KETRACO
Kenya Electricity Transmission Company Limited
"Stable Power Grid - Mfumo Thabiti wa Umeme"

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Our Ref: KETRACO-PT-007-2025-2026

15th April 2026

Notice to all Bidders,

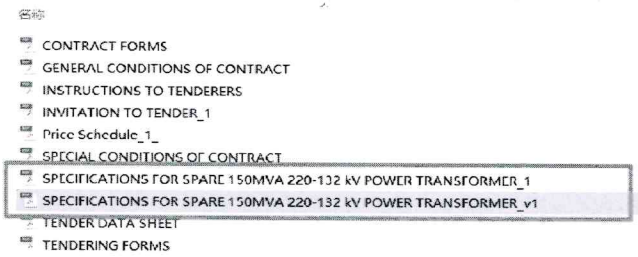
TENDER ADDENDUM AND CLARIFICATION 1

RE: TENDER FOR SUPPLY OF ONE (1) 150MVA, 220/132/33KV POWER TRANSFORMER WITH ONLOAD TAP CHANGER (OLTC), TENDER NO. KETRACO/PT/007/2025-26

The following amendments are made to the specified provisions of the **TENDER FOR SUPPLY OF ONE (1) 150MVA, 220/132/33KV POWER TRANSFORMER (TENDER NUMBER KETRACO/PT/007/2025-26)**. Save where expressly amended by the terms of this addendum, the Principal Tender Document shall continue to be in full force and effect.
Find herein the ADDENDUM, consisting of seven (7) pages into the Principal Tender Documents.

Tender Addendum and clarification NO 1

No.	Clause	Clarification	KETRACO Response
1.	150 MVA, 220/132/33 kV Power Transformer TDS	<table><tr><th>S. N.</th><th colspan="4">220/132 kV POWER TRANSFORMER</th></tr><tr><th></th><th>Specifications</th><th>UNIT</th><th colspan="2">DATA</th></tr><tr><th></th><th></th><th></th><th>Required</th><th>Offered</th></tr><tr><td>16.</td><td>Rated voltage of windings (Ur)</td><td></td><td></td><td></td></tr><tr><td></td><td>HV winding</td><td>kV</td><td>220/√3</td><td></td></tr><tr><td></td><td>LV winding</td><td>kV</td><td>132/√3</td><td></td></tr><tr><td></td><td>TV winding</td><td>kV</td><td>33</td><td></td></tr></table> In the Parameter Table, the HV and LV winding voltages are listed as 220/√3 & 132/√3kV. Please clarify whether this transformer is a single-phase	This is a three-phase transformer. The specified values refer to phase voltages based on the vector group. Refer to the updated Technical Data Sheet.

		transformer. If it is a three-phase transformer, the voltages should be 220 kV and 132 kV.Please clarify.	
2.	150 MVA, 220/132/33 kV Power Transformer TDS	2.Transformer bushing CT ratio is incorrect. Please revise according to the actual current values of each voltage level. 3. Section 5.3.9 of the bidding documents stipulates that "Two-stage cooling (ONAN/ONAF/OFAF or ONAN/ONAF1/ONAF2) shall be used for transformers rated 100MVA" whereas the parameter table specifies ONAN/ONAF. This is inconsistent with the technical requirements; Please clarify.	2. The specified bushing CT ratios are adequate. Bidders shall comply with the provided specification. 3. Clause 5.3.9 of the Technical Specification shall take precedence. The required cooling type shall be ONAN/ONAF1/ONAF2. Items 12, 23, 24, 25 and 29 in the Technical Data Sheet have been updated to reflect this requirement.
3.	150 MVA, 220/132/33 kV Power Transformer TDS	There's two technical specifications in tender documents, please confirm which one to take as the standard. 	Check the updated Technical Specification
4.	150 MVA, 220/132/33 kV Power Transformer TDS	The tender document requires the short-time withstand current of the switchgear to be 31.5kA/1s. This requirement is relatively stringent and cannot be met by conventional MR tap changers. Could we waive this requirement?	Refer to line item 38 in the updated Technical Data Sheet of the Technical Specification.

5.		The tender document stipulates that the transformer shall be subject to vibration testing if required by KETRACO. This test is not included in the standard scope. May we exclude this requirement?	This condition remains valid. Bidders shall comply with this specification.
6.		The tender document requires that the conservator tank, radiators, fan guards, piping, control box / cabinet, and junction cabinet shall be hot-dip galvanized and painted. Our bid only covers hot-dip galvanizing for the radiators. Is this acceptable?	This is not acceptable. Bidders shall comply with this specification.
7.		The tender document specifies an average ambient temperature of 30°C. Does this refer to the annual average ambient temperature?	Bidders shall comply with the atmospheric conditions specified under clause 5.1 of the Technical Specifications
8.		Regarding the requirement of 31.5kA/1s for the tap changer, a three-phase tap changer cannot meet this requirement. Only single-phase tap changers with rated current above 1800A can satisfy it. For this project, one three-phase 500A tap changer is actually sufficient. To meet the specified short-time current, three single-phase 1800A tap changers would be required, resulting in a very significant price difference. We propose waiving the requirement of 31.5kA/1s for the tap changer.	Refer to line item 38 in the updated Technical Data Sheet of the Technical Specification.
9.		Payment Terms (GCC Clause 16.1)	Refer to the payment terms specified in the Special Conditions of Contract, clause GCC 16.1.

		As per GCC 16.1, the payment terms are not explicitly defined in the tender document. We request you to kindly provide the detailed payment terms applicable for this contract.	
10.		Power of Attorney (ITT Clause 19.3) ITT Clause 19.3 specifies submission of a Power of Attorney; however, no prescribed format has been provided. Kindly confirm whether a standard format is to be followed or if we may submit the same in our company's standard format.	It may be submitted in the Company's standard format, provided that it is duly executed and bears the official stamp and signature of a qualified Advocate that is a Commissioner for Oaths.
11.		Local Services Requirement (ITT Clause 13.8(b)) For goods manufactured outside Kenya, ITT Clause 13.8(b) refers to "other local services." We request you to kindly elaborate on the scope of such local services expected under this tender.	The other local services are clearly defined under Clause 6.9 of the Technical Specifications.
12.		Country of Origin Declaration We understand that a Country-of-Origin declaration is required; however, the corresponding format is not available in the tender document. Kindly provide the prescribed format or confirm if a self-declaration on bidder's letterhead will be acceptable.	A self-declaration on bidder's letterhead is acceptable.
13.		Currency of Tender Security Kindly confirm the acceptable currency for submission of the Tender Security (KES / USD /	The currency of the Tender security is clearly specified under Clause ITT 18.1 of the Tender Data Sheet.

		any other currency), especially for overseas bidders.	
14.		Completion Schedule for Overseas Bidders We request you to kindly specify the expected completion/delivery schedule applicable for overseas bidders, including key milestones (manufacturing, inspection, shipment, and delivery).	Bidders are required to specify the delivery period under the List of Goods and delivery Schedule clause of the Price Schedule.
15.		Liquidated Damages (GCC Clause 27.1) As per GCC 27.1, Liquidated Damages (LD) are specified as 0.1% per week, whereas the maximum LD is also mentioned as 0.1%. This appears inconsistent, as the maximum LD would be reached within the first week itself. Kindly clarify whether this is intentional or if the maximum LD should be higher (e.g., 5% or 10%).	It should read, 0.1% per week, subject to a maximum of 10% of the Contract Price
16.		Project Funding Kindly confirm the source of funding for this project (e.g., internal funding / external financing agency), and whether any specific conditions related to funding are applicable to the contract.	The project shall be funded internally
17.		On-load tap changer (OLTC) The specification indicates a requirement for MR (Germany). Kindly confirm whether equivalent alternatives are acceptable.	As specified in Lines 34 and 35 of the Technical Data Sheet, the manufacturer of the On-load tap changer (OLTC) shall be Maschinenfabrik Rheinhausen (MR), Germany. Alternatives are NOT ACCEPTABLE.

18.		Losses and capitalization Please confirm if target values or maximum acceptable limits for no-load and load losses are defined for evaluation purposes.	Bidders shall specify respective guaranteed no-load and load losses. These values will be used for capitalization and adjustment of the bid price for tender evaluation purposes
19.		Cooling configuration Please confirm if any specific preference exists between ONAN/ONAF and alternative cooling arrangements.	As per clause 5.3.9 of the Technical Specifications and line 12 of the Technical Data Sheet, the required cooling type shall be ONAN/ONAF1/ONAF2. Bidders shall comply with this requirement.
20		REQUEST FOR EXTENSION OF CLOSING DATES We respectfully request that KETRACO consider extending the closing dates for both tenders by a minimum of fourteen (14) days from the current closing date of 30th April 2026.	The tender closing date has been extended by two weeks. The new deadline is **14th May 2026** at **10:30 a.m.**
21.		CLARIFICATION ON ELIGIBILITY CATEGORY We further seek clarification on whether each of the above tenders is open to all eligible bidders (Open Category) or is reserved exclusively for enterprises registered under the Access to Government Procurement Opportunities (AGPO) framework — specifically enterprises owned by Youth, Women, or Persons with Disabilities.	The invitation to tender is open to all eligible and qualified bidders who meet the requirements set out in the tender documents. This procurement is not subject to any reservations, and participation is not limited to any specific group or category, including special groups under the AGPO framework.

