# ANNEXURE-II

# TECHNICAL SPECIFICATION OF (2×3.3)/0.265kV, 40kA, 50/60Hz, THREE PHASE TEMPERATURE RISE TESTING TRANSFORMER

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| **1.0** | **FOREWORD**<br>Central Power Research Institute (herein after referred to as CPRI) intends to establish 40,000A temperature rise test facility at High Power Laboratory (HPL) in Bengaluru in order to perform the temperature rise test upto 40kA on MV Bus ducts, MV/HV Circuit Breakers, MV/HV Switchgear and Control gear, HV Switches and HV Disconnectors.<br>This Specification covers the supply of (2×3.3)/0.265kV, 40kA at 0.265kV, 50/60Hz, Three phase, Temperature Rise Testing Transformer complete with all accessories, for establishment of 40,000A Temperature Rise Test Facility at High Power Laboratory, CPRI-Bengaluru, India. |
| **2.0** | **GENERAL** |
| **2.1** | The Temperature Rise Testing Transformer covered by this specification will form part of the new 40,000A Temperature Rise Test Facility in High Power Laboratory, CPRI, Bengaluru, India. |
| **2.2** | The special features of such transformer, such as the capability to deliver continuous current of up to 40kA in temperature rise test on MV Bus ducts, MV/HV Circuit Breakers, MV/HV Switchgear and Control gear, HV Switches and HV Disconnectors. |
| **3.0** | **SCOPE** |
| **3.1** | This specification covers the design, engineering, design inputs for foundation, manufacture, assembly, stage inspection, testing at manufacturer's works, Type and Special tests, packing and transportation, insurance, supply, loading, unloading, handling, storage, erection installation, site testing and commissioning of (2×3.3)/0.265kV, 40kA at 0.265kV, 50/60Hz, Three phase, Temperature rise testing transformer, complete with all fittings, water cooling system, accessories and spares, for establishment of 40,000A Temperature Rise Test Facility at High Power Laboratory, CPRI-Bengaluru, India. |
| **3.2** | The supplier shall be responsible for the following activities:<br>• Design and engineering<br>• Manufacturing<br>• Factory tests<br>• Type and Special tests<br>• Transportation to site, unloading, handling and proper storage at the site<br>• Erection<br>• Site tests<br>• Commissioning<br>of the new transformer complete with all fittings, accessories and spares. |

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| **3.3** | The transformer shall be operated in three phase configuration and single phase configuration and will be fed by 3.3kVrms (Line to Line) laboratory supply. |
| **3.4** | The transformer ratio shall be changed by means of series or parallel manual connection of primary windings. |
| **3.5** | The transformer shall capable to deliver continuous current of up to 40kA in temperature rise test on MV Bus ducts, MV/HV Circuit Breakers, MV/HV Switchgear and Control gear, HV Switches and HV Disconnectors. |
| **3.6** | **Interfaces to be provided by CPRI:**<br>CPRI shall provide the following interfaces:<br>**(a) Electrical interfaces:**<br>• 3.3kV, Line to Line supply from the output of intermediate transformer<br>• 415 V, 3-phase supply and 230 V single phase supply for all control and measurement system<br>**(b) Mechanical/Civil interfaces:**<br>• Foundation, firefighting system<br>**(c) Control interfaces:**<br>• Interface with the laboratory automation and protection system. |
| **4.0** | **CLIMATIC CONDITIONS** |
| **4.1** | The Temperature rise testing transformer and their accessories shall be designed for satisfactory operation under tropical climatic conditions prevailing in India. |
| **4.2** | The climatic conditions prevalent at the site of the operation are as follows;<br>a) Altitude above Mean Sea Level : 920 m<br>b) Maximum ambient temperature : 45°C<br>c) Minimum ambient temperature : 10°C<br>d) Average annual temperature : 24°C<br>e) Average Humidity : 81%<br>f) Special corrosion conditions : Nil<br>g) Solar Radiation (DNI) : 4.5-5.0 kWh/Sq. m/Day<br>h) Atmospheric UV radiation : High<br>i) Pollution level : Moderate<br>j) Snow fall : Nil<br>k) Seismic Zone : Zone-II<br>l) Wind Speed : Average 5.6 km/h<br>m) Annual rainfall : 1000mm-1500mm |

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| **4.3** | The site location is situated in the CPRI campus located adjacent to Indian Institute of Science. The site can be approached<br>a) By Train: Nearest Railway station: Yeshwanthpur<br>b) By Air: Kempegowda International airport 33 km away from site.<br>c) Nearest Sea Port: Chennai |
| **5.0** | **SYSTEM PARTICULARS** |
| **5.1** | The Temperature Rise Testing Transformer shall form part of the unit system of various apparatus as shown in Figure 1, page 18 of 26 of this document. |
| **6.0** | **STANDARDS** |
| **6.1** | The Temperature Rise Testing Transformer and accessories shall generally conform to the latest editions of the relevant IEC Publications and special requirements of this specification. |
| **6.2** | The Temperature Rise Testing Transformer and accessories shall comply with the requirements of the latest edition of the following IEC Standards:<br>1) IEC Standard 60076-1, Power Transformers – Part 1: General<br>2) IEC Standard 60076-2, Power Transformers – Part 2: Temperature rise<br>3) IEC Standard 60076-3, Power Transformers – Part 3: Insulation levels and dielectric tests<br>4) IEC Standard 60076-4, Power Transformers – Part 4: Guide to the lightning impulse and switching impulse testing - Power transformers and reactors<br>5) IEC Standard 60076-5, Power Transformers – Part 5: Ability to withstand short circuit<br>Compliance is also required with the following IEC Standards<br>6) IEC Standard 60076-10, Power transformers - Part 10: Determination of sound levels<br>7) IEC Standard 60137, Insulated bushings for alternating voltages above 1000 V<br>8) IEC Standard 60296, Fluids for electro-technical applications – Unused mineral oils for transformers and switchgears.<br>9) IEC 60076-18:2012: Power transformers - Part 18: Measurement of frequency response |
| **6.3** | If a relevant IEC Publication does not exist, the supplier shall adopt other internationally accepted standards and codes.<br>In the matter of conformity, the following order shall be binding:<br>• The special requirements of this specification<br>• The latest versions of IEC Publication<br>• To the latest versions of other national/international standards/codes as applicable to the relevant equipment or component or the material used in the |

