

**2 X 660MW UDANGUDI SUPER THERMAL POWER
PROJECT**

**TECHNICAL SPECIFICATION OF OIL FILLED SERVICE
TRANSFORMERS**

DOC. NO. PE-TS-435-302-E001, R01



**BHARAT HEAVY ELECTRICALS LIMITED
POWER SECTOR
PROJECT ENGINEERING MANAGEMENT
NOIDA - 201301**

07/2021/PS-PEM-EL				TECHNICAL SPECIFICATION FOR OIL FILLED SERVICE TRANSFORMERS		SPECIFICATION NO. PE-TS-435-302-E001	
VOLUME II							
CONTENTS SHEET							
2 X 660 MW UDANGUDI STPP		REVISION 01		DATE: 15.07.2021			
		SHEET 1 OF 1					

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TECHNICAL SPECIFICATION FOR OIL FILLED SERVICE TRANSFORMER

2 X 660MW UDANGUDI STPP

SPECIFICATION NO. PE-TS- 435-302-E001

VOLUME II

REVISION 01

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SHEET 1 of 1

COMPLIANCE CERTIFICATE

The bidder shall confirm compliance to the following by signing/ stamping this compliance certificate and furnishing same with the offer.

1. The scope of supply, technical details, construction features, design parameters etc. shall be as per technical specification & there are no exclusion/ deviation with regard to same
2. There is no deviation with respect to specification other than those furnished in the 'schedule of deviations'
3. Only those technical submittals which are specifically asked for in NIT to be submitted at tender stage shall be considered as part of offer. Any other submission, even if made, shall not be considered as part of offer.
4. Any comments/ clarifications on technical/ inspection requirements furnished as part of bidder's covering letter shall not be considered by BHEL, and bidder's offer shall be construed to be in conformance with the specification.
5. Any changes made by the bidder in the price schedule with respect to the description/ quantities from those given in BOQ-Cum-Price schedule of the specification shall not be considered (i.e., technical description & quantities as per specification shall prevail).

BIDDER'S STAMP & SIGNATURE

SECTION 'I'

SPECIFIC TECHNICAL REQUIREMENTS

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1.0 SCOPE OF ENQUIRY

- 1.1 This specification covers the design, manufacture, inspection and testing at manufacturer's works, proper packing and delivery to site of **OIL FILLED SERVICE TRANSFORMERS** as mentioned in different sections of this specification, complete with all accessories for efficient and trouble-free operation.
- 1.2 It is not the intent to specify herein all the details of design & manufacture. However, the equipment shall conform in all respect to high standards of design engineering and workmanship and shall be capable of performing in continuous commercial operation.
- 1.3 Standard technical requirements of the oil filled service transformers are indicated in Section-II. Project specific requirements/changes are listed in Section-I.
- 1.4 **The requirements of Section-I shall prevail and govern in case of conflict between the corresponding requirements of Section-I and Section-II.**

2.0 BILL OF QUANTITIES:

- 2.1 Quantity requirements shall be as per BOQ-cum-price schedule as part of NIT.

3.0 TECHNICAL REQUIREMENTS

3.1 SPECIFIC TECHNICAL REQUIREMENTS

<u>S.No.</u>	<u>Reference Clause No. of Section- II</u>	<u>Specific Requirement/ Change</u>
1.	4.12.01, TECHNICAL SPECIFICATION	Additional Clause: 10mm Neoprene Gasket shall be provided. Gasket Protection Cover shall be provided in between for the following, a) HV Cable Box and Disconnecting Chamber b) Disconnecting Chamber Box and Tank body.

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		c) Front Inspection Cover for HV Cable Box Phase barriers & Rain Canopy profile shall be provided for HV Cable box. Protruded Type of Inspection Covers shall be used all over the Transformer body. Anti-Tracking Paint shall be used inside HV Cable Box/ LV Busduct.
2.	7.00.00 COMMISSIONING SPARES, SPECIAL TOOLS & TACKLES AND O & M SPARES	This Clause & Annexure-D to Section-II stands deleted.

3.2 QUALITY/INSPECTION REQUIREMENTS

<u>S.No.</u>	<u>Reference Clause No. of Section- II</u>	<u>Specific Requirement/ Change</u>
1.	CLAUSE 3.15.00: "Two (2) nos. neutral terminals shall be provided on LV side. One neutral terminal shall be part of phase connection arrangement busduct throat/ LV cable-box (as applicable)....	The Clause shall be read as "Neutral terminal shall be connected to NGR by Cable. Suitable Cable box to be provided by bidder." Cable details : XLPE CABLE 11KV-1C-300 SQ. MM.
2.	CLAUSE 3.25.00: "Maximum Transformer losses including tolerances shall be as per annexure – B, of section-I, volume-II."	This Clause & Annexure-B to Section-II stands deleted. The transformer losses shall be in line with the details & table included in Datasheet-A, Section-I.
3.	CLAUSE 6.06.00: "BHEL's Standard QP (PE-QP-999-302-E001 Rev. 0) is enclosed as per Annexure-A of section-II, volume-II for reference."	The Clause shall be read as " BHEL's QP (PE-V0-435-302-E901) is enclosed as per Annexure-A of section-II, volume-II for reference." QAP shall

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		be read in conjunction with Annexure-I & Annexure-II to QAP.
4.	CLAUSE 6.06.00: “For acceptance of short circuit reports for tests carried out earlier on similar transformers, successful bidder shall furnish the following documents for BHEL/BHEL’s customer acceptance without any commercial/ delivery implication to BHEL.	The Clause shall be read as “For acceptance of short circuit tests, reports for tests carried out within last five years from the date of techno commercial bid opening of Udangudi project i.e. 15.12.15, shall furnish the following documents for BHEL/BHEL’s customer acceptance without any commercial/ delivery implication to BHEL. The Short Circuit test reports should be for the test conducted on specified rating of transformer to be supplied under this contract. In absence of valid short circuit test reports or in case such reports are not found to be meeting the specification/ standards requirements, vendor shall conduct the short circuit test, as per Note-1, Annexure-III & Note-4 of BOQ-CUM-PRICE SCHEDULE.
5.	CLAUSE 6.06.02: “Short circuit test report of previously tested similar transformer for validation by comparison. Criteria for similarity of transformer....”	The Clause shall be read as “The Short Circuit test reports should be for the test conducted on specified rating of transformer to be supplied under this contract. Criteria for similarity of transformer....”
6.	Additional Clause:	Type test shall be conducted in line with Annexure-I to QAP. The charges of the type test shall be given separately in price schedule as indicated in BOQ-CUM-PRICE SCHEDULE Annexure-III.

4.0 DOCUMENTATION

- 4.1 Documents required along with technical offer shall be as per annexure-II.
- 4.2 Documents required after award of LOI shall be as per annexure-III.
- 4.3 Document/ drawing submission/ re-submission schedule shall be as per NIT.

SECTION -3.4: POWER TRANSFORMERS & BUS REACTOR

1.0.0 INTENT OF SPECIFICATION

This section covers the requirements of ~~EHV power transformers, bus reactor and~~ auxiliary power transformers.

2.0.0 SCOPE OF WORK

The scope of work shall include supply, installation, testing and commissioning of the following:

- a) Six numbers 400 kV class single phase generator transformers.
- b) One number 400 kV class spare single phase generator transformer
- c) One number 400 kV class three phase standby maintenance transformer
- d) Two numbers 125 MVAR 400 kV class three phase bus reactor
- e) Four numbers Unit transformers
- f) Two numbers Station transformers
- g) Four numbers 11/6.9 kV rated Unit auxiliary transformers
- h) Two numbers 11/6.9 kV rated Station auxiliary transformers
- i) Two numbers 11/6.9 kV rated AHP auxiliary transformers
- j) Two numbers 11/6.9 kV rated Sea water intake transformers
- k) Two numbers 11/34.5 kV rated External coal handling transformers
- l) Transformers as required for the **CLAUSE NA**
- m) On line dissolved gas analyzer for all generator transformers and standby maintenance transformers
- n) EHV Neutral formation for single phase generator transformers along with CT neutral box.
- o) Online partial discharge measurement equipment for all the generator transformers, standby maintenance transformer, Unit transformers and station transformers of Unit-1.
- p) Online partial discharge measurement equipment for all the Generator transformers, Unit transformers and station transformers of Unit-2.
- q) Nitrogen injection system for transformers
- r) Commissioning spares and consumables
- s) Mandatory spares
- t) Tools & tackles
- u) Any other equipment required for the system

3.0.0 CODES AND STANDARDS

The equipment to be furnished under this specification shall be in accordance with the applicable section of the latest version of the following Indian Standards, IEC publications and any other standards of latest edition including amendments, except where modified and /or supplemented by this specification.

- a) IS 12463 : Inhibited mineral insulating oil
- b) IS 2026 : Specification for Power Transformers (All parts)
- c) IS 2099 : Specification For Bushings for Alternating voltages above 1000 V
- d) IS 3347 : Dimension for porcelain transformer bushings
- e) IS 3639 : Specification For Fittings and accessories for Power Transformers
- f) IS 4257 : Porcelain Bushings for Transformers
- g) `IS 10028 : Code of practice for selection, installation and maintenance of transformers.
- h) IS-2705 : Specification for Current Transformers

- i) IS 8478 : Application Guide for On Load Tap changers.
- j) IS 10561 : Application Guide for Power Transformers.
- k) IEC 60076 : Power Transformers General (Part 1)
- l) IEC 60076 : Power Transformers Temperature rise (Part 2)
- m) IEC 60076 : Power Transformers Insulation levels, dielectric tests and external clearances in air (Part 3)
- n) IEC 60076 : Power Transformers Guide to the lightning impulse and switching impulse testing – Power transformers (Part 4)
- o) and reactors
- p) IEC 60076 : Power Transformers Ability to withstand short circuit (Part 5)
- q) IEC 60076 : Reactors 1 (Part 6)
- r) IEC 60076 : Loading guide for oil-immersed power transformers (Part 7)
- s) IEC 60076 : Power Transformers Application guide (Part 8)
- t) IEC 60076 : Power Transformers Determination of sound levels (Part 10)
- u) IEC 60076 : Power Transformers Determination of sound levels – Application guide (Part 10-1)
- v) IS 5553 : Reactors Specification (Part 2)
- w) CBIP Manual on Transformers

3.0.0 DESIGN CRITERIA

- 3.1.0 The transformer shall be designed for exceptional circumstances arising due to sudden disconnection of the load and shall be capable of operating at approximately 125% of normal rated voltage for a period of not exceeding one minute and 140% of normal rated voltage for a period of 5 seconds and 110% of normal rated voltage for continuous duration.
- 3.2.0 The transformer shall be capable of operating without injurious heating at rated output at any tap position, provided the voltage corresponding to that tap does not vary by more than $\pm 10\%$ of rated voltage. The winding including the tapping arrangement shall be designed such that the electromagnetic balance is maintained between HV and LV windings at all voltage ratios.
- 3.3.0 The transformers shall be capable of delivering the rated output at any particular tap continuously without exceeding the specified temperature limits under the following operating conditions.
 - Voltage variation of $\pm 10\%$ of rated voltage of that particular tap.
 - Frequency variation of $+3\%$ -5% of rated frequency.
 - Combined voltage and frequency variation not exceeding the rated v/f ratio by 10%.
- 3.4.0 The transformers shall be suitable for outdoor installation in a hot, saline, humid and tropical climate. They shall be capable of operating continuously at their rated outputs without exceeding specified temperature limits.
- 3.5.0 All the power transformers shall be mineral oil filled. The temperature rise of top oil (by thermometer method) shall not exceed 50°C over an ambient temperature of 50°C and Temperature rise of winding (by resistance method) shall not exceed 55°C over an ambient temperature of 50°C . Hot spot temperature based on maximum yearly weighted average temperature shall not exceed 98°C .
- 3.6.0 The maximum flux density in any part of the core and yoke at the rated MVA, voltage and frequency shall be such that at 110 per cent continuous over-voltage condition it does not exceed 1.9 Tesla.

- 3.7.0 The transformers shall withstand, without injurious heating 125% over fluxing for a period of one (1) minute and 140% over fluxing for a period of five (5) seconds. (Over fluxing caused by combined voltage and frequency fluctuations).
- 3.8.0 The transformers shall be free from annoying hum and vibration when it is in operation, even at 110% rated voltage.
- 3.9.0 The transformers shall be designed with particular attention to the suppression of maximum harmonic voltage, especially the third and fifth so as to minimize interference with communication circuit.
- 3.10.0 The transformers shall be capable of withstanding without injury, the thermal & magnetic stresses caused by faults on any of the winding /through faults with full voltage maintained on other winding for the specified duration.
- 3.11.0 Bushing CTs shall be rated for short circuit withstand duration of 1 second.
- 3.12.0 The transformer and all its accessories including CTs etc. shall be designed to withstand without injury, the thermal and mechanical effects of any external short circuit to earth and of short circuits at the terminals of any winding for the specified duration.
- 3.13.0 The transformers shall be capable of being loaded in accordance with IS: 6600/IEC-600354. There shall be no limitation imposed by bushings, tap changers etc. or any other associated equipment.
- 3.14.0 In case of radiator banks, the transformer shall be capable of operating continuously under natural cooled condition up to the specified load. ~~The forced cooling equipment shall come into operation by pre-set contacts of winding temperature indicator and the transformer shall operate as a forced cooling unit. Cooling shall be so designed that during total failure of power supply to cooling fans and oil pumps, the transformer shall be able to operate at full load for at least ten (10) minutes without the calculated winding hot spot temperature exceeding 140°C. Further, cooling shall be so designed that during total failure of cooling fans and oil pumps of one radiator bank, the transformer shall be able to operate at full load for at least ten (10) minutes without the calculated winding hot spot temperature exceeding 115°C.~~
- 3.15.0 The noise level of transformer, when energized at normal voltage and frequency with fans and pumps running shall not exceed, when measured under standard conditions, the values specified in NEMA standard publication TR-1.
- 3.16.0 Transformer tank shall be dispatched filled with oil or pure dry inert Nitrogen gas. In case the tank is filled with inert gas the temperature and pressure at the time of gas filling shall be marked on a tag. A graph showing pressure vs. temperature shall be attached for reading pressures at different temperatures. Necessary valve, two stage pressure regulators, filled up Nitrogen cylinder etc. along with other accessories required shall be provided with the tank for intermittent replenishment during transportation.
- 3.17.0 It shall be ensured that the moisture content measured at 'manufacturing works' during testing is not exceeded at site during commissioning
- 3.18.0 Impact recorder/indicator shall be provided to monitor the impact experienced by the transformer during transport.
- 3.19.0 **Generator transformers (GT)**

In addition to the above requirements **CLAUSE NA** shall take care of the following:

- a) ~~Generator transformer shall be used to connect to EHV network to evacuate power. The transformer shall be adequately sized for the stringent operating condition. It shall be rated~~

to evacuate full power of the generator with valve wide open condition at 95% operating voltage, when unit/station auxiliaries are not powered directly by generating source. Accordingly, GT shall be sized for 110% of maximum continuous rating MVA of generator.

- b) One number of single phase spare GT shall be provided common for both units, in the transformer yard. The spare GT shall be stored as per manufacturer's recommendation. Manufacturer's recommendation for long time storage shall be based on the actual installation executed by him. If the manufacturer recommends continuous charging during storage, suitable power feeding arrangement shall be provided in the switchgear for the same.
- c) The transformer shall be provided with off circuit tap changer. For tap changer, potential free contacts of GT Tap position shall be provided for remote communication to RLDC.
- d) The transformers shall be provided with 2X60% radiator banks.

3.20.0 Standby maintenance transformers

- a) The transformer shall be used to connect to EHV network to draw startup power
- b) The transformer shall be standby to Unit transformer and Station transformers. It shall be rated to backup one unit transformer and station transformer together, or two unit transformers together at any time.
- c) The transformers shall be provided with 2X50% radiator banks. The transformer shall be provided with on load tap changer. Each radiator bank shall have one spare fan.

3.21.0 Bus reactor

- a) Reactor shall be designed for exceptional circumstances arising due to sudden fluctuation in supply voltage. The reactor shall be provided with radiator banks.
- b) The crest value of the third harmonic **CLAUSE NA** in phase current not to exceed 3% of the crest value of fundamental when reactor is energised at rated voltage with sinusoidal wave form.

3.22.0 Unit Transformer (UT)

- a) Transformer shall be used to connect to Generator supply and EHV network to draw auxiliary power to feed Unit auxiliaries.
- b) 2x50% rated Unit transformer shall be provided for each Unit. UT shall be two winding type.
- c) Each UT shall be sized to feed the following loads and shall have a design margin of 10%:
 - Loads connected to Unit switchgear
 - Power requirement for FGD as specified
 - Additional load imposed on the largest rated outgoing feeder due to bus supply changeover at downstream switchgear.
- d) The transformers shall be provided with 2X60% radiator banks. The transformer shall be provided with on load tap changer.

3.23.0 Station Transformer (ST)

- a) Transformer shall be connected to IPBD busduct tap off, to draw auxiliary power to feed station auxiliaries.
- e) 2x50% rated Station transformer shall be provided for the plant. ST shall be two winding type.

- f) Each ST shall be sized to feed the following loads and shall have a design margin of 10%:
 - Loads connected to station switchgear
 - Power requirement for external coal handling as specified
 - Additional load imposed on the largest rated outgoing feeder due to bus supply changeover at downstream switchgear.
- b) The transformers shall be provided with 2X60% radiator banks. The transformer shall be provided with on load tap changer.

3.24.0 Auxiliary transformers

CLAUSE NA

- a) Required numbers of auxiliary transformers for supplying BTG auxiliaries, CHP auxiliaries, AHP auxiliaries, Sea water intake auxiliaries, etc. shall be provided .
- b) For each switchgear, 2X100% rated transformers shall be considered.
- c) Transformer shall be two winding type, sized to feed the following loads and shall have a design margin of 10%:
 - 100% load connected on both the bus sections of switchgear

- d) The transformers shall be provided with 2X50% radiator banks.

3.25.0 Efficiency

Efficiency of the transformers shall be not less than the following at 0.85 PF at full load:

- 99.0% : Auxiliary transformers

~~engineering~~. During testing, if the losses exceed the guaranteed value, penalty shall be applied for at the rates indicated in general technical specification. If the losses exceed the guaranteed value by 10% or more, the transformers may be rejected by the Owner.

4.0.0 CONSTRUCTIONAL FEATURES

4.1.0 Tank

- a) The tank shall be of welded construction and fabricated from tested quality low carbon steel of adequate thickness. After completion of tank and before painting, dye penetration test shall be carried out on welded parts of jacking bosses, lifting lugs and all load bearing members. Tank stiffeners shall be provided for general rigidity and these shall be designed to prevent retention of water.
- b) ~~The Underbase of the tank shall be fixed type.~~ ~~k. In~~
The joint shall be provided with a suitable gasket to prevent weld splatter inside the tank. Proper tank shielding shall be done to prevent excessive temperature rise of the joint.
- c) The tank shall be provided with :
 - Lifting lugs suitable for lifting the equipment complete with oil.

- A minimum of four jacking pads in accessible position to enable the transformer complete with oil to be raised or lowered using hydraulic jacks.
 - Suitable haulage holes.
- d) The tank shall be designed in such a way that it can be mounted on the plinth directly.
 - e) The base of each tank shall be so designed that it shall be possible to move the complete transformer unit by skidding in any direction without injury when using plates or rails.
 - f) The tank cover shall preferably be sloped to prevent retention of rainwater and shall not distort when lifted.
 - g) At least two adequately sized inspection openings one at each end of the tank, shall be provided for easy access to bushings and earth connections. The inspection covers shall not weigh more than 25 kg. Handles shall be provided on the inspection cover to facilitate lifting.
 - h) The tank covers shall be fitted with pockets at the position of maximum oil temperature for bulbs of oil and winding temperature indicators. It shall be possible to remove these bulbs without lowering the oil in the tank. The thermometer shall be fitted with a captive screw to prevent the ingress of water.
 - i) Bushing turrets, covers of inspection openings, thermometer pockets etc. shall be designed to prevent ingress of water into or leakage of oil from the tank.
 - j) All bolted connections shall be fitted with weather proof, hot oil resistant, resilient gasket in between for complete oil tightness. If gasket is compressible, metallic stops/other suitable means shall be provided to prevent over-compression.
 - k) Ladder with safety device for access to the top of transformer tank shall be provided.

4.2.0 Core

- a) The core shall be constructed from high grade, non-ageing, cold rolled, super grain oriented, and silicon steel laminations. CRGO Silicon steel shall be HI-B grade or equivalent.
- b) The design of the magnetic circuit shall be such as to avoid static discharges, development of short circuit paths within itself or to the earthed clamping structure and production of flux component at right angles to the plane of laminations which may cause local heating.
- ~~c) For EHV power transformers the insulation of core to clamp to tank and core to clamp plates shall be able to withstand a voltage of 10 kV (rms) for 1 minute in air.~~ **CLAUSE NA**
- d) The core shall be boltless type. Insulation of core to clamp plates shall be able to withstand a voltage of 10 kV (rms) for 1 minute for EHV transformers and 2 kV (rms) for 1 minute for other transformers.
- ~~e) For EHV power transformers, in order to ensure prevention of multiple core earthing, core isolation test at 10 kV for 1 minute shall be **CLAUSE NA** pre-commissioning stage. To facilitate above, the core & core earthing has to be done outside the tank with suitable bushing.~~
- f) The core and coil assembly shall be dried in vacuum pressure of less than 0.5 mm of Hg. Then the core and coil shall be immediately impregnated with oil to ensure the elimination of moisture with in the insulation.

