TECHNICAL REQUIREMENTS

for

110/35/10 kV 25 MVA POWER TRANSFORMER CHANGE

SE Moldelectrica.

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1. GENERAL INFORMATION AND SCOPE OF WORK

The State Enterprise "MOLDELECTRICA" (hereinafter referred as "the Beneficiary") is a company specialized in the centralization of the transport and operative dispatching services of the Moldovan energy system intends to exchange power transformer 25 MVA 110/35/10 kV in Ungheni substation.

This part of the Specifications covers the design, manufacture, factory testing, transport, delivery, erection, unloading and storage at site, commissioning and handing over in satisfactory operating condition of the new power transformer.

The transformer shall be designed and arranged in full compliance with all applicable Sections.

Power transformer is to be installed in Ungheni 110/35/10 kV substation located in northern part of the Republic of Moldova.

Substation	**Latitude**	**Longitude**
Ungheni 110/35/10 kV	47.226425	27.796666

Existing substation comprises of outdoor 110 kV AIS switchyard having 6 bays, outdoor 35 kV AIS switchgear having 7 bays and indoor containerized 10 kV metal clad AIS switchgear. Existing power transformers are located between 110 kV and 10 kV switchgears. All primary connections are done using ACSR type conductor. 110 kV connections to the power transformer are done using transformer gantry located above the transformer foundation.

Power transformer is installed on concrete foundation equipped with rail system. The existing foundation is going to be removed and a new concrete foundation is to be built prior to the transformer delivery based on the dimensions and masses of the new transformer unit (All civil and auxiliary works related to the new foundation construction procces are in the scope of another tender and are not included in the present scope of work). New foundation trays will be provided with slope and raised borders, enclosing an oil pit in which the oil content of the transformer unit can be discharged in the event of an oil leakage. All internal concrete surface of transformer oil pit is to be surfaced with a 100 mm thick layer of gravel.

Provisions are to be made by the Contractor in order to fit the new transformer under the existing 110 kV gantry. Existing phase rotation and bushings arrangement on the power transformer tank cover is to be considered for all voltage levels in order to use the existing external primary connections where it is possible.

Common to all delivery, installation and commissioning works for "Exchange of Transformer" is the following:

- Production of the equipment
- Compiling and coordination of the routes, time and size of transportation of power transformer to the substations (for mounting), obtaining permits from the relevant authorities
- Preparation of access roads to the substations and its area, including necessary rail track to an uploading and unloading place at or near the substation
- Transportation to site within two months after successful Factory Acceptance Test

- Unloading of all required equipment and material
- Equipment installation at site including securely fixing of the complete equipment
- Supervision of installation works being done by the Beneficiary personnel of all new secondary cable connections between
    - control building and power supply; and
    - transformer and necessary instrument transformer interface cubicles in the relevant control building
- Installation of subsystems at site ready for operation

The Contractor shall consult the relevant authorities to get characteristics of existing bridges and capacities of roads, as applicable.

The Contractor shall make all provisions for transportation to the site for all plant, equipment and materials required by him for the execution of the Works on the basis of the Standards of the roads and bridges as of the time for Submission of Bids.

The Contractor shall take the full responsibility of the conditions of various accesses to the site, whatsoever the Bid Drawings may show, or the Technical Specifications may specify.

The tenderer is advised to visit and examine the site and surroundings where the power transformer is to be installed and obtain for itself on its own responsibility all information that may be necessary for preparing the Bid offer and entering into a contract for supply and installation of the power transformer. The costs of visiting the site shall be at the tenderer's own expense.

The tenderer and any of its personnel or agents will be granted permission by the Beneficiary to enter upon its premises and lands for the purpose of such inspection, but only upon the express condition that the tenderer, its personnel and agents will release and indemnify the Beneficiary, its personnel and agents from and against all liability in respect thereof and neither the Beneficiary, its personnel or agents will be responsible for death or personal injury, loss of or damage to property and any other loss, damage, costs and expenses incurred as a result of the inspection.

Limits of supply:

- Primary connections – transformer bushing terminals.
- Secondary connections – external secondary cables terminal blocks in the transformer marshaling kiosk.

2. SITE CONDITIONS AND DESIGN CRITERIA

2.1 Environmental conditions

The following summarised climate data will form the design data for the working conditions of the equipment; however for particular equipment data given in the data sheets are applicable.

Item	Unit	Value
Maximum ambient temperature	°C	41
Minimum ambient temperature	°C	-35
Mean maximum daily temperature	°C	30
Annual average temperature	°C	12 - 15
Maximum solar radiation (worst case)	W/m²	1 200
Altitude	m	<400
Max. Wind • Height above ground 0 – 30 m • Height above ground 30 – 50 m	 m/s m/s	 44 50
Average rainfall annually	mm/a	400 - 600
Relative humidity, average	% rel.	75

2.2 Basic Electrical Data

The following table shows the common electrical rating of the switchgear equipment:

Item	Unit	Voltage Level		
Operating voltage (U_0/U)	kV	110	35	10
Neutral earthing system		Surge arrester/ solidly	isolated	isolated
Location		outdoor	outdoor	indoor
Pollution class		e	e	e
Insulation material temperature class		E	E	E
Seismic qualification level		high, A1	high, A1	high, A1

Item	**Unit**	**Voltage Level**		
Operating voltage (U_0/U)	kV	110	35	10
Rated voltage (U_r)	kV	123	38.5	12
Rated Frequency (f_r)	Hz	50	50	50
Short-duration power frequency withstand voltage (U_d, 1 min.)				
• common	kV	230	80	28
• across the isolating distance	kV	265	95	34
Rated lightning impulse withstand voltage (U_p, Common value, peak value)				
• common	kV	550	190	75
• across the isolating distance	kV	630	220	85
Rated short-time withstand current (I_k)	kA	40	40	40
Rated peak withstand current (I_p)	kA	100	100	100
Rated duration of short circuit (t_k)	s	3	3	3

A common minimum creepage distance of 2.25cm/kV is required

2.3 Insulation Co-ordination

In accordance with IEC 61936 and Beneficiary's standard below there are listed required minimum clearances within a substation between live parts and internal surface:

Level of rated voltage (U_r)	**123 kV**	**38.5 kV**	**12 kV**
	[mm]	**[mm]**	**[mm]**
N - Minimum phase-to-earth clearance	1100	400	200
N - Minimum phase-to-phase clearance	1100	440	220
for solid walls, without openings, with a minimum height of 1800 mm	1100	340	160
for wire meshes, screens or solid walls, with openings, with a minimum height of 1800 mm and a degree of protection of IP1XB	1200	440	260
for solid walls or screens less than 1800 mm high, and for rails, chains or ropes	1400	640	460

Level of rated voltage (U_r)	**123 kV**	**38.5 kV**	**12 kV**
	[mm]	**[mm]**	**[mm]**
Minimum height over access area for pedestrians for live parts without protective facilities	3350	2590	2500
the lowest part of any insulation above accessible surfaces	2500	2500	2500

Unspecified distances are subject of approval of Beneficiary.

Where the reduction of safety distances due to the effect of snow on accessible surfaces needs to be considered, the values given above shall be increased by 0.4 m.

2.4 Applicable standards and norms

The latest issues of Recommendations of the International Electrotechnical Commission (IEC-Standards, etc.) shall apply, in particular as listed below (wherever applicable).

- IEC 61869 Instrument transformers
- IEC 60060 High-voltage test techniques
- IEC 60071 Insulation co-ordination
- IEC 60076 Power transformers
- IEC 60085 Electrical insulation - Thermal evaluation and designation
- IEC 60137 Insulating bushings for alternating voltages above 1000 V
- IEC 60156 Insulation liquids - Determination of the breakdown voltage
- IEC 60214 Tap changers
- IEC 60247 Insulation liquids - Measurement of relative permittivity, dielectric dissipation factor (tan δ) and d.c. resistivity
- IEC 60270 High-voltage test techniques - Partial discharge measurements
- IEC 60296 Fluids for electro-technical applications - Unused mineral insulating oils for transformers and switchgear
- IEC 60442 Supervision and maintenance guide for mineral insulation oils in electrical equipment
- IEC 60529 Degrees of protection provided by enclosures (IP code)
- IEC 60567 Guide for sampling of gases and oil from oil-filled electrical equipment and for the analysis of free and dissolved gases

- IEC 60599 Interpretation of the analysis of gases in transformers and other oil-filled electrical equipment in service
- IEC 60616 Terminal and tapping markings for power transformers
- IEC 60815 Selection and dimensioning of high-voltage insulators intended for use in polluted conditions
- IEC 60947 Low-voltage switchgear and control gear
- IEC 61181 Mineral oil-filled electrical equipment - Application of dissolved gas analysis (DGA) to factory tests on electrical equipment
- IEC 62535 Insulating liquids - Test method for detection of potentially corrosive sulphur in used and unused insulating oil

Supplementary standards are the international standards ISO, the German standards DIN and VDE, the European standards EN (CENELEC), the British standards BS, the American standards (ANSI, IEEE and ASTN) or specific national standards in the above mentioned sequence, if there are no relevant IEC-standards existing or if there is no sufficient information available in the IEC-standards and/ or if explicitly asked for in these Tender Documents.

The Bidder shall submit with his offer a list of similar transformers and reactors already delivered by the manufacturer proposed. Past supply records of similar ratings of transformers for last 5 years shall be submitted in detail with the offer. In addition the Bidder shall submit with his offer valid certificates proving that the proposed manufacturers are certified by ISO 9001. Manufacturers not having sufficient experience in manufacturing and testing of similar transformers like those as specified and/ or not being certified by ISO 9001 will not be accepted.

Contractors are held responsible to carry out the erection and pre-commissioning work for power transformer under supervision of the transformer manufacturer according to the manufacturer's instruction.

Each item which is obviously necessary for proper function and completion of the work, whether especially specified in the Specification or not, is to be included in the Tender and Contract price.

Furthermore, the equipment shall comply with the stipulations of the following Articles.

3. TECHNICAL REQUIREMENTS FOR POWER TRANSFORMER

3.1 General

The design of the equipment shall be based on the conditions and requirements listed in the present document and in particular in the prevailing technical data sheets.

The equipment shall be designed for operation at the prevailing site conditions without any restriction.

The design shall be based on site and service conditions as specified hereinafter

The following minimum values of hot-spot factors each for thermal evaluation of the winding hot-spot temperature rise by calculation shall be applied as a minimum requirement, i.e. min. 1.3 for windings not exceeding U_m: 72.5 kV and not less than 1.5 for all windings from Um: 100 kV and above. This is applicable in addition to the relevant guidance of IEC 60076-2.

The transformers shall be also designed for continuous operation at any tap position within the specified temperature rise limits as above at their full rated power at 5 (five) percent under-excitation/ under-voltage conditions applied from any winding of the transformers (to be verified by steady state temperature rise test). This is applicable for the highest name plate rating of the transformer at the related kind of cooling as specified for, and for all tap changer settings.

The transformers shall be also capable of operating continuously at all tap changer settings at 115 (one-hundred and fifteen) percent excitation at long-time emergency loading conditions within the temperature limits as specified IEC 60076-7, but at 30°C ambient temperature. This is applicable for the highest name plate rating of the transformer and at related kind of cooling as specified for the highest name plate rating.

The transformers, completely assembled with tap changers, bushings, cable boxes and/ or flange connections etc. shall be also designed and constructed to withstand without damages the effects of short circuits as per IEC 60076-5 for at least 3 (three) seconds during and after long-time emergency loading conditions as specified in IEC 60076-7, but at 30°C ambient temperature.

Neutral points shall be brought out by suitable means and shall be grounded as required.

3.2 Windings

All windings shall have uniform insulation. Particular values for all insulation and test levels shall be obtained from the Technical Data Sheets of this Specification.

Due to the possibility of high transferred over-voltages medium voltage windings in power transformers having HV windings of U_m= 100 kV and above shall be designed for not less than LI: 125 kV/ AC: 50 kV. None of the windings shall be insulated for less than LI: 95 kV/ AC: 34 kV.

All windings and their leads shall be designed and arranged such as to withstand all kinds of over-voltages which may be transferred from any other winding etc. Protective capacitors shall not be provided for any of the windings. Non-linear ZnO protective elements in any windings will not be accepted.

Windings shall be of best modern design with conductors having practically constant cross-section along the whole windings, and the current densities shall not exceed 3 A/mm² in any part of the windings under rated conditions. Electrolytic copper of a high conductivity and insulation material of high quality shall be used.

The insulation material of windings and connections shall be free from insulation compounds subject to softening, shrinking or collapsing during service. Moreover, none of the material used shall disintegrate, carbonize or become brittle under the action of hot oil, under all specified load conditions.

Use of any kind of wood for insulation parts subject to test voltage stresses of LI: 550 kV and/ or AC: 230 kV and above across the insulation material is not acceptable, and the CONTRACTOR/ Manufacturer is held fully responsible for all insulation material selected.

Regulation windings for delta connected power windings shall be provided in mid-winding connection

Generally, all of the transformers shall have the highest losses at the highest current taps (lowest voltage taps) and, the values for impedance voltages on extreme tappings shall not deviate from those for principal tappings by a percentage value of more than the difference in percentage tapping factor between the concerned tappings and the principal tappings. This is applicable independent on the type and arrangement of regulation windings.

The coils must be capable of withstanding movement and distortion caused by all operating conditions. Adequate barriers shall be provided between windings and core and between the different windings. All leads or bars from the windings to the bushings shall be rigidly supported. Stresses on coils and connections must be avoided.

To increase the capability of the equipment of withstanding the stresses under short-circuit conditions modern technology in design and construction shall be applied (e.g. low current densities not exceeding the specified value as above and, pre-drying and pre-compressing of the windings before mounting onto the core, etc.).

3.3 Magnetic Core

The magnetic core shall be of the core-form type and shall be made of laminations of non-aging, cold rolled, grain oriented, silicon steel of high permeability without burrs. Each lamination shall be insulated with high quality insulation coating. Any kind of shell-form core is not acceptable for power transformers.

The maximum magnetic flux density in the limbs and yokes of the core shall not exceed values as required in the technical data sheets at rated voltage and frequency.

The core and its clamping plate's resp. tie rods shall form a rigid unit structure which shall maintain its form and position under the severe stresses encountered during shipment, installation and short circuits.

