



POWER TRANSFORMER
118 ±9*1,67%/21 KV, YNd11
2 KPL 63 MVA, ONAN

KOKKOLAN ENERGIAVERKOT OY
TECHNICAL SPECIFICATION





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1. SCOPE OF SUPPLY

The Supplier's delivery to Kokkolan Energia Oy ("the Customer") shall include:

- **2 (two) set** of three-phase **63 MVA** power transformer with **ON-LOAD Tap Changer** oil and equipment specified further on in this document.
- Factory Acceptance Tests (FAT) for the transformer at Supplier's plant.
- Transport of the transformer to the construction site (import, transport and transport costs are included in the price). The delivery includes the installation of the transformer on the transformer foundation with lifting (or traction devices), the equipment of the transformer, the filling of the oil and the testing of the transformer protection devices on site.
- Site Tests at the construction site.
- All drawings and instructions needed for installation, operation and maintenance of the transformer and planning of the station.
- The documentation will be provided in Finnish or English language.
- Routine test records.

2. DELIVERY TIMES

- Following data and information shall be submitted to the Customer:

Latest at **with tenders**:

- Power Transformer Questionnaire (filled as instructed in the Call for Tender)
- Preliminary dimensioning drawing which expresses typical main dimensions, weights, oil quantity and lifting places
- Preliminary demands for foundation and route of supply
- Preliminary list of potential suppliers for Transformer Auxiliary equipment:
 - Transformer bushing type HV / MV
 - Tap Changer equipment
 - Cooling system
 - Buchholz relay
 - Oil Level Indicators
 - Thermometers
 - Pressure Relief Device
 - Flexible separators
 - Dehydrator
- Manufacturer's Declaration of Warranty Period
- Manufacturer Authorization Form
- Drawings
 - Outline Drawing
 - Shipping Profile
- Transformer Oil Data Sheet
- List of Factory Acceptance Tests
- List of transformer equipment
- List of recommended spare parts





Latest at **six months before on-site delivery**:

- Final dimensioning drawings which express main dimensions, weights and lifting places
 - the connection drawings of the auxiliary equipment of the transformer (according to IEC standards)
 - places, dimensions and material of the connectors
 - auxiliary equipment specification
 - transformer auxiliary equipment technical data sheets
 - on-load tap charger specification
- Testing records, functional descriptions, erection, operation and maintenance manual, shall be delivered without delay at the latest 1 month after FAT, unless otherwise agreed. If requested, available preliminary documents shall be delivered during FAT.

3. STANDARDS

The transformer shall be designed, manufactured and tested according to the standards applicable in Finland (IEC/EN/HD etc.) and all local mandatory authority requirements.

Supply transformers must meet the requirements of the European Commission for power transformers (Requirements after 31 July 2021); Directive 2009/125*EC, (EU) 2019/1783, 2016 C 416/04, (EU) No 548/2014.

The equipment and systems shall comply with all local laws, regulations and requirements; the delivery shall also fulfil all requirements of local authorities and the regulations of electrical security. The Contractor undertakes, at his own expense, to arrange all official inspections and shall organize the inspections and tests performed by the authorities, if needed.

It must be possible to use the device safely. The delivery and equipment shall meet all environmental and technical requirements of the applicable directives and harmonised standards.

Additionally, health and safety requirements and local regulations shall be fulfilled. The supplier shall fulfill functional safety of safety related systems according to IEC61508 or similar internationally recognized standard in the industry suitable for similar deliveries in the Nordic countries.

The Contractor shall pay the official inspection fees and related costs after the Taking Over in cases in which the inspection is a consequence of damage due to the Contractor or a damage to be repaired under the guarantee.

