



**SPECIFICATION FOR
11 kV DRY – TYPE
DISTRIBUTION
TRANSFORMERS
(L-S17)**


CKE.LS.01.17.(01).2020

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**CAWANGAN KEJURUTERAAN
ELEKTRIK**

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1.0 GENERAL

1.1 SCOPE

- 1.1.1 This section of the specification describes and specifies requirements for the supply, installation, testing, commissioning, and handing over in approved working order and maintenance during the Defects Liability Period (DLP) of the 11 kV transformers in accordance with the Conditions of Contract, Bill of Quantities (BQs), Drawings, Technical Data, Specification etc.

1.2 STANDARDS

- 1.2.1 The material, equipment and installation shall conform to the principles of the standards laid down by the Malaysian Standards (MS), International Electrotechnical Commission (IEC) and British Standard Institution (BS). The transformers shall comply with the latest edition of relevant standards.

1.3 TECHNICAL PARTICULARS

- 1.3.1 Tenderers shall submit at the time of tendering detailed schedule of particulars and guarantees as per Appendix A in respect of the transformers, components and accessories (hereinafter referred to as “plant”) offered. No departure from this technical particulars and guarantees will be permitted except with the written approval of the Superintendent Officer (S.O.)/S.O.’s representative. Notwithstanding any description, drawings, illustrations or pamphlets which may be submitted with the tender, all details other than those stated by the Tenderers in the schedule of departures from specification, at the time of tendering, will be deemed to be in full conformity with the specification.


1.4 GUARANTEES

- 1.4.1 The Tenderers shall guarantee the plant to be supplied under this contract against faulty design, materials and workmanship at the manufacturer’s works and installed plant at site within the DLP.

1.5 ELECTRICAL SYSTEM

- 1.5.1 The transformers shall be suitable for continuous operation on an 11 kV, 3 phase, 50 Hz electrical power distribution system with neutral earthing conditions and maximum phase fault levels as follows:

11 kV solid earthed	20 kA	for 3 seconds
400 V solid earthed	31.5 kA	for 3 seconds


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1.6 TYPE OF TRANSFORMERS

- 1.6.1 The transformer shall be dry-type cast resin insulated complying with MS 60076-11 or IEC 60076-11. The transformer shall be compact and suitable only for indoor installation at site.

1.7 SERVICE CONDITIONS

- 1.7.1 The transformers shall be suitable for continuous operation at normal rating without exceeding the temperature rise limits specified. It shall be fully tropicalized. The transformer shall be minimum Class E2, C1 and F1 for environmental, climatic and fire behaviour classes respectively.
- 1.7.2 The transformer shall be capable of continuous operation with a maximum ambient temperature of 40 °C, annual average ambient temperature of 30 °C and maximum altitude of 1000 m above sea level. When transformers are required to operate outside the normal service conditions, de-rating in accordance with MS 60076-11 or IEC 60076-11 shall be applied.

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2.0 ELECTRICAL REQUIREMENT AND PERFORMANCE

2.1 VOLTAGE RATIOS

- 2.1.1 The standard voltage ratios at no-load shall be 11000 / 433 V, so as to deliver load at the declared voltage of 400/230 V, three (3) phase, four (4) wire system with the neutral solidly earthed.

2.2 WINDING CONNECTIONS AND VECTOR GROUP

- 2.2.1 The windings of all three (3) phase step-down transformers shall be connected as follows:

High-Voltage (HV) Winding	- Delta-connected
Low-Voltage (LV) Winding	- Star-connected with neutral brought out
Vector Group	- Dyn11


- 2.2.2 The neutral connection shall be capable of carrying full phase rated current.

2.3 LOSSES

- 2.3.1 The losses shall be low commensurate with the economic use of materials such that the total capitalized cost is a minimum.
- 2.3.2 The no-load loss, load loss and total losses shall not exceed the values specified in Table 1. The tolerance shall be in accordance with MS 60076-1, which allows +10% on total losses, and +15% on no-load and load losses, provided that the tolerance for total losses is not exceeded.

Rated Power	No Load Loss	Load Loss (at 120 °C)	Total Losses
kVA	W	W	W
300	400	2800	3200
500	800	4100	4900
750	1000	6000	7000
1000	1200	7000	8200
1250	1880	8200	10080
1600	2300	10300	12600
2000	2900	13000	15900

Table 1 – Transformer Losses

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2.4 TAPPINGS

- 2.4.1 Method for voltage regulation shall be provided by means of an off-load tap changer. Tapping shall be provided on the HV winding to provide a variation of the transformer ratio by + 5 %, + 2.5 %, 0 %, - 2.5 % and - 5 %. Dedicated tapping selection shall be made by the use of bolted links. These bolted links for changing the taps shall be arranged on the same side of the transformer as the HV terminals are positioned.

2.5 INSULATION LEVELS

- 2.5.1 The Rated Short Duration Separate Source AC Withstand Voltage test for LV and HV windings shall be applied at three (3) kV and 28 kV respectively.
- 2.5.2 The Rated Impulse Withstand Voltage test for HV winding shall be applied at 75 kV.