Care shall be also taken to secure uniformly distributed mechanical pressure over all the limbs and laminations to prevent setting of the core and to limit noise and vibrations to a minimum under service conditions.

The joints of limbs and yokes shall be designed and constructed to keep the no-load losses and the hot spot temperature in the magnetic core as well as the noise level as low as possible by application of the step-lap core stacking method.

To prevent closed magnetic circuit via the tank, the top main core clamping structure shall not be connected directly to the tank cover. The magnetic core shall be earthed to the tank cover at one point only through removable links in an appropriate terminal box, placed in an accessible position on the tank cover and which, by disconnection, will enable the insulation between the core and transformer tank, etc., to be tested at voltages up to 2.5 kV for the purpose of checking deterioration during service.

Magnetic circuits with an insulated sectional construction shall be provided with a separate link for each individual section. Where oil ducts or insulating barriers parallel to the plane of the laminations divide the magnetic circuit into two or more electrically separate parts, the ducts or barriers shall be bridged and the magnetic circuit shall not be regarded as being of sectional construction.

The main earthing connection shall have a cross sectional area of not less than 70 mm^2 but connections inserted between laminations may have cross sectional area reduced to a minimum of 16 mm^2.

3.4 Transformer Tank

The transformer tank shall be of the original upper flange type with reinforced bolted on cover, and the transformer tank shall have rectangular shape. Any kind of bell type tanks (e.g. modified with upper flange and cover and/ or lower flanges welded/bolted onto tank bottom etc.) or similar arrangements are not acceptable.

The tank bottom shall be of one plane and shall be a heavy rigid base structure. The four tank walls shall be plane and practically of one piece each and shall be welded directly onto the tank bottom without steps and without any additional welded and/ or bolted flanges.

The completely assembled tank shall be fully vacuum proof, including radiators, conservator and associated oil piping.

The completely assembled transformer shall be oil and gas tight and shall be capable of withstanding without damage, under service conditions, the forces arising under pressure conditions of at least 1.0 bar (>14 PSI) and/ or exceeding 25% over the maximum operating pressure, resulting from the system of oil preservation used (whatever is higher).

The construction shall be of mild steel and shall be of sufficient strength and rigidity to withstand moving, shipping and handling without any de-formation. All seams and joints shall be welded both inside and outside of the tank to secure strong, leak proof joints. Any kind of laminated tank covers are not acceptable.

The complete tank and its cover shall be designed in such a manner as to leave no external pockets in which water can accumulate, to leave no internal pockets in which oil can remain when draining the tank and/ or in which air can be trapped when filling the tank.

Wherever possible, the tank and its accessories shall be designed without pockets wherein gas may collect. Where pockets cannot be avoided, pipes shall be provided to vent any gas into the main expansion pipe.

Vent pipes shall have minimum inside diameter of 25 mm. Both ends of the tank cover shall be connected to the main expansion pipe.

All connections bolted to the tank shall be fitted with suitable gaskets.

Gaskets shall be gas and oil resistant and shall be made of such a material that no serious deterioration will occur under service conditions, i.e. heat and oil resistant nitrile rubber. All gaskets shall be of closed design (without open ends) and shall be practically of one piece only. Rubber gaskets used for flange connections of the various oil compartments shall be laid in grooves or in groove-equivalent retainers on both sides of the gaskets throughout their total length. Care shall be taken to secure uniformly distributed mechanical pressure over the gaskets and retainers throughout the total length.

Gaskets of neoprene and/ or such material which can be easily damaged by over-pressing (e.g. any kind of impregnated/ bonded or other kind of cork) are not acceptable for any of the equipment. Use of hemp as gasket material is also prohibited.

Spring-loaded pressure relief devices with trip contact and self-locking metal pin-type operation indicator of an approved type shall be mounted through approved elbow turrets onto the tank cover for rapid release of any pressure that might be generated within the tank and cause damage to the equipment. The devices shall operate at a static pressure which shall be less than the test pressure on tank. The nominal operating pressure of the devices shall not exceed 0.7 bar (or 10 PSI). The related elbow turrets shall be connected through vent pipes as above to Buchholz relay.

Power transformers shall be equipped with manholes and hand-holes of suitable size to facilitate installation and maintenance (i.e. tap changers, current transformers, bushings etc.). Manholes for tap changers shall have size of minimum 800 mm x 350 mm, and they shall be arranged in a convenient floor height (subject for approval). All openings in the cover of the transformer tank for bushings, manholes and terminal boxes shall be provided with adequate flanges.

Covers for inspection openings, hand-holes etc. located on the tank cover shall be provided with adequate gas stoppers. All inspection covers etc. shall be provided with two lifting handles each. It must be possible to remove any bushing completely without removing the tank cover.

The tank cover and all covers for mounting, cleaning, manholes, hand holes and inspection openings on tank etc. shall be earthed by suitable grounding conductors of the flexible type having a cross section of minimum 95 mm². Appropriate earthing studs with bolts and washers shall be provided, all made of stainless steel.

The following moving and handling facilities shall be provided for any equipment:

- 4 (four) jacking lugs for raising or lowering the equipment (completely filled with oil) by means of hydraulic jacks
- Lugs for lifting the complete equipment
- Eyes for lifting the core, coils, tank and/ or tank cover
- Pulling eyes for moving the equipment in any direction
- Bi-directional wheels with blocking facilities.
- 1 (one) tank access ladder of zinc-powder coated or galvanized mild steel with lockable hinged door securely fixed onto the tank cover and lower parts of the tank. Ladders shall be provided with hand-rails of min. 100 cm length at the upper end. Hand-rails shall be designed and arranged such as to avoid partial discharges/ corona when the transformer is in service and, they shall be rigidly fixed on the ladders and onto the transformer tank. If the distance between the ladder and tank cover exceeds 4 cm an appropriate platform (e.g. grating securely fixed in a rigid mounting frame) with hand-rails as specified above shall be provided.
- Filter valves of the gate valve type for oil inlet and outlet arranged diagonally on lower part of tank. A suitable valve for vacuum application shall be also provided in a convenient floor height. All of these valves shall have minimum 40 mm inside diameter and shall be equipped with flanges having adapters with 1 ½" male thread fitted with screwed cap.
- Two adequate earthing terminals completely made of stainless steel capable of carrying for 5 seconds the full lower voltage short circuit current of the transformer shall be provided and installed diagonally at the bottom of the transformer tank. Bolts and washers used shall be made of stainless steel.

3.5 Cooling

3.5.1 Radiators

Radiators shall be of the DIN type or equivalent provided with at least six cooling channels in each radiator fin. Radiators of the multi-tube type or similar arrangements are not acceptable. In case of radiators with upper headers of the elbow type ('swan neck' type) they shall not protrude beyond the tank cover by more than 45 cm. However, 'swan neck' radiators shall only be flanged directly onto the tank, and they shall not be connected to any common headers.

The cooling fins of the radiators shall have nominal width of 470 - 520 mm, and their height shall not exceed 3.0 m. The nominal sheet steel thickness of the radiator walls shall not be less than 1.2 mm.

The radiator fins shall be welded with 8 (eight) mm round stiffening rods (horizontally and diagonally) to prevent vibration during operation of the transformers. All stiffening rods shall be properly welded at all of their rests to the corners of the radiator fins. The distance between horizontally arranged bracing straps shall not exceed 100 cm.

Radiators shall be fully vacuum proof and pressure tested (with air of minimum 2 kg/cm² for not less than five minutes) and shall be liquid tight (leak proof against transformer oil of 125°C, 1 kg/cm²).

The radiators shall be fitted with suitable drain and vent plugs so that they can be completely drained and vented.

The radiators shall be connected to the tank or external headers by butterfly valves in such a manner that each radiator can be removed without draining any oil from the tank and/ or common headers (if any).

The mechanical tolerance of the arrangement shall be minimized to allow the exchange of all radiators of the same type without additional fitting.

The lower radiator headers shall be connected to the equipment tank or common headers in a height of not less than 80 cm above floor level.

Accumulation of air within the radiators and headers must be avoided. Upper common headers for connection of radiators shall be connected through isolation valves and vent pipes to the main expansion pipe.

The radiators shall be assembled and fitted to the tank in such a manner as to provide mechanical protection to them and to prevent vibrations. Suitable stiffening bars of stainless steel shall be fitted along the radiators on top and bottom. Stiffening bars shall not be arranged cross-wise on top and bottom of the radiator groups.

Hot-dip galvanized radiators shall not be provided.

Flanged on common headers, if any, shall be connected to the tank via gate valves each mounted directly onto the transformer tank or cover. Common headers shall not be connected to bushing turrets. Welded-on common headers of any kind are not acceptable.

3.5.2 Valves

All butterfly valves shall be arranged in a vertical position and in such a manner that their position indications are clearly and freely visible and legible directly from tank cover and from ground level. Valve position indicators must not be arranged underneath the flange of the tank cover.

3.5.3 Fan Units

The fan units shall be fitted in an accessible position onto suitable non-corrosive steel structure/ framework, which shall be bolted rigidly onto the radiator groups. The fan units attached to radiators shall be mounted in a height not exceeding 2.0 m above floor level.

The overall diameter of the fan units shall not exceed 105 cm, and their total weight shall be limited to a maximum of 65 kg per unit.

Each fan unit shall be individually removable without dismantling of any structure and any framework, and without having to interfere with the operation of other fans.

The propellers shall be made of sea-water proof aluminium alloy or stainless steel. Propellers or parts of the same made of any kind of plastics are not acceptable. Mechanical protection against touching of the fan blades shall be provided by round wire mesh guards of stainless steel on both sides of the fan blades.

The fan motors shall be arranged at an easily accessible position, and their terminal boxes shall be accessible without removing the guard. A nameplate made of stainless steel (at least of grade EN 1.4301 or ASTM 304) for each fan motor shall be provided clearly visible and legible on the outer housing of each fan unit at an accessible position.

Minimum 25% (twenty-five percent) more fans than required for continuous operation of full rated power within specified temperature rise limits shall be included and shall be completely wired up to the starter (contactor) units, and these additional fans shall also cover continuous loading at full rated power within the specified temperature limits at 5 (five) percent under-excitation conditions as above, as well as long-time emergency loading conditions within the temperature limits as per IEC 60076-7 at 30°C under thermal steady state conditions.

The control equipment for the cooling plant and all auxiliary devices shall be accommodated in a weather-proof cabinet (protection degree IP 55) mounted onto the transformer.

3.5.4 ONAF Cooled Transformers

Transformers with a rated power of 20 MVA and up to 250 MVA per unit shall be equipped with a forced air cooled type of cooling (ONAF). Unless specified otherwise in the Technical Data Sheets, the self-cooled capacity (ONAN) shall be at least 75% of the forced cooled rating.

The ONAN cooling shall be provided by detachable radiators flanged directly onto the tank and/ or external headers, mainly in the vicinity of the core-/ coil-arrangement at alongside(s) of the transformer.

The ONAF cooling shall be provided by means of a minimum of 8 (eight) fan units mounted underneath the radiators.

The following standard accessories shall be provided where applicable:

- 1 (one) butterfly valve each for inlet and outlet for each radiator.
- 1 (one) upper and lower common header for each cooler bank each connected onto the transformer tank via isolating valves as below.
- 1 (one) isolating valve (of the gate valve type) for connecting each of the common headers of each cooler bank with the transformer tank.
- 1 (one) isolating valve (of the gate valve type) for connecting each of the upper common headers of each cooler bank with the transformer tank or tank cover.
- 1 (one) isolating valve (of the gate valve type) for connecting each of the lower common headers of each cooler bank with the transformer tank.
- 1 (one) drain plug with screwed cap at the outlets of each lower common header suitable for temporary installation of temperature sensors directly in the oil-flow during heat-run tests.
- 1 (one) air vent plug with screwed cap at the inlets of each lower common header suitable for temporary installation of temperature sensors directly in the oil-flow during heat-run tests.

- Additional air vent plugs and drain plugs on common headers, if required.
- 1 (one) drain plug at the outlet of each radiator.
- 1 (one) air vent plug at the inlet of each radiator.
- Additional thermometer pockets in the oil flow of upper and lower common headers (if any) at tank inlets and outlets, if required.

3.5.5 Control of Cooling Units

The electrical supply for the control of the cooling units and for the motor drive unit of OLTC shall be provided by means of two independent feeders (load-break switches) installed in the fan control cabinet and/ or marshalling box as specified below.

To cover the event of an electrical supply failure, automatic switchover from the first feeder to the second feeder is required. Automatic transfer equipment shall include a time delay relay to prevent immediate transfer from normal to emergency source.

Circuit breakers shall be installed for manual switching of each cooling group. Fuses will not be accepted.

Manual and automatic cooling system control shall be integrated into the SCMS. Suitable facilities shall be provided for this purpose at the transformer side.

The fan motors or groups of motors shall be automatically controlled by a relay combination taking into consideration the winding and oil temperature. The criteria for automatic “ON/ OFF” switching operations shall be the winding temperature (ON) and the oil temperature (OFF), respectively.

Control shall be such that frequent START/ STOP operation for small temperature differences must be avoided. Time delay relays shall be provided to prevent switching OFF the motors for at least five minutes after starting of the same.

The motors shall be automatically controlled by sets of contacts on winding temperature indicators, top oil temperature indicator and relay combination taking into consideration both winding temperature and top oil temperature.

The cooling groups shall not switch OFF on winding temperature falling to values set on winding temperature indicator for switching ON of the groups, but they shall switch OFF when the top oil temperature falls below set values to switch OFF the groups. That is, the starting impulse for both the groups shall be given by the winding temperature indicators and stopping impulse by the contacts of the top oil temperature indicator.

All motor contactors and their associated apparatus shall be designed for the specified control voltage and shall be capable of holding in and operating satisfactorily and without overheating for a period of ten minutes if the supply voltage falls for that period to 85% of normal control voltage. Auxiliary transformers for control voltage shall not be provided.

The contactors shall be protected by means of thermal and magnetizing tripping elements. However, motor protection switches with adjustable setting range (approx. 120 - 150% of rated motor current) are to be provided for each of the fan motor. A group alarm shall be initiated if any fan fails; however, switching off of any further motor of the same group must be avoided.

