | 476 V |
| Minimum LV voltage | (NEC) | 392V |
| Nominal short circuit apparent power of the system | 11kV System | 500MVA (IS:2026) |
| Insulation levels: |  |  |
| 1.2/50µ sec impulse withstand | 11kV System | 75 KV |
| Power frequency one minute withstand (wet and dry) | 11kV System | 28KV  (rms) |
|  | LV System | 3 KV (rms) |
| Neutral earthing arrangements: | LV System | Solidly earthed |

1. **TECHNICAL SPECIFIC TECHNICAL REQUIREMENTS**

|  |  |
| --- | --- |
| Rated KVA (ONAN rating) | 500 KVA, 11/0.43 KV |
| No. of phases | 3 |
| Type of installation | Outdoor |
| Frequency | 50 Hz (± 5% ) |
| Cooling medium | Insulating Oil (ONAN) |
| Type of mounting | On Channels. |
| Rated voltage |  |
| a) High voltage winding | 11 KV |
| b) Low voltage winding | 0.433 KV |
| Highest continuous system voltage |  |
| a)Maximum system voltage ratio (HV / LV) | 12 KV / 0.476 KV |
| b) Rated voltage ratio (HV / LV) | 11 KV / 0.433 KV |
| No. of windings | Two winding Transformers |
| Type of cooling | ONAN ( Oil natural / Air natural |
| KVA Rating corresponding to ONAN cooling system | 100% |
| **Method of connection:** |  |
| HV: | Delta |
| LV: | Star |
| Connection symbol | Dyn 11 |
| System earthing | Neutral of LV side to be solidly |
| Percentage impedance voltage on normal tap and KVA base at 750 C corresponding to HV/ LV rating and applicable tolerance. | 4.5 %  (No negative tolerance will be allowed) |
| 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 |
| Type of tap changer | NA |
| Range of taping | No Tap up to 100 KVA. |
| Neutral terminal to be brought out | On LV side only |
| Over Voltage operating capability and duration | 112.5 % of rated voltage  ( continuous ) |
| Maximum Flux Density in any part of the core and yoke at rated voltage and frequency shall be such that the flux density with +12.5% combined voltage and frequency variation from rated voltage and frequency shall not exceed | 1.9 Tesla |
| **Insulation levels for windings** |  |
| 1. 1.2 / 50 microsecond wave shape Impulse withstand (KVP) 2. Power frequency voltage withstand (KV­rms) | HV: 75 LV: N.A.  HV: 28 LV: 03 |
| **Type of winding insulation** |  |
| 1. HV winding | Uniform |
| 1. LV winding | Uniform |
| Withstand time for three phase short circuit | 2 Seconds |
| Determination of sound levels | IS 2026 (Part-10) : 2009 |
| **Permissible Temperature Rise over ambient temperature of 500C** |  |
| 1. Of top oil measured by thermometer. | 400C up to 100 KVA & 40°C for 250 & 500KVA |
| 1. Of winding measured by **resistance**. | 450 C up to 100 KVA & 45°C for 250 & 500KVA |
| **Minimum HV clearances in air (mm) :-** |  |
| 1. Phase to Phase | 255 |
| 1. Phase to ground | 140 |
| **Bushings & Terminals** |  |
| 1. HV winding line end | **17.5** KV oil filled porcelain communicating type of bushings (Antifog type ) |
| 1. LV winding | 1.1 KV porcelain type of bushing (Antifog type) |
| **Insulation level of bushing** | HV LV |
| 1. Lightning Impulse withstand (KVP) | 75 Not applicable |
| 1. 1 Minute Power Frequency withstand voltage (KV —rms ) | 1. 3 |
| c) Creepage distance (mm) (minimum) | 25 mm/ KV |
| Material of HV & LV Conductor | EC grade Aluminum |
| Maximum current density for HV and LV winding for rated current | **2.4 Amp/ mm2** |
| **Polarisation index i.e. ratio of megger** | **Shall be greater than or equal to** |
| values at 600 sec. to 60 sec for HV to earth | 1.5, but less than or equal to '5'. |
| L.V to earth and HV to LV. | 1.5, but less than or equal to '5'. |
| Core Assembly | **Boltless type** |
| Transformer Max. Losses at 50%  Rating load (Watts). | Max. Losses at 100%  load (Watts). |
| **500 KVA 1510** | **4300 ( Copper wound transformer)** |

No-load current for 500 kVA shall not exceed 3 percent of full load current and will 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 6 percent maximum of full load current.

|  |  |  |
| --- | --- | --- |
| **6.** | **0 TYPE OF TRANSFORMER** |  |

**6.1**  The Transformers shall be of core type construction, double wound,

three phase, oil immersed, 11/0.433KV, 50 Hz with natural oil and air cooling (ONAN) to be used as step down transformers for outdoor use. The design of the tank, fittings, bushings, etc shall be such that it will not be necessary to keep the Transformer energised to prevent deterioration as the transformers may be held in reserve, outdoors, for many years.