2.6 SHORT CIRCUIT IMPEDANCE


- 2.6.1 The short circuit impedance referred to the Tap 3 at a reference temperature of 120 °C shall be in accordance with Table 2 and with tolerance of ± 10 %.

Rated Power kVA	Short Circuit Impedance %
300	4
500	
750	
1000	6
1250	
1600	
2000	

Table 2 – Short Circuit Impedance


2.7 FAULT CONDITIONS

- 2.7.1 The transformer shall be capable of withstanding on any tapping and without damage the thermal and dynamic effects of external short circuits in accordance with the conditions specified in IEC 60076-5. The transformer shall be designed to carry the full short circuit current of the system, 20 kA for three (3) seconds when operating at full load and the maximum average temperature 350 °C.

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2.8 TEMPERATURE RISE

- 2.8.1 When the transformers are loaded at their rated current and under steady load conditions, the temperature rise of each winding shall not exceed 100 °C when tested in accordance with MS 60076-11 or IEC 60076-11.

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3.0 TRANSFORMER DESIGN AND CONSTRUCTION

3.1 CORE AND CORE STRUCTURE


- 3.1.1 The framework, clamping arrangement and general structure of the core of each transformer shall be of a robust construction and shall be able to withstand the degree of shocks which may occur during transport, installation movement and service under normal conditions. Any unusual conditions shall be indicated in the data sheet of both the enquiry and purchase order.
- 3.1.2 The assembled core shall result in a rigid structure, with the clamping pressure of the press beams evenly distributed and adjusted to minimize the noise and vibration coming from the transformer when placed into operation.
- 3.1.3 The core shall be built using high quality, low loss, non-aging cold rolled grain-oriented (CGRO) silicone steel laminations or amorphous steel and having excellent magnetic properties. The core laminations shall be insulated from each other with a material having high-interlamination insulation resistance and also capable of withstanding pressure, mechanical vibration, thermal changes and temperatures which may occur under the most severe operating conditions.
- 3.1.4 The core clamping frame shall be equipped with lifting lugs strong enough to enable the finished transformer to be safely lifted, complete with all accessories in place.
- 3.1.5 The flux density in the core, based on the minimum cross-section of the steel in the core, shall not be more than 1.65 Tesla at rated frequency and rated no-load voltage.

3.2 INSULATION MATERIALS

- 3.2.1 All insulation materials used either individually or in combination with others shall be suitable for use with transformers, with an insulation system temperature of minimum 155 °C (Class F). The HV and LV windings shall be reinforced with glass fibre or quartz powder.
- 3.2.2 The need to reinforce the resin materials with glass fibre or quartz powder is essential to prevent the resin from cracking under the most severe temperature variations, over the total life-time of the transformer.

3.3 WINDING INSULATION

- 3.3.1 The winding insulation temperature shall be minimum 155 °C (Class F) in accordance with MS IEC 60085.

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3.4 HV WINDINGS

3.4.1 The conductor material used for the HV winding shall be either enamelled copper wire or copper foil. The enamel coating used, which also forms the turn-to-turn insulation, shall be suitable to be used for an insulation system temperature with minimum 155 °C (Class F).

3.4.2 The HV windings shall be either one of the following processes:

- a) wound directly onto the LV windings. The outer encapsulation and the intermediate layer winding insulation shall be composed of a mixture of epoxy resin and glass fibre, or epoxy resin and quartz powder. The completed winding block shall be cured into an oven;

or

- b) impregnated and cast under vacuum with epoxy resin and reinforced with glass fibre or quartz powder.

3.5 LV WINDINGS

3.5.1 The conductor material used for the LV windings shall be copper wire or copper foil.

3.5.2 The LV windings shall be either one of the following processes:


- a) wound using insulating copper foil preimpregnated with resin under atmospheric conditions. After the winding process, the coil shall be cured into an oven resulting in an extremely bond the conductors together to form a solid block and able to withstand the dynamic stresses produced by a short circuit;

or

- b) made of copper wire, impregnated and cast under vacuum into moulds with epoxy resin and reinforced with glass fibres or quartz powder.

3.6 COOLING CHANNEL AND COIL SURFACES

3.6.1 Cooling channels shall be arranged in a vertical manner and all coils shall have an even and smooth surface to minimize any dust accumulation and to give the maximum cooling efficiency.

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3.7 HV AND LV TERMINALS

- 3.7.1 The HV and LV terminals shall be located on opposite sides of the upper press beams of the transformer. The LV terminals shall be securely positioned using suitable insulators fastened to the press beams.
- 3.7.2 The both terminals shall be suitable for connection of cables coming from top or bottom. The HV terminals shall be dimensioned to suit the size of cable lugs.
- 3.7.3 The LV terminals shall be dimensioned to take the rated current, suitable for connection to either busbars or cable lugs.
- 3.7.4 The both terminals shall be dimensioned to accept the number and size of cables stated in the drawings.

3.8 EARTHING TERMINALS


- 3.8.1 Two (2) earthing terminals shall be provided preferably located diagonally opposite on either side of the undercarriage. Both terminals shall be made from stainless steel and have minimum M10 threads.

