TABLE OF CONTENTS

FOREWORD

The specification is intended for use by Rural Electrification and Renewable Energy Coporation (REREC) in purchasing the transformer.

It is expected that manufacturers will provide energy efficient standard design transformers that will provide high level of efficiency and significant initial cost saving. The manufacturer shall also submit information which demonstrates satisfactory service experience with products which fall within the scope of this specification.

1. SCOPE

This specification is for newly manufactured outdoor oil type power transformer as described below:

45MVA, 220,000/66,000 volts, 50 Hz, ONAN/ONAF three phase power transformer.

The **Vector Group** shall be stated on the schedule of requirements in the tender and shall be YNyn0d1 Power transformer

The specification also covers inspection and test of the transformer as well as schedule of Guaranteed Technical Particulars to be filled, signed by the manufacturer and submitted for tender evaluation.

The specification stipulates the minimum requirements for 45MVA 220kV/66kV power transformer acceptable for use in the company and it shall be the responsibility of the Manufacturer to ensure adequacy of the design, good workmanship and good engineering practice in the manufacture of the transformer for REREC.

The specification does not purport to include all the necessary provisions of a contract.

2. REFERENCES

The following standards contain provisions which, through reference in this text constitute provisions of this specification. Unless otherwise stated, the latest editions (including amendments) apply.

ISO 1461: Hot dip galvanized coatings on fabricated iron and steel articles – Specifications and test methods.

IEC 60076: Power transformers.

IEC 60044: Instrument transformers.

IEC 60137: Insulated bushings for alternating voltages above 1000 V.

IEC 60296: Specification for unused mineral insulating oil for transformers and switchgear.

IEC 60354: Loading guide for oil – immersed power transformers.

IEC 60214: Tap-changers - Part 1: Performance requirements and test methods, Part 2: Application guide.

IEC 60512: Connectors for electronic equipment

IEC 60529 - Degrees of protection provided by enclosures

BS 171: Power transformers

BS 381C: Specification for colours for identification coding and special purposes

3. TERMS AND DEFINITIONS

The terms and definitions given in the reference standards shall apply.

4. REQUIREMENTS

4.1 Service Conditions

4.1.1 Operating conditions

The transformer shall be suitable for continuous outdoor operation in tropical areas with the following conditions.

(a) Altitude: Up to 2200 metres above sea level.

(b) Temperature: average of +35ºC with a minimum of -1ºC and max +40 ºC

(c) Humidity: up to 95%,

(d) Pollution: Design pollution level to be taken as "Very *Heavy*" (Pollution level IV) according to IEC 815.

(e) Isokeraunic level: 180 thunderstorm days per year

4.1.2 System characteristics

a) The primary HV system is 220,000 volts, 3 phase, 3 wire, 50Hz, with neutral point solidly earthed.

b) The secondary MV system is 66,000 volts, 3 phase, 3 wire, 50Hz, with neutral point solidly earthed.

c) The tertiary system is 11,000 volts,3 phase,3 wire,50 Hz, with neutral point solidly earthed for local supply.

d) The Transformer shall be operated at a high loading factor.

4.2 General Requirements

4.2.1 The transformer shall be outdoor, oil-immersed, of ONAN/ONAF classification and core type (lamination stackings). All offers shall comply with the requirements of IEC 60076. Any deviations/additional requirements shall be as stated in this specification.

4.2.2 The transformer shall be a three-phase integral unit.

4.2.3 The transformer shall be of the free breathing type. A dehydrating cobalt free breather of approved design shall be provided.

4.2.4 The transformer and accessories shall be designed to facilitate operation, inspection, maintenance and repairs. All apparatus shall be designed to ensure satisfactory operation under such sudden variations of load and voltage as may be met with under working conditions on the system, including those due to short circuits.

4.2.5 The design shall incorporate every reasonable precaution and provision for the safety of all those concerned in the operation and maintenance of the equipment keeping in view the regulatory requirements in Kenya.

4.2.6 All material used shall be new and of the best quality and of the class most suitable for working under the conditions specified in clause 4.1 and shall withstand the variations of temperatures and atmospheric conditions arising under working conditions without undue distortion or deterioration or the setting up of undue stresses in any part, and also without affecting the strength and suitability of the various parts for the work which they have to perform.

4.2.7 Corresponding parts liable to be replaced shall be interchangeable.

4.2.8 All outdoor apparatus, including bushings insulators with their mountings, shall be designed so as to avoid pockets in which water can collect.

4.2.9 All connections and contacts shall be of ample section and surface for carrying continuously the specified currents without undue heating and fixed connections shall be secured by bolts or set screws of ample size, adequately locked. Lock nuts shall be used on stud connections carrying current. All leads from the winding to the terminals and bushings shall be adequately supported to prevent injury from vibration including a systematical pull under short circuit conditions.

4.2.10 All apparatus shall be designed to minimize the risk or accidental short-circuit caused by animals, birds or vermin.

4.2.11 In tank on-load-tap changers shall be located such that the space above the diverter switch chamber will be free of inter-connecting pipes etc. for lifting the diverter switch unit for inspection and maintenance purposes.

4.2.12 Galvanizing shall be applied by the hot-dipped process to ISO 1461 and for all parts other than steel wires shall consist of a thickness of zinc coating equivalent to not less than 610g of zinc per square meter of surface. The zinc coating shall be smooth, clean and of uniform thickness and free from defects. The preparation of galvanizing and the galvanizing itself shall not adversely affect the mechanical properties of the coated material. The quality will be established by tests as per ISO 1461.

4.2.13 All bolts, nuts, and washers exposed to atmosphere and in contact with non-ferrous parts which carry current shall be of phosphor bronze.

4.2.14 If bolts and nuts are placed so that they are inaccessible by means of ordinary spanners, suitable special spanners shall be provided by the supplier.

4.2.15 Except for hardware, which may have to be removed at site, all external surfaces shall receive at least four coats of paint. The total dry film thickness shall be between 100 and 130 microns.

4.2.16 Descriptive labels for mounting indoors or inside cubicles and kiosks shall be of material that will ensure permanence of the lettering. A matt or satin finish shall be provided to avoid dazzle from reflected light. Labels mounted on dark surface shall have white lettering on a black background. Danger notices shall have red lettering on a white background.

4.2.17 All interior surfaces of chambers or kiosks that are in contact with air shall receive at least three coats of paint, of which the topcoat shall be of a light shade.

4.2.18 The design and all materials and processes used in the manufacture of the transformer, shall be such as to reduce to a minimum the risk of the development of acidity in the oil.

4.2.19 Every care shall be taken to ensure that the design and manufacture of the transformers and auxiliary plant shall be such to have minimum noise and vibration levels following good modern manufacturing practices. The maximum noise levels shall be stated in the bid.

4.3 **Ratings**

4.3.1 (a) The windings of the transformer shall be rated at 45MVA (ONAF), with a minimum ONAN rating of 35 MVA. These ratings shall be for the operating conditions stated in clause 4.1.