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| | manufacture of the same.<br>• In the event a requirement is not covered by any of the above mentioned documents the same will be decided by mutual agreement between the purchaser and the supplier.<br>• Moreover reference has to be made to all applicable Indian laws. |
| **7.0** | **BASIC STRUCTURE** |
| **7.1** | The three-phase Temperature Rise Testing Transformer is required to feed the test object with well adapted current and voltage. The three-phase Temperature Rise Testing Transformer shall be an oil immersed type and shall have the primary and secondary windings separated in order to assure a galvanic insulation. |
| **7.2** | Each phase of the primary winding shall be arranged in two sections. Both the two sections must be equipped with three taps: +15%, 0% and -15% as shown in Figure 2, page 19 of 26. The two sections of each phase of the primary winding may be connected either in parallel or in series as given in Figure 3, page 20 of 26, provided that the same tap of each primary section is to be used. |
| **7.3** | In order to avoid unbalance in the case of parallel connection it is requested that the impedance of the two sections differ not more than 1- 2 %. |
| **7.4** | The three-phase Temperature Rise Testing Transformer must be able to operate in three-phase and two-phase configurations. In two phase configuration, the test object is connected to two active phases of the Transformer. Both the primary and secondary windings of the Temperature Rise Testing Transformer are star connected. Taking into account the series/parallel connection of the primary sections, the obtainable maximum output voltage and current from the three-phase Temperature Rise Testing Transformer are listed in Table 1 for both three-phase and two-phase tests. |

Table 1 – Temperature Rise Testing Transformer main ratings in three and two-phase tests

| No. | Primary winding | | | | Ratio | Secondary winding | |
|---|---|---|---|---|---|---|---|
| | Max voltage [V] | Sections tap | Sections connection | Max. current [A] | | Max. voltage [V] | Max. current [A] |
| 1 | 3300 | +15% | Parallel | 2424 | 16.50 | 200.0 | 40000 |
| 2 | 3300 | 0% | Parallel | 2788 | 14.35 | 230.0 | 40000 |
| 3 | 3300 | -15% | Parallel | 3206 | 12.48 | 264.5 | 40000 |
| 4 | 3300 | +15% | Series | 1212 | 33.00 | 100.0 | 40000 |
| 5 | 3300 | 0% | Series | 1394 | 28.70 | 115.0 | 40000 |
| 6 | 3300 | -15% | Series | 1603 | 24.95 | 132.3 | 40000 |

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| **7.5** | Each section of the primary winding must be equipped with an Off-load Tap Changer allowing to select the tap (+15%, 0%, -15%) to be used. The Off-load Tap Changer must not allow the selection of two different taps in the different primary sections and the selection of the tap must only be possible when the transformer is in de-energized condition. The Off-load Tap Changer shall be locally controlled, in order to perform maintenance operations and remotely controlled from the Control and Monitoring System of the Test Facility Control Room. |
| **7.6** | The series or parallel connection of the two sections of each phase of the primary winding shall be performed by manual operation taking into account that about 90% of the tests is performed adopting a series connection. Therefore the bushings of the primary winding have to be installed on the tank cover in such a position that must be simple to carry out the series and parallel connections of the primary sections. |
| **8.0** | **MAIN TECHNICAL CHARACTERISTICS**<br>The below Table 2 summarizes the main technical characteristics of the Temperature Rise Testing Transformer. |

Table 2 - Main technical requirements of the Temperature Rise Testing Transformer

| **Characteristics** | **Ratings** | |
|---|---|---|
| Type | Three-phase, oil insulated | |
| Rated power | Suitable to meet the two and three-phase test capabilities listed in Table 1 | |
| Number of windings | 2 | |
| Winding characteristics: | Primary | Secondary |
| *Number of sections per phase* | 2 | 1 |
| *Rated voltage* | 2 x 3300 V | 265 V |
| *Taps* | +15% ; 0% ; -15% | - |
| *Rated current* | 2 x 1603 A | 40000 A |
| *Insulation* | Uniform | |
| *Insulation voltage* | 3.6 kV | 1.1 kV |
| *Power Frequency (PF)* | 10 $kV_{rms}$ | 3 $kV_{rms}$ |
| *Lighting Impulse (LI)* | 20 $kV_{peak}$ | - |
| *Connection scheme* | Star | |
| *Neutral terminal* | Accessible | |
| Terminals characteristics: | Primary(1) | Secondary(1) |
| Type | Bushing | see clause 9.2.1 |
| *Rated voltage* | 3.6 kV | 1.1 kV |

<table>
<tr><th>Clause No.</th><th>TECHNICAL SPECIFICATION</th></tr>
<tr><td></td><td>
<table>
<tr><td>Rated current (phase terminals)</td><td>2000 A</td><td>40000 A</td></tr>
<tr><td>Rated current (neutral terminals)</td><td>2000 A</td><td>10000 A</td></tr>
<tr><td>Power Frequency (PF)</td><td>11 $kV_{rms}$</td><td>5 $kV_{rms}$</td></tr>
<tr><td>Lighting Impulse (LI)</td><td>40 $kV_{peak}$</td><td>20 $kV_{peak}$</td></tr>
<tr><td>Min. total creepage distance</td><td>90 mm</td><td>30 mm</td></tr>
<tr><td>Min. clearance in air(2)</td><td>60 mm</td><td>-</td></tr>
<tr><td>Details of connection: suitable for</td><td>3.6 kV cable</td><td>see clause 9.2.1</td></tr>
<tr><td>Frequency</td><td colspan="2">50/60 Hz</td></tr>
<tr><td>Short-circuit impedance</td><td colspan="2">Not higher than 8%</td></tr>
<tr><td>Load losses</td><td colspan="2">Not higher than 150 kW</td></tr>
<tr><td>Installation</td><td colspan="2">Indoor</td></tr>
<tr><td>Duty cycle</td><td colspan="2">Continuous</td></tr>
<tr><td>Type of cooling</td><td colspan="2">ONAN or OFAF</td></tr>
<tr><td>Temperature rise limits of insulating oil(3)</td><td colspan="2">60°C above the ambient temperature</td></tr>
</table>
(1) Relevant neutral terminals.<br>
(2) Both for phase-to-phase and phase-to-earth.<br>
(3) At rated power and measured at top level.
</td></tr>
<tr><td>9.0</td><td>DESIGN RECOMMENDATIONS AND SAFETY MEASURES<br><br>The equipment has to be designed, manufactured and tested in accordance with the best international engineering practices under stringent quality control to meet the requirement stipulated in the technical specifications. Adequate safety margin with respect to thermal, mechanical, dielectric and electrical stress etc. are to be considered during design, selection of raw material, manufacturing process.<br><br>The manufacturer shall take all necessary measures to ensure the safety of the test operator during the execution of the tests.<br><br>The construction details of Temperature Rise Testing Transformer shall be in accordance with the requirements given in the following paragraphs.</td></tr>
<tr><td>9.1</td><td>Construction details of Temperature Rise Testing Transformer:<br><br>The construction details of Temperature Rise Testing Transformer concerns the following requirements:</td></tr>
<tr><td>9.1.1</td><td>Tank:<br><br>The Transformer tank shall be provided with:<br><br>a) Four symmetrically placed lifting lugs through which it is possible to lift the</td></tr>
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| | complete transformer when filled with oil without structural damage to any part. The lifting lugs shall be so arranged and located as to be accessible for use when the Transformer is loaded on the transport vehicle.<br>b) A minimum of four jacking pads in accessible position to enable the transformer, filled with oil, to be raised or lowered using hydraulic jacks. Each jacking pad shall be designed to support with an adequate factor of safety for at least half of the total mass of the transformer filled with oil allowing in addition for maximum possible misalignment of the jacking force to the centre of the working surface.<br>c) Suitable haulage holes.<br>The tank shall be designed in such a way that it can be mounted either on the plinth directly or on rollers, as per manufacturer's standard practice.<br>The base of the 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. |
| **9.1.2** | **Core:**<br>The core shall be constructed with prime quality, non-ageing, cold rolled, grain oriented, silicon steel laminations, with no special requirements as far as specific loss is concerned.<br>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.<br>The supporting framework of the core shall be designed to avoid presence of pockets which would prevent complete emptying of tank through drain valve or cause trapping of air during oil filling.<br>Adequate lifting lugs will be provided to enable the core and windings to be lifted.<br>In case core laminations are divided into sections by insulating barriers or cooling ducts parallel to the plane of the lamination, tinned copper bridging strips shall be inserted to maintain electrical continuity between sections.<br>A drawing including the details of the internal earthing design shall be included in the user manual. |
| **9.1.3** | **Windings:**<br>The primary and secondary windings of transformer shall be separated to assure a galvanic insulation. The conductor of each transformer winding shall be of electrolytic copper, free from scales and burrs. |