The following general international standards and those latest and relevant appendices and amendments shall be complied for delivery:

International Electrotechnical Commission (IEC)

- IEC-60076 -1-8,10 Power transformers
- IEC-60071-1 Insulation co-ordination
- IEC-60060-1 High-voltage test techniques





- IEC-60270 Partial discharge measurements
- IEC-60137 Bushings for alternating voltages above 1000 V
- IEC-60214 – 1 Tap-changers – performance requirements and test methods
- IEC-60296 Fluids for electrotechnical applications – Unused mineral insulating oils for transformers and switchgear
- IEC-60156 Insulating liquids –Test method
- IEC-60354 Loading guide for oil-immersed power transformers
- IEC-60529 Degrees of protection provided by enclosures (IP code)
- IEC-60616 Terminal and tapping markings for power transformers
- IEC-60044-1 Instrument transformers –Part 1:Current transformers

Relevant IEC –Standards shall apply to the equipment and components/devices of the delivery. In case IEC –Standard does not exist, some other international well known standard shall be applied and noted by the Contractor. The Contractor shall submit a list of standards, which is proposed to be applied to any equipment and components.

4. DATA FOR DIMENSIONING

4.1. Ratings

The transformer shall be a three-phase air-cooled oil-immersed outdoor power transformer with an on-load tap changer.

Ratings:

- nominal power (in all tap positions)	63 MVA ONAN
- nominal voltages	118 ± 9x1,67 % / 21 kV
- highest operating voltages (Um)	123 kV and 24 kV
- nominal frequency	50 Hz
- short-circuit impedance	10%; tolerance ±5% of declared value
- connection	YNd11
- standards	IEC 60076 IEC 60354

The transformer must be operational in parallel with a 63 MVA power transformer with the following ratings: 118 ± 9 x 1,67 % / 21 kV, zk = 10,7...10,0...9,8 % (in tap changer positions 1...10...19).

4.2. Service conditions

The transformer will be installed outdoors on railroad tracks on the foundation.

- Ambient temperature	-40...+40°C
- Highest operating voltage under normal conditions	
high-voltage side	123 kV
low-voltage side	24 kV
- Short-circuit current; high-voltage side	31,5 kA
- Short-circuit current; low-voltage side	31,5 kA

The transformer must be operable when the neutral point of high-voltage side is either isolated from the earth or earthed.

4.3. Withstand voltages

- Test voltage for insulation 50 Hz 1 min:





	high-voltage side (also neutral point)	230 kV
	low-voltage side	50 kV
	for bushings, the test shall be rain test 50 Hz 1 min.	
-	Lightning impulse withstand voltage 1,2/50 μ s	
	high-voltage side (also neutral point)	550 kV
	low-voltage side	125 kV
-	Over voltage test 1 min 100 Hz	
	high-voltage side (also neutral point)	230 kV
	low-voltage side	50 kV
-	Auxiliary circuits 50 Hz 1 min	2 kV
-	Minimum external creepage distance of the insulation	
	high-voltage side	2500 mm
	low-voltage side	900 mm





4.4. Load capacity and cooling

- Natural oil flow
- Cooling method ONAN 63MVA
- Radiators shall be **hot-dip galvanized and painted**, removable and equipped with closing valve
- Load capacity shall be according to valid IEC 60354 standard

The highest temperature rises for continuous nominal power on principal tapping:

- top oil <math><60^{\circ}\text{C}</math>
- the hottest spot of the winding <math><80^{\circ}\text{C}</math>
- winding average <math><65^{\circ}\text{C}</math>

In the extreme tappings, 5°C higher temperature rises are allowed.

The temperature rise on the hottest spot of the winding is regarded to be equal to the value computed based on measurement as follows:

- the difference between the winding average and oil average temperature rises, derived from resistance measurements, multiplied by 1,1 is added to the top oil temperature rise.

4.5. Power losses

The capitalized power losses used for power transformer evaluation shall be as follows:

No-load losses (P_0)

Load losses (P_k):

- load losses, average value of the losses in the principle and extreme tapping position

Equivalent total losses (P_e): $P_e = 3 \times P_0 + P_k$

The equivalent total losses shall be guaranteed without any tolerances.

If the equivalent total losses defined by measurements exceed the given values, a penalty shall be applied on the basis of the capitalizing value 5000 EUR/kW. The component losses shall not exceed their own tolerance limits (according to IEC).