3.9 UNDERCARRIAGE

- 3.9.1 Each transformer shall be equipped with four (4) bi-directional wheels. These wheels shall be adjustable for either transverse or longitudinal movement and equally spaced in both directions. The undercarriage shall be sufficiently sturdy to permit the use of crowbars etc., place against it during movement to the transformers final location.

3.10 RATING PLATE FITTED TO THE TRANSFORMER

- 3.10.1 The rating plate shall be made of weatherproof material, fitted in a visible position. The entries on the plate shall be indelibly marked by either engraving, etching, stamping or by a photo-chemical process.
- 3.10.2 The rating plate shall indicate the following:
- number and year of standard;
 - manufacturer's name;
 - manufacturer's serial number;
 - year of manufacture;
 - insulation system temperature (Insulation Class) for each winding. The first letter shall refer to the HV winding, the second letter shall refer to the LV winding;
 - number of phases;
 - rated power for each kind of cooling;
 - rated frequency;
 - rated voltages, including tapping voltages

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- j) rated currents for each kind of cooling;
- k) connection symbol;
- l) short-circuit impedance at rated current and at 120 °C (subjected to test result);
- m) type of cooling;
- n) total mass;
- o) insulation levels;
- p) degree of protection;
- q) environmental class;
- r) climatic class;
- s) fire behaviour class.

3.11 RATING PLATE FITTED TO THE TRANSFORMER ENCLOSURE

- 3.11.1 Each transformer enclosure shall be provided with a rating plate of weatherproof material, fitted in a visible position, showing the items indicated in Section 3.10.2. The entries on the plate shall be indelibly marked by either engraving, etching, stamping or by a photo-chemical process.

3.12 OVERLOAD PROTECTION


The transformer shall be equipped with the temperature monitoring devices which are an Overload Protection Sensors and Digital Temperature Controller.

3.12.1 OVERLOAD PROTECTION SENSORS

- 3.12.1.1 The temperature of each winding shall be determined by one set of measurements (alarm, trip and fan) per phase by means of Platinum Thermal Resistance Sensor, PT 100. These measuring sensors shall be interchangeable. The sensor leads shall be brought out to a terminal block.
- 3.12.1.2 The PT 100 shall be supplied complete with the auxiliary equipment necessary to initiate remote alarms, trips and fans via voltage-free changeover contacts. It shall be designed and located in such a manner as to avoid the transfer of over-voltages to auxiliary or external connections.


3.12.2 DIGITAL TEMPERATURE CONTROLLER

- 3.12.2.1 The transformers shall be fitted with a digital temperature controller and shall provide the highest temperature of three phases LV coils.
- 3.12.2.2 The digital temperature controller shall provide maximum temperature memory, remote alarm connection, trip relay, and manual or automatic fan controls. It shall be provided with remote monitoring on alarm, trip and fan status.

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4.0 ENCLOSURES


- 4.1 The enclosure shall be fabricated from electrogalvanised sheet steel and finished with epoxy oven baked, naturally ventilated, with a minimum degree of protection of IP 20 in accordance with MS IEC 60529. This enclosure shall act as a safeguard against any electrical part of the transformer. The enclosures shall be supplied by the transformer manufacturer or the approved fabricator.
- 4.2 Protective conductors with 16 mm² PVC green cable shall be fitted to ensure satisfactory earthing of the panels.
- 4.3 The enclosure shall be fitted with removable panels, for easy reconnection of HV tapplings and assembling of cables. Cut-outs shall be provided for entry of Medium Voltage (MV) cables, LV cables and flanges of busbar trunking on the LV side. The size and type of cables or busbar trunking as well as the arrangement of entering the enclosure whether bottom or top entering shall be clearly stated. Inspection windows of 300 mm x 300 mm with minimum three (3) mm thickness made of transparent polycarbonate material, two (2) numbers on every sides of the enclosure shall be provided. The complete assembly of enclosure shall be securely mounted on transformer base frame.
- 4.4 When the transformers are equipped with enclosures to IP 23 or higher IP, de-rating in accordance with the manufacturer's recommendation shall be applied.
- 4.5 The minimum clearances between live parts and enclosure shall be 200 mm to prevent flashover.

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5.0 TESTING OF TRANSFORMERS

5.1 ROUTINE, TYPE AND SPECIAL TESTS

- 5.1.1 Routine tests on the transformer shall be carried out before delivery to site. Routine tests shall be made at the manufacturer's works or at an approved laboratory/factory.
- 5.1.2 Upon satisfactory completion of the routine tests, the test reports shall be submitted to the S.O.'s representative for approval at least two weeks before leaving the manufacturer's works or shipment. Copies of all test reports shall be submitted to the S.O. in quadruplicate. No item or plant shall be dispatched to site until the S.O.'s representative has given approval in writing.
- 5.1.3 All measuring instruments used for the routine tests shall be certified by the accredited laboratory, traceable accuracy and subjected to periodic calibration, according to the MS ISO 9001.
- 5.1.4 Type tests as specified in MS 60076-11 or IEC 60076-11 shall be carried out at an internationally recognized independent laboratory such as KEMA, CESI, etc. Type tests certificates shall be submitted to S.O/S.O's representative.
- 5.1.5 Type tests shall be performed on a prototype of transformer only. Unless otherwise specified in the BQs, these tests shall be performed at the manufacturer's works or at an approved laboratory/factory.
- 5.1.6 Special tests as specified in MS 60076-11 or IEC 60076-11 shall be carried out at an internationally recognized independent laboratory such as KEMA, CESI, etc. Special tests certificates shall be submitted to S.O/S.O's representative.
- 5.1.7 Special tests shall be performed when it is specified in the BQs. These tests shall be performed at the manufacturer's works or at an approved laboratory/factory.

