BSES

# Specification of

# Single Phase Oil Filled CSP Transformer

## Specification no – BSES-TS-30-SPT-R0

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Record of Revision

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## 1. Scope of work

1.1 This specification covers design, engineering, manufacture, assembly, testing at manufacture's works, packing, transportation and delivery to site, supervision of erection, testing at site & commissioning and submission of complete documentation of CSP transformers to be used in HVDS system.

1.2 The transformer shall be complete with all components and accessories, which are necessary or usual for their efficient performance and trouble free operation under the various operating and atmospheric conditions specified in annexure A.

1.3 Such of the parts that may have not been specifically included, but otherwise form part of the transformer as per standard trade and/or professional practice and/or are necessary for proper operation of transformer, will be deemed to be also included in this specification.

## 2. Codes & standards

2.1 Materials, equipment and methods used in the manufacture of Transformer shall conform to the latest edition of below mentioned standards.

2.2 Vendor shall possess valid BIS Certification.

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| IS 1180 part 1 | Outdoor type oil immersed distribution transformer upto and including 2.5MVA,33kV |
| IS 1180 part 3 | Outdoor type oil immersed distribution transformer upto and including 2.5MVA, 33kV.<br>Part 3 Natural/Synthetic Organic Ester oil Liquid Immersed. |
| IS 2026 | Power Transformers |
| IS 2026-4 | Terminal Marking, tappings and Connections for Power Transformers. |
| IS:3347 | Dimensions for Porcelain Transformer bushing |
| IS 16659 | Fluids for Electro technical Application- Unused Natural Esters for Transformers and Similar Electrical Equipment |
| IS-12444 | Specification for Cu Wire rods |
| IS-5484 | Specification for Al Wire rods |
| IS:10028 | Code of practice for selection, installation & maintenance of transformers |
| IS 5561 | Electrical Power Connectors |
| IS 5 | Colors for ready mix paints |
| IS/IEC 60071 | Co-ordination of Insulation. |
| IEC 62770 | Unused natural esters for transformers and similar electrical |

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| | equipment |
| IS2026-7/IEC 60076-7 | Loading Guide for Oil-Immersed Power Transformers. |
| IS 2026-8 /IEC 60076-8 | Application Guide for Power Transformers. |
| IS 2026-10/IEC 60076-10 | Determination of Transformer Sound Levels. |
| IS/IEC 60529 | Degrees of Protection Provided by Enclosures (IP Code). |
| IS/IEC 60947 | Low-Voltage Switchgear and Control gear. |
| IS/IEC 60137 | Bushing for alternating voltage above 1000V |
| IS:1271/IEC 60085 | Thermal evaluation and classification of electrical insulation |
| IEC 60076 | Power transformers. |
| IEC 60156 | Method for Determination of the Electric Strength for Insulating Oils. |
| IEC 60445 | Basic& Safety principles for man-machine interface, marking and identification, Identification of Equipment Terminals and conductor terminals |
| IEEE C57.155 | IEEE Guide for interpretation of Gases Generated in Natural Ester and Synthetic Ester-Immersed Transformer |
| DIN 42531 to 33 | Specification for Outdoor Bushings |
| ASTM B-49 | Specification for Cu Wire rods |
| ASTM B-233 | Specification for Al Wire rods |
| | Indian Electricity Rules |
| | Indian Electricity Act |
| | CBIP manual |

In the event of direct conflict between various order documents, the precedence of authority of documents shall be as follows –

i. Guaranteed Technical Particulars (GTP)

ii. This Specification

iii Indian Standards / IEC standards

iv Approved Vendor Drawings

v Other documents

## 3. Major Design Criteria & Parameters of the Transformer

| Sr No | Description | Data by purchaser |
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| 3.1 | Voltage variation on supply side | + / - 10 % |
| 3.2 | Frequency variation on supply side | +/ - 5 % |

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| 3.3 | Transient condition | - 20 % or + 10 % combined variation of voltage and frequency |
| 3.4 | Service Condition | Refer Annexure A |
| 3.5 | Location of equipment | Outdoor application |
| 3.6 | Reference design ambient temperature | 50 deg C |
| 3.7 | Type of transformer | Sealed type, completely self protected (CSP) |
| 3.8 | Type of construction | Core type, oil immersed |
| 3.9 | Type of cooling | Oil natural air natural (KNAN) |
| 3.10 | No of phases | Single phase on primary & secondary side |
| 3.11 | No of windings | Two (one each for primary & secondary) |
| 3.12 | Rated frequency ( Hz ) | 50 Hz |
| 3.13 | Highest system voltage HV side | 12kV |
| 3.14 | Lightning Impulse withstand voltage, kV peak | |
| 3.14.1 | For nominal system voltage of 11 kV | 75 |
| 3.15 | Power Frequency Withstand Voltage kV rms | |
| 3.15.1 | For nominal system voltage of HV | 28 |
| 3.15.2 | For nominal system voltage of LV | 3 |
| 3.16 | Thermal and Dynamic short circuit withstand | For 3 secs. |
| 3.17 | Method of 11kv system earthing | Effectively earthed at 11kv source |
| 3.18 | Rated voltage HV Phase to Neutral | $11/\sqrt{3}$ KV |
| 3.19 | Rated voltage LV | 240V |
| 3.20 | Rated HV current | |
| 3.20.1 | 16kVA | 2.52A |
| 3.20.2 | 25kVA | 3.96A |
| 3.20.3 | 50kVA | 7.87A |
| 3.21 | Rated LV current | |
| 3.21.1 | 16kVA | 66A |
| 3.21.2 | 25kVA | 104A |
| 3.21.3 | 50kVA | 208A |
| 3.22 | Percentage Impedance at 75 deg C | 4% with IS tolerance |
| 3.23 | Max Total losses(No Load+ Load Losses at $75^0$C) at 50% of the rated load , Watts | |

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| 3.23.1 | 16 kVA | 82 |
| 3.23.2 | 25 kVA | 110 |
| 3.23.3 | 50 kVA | 210 |
| 3.24 | Max Total losses (No Load+ Load Losses at $75^0$C) at 100% of the rated load , Watts | |
| 3.24.1 | 16 kVA | 224 |
| 3.24.2 | 25 kVA | 300 |
| 3.24.3 | 50 kVA | 590 |
| 3.25 | Temperature rise over reference ambient of $50^0$C | |
| 3.25.1 | Top oil by thermometer 0 C | $40^0$ C |
| 3.25.2 | Winding by resistance 0 C | $45^0$ C |
| 3.26 | Reference standard | IS 1180 part 3/IS 1180 part 1 |
| 3.27 | Overload Capability | As per IS 2026-part 7 |
| 3.28 | Noise Level | As per IEC 60076-10 |
| 3.29 | Minimum terminal clearance | |
| 3.29.1 | HV phase to earth | 140 mm |
| 3.29.2 | LV phase to earth | 40 mm |