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| 9.1.4 | **Buchholz relay:**<br>A double float/reed type Buchholz relay shall be provided. Any gas evolved in the transformer shall collect in this relay. 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.<br><br>The use of pipe or relay aperture baffles shall not be used to decrease the sensitivity of the relay. The relay shall not mal-operate for through fault conditions or be influenced by the magnetic fields around the transformer during the external fault conditions. |
| 9.1.5 | **Oil temperature indicator:**<br>The transformer shall be provided with dial type thermometer for top oil temperature indication. The thermometer shall have adjustable, electrically independent ungrounded alarm and trip contacts.<br>The setting of alarm and tripping contacts shall be adjustable at site and the typical values are given below, to be confirmed by the manufacturer:<br>• Alarm: 95°C<br>• Trip: 105 °C |
| 9.1.6 | **Pressure Relief Device:**<br>Adequate number of pressure relief device/s shall be provided at suitable locations and 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.<br>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.<br>Discharge of pressure relief device shall be properly taken through pipes that vent outside of the segregation where the Transformer is located. Concerning of the degree protection the terminal box/boxes of Pressure Relief Device should be in compliance with IP-55 of IEC- 60529. |
| 9.1.7 | **Fittings:**<br>The following minimum fittings shall be provided:<br>• rating and diagram plates on Transformer and auxiliary apparatus<br>• earthing terminals<br>• terminal marking plates<br>• conservator for main tank with oil filling hole and cap, air cell, isolating valves, drain valve, magnetic oil level gauge with low level alarm contacts |

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| | and dehydrating silica gel breather<br>• oil preservation equipment<br>• bottom and top filter valves with threaded male adaptors, bottom sampling valve and drain valve<br>• air release plug<br>• oil temperature indicator for local and remote output<br>• radiators for cooling purpose (if needed)<br>• valves, plugs etc. suitable for connection to the oil treatment plant and vacuum pump, etc.<br>• valves schedule plates |
| **9.1.8** | **Terminal Marking:**<br>The terminal marking and their physical position shall be as per IEC 60076-1. |
| **9.2** | **Specific requirements for Temperature Rise Testing Transformer:**<br>The specific requirements for construction details of the Temperature Rise Testing Transformer in connection with the execution of the Temperature rise tests are given below. |
| **9.2.1** | **Water cooling for secondary terminals:**<br>The terminals at the secondary side and temporary connections of the Temperature Rise Testing Transformer shown in Figure 4, page 21 of 26 must not conduct or transfer a significant amount of heat to the test object during the Temperature rise tests.<br>The temperature of the transformer output terminals tends to take the same temperature of the transformer insulating oil which can be up to 60 K above the ambient temperature. By taking into account the allowed temperature rise of the test object (usually lower than 60 K), it is proposed to use a water cooling system in order to control the temperature of the transformer terminals and to avoid the heat transfer to the test object. The temperature profile along the transformer terminal and the connection are shown in Figure 5, page 22 of 26. The cooling system must be able to reduce the temperature from T1 to T2 (Figure 5, page 22 of 26) at the end of the transformer terminal during the test execution period.<br>For cooling purposes each phase terminal of the transformer at the secondary side have to be forked in two hollow cylindrical conductors (refer Figure 6a, page 23 of 26). The cooling water enters one of the two conductors and comes out from the other (refer Figure 6b, page 23 of 26). Suitable copper plates shall be welded to the four hollow cylindrical conductors in order to allow the screw coupling of the connections to the test object (refer Figure 6b, page 23 of 26). |

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| | The maximum length of the terminals (including the hollow cylindrical conductors) outside the Transformer tank cover is 2 meters.<br><br>From the evaluation performed the cooling system must have the following main characteristics:<br><br>• Cooling power: 40 kWt<br>The cooling power allows to control the temperature at the end of the transformer terminals, measured by dedicated thermocouples, during the whole time period of the test execution.<br><br>• Power supply: 30 kW<br><br>• Type of cooling liquid: deionized water<br><br>The water flowing inside the terminals must be deionized, in so assuring it's very low conductivity.<br><br>• Maximum volumetric flow rate: 1.5 l/s<br>• Ability to adjust the flow rate in the range 0 to 1.5 l/s, both in local and remote control.<br><br>A suitable chiller, located outside the Test Facility, supply the water cooling system (Refer Figure 4, page 21 of 26). Also the cooling system of the transformer has to be located outside the Test Facility in so avoiding significant increase of the ambient temperature. |
| **9.2.2** | **Terminals for temperature measurement:**<br><br>As per IEC Standard 62271-1, clause 6.5.2 the difference in temperature rise between the test object and the temporary connections, at a distance of 1 meter, shall not exceed 5 K. To this purpose it is requested to measure by means of thermocouples the temperature of the test object, temporary connections and Transformer terminals. These measures are to be displayed and recorded in the Control Room of the Temperature rise Test Facility as well as they are to be listed in the test report. For convenience of test, the heat transferred to the test object due to a temperature difference higher than 5 K between the test object and the temporary connections can be accepted under the condition that the temperature rise of the test object is below the allowed design value.<br><br>Adjustment of the temperature gradient in the temporary connections, if necessary, may be achieved by modifying the cross-section of the conductors. For this reason a set of temporary connections with different cross-sections must be provided in order to make use of the suitable connection depending from the object to be tested. In case of high current ratings, for which it is necessary to use several connections in parallel for each phase, the average of the temperature difference along each conductor of the multi-conductor arrangement shall not exceed 5 K. |