- g) Core and winding shall be capable of withstanding the shock during transport, installation and service. Adequate provision shall be made to prevent movement of core and winding relative to tank during these conditions.
- h) Each core lamination shall be insulated with a material that shall not deteriorate due to pressure and hot oil.
- i) The supporting frame work of the core shall be so designed as to avoid presence of pockets which would prevent complete emptying of tank through drain valve or cause trapping of air during oil filling.
- j) Adequate lifting lugs shall be provided to enable the core and windings to be lifted.
- k) Air core reactance shall be not less than 20% to be discussed

4.3.0 Windings

- a) Conductors shall be of electrolytic grade copper, free from scales and burrs.
- b) The insulation of transformer windings and connections shall be free from insulating compounds which are liable to soften, ooze out, shrink or collapse and be non-catalytic and chemically inactive in transformer oil during service. It shall be class-A or better.
- c) Coil assembly and insulating spacers shall be so arranged as to ensure free circulation of oil and to reduce the hot spot of the winding.
- d) The coils shall be made up, shaped and braced to provide for expansion and contraction due to temperature changes.
- e) The conductor shall be transposed at sufficient intervals in order to minimize eddy currents and to equalize the distribution of currents and temperature along the winding.
- f) The end turns of the high voltage windings shall have reinforced insulation to take care of the voltage surges likely to occur during the switching or other abnormal conditions.
- g) No corona discharge shall result on the winding upon testing the transformer for induced voltage test as specified in IS.

4.4.0 Conservator & Oil Preservation System

- a) Main conservator shall have constant oil pressure system to prevent oxidation and contamination of oil due to contact with moisture, and shall be fitted with magnetic oil level gauge with low oil level potential free contacts and view glass indicator.
- ~~b) Oil preservation system shall be air cell type for transformers rated 10 MVA and above. Air cell used shall be made of nitrile rubber reinforced with glass cloth suitable for operating continuously at 100°C. CLAUSE NA~~
- c) The conservator tank shall have adequate capacity with highest and lowest visible-levels to meet the requirements of expansion of total cold oil volume in the transformer and cooling equipment from minimum ambient temperature to 100°C.
- d) Conservator shall be positioned so as not to obstruct any electrical connection to transformer. The connection of air cell to the top of the conservator shall be by air proof seal preventing entrance of air into the conservator.

- e) The conservator shall be able to withstand the vacuum during installation/maintenance periods. In addition provision shall be kept to isolate the conservator from the main tank when the latter is under vacuum by providing a vacuum sealing valve or other suitable means in the pipe connecting main tank with the conservator.
- f) The Conservator shall be fitted with 2X100% dehydrating filter breather. The breathers shall be connected in parallel to the pipe emanating from the conservator. Passage of air shall be through Silica gel. Silica gel shall be isolated from atmosphere by an oil seal. Breather shall be mounted not more than 1200 mm above rail top level. To minimize the ingress of moisture, multiple breathers of identical size shall be connected in series for main tank conservator.

4.5.0 Pressure Relief Device

Adequate number of pressure relief devices shall be provided at suitable locations. These shall be of sufficient size for rapid release of any pressure that may be generated in the tank and which may result in damage to equipment. The device shall operate at a static pressure less than the hydraulic test pressure of the transformer tank. It shall be mounted directly on the tank. One set of electrically insulated contacts shall be provided for alarm/tripping. Discharge of pressure relief device shall be properly taken through pipes and directed away from the transformer/other equipment and this shall be prevented from spraying on the tank.

4.6.0 Buchholz Relay

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

4.7.0 Oil Temperature Indicators (OTI)

Transformers shall be provided with a 150 mm dial type thermometer for top oil temperature indication. The thermometer shall have adjustable, electrically independent ungrounded alarm and trip contacts, maximum reading pointer and resetting device shall be provided in the OTI. A temperature sensing element suitably located in a pocket on top oil shall be furnished. This shall be connected to the OTI by means of capillary tubing. Temperature indicator dials shall have linear gradations to clearly read atleast every 2°C. Accuracy class of OTI shall be 1.5% or better.

The OTI shall also be provided with in built variable resistor for connecting it to transducers for remote monitoring of the temperature at DCS. The transducers shall be provided with dual outputs of 4-20 mA signal and shall be mounted in the cooler control cubicle.

4.8.0 Winding Temperature Indicator (WTI)

- a) A device for measuring the hot spot temperature of HV winding shall be provided. For transformers rated 50 MVA and above, WTI shall be provided for LV winding also.
- b) It shall comprise the following:
 - Temperature sensing element.
 - Image coil.
 - Auxiliary CTs, if required to match the image coil.
 - 150 mm dia local indicating instrument with maximum reading pointer and two adjustable electrically independent, ungrounded contacts (one for high winding temperature alarm and one for trip) besides that required for control of cooling equipment,. Temperature indicator dials shall have linear gradations to clearly read at least every 2°C. Accuracy class of WTI shall be 1.5% or better.

- Calibration device.
- c) Signal transmitter (RTD) shall provide signal for remote winding temperature (RWTI) and also separate signal for recording winding temperature at remote 'DCS system'. RTD shall be duplex platinum with nominal resistance of 100 ohms at zero degree centigrade. RTD shall be three wire ungrounded system.
- d) The WTI shall also be provided with in built variable resistor for connecting it to transducers for remote monitoring of the temperature. The transducers shall be provided with dual outputs of 4-20 mA signal and shall be mounted in the cooler control cubicle.

4.9.0 Axles and Wheels

- a) The transformers shall be provided with flanged bi-directional wheels and axles. This set of wheels and axles shall be suitable for fixing to the under carriage of transformer to facilitate its movement on rail track. Suitable locking arrangement along with foundation bolts shall be provided for the wheels to prevent accidental movement of transformer. The rail track gauge shall be 1676 mm.
- b) To prevent transformer movement during earthquake, suitable clamping devices shall be provided for fixing the transformer to the foundation. All Wheels shall be detachable and shall be made of cast iron and steel as required.
- c) Wheels shall be arranged so that they can be turned through an angle of 90° when tank is jacked up clear of the rails or floor.

4.10.0 Bushings and Current Transformers

- a) ~~Bushing for voltage rated 72.5 kV and above shall be of the oil filled condenser type. 36 kV bushing shall be solid porcelain or oil communicating type.~~
- b) ~~Oil filled condenser bushing with silicon RTV coating shall be provided with the following fittings.~~
 - ~~Oil level gauge.~~
 - ~~Oil filling plug and drain valve if not sealed.~~
 - ~~Tap for capacitance and tan delta test. (tan delta monitoring)~~
- c) ~~Alternatively, Resin Impregnated condenser type bushing shall be provided with tap for capacitance and tan delta test. (tan delta monitoring).~~
- d) The CT shall be cast resin type, with Class E insulation or better, secondary leads of CTs shall be wired up to marshaling box. The secondary terminals of the CT shall have provisions for shorting. CT shall not be mounted inside transformer.
- e) Bushings of identical rating shall be interchangeable.
- f) Porcelain used in bushing manufacture shall be homogenous, free from lamination, cavities and other flaws or imperfections that might affect the mechanical or dielectric quality and shall be thoroughly vitrified, tough and impervious to moisture.
- g) Clamps and fittings shall be of hot dip galvanised steel. The design of connectors/clamps shall ensure corona free operation at the maximum rated voltage.
- h) Bushing turrets shall be provided with vent pipes, to route any gas collection through the Buchholz relay.
- i) No arcing horns shall be provided on the bushings.

- j) The terminal marking and their physical position shall be as per IS: 2026.

4.11.0 Neutral Earthing Arrangement

- a) For solidly grounded system, the neutral terminal of the transformer shall be brought to the ground level by a tinned copper grounding ~~CLAUSE NA~~ ed from the tank by using porcelain insulators. The end of the tinned copper bar shall be brought to the bottom of the tank, at a convenient point, for making bolted connection to galvanised steel flats connected to grounding mat.
- b) For non-effectively grounded system, the neutral terminal shall be brought to cable box provided with transformer.
- c) In case of bank of three single phase transformers, HV neutral shall be formed by interconnecting HV terminals through ~~CLAUSE NA~~ copper bars, supported on porcelain insulators. For earth fault protection, cast resin CTs shall be provided in suitable enclosure after forming neutral.

4.12.0 Cable Box

Where required, a dust tight air insulated type cable box with IP: 55 protection shall be provided for terminating the cables. Inspection cover for fixed portion of cable box shall be provided. Handles for lifting cable box shall be provided. Gland plate for single core cable termination shall be of Aluminium. Oil filled type cable box shall have Pressure Relief Diaphragm

4.13.0 Cooling equipment

4.13.1 Radiator Cooling

- a) Each radiator bank shall have its own ~~cooling fans~~, shut off valves at the top and bottom (80 mm size), lifting lugs, top and bottom oil filling valves, air release plug at the top, a drain and sampling valve and thermometer pocket fitted with captive screw cap on the inlet and outlet. ~~OFAF cooled transformers shall have, in addition, 2 x 100% oil pumps and oil flow indicator. In case of failure of the running pump the standby pump shall come in immediate operation.~~ Radiators shall be designed to avoid pockets in which moisture may collect and shall withstand pressure tests.
- b) ~~Atleast one number extra cooling fan or 20~~ CLAUSE NA ~~and by fans (whichever is higher) shall be provided with each radiator bank.~~

4.14.0 Valves

- a) All valves up to and including 100 mm shall be of gun metal or of cast steel/cast iron. Larger valves may be of gun metal or may have cast iron bodies with gun metal fittings. They shall be of full way type with internal screw and shall open when turned counter clock wise when facing the hand wheel.
- b) Suitable means shall be provided for locking the valves in the open and close positions.
- c) Each valve shall be provided with the indicator to show clearly the position of the valve.
- d) All valves flanges shall have machined faces.
- e) All valves in oil line shall be suitable for continuous operation with transformer oil at 100 degree C.

- f) The oil sampling point for main tank shall have two identical valves to be put in series .Oil sampling valve shall have provision to fix rubber hose of 10 mm size to facilitate oil sampling.
- g) A valve or other suitable means shall be provided to fix the on-line dissolved gas monitoring system to facilitate continuous dissolved gas analysis. The location & size of the same shall be finalised during detail engineering stage.
- h) After testing, inside surface of all cast iron valves coming in contact with oil shall be applied with one coat of oil resisting paint/varnish with two coats of red oxide zinc chromate primer followed by two coats of fully glossy finishing paint of a shade (preferably red or yellow) distinct and different from that of main tank surface. Outside surface except gasket setting surface of butterfly valves shall be painted with two coats of red oxide zinc chromate followed by two coats of fully glossy finishing paint.
- i) All hardware used shall be cadmium plated / electro galvanised.

4.15.0 Marshalling Box

- a) The marshalling box shall have all necessary devices meant for cooler control and local temperature indicators. All the contacts of various protective devices mounted on the transformer and all the secondary terminals of the bushing CTs shall also be wired up to the terminal board in the cooler control cabinet. All the necessary terminals for remote connection to shall be wired up to the cooler control cabinet.
- b) The temperature indicators shall be so mounted that the dials are about 1200 mm from ground level. Glazed door of suitable size shall be provided for convenience of reading.
- c) Two auxiliary power supplies, 415 volt, three phase four (4) wire shall be provided at cooler control cabinet for power circuit. All loads shall be fed by one of the two feeders through an electrically interlocked automatic transfer switch housed in the cooler control cabinet. Design features of the transfer switch shall include the following :
 - Provision for the selection of one of the feeder as normal source and other as standby.
 - Upon failure of the normal source, the loads shall be automatically transferred after an adjustable time delay to standby sources.
 - Indication to be provided at cooler control cabinet for failure of normal source and for transfer to standby source and also for failure to transfer.
 - Automatic re-transfer to normal source without any intentional time delay following re-energization of the normal source.
 - Both the transfer and the re-transfers shall be dead transfers and AC feeders shall not be paralleled at any time.
 - Auto changeover shall be blocked if short circuit protective device is operated on internal fault.
- d) Necessary isolating switches and MPCB/MCB shall be provided.
- e) For cooler control circuit, control supply shall be 110 V AC. For Cooler Control circuit, Control supply shall be derive by two set of control transformers 415/110 V located in each of the Transformer cooler co. In case of GT banks Manual Bypass arrangement for control supply shall also be provided such that for the pump & fan can continue to work in-case of loss of control supply.
- f) The cooler control cabinet shall have IP 55 degree of protection.
- g) Following lamp indications shall be provided in cooler control cabinet as a minimum.

- Control supply failure
 - Power supply failure
-
- Any other indication as required.
- h) Two set of potential free initiating contact for the following signals shall be wired independently to the terminal blocks of cooler control cabinet, for connecting to protection Panel and DCS system:
- ~~Control Supply failure.~~
 - Power Supply failure.

- Buchholz relay Alarm/Trip
- Winding Temperature Indicator Alarm/Trip
- Oil Temperature Indicator Alarm/Trip
- Pressure Relief Valve Operated (Trip).
- Main tank Oil level low Alarm
- Any other contacts as required.

4.16.0 OFF Circuit tap changer

OFF-Circuit taps with the range from +5.0% to –5.0% insteps of 2.5% shall be provided on HV side of the transformer, where specified. The operating handle shall be brought out of the tank enclosure and provided with a hand wheel so that it can be operated conveniently from ground level. The operating handle shall be locked at any tap position. The design shall be such that the lock cannot be inserted unless the contacts are correctly engaged. The cranking device shall be removable, mechanical stops shall be provided to prevent cranking beyond the required level. All contacts shall be silver plated and shall be held under strong contact pressure to ensure low contact drop and avoid pitting. A warning plate indicating “For de-energized operation only” shall be fitted. The mechanism shall be provided with a mechanical tap position indicator. The direction of rotation for tap raise /lower operation shall be marked. No. of revolution of the operating handle for one tap change shall also be marked.

4.17.0 ~~On Load Tap Changer (OLTC)~~

- ~~a) The OLTC gear shall be designed to complete successfully tap changes for the maximum current to which transformer can be loaded. Devices shall be incorporated to prevent tap change when the through current is in excess of the safe current that the tap changer can handle. The OLTC gear shall withstand through fault currents without injury.~~
- ~~b) Oil, in compartments which house the breaking contacts of the OLTC shall not mix with oil in other compartments or with transformer oil. Gases released from these compartments shall be conveyed by a pipe to a separate oil conservator or to a segregated compartment within the main transformer conservator. An oil surge relay shall be installed in the above pipe. The conservator shall be provided with oil level gauge and all fitments and accessories as required.~~
- ~~c) Oil filled compartments shall be provided with filling plug, drain valve with plug, air release vent, oil sampling device, inspection opening with gasket and bolted with lifting handles.~~

- d) The OLTC shall be provided with the Local - Manual / Local - Electrical / Remote - Electrical modes of operation. The electrical operation shall be performed through a Raise / Off / Lower control switch. When the manual operating gear is in use, it shall not be possible to operate electric drive.
- e) Diverter switch, motor drive mechanism and selector switches shall be provided as per IS-10028. All electrical control switches and local operating gear shall be clearly labeled in suitable manner to indicate the direction of tap changing.
- f) A local tap changer cubicle shall be provided for housing motor drive mechanism for OLTC mounted on the tank of the transformer. The cubicle shall be fabricated with minimum 2 mm thick sheet steel complete with all wiring, MCBs, cubicle illumination lamps, anti-condensation heater with thermostatic control switch, gland plate etc. Local/ Remote selector switches shall be mounted inside the cubicle. The cubicle shall conform to IP55 degree of protection. The cubicle shall include the following as a minimum:
- Driving motor (squirrel cage totally enclosed type).
 - Electrically and mechanically interlocked reversing contactors.
 - MCCB/MPCB with integral short circuit and thermal overload protection.
 - Raise / Off / Lower control switch
 - Remote / Local selector switch lockable in 'Remote' position.
 - Mechanical tap position indicator showing rated tap voltage against each position and resettable maximum and minimum indicators.
 - Limit switches to prevent motor over-travel in either direction in addition to mechanical stops.
 - Brake or clutch to permit only one tap change at a time on manual operation.
 - Emergency manual operating devices (hand crank or hand wheel).
 - Operation counter.
 - Space heaters with MCB.
 - Cubicle lamp with door switch
 - Gaskets and hinged door with locking arrangement.
 - Terminal blocks, internal wiring, earthing terminals and double compression cable glands for power and control cables.
 - Necessary relays, contactors, current transformers etc.
 - Control supply transformer, if applicable.
 - Any other feature as required.
- g) The following electrical control features shall be provided:
- Positive completion of load current transfer, once a tap change has been initiated, without stopping on any intermediate position. In case of failure of external power supply during tap change, adequate means shall be provided to safeguard the transformer and its auxiliary equipment.
 - Only one tap change from each tap change impulse even if the control switches or push button is maintained in the operated position.
 - Cut-off of electrical control when manual control is resorted to.
 - Cut-off of a counter impulse for a reverse tap change until the mechanism comes to rest and resets the circuits for a fresh operation.
 - Cut-off of electrical control when it tends to operate the tap beyond its extreme position.
 - Voltage regulation relay shall be used for regulating the secondary voltage of power transformer with OLTC. The required dead band settings shall be set by setting the nominal value and lower and upper level values shall be set independently
 - Operation of raise control shall be automatically inhibited when the voltage falls below the specified under voltage limit.
 - Any other feature as required.

4.18.0 Numerical Tap Changer Control

The Numerical Tap Changer-cum Transformer Monitoring Unit (NTCMU) shall be provided housed in transformer relay panel. The remote tap changer-cum transformer monitoring unit shall comprise of the following:

- a. Raise / off / lower control
- b. Tap position indicator (On LCD display)
- c. Remote transformer winding temperature indication (On LCD display)
- d. Remote transformer oil temperature indication (On LCD display)
- e. Voltage sensing relay
- f. Voltage regulation relay (DAVR) for Auto operation
- g. Auto/Manual Selection
- h. Necessary auxiliary relays
- i. Necessary analog
- j. LED indications for :
 - Tap change in progress
 - OLTC Mechanism stuck
 - AC supply fail
 - Oil surge relay Alarm/Trip
 - Control supply healthy
 - Lower limit reached
 - Upper limit reached
 - Any other feature/control/annunciation as required.

The Unit shall communicate with DCS for control and indication.

4.19.0 Wiring and Terminal Blocks

- a) All control cabinets, marshaling boxes, etc. shall be fully wired at the factory to ensure proper functioning of the control, protection and interlock schemes. All contacts including spare contacts of switches, relays and other devices shall be wired up to the terminal block. The inter-connection cables shall not touch transformer body to avoid heating.
- b) Wiring shall be done with flexible 650 V grade XLPE cables with stranded copper conductor of minimum size 2.5 sq.mm. Not more than two wires shall be connected to a terminal. Wiring shall be identified at both ends with ferrules bearing wire numbers as per approved drawing. Wire termination shall be made with crimping type connectors with insulating sleeves. Wires shall not be spliced between terminals.
- c) Terminal blocks shall be of 650 V grade suitable for terminating required cable size. Terminals for CT secondary shall have provision for shorting & earthing. Not more than two wires shall be connected to any terminal. 20% spare terminals shall be provided.
- d) All devices and terminals blocks within the panel shall have identification numbers as per schematic diagram.
- e) The marshaling box shall have degree of protection of IP 55.

4.20.0 Earthing Terminals

- a) Two earthing pads (each complete with two nos. holes, M10 bolts, plain and spring washers) suitable for connection to galvanised steel earthing flat shall be provided each at position close to earth of the two diagonally opposite bottom corners of the tank.
- b) Two earthing terminals shall also be provided on cooler, cooler control cabinet and any other equipment mounted separately.

4.21.0 Insulating Oil

The insulating oil shall be EHV grade, inhibited type mineral oil, and shall conform to all parameters specified in IS/IEC standard, while tested at Supplier's premises. The transformer and all associated oil filled equipment shall normally be supplied along with the first filling of oil and 10 percent excess quantity of oil shall also be supplied in non-returnable drums. The Contractor shall furnish test certificates from the Supplier against their acceptance norms, prior to dispatch of oil from refinery to site.

4.22.0 On line Dissolved Gas Analyser (DGA)

On-line dissolved gas analyzer shall be provided for EHV power transformers (Generator transformers and Standby maintenance transformer).

It shall be GE Hydran / Kelmann / Doble make . It shall be microprocessor based, complete with extraction unit with oil pump, detection unit, sampling control unit & software. The system shall be communicated to EMS, which shall be loaded with the DGA software.