No bonus shall be applied on the losses lower than guaranteed.

4.6. Other requirements

- Sound pressure level at rated voltage and at 1,0 m from the transformer must correspond to IEC 60551.
- Auxliary voltage
 - on load tap charger 400/230 VAC 50 Hz
 - socket must be equipped with circuit breaker
 - DC auxiliary voltage is 110 VDC
- Control devices, distribution pillars, etc. exposed to moisture must be equipped with drying heating.
- Transformer tank and other weather-exposed parts shall be reliably protected against corrosion. The radiators shall be hot-dip galvanized with EVS-EN ISO 1461 or equal standard and painted, minimum Zn thickness is $60 \mu\text{m}$. The inside of the transformer tank must also be painted with a suitable paint for this purpose. The transformer tank shall be





pre-treated from outside in accordance with EVS-EN ISO 12944-4 and painted in accordance with EVS-EN ISO 12944-5 or equal. External surfaces shall be painted with two component polyurethane paint. The topcoat thickness is 40 µm and the nominal color shall be RAL 7035. Vaalean harmaa

- Drain and sampling valves shall be ball-type valves. The valve body, end pieces and valve neck shall be welded together to form a single unit (on-piece welded design with no body joints to leak). Closing (throttle) valves for radiators shall be oil-tight (metal-metal-design is not acceptable). All valves shall be chemical resistant to transformer oil.
- The transformer oil shall be in accordance with EVS-EN 60296, marked with I (inhibited transformer oil)
- The transformer shall be delivered complete with all normal parts and fittings required for proper performance and transport, including those not explicitly mentioned hereafter.
- The rating plate and thermometers shall be located so that they can be read on the ground level from the HV bushing side of the transformer, unless otherwise separately informed by the purchaser. All markings of the all phase windings shall be readable from the ground level.
- All the transformer fittings (oil conservator, cabinets, coolers etc.) shall be earthed (all parts two points).
- The rating values, circuit diagram and instruction plates shall be in Finnish or in English language.
- The valve for taking oil samples shall be: ball-cock DN 15, outlet with ½" internal winding; cap with ½" external winding.
- The sensors mounted on top of the transformer shall be protected with stainless steel or paint coated cover
- The overpressure valve shall be designed so that in case of valve operation the oil coming from power transformer shall not be spread out.
- The arrester base of the 118 kV surge arresters shall be insulated from supporting steel structure in order to render possible leakage current measurement.

5. EQUIPMENT

5.1. Transformer tank

- Filling, outlet, sampling and drainage valves both sides of the Buchholz relay
- The transformer tank shall be fitted with necessary inspection and hand holes, and with two earthing terminals on opposite sides marked with the appropriate graphical symbol. A hole must be fitted near the tap selector of the on-load tap-changer to facilitate overhauling without un tanking the transformer. The mechanical strength of its covering plate shall be equal to that of the tank wall.
- Radiators with hermetic closing valves attached to the transformer tank
- Stands for phase and starpoint surge arresters on HV
- Lifting eyes and hooks needed for lifting and transportation (also for lifting of the transformer core)
- The center of gravity of the power transformer prepared for transportation shall be marked on the transformer tank
- The transformer tank and radiators shall withstand full vacuum. The transformer shall be completely oil-tight for all parts. The tank shall be painted with **RAL 7035** weather-proof paint that protects the tank from corrosion. The radiators shall be painted same color.





- The transformer shall have a ladder for Buchholz relay maintenance and also a ladder up to the top of transformer tank. All ladders shall be provided with a safety sign "EI SAA KIIVETÄ ENNEN MAADOITUSTA" (the size shall be 400x250mm) and a lockable climbing prevention plate. A post to be poured for attachment of the safety device is installed on the cover of the transformer.
- The conductors for earthing the sections of magnetic circuit and the insulated bolts shall be collected to one place, where their insulation state can be measured from a hand hole without lowering the transformer tank oil level (so that winding shall remain in oil). Any insulation of bolts shall be duplicated in order to prevent one failure in insulation from causing harmful bolt current and to enable measurement of the insulation state.
- For vacuum treatment of the transformer on the site after an inspection or reparation requiring partial draining of oil (such as replacement of a bushing), provision for a vacuum pump (inner diameter of the pipe 100 mm) shall be made in the upper part of the transformer.
- Vibration pads under transformer (Voima).
- Steel wheels under transformer (Power) Rail spacing 3,12 m (internal spacing)