The following clarifications are made to **TENDER FOR SUPPLY OF ONE (1) 150MVA, 220/132/33KV POWER TRANSFORMER WITH ONLOAD TAP CHANGER (OLTC), TENDER NO. KETRACO/PT/007/2025-26.**

Unless expressly amended by the terms of this addendum, all other terms and conditions of the tender remain the same.

USER REPRESENTATIVE: SYSTEM OPERATION AND POWER MANAGEMENT

NAME: ENG. EDWIN ORONDO

SIGNATURE: .....

APPROVED BY: SENIOR MANAGER, SUPPLY CHAIN

NAME: JANE VULIGWA

SIGNATURE.....

KETRACO
Kenya Electricity Transmission Company Limited
"Building a World Class National Grid"

SPECIFICATIONS FOR POWER TRANSFORMERS

Table of Contents

1. FOREWORD

1.1 This specification has been prepared by System Operation and Power Management Directorate of the **Kenya Electricity Transmission Company LTD (KETRACO)** and it lays down requirements for Power Transformers.

1.2 This specification is based on the standards stipulated in Clause 3 and is subject to revision as and when required.

1.3 It shall be the manufacturer's responsibility to be knowledgeable of these standards.

2. SCOPE

This specification is intended for procurement of equipment from the manufacturer. The scope of works shall comprise the design, manufacture, factory testing, packing, transport, insurance and offloading at site.

3. REFERENCE STANDARDS

Unless otherwise stated in this Specification, the delivery shall fulfil all requirements of all the relevant IEC standards. The power transformers shall be designed and tested in accordance with the requirements of IEC and any additional requirements of this Specification. The latest revision of the standards will be applicable as they are valid on the date of tendering.

The component shall at least comply with following standards:

- IEC 60076-1 - Power transformers - General.
- IEC 60076-2 - Power transformers - Temperature rise.
- IEC 60076-3 - Power transformers - Insulation levels, dielectric tests and external clearances in air.
- IEC 60076-5 - Power transformers - Ability to withstand short circuit.
- IEC 60076-7 - Loading guide for oil-immersed power transformers

- IEC 60076-8 - Power transformers – Application guide (For calculation format)
- IEC 60076-10 - Power transformers - Determination of sound levels.
- IEC 60137 - Insulated bushings for alternating voltages above 1000V.
- IEC 60214 - On-load tap-changers.
- IEC 60529 - Degrees of protection provided by enclosures
- NEMA TR1 - Transformers, regulators and reactors [for audible sound levels]
- Current transformers shall comply with the requirements of IEC 60044/IEC 61869.

4. TERMS AND DEFINITIONS

For this specification the definitions given in the reference standards in clause 3 shall apply.

5. REQUIREMENTS

5.1 SERVICE CONDITIONS

The Power Transformers shall be suitable for outdoor operation in tropical atmospheric areas with the following conditions:

- Altitude of up to 2200 m above sea level
- Humidity of up to 90%
- Average ambient temperature of +30°C with a minimum of -1°C and a maximum of +40°C
- Heavy saline conditions

5.2 GENERAL SPECIFICATIONS

Transformers shall be outdoor, oil-immersed, three-phase type, generally with on-load tap-changer. They shall comply with the requirements of the schedules and standards listed in Clause 3 and other relevant IEC standards. Any ambiguity shall be referred to KETRACO for clarification at the time of tendering.

The transformers shall be suitable for continuous operation on a three-phase 50 Hz high voltage transmission system as specified in the Technical Data sheet.

Transformers and associated equipment shall be designed in such a manner as to meet the requirements in the Technical Data Sheet in ambient site conditions. Therefore, the temperature-rise limits given in IEC 60076-2 and IEC 60354 (i.e., hotspot) shall not be exceeded.

Note: the annual average temperature needs to be considered with the necessary correction to the IEC 60076-2 allowable temperature rises to ensure meeting the life criteria of the transformers.

Transformers shall meet the latest stage of development reached in design, construction, and materials.

The transformers and all associated facilities (e.g., tap-changer) shall have the ability to withstand the effects of short-circuit currents, defined as symmetrical short circuit current in the Technical Data Sheet, when operating on any tapping position according to requirements of IEC 60076-5.

All metal parts of the transformer except for the individual core laminations, core bolts and associated individual side plates shall be maintained at the same fixed potential. The earthing structure shall be designed to carry, without damage, the maximum possible earth fault current for a duration of at least equal to the short circuit withstand period of the main windings.

The design and manufacture of the transformers and auxiliary plant shall be such that the noise level is at a minimum and that the level of vibration does not adversely affect any clamping or produce excessive stress in any material.

Noise level (Sound Pressure) limits are based on NEMA TR1 which are generally assessed as high for modern construction, consequently the limit for this specification has been reduced by 5 dB(A). Where noise measurements are specified, they shall be made at the Manufacturer's works in the presence of KETRACO or their appointed representative.

If required by KETRACO, the transformers shall be subject to vibration tests.

The transformers shall be designed with particular attention to the suppression of harmonic currents, especially the third and fifth, to minimize interference with communications circuits.

The transformers shall be designed to ensure that leakage flux does not cause overheating in any part of the transformer.

5.3 DETAILED SPECIFICATIONS

5.3.1 Magnetic circuit

The core shall be built up of high-grade, non-ageing, low-loss, high-permeability grain-oriented steel sheets. Both sides of each steel sheet shall be insulated with a durable, hot oil and heat resistant baked

enamel varnish or other chemical treatment. The cores shall be clamped and braced to withstand, without damage or deformation, the forces caused by short-circuit stresses, transportation, or handling, and to prevent the shifting of the core laminations. The bolts, nuts, and end plates of the assembly and clamp structure shall be of nonmagnetic type and shall be effectively insulated and locked so that they ensure an even pressure on the whole core assembly and are not loosened by vibrations caused by transport and operation. The supporting framework of the cores shall be designed to avoid the presence of pockets which could prevent complete draining of the tank or cause the trapping of air when filling during service.

Suitable axial cooling ducts shall be provided to ensure free circulation of oil and efficient cooling of the core. The ducts shall be so dimensioned that the maximum temperature at any point remains within the admissible limits.

Care shall be given to the design and construction of the corner joints between columns and yokes to avoid concentration of mechanical and magnetic stresses.

Adequate metallic bridges shall be provided between the core lamination packets to keep all portions of the core assembly at the same potential.

Lifting eyes or lugs shall be provided at suitable points of the core assembly.

The core shall be earthed to the clamping structure at one point only through a removable link with a captive bolt and nut, placed for convenient access adjacent to an inspection housing on the tank cover or tank wall. All earthing connections except for those from individual core clamping rings, shall have a cross sectional area of not less than 80 mm^2. Connections inserted between laminations shall have a cross sectional area of not less than 20mm^2.

The core shall be free from over fluxing liable to cause damage or to cause maloperation of the protection equipment when the transformer is operating under the continuous overvoltage condition specified in the Technical Data Sheet. Under this steady overvoltage condition, the maximum flux density must not exceed 1.9 Tesla and the magnetizing current must not exceed 5 per cent of the rated load current at normal rated voltage.

5.3.2 Windings

The windings shall be of high conductivity electrolytic copper. High purity cellulosic Kraft Paper shall be used for the principal conductor insulation.

The conductors shall be transposed at sufficient intervals to minimize eddy currents and equalize the current and temperature distribution along the winding. Coils shall be constructed to avoid abrasion

of the insulation, (e.g., on transposed conductors), allowing for the expansion and contraction set up by the changes of temperature or the vibration encountered during normal operation.

Windings shall be so designed as to obtain an optimal value for series and shunt capacities to ensure a favorable distribution of the voltage for full impulse waves and chopped impulse waves.

Leads from winding to bushings shall be adequately supported to prevent damage from vibration and short-circuit forces.

Permanent current-carrying joints or splices shall be welded or brazed, properly formed, finished, and insulated to avoid concentration of dielectric stresses.

The windings shall be subjected to a thorough shrinking and stabilizing process. Compensation devices shall be provided for possible further shrinkage of the coils in service.

The coils, windings and leads shall be sufficiently braced and fastened to form rigid assemblies, preventing any relative movement due to transport, vibrations or other circumstances that may occur in service.

The windings shall be designed to reduce to a minimum the out-of-balance forces inherent in the transformers. Tappings shall be arranged at such positions on the windings as will preserve, as far as possible, electro-magnetic balance at all voltage ratios.

Tappings shall not be brought out from the inside of a coil, nor from intermediate turns.

The winding shall be capable of withstanding the forces to which it is subjected under all conditions, particularly the forces due to a short circuit between terminals or between any terminal and earth, with full voltage maintained on all other windings intended for connection to external sources of supply and allowing for any feedback through windings connected to rotating machines.

The assembled core and windings shall be vacuum and/or vapour-phased processed to ensure optimum moisture removal.

5.3.3 Tertiary Windings

Tertiary windings may be specified either as an auxiliary third winding or as a stabilising winding. When specified as a third winding the general terms for primary and secondary windings applies (as above), appropriate to the assigned tertiary voltage and MVA rating.

The tertiary windings of star/star connected transformers are, unless otherwise specified, stabilising windings for control of zero sequence current and for harmonic suppression.

5.3.4 Neutral Earthing

According to the general effective earthing policy of KETRACO, 400 kV, 220kV, 132kV and 66 kV systems, neutral points of transformers shall be directly connected to earth.

Neutral terminals of 33kV LV side of all transformers shall be designed for the full line-side insulation level.

5.3.5 Tank

The transformer tank shall be of welded construction with bolted cover, fabricated from steel plate of a suitable strength grade to meet the following requirements.

