

**KOLEKTOR**



# Technical catalogue



# About

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KOLEKTOR ETRA has been acting as transformer manufacturer over more than 85 years. Specializing in the manufacturing of power transformers rating up to 500 MVA and 420 kV the company is focusing its activities mainly in technical areas like loss and noise level reduction. Innovation, competence, reliability and after sales service are the words which characterize the company by our valued customers over the years.



# Power transformers

Power transformers and auto-transformers of rated power up to 500 MVA and rated voltage up to 420 kV, filled with mineral oil or environment friendly, biodegradable, unflammable insulating liquid.

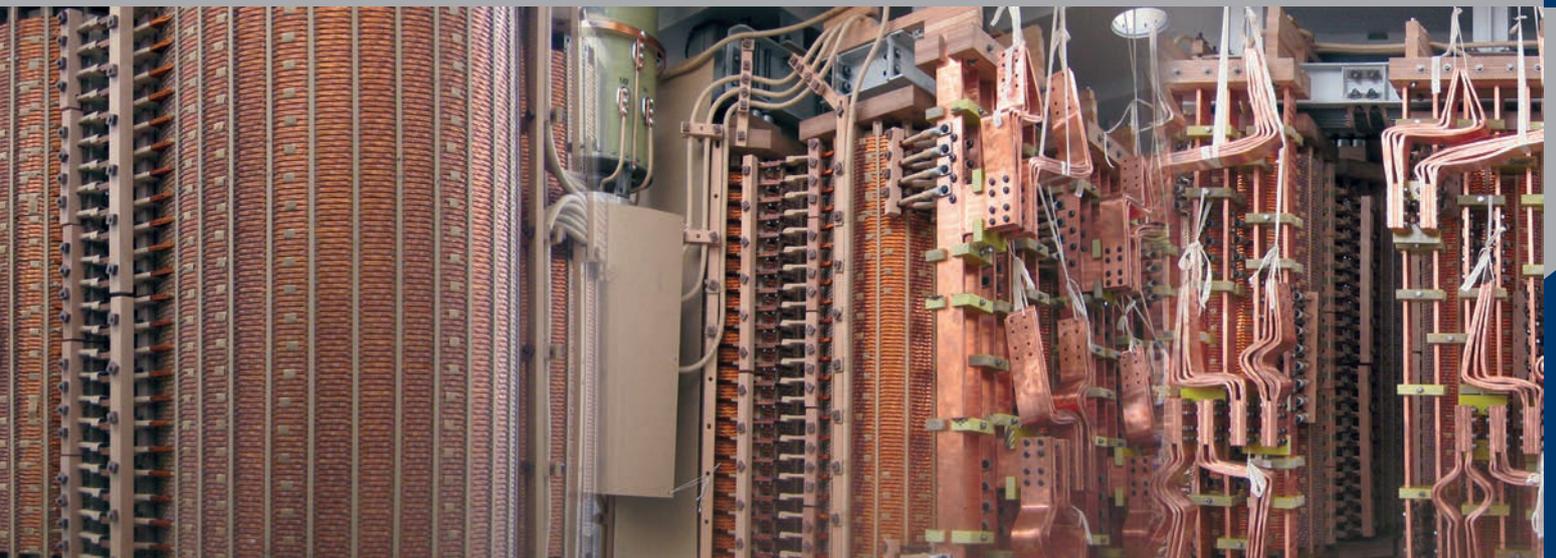
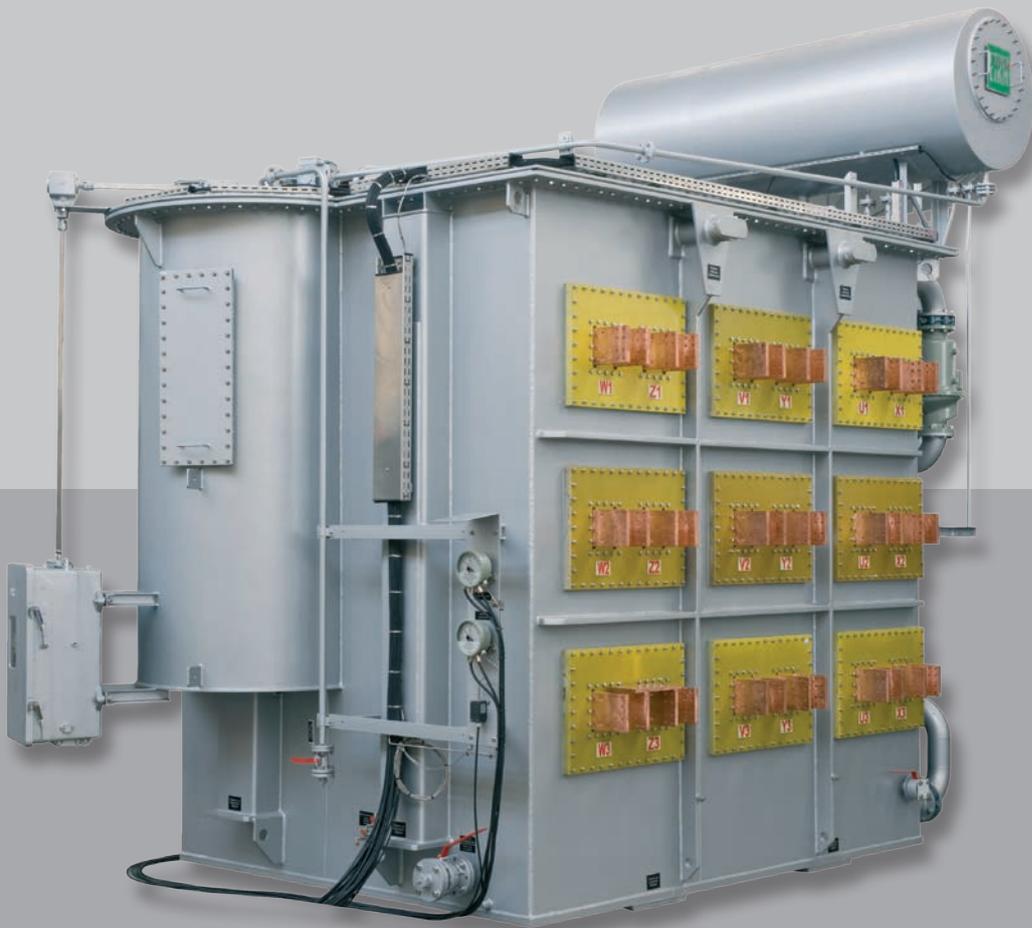