## 4. Construction & Design

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| 4.1 | **Type** | Double Copper wound, single phase, oil immersed with KNAN cooling with completely self protected (CSP) |
| 4.2 | **Major Parts** | |
| 4.2.1 | **Tank** | |
| 4.2.1.1 | Type | Sealed type with bolted cover which seals the interior of the tank from atmosphere. |
| 4.2.1.2 | Material of Construction | Tank should be round and made of good quality sheet steel |
| 4.2.1.3 | Tank Thickness | Adequate for meeting the requirements of pressure and vacuum type tests as per IS 1180 (Part – 3/Part-1) It shall be stiffed to provide sturdy and robust construction to withstand extreme pressure conditions. |

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| 4.2.1.4 | Tank features | i) The circular base plate edges of the tank shall be folded upward for at least 25 mm, to have sufficient overlap with vertical sidewall of the transformer.<br>ii) All seams and joints shall be double welded<br>iii) The tank should be capable of withstanding pressure and vacuum as per values specified in IS: 1180 (Part – 3/Part-1)<br>iv) The tank cover shall have plasticized surface at the top to guard against birdage faults. Alternatively, suitable insulating shrouds shall be provided on the bushing terminals.<br>v) The transformer shall have a self pressure venting system.<br>vi) Steel surface of the tank shall be prepared by sand blast or chemical cleaning including phosphating as per IS: 3618.<br>vii) The space on the top of oil shall be filled with dry air or nitrogen. The nitrogen plus oil volume inside the tank shall be such that even under extreme operating conditions, the pressure generated inside the tank does not exceed 0.4 Kg/cm2 positive or negative.<br>viii) Heat resistance paint (Hot oil proof) shall be provided inside the tank. On external surface one coat of Thermo setting powder paint or two coats of zinc chromate followed by two coats of synthetic enamel paint of shade conforming to No.631 of IS:-5 shall be provided. The overall thickness of the paint shall be minimum150 micron. |
| 4.2.2 | **Core** | |

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| 4.2.2.1 | Material | High grade , non ageing, low loss, high permeability, grain oriented, cold rolled silicon steel lamination |
| 4.2.2.2 | Grade | Premium Grade minimum M3 or better |
| 4.2.2.3 | Lamination thickness | 0.23 mm Max. |
| 4.2.2.5 | Maximum Flux Density at 12.5 % over excitation / over fluxing | 1.9 T |
| 4.2.26 | No load current | 2% and 4% of RFLC at 100% and 112.5% Max |
| 4.2.3 | **Winding** | |
| 4.2.3.1 | Material | Electrolytic Copper |
| 4.2.3.2 | Winding connection | |
| 4.2.3.2.1 | HV Winding | Both ends of the primary winding shall be brought out through an appropriate HV bushings, one end of HV winding shall be externally earthed. |
| 4.2.3.2.2 | LV Winding | The secondary winding shall be connected to two LV bushing |
| 4.2.3.3 | Maximum Current Density allowed | 3 Amp per sq mm |
| 4.2.3.4 | Winding Insulation | DPC insulation shall be used for HV and LV winding wires and electrical grade plain insulation Kraft paper for interleaving, no material, which can be affected by the action of oil under the operating conditions of the transformers, shall be used in the transformers or leads of the bushings. |
| 4.2.3.5 | Design features | i) The core and coil assembly shall be securely held in position to avoid any movement under short-circuit conditions.<br>ii) All turns of windings shall be adequately supported to prevent movement, in cases where turns are spaced out, a suitable inter-turn packing shall be provided.<br>iii) The type of winding provided for HV side shall be preferably disc type or spiral winding.<br>iv) The type of winding for LV side shall be preferably cylindrical, layer |
| 4.2.4 | **Transformer Oil** | |
| 4.2.4.1 | Type | i) Natural Organic Ester oil should be |

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| | | in accordance with specification as per Annex B of this document.<br>ii) One sample of oil drawn from every lot of transformer offered for inspection should be tested at CPRI/ERDA for tests as listed in IS16659. The cost of this testing should be included within the cost of transformer. |
| 4.2.5 | **Bushings and Terminations** | |
| 4.2.5.1 | Type of HV side bushing | Outdoor, Porcelain clad, creepage as per 31mm/kV(min)with voltage class of 12kV |
| 4.2.5.1.1 | Essential provision for HV side line bushing | HV bushings shall be fitted with molded heat shrinkage insulating covers / shrouds suitable for Aerial Bunched Conductor to provide protection of the bushing palm. |
| 4.2.5.2 | Type of LV side bushing | Outdoor, Porcelain clad, creepage as per 31mm/kV(min) with voltage class of 1.1kV. |
| 4.2.5.3 | Arcing Horns | Not required |
| 4.2.5.4 | Termination on HV side bushing | i) The bushing palm is suitable for termination of 1CX 150 sqmm Aerial bunched cables, with bolted type clamping arrangement both in horizontal and vertical directions.<br>ii) In case of copper/copper alloy stems, suitable bimetallic clamps with bolted type arrangement described above shall be used. |
| 4.2.5.5 | Termination of LV side bushing | Suitable for termination of 2 runs of 1CX95 sq mm XLPE cable. |
| 4.2.5.6 | Continuous Current rating | Minimum 20 % higher than the rated current of the transformer |
| 4.2.5.7 | Rated thermal short time current | 25 times the rated current for 2 sec |

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| **4.2.6** | **LT cable box** | i) The LT cable box shall be provided as an integral part of the transformer designed for outdoor duty with minimum IP-55 protection.<br>ii) MCCB is to be provided after LT bushing in the LT cable box<br>iii) The cable box shall be equipped with LED to indicate ON/OFF& tripping of LT MCCB. On resetting of LTMCCB the tripping LED shall be automatically switched off.<br>iv) LT bushing shall be inside the distribution box and a facility for sufficient outgoing feeders through cable glands shall be provided. |
| 4.2.7 | **Lightning Arrestor** | |
| 4.2.7.1 | Type | Non linear resistance type |
| 4.2.7.2 | Rated Voltage of Arrestor, kV rms | 9 |
| 4.2.7.3 | Nominal Discharge Current, kA peak | 5 |
| 4.2.7.4 | Mounting arrangement | i) Lightning arrestor shall be mounted external to the transformer and shall be suitable for outdoor type duty.<br>ii) The line terminal of the surge arrestor shall be connected the HV bushing and the earth terminal of the surge arrestor shall be solidly connected to a separate earth externally. |
| 4.2.8 | **Transformer Mounting Arrangement** | The transformers are to be mounted on single pole MS – I channel or tubular pole or PCC pole, the transformer therefore shall be provided with suitable and robust mounting arrangement. The mounting arrangement drawing shall be furnished for approval. |
| 4.2.9 | **Hardware** | |
| 4.2.9.1 | External | Stainless Steel |
| 4.2.9.2 | Internal | Cadmium plated except special hardware for frame parts and core assembly as per manufacturer's design |
| 4.2.10 | **Gasket** | i) Gaskets shall be made of synthetic rubber or synthetic rubberized cork resistant to hot transformer ester |