The tank shall be of adequate strength so that, when containing the core plus coil assembly and fully oil filled, any packing, lifting, rolling, and handling shall not cause overstressing of any part of the tank or leakage. The main tank body, tap changing compartments, radiators and associated piping facilities shall be capable of withstanding full vacuum when empty of oil.

Each tank shall be provided with a minimum of four jacking pads conveniently located to allow the raising or lowering of the completely mounted and oil filled transformer. The load carrying capacity of each jacking pad shall not be less than 50% of the total weight of the transformer. Lifting eyes or lugs for lifting the complete transformer and tank cover and facilities for the pulling and pushing of the transformer in any direction shall be provided for each unit. Tank stiffeners and mounting brackets shall be continuously welded to the tank.

Wherever possible, the transformer tank and its accessories shall be designed without pockets wherein gas may collect. Where pockets cannot be avoided, pipes shall be provided to vent the gas into the main expansion pipe. The vent pipes shall have a minimum inside diameter of 20 mm and, if necessary, shall be protected against mechanical damage.

The shape and arrangement of the tank cover and external stiffeners shall permit rainwater and desert sand to flow easily and completely to the ground.

All oil-tight joints shall be made with machined flanges and approved types of gaskets.

The gaskets shall be tight under all prevailing service and atmospheric conditions; especially against the hot oil (synthetic rubber or neoprene-bonded cork is not permitted). Means should be provided to prevent over-compression of the gaskets. The tanks shall be provided with bolted type manholes for easy inspection of bushings and windings.

The tank cover shall be fitted with thermometer pockets, for oil and winding temperature indicators, with a captive screw cap and be in the position of maximum oil temperature at continuous maximum rating.

A pressure relief device of self-re-setting type and sufficient size capable of functioning without electrical power, shall be provided for the rapid release of any pressure that may be generated within

the tank and which might result in damage to the equipment, but it shall be capable of maintaining the oil tightness of the transformer under all conditions of normal service. The device shall operate at a static pressure of less than the hydraulic test pressure for transformer tanks and shall be designed to prevent further oil flow from the transformer during its operation.

The relief device shall be mounted on the main tank and if mounted on the cover it shall be fitted with a skirt projecting inside the tank to prevent an accumulation of gas within the device. Two sets of contacts shall be provided to initiate the alarm and trip relays.

Terminals shall be provided close to each corner at the base of the tank for earthing purposes and each shall be designed to meet system fault levels.

The following plates shall be fixed to the tank at an approximate height of 1.75 m above the ground level: -

- A rating plate bearing the data specified in IEC 60076.
- A diagram plate on which the transformer tapping voltages in kilovolts shall also be indicated for each tap, together with the transformer impedances at minimum and maximum voltage ratios and for the principal tapping.
- A property plate of approved design and wording.
- A title plate.
- A valve location plate showing the location and function of all valves, drain and air release plugs and oil sampling devices.

5.3.6 Valves

Valves shall be of the fully sealing full-way type and shall be opened by turning counter-clockwise when facing the handwheel. They shall be suitable for operation between the minimum ambient and the maximum oil temperatures stated in the Technical Data Sheet. All valves shall be lockable with appropriate sub-master series padlocks. Padlocks shall be provided for locking all valves in the "open" and "closed" positions. Valves other than filter and drain valves shall be provided with an indicator, readily visible from ground level, to clearly show the position of the valve.

All valve handwheels shall be fitted with nameplates that shall be chromium plated brass not less than 3 mm thick with the engraving filed with enamel. All valves shall be fitted with spoked handwheels, the spokes and rims of which shall be smooth and where necessary, for appearance, shall be chromium plated.

Each transformer tank shall be fitted at least with the following:

- One 50mm valve at the top and one 50mm valve at the bottom of the tank, mounted diagonally opposite each other, for connection to oil circulating and oil filtering equipment. The lower valve shall also function as a drain valve, for which a suitable combine arrangement shall be made.
- Oil sampling valves at the top and bottom of the main tank.

All parts containing oil, and liable to trap air during filling, shall be fitted with a flanged type of air release plug at their highest point.

Valves shall be provided on both sides of the gas and oil actuated relays.

All valves opening to atmosphere shall be fitted with blanking plates.

5.3.7 Conservator

Transformers rated at 10MVA and above shall be fitted with an oil conservator. Sealed construction or corrugated tanks may be offered for lower ratings.

The conservator shall be made of welded steel. It shall be designed to withstand full vacuum. The conservator shall be of sufficient volume to enable expansion and contraction of oil within the highest and lowest oil levels in the conservator.

The conservator vessel shall be mounted at the highest point of the oil system and shall be connected to the highest point of the tank through a straight sloping pipe. Adequate isolating valves shall permit the removal of the main and tap-changer Buchholz relays while the conservator is still connected to the tank by a pipe bypassing the relays.

For the power transformers, the conservator vessel shall contain two compartments, one for oil in the main tank and the other for the oil associated with the current making and breaking contacts of the tap changer equipment. There shall be no communication between the two compartments in respect of the oil and air spaces. Each compartment shall be provided with the fittings detailed in this clause as if it were a separate conservator vessel.

For transformers rated above 20MVA, each conservator shall include a synthetic diaphragm (or equivalent, e.g., an airbag) ensuring an airtight seal between the transformer oil and the external air. A description of the proposed system shall be submitted with Tender. Additionally, the air outlet from each conservator vessel or its compartment shall be connected to a dehumidifying breather mounted at approximately 1.4 m above the ground level.

Where silica gel type breathers are used, they shall be of adequate capacity and of the maintenance-free type. Breathers shall be fitted with oil traps and contain a minimum of 2.5 kg of silica gel.

Breather compartments and oil cup shall be made of glass. The breather and associated pipework shall be firmly fixed to the transformer tank.

As an alternative to the airbag/diaphragm method, an automatic repetitive cycle type breather may be offered. (Note: A diaphragm restricts the operation of this class of breather and consequently, the diaphragm requirement is deleted when an automatic repetitive cycle type breather is specified.)

Each conservator compartment shall be equipped with filling valve, drain valve, lifting lugs, etc. An oil level gauge complete with low-level alarm shall be fitted to each conservator. The indicated minimum oil level shall occur when the feed pipe to the main tank is covered with not less than 12mm depth of oil. The oil levels at 15^{o}C, 35^{o}C and 90^{o}C shall be marked on the gauge. The front cover of all gauges shall be made of glass.

The front cover of all gauges shall be made of glass.

5.3.8 Transformer Oil

The transformer oil shall comply with IEC 60296 and all other applicable IEC standards, unless otherwise specified in the Tender Documents. It shall be a highly refined mineral oil suitable for use as both an insulating and cooling medium in transformers. The specified oil shall be Shell Diala S4 ZX-I. Manufacturer authorization forms shall be submitted together with the bid for purposes of tender evaluation.

5.3.9 Cooling Plant

Transformers rated up to and including 10MVA shall be ONAN cooled. For ratings above 10MVA but below 100 MVA, single stage cooling system, ONAN/ONAF shall be provided.

Two-stage cooling (ONAN/ONAF/OFAF or ONAN/ONAF1/ONAF2) shall be used for transformers rated 100MVA and higher and facilities shall be provided at the marshalling kiosk or cubicle for the selection of AUTOMATIC or MANUAL control of the cooling plant motors. The transformer manufacturer shall select his preferred arrangement, based on his economic and operational assessment.

Radiators and coolers shall be hot dip galvanized before painting; their design shall be such as to allow ease of cleaning and painting when in position. Design features offering reduced maintenance requirements such as unpainted radiators (i.e., galvanized only) may be acceptable if there is no visual impact and if the manufacturer can demonstrate long-term and trouble-free experience with this finish in similar environments. If the manufacturer wishes to offer unpainted radiators for consideration, it must be stated clearly in the tender documents.

Detachable radiators and separate cooler assemblies connected to the main tank shall be provided with machined flanged inlet and outlet pipes.

A minimum of two cooler banks shall be provided for all transformers having ratings of 30MVA and above. Where forced oil cooling is employed, two 100% rated pumps shall be supplied with one as standby, to be automatically operated in the event of failure of the other.

Plugs shall be fitted at the top and bottom of each radiator for filling and draining.

The starting or stopping of the forced-oil circulation pumps shall not cause maloperation of the gas and oil actuated relays. The oil circuit of all coolers shall be provided with the following as appropriate to tank mounted or separate bank coolers: -

- A valve at each point of connection to the transformer tank.
- A valve in the main oil connection at the bottom of each cooler.
- Loose blanking plates to permit the blanking off the main oil connection to the top of each cooler.
- A 50mm oil-filtering valve at the top and bottom of each cooler, the bottom valve shall also function as a drain valve.
- A thermometer pocket fitted with a captive screwed cap on the inlet and outlet oil branches of each cooler.

The material of the tube plates and tubes shall be such that corrosion shall not take place due to galvanic action.

Where separately mounted cooling equipment is provided, a flexible piece shall be included in each oil pipe connection between the transformer and the oil coolers. Drain plugs shall be provided in order that each section of pipework can be drained independently.

A complete set of loose blanking plates to suit the blanking of radiator and cooler connections to the main transformer tank shall be supplied complete with gaskets and delivered to KETRACO stores.

All flange joints that are separated from the main transformer tank by gaskets shall be connected thereto via adequately rated copper earthing connections. Connecting bolts shall not serve the purpose of earth continuity.

Each forced oil cooler shall be provided with a fully weatherproof motor driven oil pump. The motor shall be of the submersible type. It shall be possible to remove the pump and motor from the oil circuit without having to lower the level of the oil in the transformer or coolers.