5.2.Oil conservator

- An oil conservator supported to the transformer tank. The volume of the oil conservator shall be minimum 12% of the transformer's cold oil.
- There shall be a completely separate expansion space in the main oil conservator for the diverter switch compartment of the tap-changer.
- The main oil conservator and the expansion space of the diverter switch compartment shall be fitted with filling openings and draining valves, and with amply dimensioned (at least 1/3 dm³ silica-gel per ton of oil) two-way dehydrating breathers. Air breather's type is COMEM_EM_DA (Italy) or equivalent and silica-gel type is KC-Trockenperlen Orange (Germany) or equivalent. The main oil conservator and the diverter switch compartment shall have separate dehydrating breathers.
- One dial-type oil level indicators shall be fitted for the main oil conservator and one for the expansion space of the diverter switch compartment, provided with alarm contacts for low and high oil levels. The oil level indicators shall bear marks indicating, in addition to the maximum and minimum oil levels, the correct oil level at three different temperatures of average oil, e.g. 0 °C, + 25 °C and + 50 °C. It must be possible to test the contacts without emptying the conservator; the means needed in testing are included in the delivery. Alarms shall be given when the oil level is in maximum and minimum.
- Conservator tank shall be provided with a cleaning door complete with lifting lugs, filling cap, drain valve with captive cap.
- A shut-off valve shall be provided between the gas-operated relay and the conservator so that this relay can be loosened without emptying the tank of conservator .
- Main oil conservator shall be provided with a rubber sack (breathing bellows), which prevents the transformer oil to contact the outside air. The sack shall be changeable in case of tightness problems (cracks or similar) and capable to operate in low ambient temperatures as specified.
- The pipes and their temperature-elongation compensators for conservators are included in the scope of the delivery.
- Transformer oil shall comply with IEC 60296 class II a.



5.3. Control and device cabinet

Cabinet shall be attached to the transformer (at least IP65 protection class and the hot dip galvanized or stainless steel)

- All auxiliary circuits shall be wired to the cabinet.
- Cables shall be inserted individually through link box floor by stainless steel threaded connecting glands. Protection class for glands shall be IP 54. It is not allowed to connect any cables or wires through supporting frame.
- All secondary-wiring terminals in link box shall be with screw clamp (for wiring), sliding type disconnection and clamping yoke (for testing), for example PHOENIX URTK/S-BEN, Weidmüller WTL 6/1/STB, Entrelec M6/8 ST1 or equivalent. For all terminals shall be used fast snap engraved marking, plate shall be white color and text black color. Empty terminals amounting to 10 % of the terminals needed shall be provided at each wiring place.

Fuses and miniature circuit breakers.

- All using AC miniature circuit breakers in link box shall be provided at least with two set changeover (1NO + 1NC) auxiliary position indication contacts. Contacts shall be connected to terminals.

The link box shall be equipped with lighting. Lighting shall be connected to 230 V AC via own MCB and door-switch contact (NO when door is closed).

- Earthed socket outlet 230 V 50 Hz 16A equipped with residual current protective device.
- Two heating elements with automatic temperature sensors.
- There shall be two stainless steel ventilation systems (IP 54) with weatherproof dust filters; minimum hole for ventilation shall be 50 x 50 mm.
- Pocket for documentation inside cabinet.
- Space reservation for addition of equipment: free space 300 mm over the terminal blocks (width of free space shall be entire cabinet).
- Connection possibility for a continuously operational gas analyser device

5.4. Low voltage control, current, voltage and auxiliary cables

- Control, current, voltage and auxiliary cables shall be of the filled type with PVC or halogen free insulation and shall be generally manufactured according to IEC 60502.
- Conductors shall be electrolytic copper according to EVS-EN 60228. According to EVS-EN 50334, the conductor identification shall be by white numbers on black insulation.
- The conductors shall have inner sheath from thermoplastic.
- Screening shall be braid of copper wire. Optical covering shall be at least 85 %.
- Flame retardant: in according to IEC 60332-1.
- The outer covering shall have the name of the manufacturer, the size and rated voltage of cable, year of manufacture and type of insulation.