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| | | liquid.<br>ii) Gasket shall confirm to Type III as per IS 11149/Type C as per IS 4253 (Part 2) and shall be compatible with high contact temperature i.e thermal class of $130^0$C. |
| 4.2.11 | **Painting of transformer** | |
| 4.2.11.1 | Surface preparation | By 7 tank pretreatment process or shot blasting method |
| 4.2.11.2 | Finish on internal surfaces of the transformer | Heat resistant and oil resistant paint two coats. Paint shall neither react nor dissolve in hot transformer insulating oil. |
| 4.2.11.3 | Finish on outer surface of the transformer | Battle ship grey shade 632 IS 5 Polyurethane paint two coats, overall paint thickness shall be 150 microns (min) |
| 4.3 | **Transformer Protection** | |
| 4.3.1 | HV Protection | i) HV protection shall be provided by an internally mounted HV fuse in series with the primary winding.<br>ii) The option of using 11 KV fuse tube (preferably made of fiber glass), connected externally between the terminals of the lightning arrestor and the HV bushing can also be explored. The arrangement shall be such that the fuse tube remains in position when the fuse element inside the fuse tube blows off. |
| 4.3.2 | **LT Protection** | |
| 4.3.2.1 | MCCB Type | The MCCBs shall be trip free type with quick make and break design.<br>The design of the operating mechanism of the circuit breaker shall be such that it shall have only two positions i.e. 'ON' and 'OFF', it shall not require resetting before being switched to 'ON' position. |
| 4.3.2.2 | Utilization Category | A |
| 4.3.2.3 | Interrupting medium | Air |
| 4.3.2.4 | Design | Molded case |
| 4.3.2.5 | Type of operation | Independent manual closing |
| 4.3.2.6 | Suitability for isolation | Not suitable for isolation |
| 4.3.2.7 | Provision for maintenance | Maintainable |

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| 4.3.2.8 | Method of installation – fixed | 16 kVA | 25 kVA | 50 KVA |
| 4.3.2.9 | Number of poles | 2 | | |
| 4.3.2.10 | Rated uninterrupted current (enclosed) | 100 A | 160 A | 315 A |
| 4.3.2.11 | Voltage rating | 250/415 | | |
| 4.3.2.12 | Rated insulation voltage | 1kV | | |
| 4.3.2.13 | Rated impulse withstand voltage | 8kV | | |
| 4.3.2.14 | Ultimate Breaking Capacity Icu | 35 KA min. | | |
| 4.3.2.15 | Service Breaking capacity Ics | 35 KA min. | | |
| 4.3.2.16 | Rated frequency | 50Hz | | |
| 4.3.2.17 | Rated duty | Uninterrupted duty | | |
| 4.3.2.18 | Trip current characteristics: | | | |
| 4.3.2.19 | Type of release | Thermal-Magnetic | | |
| 4.3.2.20 | Overload setting | Variable type 60% to 100% of In. Instep of 10% | | |
| 4.3.2.21 | Short circuit settings | 250% to 900% of In. Insteps of 50% | | |
| 4.3.2.22 | Trip time at rated uninterrupted current | >2.5 hrs | | |
| 4.3.2.23 | Trip time at 2.5 Setting times normal current | < 1 minute | | |
| 4.3.2.24 | Trip time at 6 times normal current setting | < 5 secs. | | |
| 4.3.2.25 | Trip time at 9 times normal current setting | 40 millisec. | | |
| 4.3.3 | **Coordination of HT Fuse and LT MCCB** | i) The supplier shall furnish the time – current curves. The characteristics of LT MCCB and 11 KV fuse for various current multiples shall be drawn on the same sheet to indicate coordination between the LT MCCB and the HT fuse.<br>ii) The LT MCCB shall operate with time delay for over load above rated capacity of transformer unit.<br>iii) The HT fuse shall be selected such that it shall act as a back up protection for LT system faults and shall provide close co-ordination with LT MCCB<br>iv) The HT fuse shall be selected such that it shall not operate for in rush current during transformer charging | | |

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| | | v) The HT fuse shall be selected such that it shall operate instantaneously for all internal faults in the transformer.<br><br>vi) The supplier shall carry out coordination test, as indicated above, on minimum one transformer out of every 50 transformers and this shall form an Acceptance Test by the purchaser. Co-ordination of LT MCCB for external faults and HT fuse for internal faults complete with expected fault currents and $I^2t$ value of MCCB /HT fuse shall be assured/ proved. |

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**6. Fittings and Accessories on Transformer**

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| 5.1 | Rating and Diagram Plate | Required |
| 5.1.1 | Material | Anodized aluminum 16SWG |
| 5.1.2 | Background | SATIN SILVER |
| 5.1.3 | Letters, diagram & border | Black |
| 5.1.4 | Process | Etching |
| 5.1.5 | Rating and Diagram Plate details | Following details shall be provided on rating and diagram plate as a minimum<br>i) Type/kind of transformer with winding material<br>ii) standard to which it is manufactured<br>iii) manufacturer's name;<br>iv) transformer serial number;<br>v) month and year of manufacture<br>vi) rated frequency in Hz<br>vii) rated voltages in kV<br>viii) number of phases<br>ix) rated power in kVA<br>x) type of cooling (KNAN)<br>xi) rated currents in A<br>xii) 1.2/50µs wave impulse voltage withstand level in kV<br>xiii) power frequency withstand voltage in kV<br>xiv) impedance voltage at rated current |