Where forced air-cooling is provided it shall be possible to remove the fan with its motor and supporting structure without disturbing or dismantling the cooler framework or pipework. The fans

shall not be mounted directly on the radiator fins or radiators itself. Fans shall be numbered and have clearly marked direction of rotation.

Stainless steel wire mesh guards shall be provided to prevent accidental contact with the fan blades. Metal guards shall also be provided over all other moving parts. The guards shall be designed so that neither the blades nor other moving parts can be touched by a Standard Test Finger to IEC 60947-1.

Control of cooling shall be provided at the marshalling kiosk or cubicle with facilities for the selection of automatic or manual control of the cooling plant motors and remote indication/alarms.

5.3.10 Cooler System Controls

Each motor or group of motors shall be provided with a three-pole electrically operated contactor and with control gear of approved design for starting and stopping manually.

Where forced cooling is used on transformers, provision shall be included under this contract for automatic starting and stopping from contacts on the winding temperature indicating devices. The control equipment shall be provided with a short time delay device to prevent the starting of more than one motor, or group of motors in the case of multiple cooling, at a time.

Where motors are operated in groups, the group protection shall be arranged so that it will operate satisfactorily in the event of a fault occurring in a single motor.

The control arrangements are to be designed to prevent the starting of motors totaling more than 15kW simultaneously automatically. Phase failure relays are to be provided in the main cooler supply circuit.

All contacts and other parts that may require periodic renewal, adjustment or inspection shall be readily accessible.

All wiring for the control gear accommodated in the marshalling kiosk together with all necessary cable boxes and terminations and all wiring between the marshalling kiosk and the motors shall be included in the contract.

Two independent sources of power shall be made available to ensure loss of cooling capacity for a single contingency is not greater than 50 per cent.

5.3.11 Voltage Control

Unless otherwise specified, transformers with an HV Um equal to 36 kV or higher shall be equipped with an on-load tap-changer (OLTC) on the high voltage winding. The on-load tap-changer shall

comply with the requirements of IEC 60214 and other relevant IEC standards if not otherwise specified in these Specifications. It shall be possible for the power to flow in both directions.

The OLTC shall be based on the Jensen principles and shall feature low-maintenance characteristics, preferably with belt-type (oil-free) transmission gear. Maschinenfabrik Rheinhausen (MR) - Germany shall provide the OLTC; units from any other manufacturers are not acceptable. Manufacturer authorization and warranty forms shall be submitted together with the bid for purposes of tender evaluation.

The diverter switch unit shall be placed in a separate gas tight compartment, which shall be, like the whole tap-changer, integrated in the transformer tank (in-tank mounting). The diverter switch shall have an oil system completely separated from other transformer's oil and shall be equipped with a conservator, pressure relief device with alarm/trip contacts and other devices stated for the main tank. A separate gas actuated relay/oil surge relay is to be provided in the connection between the on-load tap-changer tank and conservator.

Note: Diverter switches will be vacuum type interrupters.

The diverter switch compartment shall be easily accessible for inspection, and it shall be possible to remove the diverter switch without difficulties for maintenance purposes. The inspection and maintenance of the diverter switch shall be possible without lowering the oil level in the main tank. One set of each type of lifting tackle shall be supplied to facilitate removal of the tap-changer unit. Necessary attachment facilities shall be incorporated in the main tank design.

Any enclosed compartment that is not oil-filled shall be adequately ventilated and designed to prevent the ingress of vermin. All contactors, relay coils or other parts shall be suitably protected against corrosion or deterioration due to condensation.

Means shall be provided to ensure that the operating mechanism can be locked only when the switches are making full contact.

The driving motor shall be rated for 415/240 V a.c. and shall be equipped with thermal overload and overcurrent protection to be installed in the motor drive cubicle. Control voltage inside the motor drive cubicle shall be from the station control supply of 240V a.c. Limit switches shall be provided to prevent the tap-changer mechanism from overrunning. These shall be directly connected to the operating motor circuit. In addition, mechanical stops shall be fitted to prevent the mechanism overrunning under any conditions. For on-load tap-changer equipment these stops shall withstand the full torque of the driving mechanism without damage to the tap changing equipment. The

terminals of the operating motor shall be clearly and permanently inscribed with numbers corresponding to those on the leads attached thereto.

A device shall be fitted to the tap changing mechanism to indicate the number of operations completed by the equipment.

The tap-changer shall be arranged for local hand and electrical operation, remote electrical operation and for automatic control.

Equipment for local and remote electrical and local hand operation shall comply with the following conditions:

- It shall not be possible to operate the electric drive when the hand operating gear is in use.
- It shall not be possible for any two electrical control points to be in operation at the same time.
- Each step movement shall require separate initiation at the control point.
- All electrical control switches and the local operation gear shall be clearly labelled in an approved manner to indicate the direction of tap changing.
- The remote or supervisory-remote raise/lower control shall be blocked when the AVC selector is in “automatic” position.

The local control switches shall be housed in the marshalling kiosk. These switches shall be so arranged that it is necessary for the AVC selector to be in a non-automatic position and the “local/remote” selector switch, located in the transformer marshalling kiosk, to be in the “local” position before operation is possible. Under these conditions the local selector switch shall have overriding control. If the “local/remote” switch is not in “local” position, then local operation of tap-changer shall not be possible.

The equipment shall be arranged to ensure that when a step movement has been commenced it shall be completed independently of the operation of the control relays or switches or failure of auxiliary supply or any other contingency.

The control and signaling equipment shall be provided:

- To give an indication mechanically at the transformer and electrically at the remote-control point of the tapping in use. The indicator at the transformer shall show the number of tapping in use and the indicator at the remote-control point shall clearly show the actual voltage ratio in kilovolts and the tap number representing this ratio. The numbers shall range from 1 upwards. Position 1 shall refer to the maximum LV no-load voltage and the highest number position shall refer to the minimum LV no-load voltage, for the nominal HV voltage.

- To give an indication at the remote-control point that a tap change is in progress by means of an illuminated lamp and alarm buzzer. If the tap change is not completed within the specified time the buzzer shall continue to sound until switched off by hand, but the lamp shall remain illuminated until the tap change is completed.
- To give an indication at the remote-control point by means of an approved illuminated indicator and the buzzer alarm as described above when the units of a group of transformers arranged to operate in parallel are operating at different ratios.
- To read with digital circuit voltmeter based on L.C.D. displays.

5.3.12 Terminations

Unless otherwise specified the termination will be brown-glazed outdoor bushings with IEC Class IV (31mm/kV) creepage distance which shall include the diameter correction factor (kD) appropriate to the insulator diameter.

The following termination options with their appropriate codes are possible:

AIS = Transformer to Air bushing = Standard arrangement

GIB = Connection to GIS or cable via Gas Insulated Busduct

CSC = Separable cable connector with oil filled box on transformer

CSE = Cable termination in oil-filled cable-sealing end chamber

CAF = Air-filled cable box

5.3.13 Neutral and Tertiary Connections

Unless otherwise specified, Neutral terminations shall be via outdoor bushings grounded via an insulated copper connection secured to the transformer tank.

Where tertiary stabilizing winding connections are brought out, they shall be via outdoor bushings and grounded to the tank via a removable link (or links).

When tertiary bushings are required to provide an auxiliary supply or for the provision of reactive compensation, they shall retain the full project specific creepage distance of 31mm/kV.

5.3.14 Protection, measuring and Indicating devices.

The power transformers shall be equipped with a range of protection, measuring, and indicating devices supplied by the transformer manufacturer, to include:

i. Pressure Relief devices for the tap changer chamber and two for the extreme sides of the main tank

ii. Buchholz relay shall be fitted to transformer main tank, and on each compartment where oil is separated from the other oil in the transformer.

iii. The diverter switch chamber shall be equipped with an oil surge actuated relay.

They shall have:

- Alarm contacts which close when gas collects or at low oil level.
- Tripping contacts which close following an oil surge, and gas collection in the 2nd stage.

The normally open, electrically separate, alarm and tripping contacts shall not be exposed to oil.

Each relay shall be provided with a test cock to take a flexible pipe connection for checking the operation of the relay from ground level.

iv. Winding temperature indicators shall be associated with one phase only.

One indicator shall basically serve as a thermometer for winding temperature, mounted in the control cubicle. It shall be of conventional construction with a sensing bulb positioned in a separate pocket, arranged in the top oil capillary connected with a dial. A separate pointer to register the maximum temperature reached shall be incorporated in the dial. Two adjustable trip/alarm contacts shall be provided.

The second winding temperature indicator shall be preferably of electronic simulated design with adjustable contacts for cooling control, trip, and alarm and with mA output suitable for remote and supervisory remote measuring of winding temperature. It shall be connected to a resistance (platinum 100 W at 0^{o}C) inside a stainless-steel tube placed in a pocket located in the top oil capillary.

The characteristics of the winding temperature indication devices shall be forwarded to KETRACO for approval prior to the delivery of the transformers and shall also be included in the operating and maintenance instructions.

v. A dial type oil thermometer with two (alarm/trip) adjustable contacts shall be mounted in the control cubicle. It shall be of conventional construction with a sensing bulb positioned in a separate pocket arranged in the top oil capillary and connected with a dial.

An oil thermometer, connected to a resistance (platinum 100 W at 0^{o}C) inside a stainless-steel tube placed in a pocket located in the oil, suitable for remote and supervisory remote measuring.

All indicating instruments shall have hard glass front covers.