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| **10.0** | **TESTS TO BE PERFORMED**<br>The type, special, routine and acceptance tests to be performed on Temperature Rise Testing Transformer are listed in the following paragraphs. |
| **10.1** | **Type and special tests:**<br>The bidder can submit reports of type and special tests performed on similar equipment provided that a full demonstration is given that such similar equipment are fully representative of the supplied equipment. Nevertheless, the bidder has to perform the type and special tests on the supplied equipment.<br>Referring to IEC Standard 60076 the following type tests are to be carried out:<br>a) Temperature-rise test (IEC 60076-2)<br>b) Dielectric type tests (IEC 60076-3)<br>In addition the following special tests, as per IEC Standard 60076, has to be performed:<br>a) Measurement of zero sequence impedance<br>b) Determination of sound level<br>c) Measurement of capacitance and tan delta of transformer winding<br>d) Test on oil samples as per IEC Standard 60296<br>High voltage withstand test shall be performed on auxiliary equipment and wiring after complete assembly.<br>Concerning the point d) above, the oil supplied with transformer shall have the parameters for unused new oil conforming to IEC 60296 while tested at oil Contractor's premises. No inhibitors shall be used in oil. Ten percent extra oil shall be supplied for topping up after commissioning in non-returnable containers.<br>Sweep frequency response analysis (SFRA) test shall be performed before and after short circuit test.<br>The following type tests are to be considered for the pressure relief device:<br>a) Air pressure test<br>b) Liquid pressure test<br>c) Leakage test<br>d) Contact test<br>e) Dielectric test. |
| **10.2** | **Routine tests:**<br>All the below listed routine tests in accordance with latest issue of IEC Standard 60076 shall be carried out:<br>a) Measurement of winding resistance<br>b) Measurement of voltage ratio and check of phase displacement<br>c) Measurement of short-circuit impedance and load loss<br>d) Measurement of no-load loss and current |

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| | e) Dielectric routine tests (IEC 60076-3)<br>f) Measurement of insulation resistance<br>The bidder shall inform Employer of the Tests program fifteen (15) days prior to inspection if the inspection is to be carried out in India or sixty (60) days prior to inspection if the inspection is to be carried out in abroad and shall allow CPRI representatives to witness them. |
| **10.3** | **Acceptance Tests:**<br>The Acceptance Tests at Employer's site are aimed to demonstrate that the supplied equipment is correctly assembled, fulfils its technical specification and complies with the relevant standards.<br>The Acceptance Tests shall also demonstrate the operation and the handling of the system and could be considered as a first training of Employer's engineers. For this purpose, prior to the Acceptance Tests, the bidder shall provide a detailed description of the system including: system specification and design, operation, control and safety functions.<br>Moreover the bidder shall be made available all the reports concerning the type, special and routine tests performed.<br>The Acceptance Tests shall be considered successful if the following items are verified:<br>• Check of the content of delivery for completeness and for proper condition of all components and auxiliary devices (User manual, contract drawings)<br>• Check of weights, dimensions, fitting and accessories, oil quality, material, finish and workmanship<br>• Measurement for each tap of voltage ratio at minimum and maximum input voltage, winding resistance, insulation resistance<br>• Temperature rise test at the maximum current compatible with the availability of suitable test object (3 phase and single phase) provided by the Employer. |
| **11.0** | **INSPECTION AND QUALITY ASSURANCE PLAN**<br>The Contractor shall carry out a comprehensive inspection and testing programme during manufacture of the equipment. An indication of inspection envisaged by the Employer is given below. This is however not intended to form a comprehensive programme as it is Contractor's responsibility to draw up and carry out such a programme in the form of detailed quality plan duly approved by Employer for necessary implementation.<br>Inspection checklist / quality plan and recommended field quality plan for transformer has to be submitted to CPRI for approval after placement of order and any changes required by CPRI for the same shall be incorporated and adhered to by the bidder without any commercial implications.<br>The bidder shall draw his own quality plans in line with these requirements and his |

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| | standard practices and implement such programme after approval by the Employer. Manufacturing quality plan will detail out, for all the components and equipment, various tests/inspection to be carried out as per the requirements of this specification and standards mentioned therein and quality practices and procedures followed by contractor/contractor's quality control organization, the relevant reference document and standards, acceptance norms and inspection documents raised etc. during all stages of material procurement, manufacture, assembly and final testing/performance testing.<br><br>The bidder, along with quality plan, shall also furnish copies of the reference documents/plant standards/acceptance norms/test and inspection procedure etc. referred by him in quality plans. These quality plans and reference documents/standards etc. will be subject to Employer's approval and will form a part of the contract. In these approved quality plans, Employer shall identify customer hold points (CHP), indicating tests/checks which shall be carried out in presence of the Employer's engineer or authorized representative and beyond which work will not proceed without consent of Employer's Engineer/ authorized representative in writing.<br><br>No materials/equipment shall be dispatched from the manufacturer's works before the same is either accepted subsequent to pre-dispatch final inspection including verification of records of all previous tests/inspections by Employer's Engineer /authorized representatives, or such pre-dispatch final inspection is waived by the Employer and dispatch is authorized after review of test reports.<br><br>All materials used or supplied shall be accompanied by valid and approved material certificates and test and inspection reports duly approved by the Employer. These certificates and reports shall indicate the acceptable identification number of the material they proposed to certify. The material certified shall also have the identification details stamped on it.<br><br>Employer reserves the right to carry out quality audit and quality surveillance of the systems and procedures of the Contractor and their sub-vendors for quality management and control activities. The Contractor shall provide all necessary assistance to enable the Employer carry out such audit and surveillance.<br><br>The Contractor shall undertake an inspection and testing programme during manufacture in his works and that of his sub-contractors to ensure the mechanical accuracy of components, compliance with drawings, conformance to functional and performance requirements, identification and acceptability of all materials, parts and equipment. In addition to tests as per the approved quality plan, the Contractor shall also carry out all tests/inspection required to establish that the items/equipment conform to requirements of this specification and the relevant codes/standards specified in this specification. |