Electrical isolation of motor circuits shall be provided to facilitate replacement or repair of individual units during operation of the others. In addition, one main switch with alarm contact shall be provided for each fan/ cooler group.

Voltage relays of the three-phase type, equipped with 1-CO spare contact rooted to the cabinet terminals, shall be installed for supervision of the voltage supply circuits.

Change-over-switches with three positions, i.e. for automatic, off and manual control, equipped with 1-CO spare contact rooted to the cabinet terminals, shall be provided for each of the fan groups.

The following alarm/ signal initiating devices having C.O. contacts shall be provided:

- Main power supply failure for each main power source

The fan motors shall be connected to the starting contactors by two groups. Approximately 50% of all cooling fans including specified extra fans shall be related to each fan group. The specified extra fan shall not be connected separately in any way and they shall run together with the other fans during normal operation at site. The first group (fan 1, 3, 5, etc.) shall come into operation at lower temperature (i.e. at 75°C hot spot temperature) and the second group (fan 2, 4, 6, etc.) at higher temperature (i.e. at 85°C hot spot temperature).

The control shall be such that, if the first group fails to come into operation on winding temperature reaching the set value on the contacts of winding temperature indicator, the second group when it comes into operation, consequently to winding temperature reaching higher set value, shall bring the first group of fans also into operation.

3.6 Terminals

All bushings shall be at least of the same insulation level as that for the related windings and/ or neutral. For all terminals of windings the clearances in air between life parts shall exceed those specified in IEC 60076-3 by at least 5 percent.

Each of the bushings shall be designed for a rated current of at least 150% of the rated equipment current. Generally, it has to be considered that oil impregnated paper condenser bushings are not acceptable for any of the bushings, except this is explicitly required in the data sheet.

Support insulators shall be of top quality electrical grade and shall be of a uniform shade of brown. Insulators shall have the same minimum creepage distances as specified for the related bushings.

All main flange connections, cable boxes and related covers etc. shall be earthed by suitable grounding conductors of the flexible type each having a cross section of minimum 95 mm².

Bushings shall be of the outdoor type as specified in the Technical Data Sheets. They shall correspond to IEC 60137, shall be free from defects and shall be thoroughly vitrified. Uncovered bushings other than those to be solidly grounded shall be designed for site pollution severity class “e” (very heavy) in accordance with IEC/TS 60815, unless specified otherwise in the Technical Data Sheets. However, creepage distances as specified in the Technical Data Sheets are to be considered preliminary only and may have to be corrected by the Contractor in accordance with IEC/TS 60815 dependent on the bushing average diameter.

Insulators shall be of top quality electrical grade porcelain, homogenous and non-porous, and shall be practically in one piece. If insulators are composed of several parts jointed together by synthetic resin, this shall be brought to the attention of Beneficiary.

The glaze shall not be depended upon for insulation and shall be of a uniform shade of brown, completely covering all exposed parts of the insulator.

Bushings for windings of U_m= 72.5 kV and above shall be of the epoxy-resin impregnated paper condenser type equipped with test tap at the bushing flange. Bushings for windings below U_m= 72.5 kV shall be oil-filled as per DIN and/ or EN (CENELEC) standard equipped with rigidly fixed solid gas stoppers or equivalent centralizing rings. DIN and/ or EN (CENELEC) bushings for windings of rated voltages higher than 12 kV shall be provided with metallized lower part and their clearances across the porcelain insulators shall be also properly coordinated concerning all possible transferred over-voltages.

All bushing connecting nuts, bolts, washers, rings, caps on the top shall be of non-magnetic material.

All bushings shall be designed for operation and storage in a horizontal position without any restriction. All bushings shall be designed for the highest over-current that can flow through the windings.

The bushings shall be arranged on turrets in such a manner, that removal of the same is possible without lowering of the oil to such a level where the windings are exposed to the atmosphere. Bushings up to U_m = 52 kV shall be arranged in an upright position.

Bushing turrets with removable flanged-on covers on the bushing side shall be provided for all bushings. Removable bushing turrets bolted onto appropriate flanges on the tank cover are also acceptable. Common bushing turrets of an approved design may be provided for bushings up to U_m= 52 kV and their height shall not be less than 30 cm.

Common bushing turrets shall be provided with two vent plugs each to be arranged at an approved location. Removable bushing turrets shall be provided with four adequate lifting lugs each. All bushing turrets shall be equipped with vent pipes on their highest points which shall be connected to main expansion pipe to route any gas collection through Buchholz relay.

3.7 Current Transformers

Wherever required, current transformers shall be provided in accordance with the requirements of this Specification.

The technical data shall be indicated in the Technical Data Sheets. The technical data shall be also coordinated with the protection requirements and the related switchgear CT's. If the requirements of protection show that a higher rated output and/ or ratio than specified is necessary, the Bidder/ Contractors shall provide the current transformers for the required ratings without extra price.

All current transformers shall be designed for an extended rated current of at least 150% to cover long-time emergency loading duties as per IEC 60076-7 without any restriction. All current transformers other than those which may be required for thermal replica shall be provided with test windings each.

All of the current transformers shall be arranged and connected in such a manner that easy removal of the same is possible without cutting or removal of any insulation material of the leads to the bushings etc. required and without lowering of the oil to such a level where the windings are exposed to the atmosphere.

Suitable covers of an approved design to facilitate installation of CT's shall be provided for all current transformers. Covers for hand-holes located on tank cover shall be provided with adequate gas stoppers (e.g. laminated wood). Internal arrangement of all CT's is subject to full responsibility of CONTRACTOR/ Manufacturer.

3.8 Tap Changers

3.8.1 On-load Tap Changers (OLTC)

Where required, on-load tap changers, as per specifications, for manual control and electrical remote control shall be provided as follows.

For all applications the OLTC shall be based on the principle "Dr. Jansen" comprising a tap selector with change-over switch and a rotary diverter switch of high speed transition resistor type, the diverter switch has to be equipped with vacuum interrupters.

The lifespan of the vacuum interrupters shall be in full accordance with the technical data sheets. No increased life span shall be indicated based upon the difference between through current of the transformer and rated through current of the tap changer.

No leaf springs shall be used. The tap-changer manufacturer shall prove at least fifteen years of field experience with on-load tap-changers based on vacuum interrupters. First maintenance shall be necessary earliest after 300,000 switching operations, regardless of the application and without time-dependent criteria. Second maintenance and replacement of the vacuum interrupters shall be necessary earliest after 600,000 switching operations, third maintenance shall be necessary earliest after 900,000 switching operations and earliest after 1.2 million switching operations the exchange of the diverter switch unit shall be necessary.

The selector drive shall be performed within the diverter switch and the tap-selector drive shall not be performed by using a drive shaft in the transformer tank.

Usage of alternative insulating fluids to mineral oil has to be approved by Beneficiary.

The OLTC shall be in conformity with IEC 60214. OLTC shall have been completely type tested, and related type test certificates shall be supplied with the offer. Only designs which have been type tested in accordance with the relevant IEC standards supplemented by these Specification will be accepted.

The OLTC shall withstand all kinds of through-fault currents without damage. All OLTC connected to uniformly insulated windings shall have at least same LI and/ or AC voltage withstand levels as the related windings.

Any parallel connection of tap changers is not acceptable and, any tap changer designs requiring “forced current splitting” by two parallel winding branches shall not be provided.

All equipment related to the OLTC shall be supplied by the original OLTC manufacturer. This is also applicable for all related accessories. License products etc. are not acceptable for any equipment related to OLTC.

The OLTC(s) shall be mounted from the cover into the tank (in-tank installation) at narrow side(s) of the tank. Tap changers related to the same winding shall be arranged at the same end of the tank. All diverter switches/ interrupter switches of OLTC shall have oil compartments separate from the transformer oil as well as their own closed sub-sections in the oil conservator.

Each diverter switch shall be equipped with an internal suction pipe led to the ground of its own oil compartment and to be connected to external drain and filter valves mounted at a convenient floor height. Suitable oil sampling valves shall be provided for all types of OLTC and shall be mounted at a convenient floor height.

The tap changer heads shall be also equipped with a bleeding duct each, to be connected to Buchholz relay of main tank to avoid any gas collection underneath the tap changer heads. No piping or other

equipment shall be arranged beyond the tap changer head cover to allow lifting of the OLTC inserts without any restriction and without removing (dismantling) of any other equipment.

An oil-flow operated protection relay shall be provided for internal failure protection. This oil-flow relay shall be provided on elbow pipe on tap changer head and shall have gate valve on side of piping to OLTC conservator. In addition a spring-loaded pressure relief device with trip contact and self-locking metal pin-type operation indicator, individually leakage tested with Helium, shall be mounted directly onto the tap changer head.

The drive shaft(s) from motor drive cubicle to tank cover shall be arranged in a straight vertical position (in an angle of 90° from tank cover) and shall not be linked by any articulation installed at the motor drive side outside the cabinet. Appropriate structure/ mounting brackets of an approved design may be provided by the transformer manufacturer for these purposes to meet this requirement. Drive shafts on tank cover shall be suitably and properly protected by corrosion proof metal covers (subject for approval).

The motor drive unit, plus all auxiliary equipment for operation of the tap changer, shall be incorporated in a rigid control cabinet, protection class IP 66 and shall be mounted onto the transformer tank in a convenient floor height.

The driving gear shall be of the belt-type. Oil filled driving gears are not acceptable.

The protective housing shall be of min. 4 mm thick cast aluminium and shall be of an extra-large size to prevent impermissible heat and to allow accommodation of especially supplementary equipment. Cleaning and surface preparation of the equipment shall be in accordance with the relevant Article below.

All supply and control circuits as well as terminals within the cabinet shall be marked accordingly using the rule destination/connection.

The cabinet shall have a swing frame and shall be mounted on a narrow side of transformer and the following main equipment shall be installed:

- Driving motor with adjustable motor protection equipment (setting range: approx. 120% - 150% of rated motor current)
- Main switch for emergency stop (load break switch min. 40 A), equipped with 2 CO spare contacts, marked up clearly with “STOP” on label made of synthetic resin (black characters on red background)
- Operation counter
- Control switch or push buttons for local raise/ lower operations (inside of the cabinet)
- Electrical limit switches
- Mechanical stops in end positions
- Step position indicator with imprinted position numbers, easily legible from ground floor (“1” related to the position with the maximum high voltage)
- Local/ remote switch with 2-CO signal contacts routed to the cabinet terminals

- Voltage supervisory relays for phases of supply voltage and main circuits of control voltage
- MCB's for each auxiliary supply circuit (main MCB as well as MCB's for heating and lightning circuits protection are to be equipped with 1-CO signal contact each routed to the cabinet terminals)
- 2-pol MCB's with 1-CO signal contact routed to the cabinet terminals for each control circuit
- 2-pol MCB's with 1-CO signal contact routed to the cabinet terminals for each transducer circuit
- Hand lamp (controlled via door contact)
- One permanent heater
- One heater, thermostatically controlled
- Min. two conventional position transmitter of the resistor type (resistance module with 10-Ohm resistors per step)
- Min. two additional position transmitter of the resistor type with tap position transducer, output: 0-20 mA, with individual MCB being provided in the motor drive cubicle
- Additional end position contacts (2-NO contacts for each end position separately routed to the cabinet terminals)
- Spare plug socket LV, AC (10 A, DIN) with MCB 10 A
- Terminal blocks with terminals of single insertion type with isolating facilities and test connectors and being universally suitable for connection of solid conductors from 1 mm² up to a cross-section of at least 4 mm², with ten percent spare terminals
- Aluminium plates showing the control circuits and all terminal blocks to be rigidly fixed directly onto the inner side of the front door
- Crank handle for manual operation (2-CO signalling contacts for hand crank being inserted routed to the cabinet terminals)
- Padlock facilities for front door

All equipment installed in the cabinet shall be designed for a cubicle inside temperature of at least 70°C.

A rigid pocket for storing the concerned circuit diagrams, showing the control circuits and terminal blocks, shall be securely fixed on the inner side of the front door.

The requirements to be met by the motor drive unit are summarized below:

- Mechanical indication of step position at the motor drive cabinet
- Transmission of step positions of the transformers to the load dispatch centre and to the local control room
- Manual operation in the case of a failure in the electrical supply system

- Push button remote operation via the local control room and/ or via the load dispatch centre and remote tap position indication
- Step-by-step operation with automatic stop after each step
- No interference of the running tap changing procedure by permanent control switch/ push button action
- Operation from local or remote control switch shall cause one tap movement only unless the control switch is returned to the “off” position between successful operations
- Automatic passage control for central taps
- Automatic restart of tap changing operation after a failure in the electrical supply system, interlocking to be provided against simultaneous raise/ lower operation
- Blocking of end positions by means of limit switches
- Protection to prevent over-running of any tap position to be realized by cam switches. Timer based controls are not acceptable
- Motor operation via push buttons or lower-/ raise-switch
- Hand operation by means of a crank handle
- It must not be possible to operate the electrical drive when the manual operating gear is in use

3.8.2 De-energised Tap Changers (DETC)

Where required, manually operated de-energised tap changers (DETC) of the rotary type shall be supplied for these transformers.

The DETC of the rotary shall be of a robust design with tube and bar material made from glass fibre reinforced plastic (GRP) and shall have an optimized field design through smooth surfaces, soft edges and use of innovative materials. The DETC shall be operated with either of the following drive types:

- Hexagon shaft with switch key
- Hand wheel
- Manual drive
- Motor Drive

The tap changers shall be capable of withstanding at least 180% continuous loading without damage or excessive heating without injury and all kinds of through-fault currents without damage.

The tap changer shall be gang-operated by an accessible crank handle from the ground at convenient floor height, when the transformer is de-energised.

Hand wheels and cranks shall have padlock facilities.

A dial-type indicator with imprinted position numbers, easily legible from the ground, shall be used where “1” is related to the position with the maximum high voltage.

The DETC shall be mounted from the cover into the transformer at a narrow side of the tank. The tap changer head shall be equipped with a bleeding duct to be connected to Buchholz relay of main tank to avoid any gas collection underneath the tap changer head.

No piping or other equipment shall be arranged beyond the tap changer head cover.