On-Line dissolved Gas Analysis shall provide automatic on-line analysis of nine (9) gases (Oxygen-O₂, Nitrogen -N₂, Hydrogen-H₂, Carbon monoxide-CO, Carbon dioxide-CO₂, Methane -CH₄, Ethane-C₂H₆, Ethylene -C₂H₄, Acetylene-C₂H₂) which shall be carried out in two steps, identical with a laboratory procedure ensuring a high accuracy and reliability:

- Degassing of the oil sample through extraction (according to IEC 60567) or any other method.
- DGA through gas chromatography with Thermal Conductivity Detector (TCD), Flame Ionization Detector (FID) and Methanizer or by Photo Acoustic Spectroscopy.

The whole system shall be controlled by a micro-processor. The intervals of the analysis can be defined by the operator. All results shall be displayed in ppm with a high sensitivity (0.1 ppm for certain hydro-carbons). Additionally all other operating conditions shall be stored in a database. The data shall be transmitted to a remote computer located in the control room. The integrated alarm function can be triggered on specific gas levels, defined trends and the interruption of the power supply. A visually effective traffic light system shall provide status indication. The whole system shall be installed in controlled environment housing.

The system shall be robust and suitable for operation in substation environment. Input oil temperature up to 100 degree Celsius. Input power supply shall be 230 V 50 Hz AC.

4.23.0 On line partial discharge (PD) measurement

The on line partial discharge measurement system shall be envisaged for assessing the condition of transformers in the field. By monitoring the in-service partial discharge, the insulation performance and bushing healthiness shall be reliability assessed over time and corrective action be taken before a failure occurs.

It shall be based on Ultra high frequency (UHF) technology, equipped with the following devices:

- UHF sensors that can be either mounted through tank hatches or inserted through an oil drain valve
- UHF central control unit
- UHF pulse generator
- PD evaluation server
- PD analyses software

- Ethernet switch
- Connecting cables & accessories
- Additional 100% sensors for future use

4.24.0 Nitrogen injection system

Generator transformers, Standby maintenance transformer, Station transformers Unit transformers and all transformers rated above 20 MVA shall be provided with a dedicated Nitrogen Injection system for prevention against the transformer explosion which shall use nitrogen as quenching medium. The system shall prevent transformer oil tank explosion / fire in case of internal / external cause. In the **CLAUSE NA** by external causes it shall accomplish its role as fire preventer and extinguisher without employing water or carbon dioxide. Fire shall be extinguished within reasonable with time (not more than 3 minutes so as not to harm the transformer) of system activation and within 30 seconds (maximum) of commencement of nitrogen injection. The system shall be time tested and proven type for similar rating of transformers. The system shall be fool-proof. The system shall have control cubicle, regulating valves, pipe connections, nitrogen cylinders, detectors, automatic control and manual control etc.

4.25.0 Each Transformer shall be supplied with the following accessories as applicable

The fittings listed are only indicative and other fittings which generally are required for satisfactory operation of the transformer are deemed to be included. The transformer fittings and accessories shall be of reputed make and shall be subject to approval of the Owner.

- 1) Conservator for main tank with oil filling hole and cap, isolating valves, drain valve, sump valve, magnetic oil level gauge with low level alarm contacts.
- 2) Pressure relief devices with alarm/trip contacts.
- 3) ~~Air cell type Oil preservation system complete with accessories~~
- 4) Buchholz relay with isolating valves on both sides, bleeding pipe with pet cock at the end to collect gases and alarm and trip contacts.
- 5) 150 mm dial magnetic oil level gauge with low level alarm contact.
- 6) Oil view glass
- 7) Thermometer pockets with mercury in glass thermometer (0-120 °C)
- 8) Winding temperature indicator for HV winding with alarm and trip contacts.
- 9) Winding temperature indicator for LV winding with alarm and trip contacts.
- 10) Signal transmitter for remote HV-WTI and LV-WTI.
- 11) ~~Remote winding temperature indicators for HV winding & LV winding.~~
- 12) ~~Remote oil temperature indicators~~
- 13) RTD for remote oil temperature indicators.
- 14) 150 mm dial oil temperature indicator with alarm and trip contacts.
- 15) Drain valve with locking arrangement at transformer end
- 16) Drain valve at burnt oil pit end with interconnecting pipe from transformer drain valve
- 17) Set of Sample valves (top and bottom)
- 18) ~~Oil flow indicator with alarm contacts with each oil pump~~
- 19) Set of Filter valves (top and bottom) with locking arrangement at bottom valve.
- 20) ~~Shut-off valves on both sides of oil pumps.~~
- 21) Set of Silica gel breather with oil seal
- 22) Rating plate and terminal marking plate.
- 23) Valve Schedule plate.

- 24) Do's & Don'ts plate.
- 25) marshalling box
- 26) All cabling between transformer and cabinet.
- 27) Set of Air relief devices
- 28) Ladder with safety device for access to the top of transformer tank.
- 29) HV bushings
- 30) LV bushings busduct adaptor
- 31) LV Neutral bushing with cable box
- 32) Current transformers
- 33) Inspection covers
- 34) Cover lifting eyes, lifting lugs, jacking pads, towing holes, etc.
- 35) Protected type mercury or alcohol in glass thermometer.
- 36) Flanged bi-directional wheels
- 37) Radiator banks complete with ~~fans~~, valves, etc.
- 38) Drain valves/plugs for pipe work
- ~~39) On load tap changer.~~
- ~~40) Numerical tap changer control unit~~
- 41) Off circuit tap changer

4.26.0 Painting

- (a) Painting shall be carried out as per 'CBIP Manual on Transformers'.
- (b) External and internal surfaces of all transformer tanks and chambers and other fabricated steel items shall be cleaned of scale, rust and surface dirt by blast cleaning. Inside of all oil filled chambers and tanks, hot oil resistant varnish on white epoxy paint shall be applied. Two coats of epoxy zinc phosphate or zinc chromate primer topped with two coats of aliphatic glossy paint finish shall be applied. One intermediate coat of high build micaceous iron oxide shall also be applied. Total dry film thickness shall be 150-180 microns. All interior surfaces of chambers that are in contact with oil shall have atleast three coats of paint.
- (c) The finish shade on external surface shall be of shade number 631 of IS: 5. One coat of additional paint shall be given at site over all external surfaces after erection.

5.0.0 TESTS

All tests shall be carried out using its own accessories and parts which shall be supplied along with the transformer. Tests shall be conducted on transformer as per IS: 2026/ IEC-60076/CBIP Manual.

5.1.0 Routine Tests

Following routine tests shall be conducted on each transformer:

- a) Measurement of winding resistance at all taps
- b) Measurement of voltage ratio at all taps, polarity and check of phase displacement
- c) Measurement of impedance voltage / short circuit impedance (principal tapping) and load loss.

- d) Measurement of no load loss and current.
- e) Measurement of insulation resistance.
- f) ~~Switching impulse withstand voltage test, transformer winding $U_m > 72.5$ kV~~
- g) ~~Lightning impulse withstand voltage test, transformer winding $U_m > 72.5$ kV~~
- h) Separate source withstand voltage test.
- i) Induced AC Over voltage withstand test
- j) Tests on on-load tap changers
- k) Leakage test on tank, conservator and radiator during fabrication
- l) Oil pressure test

5.2.0 Type Tests

Following type tests shall be conducted on one transformer of each type and each rating:

- a) Temperature rise Test with dissolved gas analysis test before and after.
- b) Lightning impulse withstand voltage test, transformer winding $U_m \leq 72.5$ kV
- c) Vacuum test during tank fabrication as per CBIP
- d) Pressure test on Transformer. as per CBIP
- e) Degree of protection for marshalling box and cable box

5.3.0 Special Tests

Following Special tests shall be conducted on one transformer of each type and each rating:

- a) Lightning impulse test on neutral terminal (Where neutral is resistance grounded)
- b) ~~Long duration induced AC voltage test for transformer winding $72.5 \text{ kV} < U_m \leq 170 \text{ kV}$.~~
- c) Short circuit withstand test (If valid type test report is not available for the specified rating)
- d) Measurement of zero-sequence impedance of three-phase transformers.
- e) Measurement of Acoustic noise level
- f) Measurement of the harmonics of the no-load current.
- g) ~~Measurement of the power taken by the fan and oil pump motors.~~
- h) Test with lightning impulse chopped on the tail.
- i) Determination of capacitance and dissipation factor between windings-to-earth, and between windings.
- j) Determination of transient voltage transfer characteristics.
- k) ~~SFRA test before dispatch~~

5.4.0 Additional Tests

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

- a) Magnetic circuit isolation test
- b) ~~Determination of capacitances and dissipation for condenser bushings > 72.5 kV~~
- c) Magnetic balance test on three phase transformer
- d) Dissolved gas analysis before and after temperature rise test
- e) Frequency response analysis test
- f) Measurement of magnetization current at low voltage
- g) Tests on oil
- h) Oil pressure test on completely assembled transformer
- i) Dew point measurement before dispatching.

Insulating oil shall be tested for BDV & moisture content as follows, at manufacturer's works (oil sample shall be drawn before and after heat run test):

- BDV 60 kV (min.)
- Moisture content 15 ppm

	TITLE : TECHNICAL SPECIFICATION FOR OIL FILLED SERVICE TRANSFORMERS 2 X 660MW UDANGUDI STPP	SPECIFICATION NO. PE-TS-435-302-E001
		VOLUME NO. : II
		SECTION : I
		REV NO. : 01 DATE : 15.07.2021

ANNEXURE – II

DOCUMENTS REQUIRED ALONG WITH TECHNICAL OFFER

- a) The enclosed Data Sheet-B filled up completely for each rating/ type of transformers.
- b) Schedule of deviations.
- c) Schedule of BOQ cum price schedule. (Unpriced)
- d) 10% Extra oil price schedule (Unpriced)
- e) Schedule of Mandatory spares. (Unpriced)
- f) Schedule of Type test. (Unpriced)

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ANNEXURE –III

DOCUMENTS REQUIRED AFTER AWARD OF CONTRACT

Sl No	DWG. / DOCUMENT No.	DOCUMENT TITLE	DRAWINGS/ DOCUMENTS TYPE
1	PE-V0-435-302-E011	5MVA SERVICE TRANSFORMER (11/6.9KV) TECHNICAL DATA SHEET	PRIMARY
2	PE-V0-435-302-E012	5MVA SERVICE TRANSFORMER (11/6.9KV) OUTLINE GENERAL ARRANGEMENT DRAWING [OGA]	PRIMARY
3	PE-V0-435-302-E013	5MVA SERVICE TRANSFORMER (11/6.9KV) RATING & DIAGRAM PLATE	PRIMARY
4	PE-V0-435-302-E014	5MVA SERVICE TRANSFORMER (11/6.9KV) FOUNDATION PLAN	PRIMARY
5	PE-V0-435-302-E015	5MVA SERVICE TRANSFORMER (11/6.9KV) GENERAL ARRANGEMENT OF MARSHALLING BOX	PRIMARY
6	PE-V0-435-302-E016	5MVA SERVICE TRANSFORMER (11/6.9KV) HV CABLE BOX ARRANGEMENT DRAWING	PRIMARY
7	PE-V0-435-302-E017	5MVA SERVICE TRANSFORMER (11/6.9KV) LV BUS DUCT TRUNKING DRAWING / LV CABLE BOX	PRIMARY
8	PE-V0-435-302-E018	5MVA SERVICE TRANSFORMER (11/6.9KV) H.V. BUSHING	PRIMARY
9	PE-V0-435-302-E019	5MVA SERVICE TRANSFORMER (11/6.9KV) L.V. BUSHING	PRIMARY
10	PE-V0-435-302-E020	5MVA SERVICE TRANSFORMER (11/6.9KV) LVN BUSHING	PRIMARY
11	PE-V0-435-302-E021	5MVA SERVICE TRANSFORMER (11/6.9KV) VALVE SCHEDULE PLATE	PRIMARY
12	PE-V0-435-302-E022	5MVA SERVICE TRANSFORMER (11/6.9KV) WIRING DIAGRAM FOR MARSHALLING BOX	PRIMARY
13	PE-V0-435-302-E023	5MVA SERVICE TRANSFORMER (11/6.9KV) TRANSPORTATION DETAILS	PRIMARY
14	PE-V0-435-302-E024	5MVA SERVICE TRANSFORMER (11/6.9KV) BI- DIRECTIONAL ROLLERS	PRIMARY
15	PE-V0-435-302-E025	5MVA SERVICE TRANSFORMER (11/6.9KV) DESIGN CALCULATIONS FOR SHORT CIRCUIT CAPABILITY	SECONDARY
16	PE-V0-435-302-E026	6.3MVA SERVICE TRANSFORMER (11/6.9KV) TECHNICAL DATA SHEET	PRIMARY
17	PE-V0-435-302-E027	6.3MVA SERVICE TRANSFORMER (11/6.9KV) OUTLINE GENERAL ARRANGEMENT DRAWING [OGA]	PRIMARY
18	PE-V0-435-302-E028	6.3MVA SERVICE TRANSFORMER (11/6.9KV) RATING & DIAGRAM PLATE	PRIMARY

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19	PE-V0-435-302-E029	6.3MVA SERVICE TRANSFORMER (11/6.9KV) FOUNDATION PLAN	PRIMARY
20	PE-V0-435-302-E030	6.3MVA SERVICE TRANSFORMER (11/6.9KV) GENERAL ARRANGEMENT OF MARSHALLING BOX	PRIMARY
21	PE-V0-435-302-E031	6.3MVA SERVICE TRANSFORMER (11/6.9KV) HV CABLE BOX ARRANGEMENT DRAWING	PRIMARY
22	PE-V0-435-302-E032	6.3MVA SERVICE TRANSFORMER (11/6.9KV) LV BUS DUCT TRUNKING DRAWING / LV CABLE BOX	PRIMARY
23	PE-V0-435-302-E033	6.3MVA SERVICE TRANSFORMER (11/6.9KV) H.V. BUSHING	PRIMARY
24	PE-V0-435-302-E034	6.3MVA SERVICE TRANSFORMER (11/6.9KV) L.V. BUSHING	PRIMARY
25	PE-V0-435-302-E035	6.3MVA SERVICE TRANSFORMER (11/6.9KV) LVN BUSHING	PRIMARY
26	PE-V0-435-302-E036	6.3MVA SERVICE TRANSFORMER (11/6.9KV) VALVE SCHEDULE PLATE	PRIMARY
27	PE-V0-435-302-E037	6.3MVA SERVICE TRANSFORMER (11/6.9KV) WIRING DIAGRAM FOR MARSHALLING BOX	PRIMARY
28	PE-V0-435-302-E038	6.3MVA SERVICE TRANSFORMER (11/6.9KV) TRANSPORTATION DETAILS	PRIMARY
29	PE-V0-435-302-E039	6.3MVA SERVICE TRANSFORMER (11/6.9KV) BI- DIRECTIONAL ROLLERS	PRIMARY
30	PE-V0-435-302-E040	6.3MVA SERVICE TRANSFORMER (11/6.9KV) DESIGN CALCULATIONS FOR SHORT CIRCUIT CAPABILITY	SECONDARY
31	PE-V0-435-302-E802	SERVICE TRANSFORMER O & M MANUAL	SECONDARY
32	PE-V0-435-302-E805	SERVICE TRANSFORMER TYPE TEST REPORTS	SECONDARY
33	PE-V0-435-302-E807	SERVICE TRANSFORMER MANDATORY SPARES	SECONDARY
34	PE-V0-435-302-E901	QUALITY PLAN FOR SERVICE TRANSFORMERS	PRIMARY

Note:

1. In BOM each of the item to be uniquely identified with item code no. or item Sl. no. Supplier to ensure that all the items which will find separate mention in the packing list are covered in detailed BOM. Supplier to give following undertaking in BOM: " The BOM provided here completes the scope (in content and intent) of material supply under PO no. ---- dtd ----- Any additional material which may become necessary for the intended application of supplied item/package will be supplied free of cost in most reasonable time."

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DATA SHEET –A

11/6.9 kV
SERVICE TRANSFORMER

S. No.	Description	Unit	Particulars
1.0	Quantity	Nos. & kVA	2Nos.- 5.0 MVA 2Nos.- 6.3 MVA
2.0	Installation	--	Out Door
3.0	Type of insulating oil	--	Mineral
4.0	No. of phase	No(s)	03
5.0	Frequency	Hz	50
6.0	Type of cooling	--	ONAN
7.0	Rated output under site conditions	kVA	As indicated
8.0	Rated Voltage		
9.0	HV Winding	kV	11.0
	a) LV Winding	kV	6.9
	b) No Load transformation ratio	--	11/6.9
10.0	Vector group	--	Dyn1
11.0	Impedance voltage at rated current and frequency for the principal tapping at 75 deg. C	%	5.0 MVA : 9% 6.3 MVA : 6%
12.0	Total range of tappings and tapping steps	--	± 5% in steps of 2.5%
13.0	Type of tap changing equipment	--	Off-Circuit
14.0	Temperature rise		
	a) Top oil by thermometer	deg. C	50 above ambient of 50
	b) Winding by resistance	deg. C	55 above ambient of 50
15.0	System Highest Voltage		
	a) HV Winding	kV	12.0kV
	b) LV Winding	kV	7.2 kV
16.0	Phase Connection		
	a) HV Winding	--	Delta
	b) LV Winding	--	Star

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17.0	Insulation Levels		
A)	For winding		
1	One minute power frequency withstand voltage		
	a) HV Winding	kV	28 (11kV)
	b) LV Winding	kV	20 (6.6kV)
2	Impulse withstand voltage		
	a) HV Winding	kVp	75 (11kV)
	b) LV Winding	kVp	60 (6.6kV)
B)	Insulation Levels (for bushing)		
1	One minute power frequency withstand voltage		
	a) HV Bushing	kV	38 (17.5 kV)
	b) LV Bushing	kV	20 (7.2kV)
2	Impulse withstand voltage		
	a) HV Bushing	kVp	95(17.5 kV)
	b) LV Bushing	kVp	60 (7.2kV)
18.0	Terminal details		
	a) HV Line	--	Cable box (XLPE cables: 1C-300 SQ.MM./PH)
	b) HV Neutral	--	N.A
	c) LV Line	--	Phase segregated Bus-duct
	d) LV Neutral (NGR excluded from bidder's scope of supply)	--	Cable Connection to NGR, Suitable Cable box to be provided. Cable details : XLPE CABLE 11KV-1C-300 SQ. MM.
19.0	System Fault Level		
	a) HV	kA	50 kA RMS, 3 S
	b) LV	kA	31.5 kA RMS, 3 S
20.0	Method of System Earthing		

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	a) HV System	--	Delta connected (11 KV system is low resistance earthed to limit earth fault current to 300A)
	b) LV System	--	low resistance earthed to limit earth fault current to 300A, 10S
21.0	Through fault withstand time	Sec	2 sec
22.0	Details of Cooling Equipment	--	Detachable tank mounted radiators
23.0	Provision/ accommodation of CTs in LV Neutral	--	<u>6.3MVA:</u> 1. BUSHING CTS TO BE PROVIDED AS PER DETAILS GIVEN BELOW: LV NEUTRAL: 2-CORE NEUTRAL CT: 1st CORE OF 300/1A, 5P20 CLASS, 10VA BURDEN 2nd CORE OF 630/1A, PS CLASS, $V_k \geq 35R_{ct} + 60V$, $I_e \leq 30mA$ at $V_k/2$ <u>5.0MVA:</u> 1. BUSHING CTS TO BE PROVIDED AS PER DETAILS GIVEN BELOW: LV NEUTRAL: 2-CORE NEUTRAL CT: 1st CORE OF 300/1A, 5P20 CLASS, 10VA BURDEN 2nd CORE OF 630/1A, PS CLASS, $V_k \geq 20R_{ct} + 30V$, $I_e \leq 30mA$ at $V_k/2$ Please note that, any change in the above mentioned CT details shall be taken care by bidder without any techno-commercial implication to BHEL.
24.0	Creepage distance	mm/kV	31
25.0	Painting Details		As per details mentioned in Section-I of tech. spec.

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a)	Interior (For M. Box)		Particulars shall be given to successful bidder during detail engineering. There shall be no commercial implication to BHEL on this account.
b)	Exterior		
26.0	Cable Details		BHEL SCOPE
a)	HV Side		
	Type		XLPE insulated, armoured
	Voltage Grade		11/11 kV (UE)
	Conductor Material		Al Conductor
	Nos. of Cores & Runs	Sq.mm	1C-300/ Ph
b)	LV Side		Not Applicable
	Type		Not Applicable
	Voltage Grade		
	Conductor Material		
c)	LV Neutral		
	Type		XLPE insulated armoured
	Voltage Grade		11/11 kV (UE)
	Conductor Material		Al Conductor
	Nos. of Cores & Runs	Sq.mm	1C-300
27.0	ADDITIONAL DETAILS		
a)	CRGO Silicon Steel used for core shall be Hi-B grade or equivalent.		
b)	Transformer losses shall be as per the details in table given below.		
c)	CABLE BOX: 10mm Neoprene Gasket shall be provided. Gasket Protection Cover shall be provided in between for the following, d) HV Cable Box and Disconnecting Chamber e) Disconnecting Chamber Box and Tank body. f) Front Inspection Cover for HV Cable Box Phase barriers & Rain Canopy profile shall be provided for HV Cable box. Protruded Type of Inspection Covers shall be used all over the Transformer body. Anti-Tracking Paint shall be used inside HV Cable Box/ LV Busduct.		