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| | The Employer/ Engineer and/or his duly authorized representative shall have at all reasonable times access to the contractor's premises or works and shall have the power at all reasonable times to inspect and examine the materials and workmanship of the works during its manufacture or erection and part of the work being manufactured or assembled on other's premises or works. The contractor shall obtain for the Engineer and his duly authorised representative the permission to inspect as if the components were manufactured or assembled on the contractor's premises or works.<br><br>The contractor shall give the Engineer/ Inspector, written notice of any material being ready for testing fifteen (15) days prior to inspection if the inspection is to be carried out in India or sixty (60) days prior to inspection if the inspection is to be carried out abroad. Such tests shall be to the contractor's account except for the expenses of the Inspector. The Engineer/Inspector unless the inspection of the tests is virtually waived, shall attend such tests immediately after or fifteen (15) days from the date of notification by the Contractor if the inspection is to be carried out in India or sixty (60) days from the date of notification by the Contractor if the inspection is to be carried out abroad, failing which, the contractor may proceed with the test which shall be deemed to have been made in the Inspector's presence and he shall forthwith forward to the Inspector duly certified copies of tests in triplicate. |
| **12.0** | **TECHNICAL INFORMATION TO BE SUPPLIED BY THE BIDDER**<br><br>The following technical information shall be included in the bid:<br>1) Type of transformer: (core or shell-type)<br>2) Type of core and winding arrangement<br>3) Short-circuit impedance value (percent value)<br>4) Design insulation levels between windings and ground to ensure the required insulation levels<br>5) No-load loss at rated voltage and frequency (50/60 Hz)<br>6) Load losses at rated voltage and current (50/60 Hz)<br>7) Type and technical characteristics of auxiliary devices (pumps, fans, etc.)<br>8) Technical characteristics of the output terminals water cooled (only for step-down Transformer)<br>9) Requested power for cooling radiators (if any)<br>10) Tests certificates relevant the type and special tests specified in sub-clause 10.1<br>11) Masses [kg]:<br>• total mass without oil<br>• oil<br>• total mass in service condition<br>12) Mass of the heaviest piece for transportation [kg] |

| Clause No. | TECHNICAL SPECIFICATION |
|---|---|
| | 13) Dimensions in operation conditions (length, width, height) [mm]<br>14) Dimensions of the heaviest piece for transportation (length, width, height) [mm]<br>15) List of the suggested spare parts.<br><br>The following documents shall be provided along with the supply:<br>1) General drawings, electrical schemes, installation drawings<br>2) Operational manual and Maintenance manual: These manuals shall include specific instruction relevant to the handling, installation, troubles shooting and servicing<br>3) Reports on inspection during manufacturing<br>4) Reports of routine and acceptance tests.<br><br>All documents shall be issued in English language and provided both on paper and software copy. |
| **13.0** | **INSTALLATION AND COMMISSIONING**<br><br>The supply shall include the installation and commissioning activities performed by a team of specialized workers of the bidder. These activities will be performed in a period defined by the Employer, in order to avoid interferences with other works. |
| **14.0** | **PERFORMANCE GUARANTEE**<br><br>The transformer shall have to comply with guaranteed technical parameters of this specification. |
| **15.0** | **SPARE PARTS AND MAINTENANCE** |
| **15.1** | The Bidder is required to list the suggested mandatory spares for the Temperature Rise Testing Transformer, as well as the spares which may be required for ensuring the guaranteed availability.<br><br>Any other spares which bidder feels essential for trouble free operation of transformers for at least 10 years may be listed as recommended spares with price and validity as an option. The recommended spares shall not be considered for Bid evaluation. |
| **15.2** | The Bidder shall indicate the proposed maintenance schedule during the guarantee period and the life period of the transformers. |

| Clause No. | TECHNICAL SPECIFICATION |
|---|---|
| **16.0** | **TRANSPORTATION**<br>Before despatching the transformer, the Bidder shall perform Sweep frequency response analysis (SFRA) test.<br>The Bidder shall dispatch the transformer filled with oil or in an atmosphere of nitrogen or dry air at positive pressure. In the former case, the Bidder shall take care of the weight limitation on transport and handling facility at site. In the latter case, necessary arrangement shall be ensured by the Bidder to take care of pressure drop of nitrogen or dry air during transit and storage till completion of oil filling during erection. The nitrogen or dry air cylinder provided to maintain positive pressure can be taken back by the contractor after oil filling. A gas pressure testing valve with necessary pressure gauge and adaptor valve shall be provided. |
| **17.0** | **WARRANTY**<br>The equipment shall be guaranteed for 24 months from the date of commissioning. |