The equipment shall be mounted on a narrow side of the transformer and the following main equipment shall be installed:

- Crank handle for manual operation (in a convenient floor height)
- Metal covers for drive shafts on tank cover (if applicable)
- Step position indicator ("1" related to the position with the maximum high voltage)
- Padlock facilities to prevent unauthorised operation

3.9 Insulation Oil

The insulation oil shall be new inhibited naphthenic based mineral oil with anti-oxidant (phenol) additives, and shall have properties such as to avoid formation of copper sulphide under continuous heavy loading conditions even without passivation additives.

It shall be severely hydro-treated, and shall have properties complying with latest IEC 60296, and shall have aging properties meeting Special Applications as specified in this standard. However, the typical dielectric dissipation factor at 90°C shall not exceed 0.001 after laboratory treatment and, the typical flash point shall not be less than 140°C.

Gas absorbing oil (e.g. oil with negative gassing tendency) shall not be provided.

With regard to more efficient detection of corrosive sulphur the oil shall have also passed tests in accordance with IEC 62535, and ASTM D 1275 Method B. Both tests must be fulfilled.

The Bidder/ Contractor is held responsible to prove the dryness (water content in ppm) and all other properties of the oil before utilisation. The water content in ppm and the dielectric strength of the insulation oil shall be also proved at site during commissioning.

3.10 Oil Conservator

Conservator vessels shall be provided in such a position as not to obstruct the electrical connections to the equipment and it shall have sufficient capacity to allow for oil expansion from 0°C to 120°C. Conservator vessels shall be sealed against each other and shall not be located directly on (beyond) the tank cover or at the alongside of equipment tank.

Main tank conservator vessels shall be equipped with elastic diaphragms of the air-bag type.

Magnetic type oil level indicators showing the full level range shall be fitted to all oil vessels.

Tap changers of power transformer shall have their own closed sub-section(s) in the conservator. To avoid unnecessary permanent stresses from switching compartment(s) of OLTC to that of the equipment main tank all conservator compartments shall be designed in such a manner that at the same oil temperature all oil levels are nearly equal, and the installation level of the conservator vessel(s) shall not

exceed 3.5 m above tap changer head(s) to avoid impermissible stresses at any OLTC compartment when the diverter and/ or vacuum switches are drawn out for maintenance.

The conservator vessel shall be fully vacuum proof and designed in such a way that it can be completely drained by means of drain valves. Shut-off valves of the gate valve type shall be provided directly at the conservators for all oil piping connected to the conservators in addition to drain and other valves etc. to be mounted at a convenient floor height. Conservator vessels shall be furnished with cleaning openings in such a manner as to avoid damage of rubber diaphragms, i.e. the front walls of the conservators shall be completely removable and shall be equipped with two lifting lugs each.

A vacuum application valve and vacuum equalising valves for diaphragm(s) and for OLTC conservator(s) shall be provided between the air-expansion pipes to the Silicagel breathers. The vacuum application valve and the vacuum equalising valves between the conservators and for diaphragms shall be rigidly fixed at a convenient floor height.

Each conservator vessel shall be fitted with a Silicagel breather of the maintenance-free type (Messko/ MR type MTraB or equivalent) and, the supply voltage for the same shall be provided by the DC supply of the substation. Refrigerator type of dehydrating breathers will not be accepted. The containers of the dehydrating breathers shall not be of transparent plastics of any kind.

In view of excessive humidity the breathers shall be larger in size.

The Silicagel filling capacity of each breather for transformers shall be dependent on the size of the transformer, i.e. each having a minimum filling capacity of:

- Minimum 1 kg for OLTC conservators (if any) and for main conservators of equipment up to a rated power of 8.5 MVA per unit.
- Minimum 2 kg for main conservators of transformers up to 50 MVA per unit.

Breathers for transformer main conservators shall be provided with a self-learning system with condition-dependent control of the bake out operation by monitoring of humidity and with temperature-dependent specification of the optimum bake out time.

The dehydrating breathers shall be rigidly fastened by approved side mounting rods onto brackets at an accessible position in a convenient floor height.

3.11 Piping and Valves

All piping required for the connection/ filling of the various parts of the transformer as well as the valves required for oil sampling, draining, filtering, connection of the radiators, drain and vent plugs, etc. are to be included.

The inner diameter of vacuum application pipes shall be at least 40 mm, and that of main expansion pipes to main conservator shall not be less than 80 mm and that for other piping other than small piping to Buchholz gas testing devices shall not be less than 25 mm.

All piping on tank cover shall be provided with suitable flanges for removal for transport etc. Flexible oil-pipes are not acceptable.

Isolation valves shall be provided at the conservator to cut off the supply and to drain the conservator.

All flanges to which the valves are to be connected shall be welded leak-proof onto transformer tank and piping etc. All piping shall be rigidly supported by corresponding and proper appliances.

All valves for draining, oil sampling, filling, filtering, vacuum application and vacuum equalising shall be mounted at a convenient floor height and shall be equipped with approved rigid padlocking facilities provided with padlocks for a master key system for each transformer.

All isolation valves and shut-off valves other than butterfly valves for radiators shall be proper slide valves, i.e. globe and/ or gate valves equipped with adequate operation handles and position indicators ("open"/ "shut"). Ball-type valves of any kind shall not be provided.

All gate valves in any piping to conservators shall be arranged such as to avoid gas collection in the heads of the same.

All drain valves and filter valves shall have adapters with 1½" male thread fitted with screwed captive cap. Oil sampling valves for transformer main tank shall have the same with ¾" male thread. Any kind of female threads other than in caps fitted onto sampling and filter valves in accordance with Specification are not acceptable.

Suitable oil sampling valves having adapters with 1½" male thread fitted with screwed cap shall be provided for all kinds of OLTC.

3.12 Measuring, Monitoring and Protection Equipment

The equipment of this item shall be wired up to terminal blocks inside the control kiosk. The complete wiring shall be of highly flexible stranded copper and shall be furnished with approved slip over ferrules at both ends.

All supply and control circuits as well as terminals within the cabinet shall be marked accordingly using the rule destination/connection.

All monitoring equipment arranged outside the cabinet(s) shall be of protection degree IP 55 and shall be completely made of corrosion free material. Sight glasses shall be of sand-storm proof laminated and UV-stabilised safety glass. No sight glasses of transparent plastics shall be provided for any indicators or inspection windows.

All equipment installed in control and marshalling cabinets shall be designed for a cubicle inside temperature of at least 70°C.

The following standard accessories shall be provided for each power transformer unit:

- 1 (one) twin float Buchholz relay (DN80) for transformer tank equipped with 2-NO contact for signal and 2-NO contacts for trip. The pipes connecting the Buchholz relay shall have gate valves on the conservator and tank side (easily accessible from tank cover) to enable dismantling of the relay without oil leakage. Small piping from Buchholz relay to gas sampling and testing devices shall be covered throughout the total length by approved flexible steel conduits as specified below.

- 1 (one) single-float gas-detector relay (DN25) with 2-NO alarm contacts connected to the highest point of main conservator as a leakage detector for diaphragm.

- 1 (one) protective relay with 2-NO trip contacts (MR or equivalent) for diverter switch of OLTC. The pipes connecting the relay shall have gate valves on the conservator side (easily accessible from tank cover).

- 1 (one) pressure relief device of spring loaded type (Messko/ MR or equivalent) with self-locking metal pin-type operation indicator and 2-NO trip contacts, individually leakage tested with Helium,

installed in metal housing of protection degree IP 65 for OLTC. The micro-switch of the device shall be suitable wired up to a metal cable terminal box of protection degree IP 55 with terminals suitable to receive crimped flexible conductors with a cross-section up to 2.5 mm².

- 1 (one) pressure relief device of spring loaded type (Messko/ MR or equivalent) with self-locking metal pin-type operation indicator and 2-NO trip contacts, individually leakage tested with Helium, installed in metal housing of protection degree IP 65 (for transformers above 63 MVA per unit two pressure relief valves arranged on opposite ends on the tank cover). The micro-switch of the device shall be suitable wired up to a metal cable terminal box of protection degree IP 55 with terminals suitable to receive crimped flexible conductors with a cross-section up to 2.5 mm².

- 2 (two) dial type thermometer for top oil temperature (Messko/ MR - System Tracy or equivalent) with radial type main and maximum pointer, remote indicator (PT100), and five adjustable contacts for oil temperature alarm and trip (at 95°C and 105°C) and switching OFF the cooling groups (at 65°C and 55°C). The range of temperature indication shall be from 0°C to 140°C. In addition, one signal conditioner with 4-20 mA output, with individual MCB, for remote temperature indication shall be provided in the control cabinet.

- 1 (one) thermal replica to be connected to each power winding via current transformer. These current transformers shall have accuracy 3 (three) percent, and the rated primary current shall correspond to the rated current of the related transformer winding. The effective resulting rated secondary current shall be 2 Amps. Matching units between current transformers and thermal replicas shall not be provided.

- 1 (one) dial type thermometer (Messko/ MR - System Tracy or equivalent) with radial type maximum pointer and heating coil in thermometer pocket in tank cover for each thermal replica with two remote indicators (PT100) and five adjustable contacts for winding hot spot temperature alarm and trip (at 115°C and 130°C) and switching ON the cooling groups (at 75°C and 85°C). The range of temperature indication shall be from 0°C to 160°C. In addition, a signal conditioner with 4-20 mA output, with individual MCB, for remote temperature indication shall be provided in the control cabinet.

- 1 (one) oil level indicator for each main conservator vessel.

- 1 (one) type oil level indicator for each conservator vessel for OLTC.

3.12.1 Thermometers and Thermostats

Thermometers and thermostat shall be provided with contact units adjustable to scale and easily accessible when removing the lid. Testing of the switching points shall be easily possible by moving the pointer manually. The measuring system shall not require any recalibration.

Thermometers shall be arranged in an approved manner under corrosion-proof covers near the control kiosk. Capillaries shall be properly protected throughout the total length by appropriate flexible steel conduits and shall enter the instruments from bottom side. To avoid damages at the connection points of capillary tubes to temperature detectors all heads of these sensors shall be suitably and completely covered. Thermometer pockets shall be arranged in the vicinity nearest to the active part and shall not be subjected to impermissible stray flux.

3.12.2 Oil Level indicator

Oil level indicators shall be installed inclined downwards; the angle shall be about 30°. The scale shall show a horizontal lettering, MIN, the base temperature (+20°C or +30°C, as specified in the technical data sheet) and MAX, arranged in a sector of about 140°, to be easily visible and readable at operators standing location. Floats shall be made of oil resistant solid material, resistant to heat up to 160°C. For oil vessels equipped with rubber bag minimum two pivoted float rollers shall be used, with a float arm >1000 mm the number of pivoted float rollers shall be four.

Oil level indicators shall be of magnetic type with separate sensor and indicating unit. A minimum of 2-NO contacts shall be provided, designed for a contact load of 250VDC/0.4A (non-inductive) and 250VAC/5A cos φ = 1, adjusted to maximum and minimum oil level.

Where an analogue output is required terminals shall be arranged in an additional connection box equipped with terminal row(s) and suitable cable gland(s). The output signal shall be 4 … 20 mA for the full level range.

3.12.3 Oil-flow operated protection relay

The casing of oil-flow operated protection relays shall be made of weather-resistant cast aluminium alloy, thoroughly painted, having flanges minimum DN25 with 4 bore holes. Covered sight glasses shall be provided, arranged in opposite position to each other. It shall be equipped with a terminal box being dust-proof and weatherproof by IP-code IP 56 in accordance with IEC 60529. Cable glands have to be arranged in a way that rain water drains off and does not stay on sealing, cable glands are to be installed in downward direction. In the inner of the connection box a connection diagram shall be shown.

The oil-flow operated protection relays shall have a testing feature; it shall be installed in the pipe between the tap changer and the conservator as close as possible to the tap changer head by ascending towards the conservator by 2° to 4°. Contacts shall be of magnetic type, designed for a contact load of 250VDC/5A (non-inductive) and 250VAC/6A cos φ > 0.8. It shall withstand shocks (10 g, 11 ms), vibrations (2 – 200 Hz, 1 g) and magnetic fields (25 mT) in any direction resp. polarity.

3.12.4 Buchholz relay

Buchholz relays shall be twin float and shall be designed for a pipe diameter 80 having DN80 flanges with 4 bore holes. It shall be equipped with a gas sampling and testing device made of aluminium alloy, equipped with sight-glass, and to be operated from the ground at convenient floor height. The casing of the Buchholz relays shall be made of weather-resistant cast aluminium alloy, thoroughly painted. Covered sight glasses shall be provided, arranged in opposite position to each other. It shall be equipped with a terminal box being dust-proof and weatherproof by IP-code IP 56 in accordance with IEC 60529. Cable glands have to be arranged in a way that rain water drains off and does not stay on sealing, cable glands are to be installed in downward direction. In the inner of the connection box a connection diagram shall be shown.

The Buchholz relay floats shall be hollow, the damper shall be held by magnets. The Buchholz relay shall have a test valve and a test key. For easy access and connection to the gas sampling and testing device, the test valve as well as the test key shall be accessible from the front of the Buchholz relay (in oil-flow direction) above the sight glass.

The Buchholz relay shall be installed in the pipe between the main tank and the conservator ascending towards the conservator by 0° to 5°. Contacts shall be of magnetic type, designed for a contact load of 250VDC/5A (non-inductive) and 250VAC/6A cos φ > 0.8. It shall withstand shocks (25 g, 6 ms) and vibrations (2 – 200 Hz, 1 g) in accordance with IEC 60721-3-4 class 4M6. It shall also withstand magnetic fields of up to 25 mT in any direction resp. polarity.

With accumulation of gas in the top of the Buchholz Relay the alarm contact shall be actuated. With loss of insulation liquid the trip contact shall be actuated. Also with a sudden raise of the flow rate through the Buchholz Relay the trip contact shall be actuated, too.

The pipes connecting the Buchholz relay shall have gate valves on the conservator and tank side (easily accessible from tank cover) to enable dismantling of the relay without oil leakage. Small piping from Buchholz relay to gas sampling and testing devices shall be covered throughout the total length by approved flexible steel conduits as specified below.