(b) The rating specified in this clause shall be the continuous rating at the maximum ambient temperature and altitude given in clause 4.1.

4.3.2 (a) The transformer shall be capable of carrying its full normal rating continuously at any tap under the conditions stated in clause 4.3.1 without undue stress, overheating, or the temperature rise in the hottest region exceeding 55^{o}C and 60^{o}C in oil and windings respectively.

(b) The loading capabilities shall be demonstrated by a temperature – rise test. This test shall be done in the presence of REREC Representatives during factory visit (altitude correction shall be as per clause 4.3.1 of IEC 60076-2).

4.3.3 The transformer shall be capable of withstanding the maximum fault level at its rated voltage and impedance for 2 seconds. The design should cater for the expected lifetime of the transformer.

4.3.4 The thermal ability to withstand short circuit shall be demonstrated by calculation as per IEC 60076-5 and the calculation shall be submitted with tender. The duration of the current to be used for the calculation of the thermal ability to withstand short circuit shall be 2 seconds while the maximum permissible value of the average temperature of each winding shall be as per IEC 60076-5.

4.3.5 The ability of the transformer to withstand the dynamic effects of short circuit shall

be demonstrated by tests and complete test reports (including oscillograms and records of the condition of the transformer before and after the short-circuit test) shall be submitted for tender evaluation.

4.4 Winding and Connections

4.4.1 The **Vector Group** shall be stated on the schedule of requirements in the tender and shall be YNyn0d1.

Power transformer intended for Dy connection shall have facility to change from Dyn1 to Dyn11 and vice versa**.** The links for changing over from one mode to another shall be accessible through an inspection cover.

4.4.2 The transformers shall be capable of operation without danger on any particular tapping at the rated MVA when the voltage may vary by ± 10% of the voltage corresponding to the tapping.

4.4.3 The windings and connections as well as the insulating material shall not soften, ooze, shrink or collapse during service. The materials shall be non-catalytic and chemically inactive in transformer oil during service.

4.4.4 No strip conductor wound on edge shall have a width exceeding six times its thickness. The conductors shall be transposed at sufficient intervals to minimize eddy currents and equalize the current and temperature distribution along the windings.

4.4.5 The windings and connections shall be properly braced to withstand shocks during transportation or due to short circuit and other transient conditions during service.

4.4.6 Adequate pre-shrinkage of the coil assembly using pre-compressed press board material having low moisture content for the radial spacer blocks shall be ensured by the manufacturers so that there is no displacement of the radial spacer blocks due to frequent short circuits on the transformers.

4.4.7 All windings after being wound and all fibrous hygroscopic materials used in the construction of the transformer shall be dried under vacuum and impregnated with hot oil.

4.4.8 The coil clamping rings wherever used shall preferably be of flat insulated steel laminations.

4.4.9 The radial spacer blocks must be made of pre-compressed pressboard material, which will not soften while in contact with oil or fray out into fibers or edges. The slots should be so dimensioned that the blocks will not come out of the slots.

4.4.10 All joints shall be brazed/crimped considering the vibrations due to short circuits and load fluctuations.

4.4.11 REREC will inspect built-up winding for its quality, weight of copper, insulation and overall weight of coil assembly. The size of conductor used for different windings shall also be checked during stage inspection to check the current density.

4.4.12 The transformer shall be designed with particular attention to the suppression of harmonic voltage, especially the third and fifth, so as to eliminate wave-form distortion and from any possibility of high frequency disturbances, inductive effects or of circulating currents between the neutral points at different transforming stations reaching such a magnitude as to cause interference with communication circuits.

4.4.13 The windings shall be designed to reduce to a minimum the out-of-balance forces in the transformer at all voltage ratios.

4.5 Tapping

4.5.1 Tapping Range

The transformer shall be provided with tapping on the 220kV winding for a variation of no load primary voltage for parallel operation, with Tap No. 1 having the highest voltage assignment, as follows:

220,000 volts	+ 8 × 1.67%
	- 8 × 1.67%

4.5.2. Tapping Method

Tapping shall be carried out by means of an on-load tap changer as described in clause 4.12 below.

4.6 Core and Flux Density

a) Core

4.6.1 The core shall be constructed from the laminations of high grade cold rolled non-aging, grain oriented silicon steel known as M4 or superior grade CRGO steels of maximum 0.27mm or less lamination thickness especially suitable for transformer core. The grade of CRGO shall be stated in the bid.

4.6.2 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 or to the clamping structure and the production of flux components at right angles to the plane of the laminations which may cause local heating.

4.6.3 Every care shall be exercised in the selection, treatment and handling of core steel to ensure that as far is practicable, the laminations are flat and the finally assembled core is free from distortion.

4.6.4 Adequate oil ducts shall be provided in the core for cooling. Tinned copper strip bridging pieces shall be used for maintaining electrical continuity wherever the magnetic circuit is provided into pockets by such ducts or insulating material thicker than 0.25mm.

4.6.5 There shall be no movement of the core assembly relative to the tank during transport, installation as well as in service due to sudden jerks caused by short circuits and fluctuating loads.

4.6.6 All steel sections used for supporting the core shall be thoroughly sand blasted or shot blasted after cutting, drilling and welding. Any non-magnetic or high resistance alloy shall be of established quality.

4.6.7 Adequate lifting lugs shall be provided to enable core and winding to be lifted.

4.6.8 The supporting framework of the Cores shall be so designed as to avoid the presence of pockets which would prevent complete emptying of the tank through the drain valve, or cause trapping of air during filling.

4.6.9 The insulation structure for the core to bolts and core to clamp plate shall be such as to withstand a voltage of at least 2kV AC for one minute.

(b) Flux Density

4.6.10 The primary voltage variation, which may affect the flux density at every tap, shall be kept in view while designing the transformer.

4.6.11 The transformer shall be so designed that the working flux density shall not exceed 1.6 Tesla at normal voltage, frequency & ratio.

4.6.12 Tenderers shall indicate the continuous allowable maximum flux for one minute and five seconds.

4.6.13 The limit of flux density at which core material used saturates shall also be stated in the tender. The name and grade of core material shall be stated in the tender.

4.6.14 The successful tenderer shall be required to furnish magnetization curve of the core material, design calculations and such other data/documents deemed fit by the purchaser for being satisfied that flux density is as desired.

NOTE: The above flux density has been specified to meet with the over fluxing of the core due to temporary over voltage of the orders of 25% for one minute and 40% for five seconds that may appear in abnormal conditions such as the one obtained following sudden loss of large loads.

4.7 Losses, Regulation and Impendence

4.7.1 Losses of the transformer shall be stated and shall be subject to tolerances in accordance with IEC 60076. The fixed losses shall be as low as is consistent with good design, reliability and economical use of materials.

4.7.2 Voltage regulation from no-load to continuous rated output at unity power factor, at 0.8 lagging and 0.8 leading power factor with constant voltage across the higher voltage windings shall be stated in the bid.