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| | | and frequency in percentage<br>xv) Max. Total losses at 50 % rated load<br>xvi) Max. Total losses at 100 % rated load<br>xvii) Load loss at 50% & 100% rated load<br>xviii) Energy efficiency level.<br>xix) continuous ambient temperature at which ratings apply in deg C<br>xx) top oil and winding temperature rise at rated load in deg C;<br>xxi) winding connection diagram with voltage, current and power<br>xxii) transport weight of transformer<br>xxiii) weight of core and windings<br>xxiv) Weight of core<br>xxv) Weight of winding<br>xxvi) total weight<br>xxvii) volume of oil<br>xxviii) weight of oil<br>xxix) name of the purchaser<br>xxx) PO no and date<br>xxxi) Guarantee period<br>xxxii) Manufacturer call center number & email id |
| 5.2 | Two earthing terminals with the earthing symbol | Required |
| 5.3 | Lifting lugs for complete transformers as well as for core & winding | Required |
| 5.4 | Bird guard. | Required |
| 5.5 | Pressure relief valve. | Required |
| 5.6 | Non return valve. | Required |
| 5.7 | Terminal connector | Required |
| 5.8 | HV side neutral earthing strip. | Required |
| 5.9 | Lightning arrestor | Required |
| 5.10 | Terminal marking plate | Required |
| 5.11 | Fittings as per IS 1180 | Required |
| 5.12 | Additional fittings for CSP type of distribution transformers, if any. The fittings and accessories listed are | |

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| | indicative only and any other fittings and accessories which are generally required for satisfactory operation of the transformer are to be provided without any extra cost | |

## 7. Approved make of components

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| 6.1 | Bushings | Baroda Bushing/CJI/Jaipur glass |
| 6.2 | CRGO | Nippon/JFE/Posco/Thyssen Krupp |
| 6.3 | Copper | Birla copper/Sterlite |
| 6.4 | Pre compressed Pressboard | Raman Board, Mysore/ Senapathy Whiteley, Dupont |
| 6.5 | Laminated Wood | Permalli Wallance / Rochling Engineers |
| 6.6 | Natural Ester Oil | Midel/Cargil |
| 6.7 | Mineral Oil | Apar/Savita/Raj Petro |
| 6.8 | Steel | TATA/Jindal/SAIL |
| 6.9 | Surge arrestor | Electrolite Power/Oblum/Tyco |
| 6.10 | MCCB | ABB/L&T/Schneider |
| 6.11 | Fuse | ERMCO,USA |

Note – Any other make of component to be approved by purchaser

## 8. Quality assurance

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| 7.1 | Quality Assurance program | To be submitted before contract award. Program shall contain following<br>i) The structure of the organization<br>ii) The duties and responsibilities assigned to staff ensuring quality of work.<br>iii) The bidder should have qualified technical & dedicated QA personnel at various stages of manufacture & testing.<br>iv) Factory inspection of bidder may be carried out to ascertain the quality system and process in place at manufacturing facility. The same is applicable to bidders not approved with BSES.<br>v) The system for purchasing, taking delivery and verification of materials |

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| | | vi) The system for ensuring quality of workmanship<br>vii) The system for control of documentation<br>viii) The system for the retention of records<br>ix) The arrangements for the Supplier's internal auditing<br>x) A list of the administration and work procedures required to achieve and verify Contract's quality requirements. These procedures shall be made readily available to the Purchaser for inspection on request |
| 7.2 | Quality Plan | To be submitted by the successful bidder for approval. Plan shall contain following as a minimum<br>i) An outline of the proposed work and programme sequence<br>ii) The structure of the Supplier's organization for the contract<br>iii) The duties and responsibilities assigned to staff ensuring quality of work for the contract<br>iv) Inspection Hold and notification points mutually agreed.<br>v) Submission of engineering documents required by the specification<br>vi) The inspection of materials and components on receipt<br>vii) Reference to the Supplier's work procedures appropriate to each activity<br>viii) Inspection during fabrication/construction<br>ix) Final inspection and test<br>x) Successful bidder shall include submittal of Mills invoice, Bill of lading, Mill's test certificate for grade, physical tests, dimension, specific watt loss per kG for the |

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| | | core material to the purchaser for verification in the quality plan suitably |

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**10. Progress Reporting**

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| 8.1 | Outline Document | To be submitted for purchaser approval for outline of production, inspection, testing, packing, dispatch, documentation programme |
| 8.2 | Detailed Progress report | To be submitted to Purchaser once a month containing<br>i) Progress on material procurement<br>ii) Progress on fabrication<br>iii) Progress on assembly<br>iv) Progress on internal stage inspection<br>v) Reason for any delay in total programme<br>vi) Details of test failures if any in manufacturing stages<br>vii) Progress on final box up<br>viii) Constraints<br>ix) Forward path |

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**12. Inspection & testing**

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| 9.1 | Inspection and Testing during manufacture | Only type tested equipment shall be acceptable |
| 9.1.1 | Tank | i) Check for physical properties of materials for lifting lugs, jacking pads etc. All load bearing welds, including lifting lug welds shall be subjected to required load tests.<br>ii) Certification of all test results.<br>iii) Oil leakage test<br>iv) Vacuum and Pressure test on tank as type test as per IS 1180 |
| 9.1.2 | Core | i) Sample testing of core material for checking specific loss, bend properties, magnetization characteristics and thickness.<br>ii) Check on the quality of varnish if used on the stampings. |

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| | | a) Measurement of thickness and hardness of varnish on stampings.<br>b) Solvent resistance test to check that varnish does not react in hot oil.<br>c) Check over all quality of varnish by sampling to ensure uniform hipping colour, no bare spots. No ever burnt varnish layer and no bubbles on varnished surface.<br>iii) Check on the amount of burns.<br>iv) Bow check on stampings.<br>v) Check for the overlapping of stampings. Corners of the sheet are to be apart.<br>vi) Visual and dimensional check during assembly stage.<br>vii) Check on complete core for measurements of iron-loss and check for any hot spot by exciting the core so as to induce the designed value of flux density in the core.<br>viii) Check for inter laminar insulation between core sectors before and after pressing.<br>ix) Visual and dimensional checks for straightness and roundness of core, thickness of limbs and suitability of clamps.<br>x) High voltage test (2 KV for one minute) between core and clamps.<br>xi) Certification of all test results. |
| 9.1.3 | Insulating Materials | i) Sample check for physical properties of materials.<br>ii) Check for dielectric strength.<br>iii) Visual and dimensional checks.<br>iv) Check for the reaction of hot oil on insulating materials.<br>v) Certification of all test results. |
| 9.1.4 | Windings | i) Sample check on winding |

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| | | conductor for mechanical properties and electrical conductivity.<br>ii) Visual and dimensional check on conductor for scratches, dept. mark etc.<br>iii) Sample check on insulating paper for PE value, Bursting strength, Electric strength.<br>iv) Check for the reaction of hot oil on insulating paper.<br>v) Check for the bending of the insulating paper on conductor.<br>vi) Check and ensure that physical condition of all materials taken for winding is satisfactory and free of dust.<br>vii) Check for absence of short circuit between parallel strands.<br>viii) Check for Brazed joints wherever applicable.<br>ix) Measurement of voltage ratio to be carried out when core/ yoke is completely restocked and all connections are ready.<br>x) Certification of all test results. |
| 9.1.4.1 | Checks before drying process | i) Check conditions of insulation on the conductor and between the windings.<br>ii) Check insulation distance between high voltage connection distance between high voltage connection cables and earthed and other live parts.<br>iii) Check insulation distance between low voltage connection and earthed and other parts.<br>iv) Insulation test of core earthing.<br>v) Check for proper cleanliness<br>vi) Check tightness of coils i.e. no free movement.<br>vii) Certification of all test results. |
| 9.1.4.2 | Checks during drying process | i) Measurement and recording of |