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TRANSFORMER LOSSES

1. The No-Load and Load losses for transformers are given below:

Ratings	Maximum No-Load losses at rated frequency and 100%voltage	Maximum Load losses at normal ratio, rated current and 75 deg. C
<u>5.0MVA</u>	4.5kW	36.0kW
<u>6.3 MVA</u>	5.5kW	45.0kW

2. The above indicated maximum No-Load and Load losses are inclusive of permissible tolerance as per IS-2026. Further tolerance on maximum losses is not permissible.
3. In case measured losses of transformers during testing exceeds the above mentioned values, BHEL may accept the transformer with penalty. The rate of penalty shall be 3,56,607 INR per kW. The penalty shall be calculated for each transformer as given below:

PENALTY =Penalty Rate x [measured No-Load losses - maximum No-Load losses) + (measured Load losses – maximum Load losses)]

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DATA SHEET –B**TECHNICAL PARTICULARS****[TO BE SUBMITTED ALOGWITH TECHNICAL OFFER]****11/6.9kV**

S. No	Description	5.0 MVA	6.3 MVA
1.	Rating		
2.	No Load transformation ratio		
3.	Maximum No- load losses at rated frequency and 100% rated voltage	4.5kW	5.5kW
4.	Maximum load losses at normal ratio, rated current and 75 deg. C	36.0kW	45.0kW
5.	Overall Dimensions		
6.	Total weight		
7.	Total oil Quantity		

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DATA SHEET –C
TECHNICAL PARTICULARS

[TO BE SUBMITTED AFTER AWARD OF CONTRACT FOR EACH RATING]

S. No.	Description	Unit	Particulars
1.0	Name of Manufacturer	--	
2.0	Reference Standards	--	
3.0	Installation	--	
4.0	Rated No Load Voltage		
	a) HV Winding	kV	
	b) LV Winding	kV	
5.0	Type of cooling	--	
6.0	Rated kVA	--	
7.0	No. of phase	Nos.	
8.0	Rated Frequency	Hz	
9.0	Winding connections		
	a) HV Winding		
	b) LV Winding		
10.0	Vector group		
11.0	Impedance voltage at rated current and frequency for the principal tapping at 75 deg. C	%	
12.0	Off-Circuit tap changer		
	a) Total range of tapplings (+/-)	%	
	b) Size of tapping step	%	
	c) For HV/LV variation		
13.0	Impulse voltage withstand level		
	a) HV Winding	kVp	
	b) LV Winding	kVp	
14.0	One minute power frequency withstand voltage		
	a) HV Winding	kV	
	b) LV Winding	kV	
15.0	Maximum No load losses at rated frequency and		

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	a) 100% rated voltage	kW	
	b) 110% rated voltage	kW	
16.0	Maximum Load losses at normal ratio, rated current and 75 deg. C	kW	
17.0	Tolerance on losses (+/-)		
18.0	Guaranteed maximum Temperature rise of		
	a) Top oil by thermometer above ambient of 45 deg. C	Deg. C	
	b) Winding by resistance ambient of 45 deg. C	Deg. C	
19.0	Efficiency at 75 deg. C and unity power factor for		
26.0	a) 100% full load	%	
	b) 75% full load	%	
	c) 50% full load	%	
20.0	Voltage regulation at full load at 75 deg. C		
	a) Unity power factor	%	
	b) 0.8 Power factor (Lagging)	%	
21.0	External short circuit withstand capacity & duration	MVA, sec	
22.0	Max. short time (30 sec.) rating of transformer	kVA	
23.0	Type of magnetic circuit	Core/ Shell	
24.0	Type of core joints		
25.0	Type of winding		
	a) HV Winding		
	b) LV Winding		
26.0	Type of insulation		
	a) HV Winding		
	b) LV Winding		
	c) Between core & adjacent winding		
	d) Between windings		
27.0	HV terminal arrangement		

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	a) Bushing with or without CTs		
	b) CT details (Ratio, ACC. Class, VA, Type)		
	c) Clearance between phases in air	mm	
	d) Clearances to earth in air	mm	
28.0	LV terminal arrangement		
	a) Bushing with or without CTs		
	b) CT details (Ratio, ACC. Class, VA, Type)		
	c) Clearance between phases in air	mm	
	d) Clearances to earth in air	mm	
29.0	Neutral terminal arrangement		
	a) No. of neutral terminals		
	b) Neutral CT provided or not		
	c) NCT details (Ratio, ACC. Class, VA, Type)		
30.0	HV Bushing		
	a) Rated voltage class	kV	
	b) Rated current	A	
31.0	LV Bushing		
	a) Rated voltage class	kV	
	b) Rated current	A	
32.0	LV Neutral Bushing		
	a) Rated voltage class	kV	
	b) Rated current	A	
33.0	Maximum flux density		
	a) At rated voltage	Wb/M2	
	b) At 110% rated voltage	Wb/M2	
34.0	Maximum current density for		
	a) HV Winding	Amp/mm2	
	b) LV Winding	Amp/mm2	
35.0	Magnetising current at rated voltage and frequency (% of full load current)		
36.0	Rollers		

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	a) Type		
	b) Unidirectional/ Bidirectional		
	c) Quantity		
	d) Gauges		
	a) Longitudinal	mm	
	ii) Transverse	mm	
37.0	Pressure test withstand		
	a) Tank	Kg/M2	
	b) Radiator and other fittings	Kg/M2	
38.0	Vacuum withstand		
	a) Tank	mm of Hg	
	b) Radiator and other fittings	mm of Hg	
39.0	Approximate weight of		
	a) Core	kg	
	b) Windings	kg	
	c) Tank, Fittings & Coolers etc.	kg	
40.0	Oil	kg	
	a) Total weight with oil	kg	
	b) Un-tanking weight (core & winding)	kg	
	c) Shipping weight of the heaviest package	kg	
41.0	Quantity of Insulating Oil		
	a) Oil in tank	Lts	
	b) Oil in cooling equipment	Lts	
	c) Total oil Quantity	Lts	
42.0	Dimensions		
42.1	Tank dimensions		
	a) Length	mm	
	b) Breadth	mm	
	c) Height	mm	
42.2	Shipping dimensions of the largest package		

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	a) Length	mm	
	b) Breadth	mm	
	c) Height	mm	
43.0	Overall Dimensions (LxBxH)	(mmXmmXmm)	
44.0	Details of tank and other material		
	a) Thickness of tank side plate	mm	
	b) Thickness of tank bottom plate	mm	
	c) Thickness of tank cover plate	mm	
	d) Thickness of radiator sheets	mm	
	e) Minimum clearance height for lifting core and winding from tank	mm	
45.0	Positive sequence impedance at		
	Maximum voltage tap	%	
	Minimum voltage tap	%	
46.0	Zero-sequence impedance at principal tap	%	
47.0	Paint Shade		
48.0	Voltage Variation		
49.0	Noise Level		
50.0	Degree of Protection		
	Marshalling Box		
	HV Cable Box		
	LV Flange Enclosure		
51.0	Creepage Distance		
	HV Bushing	mm/kV	
	LV Bushing	mm/kV	
	Neutral Bushing	mm/kV	
52.0	Material of Winding		
	HV/LV		

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53.0	Insulation level separate source power frequency voltage withstand		
	HV winding (kV RMS)		
	LV winding (kV RMS)		
	HV Bushing		
	LV Bushing		
	Neutral Winding		
54.0	Temperature Class of Insulation		
55.0	Over Excitation withstand time (sec)		
	100%		
	110%		
	125%		
	140%		
56.0	Thermal Time constant		
57.0	Magnetizing Inrush Current		
58.0	Radiator Details		
	No. of Radiators		
	No. of Flutes		
	Overall Dimensions		
	Radiator sizing calculations furnished	(YES/NO)	

SECTION 'II'

STANDARD TECHNICAL SPECIFICATION

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1.00.00 SCOPE

1.01.00 This specification covers the design, manufacture, inspection & testing, packing at manufacturer's works and delivery to site of mineral oil filled service Transformers complete with all fittings & accessories for satisfactory operation at site.

1.02.00 TERMINAL POINTS

1.02.01 HV bushings with terminal connector for bus duct/ cable glands & lugs in case of cable connection.

1.02.02 LV bushings with terminal connector (3 Phase + 1 Neutral) for bus duct/ cable glands & lugs in case of cable connection.

1.02.03 For HV Earthing : (Applicable in case of star connection of HV) - neutral earth busbar brought near the base of transformer/ Cable glands & lugs in case of cable connection.

1.02.04 For LV Earthing : - neutral earth busbar brought near the base of transformer/ Cable glands & lugs in case of cable connection

1.02.05 Transformer earthing pads.

1.02.06 Terminals of marshalling box for external connection to equipment supplied by the purchaser.

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2.00.00 CODES AND STANDARDS

S.NO.	STANDARD NUMBER	STANDARD TITLE
1	IS:2026 IEC: 60076	POWER TRANSFORMERS
2	IS:1180	OUTDOOR TYPE OIL IMMERSED DISTRIBUTION TRANSFORMERS UPTO AND INCLUDING 2500 kVA, 33kV - SPECIFICATION
2	IS:6600	GUIDE FOR LOADING OF OIL IMMERSED TRANSFORMER
3	IS: 3639	FITTINGS & ACCESSORIES FOR POWER TRANSFORMER
4	IS: 335 IEC: 60296	NEW INSULATING OILS
5	IS: 2099 IEC: 60137	Bushing for alternative voltage above 1000 volts
6	IS: 3347	Dimension for porcelain transformer bushings
7	IS: 2705 IEC: 60185	Current transformers
8	IS: 3637	Gas operated relays
9	IS:1271 IEC: 60216	Classification of insulating material for electrical machinery & apparatus in relation to their thermal stability in service
10	IS/IEC: 60529	Classification of degrees of protection provided by enclosures of electrical equipment
11	IS: 2071 IEC: 60060	Method of high voltage testing
12	IS: 5	Colours for ready mixed paints & enamels
13	NEMA, STANDARD-TR1	Noise level
14	CBIP Publication (latest edition)	Manual on transformers

2.01.00 The equipment shall comply with all currently applicable safety codes and statutory regulations of India as well as of the locality where the equipment is to be installed including Indian Electricity Act, Indian Electricity Rules and Bureau of Indian Standards.

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3.00.00 TECHNICAL REQUIREMENTS

- 3.01.00 Technical particulars of transformers are specified in Data Sheet –A of section-I, volume-II.
- 3.02.00 All windings shall be fully insulated. Material of the windings shall be electrolytic grade copper, free from scales and burrs. Winding shall be uniformly insulated.
- 3.03.00 The core shall be constructed from high grade, non-ageing, cold rolled, grain oriented silicon steel laminations.
- 3.04.00 Internal design of transformer shall ensure that air is not trapped in any location.
- 3.05.00 Nuts, bolts and pins used inside the transformer shall be provided with lock washers & locknuts
- 3.06.00 **Tank**
- 3.06.01 Under base of tank shall be fixed type.
- 3.06.02 Tank shall be of welded construction & fabricated from tested quality low carbon steel of adequate thickness. Tank shields, if provided, shall not resonate at natural frequency of equipment.
- 3.06.03 All steel surfaces in contact with insulating oil shall be painted with two coats of heat resistant oil in soluble insulating varnish.
- 3.06.04 Auxiliary transformers shall have suitable bi-directional skids, however auxiliary transformers above 2 MVA shall be provided with four no. of bi-directional detachable flat rollers. Suitable locking arrangement shall be provided to prevent accidental movement of transformer.
- 3.06.05 At least two adequately sized inspection openings, one at the each end of the tank for easy access to bushings and earth connections & suitable manhole shall be provided.
- 3.06.06 The main tank body including tap-changer compartment, radiators and coolers shall be capable of withstanding full vacuum.

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- 3.06.07 All tank and oil filled compartment shall be tested for oil tightness by being completely filled with oil of viscosity not greater than that of specified oil at the ambient temperature and applying pressure equal to the normal pressure plus 35 kN/m² measured at the base of the tank.
- 3.07.00 **Tank mounting**
Tank shall also be provided with lifting lugs and minimum four jacking pads. Rollers shall be provided with holding clamp plates (04 nos), required hardware and foundation bolts etc. for each transformer.
- 3.08.00 **Oil preservation**
Conservator tank of adequate capacity for expansion of oil from minimum ambient to 100 deg. C shall be provided. The transformers rated 6.3MVA and above shall be provided with air bag breathing through silica gel breather. For lower rating transformers with conventional conservator with dry air filling of the space above oil and connected to silica gel breather shall be provided.
- 3.09.00 **Radiators**
The radiators shall be detachable type, mounted on the tank. Each radiator shall be provided with a drain plug/valve at the bottom, an air release plug at the top, shut off valve at each point of connection to the tank.
- 3.10.00 **Insulating Oil**
As per IS: 335. No external inhibitors are permitted.
- 3.11.00 All transformers shall be suitable for cable/ busduct termination as indicated in data sheet-A of section-I, volume-II.

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3.12.00 Bushings/ Insulators

3.12.01 The bushings shall conform to the requirements of IS: 2099 and IS: 3347 and shall be of porcelain and above 3150A for the LV bushing Epoxy bushing shall also be acceptable.

3.12.02 For 33kV windings 36kV bushing shall be provided. For 3.3kV, 6.6kV and 11 kV windings, 17.5kV bushing shall be provided. For 415V windings, 1.1kV bushings shall be provided.

3.12.03 The porcelain shall not engage directly with hard metal and, wherever necessary, gaskets shall be interposed between the porcelain and the fitting.

3.12.04 Clamps and fittings of steel or malleable cast iron shall be galvanised.

3.12.05 Where bushing current transformer is provided, the bushing shall be mounted so that it can be removed and replaced without disturbing the current transformers. CTs shall be cast resin type & suitable for operation at ambient temperature existing at its location on the transformer.

3.12.06 Creepage distance shall be as per data sheet-A of section-I, volume-II.

3.12.07 Minimum rated current for bushings shall be as under. However, same shall comply with IS-2099 and HV/LV system fault current mentioned in Clause No. 20.00 of Datasheet A of section-I, volume-II:

- 1) H V Bushing for 33kV
7.5 MVA = 250A
5.0 MVA = 100A
2.0 MVA = 100A
- 2) H V Bushing for 11kV & 6.6kV
10.0MVA= 1000A
8.0MVA = 1000A
7.5MVA = 800A
6.3MVA = 800A
5.0MVA = 630A
3.5MVA = 250A
2.5 MVA = 250A

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2.0 MVA = 250A

1.6 MVA = 250A

1.0 MVA = 100A

630 kVA = 100A

2) H V Bushing for 3.3kV

2.5 MVA = 630A

2.0 MVA = 500A

1.6 MVA = 400A

1.0 MVA = 250A

630 kVA = 250A

3) L V Bushing for 11kV, 6.6kV & 3.3kV

10.0MVA= 2500A

8.0MVA = 2000A

7.5MVA = 1600A

6.3MVA = 1600A

5.0MVA = 1250A

3.5MVA= 1250A

4) L V Bushing for 433V/420V

2.5 MVA = 4000A

2.0 MVA = 4000A

1.6 MVA = 3150A

1.0 MVA = 2000A

630 kVA = 1000A

3.13.00 **Cable Box**

3.13.01 A dust tight air insulated type cable box with D.O.P. of IP: 55 shall be provided for terminating the cables directly of size and type specified in Data sheet-A of section-I, volume-II. The cable box shall also be provided with a suitable canopy. Suitable cable glands (double compression type) and lugs shall be provided for cable termination.

3.13.02 Dimensions of cable box shall be subject to purchaser's approval.

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- 3.13.03 Inspection cover for fixed portion of cable box shall be provided. Handles for lifting cable box shall be provided.
- 3.13.04 Creepage distance shall be as per data sheet-A of section-I, volume-II.
- 3.13.05 Provision shall be made for earthing the body of each cable box. Separate earthing pads shall be provided for this purpose, suitable for bolted connection to galvanised mild steel flat of size to be specified during contract engineering stage.
- 3.13.06 Gland plate for single core cable termination shall be of Aluminium.
- 3.13.07 Cable box(es) shall be provided with suitable air-insulated disconnecting chamber so that if required, transformer can be removed from its position without disconnecting the cables in the cable box(es). Independent supporting arrangement shall be provided for cable box(es) for this purpose. Supporting arrangement shall be supplied along with required hardware & foundation bolts etc.
- 3.14.00 **Busduct Termination**
- If LV terminals are specified to be connected by means of a busduct, a flanged throat or equivalent connection shall be provided to suit purchaser's busducts. The winding termination shall be on outdoor type of bushing. Necessary flexibles shall be provided by purchaser to connect the bushing terminals to the busbars of the busduct. Details of busduct shall be furnished during detail engineering stage. Degree of protection of LV busduct flange enclosure shall be IP:55.
- 3.15.00 **Neutral Terminals**
- Two (2) nos. neutral terminals shall be provided on LV side. One neutral terminal shall be part of phase connection arrangement busduct throat/ LV cable-box (as applicable). Other neutral terminal shall be in a separate box and brought to tank bottom by means of earthing bar of 50x6 mm of copper, supported on porcelain insulators mounted on transformer tank. The neutral earthing bar brought to the tank bottom for connection to station earth shall be provided with holes and suitable connecting hardware. This earthing bar shall have fork type arrangement at the end. However neutral may be connected to NGR as per system requirement.

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3.16.00 **Neutral CT**

Bidder to provide neutral bushing CT as per details given in data sheet – A of section-I, volume-II for restricted earth fault protection or standby earth fault protection. In case neutral CT is tank mounted, CT box shall be weather proof having D.O.P. IP: 55. The Neutral CT box shall also be provided with a suitable canopy. CTs shall be cast resin type.

All CTs (except WTI) shall be mounted in the turret of bushings, mounting inside the tank is not permitted.

3.17.00 **Valves**

3.17.01 All valves upto and including 50 mm shall be of gun metal or of cast steel. Larger valves may be of gun metal or may have cast iron bodies with gun metal fittings.

3.17.02 Sampling & drain valves should have zero leakage rate.

3.18.00 **Gaskets**

3.18.01 Gasket shall be fitted with weather proof, hot oil resistant, rubberized cork.

3.18.02 If gasket is compressible, metallic stops shall be provided to prevent over compression.

3.18.03 The gaskets shall not deteriorate during the life of transformer/shunt reactor if not opened for maintenance at site. All joints flanged or welded associated with oil shall be such that no oil leakage or sweating occurs during the life of transformer.

3.19.00 **Voltage control (off circuit type)**

3.19.01 Off circuit tap-changing switch shall be three phase, hand operated, for simultaneous switching of similar taps on all the three phases by operating an external handle/ hand wheel. The position of off-circuit tap switch handle/hand wheel provided outside the transformer tank should be such as to enable an operator standing on ground to operate the same with ease. A caution plate indicating that switch shall be operated only when the transformer is de-energised shall be fitted near tap switch.

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- 3.19.02 Operating mechanism of tap changer shall be suitably labelled to show the direction of operation for raising secondary voltage & vice versa. Position markings shall be provided.
- 3.19.03 Arrangement shall be made for securing and padlocking the tap-changing switch at any working position. It shall not be possible to set and padlock in any intermediate position.
- 3.19.04 Tap position indicator and mechanical stops to prevent over-cranking of the mechanism shall be provided.
- 3.20.00 **Marshalling box**
- 3.20.01 Tank mounted vermin and dust proof marshalling box shall be provided to accommodate indication circuits and temperature indicators etc. and provided with proper lighting and thermostatically controlled space heaters.
- 3.20.02 The marshalling box shall be fabricated using sheet steel of at least 2.5mm thickness. The marshalling box shall have domed or sloping roof.
- 3.20.03 Marshalling box shall be complete with all internal wiring and identification ferrules, cables, conduits required for wiring between marshalling box and instruments on transformer. Wiring shall be by 1100 V grade, copper cable of size 2.5mm².
- 3.20.04 The terminal blocks shall be complete with insulating barriers and clip-on type terminals suitable for 2.5mm² stranded copper wire. One dummy terminal block in between each trip wire terminal shall be provided. At least 20% spare terminals shall be provided on each panel. The gasket used shall be of neoprene rubber.
- 3.20.05 The marshalling box shall have IP: 55 degree of protection.
- 3.20.06 CT terminals shall be with shorting and disconnecting facility. TB shall be stud type for all CT & power connection.
- 3.20.07 Wiring scheme shall be engraved in a stainless steel plate with viewable font size and the same shall be fixed inside the Marshalling Box door. Refer annexure-C for standard terminal block numbering.

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3.21.00 **Flux density**

Flux density in any part of the core & yoke on any tap position with $\pm 10\%$ voltage variation from voltage corresponding to the tap shall not exceed 1.9 Wb/m^2 .

Transformer shall also withstand following conditions due to combined voltage and frequency variations:

Continuous operation for 110% flux density

At least 1 minute operation for 125% flux density

At least 5 sec. operation for 140% flux density

3.22.00 **Winding**

For 33kV, 11kV & 3.3kV winding, type of winding shall be continuous disc & for 433V/ 420V winding, type of winding shall be spiral type. The conductors shall be of Electrolytic grade copper.