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5.2 ROUTINE TESTS

5.2.1 MEASUREMENT OF WINDING RESISTANCE

5.2.1.1 The resistance and temperature of each winding of every transformer shall be measured and recorded in accordance with MS 60076-1. Winding resistance and winding temperature shall be measured at the same time. Measured values will be recorded for load loss calculation.

5.2.2 MEASUREMENT OF VOLTAGE RATIO AND CHECK OF PHASE DISPLACEMENT

5.2.2.1 The Measurement of Voltage Ratio and Check of Phase Displacement shall be in accordance with MS 60076-1.

5.2.2.2 The deviation of the voltage ratio tolerance shall be ± 0.5 % of declared ratio. The check of phase displacement shall verify the vector group of the transformer.

5.2.3 MEASUREMENT OF SHORT-CIRCUIT IMPEDANCE AND LOAD LOSS

5.2.3.1 The Measurement of Short-Circuit Impedance and Load Loss shall be carried out in accordance with MS 60076-11 or IEC 60076-11. The measurements shall be carried out quickly so that temperature rises do not cause significant heating of the windings.


5.2.3.2 The measured value of short circuit impedance, in ohm per phase, shall be corrected to reference temperature of 120 °C. The short circuit impedance tolerance shall be ± 10 %.

5.2.3.3 The load loss of the transformer shall be measured in accordance with MS 60076-1. The load loss shall be measured at ambient temperature and corrected to reference temperature of 120 °C. The load loss tolerance shall be ± 15 %.

5.2.4 MEASUREMENT OF NO-LOAD LOSS AND NO-LOAD CURRENT

5.2.4.1 The Measurement of No-Load Loss and No-Load Current shall be carried out in accordance with MS 60076-1.

5.2.4.2 The no-load loss tolerance shall be ± 15 %. The no-load current tolerance shall be not more than 30 % of the manufacturer's declared value.

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5.2.5 SEPARATE-SOURCE AC WITHSTAND VOLTAGE TEST

- 5.2.5.1 The Separate-Source AC Withstand Voltage Test shall be carried out in accordance with IEC 60076-3.
- 5.2.5.2 The test voltage shall be three (3) kV for LV side and 28 kV for HV side. The test voltage shall be applied for 60 seconds between each winding, and all the remaining windings, core, frame, connected to earth.
- 5.2.5.3 The test is successful if no collapse of the test voltage occurs.

5.2.6 INDUCED AC WITHSTAND VOLTAGE TEST

- 5.2.6.1 The Induced AC Withstand Voltage Test shall be carried out in accordance with IEC 60076-3.
- 5.2.6.2 The test voltage shall be twice of the LV rated voltage, 866 V. The test is successful if no collapse of the test voltage occurs.


5.2.7 PARTIAL DISCHARGE MEASUREMENT

- 5.2.7.1 Partial discharge measurements shall be performed on dry-type transformers. Measurement shall be made in accordance with MS 60076-11 or IEC 60076-11, IEC 60076-3 and MS IEC 60270.
- 5.2.7.2 The partial discharge measurement shall be carried out after Separate-Source AC Withstand Voltage Test and Induced AC Withstand Voltage Test are completed.
- 5.2.7.3 The partial discharge measurement shall be not more than 10 pC (pico coulombs).

5.3 TYPE TESTS

5.3.1 LIGHTNING IMPULSE TEST

- 5.3.1.1 The Lightning Impulse Test shall be carried out in accordance with IEC 60076-3.
- 5.3.1.2 The test voltage shall be 75 kV and the test impulse wave shape shall be $1.2 \mu\text{s} \pm 30\%$ / $50 \mu\text{s} \pm 20\%$.

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5.3.1.3 The Separate-Source AC Withstand Voltage Test and Induced AC Withstand Voltage Test shall be repeated after the Lightning Impulse Test.

5.3.2 TEMPERATURE RISE TEST

5.3.2.1 The Temperature Rise Test shall be carried out in accordance with MS 60076-11 or IEC 60076-11 and IEC 60076-2.

5.3.2.2 The resistance of the HV and LV windings shall be measured. These result values will be used as reference values for the calculation of the temperature rise of the two windings. The ambient temperature of the test laboratory/factory shall also be measured and registered.

5.3.2.3 For the purpose of determining when steady state conditions have been achieved, sensors and thermometers shall be placed to the centre of top yoke and as close as practicable to the innermost LV winding conductors at the top of the winding, the measurement being on the centre coil.