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| | | temperature and drying time during vacuum treatment.<br>ii) Check for completeness of drying.<br>iii) Certification of all test results. |
| 9.1.5 | Oil | As per IS 16659/ IEC 62770 |
| 9.1.6 | Test on fittings and accessories | As per manufacturer's standard |
| 9.2 | Routine tests | The sequence of routine testing shall be as follows<br>i) Visual and dimension check<br>ii) Measurements of voltage ratio<br>iii) Measurements of winding resistance<br>iv) Measurements of insulation resistance and polarization index<br>v) Separate sources voltage withstand test.<br>vi) Measurement of iron losses and exciting current at rated frequency and 90%, 100% and 112.5% rated voltage.<br>vii) Induced voltage withstand test.<br>viii) Load losses measurement at 50 % & 100 % of load.<br>ix) Impedance measurement<br>x) Routine test of tanks<br>xi) HT fuse and LT MCCB coordination test<br>xii) Oil leakage test on transformer<br>xiii) Certification of all test results.<br>xiv) Temperature Rise Test #<br><br>#Temperature rise test may be necessary to be carried one unit/lot. Purchaser's engineer, will at its discretion, select transformer for temp. rise test from any lot offered for inspection at manufacturer's works and witness the same for comparison with ERDA/CPRI type test results |
| 9.3 | Type Tests | On one transformer of each rating and type at CPRI/ERDA.<br>i) Impulse withstand test |

| | | |
|---|---|---|
| | | ii) Temperature rise test as per IS<br>iii) Dynamic & Thermal (3 sec) Short circuit test<br>iv) Air pressure test<br>v) Pressure and Vacuum test on tank<br>vi) Dissolved gas analysis before and after Temperature Rise Test<br>vii) Oil testing to be tested at CPRI/ERDA labs, whose samples shall be selected & sealed by customer.<br><br>Note – Purchaser may choose to carry out short circuit, impulse & temperature rise test on one unit from a lot offered from inspection at CPRI/ERDA |
| 9.3.2 | Notification to bidders | In case bidder had conducted type & special tests from CPRI/ERDA on BSES design and there is no design change in the transformer less than 10 years from the date of the bid opening, then bidder need not to conduct the type test from CPRI/ERDA.<br>The bidder shall submit the under taking that there is no change in design with respect to type tested design. |
| | | The product offered must be of type tested quality.<br>In case the product offered is never type tested the same as per above list to be conducted by bidder at his own cost at CPRI/ERDA. The test report shall not be more 5 years old |
| 9.4 | Customer Hold Point | i) GTP & Drawings approval<br>ii) Tank Pressure & vacuum Test<br>iii) Core & Coil Stage inspection of each lot to be offered |

**13. Packing , Shipping, Handling and Storage**

| | | |
|---|---|---|
| 10.1 | Packing | |
| 10.1.1 | Packing protection | Against corrosion, dampness, heavy rains, breakage and vibration |
| 10.1.2 | Packing for accessories and spares | Robust wooden non returnable packing |

| | | |
|---|---|---|
| | | case with all the above protection |
| 10.1.3 | Packing details | On each packing case details required as follows<br>i) Individual serial number;<br>ii) Purchaser's name;<br>iii) PO number;<br>iv) Destination;<br>v) Supplier's name;<br>vi) Name and address of supplier's agent<br>vii) Description and quantity<br>viii) Manufacturer's name<br>ix) Country of origin<br>x) Case measurements<br>xi) Gross and net weights in kilograms<br>xii) All necessary slinging and stacking instructions. |
| 10.2 | Shipping | The bidder shall ascertain at an early date and definitely before the commencement of manufacture, any transport limitations such as weights, dimensions, road culverts, overhead lines, free access etc. from the manufacturing plant to the project site; and furnish to the Purchaser confirmation that the proposed packages can be safely transported, as normal or oversize packages, upto the plant site. Any modifications required in the infrastructure and cost thereof in this connection shall be brought to the notice of the Purchaser |
| 10.3 | Handling and Storage | As per manufacturer's instruction |

**14.**

**15. Deviations**

| | | |
|---|---|---|
| 11.1 | Deviation | Deviations from this Specification shall be provided in excel sheet with tender by reference to the Specification clause/GTP/Drawing and a description of the alternative offer. In absence of such a statement, it will be assumed that the bidder complies fully with this specification. |

## 16. Drawing & Data Submission matrix

Document submission shall be as per the matrix given below. All documents/drawing shall be provided in soft copy (in pen drive) for each section. Language of the documents shall be English only. Deficient/improper drawing submission may liable for rejection.

| S No. | Documents to be submitted | Bid | Approval | Pre Dispatch |
|---|---|---|---|---|
| 12.1 | Copy of specification along with company seal & signature on each page. | Required | Required | |
| 12.2 | Guaranteed technical particulars | Required | Required | |
| 12.3 | Outline dimension drawing for each major component, general arrangement drawing showing component layout an general schematic diagrams. | Required | Required | |
| 12.4 | Type test certificates, where available, and sample routine test reports | Required | Required | |
| 12.5 | Detailed reference list of customers already using equipment offered during the last 5 years with particular emphasis on units of similar design and rating | Required | | |
| 12.6 | Performance certificates executed in last 5 years | Required | | |
| 12.7 | Details of manufacturers quality assurance standard and programme and ISO 9000 series or equivalent national certification. | Required | | |
| 12.8 | Deviations from this specification. Only deviations approved in writing before award of contract shall be accepted. | Required | | |
| 12.9 | Recommended spare parts and consumable items for the five years of operation with prices and spare parts catalogue with price list for future requirements. | Required | | |
| 12.10 | Transport / shipping dimension and weights, space required for handling parts for maintenance | Required | | |
| 12.11 | Write up on oil preservation system. | Required | Required | |
| 12.12 | Quality assurance program. | Required | Required | |
| 12.13 | Programme for production and testing | | Required | |

| | | | | |
|---|---|---|---|---|
| 12.14 | General description of the equipment and all components, including brochures | | Required | |
| 12.15 | Detailed dimension drawing for all components ,general arrangement drawing showing detailed component layout and detailed schematic and wiring drawings for all components like Lightning arrestor, birdguard, bushings | | Required | |
| 12.16 | Calculations to substantiate choice of electrical, structural, mechanical component size, ratings | | Required | |
| 12.17 | Termination arrangement | | Required | |
| 12.18 | Flow diagram of cooling system showing no. of cooling banks | | Required | |
| 12.19 | Drawings of major components like bushing,LA, MCB etc | | Required | |
| 12.20 | Lists of makes of all fittings and accessories | | Required | |
| 12.21 | Statement drawing attention to all exposed points in the equipment at which contact with or in close proximity to other metals and stating clearly what protection is employed to prevent corrosion at each point | | Required | |
| 12.22 | Detailed installation and commissioning instructions | | Required | |
| 12.23 | Inspection and test reports carried out in manufacturers works | | | Required |
| 12.24 | Test certificates of all bought out items. | | | Required |
| 12.25 | Operation and maintenance instructions as well as trouble shooting charts. | | | Required |