3.23.00 **Noise & Vibration**

The design and manufacture of transformer, fittings and accessories shall be such as to reduce noise & vibration. Noise level shall not be more than as specified in NEMA Standard Publication TR-1, when measured with transformer energised at normal voltage and frequency.

3.24.00 All transformers and their accessories shall be capable of withstanding without damage any external short circuit at the terminals for duration of two seconds.

3.25.00 Maximum Transformer losses including tolerances shall be as per annexure – B, of section-I, volume-II.

3.26.00 **LOADING CAPABILITY**

Transformer shall be suitable for continuous operation at rated kVA on any tap with voltage variation of $\pm 10\%$ corresponding to voltage of the tap. Short duration overloading shall be in accordance with IS:6600 / IEC60076-7.

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4.00.00 Fittings & accessories

4.01.00 Transformer shall be provided with, but not restricted to following minimum fittings and accessories for satisfactory operation:

4.01.01 Conventional type conservator with drain valve and oil filling hole.

4.01.02 Magnetic oil level gauge with low-level alarm contact.

4.01.03 Prismatic & toughened glass oil level gauge.

4.01.04 Gaskets

4.01.05 Gasket protection covers.

4.01.06 Silica gel breather with oil seal.

4.01.07 Double float type Buchholz relay with alarm and trip contacts with suitable gas collecting device with two shut-off valve on both side.

4.01.08 Diaphragm type explosion vent for transformers of rating less than 2MVA

4.01.09 Pocket on tank cover for thermometer.

4.01.10 Protected type mercury in glass thermometer.

4.01.11 Dial type (150 mm) Oil temperature indicator (OTI) with two sets of electrical potential- free contact rated for 2A, 220V DC, for alarm and trip purpose. The OTI shall be provided with anti-vibration mounting. OTI shall have maximum reading pointer along with resetting device. For remote oil temperature metering, an independent 4-20 mA should be made available.

4.01.12 Dial type (150 mm) Winding temperature indicator (WTI) with two sets of electrical potential- free contact rated for 2A, 220V DC, for alarm and trip purpose. The WTI shall be provided with anti-vibration mounting. WTI shall have maximum reading position along with resetting devices. For remote winding temperature metering, an independent 4-20 mA should be made available.

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- 4.01.13 Drain Valves.
- 4.01.14 Sampling devices.
- 4.01.15 Filter valves.
- 4.01.16 Earthing terminals – 2 Nos.
- 4.01.17 Rating & Diagram plates.
- 4.01.18 Valve schedule plate.
- 4.01.19 Two sets of lifting lugs (one for transformer with oil and other for tank cover).
- 4.01.20 Jacking pads.
- 4.01.21 Skids and pulling eyes on both sides.
- 4.01.22 Air release devices.
- 4.01.23 Inspection cover.
- 4.01.24 Oil filling hole and cap.
- 4.01.25 Tank mounted marshalling box.
- 4.01.26 Detachable, flat, bidirectional rollers with 90 deg. swivel mechanism.
- 4.01.27 Clamping arrangement for rollers.
- 4.01.28 Ground support for cable box.
- 4.01.29 Neutral CT secondary box.
- 4.01.30 Haulage facilities.

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- 4.01.31 Two nos. spring operated pressure relief devices with extension pipe to bring oil to plinth level along with electrically insulated contact for alarm and tripping for transformer rating 2 MVA and above.
- 4.01.32 Gas collection device along with all accessories.
- 4.02.00 Breather shall be fitted at a height not exceeding 1.5 M.
- 4.03.00 Rating and diagram plate shall be fitted at a height of about 1.75 M above the ground level.
- 4.04.00 The WTI and OTI shall have accuracy class of ± 2 deg. C or better.
- 4.05.00 Rating/ Name/ Valve schedule plates shall be of white non-hygroscopic material with engraved black lettering. Such plates shall be bi- lingual (requirement will be finalised during detailed engineering) with Hindi inscription first, followed by English. Alternatively, two separate plates with Hindi & English inscription shall be provided.
- 5.00.00 **PAINTING**
- Paint shade shall be informed to successful bidder during detail engineering as applicable for specific project. Adequate quantity of touch up paint shall also be supplied. There shall be no commercial or delivery implication to BHEL on account of paint shade, paint specification/ procedure.
- 6.00.00 **QUALITY ASSURANCE, TESTING & INSPECTION**
- 6.01.00 BHEL's Standard QP (PE-QP-999-302-E001 Rev. 0) is enclosed as per Annexure-A of section-II, volume-II for reference. In case bidder has reference QP agreed with ultimate customer, same can be submitted for specific project after award of contract for BHEL/ ultimate customer's approval. There shall be no commercial or delivery implication to BHEL on account of QP approval.
- 6.02.00 All materials, components and accessories of the transformers shall be procured, manufactured, inspected and tested by vendor/ sub-vendor as per approved quality plan.

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- 6.03.00 Tests shall be performed in presence of Purchaser's representative. The bidder shall give at least fifteen (15) days advance notice of date when the tests are to be carried out.
- 6.04.00 All routine and acceptance tests as per relevant standards and specification shall be carried out by the vendor/ sub-vendor on all transformers.
- 6.05.00 Successful bidder shall furnish List of sub-vendors/ makes of items for BHEL/ customer approval at contract stage. This shall not have any commercial implication to BHEL.
- 6.06.00 For acceptance of short circuit reports for tests carried out earlier on similar transformers, successful bidder shall furnish the following documents for BHEL/ BHEL's customer acceptance without any commercial/ delivery implication to BHEL
- 6.06.01 Calculations and design considerations to prove ability to withstand the dynamic effects of short circuit.
- 6.06.02 Short circuit test report of previously tested similar transformer for validation by comparison. Criteria for similarity of transformer for acceptance of Short circuit test report shall be as given in the Annexure-B of IEC-60076-5.
- 7.00.00 COMMISSIONING SPARES, SPECIAL TOOLS & TACKLES AND O & M SPARES**
- 7.01.00 Commissioning spares are those, which may be required during commissioning of the equipment. Bidder to furnish list of commissioning spares along with technical offer as per annexure-IV of section-I, volume-II.
- 7.02.00 The bidder shall supply with the equipment, one unused complete set of all special tools & tackles required for the erection, assembly, disassembly and proper maintenance of the equipment. A list of such tools & tackles (price deemed to be included in the total bid price) shall be submitted by the bidder along with the offer as per annexure-V of section-I, volume-II.
- 7.03.00 O & M spares are those which are required for satisfactory & trouble free operation of equipment. List of O & M spares is enclosed as per Annexure-D of section-II, volume-II. O & M spares shall be quoted (if applicable) as per BOQ-cum-price schedule as part of NIT.

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8.00.00 O & M MANUALS

- 8.01.00 O & M manuals for the installation, operation and maintenance of transformers shall be furnished at least three months before despatch of equipment.
- 8.02.00 Draft manual should first be submitted for purchaser's approval. The manual should contain minimum following details:
 - 8.02.01 General description of equipment.
 - 8.02.02 Approved Technical Data Sheet
 - 8.02.03 All drawings
 - 8.02.04 Salient constructional features.
 - 8.02.05 Technical leaflets of fittings/ important parts.
 - 8.02.06 Type and routine test certificates.
 - 8.02.07 Instructions to be followed on receipt of equipment at site & for storage.
 - 8.02.08 Instructions for foundation arrangement.
 - 8.02.09 Erection procedures and checks.
 - 8.02.10 Pre-commissioning checks.
 - 8.02.11 Commissioning procedures.
 - 8.02.12 Withdrawal arrangement/ material handling instructions.
 - 8.02.13 Operation instructions.
 - 8.02.14 Maintenance instructions.
 - 8.02.15 Trouble-shooting.
 - 8.02.16 Safety instructions.

STANDARD QUALITY PLAN

ANNEXURE - A

TITLE :		
STANDARD TECHNICAL SPECIFICATION FOR		
OIL FILLED SERVICE TRANSFORMERS		
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CUSTOMER : TANGEDCO										PROJECT: 2 x 660MW UDANGUDI STPP										PO NO.: PE-V0-435-302-E901										DATE: 10/06/2020																													
ITEM: OIL FILLED TRANSFORMER										SYSTEM:										SECTION: II										SHEET No. of																													
S. NO.	COMPONENT/ OPERATION	CHARACTERISTIC CHECK	CLASS	TYPE OF CHECK	QUANTUM OF CHECK			REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD			AGENCY			REMARKS																																											
					5	6	C/N			7	8	9	D	M	C		N																																										
1	1.0	RAW MATERIALS & BOUGHT OUT ITEMS	MA	MEASUREMENT	10%	10%																																																					
1.1		1. THICKNESS	MA	VISUAL	100%	-																																																					
		2. SURFACE DEFECTS	MA	TEST	As per IS/ Plant Sid	-																																																					
		3. CHEMICAL COMPOSITION	MA	TEST	-	-																																																					
		4. MECHANICAL PROPERTIES	MA	TEST	-	-																																																					
		5. HYDRAULIC TEST OF PIPES	MA	TEST	-	-																																																					
		1. THICKNESS & FINISH	MA	MEASUREMENT	10%	10%																																																					
		2. GRADE OF CRGO	MA	MEASUREMENT	-	-																																																					
		3. CUTTING & BURR	MA	MEASUREMENT	10%	-																																																					
		4. SCRATCHES, SURFACE FINISH	MA	VISUAL	10%	-																																																					
		5. WAVINESS & EDGE CAMBER	MA	MEASUREMENT	10%	-																																																					
1.2	CRGO STEEL	6. SPECIFIC CORE LOSS	MA	TEST	As per IS/ Plant Sid	As per IS/ Plant Sid																																																					
		7. SURFACE RESISTIVITY	MA	TEST	As per IS/ Plant Sid	-																																																					
		8. STACKING FACTOR	MA	TEST	As per IS/ Plant Sid	-																																																					
		9. PERMEABILITY	MA	TEST	As per IS/ Plant Sid	-																																																					
		10. BEND TEST/ DUCTILITY	MA	MEASUREMENT	As per IS/ Plant Sid	-																																																					
1.3	PAPER INSULATED COPPER CONDUCTOR	1. DIMENSIONS	MA	MEASUREMENT	100%	100%																																																					
		2. RESISTIVITY/CONDUCTIVITY	MA	TEST	10%	10%																																																					
		3. ELONGATION	MA	TEST	As per IS/ Plant Sid	-																																																					
		4. TENSILE STRENGTH	MA	TEST	As per IS/ Plant Sid	-																																																					
		5. PROOF STRESS IF APPLICABLE	MA	TEST	As per IS/ Plant Sid	-																																																					
		6. INSULATION TEST BETWEEN STRANDS FOR BUNCHED CONDUCTORS	MA	TEST	As per IS/ Plant Sid	-																																																					
		7. CU PURITY OF CC ROD	MA	TEST	As per IS/ Plant Sid	-																																																					
		8. CHEMICAL COMPOSITION	MA	TEST	As per IS/ Plant Sid	-																																																					
		9. PAPER COVERING	MA	VISUAL	100%	-																																																					
		10. SURFACE FINISH	MA	VISUAL	100%	-																																																					
1.4	INSULATING PAPER	1. DIMENSIONS	MA	MEASUREMENT	10%	10%																																																					
		2. DENSITY AND SUBSTANCE	MA	TEST	As per IS/ Plant Sid	-																																																					
		3. TENSILE STRENGTH	MA	TEST	As per IS/ Plant Sid	-																																																					
		4. ELONGATION	MA	TEST	As per IS/ Plant Sid	-																																																					
		5. WATER ABSORPTION	MA	TEST	As per IS/ Plant Sid	-																																																					
		6. MOISTURE CONTENT	MA	TEST	As per IS/ Plant Sid	-																																																					
		7. PH VALUE & CONDUCTIVITY	MA	TEST	As per IS/ Plant Sid	-																																																					
		8. ASH CONTENT	MA	TEST	As per IS/ Plant Sid	-																																																					
		9. ELECTRICAL STRENGTH	MA	TEST	As per IS/ Plant Sid	-																																																					
		10. AIR PERMEABILITY	MA	TEST	As per IS/ Plant Sid	-																																																					
		11. TEAR INDEX	MA	TEST	As per IS/ Plant Sid	-																																																					
		12. HEAT STABILITY	MA	TEST	As per IS/ Plant Sid	-																																																					
BHEL										BIDDER/ SUPPLIER										FOR CUSTOMER REVIEW & APPROVAL																																							
ENGINEERING										QUALITY										Doc No:										Sign & Date										Sign & Date										Seal									
Name										Name										Reviewed by:										Reviewed by:										Seal																			
Srabani Mishra & Abhay Agrawal										Kundan Prasad										by:										by:										Seal																			
Sandeep Loth										Ritesh Kumar Jaiswal										by:										by:										Seal																			