5.5. Protection equipment

- A dehydrating breather for transformer conservator and for OLTC conservator (silica gel air breather type is COMEM EM__DA or equivalent and silica-gel type is KC- Trockenperlen Orange) or equivalent.
- A Buchholz relay equipped with one alarm contact and with two tripping contacts
- A test pump for Buchholz relay





- A pressure relief device (QUALITROL or equal) for transformer tank equipped with alarm and tripping contacts.
- An overpressure valve for tap-changer equipped with alarm and tripping contacts. Instead of the tripping contact of the relief device, a separate overpressure relay may be fitted.
- A flow relay for tap-changer equipped with alarm and tripping contacts.
- Oil thermometers equipped with alarm and tripping contacts and provided with mA output (4...20 mA) for remote measurement.
- A thermal image of the LV winding (phase B) with current transformers and thermometers with alarm and tripping contacts and provided with mA output (4...20 mA) for remote measurement.
- Oil level indicators equipped with alarm contacts for high-and low oil level (in oil conservators for main tank and for tap changer). Level Viewer graded on a scale that shows tenths of effective expansion space. Normal levels are defined to +20°C ambient temperature.
- Flexible separator in conservator.

5.6. Bushings

- The bushings shall be according to requirements to EVS-EN 60137.
- The bushings in high-voltage side shall be of condenser type with Resin Impregnated Paper (RIP- system) bushings, provided with a capacitive tap (to be earthed at take-over).
- The bushings must not be fitted with protective spark gaps.
- The bushings shall be equipped with tinned copper connection clamps.
- The air clearances shall be so coordinated that the probability of a flash over from the terminal of one winding to the terminal of another winding is negligible.
- The neutral point of the HV and MV winding shall also go through the cover and it shall be insulated same way as the phase insulation. The bushing shall have same current carrying capacity as phase bushings.
- The HV star point bushing shall be identical with the HV phase conductor bushings
- Low voltage bushings shall have flexible connectors for appropriately dimensioned aluminum busbar and cable carrying MV main current.
- All the bushings have to be changeable without opening the top of the transformer.
- Current carrying capacity of the bushings shall be equal to the overload capacity of the transformer.

5.7. Cooling equipment

- The radiators shall be connected to the transformer through the shut-off valves so that they can be detached without emptying oil from the transformer itself. Shut-off valves shall be provided with reliable and clear position indicators. In addition, radiators shall be equipped with oil drain valves and air release plugs.
- The cooling fans of the transformer shall be grouped in two independent groups which shall be selected by the selection switches in the control cabinet. The fan groups with different temperatures shall be controlled by the top oil temperature of the transformer or manually from the control cabinet of the transformer. The start and stop temperatures shall be adjustable and those shall be adjusted by the Contractor.
- Each fan motor shall be equipped with thermal relay with alarm contact. Fans shall be equipped with a protective mesh and a plate or equal against falling icicles.





Control equipment (MCB's, contactors, thermal relays, etc.) for cooling fan motors shall be mounted in the control cabinet of the transformer. (400/230 VAC 50 Hz)