**7.0**  **PERFORMANCE, CAPACITY AND SHORT CIRCUIT RATING**

**7.1** The following ratings are covered under this specification

500 KVA,11/0.433 KV, Copper wound

**7.2** The Transformer shall be capable of supplying a continuous load equal to its KVA rating, under the following conditions :

* continuous steady load;
* design at maximum ambient air temperature of 500C;
* **450 C average winding temperature rise and 400C top oil temperature rise for conventional breathing transformers**

**7.3** The 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 of either winding with rated voltage on the other winding**. If short circuit tests have been carried out on the particular design of transformer offered, the test results shall be supplied with the bid.

**7.4** **The thermal ability to withstand short circuit shall be demonstrated by calculation. The Transformer shall be capable of withstanding the thermal and dynamic effects of short circuits, as specified in IEC 76-5 or IS: 2026: Ability to withstand short circuits.**

Maximum Flux Density in any part of the core and yoke at rated voltage and frequency shall be such that the flux density with +12.5% combined voltage and frequency variation from rated voltage and frequency shall not exceed **1.9 Tesla.**

**8.0 VOLTAGE RATIO & TAPPING RANGE**

**8.1** The transformers shall have the following ratio :-

* the nominal voltage ratio shall be 11,000/ 433 V for 500 KVA.
* Tolerance on the voltage ratio shall be ± 0.5%.

**Tapping Ranges and Tapping Methods for 500 KVA.**

The standard tapping ranges, shall be as follows:

Winding tapped HV

Number of tap positions:- 7

Voltage variations:- (+ 5) percent to (-10) percent in steps of 2.5 percent for variation of HV

Off circuit tap-changing arrangement shall be by means of an externally-operated switch with mechanical locking device and a position indicator. Arrangement for padlocking shall be provided.

**8.2** The bidder shall state in the technical schedule, the percentage regulation at

full load, power factor 1.0 and at full load, power factor 0.85 lagging.

Transformers shall be suitable for parallel operation with each other.

**9.0 PERCENTAGE IMPEDANCE**

**9.1** The Percentage of Impedance at 75 0 C shall be 4.5 % for 500 KVA Transformer. No negative tolerance on percentage Impedance is allowed.

**10.0 LOSSES**

The load losses shall not exceed the values given below: -

|  |  |  |
| --- | --- | --- |
| KVA Rating | Maximum losses at 50% loading (Watts) | Maximum losses at 100% loading (Watts) |
| 500 KVA | 1510 | 4300 |

**10.1** The above losses are maximum allowable and there should not be any positive tolerance.

**10.2** The offered transformer(s) should have been type-tested at CPRI/ ERDA/NTH laboratory. The bid shall be accompanied with type-test reports (short circuit test and Impulse test & temperature rise) conducted at CPRI/ ERDA/NTH laboratory for the offered transformers within five years from date of tender. The short circuit test report(s) must contain the measured no load loss and load loss, determined by CPRI/ ERDA/NTH laboratory.

In case of any doubts, Owner reserves the right to verify the original type test reports of CPRI/ ERDA/NTH laboratory or ask the supplier to conduct the type tests at CPRI/ ERDA/NTH laboratory at his (supplier's) cost for re-confirmation of the test results particularly no load losses, load losses and percentage impedance.

**10.3** However, if the loss figures will exceed the stipulated values as per specification, the Transformer(s) shall be out rightly rejected.

1. **VECTOR GROUP**

**11.1** The Transformers shall be connected delta-star, in accordance with vector group reference **Dyn11** of IEC - 76/ IS – 2026 (Part-I).

**11.2** The LV neutral shall be brought out to a terminal bushing, which shall

be identical to the phase bushings in all respects.

**12.0 LOSSES**

**12.1** Transformers would be out rightly rejected if losses exceed the values

indicated at clause-10 above.

1. **FLUX DENSITY**

Maximum Flux Density in any part of the core and yoke at rated voltage and frequency shall be such that the flux density with +12.5% combined voltage and frequency variation from rated voltage and frequency shall not exceed **1.9 Tesla.**

**14.0 INSULATION LEVELS**

The insulation levels as defined in IEC 76-C/ IS: 2026 Insulation levels and dielectric test shall apply as per Table 2:

Table 2 : Transformer insulation level

|  |  |  |
| --- | --- | --- |
|  | HV Winding | LV Winding |
| Basic Impulse voltage Level (Kvp) (1.2/50 micro. sec. Wave ) | 75 | Not Applicable |
| Power Frequency voltage withstand level, Wet and Dry (KV) | 28 | 3 |

Bushings and terminals shall be adequate for the winding insulation tests and shall flash over externally before puncture or internal failure can occur.

**15.0 NOISE LEVEL:** Determination of sound levels [IS 2026 (part l0) l.

1. **RADIO INFLUENCE VOLTAGE**

The maximum radio influence voltage shall be 250 micro Volt, measured as specified in IEC 437.