# FIGURES

**FIGURE 1**

**BLOCK DIAGRAM OF 40,000A TEMPERATURE RISE TEST FACILITY**

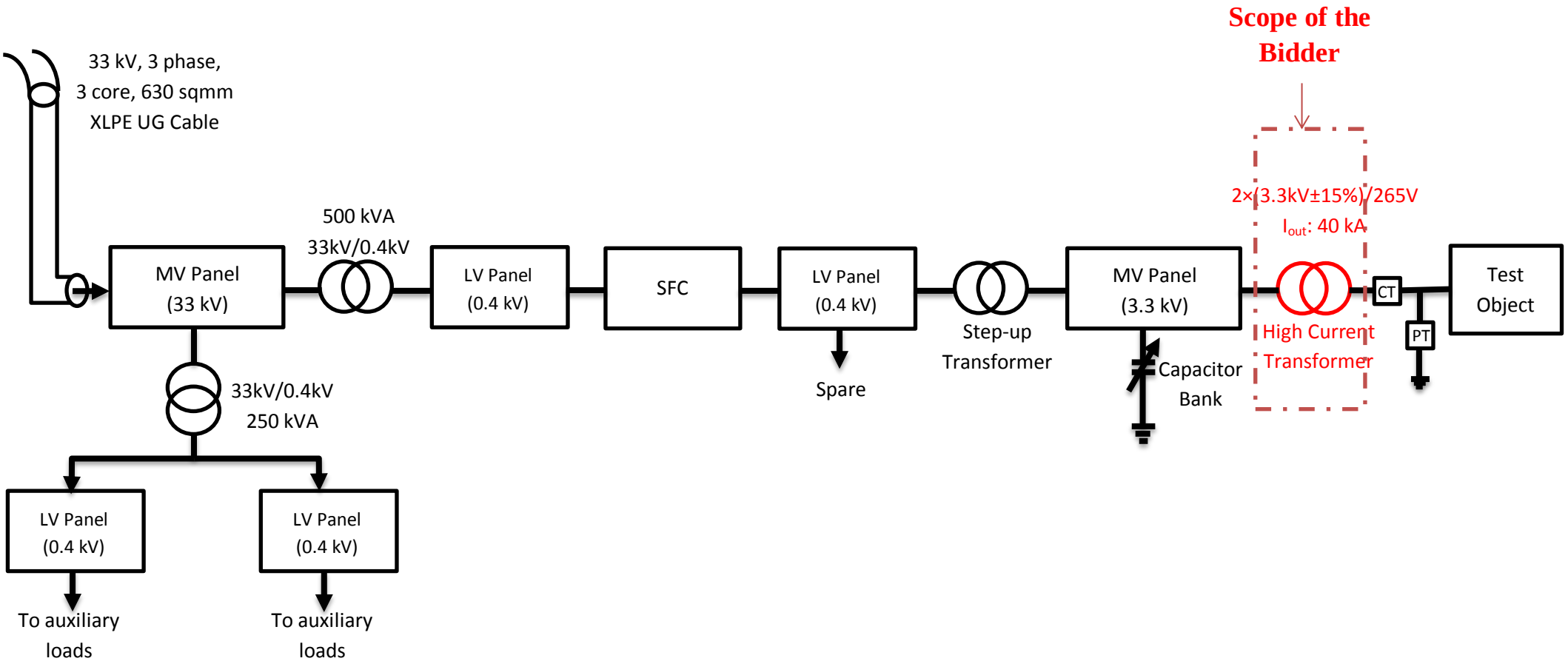


**FIGURE 2**

**ELECTRICAL SCHEME OF ONE PHASE OF THE THREE-PHASE STEP-DOWN TRANSFORMER**

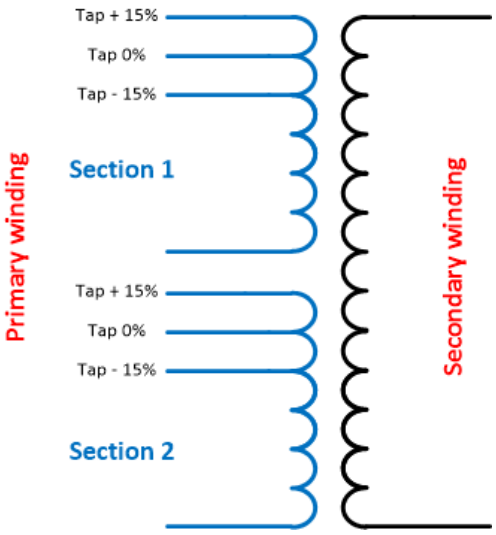


**FIGURE 3**

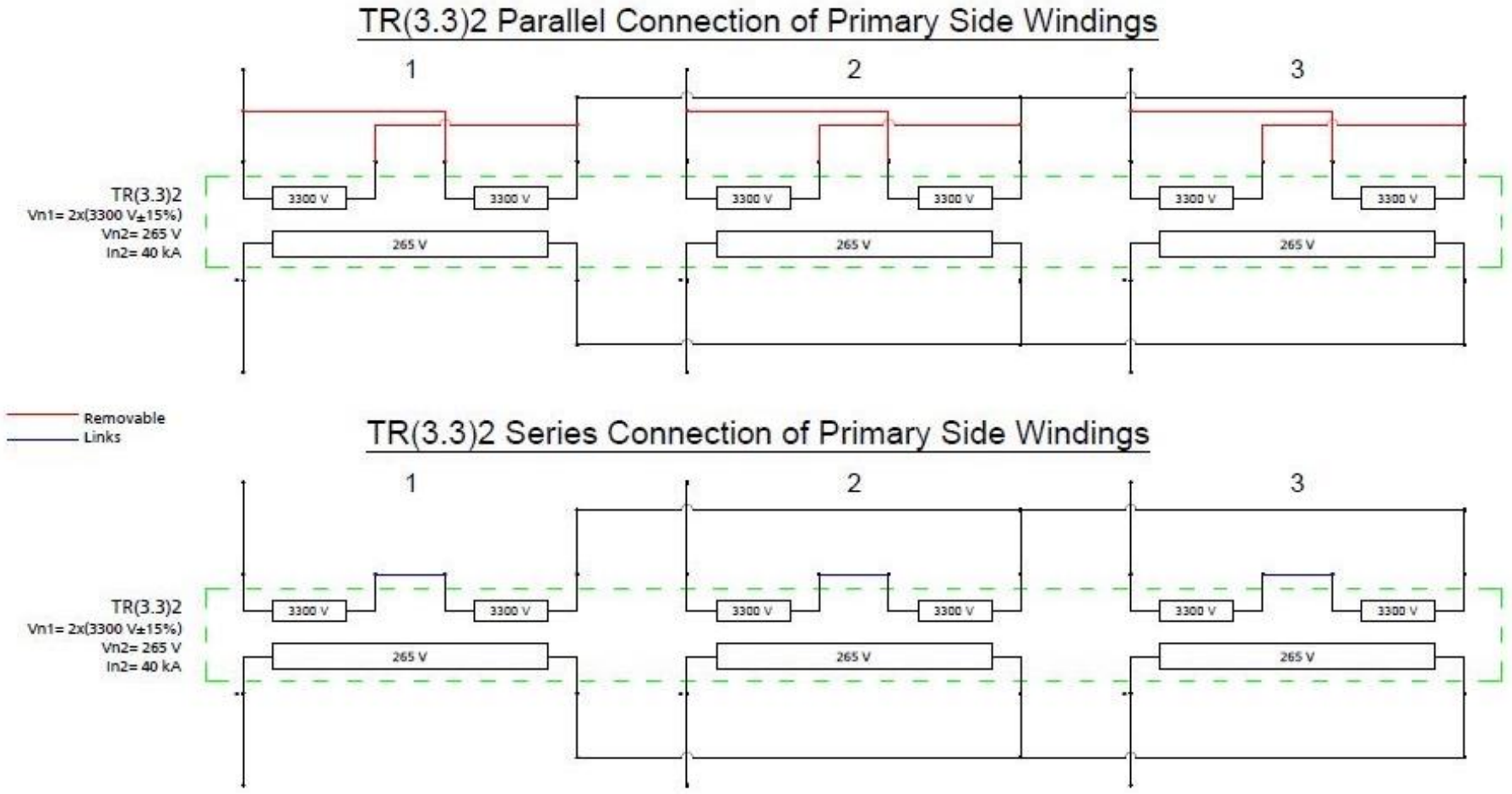

TR(3.3)2 Parallel Connection of Primary Side Windings
1
2
3
TR(3.3)2
Vn1= 2x(3300 V±15%)
Vn2= 265 V
In2= 40 kA
3300 V
265 V
Removable
Links
TR(3.3)2 Series Connection of Primary Side Windings
1
2
3
TR(3.3)2
Vn1= 2x(3300 V±15%)
Vn2= 265 V
In2= 40 kA
3300 V
265 V