4.7.3 The impedance voltage at extreme tappings and at principal tapping shall be stated and shall be subject to tolerances in accordance with IEC 60076. Typical values for existing 45 MVA

transformers at principal (nominal) tap are 11% - 13%. The minimum as per IEC 60076-5 for this size of transformer is 11.0%).

4.7.4 As per IEC 60076-5, the short-circuit apparent power of 66kV & 220kV systems shall be taken as 3,000MVA & 20,000MVA respectively in order to obtain the value of the symmetrical short circuit current to be used for the design and tests.

4.8 Terminals: Arrangement & Bushings

4.8.1 The 66kV and 220kV windings shall be brought out separately through open bushings of outdoor, weatherproof design in accordance with IEC.

4.8.2 Bushings for 220kV terminals shall be of oil-filled condenser type construction, draw-out type and shall each have a capacitance test point. Bushings for 66kV terminals shall be of the solid porcelain type or condenser type (due to insulation withstand requirements). 11kV terminals (for transformer with tertiary winding) shall be of the solid porcelain type.

4.8.3 The neutral bushing of the transformer shall be identical to the corresponding phase terminal bushings.

4.8.4 Spacing and air clearances shall be so co-ordinated as to render the probability of a flashover from the terminal of one winding to the terminal of another winding negligible.

4.8.5 Leakage distance of bushings shall not be less than 31mm/kV, based on operating phase to phase voltage.

4.8.6 Bushing terminals shall be clamp type suitable for both copper and aluminium Busbars of sizes upto 76mm diameter.

4.8.7 Each bushing of the 220kV windings shall be mounted on a turret. Each turret shall be suitable for accommodating at least two sets of current transformers.

4.8.8 Each bushing of the 66kV windings shall be mounted on a turret. Each turret shall be suitable for accommodating at least three sets of current transformers.

4.8.9 Terminal arrangement on the HV and LV sides shall be **N,** R**, Y, B** and **n, r, y, b** respectively (this shall be indicated on drawings submitted for approval before manufacture). Note: Neutral (N) on primary applicable only to YNyn0 transformers. The phase markings shall be visible from ground level.

4.9 Current Transformers to be Fitted

4.9.1. Current transformers shall be installed in the bushing turrets and shall be of the following quantities, ratios, ratings and class:

PHASE	**BUSHING CT CORE**	**BURDEN**	**RATIO**	**CLASS**
HV-SIDE (220kV)				
R	1	30VA	400-200/1A	cl. 5P20
	2	30VA	400-200/1A	cl. 5P20
Y	1	30VA	400-200/1A	cl. 5P20
	2	30VA	400-200/1A	cl. 5P20
B	1	30VA	400-200/1A	cl. 5P20
	2	30VA	400-200/1A	cl. 5P20
N	1	30VA	600-300/1A	cl. 5P20
	2	30VA	600-300/1A	cl. PX
LV-SIDE (66kV)				
r	1	30VA	1000-500/1A	cl. 5P20
	2	30VA	1000-500/1A	cl. 5P20
y	1	30VA	1000-500/1A	cl. 5P20
	2	30VA	1000-500/1A	cl. 5P20
b	1	30VA	1000-500/1A	cl. 5P20
	2	30VA	1000-500/1A	cl. 5P20
n	1	30VA	1000-500/1A	cl. 5P20
	2	30VA	1000-500/1A	cl. PX
TERTIARY WINDING (11kV)				
r	1	30VA	500/1A	cl. PX
	2	30VA	500/1A	cl. 5P20
	3	30VA	500/1A	cl. 5P20
y	1	30VA	500.1A	cl. PX
	2	30VA	500/1A	cl. 5P20
	3	30VA	500/1A	cl. 5P20
b	1	30VA	500/1A	cl. PX
	2	30VA	500/1A	cl. 5P20
	3	30VA	500/1A	cl. 5P20

4.9.2 Current transformers of suitable rating and class for winding temperature indicators shall be installed to adequately cover the transformer (HV & LV) as indicated above (as 200/1A and 400/1A) for guidance.

4.9.3 Current transformers shall also comply with the requirements of IEC 60044.

4.9.4 Full technical particulars of current transformers offered, including type test reports from an International reputable Testing Authority or a National Standards and Testing Authority of the country of manufacture, shall be submitted with tender.

4.10 AIR CLEARANCE

4.10.1 When totally assembled, as in service, electrical clearances in air shall be adequate to withstand the assigned impulse withstand test voltages.

4.10.2 Care shall be taken to ensure that all fittings are suitably positioned so as not to interfere with the external connection to the bushing terminals.

4.10.3 Minimum external air clearances shall be as shown under.

Nominal System Voltage between Phases		**66kV**	**220 kV**
Minimum clearance phase-to-earth and phase-to-neutral	mm	830	2590
Minimum clearance phase-to-phase between phases of the same winding	mm	830	2590
Minimum clearance between a line terminal of the high voltage winding and a line terminal of a lower voltage winding	mm	830	2590
Minimum clearance from live metal to oil pipe-work including conservator and pressure relief device	mm	830	2590

4.11. INSULATION LEVELS

The complete transformer arranged for service, shall be capable of withstanding the following voltages and shall comply fully with the requirements of IEC 60076 Part 3, including the latest amendments.

Nominal system voltage **(kV, rms)**	Highest system voltage **(kV, rms)**	Lightning Impulse withstand voltage, dry **(kV, peak)**	Power frequency withstand voltage, wet **(kV, rms)**
11	12	75	28
66	72.5	325	140
220	245	950	395

4.12. ON LOAD TAP CHANGER AND MECHANISM BOX

4.12.1 The transformer shall be complete with vacuum type on-load, electrically driven tap changing mechanism of the high-speed resistor transition type, and shall comply with the requirements of IEC 60214, 60512 and this specification. The equipment shall be suitable for remote operation from a control panel supplied with the transformer as well as for local operation from the Motor Drive Unit (MDU) mounted on the transformer body.

4.12.2 The mechanism shall be so designed as to ensure that when a tap change operation is in progress, it shall be able to complete the task independently irrespective of operation of any relays or switches.

4.12.3 Adequate means shall be provided to safeguard the transformer and its auxiliary circuits from damage should a failure of the auxiliary supply or any other mal-operation occur during the progress of tap changing that may prevent it from completing its task.

4.12.4 Means shall be provided in the marshalling kiosk for mechanical isolation of the supply to the Motor Drive Unit, and a suitable thermal overload device (details to be submitted with tender) shall be provided in the MDU for the protection of the motor. The possibility of over-running the mechanism at each end of the voltage range shall be prevented by means of limit switches and mechanical stops. Other techniques used to prevent tap changer runaway shall be indicated.

4.12.5 A mechanically operated device shall be provided to indicate the tap position locally, and a suitable tap position transmitter shall be provided for the remote tap position indication.

4.12.6 A counter shall be provided on the tap changing mechanism box to indicate the total number of operations completed by the equipment.

4.12.7 Contactors and associated equipment for the control circuit for local/remote and manual operations of the tap changer mechanism shall be housed in the mechanism box.