**17.0** **CORE AND WINDINGS**

**17.1** Core

**17.1.1** Stage level inspection for core construction shall be carried out by the owner.

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

**17.1.3** The core shall be constructed from high grade, non-ageing, **Cold Rolled Grain Oriented (CRGO) silicon steel of M3 Grade or HIB grade laminations only**. No other core materials shall be entertained. Bidders are requested to note that only **PRIME CORE M3/M4 Grade (0.23mm - 027 mm**) materials HIB grade are to be used. In no case, second grade core material is to be used. The purchaser at his discretion, may select samples from the core laminations and get the same tested in CPRI/ ERDA/NTH laboratory to prove the quality of the core material.

**17.1.4**

The core and winding shall be capable of withstanding shocks during transport, installation and service. Provision shall be made to prevent movement of the core and windings relative to the tank during these conditions and also during short circuits.

**17.1.5** The design shall avoid the presence of pockets which would prevent the complete emptying of the tank through the drain valve. The core material offered in the tender to be checked for its correctness before core coil assembly. For this, the tendered must ask for core and coil inspection before its tanking.

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

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

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

**17.1.9** All steel sections used for supporting the core shall be thoroughly painted, after cutting, drilling and welding.

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

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

**17.1.12** The framework and clamping arrangements shall be securely earthed.

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

**17.1.14** 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.

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

**17.1.16** 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.

**17.2** **INTERNAL EARTHING**

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

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

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

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

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

**17.3 Windings**

**17.3.1** Winding shall be subjected to a shrinking and seasoning process, so that no further shrinkage occurs during service. Adjustable devices shall be provided for taking up possible shrinkage in service.

**17.3.2** 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.

**17.3.3** 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.

**17.3.4** The winding insulation shall be free from insulating compounds which are liable to soften, ooze out, shrink or collapse. It shall be non-catalytic and chemically inert in hot transformer oil during normal service.

**17.3.5** The stacks of windings are to receive adequate shrinkage treatment.

**17.3.6** The windings and connections are to be braced to withstand shocks during transport switching, short circuit or other transient conditions.

**17.3.7** 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.

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

**17.3.9** The windings shall be uniformly insulated and the L.V neutral points shall be insulated for full voltage.

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

**17.3.11** The winding shall be so designed that all coil assembles of identical voltage ratings shall be interchangeable and field repairs to the winding can be made readily without special equipment. The coils shall have high dielectric strength.

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

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

**17.3.14** 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

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

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

**17.3.17** The winding conductor shall be of Copper. The current density shall not exceed 2.4 Amp/ mm2 for copper at normal full load current.

**18.0 BUSHINGS AND TERMINATIONS**

**18.1 Bushings**

**18.1.1** Bushings shall be of the outdoor type and easily replaceable. Cemented in types will not be accepted. They shall be sufficiently robust to withstand normal transport and erection hazards and shall confirm to TEC 137 /TS 3347 and 2099.

**18.1.2** Bushings and other current-carrying parts shall also be designed for this condition. During emergency Overloading the current in the bushing parts of the below ratings will be as follows:For 100kVA, LV current: 133.33 Amps.As per clause No.7.3, LV bushing current required is = 133.33 x 1.5=199.995 Amps. So, 250Amps bushing is required which is as per IS: 2099. The following minimum 11 KV clearance shall be provided:

External (Air) for 11 KV

Phase to phase 255 mm

Phase to earth 140 mm

**18.1.3** The dia of HT bushing stud should not be less than 12mm. As per IS -3347 Part-1 upto250 Amps up to 250 Amps bushings M12 stem is required. The 11 KV bushings of transformers shall be provided with a bi-metallic terminal connector or suitable device to receive 35 —100 mm2 AAAC or ACSR conductor directly without any bi-metallic action.

**18.2 Bushing Labels**

**18.2.1** The HV bushings shall be labeled U, V and W and the LV bushing u, v, w and n. Marking letters shall be at least 12 mm high. The means of marking shall be either, engraved metal plate; or ¨ etched anodized aluminum.

Phase identification by adhesive stickers shall not be acceptable.

**18.2.2** If labeling is to be carried out on the tank, it is preferred that one plate bused rather than individual markings for each phase, in order to prevent incorrect phase markings. Labels shall conform to the requirements of the section on labels in this specification.

**18.3 Earthing Terminals**

All transformers shall be provided with two earthing terminals conforming to relevant Standards and M12 ISO metric bolt and nut which shall be non ferrous. It shall include a spring washer and lock washer.

**19.0 TANK FABRICATION**

**19.1** All transformer sizes, the tank shall be in accordance with IS 1180(Part-I):2014.

**19.2** Transformer tanks of all types shall be designed so that the completed transformer can be lifted and transported without permanent deformation or oil leakage. Stiffeners provided on all the four side walls for rigidity should be so designed that there is no accumulation of water.

**19.3** The Tank shall be of rectangular shape with round edges fabricated from tested quality mild steel plates with minimum thickness of 4 mm. for the side walls while top cover and the bottom plate of the tank shall have a minimum thickness of 6 mm.