3.13 Name Plates and Other Designation Plates

Plates made of corrosion-proof material rigidly supported shall be supplied as specified hereinafter. Plates arranged outside control and marshalling cubicles shall be of polished stainless steel of top quality only, i.e. Cr-Ni-Mo-Ti alloyed stainless steel of grade EN 1.4571 and/ or ASTM 316Ti (background clear, engraving black, 2 mm thick, depth of engraving 0.5 mm). Plates arranged inside control and marshalling cabinets other than OLTC motor drive cubicle shall be made of engraved polished Cr-Ni alloyed stainless steel (at least grade EN 1.4301 or ASTM304). Plates arranged in OLTC motor drive cubicle shall be made of aluminium.

- A rating plate in accordance with IEC 60076. This plate shall also indicate the LI and AC withstand levels for all windings and.

- A connection diagram plate showing in an approved manner in detail the internal connections and the voltage vector relationship of the several windings in accordance with IEC and in addition a plan view of the transformer/ reactor giving the correct physical relationship of the terminals.

- A loading plan plate showing transport dimensions and masses. This plate shall also warn the erection staff, not to remove any cover before filling the tank with oil to such a level where the windings are not exposed to the atmosphere.

- A plate showing the location and function of all valves and air release cocks, plugs and all monitoring equipment, etc. in the plan view and in the different elevations of the transformer. This plate shall also warn the operator to refer to maintenance instructions before applying vacuum treatment and not to operate vacuum application and vacuum equalising valves after oil filling under vacuum.

- Identification plates, alpha-numerical numbered in accordance with the relevant standard, for all fans, marshalling cabinets, breathers, valves, cocks, accessories etc. (minimum size: 105 mm x 50 mm) rigidly fastened by rivets on unpainted unpolished base plates of same material. In addition the function (description) of the related devices shall be clearly indicated on these plates. The alpha-numerical numbers on the identification plates shall be of such a size as to be clearly legible from the floor level.

3.14 Painting

Due to the unfavourable atmospheric conditions, particular attention shall be given to the corrosion protection of all metal parts of equipment not installed in air-conditioned rooms.

The following treatments shall be applied:

3.14.1 External Surfaces

All steel surfaces of solid type transformer tanks, conservators, cable boxes, etc. shall be sand blasted in accordance with DIN 55928, Part 4 (equivalent to SIS 055900), and all surfaces of radiators and corrugated tank walls shall be thoroughly cleaned of rust, scale, grease and dirt and other foreign matter and all imperfections shall be removed by means of approved methods.

Then the following painting systems shall be applied as specified below.

Solid type transformer tanks, conservators, cable boxes etc.:

One (1) primer coat Two-component epoxy zinc-phosphate or Two-component epoxy zinc-dust	μm	100
One (1) intermediate coat Two-component epoxy micaceous iron oxide	μm	100
One (1) top coat Two-component polyurethane	μm	40
Minimum total coating thickness (dry-film, incl. tolerances)	μm	240

If any hot-dip galvanised steel parts will be provided, e.g. for access ladders etc., the same painting methods as above shall be applied. However, instead of a primer coat as specified above one adhesive base coat shall be applied. In this case, the minimum thickness of galvanising shall be 55 μm. However, a two-component epoxy zinc-dust coat instead of hot-dip galvanising is preferred. Radiators shall not be hot-dip galvanised.

In case of any kind of aluminium and/ or ordinary stainless steel (Cr-Ni alloyed only) the primer coat as above may be omitted, and the minimum thickness of the "intermediate" coat and of the top coat as specified above shall be at least 50 μm each (total minimum 100 μm).

The final coat of painting shall be non-porous and of homogeneous quality and shall be of a uniform shade of colour code RAL 7038 (agate-grey). For OLTC equipment and sub-supplier's accessories only, the colour code as per manufacturer's standard is accepted, on condition that a two-component epoxy based undercoat (minimum thickness 80 μm) and a two-component polyurethane based top coat (minimum thick-ness 8 μm) will be applied. The total dry-film thickness shall not be less than 160 μm.

Mechanical damage of painting shall be repaired at site with the same original type of painting as above.

3.14.2 Internal Surfaces

Inside the power transformer vessels, sand-blasting shall be performed in accordance with DIN 55928 Part 4 (equivalent to SIS 055900). After that, an oil and gas resistant insulating coating shall be applied to all steel surfaces in contact with oil or gas (e.g. tank, cover, core steel plates, etc.).

The minimum dry-film thickness shall be 35 μm. The applicable colour code shall be RAL 9010 (white) or equivalent.

3.15 Capitalisation of Losses

When evaluating the individual tenders received from the various Tenderers the transformer losses will be capitalised.

The Beneficiary's evaluation of a tender will take into account, in addition to the tender prices, the following costs and factors that will be added to each tenderer's price in the evaluation, using pricing information available to the Beneficiary, in the manner and to the extent indicated below:

- The evaluation shall be based on the evaluated cost for fulfilling the contract in compliance with all commercial, contractual and technical requirements set forth in this tender document. Prices shall be based on Incoterms DAP (Delivered at Place). In arriving at the evaluated cost, the price associated with non-material deviations proposed by the tenderer will be used, if applicable. If such a price is not given, the Beneficiary will make its own assessment of the cost of such a deviation for the purpose of ensuring a fair comparison of tenders;
- The guaranteed performance and productivity of the offered Facilities, reference is made to the methodology specified in the Technical Specification of power transformer. For the evaluation of Power Transformers an amount per full kW of 9000 € for no-load losses and 3500 € for load losses will be added to the offered price. For the evaluation of three winding Power Transformers an amount per full kW of 9000 € for no-load losses and 3500 € for load losses on primary winding and 2500 € on secondary and tertiary winding will be added to the offered price.

- Where tenders include for the undertaking of minor work or the provision of services or facilities by the Beneficiary in excess of the provisions allowed for in the tender documents, the Beneficiary shall assess the costs of such additional work, services and/or facilities during the duration of the contract.
- Tenders offering facilities which (i) are not in full technical compatibility with other already installed facilities, (ii) not comply with environmental standards, and which cannot prove availability of services may be rejected by the Beneficiary.
- Tenders with documents not being complete with regard to properly filled in technical data sheets as required in the technical requirements may be rejected by the Beneficiary.

Loss determination shall be performed in accordance with IEC 60076. For three winding transformers IEC 60076-8 sub clause 7.7 is applicable.

The auxiliary power losses for cooling fans and pumps (if any) of transformers will be added to the load losses.

3.16 Guaranteed Values and Penalties

The guaranteed values tendered by the CONTRACTOR in the Technical Data Sheet shall be strictly observed by both the CONTRACTOR and the BENEFICIARY.

For the guarantee data not mentioned hereinafter tolerances in accordance with IEC 60076 shall apply.

3.16.1 Losses

Losses value of the power transformer shall comply with the EU REGULATION No 548/2014 on implementing Directive 2009/125/EC or the European Parliament and of the Council with regard to small, medium and large power transformers.

If the no load losses of a power transformer exceed the guaranteed value, a penalty as indicated in the commercial part of contract for each full kW in excess of the guaranteed value will be deducted from the Contract Price.

If the load losses (plus auxiliary power losses) of a power transformer exceed the value guaranteed, a penalty as indicated in the commercial part of contract for each full kW in excess of the guaranteed value will be deducted from the Contract Price.

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

3.16.2 Rated Power and Output

If the test of temperature rise carried out on any transformer should reveal that the temperature rise of the transformer exceeds the values guaranteed, the rated power and output of the transformer at operation conditions as specified above will have to be down rated to such a degree as to obtain the temperature rise guaranteed. For each kVA of the actual transformer rating below the guaranteed rated power and output as specified previously, a penalty as indicated in the commercial part of contract will be deducted from the Contract Price of this transformer and all those transformers of the same design unless the CONTRACTOR, at his own expense, gives evidence that those transformers fulfil the guaranteed values.

3.16.3 Noise Level

Should the noise level (at maximum power output and at U_{max}.) at the specified distance exceed the required values for power transformer, the Beneficiary will penalise the excess at a penalty rate as indicated in the commercial part of the contract. Hereby is understood that values of 0.5 dB(A) and above will be rounded up to the next full two dB(A).

3.17 Rejection

The Beneficiary shall have the right to reject any transformer if the actual values are in excess of the guaranteed values by more than the margins specified hereunder (including the tolerances):

Value	Margin
No load losses	+ 0%
Load losses (at full rated power)	+ 15%
Total losses	+ 10%
Noise level (sound pressure)	+ 3 dB(A)
Temperature rise limit	+ 1.0 K

For all of the other values (including specified maximum and minimum power output of VSR) the margins stated in IEC standards are applicable, unless specified otherwise elsewhere in this Specification.

3.18 Transport

Transport of the power transformer to the point of destination shall be organised in accordance with the recommendations stated in the CIGRE TB 673 Guide on transformer transportation and other relevant documents.

The core and coils shall be completely dried before shipment and shall be assembled with the transformer tank.

To facilitate safe handling and shipping of power transformer, as many external accessories as possible, including the bushings, shall be removed and replaced with special shipping covers. Transport of completely assembled power transformer is not acceptable.

Butterfly valves and/ or other isolating valves mounted directly on tank walls shall not be removed for transport to avoid ingress of humidity during installation at site. All of those parts dismantled for

shipment shall be fitted again only after filling the tank with oil to such a level where windings will not be exposed to the atmosphere.

Bushings, radiators and other accessories which may be affected by moisture shall be moisture proof packed in seaworthy packing. Packing material, including oil drums, shall not be returned.

As far as is practicable the power transformer shall be supplied and shipped with its initial oil filling in the main tank.

If the transportation of the power transformer with oil filling is not practicable, it shall be despatched with automatic dry nitrogen or dried air filling arrangement. During transport, each power transformer shall be equipped with devices maintaining a constant pressure in the equipment concerned and facilitating tapping up by suitable automatic facilities from reserve bottles. In this case, drained oil of at least the same quality as used during factory tests shall be delivered in drums or containers in a sufficient quantity to refill the transformer and to replenish losses during subsequent processing at site.

3.19 Impact Recorders

Electronic transport monitors (impact recorders with electronic data storage), capable of indicating all horizontal and vertical impacts, shall be rigidly attached to each power transformer. Two impact recorders shall be provided for each transformer unit as above.

Provisions must be made to ensure that these indicators are sealed, that they will be completely functional without interruption of indicated records during the entire period of shipment, including loading and unloading, and to ensure that the Beneficiary will receive clearly indicated data by breaking the seal. Instructions for interpretation of the recorded data and a user manual for the equipment shall be provided prior to shipment.

4. INSPECTIONS AND TESTS

Transformer shall be subjected to inspections and witness tests to be performed at the manufacturer's premises and test shop, recognised and certified by the relevant IEC/ISO standards, and at site, as specified hereinafter to verify their conformity with the guaranteed and other design data.

The tests shall be performed in accordance with the latest issues of the Recommendations of the International Electrotechnical Commission (IEC-standards) supplemented by this specification. Tests shall only be conducted with the aid and in accordance with test specification(s) and standards clearly identified as approved for use by the Beneficiary, and, where applicable, employ test instruments of suitable quality calibrated to manufacturer's recommendations by a reputable agency within the previous six (6) months.

The transformer being ready for test shall be completely assembled including all original equipment and original accessories.

In the event of test results not satisfying the requirements of the Technical Specification or guaranteed performance, the Bidder/ Contractor shall improve the equipment until satisfactory results are obtained and shall conduct retests at his own expense. All expenses incurred by the Beneficiary in attending the retest shall be borne by the Bidder/ Contractor.

Should any one of the results of the tests prescribed in the Technical Specifications fails a third time to satisfy the requirements of the Specification, or if the equipment does not satisfy the guaranteed performance, the Beneficiary may at his own volition and option refuse acceptance of the equipment

and require the Equipment to be replaced or alternatively accept the Equipment upon reduction in the Contract Price.

Tests on transformer shall be performed at manufacturer's works, except if the capability of the testing laboratory at manufacturer's works is insufficient for conduction of the tests in full compliance with IEC and the contractual specifications.

In case of any reason that the transformer cannot be tested at manufacturer's works with all external components and fittings that may affect the performance during the tests mounted as in the intended operating condition, agreement must be found between the manufacturer and the purchaser. Such agreement may necessitate testing of the transformer in a different location.

The Contractor is obliged to submit a detailed test procedure - including detailed test connections for all dielectric tests and data of test equipment used for impulse tests - for approval in due time, prior to the tests (at the latest three months before testing). Detailed test schedules separately for each unit showing working-day-wise when each of the witness tests will be carried out (max. 10 hours per working day, and at day time) shall be submitted for approval along with the test procedure as above.

Test procedures and test protocols shall be subject to the approval of the Beneficiary. Compilation of routine test protocols shall be covered by a table of contents, clearly structured by the relevant standards and their sub-clauses.

The Contractor shall notify the Beneficiary at least 30 days in advance of the date and the place at which any equipment or Work will be ready for testing or inspection.

All test protocols shall be submitted, test protocols shall clearly show acceptance criteria as e.g. expected value and appropriate tolerances.

The cost of making any test shall be borne by the Contractor. This shall apply to tests performed at the place of manufacture, the Site or elsewhere.

The costs for those tests that have not been mentioned expressly in the Contract Documents, but which are routine for the type of work involved or whose necessity can be considered as understood in connection with the various works, shall be borne by the Contractor.

The costs for the tests shall include also the supply of all samples, machinery, instruments, accessories for, as well as all reports and certifications about the test, as well as the presence of corresponding competent personnel.

The following tests shall be performed in the presence of the Beneficiary:

Routine Tests

- Measurement of voltage ratio at all tap positions.
- Check of vector group.
- Measurement of winding resistances of all phases (phase to neutral, where applicable) and at all tap positions.

- Measurement of no load losses and current from 90% to minimum 120% of rated voltage and/ or vice versa in 10% intervals, at rated frequency. A respective magnetising curve current from 90% to approx. 125% shall be added to the test report.

- Measurement of load losses and impedance voltages/ short-circuit impedances at rated frequency at principal tap position(s) and all extreme positions.