5.3.15 Control Cubicles

Each transformer shall be fitted with a control cubicle of welded galvanized sheet steel housing, mounted on the transformer tank, in a position easily accessible from the ground level. The cabinet shall contain all control and protective equipment for the cooling system, as well as the termination of all secondary circuits. The control cubicles shall be appropriately positioned at a maximum height of 1.5m for ease of operation and maintenance. It shall not require a ladder to access the control cubicle.

The internal arrangement of the cabinet shall keep the various circuits clearly separate from each other, permitting easy and safe independent maintenance and repair of each of them without disturbing the others.

Additionally, for the power transformers, tap-changer cubicle for local control shall be provided as required in previous clauses.

The cubicles shall comply with the requirements of Section 5.2. All control cubicles shall be of IP 65 degree of protection, weather, vermin, and insect-proof with sufficient ventilation and equipped with humidity controlled heating and sufficient illumination switched on and off by door contacts as well as one British-type socket outlet 240V a.c., 16 A. Separate sunshades shall be provided for each cubicle. Wherever applicable window panels shall be fitted with laminated glass only.

5.3.16 Corrosion Protection and Painting

The corrosion protection and painting shall meet requirements stated in Section 5.2.

The conservator vessel (note 1), radiators, fan grills (note 2), pipework, control boxes or cubicles, marshalling cubicles shall be hot dip galvanized and painted.

Note 1: Where these are too large to galvanize, the same corrosion protection treatment as the tank shall be used.

Note 2: Not applicable to stainless steel grills.

The proposed method for tank corrosion protection manufacturer shall submit for approval.

External surfaces shall be treated with anticorrosive and water-resistant paint and internal surfaces with oil-resistant anti-condensation paint.

In any case the manufacturer shall submit for approval the proposed painting coats with their chemical content and recommended application guide of the manufacturer. The equipment must be so designed that any features that may encourage the formation of rust are avoided.

6. TESTS AND ACCEPTANCE

6.1 General

All tests shall be performed in accordance with IEC 60076, IEC 60060, IEC 60270, and other relevant IEC Standards.

Routine and Type tests shall be performed in accordance with the requirements of IEC 60076-1, -2, -3, -4, -5 and -10 appropriate to the voltage class of the transformer under consideration. Additionally, some tests in the class identified as 'Special' in IEC 60076 are included, which may in practice be effectively a Routine or Type Test, as appropriate.

The following list of tests is generally in accordance with the requirements for large and medium classes of transformers; further data will be included in the Technical Data Sheet.

6.2 Type Tests

The following type tests shall be performed:

- Temperature Rise Test - These tests shall be carried out with the transformer at tap positions giving highest losses and with the standby cooling unit out of service.

- Lightning Impulse (LI) test (Um>72.5kV) - These tests shall be carried out in accordance with IEC Recommendations on the HV and LV line terminals and on the neutral terminals. Tap-changers shall be in the position of minimum, principal and maximum tap as each phase is tested in turn (A-B-C).

- Switching impulse (SI) tests are applicable on transformers having an HV Um ≥ 245kV. There is currently no requirement to apply this test as a Type Test at Um < 245 kV.
- Short-circuit: In-lieu evidence from demonstrably similar units and/or mechanical and thermal calculations shall be provided to demonstrate clear margins of short-circuit current withstand at system fault levels for all transformers. All tests and calculations shall be fully in accordance with IEC 60076-5.

6.3 Routine Tests

Tests which include partial discharge measurements shall be made after the principal dielectric withstand tests and after temperature rise type tests.

The following routine tests shall be performed:

- Measurement of winding resistances of all phases (phase to neutral, where applicable) and at all tap positions.
- Measurement of voltage ratio and check of voltage vector relationship
- Measurement of impedance voltage (principal tapping) short-circuit impedance and load loss.
- Measurement of no-load losses and no-load current at rated frequency and nominal voltage.
- Lightning impulse (LI) withstand test: Transformers with HV Um > 72.5 kV.
- Switching Impulse (SI) withstand test: Transformers with HV Um ≥ 245kV
- Induced-voltage test with partial discharge measurement.
- Long Duration AC (ACLD): Um ≥ 245kV

The test steps U1 (withstand level) and U2 (PD measurement level) will be at the enhanced values of 1.8 Um and 1.6 Um respectively. The test sequence and PD limits shall be as given in IEC 60076-3. The phase to ground test values for transformers with HV windings rated at 220 kV and 400 kV are given in the following table.

Table 1: Phase to Ground Test Values for Transformers with HV windings at 220kV and 400kV

HV Ur (kV)	HV Um (kV)	U1 (kV)	U2 (kV)	PD test duration (minutes)	Max PD (pC)
220	245	255	226	30	500
400	420	436	388	60	500

- Short Duration AC (ACSD): Um ≤ 170kV
- Separate source voltage test.
- Tests on on-load tap-changers.
- Measurement of insulation of core.
- Tests of auxiliary and control circuits;
- Main circuits resistance measuring;
- Protection degree check;
- Tightness test;
- Mounting diagram check;
- Performance check.
- Vacuum deflection test, IEC 60076-1 sub-clause 11.9, applicable for tank and all other oil-filled compartments (150 Pa to be applied for at least 5 hours)
- Pressure deflection test, IEC 60076-1 sub-clause 11.10, applicable for tank and all other oil filled compartments at min. 100 kPa measured on tank bottom for at least 24 hours
- Measurement of zero-sequence impedance: Routine test for all transformers with Um equal to or greater than 12 kV.

All tests shall be performed in accordance with IEC 60076 in the presence of the Employer.

6.4 Special Tests

The following 'special' category tests shall be performed only when specified in the Technical Data Sheet and may be on each unit (equivalent to a routine test) or on one unit (equivalent to a type test) as indicated:

- SFRA test
- Vacuum Test
- Dielectric tests in accordance with IEC 60076-3. In terms of the system voltages, the applicable special dielectric tests are:
    - Chopped wave lightning impulse - This test is a requirement at all system voltages on line terminals and shall be at 110% of the full wave impulse level. (Type or routine test as appropriate to transformer HV Um.)
    - Um =145 kV: The long duration AC (ACLD) is a special optional test at this voltage, in the manner of a routine test, i.e., on all transformers when specified.
    - Um =245 kV: The short duration AC (ACSD) is a special option at this voltage, in the manner of a routine test, i.e., on all transformers. (Note: In accordance with IEC 60076-3, if the ACSD is specified the requirement for a routine switching impulse test is deleted.)
    - Um > 245 kV: The ACSD test may be included as special option as an additional routine test. Measurement of zero-sequence impedance: Routine test for all transformers with Um equal to or greater than 12 kV.
- Determination of sound levels to IEC 60076-10: for all transformers with Um equal or greater than 12 kV.
- Measurement of the harmonics of the no-load current: Routine test for all transformers with Um equal to or greater than 36 kV.
- Measurement of the power by the fan motors and oil pumps (Power Transformers): Type test.
- Determination of capacitance, windings to earth and between windings: Routine test for all transformers with Um equal to or greater than 36 kV.
- Measurement of insulation resistance to earth and loss angle of insulation system capacitances: Routine test for all transformers with Um equal to or greater than 36 kV.
    -

6.5 Tests on Transformer Components

Tests during and after manufacture shall be carried out on the transformer components to verify compliance with the Specifications, good workmanship, and their capability to perform the required duties when in service.

Unless otherwise specifically mentioned these tests shall be made in accordance with the one of the applicable international standards, subject to the approval of KETRACO, or according to a method proposed by the Contractor and approved by KETRACO.

Transformer Tanks

- **Vacuum**

One transformer tank, tap changing compartment, radiator and cooler of each size shall be subjected when empty of oil to the vacuum test level specified in the Technical Data Sheet. A further test at a vacuum equivalent to 3 mbar absolute pressure for a period of 8 hours shall be made for the purpose of checking the mechanical withstand capability of the tank; during this test no damage or fractures shall occur. This test is only applicable to units of 220kV and above and may be combined with other tests or made during the processing of the unit.

- **Pressure**

When required by KETRACO one pressure relief device of each size shall be subjected to increasing oil pressure and shall operate before reaching normal pressure plus 35 kN/m2.

The operating pressure shall be recorded on the test certificate.

- **Oil Leakage**

All tanks and oil filled compartments including all forms of radiator shall be tested for oil tightness by being filled with oil of a viscosity not greater than that of IEC 60296 insulating oil at a temperature of 150^{o}C and subjected to a pressure equal to the normal pressure plus 35 kN/m2. This pressure shall be maintained for a period of not less than 24 hours, during which time no leakage shall occur.

Detachable radiators may be tested as separate units.

Fans, Motors, Pipework, Oil Sampling Devices and Valves

- **Type Tests**

Motors - Performance tests shall be in accordance with IEC 60034-1 however, certificates of type tests in accordance with IEC standard will be accepted.

Except for non-return valves, all valves and oil sampling devices which are subject to oil pressure in service or during maintenance shall withstand, when empty of oil, absolute pressure not exceeding 350 m bars. In the case of valves this test is to be applied to the body only. The type test shall subsequently be followed by a repeat oil leakage test.

- **Routine Tests**

Oil filled equipment - The bodies of all oil pumps complete with submerged motors, if any, and the oil pipework, oil sampling devices and valves shall withstand a hydraulic pressure of 140 kN/m2 for 15 minutes.

Fans - Static and dynamic balance shall be checked on all fan impellers.

Control gear - All control gear shall be subjected to the tests specified in the appropriate IEC.