**19.4** All sealing washers / gaskets shall be made of oil and heat resistant neoprene rubber or neoprene bonded cork seals suitable for temperature as stipulated in this specification. Surfaces at gasketted joints shall be such that an even face is presented to gasket, thereby eliminating the necessity for the gasket to take up surface irregularities.

**19.5** 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.

**19.6** The transformer tank shall be complete with all accessories, lifting lugs etc. and shall be designed to allow the complete transformer filled with oil to be lifted by crane or jacks without risk of any damage and can be transported by Rail/ Road without straining any joints and without causing any leakage of oil.

**19.7** Cable End Box with box thickness minimum 3.0 mm with suitable gland is to be provided and the electrical clearances shall be as per IS 1180(Part-I):2014.

**19.8** The height of the tank shall be such that minimum vertical clearance up to the top cover plate of 80mm is achieved from the top of the yoke.

**20.0 PRESSURE RELIEF DEVICE**

Transformers shall be fitted with a pressure relief device in the form of explosion Vent.

The tendered shall state the pressure at which it is designed to operate.

**21.0 OIL LEVEL GAUGE**

Oil level gauge indicating oil level at minimum, 30°C and maximum operating Temperature.

NOTES: Minimum and maximum positions correspond to the operating temperature of -5°C and 90°C respectively (for non-sealed type transformer).

**22.0 CONSERVATORS AND BREATHERS**

All the transformers shall be provided with conservator tank.

**22.1** The conservator tank shall be so designed and located as to eliminate any trapping of air in the transformer or pipe work. It shall be inclined at an angle of about 5 degrees to the horizontal towards the drain plug and the pipe connecting the main tank to the conservator should project about 2° mm above the bottom of the conservator so as to create a sump for the collection of impurities. Minimum oil level corresponding to 5° C shall be well above the sump level.

**22.2** All transformers shall be fitted with a silica gel breather of weather proof design at a convenient height with oil seal at the bottom, draw in plug and filling holes with covers to isolate the silica gel from the atmosphere. The breather pipe should be connected at top of the conservator tank with two bends at right angles. The cover of the main tank shall be provided with air release plug to enable the trapped air to be released.

**23.0 FITTINGS AND ACCESSORIES**

**23.1** The following standard fittings and accessories shall be provided :

¨ Rating, diagram and terminal marking plate.

¨ Two earthing terminals.

¨ Lifting lugs/ platform lugs.

¨ Pressure relief device or explosion vent.

¨ Silicagel breather.

¨ Oil level gauge indicating oil level at minimum, 30°C and maximum operating temperature. NOTES: Minimum and maximum positions correspond to the operating temperature of -5°C and 90°C respectively (for non-sealed type transformer).

- Top filter valve with locking arrangement.

¨ Bottom filter valve with locking arrangement.

¨ Air release plugs at transformer top cover, bushing turrets etc.

¨ Set of Radiators.

¨ Conservator Tank

* Buchholz relay .
* Non return valve (for conducting pressure test).Non-returnable Valve shall not be provided for transformers with conservator.
* Bi-metallic terminal connectors on the bushings for connection with overhead ACSR/ AAAC conductor. The Specification and brief details of the salient features of these terminals should be stated.

**24.0 TRANSFORMER OIL**

**Transformer oil: Oil parameters in line with the IS:335.**

The transformers shall be supplied complete with first filling of transformer oil up to maximum permissible level. The quantity of oil required for the first filling of the transformer and its full specification shall be stated in the bid. The complete first filling shall be of new oil free from inhibitors and additives up to maximum permissible level for the supplied Transformer. The bidder shall quote the price of transformer including the cost of Transformer Oil required for initial filling.

The insulating oil for the transformer shall be of EHV grade, generally conforming to latest version of IS: 335. No inhibitors shall be used in the oil. The dielectric strength of the oil shall not be less than 60 KV at 2.5 mm. gap when tested in accordance with IS: 6792/ 1972. If an anti-oxidant inhibitor is recommended, its use shall be subject to the purchaser's approval.

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 contractor shall warrant that oil furnished is in accordance with the following specifications.

|  |  |  |  |
| --- | --- | --- | --- |
| S.No | Characteristic | Requirement | Method of Test |
| 01 | 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. |
| 02 | Density at 200C | 0.89 g/cm3 Max. | IS:1448 |
| 03 | Kinematic Viscosity at 27 deg. C Max | 27 CST | IS:1448 |
| 04 | Interfacial tension at  27deg.C Min. | 0.03 N/m | IS: 6104 |
| 05 | Flash Point | 136 0C | IS:1448 |
| 06 | Pour Point Max. | -6 0C | IS:1448 |
| 07 | Naturalization Value  (Total Acidity) Max. | 0.03 mg KOH/gm | IS:335 |
| 08 | Electric strength  Breakdown (voltage) Min. | 72.5 KV | IS: 6792 |
| 09 | Dielectric dissipation  factor tan delta at 900 C | 0.03 Max | IS: 6262 |
| 10 | Min specific resistance (resistively) at 90 deg.C | 35X1012 ohm cm (min.) | IS:6103 |
| 11 | Oxidation stability |  |  |
| 12 | Neutralization value after oxidation | 0.40mg KOH/g |  |
| 13 | Total sludge after  oxidation | 0.10% by weight max. |  |
| 14 | Presence of oxidation  Inhibitor | The oil shall not contain anti-oxidant Additives. | IS:335 |
| 15 | Water content Max: | Less than 25ppm | IS:2362 |