MANUFACTURER/ BIDDER/ SUPPLIER NAME & ADDRESS										STANDARD QUALITY PLAN										SPEC. NO : PE-TS-435-302-E001, R0										DATE: 10/06/2020									
CUSTOMER : TANGEDCO										PROJECT : 2 X 660MW UDANGUDI STPP										QP NO.: PE-V0-435-302-E001										DATE:									
ITEM: OIL FILLED TRANSFORMER										SYSTEM:										PO NO.:										SECTION: II									
S. NO.	COMPONENT/ OPERATION	CHARACTERISTIC CHECK			CLASS	TYPE OF CHECK		QUANTUM OF CHECK		REFERENCE DOCUMENT	ACCEPTANCE NORM		FORMAT OF RECORD		AGENCY				REMARKS																				
		3	4	5		M	C/N	6	7		8	9	D	M	C	N																							
1.5	INSULATION & PRESS BOARD MOULDING (STOCK ITEMS)	1. DIMENSION	MA	MEASUREMENT	MA	10%	10%	As per IS/ Plant Std	Manf. Std / IS:1576/ IEC 60641	Manf. Std / IS:1576/ IEC 60641	QC RECORD/SUPPLIER'S TEST CERTIFICATE	✓	✓	✓	P	V	V																						
		2. COMPRESSIBILITY	MA	TEST	MA	As per IS/ Plant Std	-	As per IS/ Plant Std	-DO-	-DO-	SUPPLIER'S TEST CERT.		✓		V	-	-																						
		3. DENSITY	MA	TEST	MA	As per IS/ Plant Std	-	As per IS/ Plant Std	-DO-	-DO-	SUPPLIER'S TEST CERT.		✓		V	-	-																						
		4.TENSILE STRENGTH	MA	TEST	MA	As per IS/ Plant Std	-	As per IS/ Plant Std	-DO-	-DO-	SUPPLIER'S TEST CERT.		✓		V	-	-																						
		5.PH VALUE/CONDUCTIVITY OF WATER EXTRACT	MA	TEST	MA	As per IS/ Plant Std	-	As per IS/ Plant Std	-DO-	-DO-	SUPPLIER'S TEST CERT.		✓		V	-	-																						
		6. ELECTRICAL STRENGTH IN AIR & OIL	MA	TEST	MA	As per IS/ Plant Std	-	As per IS/ Plant Std	-DO-	-DO-	SUPPLIER'S TEST CERT.		✓		V	V	V																						
		7.SHRIKAGE IN AIR	MA	TEST	MA	As per IS/ Plant Std	-	As per IS/ Plant Std	-DO-	-DO-	SUPPLIER'S TEST CERT.		✓		V	V	V																						
		8.FLEXIBILITY	MA	TEST	MA	As per IS/ Plant Std	-	As per IS/ Plant Std	-DO-	-DO-	SUPPLIER'S TEST CERT.		✓		V	-	-																						
		9.ASH CONTENT	MA	TEST	MA	As per IS/ Plant Std	-	As per IS/ Plant Std	-DO-	-DO-	SUPPLIER'S TEST CERT.		✓		V	-	-																						
		10. MOISTURE CONTENT	MA	TEST	MA	As per IS/ Plant Std	-	As per IS/ Plant Std	-DO-	-DO-	SUPPLIER'S TEST CERT.		✓		V	-	-																						
		11. COHESION BETWEEN PLYS	MA	TEST	MA	As per IS/ Plant Std	-	As per IS/ Plant Std	-DO-	-DO-	SUPPLIER'S TEST CERT.		✓		V	-	-																						
		12. ELONGATION	MA	TEST	MA	As per IS/ Plant Std	-	As per IS/ Plant Std	-DO-	-DO-	SUPPLIER'S TEST CERT.		✓		V	-	-																						
		13. OIL ABSORPTION	MA	TEST	MA	As per IS/ Plant Std	-	As per IS/ Plant Std	-DO-	-DO-	SUPPLIER'S TEST CERT.		✓		V	-	-																						
1.6	DENSIFIED WOOD	1. DIMENSION	MA	MEASUREMENT	MA	10%	10%	As per IS/ Plant Std	Manf. Std / IS:3513/ IEC61061	Manf. Std / IS:3513/ IEC61061	QC RECORD		✓	✓	P	-	-																						
		2. SURFACE FINISH	MA	VISUAL	MA	As per IS/ Plant Std	-	As per IS/ Plant Std	-DO-	-DO-	SUPPLIER'S TEST CERT.		✓		P	-	-																						
		3. ELECTRICAL STRENGTH IN OIL	MA	TEST	MA	As per IS/ Plant Std	-	As per IS/ Plant Std	-DO-	-DO-	SUPPLIER'S TEST CERT.		✓		P	V	V																						
		4. OIL ABSORPTION	MA	TEST	MA	As per IS/ Plant Std	-	As per IS/ Plant Std	-DO-	-DO-	SUPPLIER'S TEST CERT.		✓		P	-	-																						
		5. MOISTURE CONTENT	MA	TEST	MA	As per IS/ Plant Std	-	As per IS/ Plant Std	-DO-	-DO-	SUPPLIER'S TEST CERT.		✓		V	-	-																						
		6. COMPRESSION STRENGTH	MA	TEST	MA	As per IS/ Plant Std	-	As per IS/ Plant Std	-DO-	-DO-	SUPPLIER'S TEST CERT.		✓		V	-	-																						
		7. CROSSBREAKING STRENGTH	MA	TEST	MA	As per IS/ Plant Std	-	As per IS/ Plant Std	-DO-	-DO-	SUPPLIER'S TEST CERT.		✓		V	-	-																						
		8. TENSILE STRENGTH	MA	TEST	MA	As per IS/ Plant Std	-	As per IS/ Plant Std	-DO-	-DO-	SUPPLIER'S TEST CERT.		✓		V	-	-																						
		9. SHRIKAGE IN AIR AND OIL	MA	TEST	MA	As per IS/ Plant Std	-	As per IS/ Plant Std	-DO-	-DO-	SUPPLIER'S TEST CERT.		✓		V	-	-																						
		10. SPECIFIC GRAVITY/ DENSITY	MA	TEST	MA	As per IS/ Plant Std	-	As per IS/ Plant Std	-DO-	-DO-	SUPPLIER'S TEST CERT.		✓		V	-	-																						
		1. DIMENSION	MA	MEASUREMENT	MA	10%	10%	As per IS/ Plant Std	Manf. Std / IS:4253	Manf. Std / IS:4253	QC RECORD		✓	✓	P	-	-																						
		2. HARDNESS	MA	TEST	MA	As per IS/ Plant Std	-	As per IS/ Plant Std	-DO-	-DO-	SUPPLIER'S TEST CERT.		✓		V	V	V																						
		3. TENSILE STRENGTH	MA	TEST	MA	As per IS/ Plant Std	-	As per IS/ Plant Std	-DO-	-DO-	SUPPLIER'S TEST CERT.		✓		V	-	-																						
1.7	GASKET (RUBBER BONDED CORK SHEET) (IF APPLICABLE)	4. COMPRESSIBILITY	MA	TEST	MA	As per IS/ Plant Std	-	As per IS/ Plant Std	-DO-	-DO-	SUPPLIER'S TEST CERT.		✓		V	V	V																						
		5. RECOVERY	MA	TEST	MA	As per IS/ Plant Std	-	As per IS/ Plant Std	-DO-	-DO-	SUPPLIER'S TEST CERT.		✓		V	-	-																						
		6. COMPRESSION SET	MA	TEST	MA	As per IS/ Plant Std	-	As per IS/ Plant Std	-DO-	-DO-	SUPPLIER'S TEST CERT.		✓		V	-	-																						
		7. FLEXIBILITY	MA	TEST	MA	As per IS/ Plant Std	-	As per IS/ Plant Std	-DO-	-DO-	SUPPLIER'S TEST CERT.		✓		V	-	-																						
		8. FLUID RESISTANCE TEST	MA	TEST	MA	As per IS/ Plant Std	-	As per IS/ Plant Std	-DO-	-DO-	SUPPLIER'S TEST CERT.		✓		V	-	-																						
		9. CHLORIDE/SULPHATE CONTENT OF WATER EXTRACT	MA	TEST	MA	As per IS/ Plant Std	-	As per IS/ Plant Std	-DO-	-DO-	SUPPLIER'S TEST CERT.		✓		V	-	-																						
		10. ACCELERATED AGING TEST IN OIL	MA	TEST	MA	As per IS/ Plant Std	-	As per IS/ Plant Std	-DO-	-DO-	SUPPLIER'S TEST CERT.		✓		V	-	-																						
		11. DENSITY	MA	TEST	MA	As per IS/ Plant Std	-	As per IS/ Plant Std	-DO-	-DO-	SUPPLIER'S TEST CERT.		✓		V	-	-																						
		1. DIMENSION	MA	MEASUREMENT	MA	10%	10%	As per IS/ Plant Std	Manf. Std / IS:4253	Manf. Std / IS:4253	SUPPLIER'S TEST CERT.		✓		P	-	-																						
		2. SHORE HARDNESS	MA	TEST	MA	As per IS/ Plant Std	-	As per IS/ Plant Std	-DO-	-DO-	SUPPLIER'S TEST CERT.		✓		P	V	V																						
		3. TENSILE STRENGTH	MA	TEST	MA	As per IS/ Plant Std	-	As per IS/ Plant Std	-DO-	-DO-	SUPPLIER'S TEST CERT.		✓		V	-	-																						
		4. ELONGATION AT BREAK	MA	TEST	MA	As per IS/ Plant Std	-	As per IS/ Plant Std	-DO-	-DO-	SUPPLIER'S TEST CERT.		✓		V	-	-																						
		5. COMPRESSION SET	MA	TEST	MA	As per IS/ Plant Std	-	As per IS/ Plant Std	-DO-	-DO-	SUPPLIER'S TEST CERT.		✓		V	-	-																						
1.8	NITRILE RUBBER CORD AND "O" RING(IF APPLICABLE)	6. ACCELERATED AGEING IN OIL	MA	TEST	MA	As per IS/ Plant Std	-	As per IS/ Plant Std	-DO-	-DO-	SUPPLIER'S TEST CERT.		✓		V	V	V																						
		1. DIMENSION	MA	MEASUREMENT	MA	10%	10%	As per IS/ Plant Std	Manf. Std / IS:4253	Manf. Std / IS:4253	SUPPLIER'S TEST CERT.		✓		P	-	-																						
		2. SHORE HARDNESS	MA	TEST	MA	As per IS/ Plant Std	-	As per IS/ Plant Std	-DO-	-DO-	SUPPLIER'S TEST CERT.		✓		P	V	V																						
		3. TENSILE STRENGTH	MA	TEST	MA	As per IS/ Plant Std	-	As per IS/ Plant Std	-DO-	-DO-	SUPPLIER'S TEST CERT.		✓		V	-	-																						
		4. ELONGATION AT BREAK	MA	TEST	MA	As per IS/ Plant Std	-	As per IS/ Plant Std	-DO-	-DO-	SUPPLIER'S TEST CERT.		✓		V	-	-																						
		5. COMPRESSION SET	MA	TEST	MA	As per IS/ Plant Std	-	As per IS/ Plant Std	-DO-	-DO-	SUPPLIER'S TEST CERT.		✓		V	-	-																						
		6. ACCELERATED AGEING IN OIL	MA	TEST	MA	As per IS/ Plant Std	-	As per IS/ Plant Std	-DO-	-DO-	SUPPLIER'S TEST CERT.		✓		V	V	V																						
		1. DIMENSION	MA	MEASUREMENT	MA	10%	10%	As per IS/ Plant Std	Manf. Std / IS:4253	Manf. Std / IS:4253	SUPPLIER'S TEST CERT.		✓		P	-	-																						
		2. SHORE HARDNESS	MA	TEST	MA	As per IS/ Plant Std	-	As per IS/ Plant Std	-DO-	-DO-	SUPPLIER'S TEST CERT.		✓		P	V	V																						
		3. TENSILE STRENGTH	MA	TEST	MA	As per IS/ Plant Std	-	As per IS/ Plant Std	-DO-	-DO-	SUPPLIER'S TEST CERT.		✓		V	-	-																						
		4. ELONGATION AT BREAK	MA	TEST	MA	As per IS/ Plant Std	-	As per IS/ Plant Std	-DO-	-DO-	SUPPLIER'S TEST CERT.		✓		V	-	-																						
		5. COMPRESSION SET	MA	TEST	MA	As per IS/ Plant Std	-	As per IS/ Plant Std	-DO-	-DO-	SUPPLIER'S TEST CERT.		✓		V	-	-																						
		6. ACCELERATED AGEING IN OIL	MA	TEST	MA	As per IS/ Plant Std	-	As per IS/ Plant Std	-DO-	-DO-	SUPPLIER'S TEST CERT.		✓		V	V	V																						
1.9	DENSIFIED WOOD	1. DIMENSION	MA	MEASUREMENT	MA	10%	10%	As per IS/ Plant Std	Manf. Std / IS:3513/ IEC61061	Manf. Std / IS:3513/ IEC61061	QC RECORD		✓	✓	P	-	-																						
		2. SURFACE FINISH	MA	VISUAL	MA	As per IS/ Plant Std	-	As per IS/ Plant Std	-DO-	-DO-	SUPPLIER'S TEST CERT.		✓		P	-	-																						
		3. ELECTRICAL STRENGTH IN OIL	MA	TEST	MA	As per IS/ Plant Std	-	As per IS/ Plant Std	-DO-	-DO-	SUPPLIER'S TEST CERT.		✓		P	V	V																						
		4. OIL ABSORPTION	MA	TEST	MA	As per IS/ Plant Std	-	As per IS/ Plant Std	-DO-	-DO-	SUPPLIER'S TEST CERT.		✓		P	-	-																						
		5. MOISTURE CONTENT	MA	TEST	MA	As per IS/ Plant Std	-	As per IS/ Plant Std	-DO-	-DO-	SUPPLIER'S TEST CERT.		✓		V	-	-																						
		6. COMPRESSION STRENGTH	MA	TEST	MA	As per IS/ Plant Std	-	As per IS/ Plant Std	-DO-	-DO-	SUPPLIER'S TEST CERT.		✓		V	-	-																						
		7. CROSSBREAKING STRENGTH	MA	TEST	MA	As per IS/ Plant Std	-	As per IS/ Plant Std	-DO-	-DO-	SUPPLIER'S TEST CERT.		✓		V	-	-																						
		8. TENSILE STRENGTH	MA	TEST	MA	As per IS/ Plant Std	-	As per IS/ Plant Std	-DO-	-DO-	SUPPLIER'S TEST CERT.		✓		V	-	-																						
		9. SHRIKAGE IN AIR AND OIL	MA	TEST	MA	As per IS/ Plant Std	-	As per IS/ Plant Std	-DO-	-DO-	SUPPLIER'S TEST CERT.		✓		V	-	-																						
		10. SPECIFIC GRAVITY/ DENSITY	MA	TEST	MA	As per IS/ Plant Std	-	As per IS/ Plant Std	-DO-	-DO-	SUPPLIER'S TEST CERT.		✓		V	-	-																						
		1. DIMENSION	MA	MEASUREMENT	MA	10%	10%	As per IS/ Plant Std	Manf. Std / IS:4253	Manf. Std / IS:4253	QC RECORD		✓	✓	P	-	-																						
		2. HARDNESS	MA	TEST	MA	As per IS/ Plant Std	-	As per IS/ Plant Std	-DO-	-DO-	SUPPLIER'S TEST CERT.		✓		V	V	V																						
		3. TENSILE STRENGTH	MA	TEST	MA	As per IS/ Plant Std	-	As per IS/ Plant Std	-DO-	-DO-	SUPPLIER'S TEST CERT.		✓		V	-	-																						
1.10	GASKET (RUBBER BONDED CORK SHEET) (IF APPLICABLE)	4. COMPRESSIBILITY	MA	TEST	MA	As per IS/ Plant Std	-	As per IS/ Plant Std	-DO-	-DO-	SUPPLIER'S TEST CERT.		✓		V	V	V																						
		5. RECOVERY	MA	TEST	MA	As per IS/ Plant Std	-	As per IS/ Plant Std	-DO-	-DO-	SUPPLIER'S TEST CERT.		✓		V	-	-																						
		6. COMPRESSION SET	MA	TEST	MA	As per IS/ Plant Std	-	As per IS/ Plant Std	-DO-	-DO-	SUPPLIER'S TEST CERT.		✓		V	-	-																						
		7. FLEXIBILITY	MA	TEST	MA	As per IS/ Plant Std	-	As per IS/ Plant Std	-DO-	-DO-	SUPPLIER'S TEST CERT.		✓		V	-	-																						
		8. FLUID RESISTANCE TEST	MA	TEST	MA	As per IS/ Plant Std	-	As per IS/ Plant Std	-DO-	-DO-	SUPPLIER'S TEST CERT.		✓		V	-	-																						
		9. CHLORIDE/SULPHATE CONTENT OF WATER EXTRACT	MA	TEST	MA	As per IS/ Plant Std	-	As per IS/ Plant Std	-DO-	-DO-	SUPPLIER'S TEST CERT.		✓		V	-	-																						
		10. ACCELERATED AGING TEST IN OIL	MA	TEST	MA	As per IS/ Plant Std	-	As per IS/ Plant Std	-DO-	-DO-	SUPPLIER'S TEST CERT.		✓		V	-	-																						
		11. DENSITY	MA	TEST	MA	As per IS/ Plant Std	-	As per IS/ Plant Std	-DO-	-DO-	SUPPLIER'S TEST CERT.		✓		V	-	-																						
		1. DIMENSION	MA	MEASUREMENT	MA	10%	10%	As per IS/ Plant Std	Manf. Std / IS:4253	Manf. Std / IS:4253	SUPPLIER'S TEST CERT.		✓		P	-	-																						
		2. SHORE HARDNESS	MA	TEST	MA	As per IS/ Plant Std	-	As per IS/ Plant Std	-DO-	-DO-	SUPPLIER'S TEST CERT.		✓		P	V	V																						
		3. TENSILE STRENGTH	MA	TEST	MA	As per IS/ Plant Std	-	As per IS/ Plant Std	-DO-	-DO-	SUPPLIER'S TEST CERT.		✓		V	-	-																						
		4. ELONGATION AT BREAK	MA	TEST	MA	As per IS/ Plant Std	-	As per IS/ Plant Std	-DO-	-DO-	SUPPLIER'S TEST CERT.		✓		V	-	-																						
		5. COMPRESSION SET	MA	TEST	MA	As per IS/ Plant Std	-	As per IS/ Plant Std	-DO-	-DO-	SUPPLIER'S TEST CERT.		✓		V	-	-																						
1.11	NITRILE RUBBER CORD AND "O" RING(IF APPLICABLE)	6. ACCELERATED AGEING IN OIL	MA	TEST	MA	As per IS/ Plant Std	-	As per IS/ Plant Std	-DO-	-DO-	SUPPLIER'S TEST CERT.		✓		V	V	V																						
		1. DIMENSION	MA	MEASUREMENT	MA	10%	10%	As per IS/ Plant Std	Manf. Std / IS:4253	Manf. Std / IS:4253	SUPPLIER'S TEST CERT.		✓		P	-	-																						
		2. SHORE HARDNESS	MA	TEST	MA	As per IS/ Plant Std	-	As per IS/ Plant Std	-DO-	-DO-	SUPPLIER'S TEST CERT.		✓		P	V	V																						
		3. TENSILE STRENGTH	MA	TEST	MA	As per IS/ Plant Std	-	As per IS/ Plant Std	-DO-	-DO-	SUPPLIER'S TEST CERT.		✓		V	-	-																						
		4. ELONGATION AT BREAK	MA	TEST	MA	As per IS/ Plant Std	-	As per IS/ Plant Std	-DO-	-DO-	SUPPLIER'S TEST CERT.		✓		V	-	-																						
		5. COMPRESSION SET	MA	TEST	MA	As per IS/ Plant Std	-	As per IS/ Plant Std	-DO-	-DO-	SUPPLIER'S TEST CERT.		✓		V	-	-																						
		6. ACCELERATED AGEING IN OIL	MA	TEST	MA	As per IS/ Plant Std	-	As per IS/ Plant Std	-DO-	-DO-	SUPPLIER'S TEST CERT.		✓		V	V	V																						
		1. DIMENSION	MA	MEASUREMENT	MA	10%	10%	As per IS/ Plant Std	Manf. Std / IS:4253	Manf. Std / IS:4253	SUPPLIER'S TEST CERT.		✓		P	-	-																						
		2. SHORE HARDNESS	MA	TEST	MA	As per IS/ Plant Std	-	As per IS/ Plant Std	-DO-	-DO-	SUPPLIER'S TEST CERT.		✓		P	V	V																						
		3. TENSILE STRENGTH	MA	TEST	MA	As per IS/ Plant Std	-	As per IS/ Plant Std	-DO-	-DO-	SUPPLIER'S TEST CERT.		✓		V	-	-																						
		4. ELONGATION AT BREAK	MA	TEST	MA	As per IS/ Plant Std	-	As per IS/ Plant Std	-DO-	-DO-	SUPPLIER'S TEST CERT.		✓		V	-	-																						
		5. COMPRESSION SET	MA	TEST	MA	As per IS/ Plant Std	-	As per IS/ Plant Std	-DO-	-DO-	SUPPLIER'S TEST CERT.		✓		V	-	-																						
		6. ACCELERATED AGEING IN OIL	MA	TEST	MA	As per IS/ Plant Std	-	As per IS/ Plant Std	-DO-	-DO-	SUPPLIER'S TEST CERT.		✓		V	V	V																						

MANUFACTURER/ BIDDER/ SUPPLIER NAME & ADDRESS										STANDARD QUALITY PLAN										SPEC. NO : PE-TS-435-302-E001, R0										DATE: 10/06/2020									
CUSTOMER : TANGEDCO										PROJECT : 2 X 660MW UDANGUDI STPP										QP NO.: PE-V0-435-302-E001										DATE:									
ITEM: OIL FILLED TRANSFORMER										SYSTEM:										PO NO.:										SECTION: II									
S. NO.	COMPONENT/ OPERATION	CHARACTERISTIC CHECK			CLASS	TYPE OF CHECK		QUANTUM OF CHECK		REFERENCE DOCUMENT	ACCEPTANCE NORM		FORMAT OF RECORD																										

MANUFACTURER/ BIDDER/ SUPPLIER NAME & ADDRESS										STANDARD QUALITY PLAN										SPEC. NO : PE-TS-435-302-E001, R0										DATE: 10/06/2020									
CUSTOMER : TANGEDCO										PROJECT: 2 x 660MW UDANGUDI STPP										PO NO. : PE-V0-435-302-E901										DATE: 10/06/2020									
ITEM: OIL FILLED TRANSFORMER										SYSTEM: II										SECTION: II										SHEET No. of									
S. NO.	COMPONENT/ OPERATION	CHARACTERISTIC CHECK	CLASS	TYPE OF CHECK	QUANTUM OF CHECK			REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD			AGENCY			REMARKS																							
1	2	3	4	5	M	C/N		7	8	9			**																										
1.9	INSULATING OIL	1. APPEARANCE OF OIL	MA	VISUAL				IEC60296 / IS335		SUPPLIER'S TEST CERT.			✓	D	M	C	N																						
		2. DENSITY AT 29.5 DEG C	MA	TEST				IS 1448(16)	IS 1448(16)	SUPPLIER'S TEST CERT.			✓		V	V	V																						
		3. KINEMATIC VISCOSITY AT 27 DEG C	MA	TEST				IS 1448(25)	IS 1448(25)	SUPPLIER'S TEST CERT.			✓		V	V	V																						
		4. INTERFACIAL TENSION AT 27 DEG C	MA	TEST				IS 6104	IS 6104	SUPPLIER'S TEST CERT.			✓		V	V	V																						
		5. FLASH POINT	MA	TEST				IS 1448(21)	IS 1448(21)	SUPPLIER'S TEST CERT.			✓		V	V	V																						
		6. POUR POINT	MA	TEST				IS 1448(10)	IS 1448(10)	SUPPLIER'S TEST CERT.			✓		V	V	V																						
		7. NEUTRALIZATION VALUE	MA	TEST				IS 1448(2)	IS 1448(2)	SUPPLIER'S TEST CERT.			✓		V	V	V																						
		8. CORROSIVE SULPHUR	MA	TEST				IS 335	IS 335	SUPPLIER'S TEST CERT.			✓		V	V	V																						
		9. DIELECTRIC DISSIPATION FACTOR	MA	TEST				IS 6262	IS 6262	SUPPLIER'S TEST CERT.			✓		V	V	V																						
		10. SPECIFIC RESISTANCE (RESISTIVITY)	MA	TEST			ONE SAMPLE	IS 6103	IS 6103	SUPPLIER'S TEST CERT.			✓		V	V	V																						
1.10	PAINT & VARNISH FITTING AND ACCESSORIES	11. AGEING CHARACTERISTICS AFTER ACCELERATED AGING	MA	TEST			IS 12177	IS 12177	SUPPLIER'S TEST CERT.			✓		V	V	V																							
		12. OXIDATION STABILITY	MA	TEST				IS 335	IS 335	SUPPLIER'S TEST CERT.			✓		V	V	V																						
		13. PRESENCE OF OXIDATION INHIBITOR	MA	TEST				IS 13631	IS 13631	SUPPLIER'S TEST CERT.			✓		V	V	V																						
		14. ELECTRIC STRENGTH (BDV, TAN-DELTA)	MA	TEST				IS 6262	IS 6262	SUPPLIER'S TEST CERT.			✓		V	V	V																						
		15. AS DELIVERED	MA	TEST				IS 13567	IS 13567	SUPPLIER'S TEST CERT.			✓		V	V	V																						
		16. AFTER TREATMENT	MA	TEST				IS 335 / IEC-60296	IS 335 / IEC-60296	SUPPLIER'S TEST CERT.			✓		V	V	V																						
		17. WATER CONTENT	MA	TEST				MANF-STD	MANF-STD	SUPPLIER'S TEST CERT.			✓	P	V	V																							
		18. SK VALUE	MA	TEST																																			
		19. SHELF LIFE	MA	VISUAL			100%																																
		20. 2.1	PORCELAIN BUSHING (IF APPLICABLE)	1. DIMENSION	MA	MEASUREMENT	100%		APPROVED DRAWING/ IS-2099/IS-8603/IS-3347/IS 12676 / IEC60137 / IEC 60660	APPROVED DRAWING/ IS-2099/IS-8603/IS-3347/IS 12676 / IEC60137 / IEC 60660	SUPPLIER'S TEST CERT / QC RECORD			✓		P	-	-	REFER APPROVED DRAWING OF HV AND LV BUSHING FOR APPLICABILITY																				
2. VISUAL DEFECTS	MA	VISUAL		100%					SUPPLIER'S TEST CERT.			✓		V	-	-																							
3. ROUTINE TESTING	MA	TEST		100%		100%			QC RECORDS/SUPPLIER'S TEST CERTIFICATE			✓		V	V	V																							
1. TYPE, SIZE & MAKE	MA	VISUAL		100%		100%			SUPPLIER'S TEST CERT.			✓		P	V	V																							
2.2	BUCHHOLZ RELAY	2. CONTINUITY FOR ALARM & TRIP (PERFORMANCE)	MA	TEST	As per IS/ Plant Std					SUPPLIER'S TEST CERT.			✓		V	V	-																						
		3. POROSITY TEST	MA	TEST	As per IS/ Plant Std					SUPPLIER'S TEST CERT.			✓		V	V	-																						
		4. HIGH VOLTAGE & IR TEST	MA	TEST	As per IS/ Plant Std			Manf. Std / IS:3637	Manf. Std / IS:3637	SUPPLIER'S TEST CERT.			✓		V	V	-																						
		5. ELEMENT TEST	MA	TEST	As per IS/ Plant Std					SUPPLIER'S TEST CERT.			✓		V	V	-																						
		6. GAS VOLUME TEST	MA	TEST	As per IS/ Plant Std					SUPPLIER'S TEST CERT.			✓		V	V	V																						
2.3	PRESSURE RELIEF DEVICE	7. LOSS OF OIL & SURGE TEST	MA	TEST	As per IS/ Plant Std					SUPPLIER'S TEST CERT.			✓		V	V	-																						
		1. TYPE, SIZE & MAKE	MA	VISUAL	100%					QC RECORD			✓		P	V	V																						
		2. OPERATION (PRESSURE & FLAG INDICATION)	MA	TEST	As per IS/ Plant Std			Manf. Std	Manf. Std	SUPPLIER'S TEST CERT.					V	-	-																						
		3. HV TEST	MA	TEST	As per IS/ Plant Std					SUPPLIER'S TEST CERT.			✓		V	-	-																						
		4. SWITCH CONTACT OPERATION	MA	TEST	As per IS/ Plant Std					SUPPLIER'S TEST CERT.			✓		V	V	V																						