## 17. Annexure – A Service Conditions

| | | |
| --- | --- | --- |
| 1.0 | Delhi Atmospheric conditions | |
| 1.1 | Average grade atmosphere : | Heavily polluted, dry |
| 1.2 | Maximum altitude above sea level | 1000 M |
| 1.3 | Ambient Air temperature | Highest 50 deg C, Average 40 deg C |
| | Design ambient temperature | 50 deg C |
| 1.4 | Relative Humidity | 90 % Max |
| 1.5 | Seismic Zone | 4 |
| 1.6 | Rainfall | 750 mm concentrated in four months |

## 18. Annexure – B Technical Particulars of Natural Ester Oil

The Natural Ester Oil shall be certified as K Class as per IS 16659/IEC 62770.

| Sr. No | Item description | Specification requirement |
|---|---|---|
| 4.1.0 | Physical property | |
| 4.1.1 | Appearance | Clear, free from sediments and suspended matter. |
| 4.1.2 | Viscosity | |
| 4.1.2.1 | At 100° C, Max | 15 mm2/sec |
| 4.1.2.2 | At 40°, , Max | 50 mm2/sec |
| 4.1.3 | Pour point , Max | -10° C |
| 4.1.4 | Water content, Max | 200 mg/kg (ppm) |
| 4.1.5 | Density at 200C, Max | 1.0 g/ $cm^3$ |
| 4.2.0 | Electrical property | |
| 4.2.1 | Dielectric breakdown voltage (2.5 mm gap), Min | 65kV |
| 4.2.2 | Dielectric Dissipation factor (Tanδ) at 900 C, Max | 0.05 |
| 4.3.0 | Chemical property | |
| 4.3.1 | Soluble acidity, Max | 0.06 mg KOH/gm |
| 4.3.2 | Corrosive sulfur | Non corrosive |
| 4.3.3 | Total additives, Max | weight fraction 5% |
| 4.4.0 | Performance-After oxidation stability test | |
| 4.4.1 | Total acidity, Max | 0.6 mg KOH/g |
| 4.4.2 | Viscosity at $40^0$ C, Max | 30% increase over the initial value |
| 4.4.3 | Dielectric Dissipation factor (Tanδ) at $90^0$ C, Max | 0.5 |
| 4.5.0 | Health, safety and environment (HSE) | |
| 4.5.1 | Fire point, Min | 300° C |
| 4.5.2 | Flash point, Min | 250°C |
| 4.5.3 | Biodegradation | Readily biodegradable |

## 19. Annexure – C Guaranteed Technical Particulars (Data by Seller)

| S. No. | Description | Specified/Required | Offered |
|---|---|---|---|
| 1.0 | Name of manufacturer | | |
| 2.0 | Type | | |
| 3.0 | Ratings | | |
| 3.1 | Nominal Continuous Rating, KVA | 16/25/50kVA | |
| 3.2 | Rated voltage-HV, Volts | 11/√3 kV | |
| 3.3 | Rated voltage-LV, Volts | 240V | |
| 3.4 | Rated current-HV, Amps | | |
| 3.5 | Rated current-LV, Amps | | |
| 3.6 | No load voltage ratio | | |
| 3.7 | Number of phases | | |
| 3.8 | Frequency, Hz | 50 Hz | |
| 4.0 | Connections | | |
| 4.1 | High voltage | | |
| 4.2 | Low voltage | | |
| 5.0 | Method of cooling | KNAN | |
| 6.0 | Impedance voltage at rated voltage and frequency at $75^0$C | 4% with IS tolerance | |
| 6.1 | Impedance | | |
| 6.2 | Reactance | | |
| 6.3 | Resistance | | |
| 7.0 | Resistance of the winding at $75^0$C in ohm | | |
| 7.1 | HV | | |
| 7.2 | LV | | |
| 8.0 | Guaranteed maximum Total Losses (no load losses+load losses at 75 deg.C), Watt | | |
| 8.1 | 50% of load | | |
| 8.2 | 100% of load | as per Spec Cl 3.24 | |
| 8.3 | No Load Loss (Max) | as per Spec Cl 3.25 | |
| 8.4 | Total $I^2R$ losses of windings @ 75 deg C, Watt | | |
| 8.5 | Total stray loses @ 75 deg C, Watt | | |
| 8.6 | Total Load losses (Max.), Watt | | |
| 8.7 | No load loss at maximum permissible voltage and frequency (approx.), Watt | | |
| 9.0 | Temperature rise over reference ambient of $50^0$ C | | |
| 9.1 | Top oil by thermometer | $35^0$ C | |
| 9.2 | Winding by resistance | $40^0$ C | |

| | | | |
|---|---|---|---|
| 9.3 | Temperature of hottest spot in the winding at full load , $^0$ C | | |
| 10.0 | Efficiency | | |
| 10.1 | Efficiency at 75$^0$C and unity power factor, % | | |
| 10.1.1 | at 110% load | | |
| 10.1.2 | at 100% load | | |
| 10.1.3 | at 80% load | | |
| 10.1.4 | at 60% load | | |
| 10.1.5 | at 40% load | | |
| 10.1.6 | at 20% load | | |
| 10.2 | Efficiency at 75$^0$C and 0.8 power factor lag, % | | |
| 10.2.1 | at 110% load | | |
| 10.2.2 | at 100% load | | |
| 10.2.3 | at 80% load | | |
| 10.2.4 | at 60% load | | |
| 10.2.5 | at 40% load | | |
| 10.2.6 | at 20% load | | |
| 10.3 | Maximum efficiency at 75$^0$C, % | | |
| 10.4 | Load and power factor at which it Occurs | | |
| 11.0 | Regulation, (%) | | |
| 11.1 | Regulation at full load at 75$^0$ C | | |
| 11.1.1 | at unity power factor | | |
| 11.1.2 | at 0.8 power factor lagging | | |
| 11.2 | Regulation at 112.5% load at 75$^0$ C | | |
| 11.2.1 | at unity power factor | | |
| 11.2.2 | at 0.8 power factor lagging | | |
| 12.0 | Details of tank | | |
| 12.1 | Type | Sealed type with bolted cover which seals the interior of the tank from atmosphere. | |
| 12.2 | Material | Tank should be round and made of good quality sheet steel | |
| 12.3 | Thickness of tank sheet | | |
| 12.3.1 | Sides, mm | | |
| 12.3.2 | Top, mm | | |
| 12.3.3 | Bottom, mm | | |
| 12.4 | Confirmation of Tank designed and tested for Vacuum, Pressure As per IS 1180(Yes/ No) | | |