**26.0 RATING AND CONNECTION PLATE**

Each transformer shall be provided with a rating plate of weatherproof material showing the following items indelibly marked:

* type of transformer
* standard to which it is manufactured (preferably IEC 76)
* manufacturer's name
* transformer serial number
* year of manufacture
* rated frequency in Hz (50)
* rated voltages in KV (11/0.433)
* number of phases (3)
* rated power in KVA
* type of cooling (ONAN)
* rated currents in A
* vector group symbol (Dyn11)
* 1.2/501.ts wave impulse voltage withstand level in KVp
* power frequency withstand voltage in KV impedance voltage at rated current and frequency in percentage at 75° C at normal tap
* Measured load loss in KW at rated current and at 75°C at normal tap
* Measured no-load loss in KW at rated voltage and rated frequency continuous ambient temperature at which ratings apply in °C
* top oil and winding temperature rise at rated load in °C
* winding connection diagram
* Total weight in kg with complete oil filled.
* total weight of the transformer without oil
* Volume of oil in litres.
* weight of core and windings in kg; and
* name of the purchaser OPTCL

Rating & Connection Plate. The Rating and connecting plate shall be as per IS 1180(Part-I):2014.

**27.0** **BASE MOUNTING ARRANGEMENT**

The under-base of all three phase transformers up to 200 kVA ratings shall be provided with two 75 mm x 40 mm channels 460 mm long as shown in Fig. 6 of IS: 1180 Part-I, 2014, to make them suitable for fixing to a platforrm or plinth.

The under-base of all transformers beyond 200 kVA shall be as per Fig. 7 of IS: 1180 Part-I, 2014,to make them suitable for mounting on rollers.

**27 (a)** BIS ENERGY LEVEL-II : In addition to above, the supplied Distribution Transformers must contain BIS ENERGY LEVEL-II with style and information provided by the Bureu of Indian Standard.

**28.0 PAINTING**

**28.1** All paints shall be applied in accordance with the paint manufacturer's recommendations. Particular attention shall be paid to the following:

**28. 2** a) Proper storage to avoid exposure as well as extremes of temperature.

1. Surface preparation prior to painting.
2. Mixing and thinning
3. Application of paints and the recommended limit on time intervals between coats.
4. Shelf life for storage.

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

**28.3.1** All primers shall be well marked into the surface, particularly in areas where painting is evident, and the first priming coat shall be applied as soon as possible after cleaning. The paint shall be applied by airless spray according to the manufacturer's recommendations. However, wherever airless spray is not possible, conventional spray be used with prior approval of purchaser.

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

**28.4 Cleaning and Surface Preparation**

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

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

**28.4.3** The pressure and Volume of the compressed air supply for the blast cleaning shall meet the work requirements and shall be sufficiently free from all water contamination prior to any painting.

**28.4.4** Chipping, scraping and steel wire brushing using manual or power driven tools cannot remove firmly adherent mill-scale and shall only be used where blast cleaning is impractical.

**28.5 Protective Coating**

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

**28.6 Paint Material**

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

1. Heat resistant paint (Hot oil proof) for inside surface.

ii) For external surfaces one coat of Thermo Setting Paint or 2 coats of Zinc phosphate followed by 2 coats of P.0 (Poly-urethene) paint. The color of the finishing coats shall be dark admiral gray.

**28.7 Painting Procedure**

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

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

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

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

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

**28.8 Damages to Paints Work**

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

Any damaged paint work shall be made as follows:

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

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

**28.9 Dry Film Thickness**

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

Each coat of paint shall be allowed to harden before the next is applied as per manufacture's recommendations. Particular attention must be paid to full film thickness at edges.

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

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Sl. No | Paint Type | Area to be painted | No of Coats | Total Dry film thickness(Min) |
| 1. | Powder paint  (2) Thermo setting powder. | Inside outside | 01  01 | 30 micron  60 micron |
| 2. | Liquid paint |  |  |  |
|  | a) Zinc Chromate | Out side | 01 | 30 micron |
|  | (Primer) |  |  |  |
|  | b) P.U. Paint (Finish | Out side | 02 | 25 each |
|  | Coat) |  |  |  |
|  | c) Hot Oil paint | inside | 01 | 35/10 micron |

The colour of the finishing coat shall be Sky Blue/ Dark Admiral Gray/ Deep Green or any other colour as decided by the Purchaser

**29.0 SEALING GASKETS**

Gaskets shall be made of synthetic rubber or synthetic rubberized cork resistant to hot transformer oil.