5.4 SPECIAL TESTS

5.4.1 SOUND LEVEL MEASUREMENT

5.4.1.1 The Sound Level Measurement shall be carried out in accordance with IEC 60076-10.

5.4.1.2 A distance of one (1) metre in between transformer and microphone is recommended to measure the Sound Level of transformers without enclosures and forced air cooling. For measurements made with forced air cooling, the distance of two (2) metre shall be applied.

5.4.1.3 The measuring positions shall be approximately equally spaced and not more than one (1) metre apart with a minimum number of six (6) microphone positions.

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- 5.4.1.4 The average sound pressure level (SPL) of each transformer shall be less than the value given in Table 3.

Rated Power kVA	SPL dB(A)
300	65
500	
750	
1000	68
1250	
1600	
2000	70

Table 3 – Sound Pressure Level

5.4.2 SHORT-CIRCUIT TEST


- 5.4.2.1 The Sound-Circuit Test shall be carried out in accordance with IEC 60076-5.
- 5.4.2.2 The partial discharge measurement shall be repeated after the short-circuit test. The partial discharge measurement shall be not more than 10 pC.

5.4.3 ENVIRONMENT TEST

- 5.4.3.1 This test establishes the suitability of transformers for Environmental Class. Environmental Class is identified in terms of humidity, condensation, pollution and ambient temperature. These are important not only during service but also during storage before installation. The test shall be in accordance with MS 60076-11 or IEC 60076-11.
- 5.4.3.2 The transformer Environmental Class shall be of Class E2 where it is defined as frequent condensation or heavy pollution or combination of both.

5.4.4 CLIMATIC TEST


- 5.4.4.1 This test will determine the suitability of transformers for Climatic Class. The test shall be in accordance with MS 60076-11 or IEC 60076-11. The test shall be carried out on a complete transformer without enclosure.

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5.4.4.2 The transformer Climatic Class shall be of Class C1 where the transformer is suitable for operation at ambient temperature not below -5 °C but may be exposed during transport and storage to ambient temperatures down to -25 °C.


5.4.5 FIRE BEHAVIOUR TEST

5.4.5.1 The transformer Fire Behaviour Class shall be of Class F1 in accordance with MS 60076-11 or IEC 60076-11 where the transformer when subjected to a fire hazard, restricted flammability is required, and the emission of toxic substances and opaque smoke shall be minimized.

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6.0 PACKING

- 6.1 All plant shall be packed in a manner so that they are protected adequately against the tropical climatic conditions encountered during shipment and storage at site. All fragile parts shall be packed separately in an approved manner.

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7.0 EARTHING SYSTEMS


7.1 EARTHING REQUIREMENTS

- 7.1.1 All earthing system and accessories shall comply with Electricity Regulations 1994, IEC 60364-5-54, IEC 60364-4-44, BS EN 13601 and BS 7430.
- 7.1.2 All protective and earthing conductors shall be of high conductivity copper conductor either stranded or solid, continuous throughout the whole lengths. They shall be robust design and protected from mechanical damage and corrosion. Before connecting the protective or earthing conductor, the metal works, the conductors and the metal work at the point of contact, including the clamps, shall be thoroughly cleaned of surface corrosion or paint to ensure that good electrical contact is made.
- 7.1.3 The neutral earthing of the LV system of the transformer shall be solidly earthed to achieve an earth resistance less than three (3) ohms. The neutral earthing shall be connected to its earth electrodes by means of PVC black insulated copper cable. The cross-sectional areas of the neutral earthing shall be in accordance with Table 4.

Rated Power of Power Transformer kVA	Cross-sectional Area of Neutral Earthing Conductor (mm ²)
300	35
500	70
750	95
1000	
1250	
1600	120
2000	150


Table 4 – Cross-sectional Areas of Neutral Earthing Conductors

- 7.1.4 The transformer frame earthing shall be connected from earthing terminals to main earthing bar (MEB) and earth electrodes by means of copper tape/bar. The earth electrode resistance shall be less than three (3) ohms.
- 7.1.5 The perimeter copper tape/bar with dimension not less than 25 mm x 6 mm shall be installed around the four walls of the transformer room at a height of 300 mm

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from the finished floor level. They shall be securely fixed at intervals not exceeding 500 mm by means of Direct Contact (DC) tape clips. The both ends of the copper tape/bar shall be connected to the MEB.