- Lightning impulse test for all power windings of transformer. The following test sequence shall be applied:
    - One or more reduced level full impulse (lines and neutral)
    - One reduced level chopped impulse (lines only)
    - One full level full impulse (lines and neutral)
    - One reduced level chopped impulse (lines only)
    - Two full level chopped impulses (lines only)
    - Two full level full impulses (lines and neutral)
    - One or more reduced level full impulse (lines and neutral)

  The peak value of chopped impulse shall be at least 1.1 times the amplitude of full impulse. However, only for cases where the over-swing to the opposite polarity is greater than 30%, it is permissible to add a series connected damping resistor in the chopping circuit to limit the amount of over-swing to the opposite polarity. When a resistor is added in the chopping circuit, the resistor shall not decrease the over-swing to the opposite polarity essentially below 30% of the amplitude of the chopped wave. Neutral points of the windings under test shall not be grounded through resistors other than a measuring shunt. The best achievable impulse-shape shall be applied by serial and/ or parallel connection of the required number of stages of the impulse generator which can be applied to the test object by any required combination of parallel and/ or serial connection of all available stages of the impulse generator without any restriction. With regard to the wave-shape wider tolerances may be accepted as per IEC 60076. Impulse tests on neutrals shall be applied directly with all line terminals earthed, either solidly or through adequate resistors. The test voltages shall be measured via appropriate voltage dividers and shall be clearly indicated by peak-voltmeters and/ or in oscillographic or digital records.

- Separate-source AC withstand voltage test in accordance with IEC 60076-3 (2000), clause 11 (including measurement of charging current) after impulse tests. The peak value of voltage shall be measured during this test.

- Induced AC voltage withstand tests
    - in accordance with IEC 60076-3 for transformers having uniformly insulated windings only (for three-phase windings with symmetrical three-phase voltages induced in the three winding phases),
    - monitoring of partial discharges for all windings of Um= 100 kV and above during tests as per IEC 60076-3.
    - measurement of partial discharges, in accordance with IEC 60076-3 at all transformer windings of Um= 100 kV and above.

The peak value of the induced test voltage shall be measured during all induced AC voltage withstand tests. Partial discharge monitoring (after separate source over-voltage tests) and partial discharge measurements shall be performed at a test area and under test conditions where the background noise and/ or any other disturbances will be less than 100 pC (at day time as above). Partial discharge tests shall be performed after successful completion of all other dielectric tests.

- Dissolved gas in oil analysis by chromatography prior to all tests and after completion of dielectric tests (check test reports only).
- Frequency response analysis (SFRA-test) using swept frequency in a range of 10 Hz to 2 MHz This test is to provide base line readings of the windings in as-new condition. The test shall be performed after successful completion of all dielectric tests.
- Measurement of the capacitance and insulation power factor at 10 kV. The tan delta value at 20°C shall be less than 0.5%.
- Measuring of insulation resistance at 2500 V DC (R15, R60, R600). The polarisation index R10min / R1min shall be greater than 1.1.
- Measurement of the insulation resistance (R60) between the core and tank at 2500 V DC.
- Measurement of ratio and polarity check on current transformers.
- Measurement of the harmonic content of no-load current at 90%, 100%, 110% and 120% of rated voltage at rated frequency (after no-load test).
- Determination of efficiencies at 125%, 100%, 75%, 50% and 25% load at power factor 1.0 and 0.8 (documentation only).
- Operation tests on OLTC.
- Measurement of zero sequence impedance (at rated frequency) at principal tap(s) and all extremes.
- Applied over-voltage test at 2000 V AC, 60 sec. on wiring, control and supervisory equipment (1000 V AC plus 2 x Un on motors as per IEC 60034-1, and 500 V AC on PT 100, all electronic devices disconnected).

Type Tests and Special Tests

- Lightning impulse test for all power windings of transformers not having windings of Um= 100 kV and above. The following test sequence shall be applied:
    - One or more reduced level full impulse (lines and neutral)
    - One reduced level chopped impulse (lines only)
    - One full level full impulse (lines and neutral)
    - One reduced level chopped impulse (lines only)
    - Two full level chopped impulses (lines only)
    - Two full level full impulses (lines and neutral).

- One or more reduced level full impulse (lines and neutral in case of ZnO elements)

The peak value of chopped impulse shall be at least 1.1 times the amplitude of full impulse. However, only for cases where the over-swing to the opposite polarity is greater than 30%, it is permissible to add a series connected damping resistor in the chopping circuit to limit the amount of over-swing to the opposite polarity. When a resistor is added in the chopping circuit, the resistor shall not decrease the over-swing to the opposite polarity essentially below 30% of the amplitude of the chopped wave. Neutral points of the windings under test shall not be grounded through resistors other than a measuring shunt. The best achievable impulse-shape shall be applied by serial and/ or parallel connection of the required number of stages of the impulse generator which can be applied to the test object by any required combination of parallel and/ or serial connection of all available stages of the impulse generator without any restriction. With regard to the wave-shape wider tolerances may be accepted as per IEC 60076. Impulse tests on neutrals shall be applied directly with all line terminals earthed, either solidly or through adequate resistors. The test voltages shall be measured via appropriate voltage dividers and shall be clearly indicated by peak-voltmeters and/ or in oscillographic or digital records.

- Measurement of the acoustic sound level at rated voltage and frequency.

- Measurement of the cooling losses at rated supply voltage and frequency, and check of rotation direction of fans.

- Steady state temperature rise tests at every cooling method at related rated conditions and for long-time emergency loading conditions as per IEC 60076-7 as specified in the relevant Article before. Each of the heat-run tests shall be performed at the highest current taps of the windings under test with the highest applicable total losses to be applied. In case of auto-transformers the winding temperature rises shall be determined in the applicable highest current taps for both, the common and the series winding (i.e. for both, step-down and step-up operation). During all of the heat-run tests the top oil temperature shall be measured in tank cover directly in top oil by approved screwed-in temperature sensors at a minimum of three points as approved. The top oil temperature may be alternatively measured in the hot transformer oil by at least three thermometer pockets as specified above. By agreement the top oil temperature may be additionally measured directly in the hot oil of inlets of the cooling equipment. In case of measurements of top oil temperatures taken in pockets the final top oil temperature shall be corrected by +2 K. The bottom oil temperature shall be measured by at least two points placed either directly into return headers or at return headers of cooling equipment. Measurements on radiator and/ or tank walls are not acceptable. Location of all measuring points, including those for measurements of ambient air temperature, is subject for approval. The winding hot-spot temperature rise shall be determined by calculation only using hot spot factor as specified previously. The oil used during type tests shall have same or higher kinematic viscosity as final oil used at site for operation.

- Thermo-visual infra-red measurements during temperature rise tests for auto-transformers

- Tests on Transformer Tank and Accessories

  Prior to the acceptance tests, the Contractor/ Manufacturer shall submit the following test certificates as a minimum requirement:

- Vacuum test on tank and all other oil-filled compartments (to be applied at 1.5 mbar for at least 5 hours)
- Pressure test on tank and all oil filled compartments at min. 1.0 bar measured on tank bottom for at least 24 hours
- Insulating oil used during factory tests and at site
- Bushings
- Current transformers
- Buchholz relays
- Tap changers and related equipment
- Core losses of laminations (W17/50)

5. TECHNICAL DOCUMENTS

5.1 Language

Unless the Contractor is a national of the Beneficiary's country and the Beneficiary and the Contractor agree to use the local language, all Contract Documents, all correspondence and communications to be given, and all other documentation to be prepared and supplied under the Contract shall be written in English, and the Contract shall be construed and interpreted in accordance with that language.

If any of the Contract Documents, correspondence or communications are prepared in any language other than the governing language, the English translation of such documents, correspondence or communications shall prevail in matters of interpretation.

5.2 System of Measurement

All documents shall be prepared and all Works shall be carried out using SI (System International) units of measurement. Metric units shall be used in all documents, correspondence, technical schedules and drawings. On drawings or printed pamphlets where other units have been used, the metric equivalent shall be marked in addition.

5.3 Preparation of bids

The Bidder shall submit the following documents in its Bid:

Certification according to ISO 9001, ISO 14001 and OHSAS 18001/ISO 45001 or equivalent, and description of quality assurance system, and environmental management. This requirement refers to Bidder, subcontractors and manufacturers, where applicable.

Time Schedule, depicting mainly design/submission of drawings, manufacturing, factory acceptance testing, shipping time, customs clearance, inland transport, civil works, erection works, commissioning, trail run, training, and final completion date.

Technical Data Sheets (fully completed schedules, with all required data properly filled in). Only technical data from Subcontractors and/or Suppliers, authorizing the Bidder to be included in its Bid and mentioned by the Bidder shall be given in the technical schedules.

Lists of Deviations: A Bidder shall complete and submit a List of Deviations from the Technical Data Sheets and Beneficiary's Requirements. In case of absence of deviation, the respective statement ("no deviation") in the form provided, duly signed, shall be provided within the Bid. The Bidders are encouraged, for the deviations so identified, to provide the reason for such deviation that will help to avoid some unnecessary clarifications. Any deviation from requirements will be evaluated by Beneficiary's Evaluation Committee. Bidders are cautioned that any major deviation will be a cause for rejection of the Bid.

Filled in **Manufacturer's Authorization Form** if the Bidder is not itself the manufacturer.

Manufacturing Capacity: The Bidder shall provide adequate information to demonstrate that it has the capability to meet the requirements for all Major Items of Plant and Equipment.

Drawings and Supporting documents (catalogues, literature, etc.) for the Proposed Major Items of the Plant and Equipment.

Separate Dossier for Proposed Manufacturers: Where the Bidder is not a manufacturer, the Bidder shall submit the following documents for proposed manufacturer of the Major Items of Plant and Equipment completed by the Bidder with technical data/information having as source the primary documents of Subcontractors/Manufacturers/Suppliers (and which can be confirmed by them, if found necessary):

- **Manufacturer's Technical specifications** for each relevant part of the Major Plant and Equipment as offered by the proposed Manufacturer (Manufacture's Technical specifications in such detail that compliance with the technical criteria and requirements can be verified. This documentation shall, as minimum, concern the major equipment/components);
- **Quality assurance documents** (ISO certificates for design, manufacturing, test, supply of the proposed main equipment);
- **Drawings** for the proposed Major Items of the Plant and Equipment;
- **Supporting documents** (catalogues, literature etc.);
- **Manufacturing Capacity:** The Bidder shall provide adequate information to demonstrate that the proposed manufacturer has the capability to meet the requirements for all Major Items of Plant and Equipment.

5.4 Documents associated with the implementation of the project

5.4.1 Basic Requirements

The complete delivery has to be documented in a totally complete manner and in its entire scope. The complete documentation, drawings, manuals, etc. shall be included in the supply and will be subject to the approval of the Beneficiary according to the requirements of this Specification.

Brochures, Manuals, Leaflets etc. being part of the documentation shall be provided with a cover sheet, following the a.m. rules. The practice of cover sheets is restricted to that use only. Inconsistent and non-specific statements and representations between project specific documents and a standard documentation will not be accepted. Documentation of the same type shall be similar in size and form.

More detailed documentation requirements of further parts of technical specification shall be regarded.

The general documents, calculations, certifications, manuals, drawings, etc. relating to the manufacturing works, which are to be prepared during detailed design by the Supplier are listed here below.

5.4.2 Time Bar Schedule and Work Breakdown Structure

A time bar schedule is a listing of the project's milestones, activities, and deliverables, with intended start and finish dates, resource allocation and duration, linked by dependencies and scheduled events.

Work breakdown structure (WBS) is a hierarchical and incremental decomposition of the project into phases, deliverables and work packages. The detailing level shall be:

- No single activity or group of activities at the lowest level of detail of the WBS to produce a single deliverable should be more than 80 hours of effort
- No activity or group of activities at the lowest level of detail of the WBS should be longer than one month long

All project activities shall be grouped by equipment type and works type. An activity grouping of equipment shall contain as superordinate groups:

- Design
- Procurement
- Manufacturing
- FAT as a Milestone
- Shipping
- Erection/Installation
- Commissioning
- SAT as a Milestone

All such groups except milestones shall contain further detailed activities.

A draft release of Time Bar Schedule shall be included in the Tender Documents. After Contract signing the Time Bar Schedules has to be updated with all works and schedules of all involved parties. After approval by Beneficiary this will serve as contractual base for the implementation of the project.

5.4.3 Method Statements

Before commencing any part of the works the Contractor shall submit method statements for all major works, e.g. erection / installation, electro-mechanical works, site tests etc.

The method statement shall include a detailed description of the proposed procedure for carrying out the works, calculations associated with any proposed temporary works, sketches, equipment to be used to the Beneficiary's approval.

The submission shall include equipment specifications, catalogues, data, manufacturer's published specifications, protective devices, test apparatus, installation procedures, test procedures, etc.

Works carried out without prior submission of a method statement and without obtaining the Beneficiary's approval of the same will be at the Contractor's own risk and might be subject for rejection by the Beneficiary.

5.4.4 Design Drawings

Design drawings comprise all documentation necessary to define the works and the supply within this project. In detail they are covered by:

- Mechanical systems drawings (layout drawings and section views of equipment, schematics, circuit and wiring diagrams, parts lists…)
- Electrical drawings (overall single line diagram of complete substation, particular single line diagram of concerned switchgear, layout drawings and section views of equipment, assembly drawings, schematics, circuit and wiring diagrams, protection and control design incl. substation LAN and communication connections (if any), parts lists…)

Design drawings shall show the equipment within the substation and the switchgear, together with all existing equipment and facilities. Sufficient overall dimensions shall be indicated.

These drawings shall also show the internal and external connections of all apparatus, their designations, terminal numbers, colour codes, etc.

The drawings shall be provided by one Originator only. They shall be commonly used for manufacturing, installation and operation of the equipment, accordingly revised if necessary.

Any drawings with doubled and repeated representation will not be accepted. For equipment with multiple use a set of "General Drawings" shall be provided.

5.4.5 Factory and Internal Working Drawings

Detailed factory and internal working manufacturing drawings shall show:

- Detail dimensions
- Tolerances
- Materials
- Nameplate diagrams

5.4.6 Shipment Details

Shipment details include a.o. instructions for loading, unloading, handling and special precautions to be observed for storage at site.