Gaskets wherever used shall conform to Type III as per IS 1l149/Type C as per IS 4253 (Part2)'

**30.0 SUPRESSION OF HARMONICS**

The transformer shall be designed with attention to the suppression of harmonic voltage especially the third and fifth.

**31.0 TESTS**

**31.l General**

All routine, type and special tests as described in 31.2 to 31.4 shall be performed as per relevant parts of IS 2026. Pressure and oil leakage test shall be conducted as per 31.5.

**31.2 Routine Tests** **(to be conducted on all units)**

The following shall constitute the routine tests:

**a)** Measurement of winding resistance [IS 2026 (Part l)1.

**b)** Measurement of voltage ratio and check of phase displacement [IS 2026 (Part l)].

**c)** Measurement of short-circuit impedance

(principal tapping, when applicable) no load loss at 50 percent and 100 percent load US 2026 (Part l)1.

**d)** Measurement of no-load loss and current lls 2026 (Part l)1.

**e)** Measurement of insulation resistance US 2026 (Part l)1.

**f)** Induced over-voltage withstand test [lS 2026 (Part 3)1.

**g)** Separate-source voltage withstand test US 2026 (Part 3)1.

**h)** Pressure test (see 21.5)'

**j)** Oil leakage test (see 21.5).

**31.3 type Tests** (to be conducted on one unit)

The following shall constitute the type tests:

**a)** Lightning impulse test [lS 2026 (Pa\*3)]' t3 IS 1180 (Part t) z 2014

**b)** Temperature-rise resr [IS 2026 (part 2)).

**NOTE** \_ Maximum **measured** total loss (No load at rated excitation + load loss at maximum current tap converted to 75 °C reference temperature) at 100 percent loading shall be supplied during temperature rise test.

**c)** Short-circuit withstand test IIS 2026(part 5)] (up to 200 kVA).

**NOTE** \_ Routine tests before and after short circuit test shall be conducted as per IS 2026 (part l).

**d)** Pressure test (see 2l.S)

**31.4 Special Tests (to be conducted on one unit)**

The following special tests shall be carried out.

**a)** Determination of sound levels [IS 2026 (part l0)l

**b)** Short-circuit withstand test US 2026 (part 5)l (above 200 kVA)

The ability to withstand thermal effects of short circuit shall be demonstrated by test.(Duration of external short circuit is 2.0 sec). The transformer is to be tested accordingly.

**NOTE** - Routine tests before and after short circuit test shall be conducted as per IS 2026 (part l).

**c)** No load current at I12.5 percent voltage (see 5,9.3).

**d)** Paint adhesion tests. The test is performed as per ASTM D3359 (Standard Test Methods for measuring adhesion by Tape test).

**e)** BDV and moisture content of oil in the transformer (lS 335).

**NOTE** - Tests at (d) and (e) may be carried out on more than one unit (One unit in each Lot of inspection).

**31.5** Pressure and Oil Leakage Test

**31.5.1** For Transformers up to 200 kVA

**31.5.1.1** **Pressure test (type test)**

For non-sealed and sealed type transformers, the transformer tank shall be subjected to air pressure of **80 kPa** for **30** min and vacuum of **250.mm of mercury for 30 min**. The permanent deflection of flat plates, after pressure/vacuum has been released, shall not exceed the values given below.

|  |  |  |
| --- | --- | --- |
| **Sl.No** | **Length of plate** | **Deflection** |
| 1 | Up to 750 mm | 5.0 mm |
| 2 | 751 mm to 1250 mm | 6.5 mm |

**31.5.1,2 Pressure (routine test)**

**a)** **Non-sealed type transformers** (plain tanks)

The transformer with bolted cover shall be tested at an air pressure of **35 kpa** above atmosphere pressure maintained inside the tank for **l0 min**. There should be no leakage at any point.

**31.5.1.3 Oil leakage test (routine test)**

The assembled transformer for non-sealed and sealed type with all fittings including bushings in position shall be tested at a pressure equivalent to twice the normal head measured at the base of the tank for 8 h. There should be no leakage at any point. Tank with corrugations shall be tested for oil leakage test a pressure of l5 kpa measured at the top of the tank for 6 h. There should be no leakage at any point.

**31.5.2** **For** **Transformer 500 kVA**

**31.5.2.1 Pressure test (Type test)**

For non-sealed and sealed type transformers, the transformer tank subjected to air pressure of **80 kpa for 30 min** and **vacuum of 500 mm of mercury for 30 min**. The permanent deflection of flat plate, after pressure/vacuum has been released, shall not exceed the values given below.

|  |  |  |
| --- | --- | --- |
| **Sl.No** | **Length of plate** | **Deflection** |
| 1 | Up to 750 mm | 5.0 mm |
| 2 | 751 mm to I 250 mm | 6.5 mm |
| 3 | I 251 mm to I 750 mm | 8.0 mm |
| 4 | Above I 751 mm | 9.0 mm |

**31.5.2.2 Pressure test (routine test)**

The transformer tank with welded/bolted cover shall be tested at a pressure of **35 kpa above atmosphere pressure maintained inside the tank for l0 min. There should be no leakage at any point.**

***b) Corrugated tanks***

The corrugated transformer tank shall be tested for air pressure of l5 kpa above atmosphere pressure maintained inside the tank for l0 min. There should be no leakage at any point.