4.12.8 The tap changer shall be housed in a **separate compartment** and shall be **Vacuum Type**. Sufficient documentation for the vacuum switch in form of manuals, instructions, drawings, technical characteristics, copies of type test certificates and type test reports (from an Independent and ISO/IEC 17025 accredited Testing Laboratory), manufacturing and export experience of the supplier shall be submitted with the tender for technical evaluation. The tap changer shall be of a design & make approved by REREC.

4.12.9 The Motor Drive Unit shall have the following in addition to what has been stated above:

(a) Isolating switch in the transformer marshalling box for the supply to the tap changer Motor Drive Unit,

(b) Raise/lower contactors for tap changer motor operation, and associated single-phase protection/overload relay,

(c) Switch for selection of local/remote tap changer control,

(d) Switch or switches for local tap changer operation,

(e) Provisions shall be made available for hand operation in the mechanism box.

4.12.10 The tap changer shall be of internationally reputable manufacture and proven reliability in service. Detailed documentation and copies of certificates shall be submitted with the tender for evaluation.

4.12.11 Remote Tap Changer Control Panel

The remote tap changer control panel shall contain the following devices:

- Automatic Voltage Regulating Relay (to be of REREC approved design and technical details shall be submitted with tender).
- Off/Manual/Automatic switch for the Relay.
- Raise /Lower control switch.
- Raise , Lower, 'out of step' and tap change in progress indication lamps
- Dial type Tap position indicator (technical details to be submitted with the tender).
- Master/Follower/Independent Scheme and selector switch. The Tap Changer shall employ, negative reactance or circulating current principle scheme for parallel operation .
- Local /Remote switch
- KV meter (technical details to be submitted with the tender)
- Door operated lamp and anti-condensation heater.
- Heater switch ON/OFF to control anti-condensation heater
- Various control circuits controlled by Miniature Circuit Breakers

4.12.12 AUTOMATIC VOLTAGE REGULATING RELAY

The relay shall be of REREC *approved make & design and shall, as a minimum, incorporate the following features:*

- Rated voltage 110V AC.
- Rated Current 1 Amp.
- Initial time delay range 5-100 seconds, and ability to select Integrated delay or Definite time delay.
- Inter-tap delay 1-80 seconds
- Relay voltage setting, adjustable in steps of 1V from 85 - 130V
- Line drop compensation 0-20 V at rated current for both reactive and resistive setting
- Under voltage inhibit range 70%-90% & over current inhibit range 150%-250%
- Bandwidth range 0.5-5 % of voltage level
- Over voltage inhibit
- The AVR should have a selector switch with OFF/Manual/Auto
- Should be of Numeric Design.

- The Relay shall be Designed to employ both Circulating Current Compensation or Negative(Reverse) Reactance compounding to minimize circulating current for Parallel Transformer Operation.
- Tap changer Maintenance, by maintaining Tap Operation count.
- Tap Changer Mechanism Failure.
- Should have capability to be connected to the SAS network via IEC 61850

Sufficient documentation in form of price, instruction manuals, drawings, technical characteristics and test certificates from international/national testing/standards laboratory of the country of manufacture shall be submitted with the tender to facilitate technical evaluation.

4.13. PARALLEL OPERATION

4.13.1 A scheme for operating this transformer in parallel with other similar units of different rating shall be provided

4.13.2 The scheme shall maintain the transformers in stable parallel operation and limit circulating current to a minimum.

4.13.3 In the event of this transformer being disconnected from the system, its reconnection shall not result in its tap changer failing to operate automatically because of tapping discrepancy.

4.13.4 Suitable selector switch shall be provided, so that any one transformer of the group can at a time be selected as “Master”, “Follower” or “Independent”.

4.13.5 Necessary interlock blocking independent control when the units are in parallel shall be provided.

4.13.6 The scheme shall be such that only one transformer of a group can be selected as “Master”.

4.13.7 An out –of- step device shall be provided for each transformer which shall be arranged to prevent further tapchanging when transformers in a group operating in “Parallel control” are one tap out-of-step.

4.14. MARSHALLING KIOSK (Box)

4.14.1 The marshalling kiosk shall be of outdoor, IP 55, weatherproof, vermin-proof type with a hinged, lockable door fitted with a glass panel to facilitate reading of oil and winding temperature gauges without opening the door. The kiosk shall be mounted so that its window is approximately 1600mm above ground level; and shall accommodate at least the following items:-

a) Winding temperature indicator for both 220kV and 66kV with a maximum pointer drag hand type with a resetting knob and three separately adjustable mercury contacts for alarm, trip and operation of cooler control circuits as required.

b) Two oil temperature indicators with a maximum pointer drag hand type with a resetting knob and two separately adjustable mercury contacts for alarm and trip.

c) A mechanical isolating switch for the incoming 3 phase, 4 wire, 415V 50Hz supply to the marshalling kiosk. 415 volts and 240 volts socket outlets (square pins) shall also be provided in the kiosk.

d) A mechanical isolating switch for the outgoing 3 phase 4-wire 415V 50Hz supply to the OLTC Motor drive unit.

e) Suitable starters for the cooling fan motors complete with thermal overload/single phase protection relay and normally-closed electrical auxiliary contacts for motor failure alarm/trip circuits. Each fan shall be protected by an MCB with trip contacts for indication.

f) A selector switch with 'OFF', 'MANUAL' and AUTO positions for cooling fan motors

g) An internal standard screw type illumination lamp and heater for the kiosk with respective switches. The lamp shall be door switch operated.

h) Wiring, fuses, links, terminal boards and cable glands for bottom entry of multicore cables.

i) Anti-condensation heater with a switch.

j) Thermostat for anti-condensation heater control.

k) Hygrostat for anti-condensation heater control.

l) MCB control for each of the circuits.

m) Phase sequence relay for detection of wrong phase rotation for the supply to the fans and the OLTC Motor Drive Unit.

Detailed technical details, drawings, and schematics shall be submitted with the tender documents for evaluation.

4.15. AUXILIARY SUPPLIES

Equipment shall be rated for the following auxiliary power supplies:

(a) Cooler control circuits: 240 V, single phase, 50Hz

(b) Tap changer control: 240 V, single phase, 50Hz

(c) Cooling fan motors: 415 V, three phase, 50Hz

(d) Tap changer motor: 415 V, three phase, 50Hz

4.16. TRANSFORMER TANK AND TANK COVER

4.16.1 The tank shall be of top cover design and shall be constructed of mild steel plates of sufficient thickness and strength and shall be complete with all accessories. It shall be designed so as to allow the complete transformer when filled with oil to be lifted by crane or jacks, transported by road, rail or on water without overstraining any joints and without causing subsequent leakage of oil. The minimum thickness for sides, bottom and top cover shall be 8mm, 20mm and 20mm respectively.

4.16.2 The base of the tank shall be so designed that it shall be possible to move the complete transformer unit in any direction without injury when using rollers, and/or plates

4.16.3 The tank and its accessories shall be so designed as to prevent collecting or trapping of gases. Where this cannot be avoided, pipes shall be provided to vent the gas into the main expansion pipe. The vent shall have a minimum outside diameter of 19mm except for short pipes which may be 6.35mm minimum inside diameter.