5.4.7 Acceptance Test Schedules and Procedures

Prior to any acceptance test an according procedure shall be submitted for approval, showing all tests intended to be performed together with individual test procedure containing per test

- Test values
- Specified values and
- Acceptance criteria
- Appropriate tolerances

During acceptance tests all earlier routine test and other acceptance test protocols of the equipment shall be available and ready to be checked for reference. Compilation of routine test protocols shall be covered by a table of contents, clearly structured by test item designation, the applicable standards and their sub clauses.

5.4.8 Catalogue Cuts, Illustrations, etc.

Applicable requirements of this paragraph with reference to drawings shall apply equally to catalogue cuts, illustrations, printed specifications, data sheets, design data, analysis and calculation, and manufacturer's descriptive literature and instructions for all equipment furnished to demonstrate fully that all parts will conform to the requirements and intent of the Contract Documents.

5.4.9 Installation Manual

The Supplier shall provide the Beneficiary with an Installation Manual covering installation procedure and instruction to facilitate smooth erection, assembly and testing on site of all equipment to be installed.

The instructions therein shall specify the exact procedures to be followed during installation, indicate data to be measured and recorded (adjustments, setting of limits, etc.), quantities, dimensions and tolerances to be checked, etc.

The manual shall include information on handling and slinging the major pieces of equipment, erection, tolerances, settings and adjustments and special precautions to be taken during installation.

5.4.10 Commissioning Manual

The Supplier shall provide the Beneficiary with a Commissioning Manual which shall include procedures and instructions to be followed during the commissioning of all equipment to be installed.

The instructions therein shall specify the exact procedures to be followed during commissioning and shall indicate all data to be measured (and where appropriate, recorded in the manual itself) and all adjustments, setting of limits, etc., quantities, dimensions and tolerances to be checked.

5.4.11 Operation and Maintenance Manual

The Supplier shall provide the Beneficiary with an Operation and Maintenance Manual; it shall include procedures and instructions to be followed by the operating and maintenance staff necessary for reliable operation and maintenance of all the equipment.

The manual shall contain at least the following documents and data as a minimum:

- General description of the equipment, operation in particular
- Main technical characteristics
- Connection to external system
- Instructions for operating personnel including periodic tests, check-points, actions required following each individual alarm signal, etc.
- Summary of important rules, standards, safety precautions and instructions to be followed during equipment operation and maintenance
- Safety and warning signs to be placed in the plant/ substations, etc.
- Enclosures: Important principle diagrams and layout diagrams

Sections on “maintenance” shall be divided into three parts, namely:

- Current (preventive) maintenance indicating inspection periods, routine cleaning and lubricating procedures (if required), safety checks, adjustments, etc.
- Repairs and overhauls describing the dismantling, removal and replacement of parts (with spare part lists for all equipment), troubleshooting guides, repair instructions, etc.
- All acceptance workshop tests and site readings as a reference

The Operation and Maintenance Manual, supplemented by any additional drawings and project documents to be submitted to the Beneficiary will be the only document to be generally used by the power operating staff.

All instruction sheets shall be properly bound in booklet form containing all information, description of equipment, diagrams, etc. necessary to enable the Beneficiary to properly operate and maintain the whole of the work including operating forms and operator's log sheets for all mechanical and electrical plant and equipment. The various instructions shall be written in a style easily intelligible for the operating and maintenance personnel explaining for various situations what is to be done and why.

During the guarantee period the Contractor shall revise and/or update the operating and maintenance instructions, and introduce all such modifications into the final operation and maintenance manuals to the satisfaction of the Beneficiary.

5.4.12 As-Built Documentation

The Contractor shall supply to the Beneficiary complete documentation of the work. The documentation in a form acceptable to the Beneficiary shall consist besides above mentioned manuals of all installation and construction drawings as required for the Beneficiary's maintenance; dismantling, re-assembling and adjusting of all delivered and erected parts of the work.

The work will not be considered as completed and Final Acceptance Certificate (FAC) will not be issued until all documentation as specified in this clause has been delivered by the Contractor.

5.4.13 Normative Background

The documentation shall be prepared according to latest IEC- and ISO-standards.

The document classes, their contents and their basic document structure shall comply with IEC 61355. The designation of the documents shall be indicated as given therein, the build-up shall be carried out according to the basic rules for the management of technical documents, given in the standard ISO 11442.

The systematic of apparatus and equipment classification, designation and identification shall follow IEC 81346; in particular the elaborated practice of IG EVU shall be used.

In particular all devices having a movable part, for example a contact, shall be shown in a position or state representing the non-actuated or de-energised state.

The terminal designation of the HV-apparatus shall be according to DIN 43456. Additionally the standard IEC 60445 is applicable.

The schematic layout of circuit diagrams and function diagrams shall have the layout and the top-down structure as described in IEC 61082 and IEC 62023, references to control room, protection and other panels shall be included. The symbolism in the drawings shall follow IEC 60617 and ISO IEC 81714.

All documents, including those of sub suppliers and subassemblies, shall have a title block in conformance with ISO 7200 containing besides the mandatory fields as

- Legal owner
- Identification Number (= Customers drawing number)
- Revision Index
- Title
- Date of Issue
- Responsible Person
- Document Type

also at least

- Page number
- Number of pages
- Responsible department
- Creator
- Approval person

5.4.14 Document and Parts Lists

For the complete delivery and all sub deliveries the Bidder/ Contractor has to provide a main document list containing the information of all his documents belonging to his delivery. Document lists may be structured in main document list and subordinated document lists; they all shall contain at least the following columns:

- Running number
- Customers drawing number
- Suppliers drawing number
- Revision index
- Number of sheets
- Document title
- Document file name
- Date of document submittal
- Date of document approval
- Status of document approval

Document list has to be updated with each and every submitted drawing and is part of every document submittal.

Parts lists shall be in full conformity with IEC 62027 Class A. Data sets of items listed therein shall contain all information classified as mandatory and classified as conditional.

5.4.15 Supplier's Communications, Drawing Submittal, Data and Instructions

The Supplier shall, besides normal communication, submit for approval drawings, design data, installation, operating and maintenance instructions, and catalogue cuts as outlined herein. All submitted documents shall be accompanied by consecutively numbered document transmittal sheets containing a list with submission date, documents-no, revision, title, etc.

The sequence of submission shall be such that sufficient previous information is available for checking each document when it is received. Piecemeal submission of documents is not acceptable; such submittals are deemed to be not received by the Beneficiary.

For data exchange to other CAD-systems, all drawings shall be provided as AutoCAD DXF-format version 2012, respectively in approved MS-Office format for charts, tables, lists etc. In addition all documentation has to be provided as PDF-file for documentation purpose. PDF-files shall be ready prepared for text capture. Documents with more than one page shall be submitted as one electronic file only.

All drawing shall be printed with dark lines on a white background.

If not otherwise requested the Contractor shall provide all electronic files in a uniform file designation system. Contractor shall propose to the Beneficiary a file designation system for approval. All drawing submittals with arbitrary filenames will be rejected.

The Beneficiary will approve the Contractor's drawings and will return with comments or commented drawing.

- "Approved"
- "Approved, Except as Noted", or
- "Returned for Corrections", or
- “For Information Only”

The Contractor shall revise the Drawings marked with (2) or (3) and resubmit the same for final approval. Every revision shall be defined by numeral or letter, date and subject in a revision block.

The Beneficiary’s approval of the Contractor's and Sub-Contractor's drawings shall not relieve the Contractor from his responsibility for errors or omissions which may exist, even though work is done in accordance with such approved drawings. If such errors or omissions are discovered later, they shall be corrected and the work shall be made good by the Contractor at his own expense, irrespective of any approval of the Beneficiary.

Drawings to be supplied by Sub-Contractors shall be checked thoroughly by the Contractor with regard to measurements, size of components, materials and details to satisfy himself that they conform to the requirements and to the intent of the Technical Specifications, and the Contractor shall place thereon the date of his approval. Drawings found to be inaccurate or otherwise in error shall be re-turned to the Sub-Contractor for correction before submitting them to the Beneficiary.

No major revisions affecting the design will be made after a Drawing has been marked "Approved" without resubmitting the Drawing for formal approval of said revision.

Any fabrication, erection or installation of works or portion thereof prior to the approval of Drawings pertinent thereto shall be at the Contractor's risk.

6. GUARANTEES AND LIABILITIES

6.1 Completion Time Guarantee

The Contractor guarantees that it shall attain Completion of the Facilities (or a part for which a separate Time for Completion is specified within the Time for Completion specified in Contract, or within such extended time to which the Contractor shall be entitled hereof.

If the Contractor fails to attain Completion of the Facilities or any part thereof within the Time for Completion or any extension the Contractor shall pay to the Beneficiary liquidated damages in the amount specified in the Contract as a percentage rate of the Contract Price.

However, the payment of liquidated damages shall not in any way relieve the Contractor from any of its obligations to complete the Facilities or from any other obligations and liabilities of the Contractor under the Contract.

6.2 Defect Liability

The Contractor warrants that the Facilities or any part thereof shall be free from defects in the design, engineering, materials and workmanship of the Plant and Equipment sup-plied and of the work executed.

The Defect Liability Period shall be eighteen (18) months from the date of Completion of the Facilities (or any part thereof) or twelve (12) months from the date of Operational Acceptance of the Facilities (or any part thereof), whichever first occurs, unless specified otherwise in the Contract.

If during the Defect Liability Period any defect should be found in the design, engineering, materials and workmanship of the Plant and Equipment supplied or of the work executed by the Contractor, the Contractor shall promptly, in consultation and agreement with the Beneficiary regarding appropriate remedying of the defects, and at its cost, repair, replace or otherwise make good (as the Contractor shall, at its discretion, determine) such defect as well as any damage to the Facilities caused by such defect.

The Contractor shall not be responsible for the repair, replacement or making good of any defects or of any damage to the Facilities arising out of or resulting from any of the following causes:

- improper operation or maintenance of the Facilities by the Beneficiary;
- operation of the Facilities outside specifications provided in the Contract; or
- normal wear and tear.

The Contractor’s obligations under this shall not apply to:

- any materials which are supplied by the Beneficiary hereof, are normally consumed in operation, or which have a normal life shorter than the Defect Liability Period stated herein;
- any designs, specifications or other data designed, supplied or specified by or on behalf of the Beneficiary, or any matters for which the Contractor has disclaimed responsibility herein;

The Beneficiary shall give the Contractor a notice stating the nature of any such defect together with all available evidence thereof, promptly following the discovery thereof. The Beneficiary shall afford all reasonable opportunity for the Contractor to inspect any such defect.

The Beneficiary shall afford the Contractor all necessary access to the Facilities and the Site to enable the Contractor to perform its obligations.

The Contractor may, with the consent of the Beneficiary, remove from the Site any Plant and Equipment or any part of the Facilities which are defective if the nature of the defect, and/or any damage to the Facilities caused by the defect, is such that repairs cannot be expeditiously carried out at the site.

If the repair, replacement or making good is of such a character that it may affect the efficiency of the Facilities or any part thereof, the Beneficiary may give to the Contractor a notice requiring that tests of the defective part of the Facilities shall be made by the Contractor immediately upon Completion of such remedial work, whereupon the Contractor shall carry out such tests.

If such part fails the tests, the Contractor shall carry out further repair, replacement or making good (as the case may be) until that part of the Facilities passes such tests. The tests shall be agreed upon by the Beneficiary and the Contractor.

If the Facilities or any part thereof cannot be used by reason of such defect and/or making good such defect, the Defect Liability Period of the Facilities or such part, as the case may be, shall be extended by a period equal to the period during which the Facilities or such part cannot be used by the Beneficiary because of any of the aforesaid reasons.

6.3 Functional Guarantees

The Contractor guarantees that during the Guarantee Test, the Facilities and all parts thereof shall attain the Functional Guarantees specified in the Contract subject to and upon the conditions therein specified.

If, for reasons attributable to the Contractor, the guaranteed level of the Functional Guarantees specified in the Contract are not met either in whole or in part, the Contractor shall at its cost and expense make such Changes, modifications and/or additions to the Plant or any part thereof as may be necessary to meet at least the guaranteed level of such Guarantees. The Contractor shall notify the Beneficiary upon Completion of the necessary Changes, modifications and/or additions, and shall request the Beneficiary to repeat the Guarantee Test until the guaranteed level of the Guarantees has been met.

If, for reasons attributable to the Contractor, the Functional Guarantees specified in the Contract are not attained either in whole or in part, the Contractor shall, at the Employer's option, either

- make such Changes, modifications and/or additions to the Facilities or any part thereof that are necessary to attain the Functional Guarantees at its cost and expense, and shall request the Employer to repeat the Guarantee Test; or

- pay liquidated damages to the Employer in respect of the failure to meet the Functional Guarantees in accordance with the provisions in the Contract.

Minimum requirements for power transformer performance during the site acceptance procedures, functional tests and for defect liability period shall be as follows:

No	Parameters	SAT/before functional test	After functional test	During the defect liability period
1	Winding insulation resistance recalculated to 20 ^{o}C (MΩ)	min 5500	min 5500	min 5500
2	Tan Delta of windings (%)	max. 0.5	max. 0.5	max. 0.5
3	Oil dielectrical strength (kV)	min. 70	min. 70	min. 70
4	Tan Delta of oil 90^{o}C	max. 0.2	max. 0.2	max. 0.2
5	Water content in oil by Karl Fischer method (ppm)	max. 5	max. 5	max. 5
6	Sum of gases dissolved in transformer oil (%)	0	max. 0.5	Max. 5% increase comparative with SAT value
7	Individual concentration of gases dissolved in transformer oil (%)	0	below limit as per IEC 60599	below limit as per IEC 60599

7. DRAWINGS AND PHOTOS

The Tender Drawings issued with the Bidding Documents are of a general nature only but are considered to be sufficient for the purpose of bidding. Tender Drawings are not to be used for manufacturing or ordering materials.