| | | | |
|---|---|---|---|
| 12.4.1 | Vacuum mm of Hg. / ($kN/m^2$) | As per IS 1180 | |
| 12.4.2 | Pressure mm of Hg. | | |
| 12.5 | Is the tank lid sloped? | Yes | |
| 13.0 | Core | | |
| 13.1 | Type | Core | |
| 13.2 | Core material grade | Premium grade minimum M3 or better | |
| 13.3 | Core lamination thickness in mm | | |
| 13.4 | Insulation of lamination | With insulation coating on both sides | |
| 13.5 | Details of core | | |
| 13.5.1 | Core material grade | Premium grade minimum M3 or better | |
| 13.5.2 | Diameter, mm | | |
| 13.5.3 | Cross sectional area, $mm^2$ | | |
| 13.5.3.1 | Gross, $mm^2$ | | |
| 13.5.3.2 | Net, $mm^2$ | | |
| 13.5.4 | Window height, mm | | |
| 13.5.5 | Limb center, mm | | |
| 13.5.5 | Weight of stamping in core and yoke separately | | |
| 13.5.6.1 | Core, kgs | | |
| 13.5.6.2 | Yoke, kgs | | |
| 13.5.6.3 | Total, kgs | | |
| 13.6 | Design flux density at rated voltage , Tesla | | |
| 13.7 | Maximum flux density at 12.5 % over excitation /over fluxing, Tesla | 1.9 Tesla Max allowed | |
| 13.8 | Guaranteed No Load current at 100% rated voltage , Amps | | |
| 13.8.1 | HV | | |
| 13.8.2 | LV | | |
| 13.9 | Guaranteed No Load current At 110% rated voltage, Amps | | |
| 13.9.1 | HV | | |
| 13.9.2 | LV | | |
| 14.0 | HV coil construction details | | |
| 14.1 | Type of winding | | |
| 14.2 | Size of conductor (Bare), mm | | |
| 14.3 | Cross sectional area of conductor, $mm^2$ | | |
| 14.4 | Number of coils per limb | | |
| 14.5 | Outer diameter of coil, mm | | |
| 14.6 | Inner diameter of coil, mm | | |

| | | | |
|---|---|---|---|
| 14.7 | Insulation of conductor | | |
| 14.8 | Interlayer reinforcement detail | | |
| 14.9 | Current at full load, Amp | | |
| 14.10 | Normal working current density, Amp/mm$^2$ | | |
| 14.11 | End turn insulation | | |
| 14.12 | Weight of bare conductor used in one leg of HV, kg | | |
| 14.13 | Weight of insulated conductor used in one leg of HV, kg | | |
| 14.14 | Number of turns per leg | | |
| 14.15 | Length of mean turns, mm | | |
| 14.16 | Axial length, mm | | |
| 15.0 | LV coil constructional details | | |
| 15.1 | Type of winding | | |
| 15.2 | Size of conductor (Bare), mm | | |
| 15.3 | Cross sectional area of conductor, mm$^2$ | | |
| 15.4 | Number of coils per limb | | |
| 15.5 | Outer diameter of coil, mm | | |
| 15.6 | Inner diameter of coil, mm | | |
| 15.7 | Insulation of conductor | | |
| 15.8 | Interlayer reinforcement detail | | |
| 15.9 | Current at full load, Amp | | |
| 15.10 | Normal working current density, Amp/mm$^2$ | | |
| 15.11 | End turn insulation | | |
| 15.12 | Weight of bare conductor used in one leg of LV, kg | | |
| 15.13 | Weight of insulated conductor used in one leg of LV, kg | | |
| 15.14 | Number of turns per leg | | |
| 15.15 | Length of mean turns, mm | | |
| 15.16 | Axial length, mm | | |
| 16.0 | Insulation details material and size | | |
| 16.1 | HV coil end packing | TUP paper | |
| 16.2 | LV coil end packing | | |
| 16.3 | Inter coil spacer of HT sections | | |
| 16.4 | Bottom core strip insulation | | |
| 16.5 | Yoke insulation | | |
| 16.6 | Clamp insulation | | |
| 16.7 | Inter phase barrier | | |
| 16.8 | Core wrap | | |
| 16.9 | Cylindrical insulation between HT & LT | | |
| 16.10 | Type of blocks used between coils | | |
| 17.0 | Details of clearances | | |

| | | | |
|---|---|---|---|
| 17.1 | Internal clearance between inner walls of tank and core coil assembly unit, mm | | |
| 17.2 | Radial clearance between LV and HV winding, mm | | |
| 17.3 | Phase to phase clearance between HV limb, mm | | |
| 17.4 | Clearance from top of the yoke to the inside of the top cover of tank, mm | | |
| 17.5 | Radial clearance of LV coil from core, mm | | |
| 17.6 | Horizontal duct between HT sectional coil | | |
| 17.7 | End clearance of HT coil from yoke, mm | | |
| 17.8 | Minimum clearance between core and tank bottom, mm | | |
| 18.0 | Impulse test voltage of winding for 1.2/50 micro seconds wave according to relevant IS | | |
| 18.1 | HV | | |
| 18.2 | LV | | |
| 19.0 | Volts per coil of HV winding, Volts | | |
| 20.0 | Approximate volts per layer of HV winding, Volts | | |
| 21.0 | Induced over voltage test at double frequency | | |
| 22.0 | Permissible duration of overload following continuous running at normal rated load in ambient temperature of $50^0$C | | |
| 22.1 | 10%overload | | |
| 22.2 | 20%overload | | |
| 22.3 | 30%overload | | |
| 23.0 | RMS value of symmetrical short circuit current which the transformer can withstand and its duration | | |
| 24.0 | Terminal arrangement of HV side | | |
| 25.0 | Terminal arrangement of LV side | | |
| 26.0 | Particulars of HV bushing | | |
| 27.1 | Make | | |
| 27.2 | Type | | |
| 27.3 | Dry withstand voltage for one minute | | |
| 27.4 | Wet withstand voltage for thirty minutes | | |
| 27.5 | Voltage rating | | |
| 27.6 | Impulse withstand voltage 1.2/50 | | |