MANUFACTURER/ BIDDER/ SUPPLIER NAME & ADDRESS										STANDARD QUALITY PLAN										SPEC. NO. : PE-TS-435-302-E001, R0										DATE: 10/06/2020									
PROJECT: 2 X 660MW UDANGUDI STPP										CUSTOMER : TANGEDCO										QF NO. : PE-V0-435-302-E901										DATE: 10/06/2020									
ITEM: OIL FILLED TRANSFORMER										SYSTEM:										PO NO. :										DATE: 10/06/2020									
																				SECTION: II										SHEET No. of									
S. NO.	COMPONENT/ OPERATION	CHARACTERISTIC CHECK	CLASS	TYPE OF CHECK	QUANTUM OF CHECK			REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD			AGENCY				REMARKS																						
					5	6	7			8	9	*	D	M	C	N																							
1	MAGNETIC OIL LAYEL GAUGE (MOG)	3	4	5	M	C/N		7	8	9	*	D	M	C	N	REFER APPROVED DATA SHEET FOR OFF-CIRCUIT TAP CHANGERS/ SWITCH (IF APPLICABLE)																							
1. TYPE, SIZE & MAKE		MA	VISUAL	100%	-		Manf. Std	Manf. Std / IEC 60214	QC RECORD	SUPPLIERS TEST CERT.	✓	P	V	-	-																								
2. DIAL MARKING		MA	VISUAL	10%	-																																		
3. SWITCH CONTINUITY		MA	TEST	10%	-																																		
4. HV TEST		MA	TEST	10%	-																																		
5. OPERATION TEST	MA	TEST	10%	-												REFER APPROVED DATA SHEET FOR OFF-CIRCUIT TAP CHANGERS/ SWITCH (IF APPLICABLE)																							
1. DIMENSIONS	MA	MEASUREMENT	100%	100%																																			
2. PHYSICAL CONDITION	MA	VISUAL	100%	100%																																			
3. OPERATION OF SWITCH	MA	TEST	-do-	-do-																																			
4. INSULATION RESISTANCE TEST	MA	TEST	-do-	-do-																																			
2.5	OFF-CIRCUIT TAP CHANGERS/ SWITCH (IF APPLICABLE)	5. LEAK TEST OF HANDLE STUFFING BOX	MA	TEST	-do-	-do-										REFER APPROVED DATA SHEET FOR OFF-CIRCUIT TAP CHANGERS/ SWITCH (IF APPLICABLE)																							
6. MILLI VOLT DROP TEST		MA	TEST	-do-	-do-																																		
1. VISUAL CHECK		MA	VISUAL	100%	100%																																		
2. DIMENSIONAL CHECK		MA	MEASUREMENT	100%	100%																																		
3. MECHANICAL OPERATION ON DIVERTER & SELECTOR SWITCH, 4000 SWITCHING OPER. (MIN)		MA	VERIFY	-do-	-do-																																		
2.6	ON LOAD TAP CHANGER (IF APPLICABLE)	4. HV TEST ON AUXILIARY CIRCUIT	MA	TEST	-do-	-do-	IS 8468/IEC 60214	IS 8468/IEC 60214	IS 8468/IEC 60214	SUPPLIERS TEST CERT.	✓	P	V	-	-	REFER APPROVED DATA SHEET FOR ON LOAD TAP CHANGER (IF APPLICABLE)																							
5. SEQUENCE TEST		MA	TEST	-do-	-do-																																		
6. PRESSURE TEST OF DIVERTER SWITCH COMPARTMENT WITH OIL		MA	TEST	-do-	-do-																																		
7. MECHANICAL TEST OF TAP SELECTOR WITH MOTOR DRIVE 500 SATISFACTORY OP(MIN ALL) FROM ONE EXTREME POSITION TO THE OTHER IN AIR		MA	TEST	-do-	-do-																																		
8. OPM TEST OF COMPLETE TAP-CHANGER		MA	TEST	-do-	-do-																																		
2.7	GUN METAL / CAST IRON VALVES GATE/GLOBE/ BUTTERFLY)	9. AUX. CKT. HV TEST AT 2 KV FOR 1 MIN.	MA	TEST	-do-	-do-	Manf. Std./IS:778(1) -DO-	Manf. Std /IS:778(1) -DO-	IS 778(1)	SUPPLIERS TEST CERT.	✓	P	V	V	-	-																							
1. DIMENSIONAL CHECK		MA	MEASUREMENT	100%	100%																																		
2. TYPE, SIZE & MAKE		MA	VISUAL	100%	As per IS/ Plant Std																																		
3. LEAKAGE TEST(HYDRAULIC TEST FOR BODY & SEAT)		MA	TEST	As per IS/ Plant Std	As per IS/ Plant Std																																		
4. OPERATIONAL TEST (CLOSE & OPEN)		MA	TEST	As per IS/ Plant Std	-																																		
2.8	BUSHING CT	1. VISUAL CHECK/DIMENSIONAL CHECK	MA	MEASURE/VISUAL TEST	As per IS/ Plant Std	-	Manf. Std./IS:2705/IEC 60044	Manf. Std./IS:2705/IEC 60044	Manf. Std./IS:2705/IEC 60044	SUPPLIERS TEST CERT.	✓	V	V	V	V	REFER APPROVED DATA SHEET FOR BUSHING CT																							
2. ROUTINE TEST		MA	TEST	100%	100%																																		
1. VISUAL CHECK FOR WIRING		MA	TEST	100%	100%																																		
2. DIMENSIONAL CHECK		MA	MEASURE/TEST	100%	100%																																		
3. CHECK FOR MAKE OF COMPONENTS		MA	MEASURE/TEST	100%	100%																																		
2.9	MARSHALING BOX/RTCC	4. 2 KV INSULATION TEST ON AUXILIARY WIRING	MA	MEASURE/TEST	100%	100%	APPROVED DRAWING	APPROVED DRAWING	APPROVED DRAWING	QC RECORD	✓	P	V	V	V	REFER APPROVED DATA SHEET FOR MARSHALING BOX/RTCC																							
5. CHECK FOR PAINT SHADE & THICKNESS		MA	MEASURE/TEST	100%	100%																																		
6. DEGREE OF PROT. BY PAPER INSERTION		MA	MEASURE/TEST	100%	100%																																		
		MA	MEASURE/TEST	100%	100%																																		
		MA	MEASURE/TEST	100%	100%																																		

MANUFACTURER/ BIDDER/ SUPPLIER NAME & ADDRESS										STANDARD QUALITY PLAN										SPEC. NO : PE-TS-435-302-E001, R0										DATE: 10/06/2020									
CUSTOMER : TANGEDCO										PROJECT : 2 X 660MW UDANGUDI STPP										QP NO.: PE-V0-435-302-E901										DATE: 10/06/2020									
ITEM: OIL FILLED TRANSFORMER										SYSTEM:										PO NO.:										DATE:									
																				SECTION: II										SHEET No. of									
S. NO.	COMPONENT/ OPERATION	CHARACTERISTIC CHECK	CLASS	TYPE OF CHECK		QUANTUM OF CHECK			REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD			AGENCY				REMARKS																					
				5	4	M	C/N	7			8	9	D	M	C	N																							
1		11. SURFACE CLEANING BY SAND/ SHOT BLASTING	MA	VISUAL	100%	100%	100%	100%	MANF. DRG./STAND.	MANF. DRG./STAND.	QC RECORD	QC RECORD	✓		V	V	V																						
		12. PRIMER COATING, PAINT SHADE THICKNESS INSIDE & OUTSIDE	MA	MEASUREMENT	100%	100%	100%	100%	IS:101/ BHEL specification	IS:101/ BHEL specification	QC RECORD	QC RECORD	✓		V	V	V																						
		13. PAINT FILM ADHESION TEST	MA	TEST	100%	100%	100%	100%	IS:101/ BHEL specification	IS:101/ BHEL specification	QC RECORD	QC RECORD	✓		V	V	V																						
		14. VACUUM TEST (TANK)	CR	VACCUUM TEST	1 UNIT EACH TYPE	1 UNIT EACH TYPE	1 UNIT EACH TYPE	1 UNIT EACH TYPE	CBIP/ IS:1180	CBIP/ IS:1180	QC FORMAT	QC RECORD	✓		V	W	W																						
		15. PRESSURE TEST (TANK)	CR	PRESSURE TEST	1 UNIT EACH TYPE	1 UNIT EACH TYPE	1 UNIT EACH TYPE	1 UNIT EACH TYPE	CBIP/ IS:1180	CBIP/ IS:1180	QC FORMAT	QC RECORD	✓		V	W	W																						
3.2	CORE STAMPING	1. BURR & BOW	MA	VISUAL	100%	100%	100%	100%	MANF. DRG./STAND.	MANF. DRG./STAND.	QC RECORD	QC RECORD			P	-	-																						
		2. DIMENSIONAL CHECK	MA	MEASUREMENT	100%	100%	100%	100%	MANF. DRG./STAND.	MANF. DRG./STAND.	QC RECORD	QC RECORD			P	-	-																						
		2. DIMENSIONAL CHECK	MA	MEASUREMENT	100%	100%	100%	100%			QC RECORD	QC RECORD			P	-	-																						
		2. ASSEMBLY OF LIMB INSULATION AND LIMB PLATES	MA	VISUAL	100%	100%	100%	100%			QC RECORD	QC RECORD			P	-	-																						
		3. RECTANGULARITY OF CORE ASSEMBLY	MA	VISUAL	100%	100%	100%	100%			QC RECORD	QC RECORD			P	-	-																						
		4. FREEDOM FROM OVERLAPS & AIR GAP AT JOINTS	MA	VISUAL	100%	100%	100%	100%	MANF. DRG./STAND.	MANF. DRG./STAND.	QC RECORD	QC RECORD			P	-	-																						
3.3	CORE BUILDING	5. LEANING OF CORE (I.E CORE VERTICALITY)	MA	VISUAL	100%	100%	100%	100%			QC RECORD	QC RECORD			P	-	-																						
		6. LIMB & STACK THICKNESS	MA	VISUAL	100%	100%	100%	100%			QC RECORD	QC RECORD			P	-	-																						
		7. LIMB CLAMPING & BINDING	MA	VISUAL	100%	100%	100%	100%			QC RECORD	QC RECORD			P	-	-																						
		8. CORE DIAMETER	MA	VISUAL	100%	100%	100%	100%			QC RECORD	QC RECORD	✓		P	V	V																						
		9. EARTHING OF CORE	MA	VISUAL	100%	100%	100%	100%			QC RECORD	QC RECORD	✓		P	V	V																						
		1. DIMENSIONAL CHECK	MA	MEASURE	100%	100%	100%	100%			QC RECORD	QC RECORD			P	-	-																						
		2. FLUX DENSITY MEASUREMENT	MA	MEASURE	100%	100%	100%	100%			QC RECORD	QC RECORD			P	-	-																						
		3. ISOLATION TEST BETWEEN(CORE TO CORE CLAMPS)	MA	TEST	100%	100%	100%	100%			QC RECORD	QC RECORD			P	-	-																						
3.4	TEST OF CORE	4.TORQUE TIGHTNESS	MA	MEASURE	100%	100%	100%	100%	MANF. DRG./STAND.	MANF. DRG./STAND.	QC RECORD	QC RECORD			P	-	-																						
		5. CORE INSULATION	MA	ELECTRICAL	100%	100%	100%	100%			QC RECORD	QC RECORD			P	-	-																						
		6.CORE LOSS	MA	ELECTRICAL WITH DUMMY COIL	100%	100%	100%	100%			QC RECORD	QC RECORD	✓		P	V	V																						
		7. VISUAL CHECKS OF CORE VERTICALITY	MA	VISUAL	100%	100%	100%	100%			QC RECORD	QC RECORD			P	-	-																						
		1. BRAZING PROCEDURE & BRAZER QUALIFICATION	MA	REVIEW	100%	100%	100%	100%			QC RECORD	QC RECORD			P	-	-																						
		2. CONDUCTOR SIZE	MA	MEASUREMENT	100%	100%	100%	100%			QC RECORD	QC RECORD			P	-	-																						
		3. RADIAL DEPTH OF WINDING	MA	MEASUREMENT	100%	100%	100%	100%			QC RECORD	QC RECORD			P	-	-																						
		4. ANCHORING & BINDING AT START & FINISH	MA	MEASUREMENT	100%	100%	100%	100%			QC RECORD	QC RECORD			P	-	-																						
		5. NO. OF TURNS	MA	MEASUREMENT	100%	100%	100%	100%			QC RECORD	QC RECORD			P	-	-																						
		6. TRANSDPOSITION OF CROSS-OVERS	MA	MEASUREMENT	100%	100%	100%	100%	MANF. STANDARD	MANF. STANDARD	QC RECORD	QC RECORD			P	-	-																						
3.5	WINDING	7. DIMENSIONAL CHECK (OD, ID & AXIAL LENGTH)	MA	MEASUREMENT	100%	100%	100%	100%			QC RECORD	QC RECORD			P	-	-																						
		8. INSULATION ARRANGEMENT & ALIGNMT.	MA	MEASUREMENT	100%	100%	100%	100%			QC RECORD	QC RECORD			P	-	-																						
		9. WINDING LENGTH	MA	MEASUREMENT	100%	100%	100%	100%			QC RECORD	QC RECORD			P	-	-																						

ENGINEERING				BHEL				QUALITY				BIDDER/ SUPPLIER				FOR CUSTOMER REVIEW & APPROVAL			
Sign & Date	Name	Checked by:	Reviewed by:	Sign & Date	Name	Checked by:	Reviewed by:	Sign & Date	Name	Checked by:	Reviewed by:	Sign & Date	Name	Checked by:	Reviewed by:	Sign & Date	Name	Checked by:	Reviewed by:
		Srabani Mishra & Abhay Agrawal	Sandeep Lodh			Kundan Prasad	Ritesh Kumar Jaiswal												

MANUFACTURER/ BIDDER/ SUPPLIER NAME & ADDRESS										STANDARD QUALITY PLAN										SPEC. NO : PE-TS-435-302-E001, R0										DATE: 10/06/2020									
CUSTOMER : TANGEDCO										PROJECT : 2 X 660MW UDANGUDI STPP										DATE: 10/06/2020										DATE: 10/06/2020									
ITEM: OIL FILLED TRANSFORMER										SYSTEM: II										PO NO.:										SHEET No. of									
MANUFACTURER/ BIDDER/ SUPPLIER NAME & ADDRESS										SYSTEM: II										SECTION: II										SHEET No. of									
S. NO.	COMPONENT/ OPERATION	CHARACTERISTIC CHECK	CLASS	TYPE OF CHECK	QUANTUM OF CHECK			REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD			AGENCY			REMARKS																							
					M	C/N				7	8	9	D	M	C		N																						
1	2	3	4	5	6																																		
3.5	WINDING	10. BRAZED JOINTS	MA	MEASUREMENT	100%	-	MANF. STANDARD	MANF. STANDARD	QC RECORD		P	-	-																										
		11. LEAD & COIL IDENTIFICATION	MA	MEASUREMENT	100%	-			QC RECORD		P	-	-																										
		12. FREE FROM DAMAGES	MA	MEASUREMENT	100%	-			QC RECORD		P	-	-																										
		13. CONTINUITY TEST FOR LEADS	MA	MEASUREMENT	100%	-			QC RECORD		P	-	-																										
		14. TURN TO TURN INSULATION	MA	MEASUREMENT	100%	100%			QC RECORD	✓	P	V	V																										
3.6	CORE COIL ASSEMBLY	15. MEASURE OF RESISTANCE	MA	MEASUREMENT	100%	100%	MANF. STANDARD	MANF. STANDARD	QC RECORD	✓	P	V	V																										
		1. CLEANLINESS OF CORE	MA	VISUAL	100%	-			QC RECORD		P	-	-																										
		2. ALIGNMENT OF SPACERS/BLOCKS	MA	VISUAL	100%	-			QC RECORD		V	-	-																										
		3. ELECT. CLEARANCE & INSP. OF CORE & COIL ASSLY AFTER COMPLETION OF TERMINAL GEAR	MA	VISUAL/MEASURE MENT	100%	-			QC RECORD		V	-	-																										
		4. CHECK PROVISION OF CORE FRAME EARTHING	MA	VISUAL	100%	-			QC RECORD		V	-	-																										
3.7	CONNECTION AND TAP SWITCH ASSEMBLY	1. RATIO TEST ON ALL TAPS	MA	TEST	100%	100%	MANF. STANDARD	MANF. STANDARD	QC RECORD	✓	P	V	V																										
		2. LEAD DISPOSITION	MA	VISUAL	100%	-			QC RECORD		P	-	-																										
		3. BRAZING OF JOINTS	MA	VISUAL	100%	-			QC RECORD		P	-	-																										
		4. CRIMPING OF JOINTS	MA	VISUAL	100%	-			QC RECORD		P	-	-																										
		5. INSULATION OVER JOINTS	MA	VISUAL	100%	-			QC RECORD		P	-	-																										
3.8	OVERVIEWING AND TANKING	6. VECTOR GROUP	MA	TEST	100%	-	MANF. DRG./RELEVANT STAND.	MANF. DRG./RELEVANT STAND.	QC RECORD		P	-	-																										
		1. CLEANLINESS OF TANK	MA	VISUAL	100%	-			QC RECORD		P	-	-																										
		2. DRAWING	MA	PHYSICAL	100%	-			QC RECORD		P	-	-																										
		3. CHECK TIGHTNESS OF CLAMPED BLOCKS AND MEASUREMENTS OF WINDING HEIGHT	MA	MEASUREMENT	100%	-			QC RECORD		P	-	-																										
		4. ELECTRICAL CLEARANCES	MA	MEASUREMENT	100%	-			QC RECORD		P	-	-																										
4	TYPE & SPECIAL TEST ON TRANSFORMER	5. OIL FILLING AND AIR RELEASE	MA	PHYSICAL	100%	-	MANF. DRG./RELEVANT STAND.	MANF. DRG./RELEVANT STAND.	QC RECORD		P	-	-																										
		6. DRYNESS (TAN-DELTA & IR)	MA	MEASUREMENT	100%	-			QC RECORD		P	-	-																										
		1. REVIEW OF TYPE TEST & SPECIAL TEST REPORT	MA	VERIFY	100%	100%			TEST REPORTS	✓	P	V	V	1. Type test as per enclosed annexure-1 to be conducted. 2. BHEL SHALL WITNESS THE TESTS MENTIONED IN ANNEXURE-1. 3. CUSTOMER'S WITNESS SHALL BE INFORMED DURING DOCUMENT APPROVAL STAGE.																									
		2. REVIEW OF ALL PREVIOUS STAGE OF INSP. AS PER QR PRIOR TO FINAL TESTING	MA	VERIFY					REPORTS																														
		1. VERIFICATION OF COMPLETENESS/ DIMENSIONAL CHECK	MA	MEASUREMENT	100%	100%			AS PER APPROVED OGA DATA SHEET/IS:2026	✓	P	W	W																										
5	ROUTINE TEST	2. MEASUREMENT OF VOLTAGE RATIO AT ALL TAPS.POLARITY & VECTOR GROUP VERIFICATION	MA	MEASUREMENT	100%	100%	AS PER APPROVED OGA DATA SHEET/IS:2026	AS PER APPROVED OGA DATA SHEET/IS:2026	QC RECORD	✓	P	W	W																										
		3. MEASUREMENT OF WINDING RESISTANCE ON HV & LV ON ALL THE TAPS	MA	MEASUREMENT	100%	100%			QC RECORD	✓	P	W	W																										
		4. MAGNETIC BALANCE TEST	MA	MEASUREMENT	100%	100%			QC RECORD	✓	P	W	W																										
		5. MEASUREMENT OF NO-LOAD LOSSES & CURRENT AT 90%, 100% & 110% RATED VOLTAGE	MA	MEASUREMENT	100%	100%			QC RECORD	✓	P	W	W																										
		6. LOAD LOSS & SHORT CIRCUIT IMPEDENCE MEASUREMENT ON PRINCIPAL & EXTREME TAPS.	MA	MEASUREMENT	100%	100%			QC RECORD	✓	P	W	W																										
BHEL										BHEL										FOR CUSTOMER REVIEW & APPROVAL																			
ENGINEERING										QUALITY										Doc No:																			
SIGN & Date										SIGN & Date										Reviewed by:																			
Name										Name										Sign & Date																			
Checked by:										Checked by:										Name																			
Reviewed by:										Reviewed by:										Seal																			
Srabani Mishra & Abhay Agrawal										Kundan Prasad																													
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MANUFACTURER/ BIDDER/ SUPPLIER NAME & ADDRESS		STANDARD QUALITY PLAN		CUSTOMER : TANGEDCO		SPEC. NO : PE-TS-435-302-E001, R0		DATE: 10/06/2020									
PROJECT: 2 X 660MW UDANGUDI STPP		ITEM: OIL FILLED TRANSFORMER		SYSTEM:		PO NO.:		DATE:									
						SECTION: II		SHEET No. of									
S. NO.	COMPONENT/ OPERATION	CHARACTERISTIC CHECK	CLASS	TYPE OF CHECK	QUANTUM OF CHECK		REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD				AGENCY				REMARKS
1	2	3	4	5	6		7	8	9				10				
					M	C/N					D	M	C	N			
5	ROUTINE TEST	7. DIELECTRIC TEST 1) INDUCED OVERVOLTAGE 2) SEPARATE SOURCE VOLTAGE WITHSTAND TEST	MA	MEASUREMENT	100%	100%	IS:2026	IS:2026	QC RECORD	✓		P	W	W			
		8. MEASUREMENT OF CAPACITANCE & TAN DELTA TO DETERMINE CAPACITANCE BETWEEN WINDING & EARTH	MA	MEASUREMENT	100%	100%	IS:2026	IS:2026	QC RECORD	✓		P	W	W			
		9. MEASUREMENT OF NO LOAD CURRENT WITH 415 V, 50 HZ AC SUPPLY.	MA	MEASUREMENT	100%	100%	AS PER APPROVED DATA SHEET./IS2026	AS PER APPROVED DATA SHEET./IS2026	QC RECORD	✓		P	W	W			
		10. MEASUREMENT OF INSULATION RESISTANCE OF WINDING	MA	MEASUREMENT	100%	100%	IS:2026	IS:2026	QC RECORD	✓		P	W	W			
		11. REPEAT NO LOAD CURRENTS/LOSS MEASUREMENT & IR MEASUREMENT AFTER COMPLETION OF ALL DIELECTRIC TEST.	MA	MEASUREMENT	100%	100%	AS PER APPROVED DATA SHEET./IS2026	AS PER APPROVED DATA SHEET./IS2026	QC RECORD	✓		P	W	W			
6	PRE SHIPMENT CHECK & DESPATCH	12. VERIFICATION OF OIL LEAKAGE TEST WITH ALL FITTING & ACCESSORIES AT NORMAL PRESSURE PLUS 35KPA FOR 24 HOURS.	MA	MEASUREMENT	100%	100%	CBIP	CBIP	QC RECORD	✓		P	W	W			
		13. JACKING TEST FOLLOWED BY D.P. TEST	MA	MEASUREMENT	100%	100%	CBIP	CBIP	QC RECORD	✓		P	W	W			
		14. PAINT SHADE, ADHESION TEST & DFT	MA	MEASUREMENT	100%	100%	DATA SHEET/ IS:101/ BHSL SPECIFICATION	DATA SHEET/ IS:101/ BHSL SPECIFICATION	QC RECORD	✓		P	W	W			
		15. PROTECTION ON M. BOX & CABLE BOX BY PAPER INSERTION	MA	MEASUREMENT	100%	100%	MFG. STD.	MFG. STD.	QC RECORD	✓		P	W	W			
		16. 2 KV TEST ON M.BOX WIRING & FUNCTIONAL CHECK FOR COMPONENT OF MB	MA	MEASUREMENT	100%	100%	APPROVED DWG./ MFG. STD.	APPROVED DWG./ MFG. STD.	QC RECORD	✓		P	W	W			
7	Packing	1. TRANSFORMER- VERIFICATION OF FINAL TRANSPORTION.	MA	VISUAL	100%	100%	BHSL SPECIFICATION	BHSL SPECIFICATION	QC RECORD	✓		P	W	W			
		2. DEW POINTS MEASUREMENT OF N2/ DRY GAS TIGHTNESS/ PR READING (ONLY APPLICABLE FOR TRANSFORMERS DISPATCHED WITH GAS FILLING).	MA	MEASUREMENT	100%	100%	MANUF. STANDARD	MANUF. STANDARD	QC RECORD	✓		P	W	W			
		3. PACKING OF LOOSE ITEMS	MA	VISUAL	100%	100%	BHSL SPECIFICATION	BHSL SPECIFICATION	QC RECORD	✓		P	W	W		REFER NOTE 9 & 10	
NOTES:																	
1. BHSL RESERVES THE RIGHT FOR CONDUCTING REPEAT TEST IF REQUIRED.																	
2. IN CASE OF FOREIGN SUPPLIER, ALL TEST CERTIFICATES SHALL BE FURNISHED BY THE SUPPLIER, DULY WITNESSED/ VERIFIED BY SUPPLIER'S TPI.																	
3. PHOTOGRAPHS OF COMPLETE TRANSFORMER & ITS ACCESSORIES SHALL BE SENT TO BHSL PURCHASE GROUP FOR REVIEW BEFORE ISSUING MDCC.																	
4. IN CASE THERE ARE ANY CHANGES IN QP COMMENTED BY CUSTOMER AT CONTRACT STAGE, THE SAME SHALL BE CARRIED OUT BY THE BIDDER WITHOUT ANY IMPLICATION TO BHSL/ CUSTOMER.																	
5. PROJECT SPECIFIC QUALITY PLAN TO BE DEVELOPED BASED ON CUSTOMER REQUIREMENT.																	
6. FOR EXPORT JOB, PACKING SHALL BE AS PER BHSL SEAWORTHY PACKING SPECIFICATION.																	
7. LATEST REVISION YEAR OF ISSUE OF ALL THE STANDARDS (IS/ASME/IEC ETC.) INDICATED IN QP SHALL BE REFERRED.																	
8. PACKING SHALL BE SUITABLE FOR STORAGE AT SITE IN TROPICAL CLIMATE CONDITIONS.																	
9. TRANSFORMER TANK SHALL BE DISPATCHED FILLED WITH OIL OR PURE DRY INERT NITROGEN GAS. IN CASE THE TANK IS FILLED WITH INERT GAS THE TEMPERATURE AND PRESSURE AT THE TIME OF GAS FILLING SHALL BE MARKED ON A TAG. A GRAPH SHOWING PRESSURE VS. TEMPERATURE SHALL BE ATTACHED FOR READING PRESSURES AT DIFFERENT TEMPERATURES.																	
10. IMPACT RECORDER/INDICATOR SHALL BE PROVIDED TO MONITOR THE TRANSFORMER DURING TRANSPORT.																	