4.16.4 All joints, other than those that may have to be broken shall be welded. Caulking of unsatisfactorily welded joints is forbidden.

4.16.5.The main tank body shall be pressure tested and a certificate issued by the national standards and testing laboratory ascertaining the soundness of all welded joints. A certified copy of the certificate shall be submitted with the tender for evaluation.

4.16.6 Tank shall be provided with lifting lugs suitable for lifting the complete transformer with oil. Further more, a minimum of four accessible jacking positions shall be provided to enable the complete transformer to be raised or lowered using jacks.

4.16.7 The transformer tank and all attachments normally under oil shall be capable of withstanding full vacuum. The oil conservator shall withstand at least 35% full Vacuum.

4.16.8 Tank cover shall be of such a design and construction as to prevent accumulation of water and shall be bolted to the flange on the tank top to form a weatherproof joint.

4.16.9 Inspection openings shall be provided as necessary to give easy access to bushings, tapping switch and for testing or general inspection.

4.16.10 Tank cover and inspection covers shall be provided with suitable lifting arrangements. Inspection covers shall not weigh more than 25 kg apiece.

4.16.11 The tank cover shall be fitted with isolated pockets for oil and winding temperature instrument bulbs. Protection shall be provided where necessary for each capillary tube. The pocket shall

be fitted with a captive screwed cap to prevent the ingress of water. Detailed drawings shall be provided.

4.16.12 The pocket shall be located in a position of maximum oil temperature at continuous maximum rating and it shall be possible to insert and remove the instrument bulbs without lowering the oil in the tank.

4.16.13 Gaskets for weather and oil-tight joint faces shall be of synthetic rubber-and-cork composition and shall have a minimum thickness of 5mm, except that where jointing faces are precision-machined thinner gaskets may be used.

4.17. PAINT WORK

Cleaning and painting shall be in accordance with the following requirements. Any deviations in methodology shall be stated and may only be those that will produce demonstrably superior results.

A test report issued by the national standards and testing laboratory shall be produced at the time of acceptance testing of the transformer.

4.17.1 Tanks and Accessories

(a) 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 or other suitable approved method. After cleaning, these surfaces should be immediately covered with paint.

(b) The exterior shall be thoroughly cleaned by shot blasting or other approved method and given priming coat followed by two coats of contrasting colours of durable weather-resisting paint. The final coat shall be high gloss of shade No. 632 (Admiralty Grey) according to BS 381C.

(c) The interior of all transformer tanks and other oil-filled chambers shall be cleaned of all scale and rust by shot blasting or other approved method. Hot oil resistant varnish on white synthetic enamel paint is to be used for painting the inside of all oil filled chambers, including transformer tanks and CT chambers & covers. The final coat shall be of a light-coloured anti-condensation finish.

4.17.2 Radiators

(a) Radiators shall be thoroughly degreased and treated externally by phospating and/or other rust-inhibiting process.

(b) Radiators shall be flood-painted with a primer and two coats of durable weather and oil resisting paint. The final external coat shall be high gloss of shade No. 632 (Admiralty

Grey) according to BS 381C. The total paint thickness shall not be less than 85µm at any point.

4.18. COOLING SYSTEM

4.18.1 Radiators shall be supplied in banks as suitable. Each bank shall be fitted with gate valves with legible labelling for OPEN/CLOSED positions and used for full isolation from the main tank. Each radiator shall have a top and bottom isolating butterfly valve. The radiator design shall exclude accumulation of rainwater.

4.18.2 Radiator banks shall be mounted directly to the transformer main tank for best use of space.

4.18.3 Each radiator shall have a bleeding facility (to allow escape of air) on top.

4.18.4 Separately mounted AC motor driven fans fitted with wire mesh guards shall be provided for the radiators. The fan motors shall be totally enclosed, weatherproof, outdoor type suitable for continuous operation and shall be fitted with terminal boxes and glands to accommodate multicore electric supply cables. Technical details of the fan motor shall be supplied with the tender.

4.18.5 Suitable starters, protection/warning devices, contactors and switches for the motors shall be provided as stipulated in clause 4.14 above.

4.18.6 Suitable lifting lugs shall be provided for removal and assembly of radiators.

4.18.7 The complete cooling system and the fittings shall be fully co-ordinated. Where necessary, the cooling fan motors shall be fired in designed groups and in such sequence as to achieve the desired control at maximum efficiency and safety.

4.19. FITTINGS

(All fittings & accessories including Gas & Oil Actuated Relays shall be of a <u>design & make</u> approved by REREC*)*

4.19.1 Conservator

The transformer shall be provided with a conservator having a filling orifice, an isolating valve, a drain valve and a cobalt free dehydrating breather (with oil seal) which shall be accessible from ground level. The drain pipe shall be located at the lowest point in the conservator in its final installed position and welded such that it can drain all the sludge in the conservator.

The conservator shall be partitioned proportionately to separate the main tank oil and the tapchanger oil. Each compartment to be fitted with a breather and an oil level indicator with electrical contacts for alarms. The conservator complete with drain valve shall be in such a position as not to obstruct the electrical connections to the transformer. An oil gauge shall be provided at one end of the conservator marked with oil levels that can be read by a person

standing on the ground. Expansion joints may be provided in the inlet and outlet pipes to the transformer as necessary.

4.19.2 **Gas and Oil Actuated Relay (Transformer main tank)**

Transformers shall be provided with a gas and oil actuated relay (Buchholz relay) of double float type with alarm and tripping contacts to detect accumulation of gas and sudden changes of oil pressure. Shut off valves and flange couplings shall be provided to facilitate easy removal of the relay without lowering oil level in the main tank. A bleed valve for gas venting, a test valve and a terminal box suitably wired to the marshalling kiosk shall also be provided. The gas venting pipe shall be brought down to a height reachable from ground level and shall be fitted with a gas sampling device at the end. Provision should be made on the relay for simulation of gas and oil surge for testing purposes.

4.19.3 **Gas and Oil Actuated Relay (Tap changer compartment)**

Tap changer compartment shall be provided with a gas and oil actuated relay (Buchholz relay) of double float type with tripping contacts to detect accumulation of gas and sudden changes of oil pressure. Shut off valves and flange couplings shall be provided to facilitate easy removal of the relay without lowering oil level in the tap changer compartment. A bleed valve for gas venting, a test valve and a terminal box suitably wired to the marshalling kiosk shall also be provided. The gas venting pipe shall be brought down to a height reachable from ground level and shall be fitted with a gas sampling device at the end. Provision should be made on the relay for simulation of gas and oil surge for testing purposes.

4.19.3 **Pressure Relief Device**

Two (2) pressure relief devices shall be provided for the main tank, complete with trip contacts suitably wired to the marshalling kiosk. The device shall be resettable after an operation. Details of the device shall be submitted with the offer.