**31.5.2.3 Oil leakage test (routine test)**

The assembled transformer for non-sealed and sealed type with all fittings including bushing in position shall be tested at a pressure equivalent to twice the normal head measured at the base of the tank for 8 h. There should be no leakage at any point. Tank with corrugations shall be tested for oil leakage test a pressure of 15 kPa measured at the top of the tank for 6 h. There should be no leakage at any point.

**31.4** **TEST VOLTAGE**

Transformers shall be capable of withstanding the Power frequency and Impulse test voltage as described below:

|  |  |  |  |
| --- | --- | --- | --- |
| Nominal system voltage | Highest  System voltage | Impulse Test  voltage | Power frequency test voltage |
| 433 V (rms) |  |  | 3 KV (rms) |
| 11 KV (rms) | 12 KV (rms) | 75 KV (Peak) | 28 KV (rms) |

**32.0 COMPLIANCE WITH SPECIFICATION**

The transformers shall comply in all respects with the requirements of this specification. However, any minor departure from the provisions of the specification shall be disclosed at the time of tendering in the Non Compliance Schedule as in Annexure-3.

**33.0 COMPLIANCE WITH REGULATIONS**

All the equipment shall comply in all respects with the Indian Regulations and acts in force.The equipment and connections shall be designed and arranged to minimize the risk of fire and any damage which might be caused in the event of fire.

**34.0 GUARANTEE**

The supplier shall guarantee the following:

* Quality and strength of materials used;
* Satisfactory operation during the guarantee period of thirty six months (**60 months**) from the date of commissioning.
* Performance figures as supplied by the tendered in the schedule of guaranteed particulars;
* The offered surface treatment shall protect the treated metal from corrosion for a period of not less than five years from the date of delivery.

**35.0 PACKING AND SHIPPING**

**35.1 Packing**

The equipment and any supporting structures are to be transported adequately sealed against water ingress. All accessories and spares shall be packed and securely clamped against movement in robust, wooden, non-returnable packing cases to ensure safe transit in rough terrain, cross country road conditions and in heavy rains from the manufacturer's works to the work sites/ earmarked destinations.

**35.1.1** All accessories shall be carefully packed so that they are fully protected during transport and handling operations and in storage. Internal surfaces of loose accessories shall be sealed by means of gaskets and blanking off plates. All parts liable to rust shall receive an anti-rusting coat and shall be suitably protected. It shall be the responsibility of the Supplier to make good any damage caused through insufficient packing.

**35.2 Transportation**

The Supplier shall be responsible for the transport of all plant and equipment supplied by them and for the transport of all goods to the various specified destinations including all road clearance, offloading, warehousing and insurance.

The Supplier shall inform himself fully as to all relevant transport facilities and requirements and loading gauges and ensure that the equipment as packed for transport conform to these limitations. The Supplier shall also be responsible for verifying the access facilities specified.

The Supplier shall be responsible for the transportation of all loads associated with the contract works and shall take all reasonable steps to prevent any highways or bridges from being damaged by his traffic and shall select routes, choose and use vehicles and restrict and distribute loads so that the risk of damage shall be avoided. The Supplier shall immediately report to the Purchaser any claims made against the Supplier arising out of alleged damage to a highway or bridge.

All transport accessories, such as riding lugs, jacking pads or blanking off plates shall become the property of the Purchaser.All items of equipment shall be securely clamped against movement to ensure safe transit from the manufacturer's facilities to the specified destinations.

The Supplier shall advice the storage requirements for any plant and equipment that may be delivered to the Purchaser's stores. The Supplier shall be required to accept responsibility for the advice given in so far as these arrangements may have a bearing on the behavior of the equipment in subsequent service.

**36.0 Hazardous substances**

The Supplier shall submit safety data sheets for all hazardous substances used with the equipment. The Supplier shall give an assurance that there are no other substances classified as hazardous in the equipment supplied. No oil shall be supplied or used at any stage of manufacture or test without a certificate acceptable to the Purchaser that it has a PCB content of less than 2 mg/ kg. The Supplier shall accept responsibility for the disposal of such hazardous substances, should any be found.

The Supplier shall also be responsible for any injuries resulting from hazardous substances due to non-compliance with these requirements.

37.0 SUBMITTALS

37.1 Submittals required with the bid

The following shall be required with each copy of the bid :

Completed technical data schedule;

Descriptive literature giving full technical details of equipment offered;

Outline dimensions drawing for each major component, general arrangement drawing showing component layout and general schematic diagram;

* **Type test certificates** (short circuit withstand test and impulse test & temperature rise) of the offered transformers conducted at CPRI/ or any NABL Accredited laboratory without which tender will be out rightly rejected.
* **Sample routine test reports;**

Detailed reference list of customers already using equipment offered along with performance certificates of such equipment, during the last 3 (three) years with particular emphasis on units of similar design and rating;

* Details of manufacturer's quality assurance standards and programme and ISO 9000 series or equivalent national certification;
* Deviations from this specification. Only deviations approved in writing before award of contract shall be accepted;
* List of recommended spare parts and consumable items for five year of operation with prices and spare parts catalogue with price list for future requirements.