- 7.1.6 Earth electrodes shall be of copper jacketed steel core rods with minimum 14 mm diameter and supplied in 1500 mm length and shall have provision for screw coupling with another standard length. The copper jacket of 99.9 % pure electrolytic copper shall be of minimum radial thickness 0.25 mm and shall be molecularly bonded to the steel core to ensure that the copper jacket and steel core are not separable.
- 7.1.7 Each earth electrode shall be driven 3000 mm in depth. Where the desired earth resistance value cannot be achieved after the first earth electrode have been driven, sufficient number of earth electrodes in parallel shall be installed outside the resistance area until required value is reached. Mutual separation between two earth electrodes shall be more than, but less than twice, the driven depth of the earth electrode. Earth electrodes shall not be installed close to a metallic fence. Unless the metallic fence is separately earthed, the fence shall be separated from the electrical earthing system by at least 2000 mm. Interconnection between different earth electrodes shall be by means of 25 mm x 3 mm annealed copper tape.
- 7.1.8 The connection of the earthing conductor and/or the earth electrode to the earth electrode shall be soundly made by the use of plumbed joints, either by exothermic welding or by brazing using zinc-free material with a melting point of at least 600 °C.
- 7.1.9 Each earth electrodes shall be provided with heavy duty type inspection chamber with removable cover. The inspection chamber shall be of square or round type and tested in accordance with IEC 62561-5. The minimum size of square type inspection chamber shall be 300 mm (width) x 300 mm (length) x 180 mm (height). The inspection chamber shall be tested to a force of minimum 15 kN. Lifting hook shall be provided in the cover. The brand name shall be durably marked on the removable cover.
- 7.1.10 The earthing points shall be identified by permanent label durably marked with the words 'Transformer Frame Earthing' or 'Transformer Neutral Earthing' fixed at the point of connection of every earthing conductor to an earth electrode.

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8.0 TESTING AND COMMISSIONING

8.1 TESTING

- 8.1.1 The whole of the plant to be supplied under this Contract shall be subjected as mentioned in Section 5.0. The approval by the S.O./S.O.'s Representative of the test results shall not prejudice the right of the S.O./S.O.'s Representative to reject the transformer if it fails to comply with the specification when erected or it fails to give complete satisfaction in service within the DLP.
- 8.1.2 The costs required for the testing and commissioning, including the provision of all necessary equipment, facilities, expenses, allowances etc. for the S.O./S.O.'s Representative and his officers to inspect the plant and verify the tests, shall be deemed to be included in the Tender Price.
- 8.1.3 Adequate notice shall be given when the plant is ready for testing and commissioning and every facility shall be provided by the Electrical Contractor to enable the S.O./S.O.'s Representative to carry out the tests.

8.2 ON SITE TESTING


- 8.2.1 Upon completion of the installation work on site, the Electrical Contractor shall at his own expense, arrange for all necessary tests to be carried out on the equipment by an Electrical Service Engineer registered with Suruhanjaya Tenaga (ST) as part of the tests required for the whole installation under this Contract. The tests to be carried out shall be as prescribed in the MS 60076-11 or IEC 60076-11 and any other tests as recommended by the Electrical Contractor. In the event the installation fails to pass any of these tests, the Electrical Contractor shall take such measures which are necessary to remedy the defects or any other measures as instructed by the S.O./S.O.'s Representative and the installation shall not be considered as completed until all such tests and remedies have been passed and approved.
- 8.2.2 The tests to be carried out by the Electrical Contractor shall consist of the following minimum tests:
- (a) 2000 V d.c Insulation Resistance test.
 - (b) 24 kV a.c. Separate-Source AC Withstand Voltage test for 1.0 minute.
 - (c) Testing and setting of safety devices and measuring gauges.
 - (d) Any other tests as recommended by the manufacturer.

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- 8.2.3 The S.O./S.O.'s Representative reserves the right to be present at all tests and the Electrical Contractor shall give at least one (1) week notice in writing to the S.O./S.O.'s Representative for this purpose. In any case no test shall be carried out without prior approval of the S.O./S.O.'s Representative. Copies of all the test certificates shall be submitted to the S.O./S.O.'s Representative within one (1) week after the completion of the testing.


8.3 COMMISSIONING

- 8.3.1 On successful testing of the complete installation, the Electrical Contractor shall arrange to commission the plant in the presence of the S.O./S.O.'s Representative on a date to be decided by the S.O./S.O.'s Representative.

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9.0 REJECTION OF PLANT

- 9.1 Any item of plant or components which fails to comply with the requirements of this specification in any respect whatsoever at any stage of manufacture, test, erection or on completion at site within the DLP of the contract shall be rejected by the S.O./S.O.'s Representative either in whole or in part as he considers necessary. After adjustment or modification if so directed by the S.O./S.O.'s Representative, the Electrical Contractor shall submit the item for further inspection and/or tests as necessary. Plant or components with defects of such nature that, in the decision of the S.O./S.O.'s Representative, the requirements of this specification cannot be fulfilled by adjustment or modification shall be replaced by the Electrical Contractor at his own expense and to the satisfaction of the S.O./S.O.'s Representative.

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10.0 DOCUMENT REQUIREMENTS

10.1 MANUFACTURER'S CATALOGUES


- 10.1.1 The tenderer shall submit the manufacturer's catalogues. The catalogues shall contain the technical specification giving detailed information on the winding technology, transformer losses, overall dimensions for each transformer rating, weight and etc.