4.19.4 **Winding Temperature Indicator**

(a) The transformer shall be provided with winding temperature indicator, maximum indicator and associated current transformers. The temperature indicator shall have a scale ranging from 20°C to 150°C, preferably uniformly divided and its type to be stated in the bid. The indicator shall have four sets of independently adjustable contacts as follows:

I. Fan Group stage 1

Adjustable setting: 70°C to 150°C

Fixed differential: Not more than 10°C

II. Fan Group stage 2

Adjustable setting: 70°C to 150°C

Fixed differential: Not more than 10°C

III. **Alarm**

Adjustable setting: 70°C to 150°C

Fixed differential: Not more than 10°C

IV. Trip

Adjustable setting: 70° to 150°C

Fixed differential: Not more than 10°C

(b) All contacts shall be adjustable to a scale and shall be accessible on removal of the cover for dial type devices. For purposes of (i) and (ii) above, the contacts shall be suitable for making or breaking 150VA between the limits of 30 and 250 V a.c. or d.c., and making 500 VA between the limits of the 110 and 250 V d.c.

(c) Isolating and test links shall be provided in a control cubicle to allow for measuring the oil temperature and testing the heater coil.

(d) The current transformer providing winding temperature indication shall be located at the discretion of the manufacturer, in the best position for the duty.

(e) Calibration of indicator shall be related to the winding having the maximum temperature rise.

(f) If the value on the winding temperature indicator varies by more than 3°C from the values derived from the tests specified in clause 5, then adjustments shall be made to the equipment to achieve these limits.

4.19.5 **Oil Temperature Indicator**

Transformers shall be provided with an oil temperature indicator with a maximum pointer and contacts for alarm and trip signals, similar to winding temperature indicator above.

4.20. ACCESSORIES

The following shall be provided:

4.20.1 Valves with blank flanges fitted at the top and bottom for oil filtration purposes, having the following features:

(a) The valve located at the bottom of the tank shall also be suitable for draining oil from the transformer tank.

(b) All valves shall close with a clockwise rotation. The main inlet and outlet valves shall be provided with “open” and “closed” position indicators, visible from ground level.

(c) All valves shall have provision for padlocking in the open and closed position for operation purposes. The hole for the padlock shall have a clearance of not less than 8mm and not more than 10mm. Locking pin shall be of anti-rattle design to limit noise emissions. The locking padlocks shall be provided.

(d) Closed/Open positions of all valves must be clearly marked.

4.20.2 Oil sampling device appropriately located to obtain samples of transformer oil from the top and bottom of the tank.

4.20.3 Two earthing terminals located at diagonally opposite corners of the tank.

4.20.4 Air release valves or plugs for the main tank, suitably located.

4.20.5 Non-deteriorating detailed diagram and rating plates.

4.20.6 Other Fittings/accessories

Diagram plate
Plate of valves and oil piping.
Motor drive electrical and protection diagram.
Cooling control electrical and protection diagram.
Electrical scheme for operating this in parallel with other similar units.
Detailed list of the transformer equipment & fittings including their drawings, brochures & instruction manuals.
Shipping data
Detailed erection, installation, operation and maintenance manuals in English language.
Testing Plan.
Impact recorder for the whole duration of transit and a report provided afterwards.

2 Sets of keys for padlocking devices.
(all control boxes as well as valves to be padlocked)

4.21. TRANSFORMER OIL

The transformer and all associated oil immersed equipment shall be supplied oil filled. The oil shall comply with all the requirements of IEC 60296 (class 1: un-inhibited oil). Tenderer shall provide the

chemical composition and properties of the oil and the replacement cycle over the expected life of the transformer.

4.22. CAPITALIZATION

4.22.1 Transformer losses shall be capitalized at the following rates to facilitate evaluation and comparison of tenders.

Total load losses, ONAF rating (copper loss + stray loss) at rated current at 75^0 C in KW, including auxiliary losses	US$ 4000 per kW for 35 years
Total no load losses in KW (core loss + dielectric loss)	US$ 9000 per kW for 35 years

Losses will be capitalized at the above rates and added to the bid price according to the formula below:

Gep = Gbp + G($), where Gep = Bid evaluation price, Gbp = Bid price and

G($) = Adjustment for the cost of the operation and maintenance for 35 years (all in US Dollars)

G($) is obtained by using the following formula:

G($) = US$ 4000 X {Total load losses, ONAF rating (copper loss + stray loss) at rated current at 75^0 C in KW, including auxiliary losses} + US$ 9000 X {Total no load losses in KW (core loss + dielectric loss)}.

4.22.2 The guaranteed transformer losses used in the above capitalization formula shall be the maximum allowed and no plus tolerance shall be allowed during acceptance testing.

4.23. QUALITY MANAGEMENT SYSTEM

4.23.1 The bidder shall submit a quality assurance plan (QAP) that will be used to ensure that the transformer design, material, workmanship, tests, service capability, maintenance and documentation, will fulfil the requirements stated in the contract documents, standards, specifications and regulations. The QAP shall be based on and include relevant parts to fulfil the requirements of ISO 9001:2008.

4.23.2 The Manufacturer's Declaration of Conformity to reference standards and copies of quality management certifications including copy of valid and relevant ISO 9001: 2008 certificate shall be submitted with the tender for evaluation.

4.23.3 The bidder shall indicate the delivery time of each type of transformer, manufacturer's monthly & annual production capacity and experience in the production of the type and size of

transformer being offered. A detailed list & contact addresses (including e-mail) of the manufacturer's previous customers outside the country of manufacture for exact or similar rating of transformers sold in the last five years shall be submitted with the tender for evaluation.

5.0 TESTS AND INSPECTION

5.1 The transformer shall be inspected and tested in accordance with the requirements of IEC 60076 and this specification. It shall be the responsibility of the manufacturer to perform or to have performed all the tests specified. Tenderers shall confirm the manufacturer's capabilities in this regard when submitting tenders. Any limitations shall be clearly specified.

5.2 Copies of Type Test Certificates and Type Test Reports issued by the relevant Independent International or National Testing/ Standards Authority of country of manufacture or ISO/IEC 17025 accredited and independent testing laboratory shall be submitted with the offer for evaluation (all in English Language). A copy of the accreditation certificate for the independent laboratory shall also be submitted. Any translations of certificates and test reports into English language shall be signed and stamped by the Testing Authority**.**

1) Copies of type test certificates and type test reports for the transformer to be submitted for tender evaluation shall include:

a) Dielectric tests to IEC 60076 (Lightning Impulse Test).
b) Short circuit withstand test to IEC 60076.
   - thermal ability of the transformer to withstand short circuit,
   - ability of the transformer to withstand the dynamic effects of short circuit
c) Temperature rise test to IEC 60076.

Note: Temperature rise test to IEC 60076 if conducted at the manufacturer's premises (factory) MUST be in the presence of representatives of ISO/IEC 17025 accredited and independent testing laboratory; who shall sign the certificates and test reports.

2) Copies of type test certificates and type test reports for the on load tap changer to be submitted for tender evaluation shall include:

a) Dielectric tests (Lightning Impulse and Power Frequency Withstand Tests).
b) Short circuit withstand test.
c) Temperature rise test.
d) Switching tests.
e) Transition impedance test.
f) Mechanical tests.