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# Special transformers

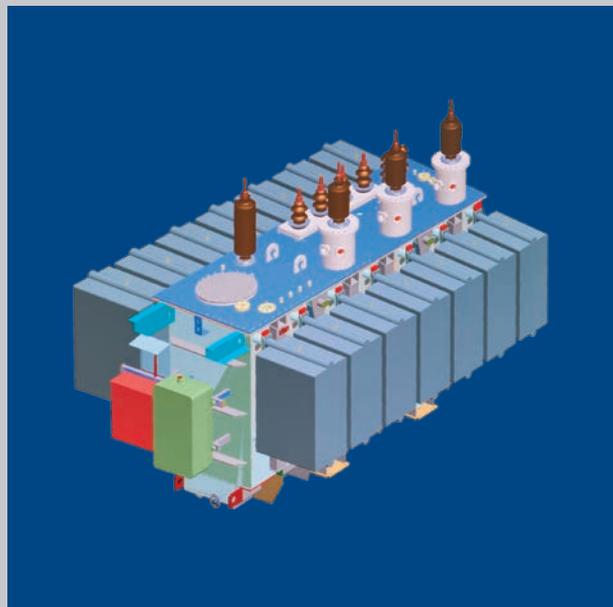
- Furnace transformers with on-load tap-changing used for arc furnaces.
- Furnace transformers with off-load tap-changing used for induction furnaces.
- Rectifier transformers.
- Grounding transformers for the neutral point earthing.