10.2 SHOP DRAWINGS

- 10.2.1 Two (2) sets of prints of shop drawings for construction and/or installation shall be submitted to the S.O./S.O.'s Representative for approval. The Electrical Contractor shall prepare and submit shop drawings for the whole work at least two (2) weeks before the work begins. If the shop drawings submitted are not acceptable by the S.O./S.O.'s Representative, the Electrical Contractor shall amend and re-submit the shop drawings within two (2) weeks from the date of return of the shop drawings. No work including construction of the transformers shall be carried out without the shop drawings being approved by the S.O./S.O.'s Representative.
- 10.2.2 The shop drawings shall include and show the dimensioned general arrangements, layouts, positions of transformers, wiring, all others necessary for the complete plant installations as specified in the Drawings and/or Bill of Quantities and schematic wiring diagrams of the control circuits;
- 10.2.3 The cost of all these shop drawings, whether or not provided in the BQs, is deemed to be included in the Contract.

10.3 MANUALS

- 10.3.1 Manual shall include the installation, operation and maintenance instructions of the plant. As soon as the general arrangement and details of the plant to be supplied have been finalized and before the delivery of the plant, the Electrical Contractor shall submit to the S.O./S.O.'s Representative two (2) copies of detailed installation, operation and maintenance instructions in respect of the plant to be supplied. The instructions shall cover the whole of the plant.
- 10.3.2 The instruction shall include diagrams with essential details of the plant installation, operation and maintenance techniques. Each of the above two (2) sets of installation, operation and maintenance instructions submitted shall be bound with hard-covers and titles to the satisfaction of the S.O./S.O.'s Representative. The cost of these manuals shall be deemed to be included in the Tender Price.

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10.3.3 The following manuals and documents of the plant shall be supplied:

- (a) Installation, Operation and Maintenance Instruction.
- (b) Product Data and Technical Detail Catalogues
- (c) Routine Test Certificates

10.4 AS-INSTALLED DRAWINGS

10.4.1 Each of the as built documents shall be bound together with hard cover and submitted in minimum four (4) sets upon issuance of Certificate of Practical Completion of the project.

10.4.2 In addition, one (1) set of the as installed drawing shall be submitted in the form of original document, and four (4) sets in physical digital storage.


10.4.3 The As-Installed drawings shall comprise of:

- (a) Site Plan.
- (b) Schematic Wiring Diagrams and Electrical Layout Plans.
- (c) Control Circuit drawings.
- (d) Layout Plans of cable routes and earthing points with reference to easily recognizable buildings and structures.

10.4.4 These drawings shall be labelled at the lower right hand corner with the Electrical Contractor's name and address, date of commissioning, scale, drawing number (the drawing number to be obtained from the S.O./S.O.'s Representative), titles and the following particulars:


JABATAN KERJA RAYA MALAYSIA
CAWANGAN KEJURUTERAAN ELEKTRIK

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10.5 DECLARATION OF CONFORMITY (DoC)

10.5.1 The DoC is a document drawn up by the manufacturer on company letter head and signed by authorized person confirming that the product complies with the regulations, standards and technical specification. It shall be prepared and maintained in accordance with ISO/IEC 17050-1. The manufacturer shall satisfy itself that the DoC is authentic and applies to the plant to be supplied to JKR.

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11.0 TRANSFORMER ROOM

- 11.1 Approved type of rubber mat shall be provided around the transformers. The rubber mat shall extend to the full length and width of the transformer and shall be of thickness not less than 6 mm and width 1000 mm.
- 11.2 'BAHAYA' sign, 'DI LARANG MASUK' sign, sign indicating 'Substation No:' and electric shock treatment chart shall be installed at a place as required in accordance with Electricity Regulations 1994 and to the satisfaction of the S.O./S.O.'s Representative. 'DI LARANG MEROKOK' sign shall also be installed.
- 11.3 All trenches in the transformer rooms shall be filled up with washed river sand to a level above cable ducts.
- 11.4 As installed schematic wiring diagrams shall be suitably framed up in the transformer room.
- 11.5 One (1) unit of nine (9) kg portable dry powder fire extinguisher for A, B, C class of fire and complete with pressure gauge, discharge hose with nozzle installed on wall bracket shall be provided in every transformer room. The extinguisher shall be certified by Jabatan Bomba Dan Penyelamat Malaysia valid to be used for a period of 12 months from the completion date of the Contract.

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12.0 SERVICE AND MAINTENANCE

- 12.1 Under this Contract, the Electrical Contractor shall provide and carrying out comprehensive service and maintenance of the plant during the DLP in accordance with Appendix B - Schedule of Service and Maintenance and all other works as deemed necessary by the S.O./S.O.'s Representative.
- 12.2 All works shall be carried out by competent personnel. All labour, material, tools and parts necessary to rectify the defects due to manufacturing or installation faults shall be supplied or executed at the Electrical Contractor's cost.
- 12.3 All works shall be carried out as soon as the Electrical Contractor has been informed by the S.O./S.O.'s Representative or the occupant and shall be completed within a reasonable time as stipulated in the Form of Contract except under emergency situation. If the Electrical Contractor fails to comply with the above requirement, the S.O./S.O.'s Representative reserves the right to engage another party to carry out the works, in which case, the Electrical Contractor shall be responsible for all the expenses incurred.