5.3 The transformer shall be subject to acceptance tests at the manufactures' works before dispatch. Acceptance tests shall be witnessed by Engineers appointed by REREC and shall include the following:

5.3.1 **Routine tests to IEC 60076 (to be done during acceptance testing at factory)**

- Measurement of winding resistance
- Ratio test
- Vector group
- Separate source voltage withstand test
- Induced over-voltage
- Insulation resistance
- Oil leakage test on fully assembled transformer for 12 hours
- Measurement of impedance voltage
- Magnetic balance
- Measurement of no-load loss and current
- Measurement of load loss (at normal & extreme taps)
- Tests on on-load tap-changer
- Tests on on-load tap-changer remote control panel
- Efficiency at 50%, 75%, 100% loading at unity p.f and rated terminal voltage (Corrected to 75°C)
- Lightning impulse withstand test

5.3.2 **Type Tests to IEC 60076 (to be done during acceptance testing at factory)**

- Temperature rise test – To be performed on one unit during acceptance testing.

Note: Lightning Impulse Withstand Test is required and is already listed under 5.3.1 Routine Tests as per IEC 60076.

5.3.3 **Additional tests (to be done during acceptance testing at factory)**

- Visual Inspection (verification of auxiliaries, fittings & accessories, markings & nameplates, paintwork, workmanship and finish)
- Measurement of power taken by the fans
- Insulation dissipation factor
- Condenser bushing capacitance and tan delta
- DGA (dissolved gas analysis) of the insulating oil.- To be performed before and after temperature rise test
- Acoustic and sound level
- Insulation tests on the auxiliary wiring in the marshalling boxes
- Measurement of zero sequence impedance
- Measurement of harmonics no-load current
- CT ratio and polarity

- Measurement of zero phase sequence impedance
- Paint thickness
- Tank pressure test

5.1 Testing Facility

5.1.1 The bidder shall provide current e-mail address, fax and telephone numbers and contact person at the Testing Authority where Type Tests and Special Tests to IEC 60076 were carried out.

5.1.2 All test and measuring equipment to be used during acceptance testing shall have been calibrated and copies of valid calibration certificates shall be provided to REREC Engineers. A detailed list of workshop tools, test/measuring equipment and list of tests to IEC 60076 that can be carried out by the manufacturer shall be submitted with the tender for evaluation.

5.2 Test reports for each transformer (including its individual components) shall be submitted to REREC for approval before shipment.

5.3 On receipt of the transformer, REREC will inspect it and may perform or have performed any of the relevant tests in order to verify compliance with the specification. The manufacturer shall replace/rectify without charge to REREC, equipment which upon examination, test or use fail to meet any or all of the requirements in the specification.

6.0 MARKING, LABELLING AND PACKING

6.1 The transformer and associated components shall be packed in a manner as to protect it from any damage in transportation and handling. It shall be dispatched oil-filled and fully wired. All piping shall follow the contour of the transformer as closely as possible to avoid damage during transportation and handling. Auxilliary equipment and accessories/fittings shall be protected against mechanical damage and oil vandalism.

6.2 Each assembly and package of items associated with the transformer shall be suitably marked for ease of identification.

6.3 In addition to markings and labels required elsewhere in the tender & specification, each equipment and component shall be marked in accordance with the relevant IEC standard. Each transformer shall be provided with a rating plate of weatherproof material, fitted in a visible position, showing the appropriate details listed in IEC 60076. The entries on the plate shall be indelibly marked (either by etching, engraving or stamping).

6.4 In addition, the name plate shall include load and no load losses for the highest, lowest and principle tap positions, temperature class of insulation, connection diagram and the inscription 'PROPERTY OF THE RURAL ELECTRIFICATION AND RENEWABLE ENERGY CORPORATION.' all marked indelibly as in 6.4.

Annex A

SCHEDULE OF GUARANTEED TECHNICAL PARTICULARS FOR TRANSFORMER OFFERED

No.	**Requirements**	**REREC requirements**	**BIDDER'S OFFER**
1.	Name of the manufacturer and country of manufacture		
2.	Applicable standards (design & test)	As Provided in Clause 2.	
3.	Service (indoor/outdoor), altitude, temperature range, humidity and environment (pollution severity level)	As provided in clause 4.1.1	
4	Rating		
	a) 1. With ONAN cooling, MVA	35 MVA	
	2. With ONAF cooling, MVA	45 MVA	
	b) Rated no load voltage		
	HV-kV	220 kV	
	LV-kV	66 kV	
5.	Temperature rise of top oil (deg.C)	55	
6.	Temperature rise of winding measured by resistance.	60	
	i) With ONAN cooling (deg. C)		
	ii) With ONAF cooling (deg. C)		
	iii) Period of operation of transformer at full load without calculated winding hot spot temperature exceeding 140°C and with a. 50% coolers off b. 100% coolers off		
7.	Rated frequency (Hz)	50	
8.	No. of windings	3	
9.	Number of phases	3	
10.	Connection symbol & vector group	YNyn0d1	
11.	Tappings:		
	i) Type of tap changer (must be of a Type & make approved by REREC)	MR OLTC	
	ii) Tap step (percent)	1.67	
	iii) Total tap ranges - (+) percent to (-) percent	13.36	
	iv) Tappings provided at (HV-N required)	17	

12.	Magnetization data at no load, at 90% rating, at 100% rating and at 110% rated voltage and load and frequency		
	i) Current in Amps		
	ii) Power factor		
	iii) Total no load losses in KW (core loss + dielectric loss)	35	
13.	Total load losses (copper loss + stray loss) at rated current at 75^0 C in KW		
	i) For ONAN Rating		
	ii) For ONAF Rating (including auxiliary losses)	150	
	iii) Auxiliary Losses		
14.	% impedance voltage at rated current and frequency at 75^0 C.		
	i) Positive sequence at normal tap in %	12	
	ii) Positive sequence at Max. Voltage tap in %		
	iii) Positive sequence at Min. voltage tap in %		
	iv) Minimum short-circuit apparent power		
	v) symmetrical short circuit current		
15.	Reactance per phase at rated frequency at normal tap on rated MVA base: - HV to LV - %		
16.	Resistance at 75^0 C of:		
	HV Winding in ohms (at principle & extreme taps)		
	LV Winding in ohms		
17.	Efficiency at 75^0 C taking in to account input of cooling plant loss: At Unity Power Factor and at 0.8 Power Factor Lagging:		
	i) At 125% full load		
	ii) At 100% full load		
	iii) At 75% full load		
	iv) At 50% full load		
18.	Regulation at full load & at 75^0 C		
	i) At unity p.f. in %		
	ii) At 0.8 p.f. (lag) in %		
19.	a) Short time thermal rating of HV winding in kA and duration in seconds		
	b) Short time Thermal rating of LV winding in kA & duration in seconds		
20.	a) Overload capacity for 2 hours after continuous full load run (indicate clause of standard)		
	b) Thermal time constant in hours		