1. Ungheni 110/35/10 kV substation aerial view

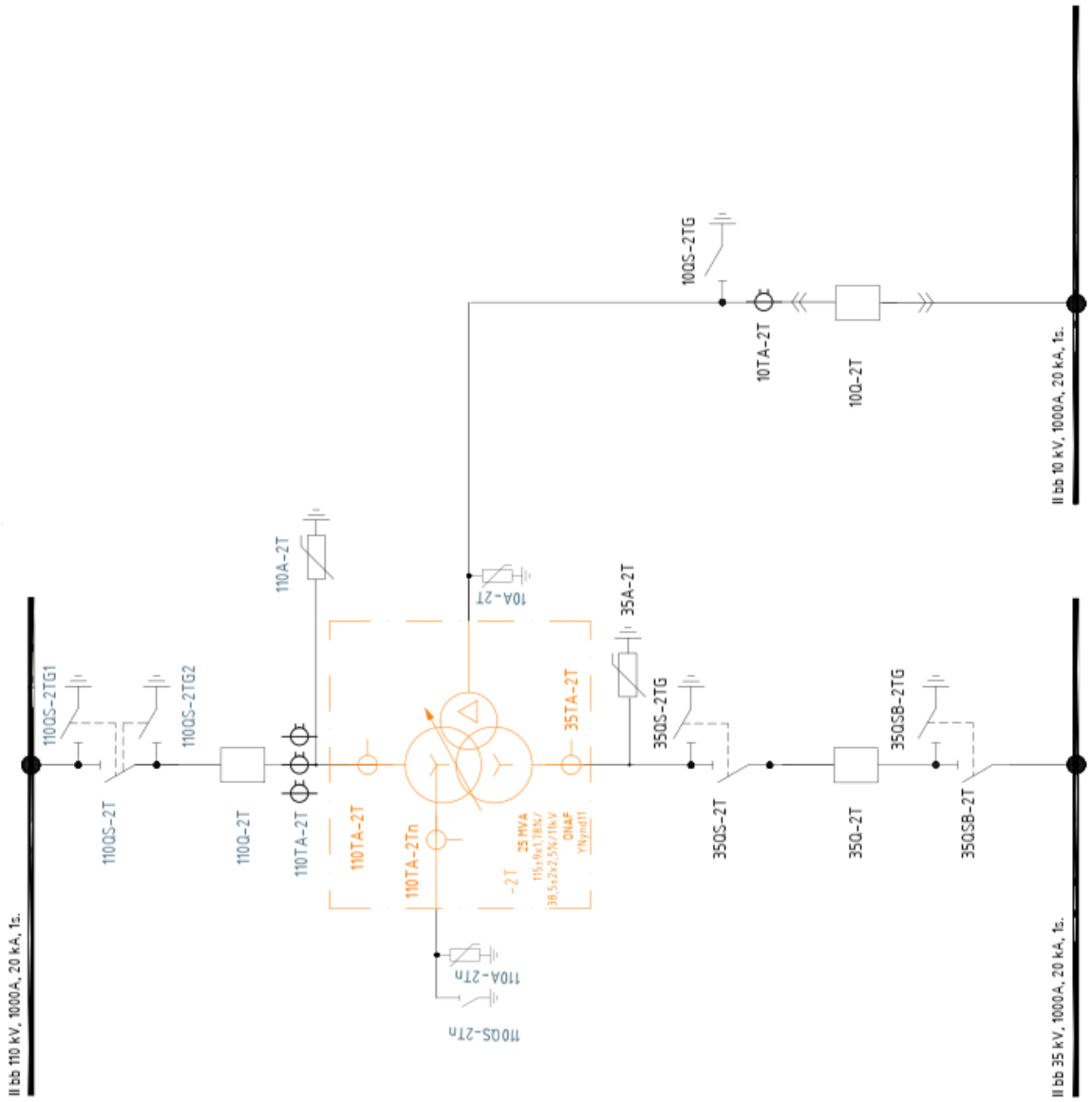
2. View from the existing transformer to the main access gate.

3. Existing transformer 35 kV and 10 kV external connections

4. Power transformer area, view from the substation access gate

5. Existing transformer 110 kV side view.

6. Existing transformer 110 kV side view.



7. SE Ungheni 110/35/10 kV 2T SLD

8. TECHNICAL DATA SHEET

Power transformer Ungheni 25 MVA, 115 ± 9x1.78 % /38.5±2x2.5%/11 kV				
No	**Description**	**Unit**	**Data required**	**Data offered**
1	**GENERAL**			
	Manufacturer			
	- country			
	- city			
	Kind of installation		outdoor	
	Standards		IEC60076	
			IEC60137	
			IEC61463	
			IEEE 693-2005	
	Single or three-phase unit		Three-phase	
	Type of core		3 limb, step-lap stacked core form	
	Type of tank		Upper flange tank	
	Tank fully vacuum proof		Yes	
	Number of windings		Three	
	Winding material (HV,MV,LV)		Coper	
	Insulation oil			
	- manufacturer			
	- type			
	- specification of oil		IEC 60296	
	- insulation oil inhibited		Yes	
	- test method for corrosive sulphur		IEC 62535 and ASTDM D1275B	
2	**RATINGS**			
	Rated power at nominal voltage (primary/secondary/tertiary)			
	- at ONAN cooling	MVA	20/20/20	
	- at ONAF cooling	MVA	25/25/25	
	Maximum ambient temperature	^{o}C	50	
	Annual average ambient temperature	^{o}C	15	
	Minimum ambient temparature	^{o}C	-30	
	Maximum service altitude	m	1000	
	Temperature rise limits at all tap changer settings			
	- oil/top	K	50	
	- windings/average	K	55	
	- windings/hot spot	K	68	

	Rated voltages (no load)			
	- HV	kV	115	
	- MV	kV	38.5	
	- LV	kV	11	
	Rated frequency	Hz	50	
	Permissible load at neutral point	%	100/solidly earthed/surge arrester	
	Vector group symbol		YNyn0d11	
	Impedance voltage – HV/LV (25 MVA basis)			
	- maximum tap position	%	Specify	
	- nominal tap position	%	17.5	
	- minimum tap position	%	Specify	
	Impedance voltage – HV/MV (25 MVA basis)			
	- maximum tap position	%	Specify	
	- nominal tap position	%	10.5	
	- minimum tap position	%	Specify	
	Impedance voltage – secondary/tertiary (25 MVA basis)	%	Min. 6.5 (±30%/-0%)	
	Magnetic flux density at			
	-rated voltage and frequency	Tesla	Max. 1.7	
	No load losses (tolerance +0%)	kW	<15	
	No load current (Io/In)	%	0.1	
	Core losses (W17/50)	W/kg	Max. 0.9	
	Short circuit voltage			
	- HV-LV	%	17.5	
	- HV-MV	%	10.5	
	- MV-LV	%	6.5	
	Load losses at rated power			
	HV/LV (25 MVA basis)			
	- maximum tap position	kW	Specify	
	- nominal tap position	kW	Max. 120	
	- minimum tap position	kW	Specify	
	HV/MV (25 MVA basis)			
	- maximum tap position	kW	Specify	
	- nominal tap position	kW	Max. 120	
	- minimum tap position	kW	Specify	
	MT/JT (25 MVA basis)	kW	Max. 110	
	HV winding (25 MVA basis)			
	- maximum tap position	kW	Specify	

	- nominal tap position	kW	Specify	
	- minimum tap position	kW	Specify	
	LV winding (25 MVA basis)	kW	Specify	
	MT winding (25 MVA basis)			
	- maximum tap position	kW	Specify	
	- nominal tap position	kW	Specify	
	- minimum tap position	kW	Specify	
	Power consumption of cooling plant	kW	Specify	
	Efficiency referred to 75 ^{o}C at rated voltage taping and at:			
	- 100% rated output and 1.0 power factor	%	99.7	
	- 75% rated output and 1.0 power factor	%	99.7	
	- 50% rated output and 1.0 power factor	%	99.7	
	- 25% rated output and 1.0 power factor	%	99.7	
	- 100% rated output and 0.8 power factor	%	99.7	
	- 75% rated output and 0.8 power factor	%	99.7	
	- 50% rated output and 0.8 power factor	%	99.7	
	- 25% rated output and 0.8 power factor	%	99.7	
	Voltage variation range HV	kV	+/- 18.423	
	Taping range HV	%	+/- 16	
	Number of steps HV	steps	+/- 9	
	Continuous power on all taps		Yes	
	Voltage variation range MV 38.5 kV	kV	+/- 1.925	
	Tapping range MV 38.5 kV	%	+/- 5	
	Number of steps MV 38.5 kV	steps	+/- 2	
	Principal taping HV	kV	115	
	Principal taping MV	kV	38.5	
	Winding insulation design			
	- HV		Uniform	
	- MV		Uniform	
	- LV		Uniform	
	Seismicity on MSK scale		IX	
3	**INSULATION LEVEL**			
	Insulation level HV winding			
	- Power frequency withstand voltage line/neutral	kV	230/230	
	- Lightning impulse level line/neutral	kV	550/550	
	Insulation level LV winding			

	- Power frequency withstand voltage	kV	34	
	- Lightning impulse level	kV	110	
	Insulation level MT winding			
	- Power frequency withstand voltage line/neutral	kV	95/95	
	- Lightning impulse level line/neutral	kV	250/250	
4	**OPERATION DETAILS**			
	Cooling method		ONAN/ONAF	
	Noise level (LpA) at a measuring distance of 2.0 m (all forced cooling in operation)	dB(A)	Max. 60	
5	**BUSHINGS**			
	HV (lines)			
	- manufacturer			
	- type			
	- rated current	A	800	
	- power frequency test voltage	kV	255	
	- lightning impulse level		550	
	- minimum creepage distance in accordance with IEC 60815	mm	2835	
	- cantilever load level according to IEC 60137	daN	Specify	
	HV (neutral)			
	- manufacturer			
	- type			
	- rated current	A		
	- power frequency test voltage	kV	105	
	- lightning impulse level		250	
	- minimum creepage distance in accordance with IEC 60815	mm	1050	
	- cantilever load level according to IEC 60137	daN	Specify	
	LV			
	- manufacturer			
	- type			
	- rated current	A	2000	
	- power frequency test voltage	kV	42	
	- lightning impulse level		110	
	- minimum creepage distance in accordance with IEC 60815	mm	280	

	- cantilever load level according to IEC 60137	daN	Specify	
	MT (lines/neutral)			
	- manufacturer			
	- type			
	- rated current	A	630	
	- power frequency test voltage	kV	105	
	- lightning impulse level		250	
	- minimum creepage distance in accordance with IEC 60815	mm	1050	
	- cantilever load level according to IEC 60137	dan	Specify	
6	**CURRENT TRANSFORMERS**			
	115 kV line side			
	For protection purposes			
	Rated output	VA	10	
	Ratio			
	- primary	A	100-150-200-300	
	- secondary	A	5	
	Class		0.5sFS5	
	For protection purposes			
	Rated output	VA	30	
	Ratio			
	- primary	A	200-300-400-600	
	- secondary	A	5	
	Class		5P20	
	For protection purposes			
	Rated output	VA	30	
	Ratio			
	- primary	A	200-300-400-600	
	- secondary	A	5	
	Class		5P20	
	115 kV neutral side			
	For protection purposes			
	Rated output	VA	10	
	Ratio			
	- primary	A	200-300-400-600	

	- secondary	A	5	
	Class		5P20	
	38.5 kV line side			
	For protection purposes			
	Rated output	VA	10	
	Ratio			
	- primary	A	100-200-300-400	
	- secondary	A	5	
	Class		0.5sFS5	
	For protection purposes			
	Rated output	VA	30	
	Ratio			
	- primary	A	200-300-400-600	
	- secondary	A	5	
	Class		5P20	
7	**ON-LOAD TAP CHANGER**			
	Manufacturer			
	Type			
	Rated through current	A	400	
	Rated step capacity	kVA	1320	
	Lightning impulses level	kV	550	
	Power frequency withstand test voltage	kV	230	
	Short-time current			
	- 3s value	kA	6	
	- peak value	kA	15	
	Type of connection		Neutral	
	Type of switching		Vacuum type diverter switch	
	Contact life operation	Nos	Min. 600 000	
	Auxiliary supply voltage (AC)	V	400/230	
8	**PROTECTION AND MONITORING EQUIPMENT**			
	- Buchholz relay		EMB BF 80/10 (or. equ.)	
	- Oil flow operated protection relay		EMB URF 25/10 (or. equ.)	
	- Conservator gas detection relay		EMB CF-38 (or/ equ.)	
	- Oil level indicator			
	Type			

	Manufacturer			
	- Pressure relief device		resettable spring loaded	
	Type			
	Manufacturer			
	- Dehydrating breather		Automatic, maintenance free	
	Type			
	Manufacturer			
	- Oil temperature indicator			
	Type			
	Manufacturer			
	- Winding temperature indicator			
	Type			
	Manufacturer			
9	**MASSES, MEASURES AND DRAWINGS**			
	Transformer masses:			
	- total mass	kg		
	- transportation mass	kg		
	- untanking mass	kg		
	- mass of insulating liquid	kg		
	Overall dimensions including bushings:			
	- height	mm		
	- depth	mm		
	- width	mm	max. 6250	
	Gauge of the tank			
	- longitudinal	mm	1524	
	- transverse	mm	2000	
10	**RELIABILITY REQUIREMENTS**			
	Design of windings and/or magnetic core pressing system shoud not require any maintenance for the whole expected life term		Yes	
	Manufacture has to have experience in short-circuit tests ≥ 110 kV rated voltage transformers (withstand short circuit) according to IEC standard in independent laboratories not earlier than 2010		Specify transformer type, present test report	
	Life time	year	Min. 30	
11	**DELIVERY**			
	Incoterms		DAP	

	Unloading on site		Yes	
12	**DOCUMENTS TO BE PROVIDED WITH THE OFFER**			
	Transformer data plate (photo or drawing)		Provide	
	Passport or Test Certificate of the similar* transformer previously manufactured not earlier than 2010		Provide	
	Reference list of the similar transformers for the last 5 years with end users contacts		Provide	
	Certificate for manufacture's test laboratory (ISO/IEC)		Provide	
	Outline transformer drawing		Provide	
	Oil test certificate		Provide	
	Short-circuit test report		Provide	
	OLTC Type Test Report performed in independent and accredited European Laboratory according to IEC 60214-I:2014,		Provide	
	OLTC instalatuon and operation manual		Provide	
	Other documents required according to chapter 5 of the present document		Provide	

- Similar transformer is a three – winding transformer with same/similar rated power, HV and MV rated voltage, no-load and load losses, impedance voltage, sound pressure level.

Bidder's name: _____

Signature and stamp/electronic signature of the bidder:_____