| | | | |
|---|---|---|---|
| | micro second wave | | |
| 27.7 | Total creepage distance in air | mm | |
| 27.8 | Height of bushing above transformer tank | | |
| 28.0 | Particulars of LV neutral bushing | | |
| 28.1 | Make | | |
| 28.2 | Type | | |
| 28.3 | Voltage rating | | |
| 28.4 | Dry withstand voltage for one minute | | |
| 28.5 | Wet withstand voltage for thirty minutes | | |
| 28.6 | Total creepage distance in air, mm | | |
| 28.7 | Height of bushing above transformer Tank, mm | | |
| 29.0 | Time constant of transformer | | |
| 30.0 | MCCB rating | | |
| 30.1 | Make and model no. | | |
| 30.2 | Utilization Category | A | |
| 30.3 | Interrupting medium | Air | |
| 30.4 | Design | Molded case | |
| 30.5 | Type of operation | Independent manual closing | |
| 30.6 | Voltage rating | 240/415 | |
| 30.7 | Number of poles | 2 | |
| 30.8 | Rated insulation voltage | 1kV | |
| 30.9 | Rated impulse withstand voltage | 8kV | |
| 30.10 | Rated frequency | 50Hz | |
| 30.11 | Rated duty | Uninterrupted duty | |
| 30.12 | Ultimate Breaking Capacity Icu | 35 KA min. | |
| 30.13 | Service Breaking capacity Ics | 35 KA min. | |
| 30.14 | Trip current characteristics | | |
| 30.14.1 | Rated current | | |
| 30.14.2 | Overload setting | 60% t0 100% of In. Insteps of 10% | |
| 30.14.3 | Short circuit settings | | |
| 30.14.4 | Trip time at rated uninterrupted current | >2.5 hrs | |
| 30.14.5 | Trip time at 2.5 Setting times normal current | < 1 minute | |
| 30.14.6 | Trip time at 6 times normal current setting | < 5 secs. | |
| 30.14.7 | Trip time at 9 times normal current setting | 40 millisec. | |
| 31.0 | HV fuse rating | | |

| | | | |
|---|---|---|---|
| 31.1 | Make | | |
| 31.2 | Tripping curves provided | Yes/No | |
| 31.3 | Fuse catalogue is provided | Yes/No | |
| 31.4 | Tripping coordination graph of HV fuse and MCCB is provided | Yes/No | |
| 32.0 | Transformer oil | | |
| 32.1 | Dielectric strength | | |
| 32.2 | Resistivity | | |
| 32.3 | Acidity | | |
| 32.4 | Tan delta | | |
| 32.5 | Name of supplier | | |
| 32.6 | Quantity of transformer oil, Liters | | |
| 33.0 | Weight of the following | | |
| 33.1 | Tank and fittings, Kgs | | |
| 33.2 | Core, Kgs | | |
| 33.3 | Winding weight, Kgs | | |
| 33.4 | Core and windings, Kgs | | |
| 33.5 | Transformer oil, Kgs | | |
| 33.6 | Total weight of transformer including oil, Kgs | | |
| 34.0 | Overall dimensions of transformer | | |
| 34.1 | Length | mm | |
| 34.2 | Breadth | mm | |
| 34.3 | Height | mm | |
| 35.0 | Name of material and size used for clamping of core winding | | |
| 35.1 | Core clamp | | |
| 35.2 | Tie rod | | |
| 35.3 | Core bolt | | |
| 35.4 | Bottom plate | | |
| 36.0 | Tests | | |
| 36.1 | Is the offered 16/25/50 kVA distribution transformer type tested? (Yes, No) | | |
| 36.2 | All in process tests confirmed as per Cl. 9.1 (Yes/ No) | | |
| 36.3 | All Routine Tests confirmed as per Cl.9.2 (Yes / No) | | |
| 36.4 | All Type Tests confirmed as per Cl.9.3 (Yes/ No) | | |

## 20. Annexure – D Guaranteed Technical Particulars of Natural Ester oil

Bidder to submit duly filled & signed along with techno commercial offer.

| Sr. No | Item description | Specification requirement | Data by Vendor |
|---|---|---|---|
| 1.0 | Manufacturer Name | | |
| 1.1 | Address | | |
| 1.2 | Contact person | | |
| 1.3 | Contact telephone no | | |
| 2.0 | Physical property | | |
| 2.1 | Appearance | Clear, free from sediments and suspended matter. | |
| 2.2 | Viscosity | | |
| 2.2.1 | At 100° C, Max | 15 $mm^2/sec$ | |
| 2.2.2 | At 40°, , Max | 50 $mm^2/sec$ | |
| 2.3 | Pour point , Max | -10° C | |
| 2.4 | Water content, Max | 200 mg/kg (ppm) | |
| 2.5 | Density at 20° C, Max | 1.0 g/ $cm^3$ | |
| 3.0 | Electrical property | | |
| 3.1 | Dielectric breakdown voltage(2.5 mm gap), Min | 65kV | |
| 3.2 | Dielectric Dissipation factor (Tanδ) at 900 C, Max | 0.05 | |
| 4.0 | Chemical property | | |
| 4.1 | Soluble acidity, Max | 0.06 mg KOH/gm | |
| 4.2 | Corrosive sulfur | Non corrosive | |
| 4.3 | Total additives, Max | weight fraction 5% | |
| 5.0 | Performance-After oxidation stability test | | |
| 5.1 | Total acidity, Max | 0.6 mg KOH/g | |
| 5.2 | Viscosity at 400 C, Max | 30% increase over the initial value | |
| 5.3 | Dielectric Dissipation factor (Tanδ) at 90° C, Max | 0.5 | |
| 6.0 | Health, safety and environment (HSE) | | |
| 6.1 | Fire point, Min | 300° C | |
| 6.2 | Flash point, Min | 250° C | |
| 6.3 | Biodegradation | Readily biodegradable | |
| 7.0 | Packing & delivery as per specification | | YES / NO |
| 7.1 | Size of oil drum | 210 liter minimum | |
| 7.2 | Quantity of oil to be supplied in DRUM | | |
| 8.0 | Copy of Type test report | Submitted along with GTP? | YES / NO |
| 9.0 | Deviation sheet | Submitted along with GTP? | YES / NO |

## 21. Annexure – E Recommended Spares (Data by Supplier)

List of recommended spares as following –

| Sr No | Description of spare part | Unit | Quantity |
| --- | --- | --- | --- |
| | | | |
| 1 | | No | |
| 2 | | No | |
| 3 | | No | |
| 4 | | No | |
| 5 | | No | |
| 6 | | No | |