Motors - Each machine shall be subjected to the following tests where applicable:

- Measurement of winding resistance (cold).
- No load test at rated voltage for determination of fixed losses.
- An overvoltage test at 1.5 times rated voltage applied with the machine running at no load, for a period of 3 minutes, to test interturn insulation.
- High voltage in accordance with IEC 60034-1.

- **Oil Sample Tests**

Samples of oil from each consignment shall be tested in accordance with IEC 60296 before dispatch.

Subject to the agreement of KETRACO, a test certificate confirming that the oil from which the consignment was drawn has been tested in accordance with IEC 60296, may be accepted.

Gas and Oil Actuated Relays

- **Routine Tests**

The following tests shall be done on relays when completely assembled. Where oil is referred to, it shall have a viscosity not greater than that of IEC 60296 insulating oil at 150^{o}C.

Oil leakage - The relay, when filled with oil shall be subjected to an internal pressure of 140 kN/m2 for 15 minutes. No leakage shall occur either from the casing or into normally oil free spaces, such as floats, within the casing.

Gas Collection - With the relay mounted as in service and at a rising angle of 5 degrees (tank to conservator) and full of oil, gas shall be introduced into the relay until the gas collection contacts

close. The oil level contacts shall not close when gas is escaping freely from the relay on the conservator side. These contacts shall, however, close when the pipework is empty of oil.

The empty relay shall be tilted, as if mounted in pipework rising from tank to conservator, at an increasing angle until the gas collection contacts open. The angle of tilt shall then be reduced, and the gas collection contacts shall close before the angle is reduced to less than 13 degrees to the horizontal.

With the relay mounted at a falling angle of 16 degrees to the horizontal and full of oil, the gas collection contacts shall be open.

Oil surge - with the relay mounted as in service and full of oil at approximately 150°C, the surge contacts shall close within the steady oil flow limits specified in the Technical Data Sheet. This operation shall not be adversely affected when the gas collection contacts have already closed, and gas is escaping freely.

Voltage - with the relay empty of oil, a voltage of 2kV shall be applied in turn between each of the electrical circuits and the casing for one minute, the remaining circuits being connected to the

Voltage Control Equipment

Type and routine tests shall be carried out in accordance with IEC 60214.

Tests on Bushings

It is not intended to test the bushings separately during the transformer factory tests.

All bushings supplied including spares, shall be supplied with full documentation in accordance with IEC 60137 and/or IEC 61639, plus additional items as follows:

- Routine test certificates. All condenser-graded bushings shall have a routine lightning impulse withstand test of five full wave negative impulses at a level not less than the transformer rating.
- Type test reports, which shall include confirmation of creepage distance and pollution tests. The lightning impulse type test shall include chopped impulses and is applicable to all condenser-graded bushings.
- Bushing temperature rises shall be based on local ambient temperatures.
- Installation and maintenance instructions

Structures

A representative sample of each type of support structure being provided shall be assembled prior to dispatch to site, and loads applied which simulate the specified design parameters.

Galvanizing

Samples selected by KETRACO of all galvanized material shall be subjected to the galvanizing tests set out in BS EN 10244-2 (Testing of Zinc Coating on Galvanized Wires) or BS EN ISO 1461 (Testing of Zinc Coating on Galvanized Articles other than Wire) whichever is applicable.

Handling Devices and Lifting Tackle

- **Mechanical Tests**

All handling devices and lifting tackle supplied for maintenance purposes under this Contract shall, unless they are built into and form part of the equipment, be tested and marked and certificates of the test provided in the manner required by the appropriate regulations.

- **Operational Tests**

Lifting tackle built into and forming part of the equipment shall be operated with the maximum working load to the IEC or BS Specifications.

Dielectric Tests on Auxiliary and Control Circuits

All secondary wiring, including panel wiring and control circuits and all apparatus connected directly thereto shall withstand a high voltage test of 2000V to earth unless otherwise specified.

6.6 FACTORY ACCEPTANCE TESTS

There shall be physical Factory Acceptance Testing (FAT) at the manufacturer's premises, as per the IEC 60076, IEC 60060, IEC 60270, and other relevant IEC Standards. The testing shall be attended by KETRACO Engineers before dispatch of the equipment. The team will also inspect the items declared in the packing list to confirm inclusion of all components, modules, and accessories. The tenderer shall inform KETRACO at least one month in advance of the FAT date and submit the test protocol for approval. Tenderers shall give separate costs for at least five (5) days of FAT at the factory for a maximum of two engineers. This shall cover the flight, accommodation and a daily 200 USD stipend for each of the client engineers for the total duration of FAT.

6.7 MANDATORY SPARES

The following listed items shall be supplied alongside the transformer unit as mandatory spares;

a) High voltage bushing (1)
b) Low voltage bushing (1)
c) Neutral bushing (1)
d) Oil temperature indicator (1)
e) Winding temperature indicator (1)
f) Fan (1)
g) Silica Gel filling (5kgs)
h) Silica gel breather (1)
i) Pressure Relief Device (2)
j) Buchholz relay (1)
k) Oil surge relay (1)
l) 2 Sets of gaskets(lot)
m) Transformer oil (4,200 l, in a tank)

6.8 PACKING, SHIPPING AND TRANSPORTATION

If the transformer is to be transported with oil it shall be filled to such a level as to cover the windings completely.

If the transformers are to be shipped without oil, the tank shall be filled with dry nitrogen gas, and automatic pressure regulating equipment shall be provided to maintain the pressure of the gas. Transformers to be transported with gas shall be filled and maintained by the Supplier at a pressure more than atmospheric pressure until the gas is replaced by oil. The gas pressure before dispatch and upon receipt on site shall be recorded. Means shall be provided for measuring the pressure in the tank.

Where oil for the first filling is to be provided it shall be supplied by the manufacturer in non-returnable tanks.

All openings for transformer components, e.g., bushings which have been removed from the transformers during transport, shall be covered by blanking-off plates. Condenser type bushings shall be shipped with self-contained oil filled tanks. Transformers shall be equipped with instruments to register “Shock” loading suffered during transit. The extracted and analyzed shock recorder report shall be submitted within three weeks of site delivery of the transformer.

All parts shall be carefully packed for transport in such a manner that they are protected against mechanical injury and the injurious effects of water and climatic conditions encountered during transit to their destination, as well as during long storage before erection.

The Supplier shall prepare and submit for the approval of KETRACO the method to be adopted for shipping and transportation.

The supplier shall ensure the transformer consignment is insured over the period during shipping, handling at the ports, transportation on land and offloading at storage site.

6.9 SITE PREPARATION AND DELIVERY

The site location for delivery of the transformer shall be at **Isinya Substation**. KETRACO shall identify the exact location and the supplier shall have the area prepared for temporary storage. The surface shall be prepared by gravelling and the transformer tank placed on treated wooden electric poles supplied by the bidder laid on the ground. The ground shall be layered with gravel covering the storage area to have the transformer tank, packaging of outdoor accessories and transformer oil. The ground shall be graveled to cover two (2) meters beyond the perimeter of the transformer tank and accessories footprint.

7. PERFORMANCE GUARANTEES AND REJECTION

The Contractor shall guarantee that the transformer comply with the performance stated in the Technical Schedules. Tolerances shall not exceed the values specified in IEC 60076 or those given in the Technical Schedules.

The loss evaluation is to be applied at the maximum ratings and at the principal tap positions.

7.1 Transformer losses capitalization.

The loss evaluation is to be applied at the maximum ratings and at the principal tap positions.

The transformer losses shall be capitalized at the following rates to facilitate evaluation and comparison of tenders:

Total load losses, ONAF2 rating (copper loss stray loss) at rated current at 75˚C in KW, including auxiliary losses	US$ 2577 per kW for 35 years
Total no load losses in KW (Core loss + Dielectric loss)	US$ 4339 per kW for 35 years

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

$$Gep = Gbp + G(\$)$$

Where;

$$Gep = Bid\ Evaluation\ Price$$

$$Gbp = Bid\ Price$$

$$G(\$) = \ Adjustment\ for\ the\ cost\ of\ the\ operation\ and\ maintenance\ for\ 35\ years(in\ USD)$$

Formula for G ($) is as below;

$$G(\$) = \text{US\$ } 2577 \times (\text{Total load losses, ONAF2 rating(copper loss} + \text{stray loss) at rated current at 75 ˚C in KW, including auxiliary losses)} + \text{ US\$ } 4339 \times (\text{Total no load losses in KW(core loss} + \text{dielectric loss))}$$

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.

7.2 Transformers Losses

7.2.1 No Load Losses

If the no load losses of a transformer exceed the guaranteed value, by more than the margins specified hereunder, a penalty as specified for each full kW in excess of the guaranteed value will be deducted from the Contract Price.

The penalty will be 9000 USD/kW. It is thereby understood that values of 0.5 kW and above will be rounded up to the next full kW.

7.2.2 On Load Losses

If the on load losses (plus auxiliary power losses) of a transformer exceed the value guaranteed, by more than the margins specified hereunder, a penalty as indicated for each full kW in excess of the guaranteed value will be deducted from the Contract Price.

The penalty will be 5000 USD/kW. It is thereby understood that values of 0.5 kW and above will be rounded up to the next full kW.

7.2.3 Noise level

Should the noise level (at maximum power (ONAF/OFAF) output and at Umax) for the transformers, at the specified distance according to IEC, exceed the guaranteed values but not exceed by 3 dB, the Contractor shall pay liquidated damages (penalty) to the Employer.