**FIGURE 4**

**TEMPERATURE RISE TEST ARRANGEMENT WITH WATER COOLING SYSTEM: TOP VIEW**

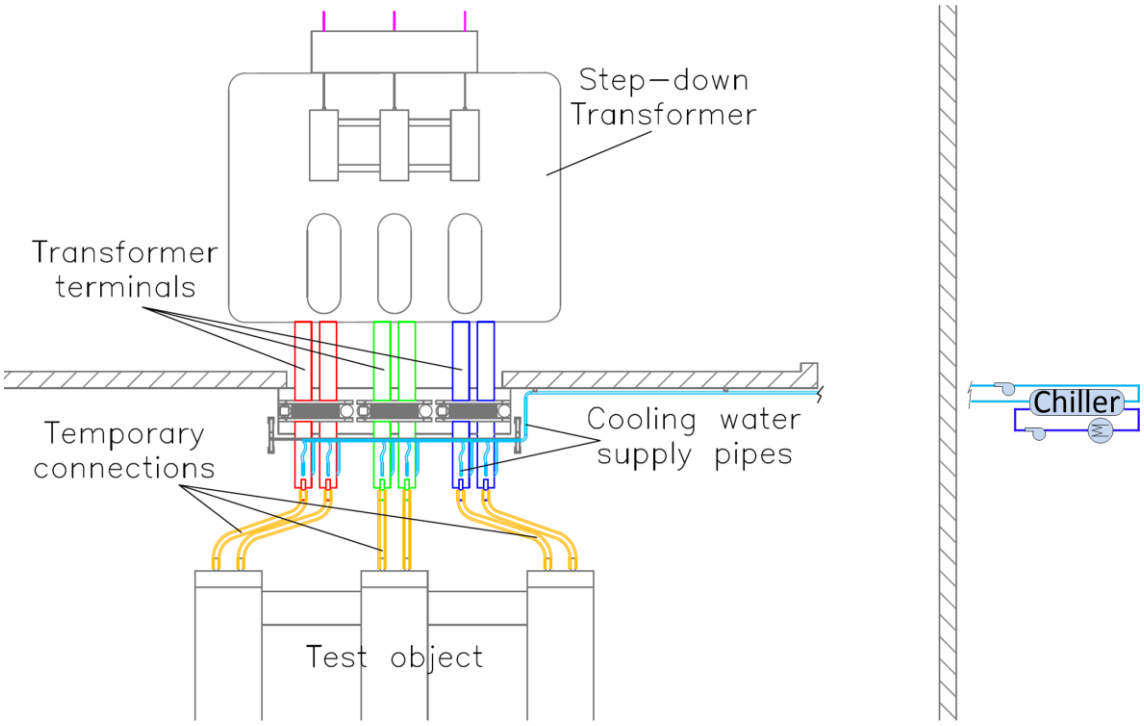


**FIGURE 5**

**TEMPERATURE RISE TEST ARRANGEMENT AND TEMPERATURE PROFILE ALONG THE TRANSFORMER TERMINAL AND THE TEMPORARY CONNECTION**

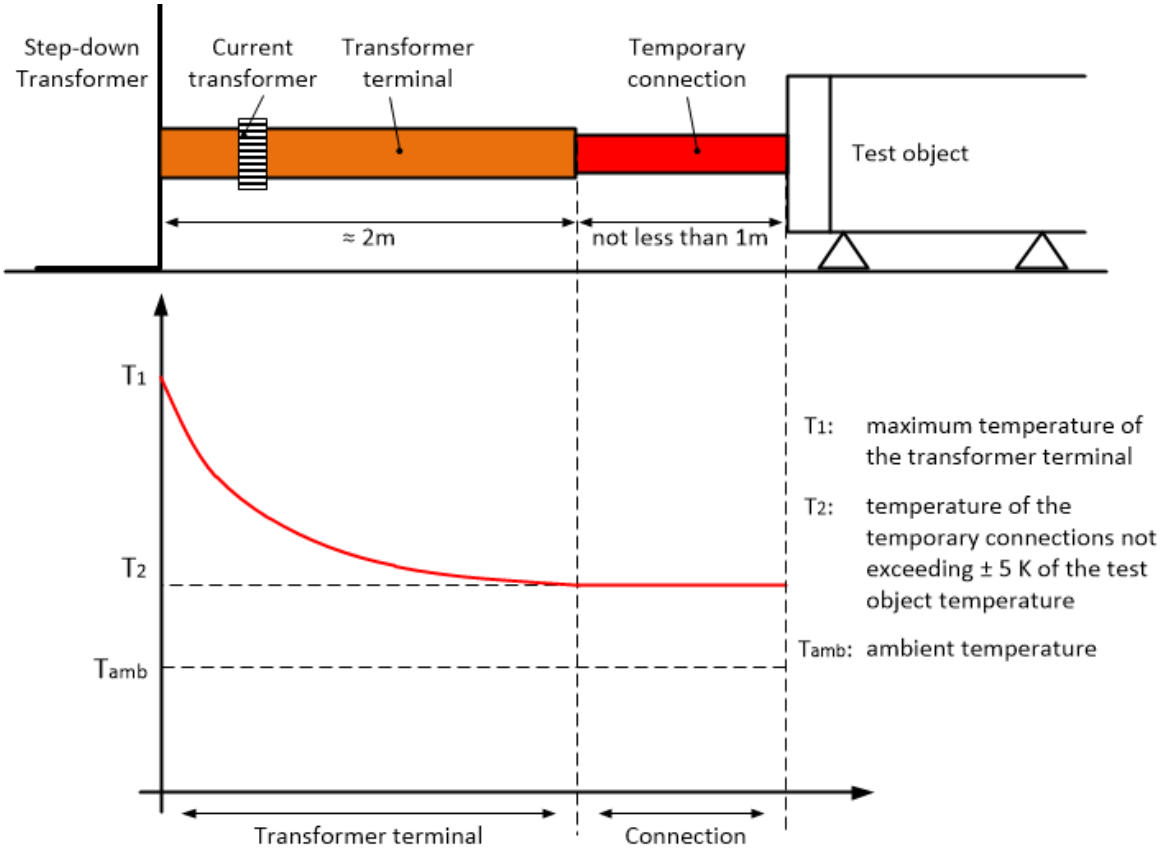
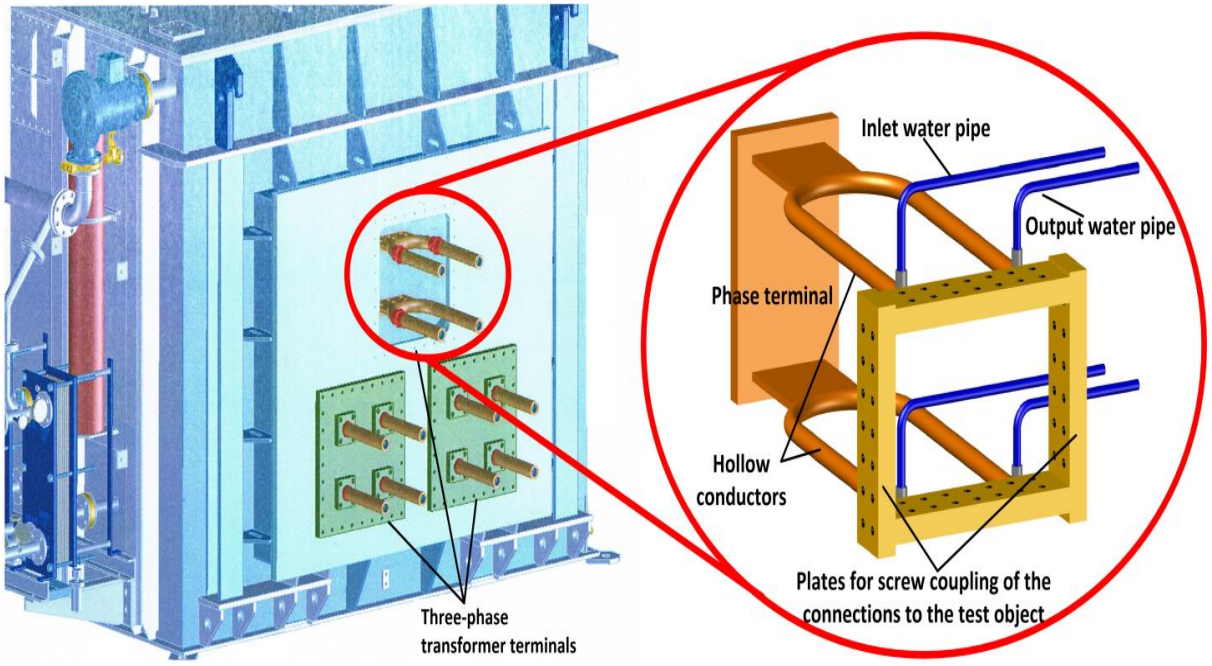