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13.0 LIST OF STANDARDS

STANDARD	DESCRIPTION
MS 60076-1	Power transformers – Part 1: General
IEC 60076-2	Power transformers – Part 2: Temperature rise
IEC 60076-3	Power transformers – Part 3: Insulation levels, dielectric tests and external clearances in air
IEC 60076-5	Power transformers – Part 5: Ability to withstand short circuit
IEC 60076-10	Power transformers – Part 10: Determination of sound levels
MS 60076-11	Power transformers – Part 11: Dry-type transformers
IEC 60076-11	Power transformers – Part 11: Dry-type transformers
MS IEC 60085	Electrical insulation - Thermal evaluation and designation
MS IEC 60529	Degree of Protection Provided by Enclosures (IP Code) (First Revision)
MS IEC 60270	High-voltage test techniques - Partial discharge measurements
MS ISO 9001	Quality Management Systems – Requirements (First Revision)
BS EN 13601	Copper and copper alloys. Copper rod, bar and wire for general electrical purposes
IEC 60364-5-54	Low-voltage electrical installations - Part 5-54: Selection and erection of electrical equipment - Earthing arrangements and protective conductors
IEC 60364-4-44	Low-voltage electrical installations - Part 4-44: Protection for safety - Protection against voltage disturbances and electromagnetic disturbances.
BS 7430	Code of practice for earthing
IEC 62561-5	Lightning protection system components (LPSC) - Part 5: Requirements for earth electrode inspection housings and earth electrode seals
ISO/IEC 17050-1	Conformity assessment - Supplier's declaration of conformity - Part 1: General requirements



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APPENDIX A: SCHEDULE OF PARTICULARS AND GUARANTEES

Name of Manufacturer:

Name and address of local authorized agent:

Country of Origin:

Section	Parameter	Unit	Specification	Transformer Offered			
				Tx 1 =.....kVA	Tx 2 =.....kVA	Tx 3 =.....kVA	Tx 4 =.....kVA
-	Model No.	-	-				
-	Rated power	kVA	-				
1.5	Number of phases	-	3 Ø				
1.5	Frequency	Hz	50				
1.6	Type of transformers	-	Cast resin				
1.7	Altitude above sea-level, if in excess of 1000 m	m	1000				
2.1	Voltage ratio	V	11000/433				
2.2	Vector group	-	Dyn11				



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Section	Parameter	Unit	Specification	Transformer Offered			
				Tx 1 =.....kVA	Tx 2 =.....kVA	Tx 3 =.....kVA	Tx 4 =.....kVA
2.3	No-load loss	W	Refer to Table 1				
2.3	Load loss at 120 °C	W	Refer to Table 1				
2.4	Tappings	-	+ 5 %, + 2.5 %, 0 %, - 2.5 % and - 5 %				
2.5	Rated lightning impulse	kV	75				
2.6	Short circuit impedance at 120 °C	%	Refer to Table 2				
2.8	Temperature rise	°C	≤ 100				
3.1	Flux density at rated frequency and rated no-load voltage	Tesla	≤ 1.65				
3.3	Class of winding insulation	-	Minimum Class F				
3.4	HV windings material	-	Copper				
3.4	Type of HV windings	-	Refer to section 3.4				
3.5	LV windings material	-	Copper				
3.5	Type of LV windings	-	Refer to section 3.5				
3.8	Earthing terminals	nos.	2				



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Section	Parameter	Unit	Specification	Transformer Offered			
				Tx 1 =.....kVA	Tx 2 =.....kVA	Tx 3 =.....kVA	Tx 4 =.....kVA
3.9	Wheels	nos.	4 (bi-directional)				
3.10	Rating plate fitted to the transformer	no.	1				
3.11	Rating plate fitted to the transformer enclosure	no.	1				
4.1	Enclosures material	-	Electrogalvanised sheet steel				
5.4.1	Sound level	dB(A)	Refer to table 3				
-	Total mass of complete transformer	kg	-				
-	Overall dimension	mm	-				
-	Any peculiarities of installation, assembly, transport and handling. Restrictions on dimensions and mass	-	-				
-	Schedule of departure from specification	-	-				

Signature :

Name of Tenderer :

Date :

Company's Stamp :

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APPENDIX B: SCHEDULE OF SERVICE AND MAINTENANCE

Item	Description	Every Month	6 th Month	12 th Month
1	Verify the winding temperature within operational range	✓		
2	Ensure the cooling fan is operational	✓		
3	Observe for any abnormally high temperature or noise level and rectify	✓		
4	Making good any damage to roads, buildings, drains cables, pipes, concrete areas, paved areas etc. which had not been properly made good arising out of Electrical Contractor work.		✓	
5	Conduct visual inspection of coils, wiring and monitoring equipment for any suspected damage.			✓
6	Measurement of temperatures of joints, bushings etc. by using a thermal imaging camera and rectify.			✓
7	Replacing and making good all loose and burnt cables and terminations, all mechanical support and linkage, earth electrodes, earth electrode chambers and covers, conduits, trunkings etc.			✓
8	Tightening winding supports			✓
9	Clean and vacuum dust or contamination from transformer			✓
10	External surface to be cleaned and to touch up with paint if corroded			✓