The penalty will be 12000 USD/dB. It is thereby understood that values of 0.5 dB(A) and above will be rounded up to the next full dB.

7.2.4 Rejection of the Transformers

The Employer shall have the right to reject any transformer (after Factory Acceptance Test) if the actual values are in excess of the guaranteed values by more than the margins specified hereunder:

- No-load losses + 10%
- Load losses (forced cooling) + 10%
- Total losses + 10%
- Noise level + 3 dB (A)

For all of the other values the margins stated in IEC standards are applicable, unless specified otherwise elsewhere in these Specifications.

The values for all insulation and test levels shall be obtained from the description of the general technical requirements of these Specifications

7.2.5 Temperature Rise

The temperature rise of windings shall be determined by type test. If, according to the results of the tests carried out within the scope of the Contract, the measured temperature rise exceeds the guaranteed value, the price for all transformers shall be reduced as a compensation for decreased life expectancy. The compensation shall be computed as follows:

Table 2: Computation of Price Reduction

Temperature Rise Over the Admissible Limit in Kelvin (K)	Compensation in Percent of the Total F.O.B. Price of the Transformer
0 – 1.99	0

2 – 2.99	4.5
3 – 3.99	9.0
4 – 5.00	13.5

No additional payment will be payable for measured temperature rise of less than the guaranteed maximum.

7.2.6 Noise Limits

The power transformer shall be so designed and constructed that harmful vibrations are eliminated and that no avoidable noise will occur at any operating conditions.

The maximum allowed noise limit is 82 dB at a measuring distance of 2.0 m (all forced cooling in operation).

The determination of the audible noise level and the measurement methods for the various part of the power transformer will be in accordance with IEC 60076-10 and will be verified by the relevant test.

KETRACO may during tests at works, reject a power transformer for the following reasons:

- If any of the losses exceed 10% of the guaranteed values.
- If the impedance voltage exceeds tolerance values specified by IEC of the guaranteed value;
- If the temperature rise exceeds more than 5 K of the prescribed values.

8. GUARANTEED TECHNICAL PARTICULARS

(To be filled and signed by the Manufacturer and submitted together with copies of Manufacturer's Authorization forms, catalogues and brochures of all the transformer equipment/devices and accessories, drawings, technical data sales records and copies of type test certificates and type test reports for tender evaluation)

The tenderer shall fill the guaranteed values of the equipment being supplied in the formats given below, basing on conditions stated in all the clauses under item 5 and the requirements in the technical data sheet: *(where parameters given differ from those in the manufacturers standard technical data sheet, sufficient comments shall be provided).*

In filling in the Guaranteed Technical Particulars section, where it is stated specify, tenderers shall refer to the relevant clauses in this specification. Actual dimensions and values are to be used in filling the Guaranteed Technical Particulars section. Blanks and words like "*Noted*" shall be considered non-responsive.

8.1 GUARANTEED SPECIFICATIONS OF THE EQUIPMENT TO BE SUPPLIED

Table 8.1: *Guaranteed specifications of equipment supplied.*

CLAUSE	CLAUSE REQUIREMENT	BIDDERS GUARANTEED PARAMETER VALUE	DESCRIPTIVE RESPONSE & COMMENTS	MANUFACTURERS TECHNICAL MANUAL REFERENCE
2	Scope			
3	*REFERENCE STANDARDS*			
	SERVICE CONDITIONS			
5.1	*Altitude*			
	Pollution			
	Humidity			
	Temperatures			
	CONSTRUCTION			
5.3.1	*Magnetic Circuit*			
5.3.2	*Windings*			
5.3.3	*Tertiary Winding*			
5.3.4	*Neutral Earthing*			
5.3.5	*Tank*			
5.3.6	*Valves*			
5.3.7	*Conservator*			
5.3.8	*Transformer oil*			
5.3.9	*Cooling Plant*			

5.3.10	*Cooler system control*			
5.3.11	*Voltage Control*			
5.3.13	*Terminations*			
5.3.14	*Protection, measuring and Indicating devices.*			
5.3.15	*Control Cubicles*			
5.3.16	*Corrosion Protection and Painting*			
6.0	TESTS & ACCEPTANCE			
6.2	*Type Tests*			
6.3	*Routine Tests*			
	Tests on transformer components			
6.5.1	*Transformer tanks*			
6.5.2	*Fans, Motors, Pipework, Oil Sampling Devices and Valves*			
6.5.3	*Gas and Oil Actuated Relays*			
6.5.4	*Voltage Control Equipment*			
6.5.5	*Bushings*			
6.5.6	*Structures*			
6.5.7	*Galvanizing*			
6.5.9	*Auxiliary and control circuits*			
6.6	*Factory Visit*			
6.7	*Packing, Shipping and Transportation*			
7.0	*PERFORMANCE GUARANTEES AND REJECTION*			
8.0	*SPECIFIC REQUIREMENTS*			

Manufacturer ‘s Name: ……

Signature: …….

Stamp and Date: …….

8.2 TECHNICAL DATA SHEET (TDS)

Table 10.2: *150 MVA, 220/132/33 kV Power Transformer TDS*

S. N.	220/132/33 kV POWER TRANSFORMER			
	Specifications	**UNIT**	**DATA**	
			Required	**Offered**
1.	Manufacturer & Place of manufacturing		To be specified	
2.	Country of Manufacture		To be specified	
3.	Type		Three phase Autotransformer, oil-immersed, core type with tertiary winding	
4.	Standards		IEC 60076, 60137, 60214	
5.	Altitude	m	2200	
6.	Ambient temperature			
	Maximum	℃	40	
	Annual average	℃	30	
7.	Mounting		Outdoor	
8.	Rated voltage ratio	kV	220/132/33	
9.	Rated frequency	Hz	50	
10.	Rated Primary Current			
	Primary side (HV)	A	To be specified	
	Secondary side (LV)	A	To be specified	
	Tertiary Side (TV)	A	To be specified	
11.	Vector group (3 phase group connection)		YNa0d11	
12.	Cooling Type		ONAN/ONAF1/ONAF2	
13.	Function of tertiary winding (TV)		control of zero sequence current, harmonic suppression and Loading	
14.	Method of earthing			
	HV winding		Solid	
	LV winding		Solid	
	TV winding		Delta connected	
15.	Type of windings (graded/non-graded)			
	HV winding (Series)		Graded	
	LV winding (Common)		Graded	
	TV winding		Non-graded	

S. N.	220/132 kV POWER TRANSFORMER			
	Specifications	**UNIT**	**DATA**	
			Required	**Offered**
16.	Rated voltage of windings (Ur)			
	HV winding	kV	220/√3	
	LV winding	kV	132/√3	
	TV winding	kV	33	
17.	Highest voltage for equipment (Um)			
	HV winding	kV	245	
	LV winding	kV	145	
	TV winding	kV	36	
	HV Neutral (Solidly grounded)	kV	127	
18.	Rated lightning impulse withstand voltage at:			
	HV terminals	kV	1050	
	LV terminals	kV	650	
	Neutral terminal	kV	525	
	TV Terminals	kV	170	
19.	Rated switching impulse withstand voltage at:			
	HV terminals	kV	850	
	LV terminals	kV	N/A	
	Neutral terminal	kV	425	
	TV Terminals	kV	N/A	
20.	Rated power frequency withstand voltage at			
	HV terminal	kV	460	
	LV terminal	kV	275	
	Neutral terminal	kV	265	
	TV terminals	kV	70	
21.	Rated lightning impulse withstand voltage at:			
	HV Windings	kV	To be specified	
	LV Windings	kV	To be specified	
	Neutral Windings	kV	To be specified	

	TV Windings	kV	To be specified	
22.	Rated power frequency withstand voltage at			
	HV Windings	kV	To be specified	
	LV Windings	kV	To be specified	
	Neutral Windings	kV	To be specified	
	TV Windings	kV	To be specified	

S. N.	220/132 kV POWER TRANSFORMER			
	Specifications	**UNIT**	**DATA**	
			Required	**Offered**
23.	Rated power with ONAF 2 Primary/Secondary	MVA	150/150	
24.	Rated power with ONAF 1 Primary/Secondary	MVA	120/120	
25.	Rated power with ONAN Primary/Secondary	MVA	90/90	
26.	Rated power of tertiary at site conditions (Full cooling)	MVA	30	
27.	Maximum temperature rise at rated power above ambient at: [Performance Guarantee]			
	Oil	°C	56	
	Windings	°C	61	
	Windings hot-spot	°C	74	
28.	Total No-load losses (Core loss + dielectric loss) at rated frequency and 100% voltage[Performance Guarantee]	kW	To be specified	
29.	Total full-load losses (Copper + Stray loss) at rated frequency and 100% Voltage at 75 °C [Performance Guarantee]			
	For ONAN rating	kW	To be specified	
	For ONAF2 rating (including auxiliary losses)	kW	To be specified	
30.	Total auxiliary losses at full load	kW	To be specified	
31.	Maximum current density at rated power:	A/cm^2	250	
32.	Symmetrical short circuit through current (duration 1 s)			
	HV terminals	kA	40	
	LV terminals	kA	31.5	
33.	Maximum flux density in iron at rated voltage, power frequency and principal tapping :	Tesla	1.6	
	On-load Tap Changer			
34.	Manufacturer		Maschinenfabrik Rheinhausen (MR)	
35.	Country of Manufacture		Germany	
36.	Type		Vacuum	
37.	Rated Current	A	175	
38.	Rated short time current (1 s)	kA	To be specified	
39.	Step Voltage	V	To be specified	