21.	a) Insulation Levels (of offered transformer & test voltages at factory):		
	i) Lightning impulse kV (peak)		
	ii) Power frequency voltage withstand kV (rms)		
	ii) Altitude of factory		
	b) Voltage to earth for which star point will be insulated		
	i) Impulse kV (Peak)		
	ii) Power frequency (kV)		
22.	Noise level when energized at normal voltage and normal frequency at no load.		
23.	Approximate weights		
	i) Core (kg)		
	ii) Windings (kg) (Copper + Insulation) (separately)		
	iii) Tank & Fittings (kg)		
	iv) Oil (kg)		
	v) Total weight (kg)		
24.	Details of oil and quantity in liters		
25.	Net core area in sq. meters		
26.	Type of transformer (stacked core type required)		
27.	Material of Laminations		
	i. Grade of CRGO		
	ii. Thickness of lamination		
	iii. Stack-factor		
	iv. Specific weight/m^3		
	v. Specific loss watts/kg.		
28.	Maximum flux density at rated voltage and frequency in Tesla/lines/cm^2		
29.	Conductor area in sq. cm. and current density in Amps/Sq. cm.		
	HV		
	LV		
	Regulation winding.		
30.	Type of windings		
	HV		
	LV		
31.	Winding insulation type and class, graded or ungraded		
	HV		
	LV		
32.	a) Insulating material		
	i) Turn insulation		
	ii) HV side		
	iii) LV side		

	b) Between HV and LV as applicable.				
	c) For core bolts, washers and end plates				
	d) Tapping connection				
33.	i) Type of axial support:- HV winding LV winding				
	ii) Type of Radial Coil support :- HV winding LV winding				
34.	Clearances in air	Phase to phase	HV - HV		
			HV - LV		
			LV - LV		
		Phase to earth	HV - E		
			LV - E		
35.	Details of Tank				
	i) Material for tank				
	ii) Type of the tank				
	iii) Thickness of sides in mm				
	iv) Thickness of Bottom in mm				
	v) Thickness of Cover in mm				
	vi) Thickness of Radiators in mm				
36.	Shipping details – List parts normally detached for transport and indicate protection against mechanical damage and oil vandals for entire transformer				
37.	Details of Bushings (indicate details for each) HV LV NEUTRAL				
	i) Type				
	ii) One minute dry withstand power frequency voltage kV (rms)				
	iii) One minute wet withstand power frequency voltage kV (rms)				
	iv) 1.2/50µs lightning impulse voltage, dry (kVp)				
	v) Total creepage distance in Air (mm)				
	vi) Weight of bushings (kg)				
	vii) Phase to earth clearance in air of live parts at the top of bushings.				
	viii) Maximum current rating of each bushing				
	ix) Quantity of oil in the bushings in liters				
38.	On load tap changer (OLTC)				

	i) Manufacturer and Type & Model No. (must be of a Type & make approved by REREC)	MR OLTC	
	ii) Rating		
	iii) Rated voltage kV		
	iv) Rated current Amps		
	v) Step voltage kV		
	vi) No. of steps No.		
	vii) Approximate over all dimensions (Width x Breadth x Depth) in mm		
	viii) Approximate overall weight in kg.		
	ix) Time to complete one tap change step in seconds		
	x) List technical documents including type test certificates and type test reports, manufacturing experience, sales records, installation instructions and manuals and manufacturer's authorization submitted for the OLTC offered.		
	xi) Automatic Voltage Regulating Relay (to be of REREC approved design & make and technical details submitted with tender)		
39.	Cooling System:		
	i) Grade of oil ii) Quantity of oil in Transformer in litres		
	iii) Weight of oil in Transformer in litres		
	iv) Type and make of material used for radiators.		
	v) Total radiating surface in m^2		
	vii) No. of tubes/fins & copulate dimensions thereof.		
	viii) Total weight of Radiators in kg.		
40.	Cooling Equipment : Fan motor		
	i) Make and Type (Details)		
	ii) Number connected --- (No.)		
	iii) Nos. in standby --- (No.)		
	iv) Rated power --- (kW)		
	v) Rated Voltage		
	vi) Temp. at which control is adjustable		
	vii) Capacity in Litres/Minute		
41.	Overall dimensions of transformer including cooling gear, tap changing gear etc.		
	a) Length mm		

	b) Breadth mm		
	c) Height mm		
	d) Reference drawing No.		
42.	Type and size of oil temperature indicator.		
43.	Type of oil level indicator.		
44.	Type and size of Gas operated relay.		
45.	Type & size of winding temperature indicators.		
46.	Ratio and Type of CT used for winding temperature indicator		
47.	Capacity of conservator vessel (Litres)		
48.	Type of oil preservative installed		
49.	Valve sizes and Numbers required/fitted		
	i) drain valves -mm- No.		
	ii) filter valves -mm- No.		
	iii) sampling valves -mm- No.		
50.	Size of Rail gauge for installation in yard		
	a) Longer axis		
	b) Shorter axis		
51.	a) Type and make of pressure relief device		
	b) Minimum pressure at which the device operates (kPa)		
52.	Make & size of silica-gel breaker.		
53.	Manufacturer's Guarantee and Warranty		
54.	List catalogues, brochures, technical data, drawings submitted to support the offer.		
55.	Detailed list & contact addresses of the manufacturer's previous customers outside the country of manufacture for exact or similar rating of transformers sold in the last five years submitted to support the offer.		
56.	List Type Test Certificates and Type Test Reports submitted with tender (indicate test report numbers, date, Independent Testing Institution and contact addresses) a) Dielectric tests to IEC 60076 (Lightning Impulse and Power Frequency Withstand Tests). b) Short circuit withstand test to IEC 60076. ▪ thermal ability of the transformer to withstand short circuit, ▪ ability of the transformer to withstand the dynamic effects of short circuit. c) Temperature rise test to IEC 60076. *Note: Temperature rise test to IEC 60076 if conducted at the manufacturer's premises (factory) MUST be in the presence of representatives of ISO/IEC 17025 accredited and independent testing laboratory; who shall sign the certificates and test reports.*		

57.	Testing facility (of the manufacturer)	Detailed list of manufacturer's workshop tools, test and measuring equipment		
		List of tests to IEC 60076 that can be carried out by the manufacturer		
		List Acceptance Tests to be witnessed by REREC Engineers at the factory		
58.	List test reports (for transformer and components) to be submitted to REREC for approval before shipment			
59.	Copy of ISO 9001:2008 Certificate submitted			
60.	Quality Assurance Plan			
61.	Manufacturer's Declaration of Conformity to Standards (including IEC 60076)			
62.	Deviations from tender specifications and supporting data, test reports, technical documents etc.			
63.	Inspection of the transformer and components at REREC stores/site.			
64.	List and details of current transformers to be fitted			
65.	Auxiliaries, fittings and accessories to be fitted.			
66.	Manufacturing capacity (number of similar units produced per month) and manufacturer's experience			

……

Manufacturer's Name, Signature, Stamp and Date