**FIGURE 6**

**TEMPERATURE RISE TESTING TRANSFORMER TERMINALS ARRANGEMENT FOR COOLING PURPOSES**




**a) Transformer terminals shape**

**b) Screw coupling of the transformer terminals for the connection to the test object**

# APPENDIX

## Appendix- 1

## TRANSFORMER CHARACTERISTICS TO BE FILLED BY THE BIDDER

| No. | Description | Conditions | Units | @ 50Hz | @ 60Hz |
|---|---|---|---|---|---|
| | **Rating:** | | | | |
| 1 | Rated power | | MVA | | |
| 2 | Primary voltage | | kV rms | | |
| 3 | Secondary voltage | | kV rms | | |
| 4 | Voltage ratio | | | | |
| 5 | Primary current | | kA | | |
| 6 | Secondary current | | kA | | |
| 7 | Impedance voltage at rated power for all voltage ratios | | % | | |
| 8 | Short-circuit reactance at rated current | | Ω | | |
| 9 | Resistance at rated (related to the load loss) | | | | |
| 10 | Type of transformer | | | | |
| | **Core:** | | | | |
| 11 | Type | | | | |
| 12 | No-load loss at rated voltage | | kW | | |
| 13 | No load current at rated voltage | | A | | |
| 14 | Maximum induction level at rated voltage | | T | | |
| 15 | Core material | | | | |
| | a) Type | | | | |
| | b) Thickness | | mm | | |
| | c) Total loss | Basis f=50Hz, at operating flux density | W/kg | | |
| | d) Weight | | kg | | |
| | **Windings** | | | | |
| 16 | Primary | | | | |
| | a) Type | | | | |
| | b) Conductor<br>• number of strips<br>• cross section | | | | |
| | c) Number of turns | | | | |
| | d) Type of insulation | | | | |

| No. | Description | Conditions | Units | @ 50Hz | @ 60Hz |
|---|---|---|---|---|---|
| | e) Insulation level<br>• power frequency withstand voltage<br>• induced overvoltage level<br>• lightning impulse withstand voltage | | kV | | |
| 17 | Secondary | | | | |
| | a) Type | | | | |
| | b) Conductor<br>• number of strips<br>• cross section | | | | |
| | c) Number of turns | | | | |
| | d) Type of insulation | | | | |
| | e) Insulation level<br>• power frequency withstand voltage<br>• induced overvoltage level<br>• switching impulse withstand voltage<br>• lightning impulse withstand voltage | | | | |
| 18 | Forces | | | | |
| | a) calculation of forces | | | | |
| | b) clamping of windings and connections | | | | |
| | **Cooling** | | | | |
| 19 | Type | | | | |
| 20 | Number of radiators | | | | |
| 21 | Size | | | | |
| | **Temperature rise** | | | | |
| 22 | When performing short-time duty requirement<br>• Oil<br>• Windings | | °C | | |
| | **Bushings** | | | | |
| 23 | Type | | | | |
| 24 | Manufacturer | | | | |
| 25 | Weight | | kg | | |
| 26 | size | | | | |
| | **Overall Dimensions** | | | | |
| 27 | Length | | mm | | |
| 28 | Breadth | | mm | | |
| 29 | Height | | mm | | |
| 30 | Untanking height | | mm | | |

| No. | Description | Conditions | Units | @ 50Hz | @ 60Hz |
|---|---|---|---|---|---|
| | **Masses** | | | | |
| 31 | Core and windings | | kg | | |
| 32 | Tank fitting and accessories | | kg | | |
| 33 | Oil | | kg | | |
| 34 | Total Mass | | kg | | |
| 35 | Capacity of the crane for untanking | | kg | | |
| | **Transport** | | | | |
| 36 | Mass of heaviest package | | kg | | |
| 37 | Dimension of largest package<br>• Length<br>• Breadth<br>• Height | | <br>mm<br>mm<br>mm | | |

Note: Bidders are required to fill in the Appendix-1 (Technical Data Sheet) as per the format and submit along with bid. The technical information to be supplied by the bidder as per clause No. 12.0 of this document are also enclosed along with bid.