40.	Tapped winding		HV	
41.	Tapping range		± 1.25% in ± 12 steps	
42.	Variation per step	V	To be specified	
43.	Principle Tap Position		To be specified	
44.	Minimum number of operations	No.	200,000	

S. N.	220/132 kV POWER TRANSFORMER			
	Specifications	**UNIT**	**DATA**	
			Required	**Offered**
45.	Automatic voltage control		Yes	
46.	HV - LV Impedance voltage range at 75˚C, rated frequency and full rating and principal tap:	%	12.5	
47.	Motor supply voltage	VAC	415	
48.	Terminal connections (HV, LV, TV)		Through terminal bushings	
	LV terminal		Outdoor bushing	
	Neutral terminal		Outdoor bushing	
	TV terminal		Outdoor bushing	
49.	**Transformer Bushings**			
	Manufacturer		To be specified	
	Country of manufacture		To be specified	
	Type			
	HV		OIP	
	LV		OIP	
	TV		Porcelain Solid Bushing	
	Arcing Length			
	HV	mm	To be specified	
	LV	mm	To be specified	
	TV	mm	To be specified	
	Power Frequency Withstand Voltage of external part			
	HV	kV	To be specified	
	LV	kV	To be specified	
	TV	kV	To be specified	
	Lightning Impulse Withstand Voltage of External Part			
	HV	kV	To be specified	
	LV	kV	To be specified	
	TV	kV	To be specified	

S. N.	220/132 kV POWER TRANSFORMER			
	Specifications	**UNIT**	**DATA**	
			Required	**Offered**
50.	Bushing Creepage Distance			
	HV terminal	mm	To be specified	
	LV terminal	mm	To be specified	
	Neutral terminal	mm	To be specified	
	TV terminal	mm	To be specified	
51.	Number of stand-by fans	No.	One per group	
52.	**Oil**			
	Manufacturer		Shell	
	Type designation		Diala S4 ZX-I	
	Oil preservation system		Air-bag	
	Country of manufacture		to be specified	
	Naphthenic or Paraphenic based oil		Naphthenic	
	Type – inhibited/ trace inhibited/ non-inhibited		non-inhibited	
	Details of inhibitor		By manufacturer	
	Details of passivators		By manufacturer	
	Viscosity at 40 °C (Acc. to ISO 3104)	mm^2/s	Max. 12	
	Viscosity at –30 °C (Acc. to ISO 3104)	mm^2/s	Max. 1800	
	Pour point (Acc. To ISO 3016)	°C	Max. -40	
	Water content (Acc. To IEC 60814)	mg/kg	Max. 40 for delivery in drums (IBC)	
	Breakdown voltage (Acc. To IEC 60156)			
	As delivered	kV	Min. 30	
	After laboratory treatment	kV	Min. 70	
	Density at 20 °C (Acc. To ISO3675 or ISO12185)	g/ml	Max. 0.895	
	DDF at 90 °C (Acc. To IEC 60247 / IEC 61620)		Max. 0.005	
	Appearance		Clear, free from sediment and suspended matter	
	Acidity (Acc. To IEC 62021-1 / IEC 62021-2)	mg KOH/g	Max. 0.01	

S. N.	220/132 kV POWER TRANSFORMER			
	Specifications	**UNIT**	**DATA**	
			Required	**Offered**
	Interfacial tension (Acc. To EN 14210/ASTM D971)	mN/m	Min. 40	
	Total Sulphur content (Acc. To IP 373 / ISO 14596)	%	Max. 0.05	
	Corrosive Sulphur (Acc. To DIN 51353)		Not corrosive	
	Copper Corrosion (Acc. To IEC 62535)		Not corrosive	
	Potentially corrosive Sulphur (Acc. To IEC 62535)		Not corrosive	
	DBDS (Acc. To IEC 62697-1)	mg/kg	Not detectable (<5)	
	Inhibitors of IEC 60666 (Acc. To IEC 60666)	%	(U) uninhibited oil (Max. 0.01)	
	Metal passivator additivesof IEC 60666	mg/kg	Max. 5	
	2-Furfural and related compounds content (Acc. To IEC 61198)	mg/kg	Max. 0.05 (for each individual compound)	
	Oxidation stability (Acc. To IEC 61125:1992 (Method C))			
	Test duration (for uninhibited oil)	h	164	
	Total acidity (Acc. To 1.9.4 of IEC 61125:1992)	mg KOH/g	Max. 1.2	
	Sludge (Acc. To 1.9.1 of IEC 61125:1992)	%	Max. 0.80	
	DDF at 90 °C (Acc. To 1.9.6 of IEC 61125, Amendment 1 (2004) +IEC 60247)		Max. 0.50	
	Flash point (Acc. To ISO 2719)	°C	Min. 135	
	PCA content (Acc. To IP 346)	%	Max. 3	
	PCB content (Acc. To IEC 61619)	mg/kg	Not detectable (Max. 2)	
53.	Winding Material		Electrolytic Copper	
54.	Maximum sound pressure level (NEMA TR1 - 5dB(A))	dB(A)	82	
55.	Conservator vessel, radiators, fan grilles, control boxes or cubicles and pipework anticorrosion protection		Hot dip galvanized and painted	
56.	Tank anticorrosion protection		Yes	
57.	Supply voltage for transformer auxiliaries	V	415/240 AC	
58.	Control/Protection voltage	V	110 DC	

8.3 Bushing Current Transformer specifications for 150 MVA 220/132/33kV Transformer

	PHASE	CORE	BURDEN	RATIO	CLASS
HV (220kV)	R	1	30VA	800-400/1A	5P20
		2	30VA	800-400/1A	PX
		3	15VA	800-400/1A	0.2S
	Y	1	30VA	800-400/1A	5P20
		2	30VA	800-400/1A	PX
		3	15VA	800-400/1A	0.2S
	B	1	30VA	800-400/1A	5P20
		2	30VA	800-400/1A	PX
		3	15VA	800-400/1A	0.2S
LV (132kV)	r	1	30VA	800-400/1A	5P20
		2	30VA	800-400/1A	PX
		3	15VA	800-400/1A	0.2S
	y	1	30VA	800-400/1A	5P20
		2	30VA	800-400/1A	PX
		3	15VA	800-400/1A	0.2S
	b	1	30VA	800-400/1A	5P20
		2	30VA	800-400/1A	PX
		3	15VA	800-400/1A	0.2S
HV & LV Neutral	n	1	30VA	400/200/1A	5P20
		2	30VA	400/200/1A	PX
TV (33kV)	r	1	30VA	800-400/1A	5P20
		2	30VA	800-400/1A	5P20
		3	15VA	800-400/1A	0.5
	y	1	30VA	800-400/1A	5P20
		2	30VA	800-400/1A	5P20
		3	15VA	800-400/1A	0.5
	b	1	30VA	800-400/1A	5P20
		2	30VA	800-400/1A	5P20
		3	15VA	800-400/1A	0.5

Price Schedule: Goods Manufactured Outside Kenya, to be Imported

				(Group C Tenders, goods to be imported) Currencies in accordance with ITT 15			Date: _____ ITT No: _____ Alternative No: _____ Page N° _____ of _____	
1	2	3	4	5	6	7	8	9
Line Item N°	Description of Goods	Country of Origin	Delivery Date as defined by Incoterms	Quantity and physical unit	Unit price CIP *[insert place of destination]* in accordance with ITT 14.8(b)(i)	CIP Price per line item (Col. 5x6)	Price per line item for inland transportation and other services required in Kenya to convey the Goods to their final destination specified in TDS	Total Price per Line item (Col. 7+8)
[insert number of the item]	*[insert name of good]*	*[insert country of origin of the Good]*	*[insert quoted Delivery Date]*	*[insert number of units to be supplied and name of the physical unit]*	*[insert unit price DDP per unit]*	*[insert total DDP price per line item]*	*[insert the corresponding price per line item]*	*[insert total price of the line item]*
1	150MVA, 220/132kV Power transformer with on-load tap changer (OLTC) switch			1				
2	Mandatory spares			1 (Lot)				
							Total Price	

Name of tenderer *[insert complete name of tenderer]* Signature of tenderer *[signature of person signing the Tender]* Date *[Insert Date]*

Price and Completion Schedule - Related Services

Currencies in accordance with ITT 15					Date: _____ ITT No: _____ Alternative No: _____ Page N° _____ of _____	
1	2	3	4	5	6	7
Service N°	Description of Services (excludes inland transportation and other services required in Kenya to convey the goods to their final destination)	Country of Origin	Delivery Date at place of Final destination	Quantity and physical unit	Unit price	Total Price per Service (Col. 5*6 or estimate)
[insert number of the Service]	*[insert name of Services]*	*[insert country of origin of the Services]*	*[insert delivery date at place of final destination per Service]*	*[insert number of units to be supplied and name of the physical unit]*	*[insert unit price per item]*	*[insert total price per item]*
3	Storage Site Preparation (Isinya) as per 6.9 of Technical Specifications					
4	FAT costs as per 6.6 of Technical Specifications					
				Total Tender Price		

Name of tenderer [*insert complete name of tenderer*] Signature of tenderer [*signature of person signing the Tender*] Date [*insert date*]

1. List of Goods and Delivery Schedule

[The Procuring Entity shall fill in this table, with the exception of the column "Tenderer's offered Delivery date" to be filled by the tenderer]

NO.	ITEM	Quantity	Delivery Period
1	150MVA , 220/132kV Power transformer with on-load tap changer (OLTC) switch	01	
2	Mandatory Spares	Lot	