5.8. Thermometers

- For monitoring of top-oil temperature the transformer with cooling system ONAN shall be fitted with weatherproof dial-type thermometer capable of withstanding transformer vibration, attached to the tank wall. The thermometer shall be provided with an adjustable alarm contact (the setting + 80°C at take-over) and with a tripping contact (+100 °C), and, moreover, with a maximum indicating pointer with a resetting device. The scale and setting shall range up to at least +120 °C. Thermometer shall fit for remote measurement (4...20 mA floating DC signal).
- Thermometers and other instruments shall be protected against rain by means of metallic cover or similar. Furthermore, the capillary tubing's of thermometers shall be provided with protective trays on top of the transformer tank.
- The thermometer shall have an extra oil-filled thermometer pocket for remote reading of top-oil temperature, excluding the instruments themselves. The fastening threads for the temperature sensor shall be R 1" and the immersion length 190 mm. When delivered the pocket shall be closed by a removable plug.
- For MV winding in one phase (a) there shall be thermal image calibrated on the basis of the temperature rise type test, for display of the hottest-spot temperature of the winding. The thermal image shall simulate – both at steady state and in transient conditions – the temperature of the winding, but it (or the contacts) shall not respond to a temperature rise caused by a transitory short circuit. The thermal image shall be provided with a dial type thermometer similar to the top-oil thermometer but with a scale and setting range of up to +150 °C and with two tripping contacts. The alarm of the thermal image shall give an extra start to all fans and pumps, including any redundant group if existing. The setting of the alarm contacts shall be +120 °C and that of the tripping contacts +140°C at take-over. The thermal images shall fit for remote measurement (4... 20 mA floating DC signal).

5.9. Tap changer

On-Load Tap Changer

- The transformer shall be equipped with ON-LOAD tap changer on HV side.
- The nominal current of the tap changer shall correspond the load capacity of the transformer so that the control is allowed at load range of 0...1,5*I_n with oil temperatures down to -25 °C.
- The tap changer must be structured so that it cannot stay between two positions.
- The tap changer and its operation device must be ready to operate after voltage breaks without any actions
- The tap changer shall be possible to control with:
 - local manual crank
 - Push buttons of operating device
 - Remote control (voltage regulator, push buttons in the control room, remote drive).
- Control voltage shall be 230 V 50 Hz and motor voltage shall be 3-phase 400 V 50 Hz.
- There shall be in the control cabinet among other things:
 - A motor circuit breaker with alarm contacts for the motor-drive



- An operation counter for the tap changer
- A local position pointer
- A drying heating
- At least following signals shall be available from on load tap-changer and connected to terminals:
 - BIN CODE (suitable for 110-220 VDC) signal (5 wires) for on load tap-changer position indication,
 - mA signal (4-20 mA) for on load tap-changer position indication,
 - LOCAL and/or DISCONNECTED position of control switch,
 - MCB open position of motor AC supply (separate auxiliary contact),
 - MCB trip signal of motor AC supply (separate auxiliary contact),
 - MCB open position of heating AC supply (two separate auxiliary contacts),
 - TC in progress,
 - Door of tap-changer box is open.
- A grounded outlet, protected with residual current device (RCD), must be in the control box.

5.10. Placing of equipment

- Sign with details of transformer, coil couplers and associated equipment manufacturer, model, serial number, type and electrical data shall be mounted on the component.
- On the plate for the oil-insulated transformer will be apparent indication of the oil manufacturer, type and weight.
- All the signs were made of corrosion-resistant materials and fitted with permanent text. All information must be given in Finnish or in English.
- Signs shall be located so that, after installation, these can be easily read from ground level.
- Oil level indicator, thermometers and plates shall be readable at the side of high-voltage insulators.
- The markings and the placing of the terminals of primary circuits on top of the transformer shall be as follows:
 - high-voltage side (HV) N, A, B, C
 - intermediate -voltage side (MV) a, b, c

5.11. Name plates

The plates shall be of stainless steel with engraved texts.

The transformer shall carry the necessary rating, diagram and instruction plates inscribed in Finnish.

Besides the data required by the EVS-EN 60076-1, the following data shall be marked on the rating plate of the transformer:

- the short-circuit strength (short-circuit current and the corresponding short circuit duration), for all winding separately.
- the type of the transformer oil.