BHEL				BIDDER/ SUPPLIER				FOR CUSTOMER REVIEW & APPROVAL			
ENGINEERING		QUALITY		Sign & Date		Sign & Date		Doc No:		Sign & Date	
Prepared by:	Sign & Date	Name	Sign & Date	Seal	Seal	Reviewed by:	Reviewed by:	Reviewed by:	Reviewed by:	Reviewed by:	Reviewed by:
Reviewed by:		Srabani Mishra & Abhay Agrawal		Kundan Prasad							
		Sandeep Lodh		Ritesh Kumar Jaiswal							

NOTES:

1. BHEL RESERVES THE RIGHT FOR CONDUCTING REPEAT TEST IF REQUIRED.

2. IN CASE OF FOREIGN SUPPLIER, ALL TEST CERTIFICATES SHALL BE FURNISHED BY THE SUPPLIER, DULY WITNESSED/ VERIFIED BY SUPPLIER'S TPI.

3. PHOTOGRAPHS OF COMPLETE TRANSFORMER & ITS ACCESSORIES AFTER PACKING TO BE SENT TO BHEL PURCHASE GROUP FOR REVIEW BEFORE ISSUING MDCC.

4. IN CASE THERE ARE ANY CHANGES IN QP COMMENTED BY CUSTOMER AT CONTRACT STAGE, THE SAME SHALL BE CARRIED OUT BY THE BIDDER WITHOUT ANY IMPLICATION TO BHEL/ CUSTOMER.

5. PROJECT SPECIFIC QUALITY PLAN TO BE DEVELOPED BASED ON CUSTOMER REQUIREMENT.

6. FOR EXPORT JOB, PACKING SHALL BE AS PER BHEL SEAWORTHY PACKING SPECIFICATION.

7. LATEST REVISION/ YEAR OF ISSUE OF ALL THE STANDARDS (IS/ ASME/ IEC ETC.) INDICATED IN QP SHALL BE REFERRED.

8. PACKING SHALL BE SUITABLE FOR STORAGE AT SITE IN TROPICAL CLIMATE CONDITIONS.

9. TRANSFORMER TANK SHALL BE DISPATCHED FILLED WITH OIL OR PURE DRY /INERT NITROGEN GAS. IN CASE THE TANK IS FILLED WITH INERT GAS THE TEMPERATURE AND PRESSURE AT THE TIME OF GAS FILLING SHALL BE MARKED ON A TAG. A GRAPH SHOWING PRESSURE VS. TEMPERATURE SHALL BE ATTACHED FOR READING PRESSURES AT DIFFERENT TEMPERATURES.

10. IMPACT RECORDER/INDICATOR SHALL BE PROVIDED TO MONITOR THE IMPACT EXPERIENCED BY THE TRANSFORMER DURING TRANSPORT.

		MANUFACTURER/ BIDDER/ SUPPLIER NAME & ADDRESS				STANDARD QUALITY PLAN				SPEC. NO : PE-TS-435-302-E001, R0				DATE:			
		CUSTOMER : TANGEDCO				PROJECT : 2 X 660MW UDANGUDI STPP				QP NO.: PE-V0-435-302-E901				DATE: 10/06/2020			
		ITEM: OIL FILLED TRANSFORMER				SYSTEM:				PO NO.:				DATE:			
										SECTION: II				SHEET No. of			

S. NO.	COMPONENT/ OPERATION	CHARACTERISTIC CHECK	CLASS	TYPE OF CHECK	QUANTUM OF CHECK		REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY				REMARKS
					M	C/N					D	M	C	
1	2	3	4	5	6		7	8	9	*				

LEGENDS:
* RECORDS, IDENTIFIED WITH "TICK"(✓) SHALL BE ESSENTIALLY INCLUDED BY SUPPLIER IN QA DOCUMENTATION
** M: SUPPLIER/ MANUFACTURER/ SUB-SUPPLIER, C: MAIN SUPPLIER/ BHEL/ THIRD PARTY INSPECTION AGENCY, N: CUSTOMER, P: PERFORM, W: WITNESS, V: VERIFICATION, AS APPROPRIATE MA: MAJOR, MI: MINOR, CR: CRITICAL

BHEL				BIDDER/ SUPPLIER				FOR CUSTOMER REVIEW & APPROVAL			
ENGINEERING		QUALITY		SIGN & DATE		SIGN & DATE		SIGN & DATE		SIGN & DATE	
Sign & Date	Name	Sign & Date	Name	Sign & Date	Seal	Sign & Date	Seal	Sign & Date	Seal	Sign & Date	Seal
Prepared by:	Srabani Mishra & Abhay Agrawal	Checked by:	Kundan Prasad	Reviewed by:		Reviewed by:		Reviewed by:		Reviewed by:	
Reviewed by:	Sandeep Lodh	Reviewed by:	Ritesh Kumar Jalawal	Reviewed by:		Reviewed by:		Reviewed by:		Reviewed by:	

	TITLE : TECHNICAL SPECIFICATION FOR OIL FILLED SERVICE TRANSFORMERS 2 X 660MW UDANGUDI STPP	SPECIFICATION NO. PE-TS-435-302-E001
		VOLUME NO. : II
		SECTION: II
		REV NO. : 01 DATE : 15.07.2021

ANNEXURE-I TO QAP

LIST OF TYPE TEST, SPECIAL TEST & ROUTINE TEST (ADDITIONAL TO QAP)

S. No.	TYPE TEST (to be conducted on one transformer of each rating)
a)	Temperature Rise Test
b)	DGA before & after temperature rise test
c)	Lightning impulse withstand voltage test, transformer winding Um<72.5 kV
d)	Vacuum Test during tank fabrication in line with CBIP
e)	Pressure Test in line with CBIP manual
f)	DOP test for Marshalling box & Cable box
g)	Measurement of Acoustic noise level
	SPECIAL TEST (to be conducted on one transformer of each rating)
a)	Lightning impulse test on neutral terminal (Where neutral is resistance grounded)
b)	Short circuit withstand test (If valid test report is not available for the specified rating)
c)	Measurement of zero-sequence impedance of three-phase transformers
d)	Measurement of the harmonics of the no-load current
e)	Test with lightning impulse chopped on the tail.
f)	Determination of capacitance and dissipation factor (tan delta) between windings-to-earth, and between windings
g)	Determination of transient voltage transfer characteristics
	ROUTINE TEST (ADDITIONAL TO THE TESTS COVERED IN QAP) (to be conducted on all transformers)
a)	Magnetic circuit isolation test
b)	Magnetic Balance test on three phase transformers
c)	Frequency Response Analysis test
d)	Measurement of magnetization current at low voltage
e)	Tests on oil
f)	Oil pressure test on completely assembled transformer
g)	Dew point measurement before dispatching.
h)	Insulating oil shall be tested for BDV & moisture content as follows, at manufacturer's works (oil sample shall be drawn before and after heat run test): • BDV 60 kV (min.) • Moisture content 15 ppm

ANNEXURE-II TO QAP

Domestic Packing for Oil Filled Transformers Rating <10MVA

A. Transformer shall be despatched in open in such a manner there shall be no damage during transit.

B. Transformer Radiator Assembly, Conservator, Spares and Accessories shall be despatched in "Crate Packing" using wood.

C. Transformer Oil (Extra Oil + Spare Oil) shall be despatched in Non Returnable Sealed Drums with proper marking of Volume and Vendor details.

D. Paint for touchup shall be despatched in "Crate Packing" using wood.

E. CRATE PACKING DETAILS

1.0 PREPARATION OF PACKING CASES:

1.1 DIMENSIONS

- 1.1.1 Minimum number of planks shall be used for a shook.
- 1.1.2 Thickness of planks for Front, rear, top and bottom sides and binding, jointing battens shall be 25/20mm +2/-3 mm
- 1.1.3 Horizontal, vertical, diagonal planks shall be given for binding
- 1.1.4 Width of binding planks shall be minimum 100mm
- 1.1.5 Distance between any 2 binding planks shall be less than 750mm
- 1.1.6 Diagonal planks shall be used in between vertical binding planks when distance between inner to inner of vertical planks is more than 750mm
- 1.1.7 Distance of the outer edges of these planks from the edge of case shall be less than 250mm.
- 1.1.8 Diagonal planks are not required for top planks and width side, if the width of pallet is less than 750mm.

1.2 JOINTING OF PLANKS

Single length planks shall be used for cubicles whose overall length is less than 2400mm. For cubicles of length more than 2400mm, jointing is permitted. The jointing shall be done with one single or maximum of 2 planks of wood same as other planks of width 250 mm (minimum) with two rows of nails on either side of the joint in zigzag manner. From the joint along height side, it shall be of lap joint with overlap of at least the width of plank.

1.3 TONGUE AND GROOVE JOINTS

Two consecutive planks shall be joined by tongue and groove joint. Depth of tongue shall be 12+1 mm, thickness of tongue shall be 8 +1 mm. The groove dimensions shall be such that the tongue fits tightly into the groove to make a good joint. This type of joint can be done based on the product requirement wherever required.

1.4 PERMISSIBLE DEFECTS

Wood shall be free from knots, bows, visible sign of infection and any kind of decay caused by insects, fungus, etc. End splits: Longest end splits at each end shall be measured and lengths added together. The added length shall not exceed 60mm per meter run of shook's. Wood pins shall be used to prevent further development of split.

Surface cracks: Surface cracks with a maximum depth of 3mm are permissible. A continuous crack of any depth all along the length is not allowed.

1.5 OTHER MATERIALS

1.5.1 NAILS

The dia. of the nails shall be 3.15mm. The length of the nails shall be 65mm wherever two planks of 25mm thickness are joined and 75mm wherever a 25mm plank is joined to a 50mm plank.

1.5.2 BLUE NAILS

These are used for nailing bituminized Kraft paper/hessian cloth to the planks. The length of the nails shall be 16mm.

1.5.3 HOOP IRON STRIPS

These are used for strapping the boxes. The width of the strips shall be 19+1mm and thickness 0.6+0.01mm. The material shall be free from rust. If sufficient nailing is done for bigger boxes, strapping need not be done.

1.5.4 CLIPS

These shall be used for strapping the hoop iron strips on the boxes.

1.5.5 BRACKETS

These brackets are used for nailing to the corners of cubicle boxes. The brackets shall be of mild steel of thickness min 2mm and width 25+1mm. The brackets shall be of "L" shape, the length of each side being 100+2mm. Two holes shall be provided towards the end of each side for screwing /nailing.

1.5.6 MULTI LAYERED CROSS LAMINATED POLYTHELENE FILM
100GSM (Colourless) Multi Layered Cross Laminated Polyethylene Film are used to make covers to the jobs individually. The cross lamination gives qualities of extra toughness, together with flexibility and lightness coupled with good weather resistance to ultra violet rays.

1.5.7 RUBBERISED COIR

The rubberized coir is used as cushioning material. For the packing of loose items, items are to be arrested by using rubberized coir. For the packing of cubicles rubberized coir of thickness 25mm and width 75mm shall be used.

1.5.8 FASTENERS

Bolts, double nuts, spring washers will have to be used to hold the job that there shall be no jerk.

1.5.8 PACKING SLIP

Packing slip kept in the polyethylene bag shall be placed in the box at appropriate place. In addition, one more packing slip covered in polyethylene cover and packing slip holder shall be nailed to front / rear of case.

1.5.9 MARKING PLATE

Marking on the packing case shall be done as per the manufacturer standard.

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ANNEXURE - B

TRANSFORMER LOSSES

NOT APPLICABLE

1. The No-Load and Load losses for transformers 2.0MVA & above and voltage ratio 33kV/6.9kV, 33kV/3.5kV, 11kV/6.9kV, 11kV/3.5kV, 6.6kV/3.5kV are given below:

Ratings	Maximum No-Load losses at rated frequency and 100%voltage	Maximum Load losses at normal ratio, rated current and 75 deg. C
<u>10.0 MVA</u>	9.0kW	72.0kW
<u>8.0MVA</u>	7.5 kW	57.0kW
<u>7.5 MVA</u>	7.2 kW	50.0kW
<u>6.3MVA</u>	6.5kW	45.0kW
<u>5.0MVA</u>	5.5kW	36.0kW
<u>3.5MVA</u>	4.5kW	32.0kW
<u>2.5 MVA</u>	2.8kW	30.0kW
<u>2.0MVA</u>	2.4 kW	24.0kW

The above indicated maximum No-Load and Load losses are inclusive of permissible tolerance as per IS-2026. Further tolerance on maximum losses is not permissible.

2. Transformers of rating 2.5MVA & below and voltage ratio 33kV/433V, ~~11kV/433V~~, 6.6kV/433V, 3.3kV/433V shall have Energy Efficiency Level 1 as per IS-1180. However, percent impedance shall be as per Data Sheet-A of section-I, volume-II of ~~technical~~ specification.

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ANNEXURE – C

Terminal No.	Description	Remarks	Notes:
T-01	230V, Single Phase, 50Hz, AC		1). The Terminals from T-01 to T-48 shall be designated as indicated in the chart for all outdoor transformers (ONAN cooling).
T-02	Supply		
T-03	MOG (Oil Level) Alarm		
T-04			2). The Terminals which are not used for a particular Transformer shall be left as spare. e.g. in case there is only one WTI alarm & trip, then terminals T-25 to T-28 & T-38 to T-40 shall be left as spare terminals.
T-05	Buchholz Relay Alarm		
T-06			
T-07	Buchholz Relay Trip		3). Provide 20% spare TBs.
T-08			
T-09	PRV-1 Alarm		
T-10			If applicable
T-11	PRV-1 Trip		
T-12			
T-13	PRV-2 Alarm		
T-14			
T-15	PRV-2 Trip		
T-16			
T-17	OTI Alarm		
T-18			
T-19	OTI Trip		
T-20			
T-21	WTI-1 Alarm		
T-22			
T-23	WTI-1 Trip		
T-24			
T-25 to T-28	SPARE	If applicable	
T-29	4-20 mA for OTI (DDCMIS)		
T-30	4-20 mA for OTI (SCADA)		
T-31			If applicable
T-32	4-20 mA for WTI-HV (DDCMIS)		
T-33	4-20 mA for WTI-HV (SCADA)		
T-34			
T-35			
T-36			
T-37 to T-50	SPARE		
T-51	WTI 1-CT		
T-52	CT Shorting Terminal		
T-53			If applicable
T-54	WTI 2-CT		
T-55	CT Shorting Terminal		
T-56			
T-57	LV Neutral CT (REF Protection)		
T-58	CT Shorting Terminal		
T-59			
T-60	LV Neutral CT (E/F Protection)		
T-61	CT Shorting Terminal		
T-62			
T-63	HV Neutral CT (REF Protection)		
T-64	CT Shorting Terminal		
T-65			
T-66	HV U-PHASE CT		
T-67	CT Shorting Terminal		
T-68			
T-69	HV V-PHASE CT		
T-70	CT Shorting Terminal		
T-71			
T-72	HV W-PHASE CT		
T-73	CT Shorting Terminal		
T-74			
T-75 to T-80	SPARE TBs (for CT)		

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ANNEXURE – D

NOT APPLICABLE

LIST OF O & M SPARES

S. NO.	DESCRIPTION	QTY
1	HV bushing with metal parts & gaskets	1 no. for each rating
2	LV bushing with metal parts & gaskets	1 no. for each rating
3	WTI with alarm & trip contacts	1 no.
4	OTI with alarm & trip contacts	1 no.
5	Magnetic oil level gauge	1 no.
6	Diaphragm of explosion vent	1 no.
7	Buchholz relay	1 no.
8	Silica gel charge	Three charge
9	Floats with contacts for Buchholz relay	1 set
10	Set of gaskets	2 sets
11	Set of valves (1 no. of each size & Type)	1 set
12	Set of windings for one limb in a suitable oil container (container shall be completely filled with transformer oil)	1 no. of each rating & type of transformer.
13	Contact for tap changer	1 set
14	Pressure relief device for 2MVA & above transformers	1 no.
15	Hydraulic/screw Jacks	4 no.
16	Any other item considered essential by the bidder	

Note:

- Wherever set is indicated above, it means the total parts/ accessories required to replace the particular item for a given equipment
- O & M spares shall be supplied along with transformers and packed separately with proper inscription.