**37.2 Submittals required after contract award**

**37.2.1 Programme**

Five copies of the programme for production and testing

**37.2.2 Technical Particulars**

Within 30 days of contract award five bound folders with records of the technical particulars relating to the equipment. Each folder shall contain the following information:

General description of the equipment and all components, including brochures(OGA);

Technical data schedule, with approved revision(GTP);

Calculations to substantiate choice of electrical, structural, mechanical component size/ ratings;

i) Heat Dissipation

ii) Flux Density

* Detailed dimension drawing for all components, general arrangement drawing showing detailed component layout and detailed schematic and wiring drawings for all components; along with core-coil assembly drawings, showing details of core such as grade, thickness, window height, leg centre, diameter, step width, step thickness and details of windings such as I.D., O.D , thickness , Conductor size, No. of turns, major and minor insulations, winding height etc.
* Detailed loading drawing to enable the Purchaser to design and construct foundations for the transformer;
* Statement drawing attention to all exposed points in the equipment at which copper / aluminum or aluminum alloy parts are in contact with or in close proximity to other metals and stating clearly what protection is employed to prevent corrosion at each point;
* Detailed installation and commissioning instructions;
* At the final hold point for Purchaser approval prior to delivery of the equipment the following shall be submitted ;
* Inspection and test reports carried out in the manufacturer's works
* Operation and maintenance instructions as well as trouble shooting charts.

**37.2.3 Operation and Maintenance Instructions**

A copy of installation and commissioning instructions and of the operation and maintenance instructions and troubleshooting charts shall be supplied with each transformer.

**37.3 Drawings**

**37.3.1** Within 15 days of award of contract, the Supplier shall submit 4 complete sets of drawings as detailed below describing equipment in details. These drawings would be duly approved by the Purchaser after due securitization and approval will be communicated within 15 days of receipt of these drawings. After the drawings are approved and communicated to the supplier, he would supply ten complete sets of final drawings.

**37.3.2** All detail drawings submitted for approval shall be to scale not less than 1:20. All important dimensions shall be given and the material of which each part is to be constructed shall be indicated on the drawings. All documents and drawings shall be submitted in accordance with the provisions of this specification and shall become the property of the Purchaser.

**37.3.3** All drawings and calculations, submitted to the Purchaser, shall be on international standard size paper, either AO, A1, A2, A3 or A4. All such drawings and calculations shall be provided with a contract title block, which shall include the name of the Purchaser and shall be assigned an unique project drawing number; the contract title block and project numbering system shall be agreed with the Purchaser.

**37.3.4** Script sizes and thickness of scripts and lines be selected so that if reduced by two stages the alphanumeric characters and lines are still perfectly legible so as to facilitate microfilming.

**37.3.5** For presentation of design drawings and circuit documents IEC Publication 617 or equivalent standards for graphical symbols are to be followed. The drawing approval will be communicated within 15 days from the receipt of drawings from the Bidder and for any delay in furnishing the drawings, if delivery period will be delayed, no extension of delivery time will be granted due to this.

**37.3.6** The following drawings for each item are to be submitted as part of this Contract.

1. Outline dimensional drawings of transformers and accessories
2. Assembly drawings and weights of main component parts.
3. Transportation drawings showing dimensions and weights of each package.
4. Drawings giving the weights for foundations each.
5. Drawing showing details such as clamping arrangements of core, core assembly showing oil duct section of HT and LT coils with conductor size showing insulation arrangements of windings and their reinforcement to withstand short circuit stresses, in side tank dimensions showing core assembly. Details of core and windings, as enumerated at Cl. No. 33.2.2 of this part of Specification shall be indicated in the above drawings.
6. Schematic diagram showing the flow of oil in the cooling system as well as each limb and winding. Longitudinal and cross- sectional views showing the duct sizes, cooling pipe etc. for transformer/ heat exchanger, drawn to scale shall be furnished.
7. Large Scale drawings of high and low tension winding of the transformers showing the nature and arrangements of insulation and terminal connection.
8. Name plate drawing showing details as per Cl. 23 of Part-2 of Technical Specification.

**38.0 FASTENERS**

**38.1** All bolts, studs, screw threads, pipe threads, bolt heads and nuts

shall comply with the appropriate Indian Standards for metric threads, or the technical equivalent.

**38.2** 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.

**38.3** 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.

**38.4**  As per clause No. 15.3 of IS 1180(Part-I):2014, all bolts/nuts/washers exposed to atmosphere shall be as follows. For Size 12 mm or below stainless steel. Above 12mm HDG or electro galvanization with passivation or hot dip galvanized.