Information to be given on rating plate		
[in English]	Example	[Finnish]
Kind of transformer - (power)transformer		Muuntaja tyyppi - tehomuuntaja
Number of standard	IEC 60076	Standardi
Manufacturer's name		Valmistajan nimi
Designation of type		Tyypimerkintä
Year of manufacture		Valmistusvuosi
Number of phases		Vaihe numero
Serial number		Sarjanumero
Rated power [of each winding]	63000 kVA	Nimellisteho
Rated voltages and tapping range	118 ±9x1,67% /21 kV	Nimellisjännite ja säätöalue
Rated frequency	50 Hz	Nimellistaajuus
Rated currents	A or kA	Nimellisvirta
Connection symbol	YNd11	KytKentäryhmä
Short-circuit impedance [several impedances for different two-winding combinations]		Oikosulku impedanssi
Type of cooling	ONAN	Jäähdytystapa
Total mass	t	Kokonaispaino
Mass of insulating oil	t	Öljyn paino
Insulation levels (withstand voltages)	kV	Eristystaso
Tapping voltages	kV	Säätöjännite
Tapping currents	A or kA	Käämikytkimen virta
Temperature rises of top oil and windings [if not normal values]	°C	
Insulating liquid [if not mineral oil]		Eristysaine
Type of the transformer oil		Öljyn tyyppi
Connection diagram [in cases where the connection symbol will not give complete information regarding the internal connections]		KytKentäkaavio
Transportation mass [for transformers exceeding 5 t total mass]	t	Kuljetuspaino
Untanking mass [for transformers exceeding 5 t total mass]	t	Tyhjä paino
Total mass	t	Kokonaispaino
Vacuum withstand capability of the tank and of the conservator		Tyhjönkestävä
Total power taken by the fans motors	kW	Puhallinteho
Short-circuit strength (current and during)	kA, s	Oikosulkuteho
Current transformers		Virtamuuntajat



Furthermore, fittings of the transformer shall have their own protection and oil piping diagram according to the pertinent Standard (including fans, valves, etc.). At least the following data shall be marked on the separate protection and oil piping diagram of the transformer:

- The location of all protection devices.
- The location of all valves and oil pipes (the position of the valves shall be shown).

6. TESTING

6.1. Factory tests

The tests shall be performed according to the IEC 60076-1...5 standards. If there are no results available of type tests made on identical transformer, the type tests shall be included in the scope of the delivery.

The delivery shall include following measurements and tests performed in the factory:

- measurement of windings resistance
- measurement of voltage ratio and check of connection group
- measurement of no-load loss and current
- measurement of short-circuit impedance and load loss
- dielectric routine tests (EVS-E N 60076-3)
- tests on on-load tap-changers, where appropriate
- determination of capacitances windings-to-earth, and between windings
- measurement of zero-sequence impedances
- measurement of insulation resistance to earth of the windings, and measurement of dissipation factor ($\tan \delta$) of the insulation system capacitances
- checking of the control and protection devices
- operation test of the tap-changer
- sound pressure measurement
- test certificate of sensors for measurement of oil and winding temperature, Buchholz relay, silica gel air breather, current transformer, tap-changer, oil level indicator, overpressure valve, protection relay for tap-changer, all valves, silica gel
- test certificate of bushings
- test certificate of transformer oil
- lightning impulse test (high and low voltage sides)
- temperature rise test
- gas analyze of oil sample

The Customer's representative shall have the possibility to oversee the tests. The date of the tests shall be informed to the Customer at least 15 days before performing the tests.

6.2. Site tests

The delivery shall include following site measurements and tests:

- operational tests
- measurement of electric breakdown voltage, a 0-oil sample within 1-2 months, 1 years and 2 years of commissioning and water content of oil sample will be delivered by the Customer





7. DOCUMENTS

The Supplier shall submit the instructions needed in erection, operation and maintenance of the transformer in two (2) sets (A4 size folders) and in addition in flash drive in MS Word- or PDF-format.

The Supplier shall submit the connection diagrams and dimensioning drawings of transformer's auxiliary devices in folders mentioned above and also in .dwg- or .dxf-format.

Test reports of factory tests shall be enclosed in the instruction folders.

The Supplier shall submit the test reports of site tests to the Customer at latest 1 month after performing the tests.