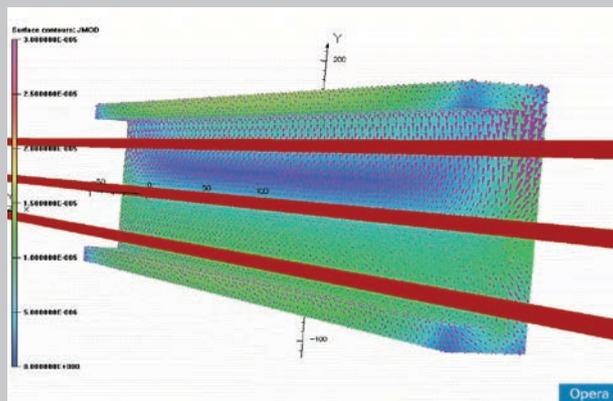
# Knowledge

All our products are result of our own design

In our archives we preserve more than 4000 different designs. Most of them are currently used for the performance of our servicing activities, but taken as a whole, they are a unique source of tradition, experience and excellence. With modern and approved computer techniques, use of new materials and technologies, we are constantly developing new products.

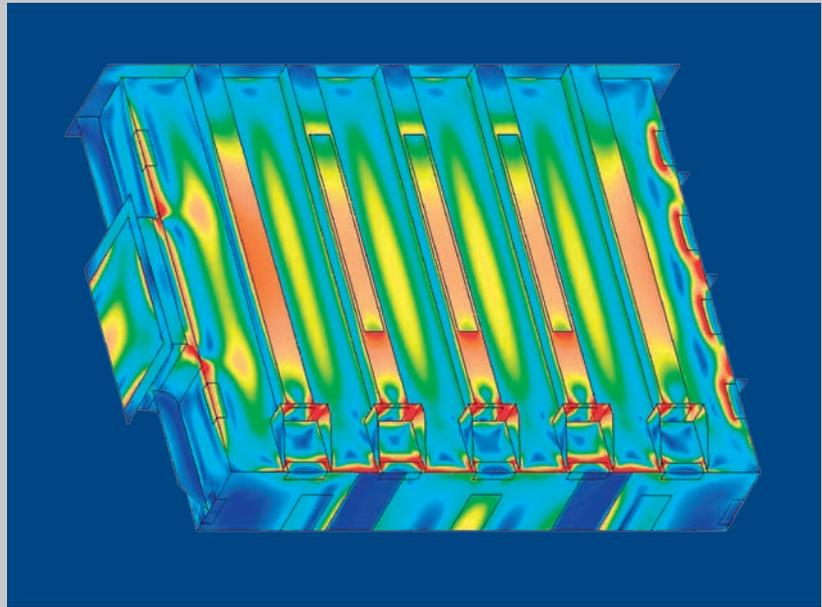


*Magnetic field between conductors and ferrous beam*

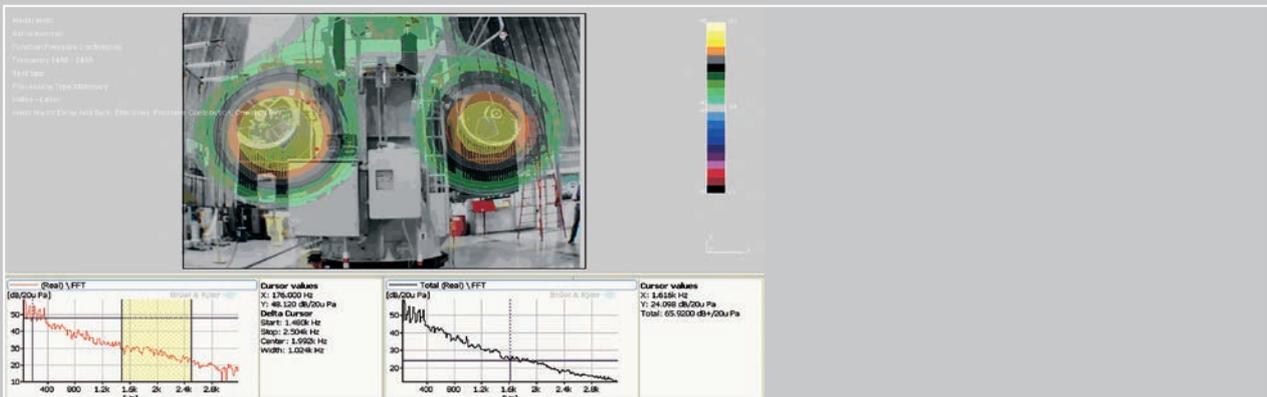


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Our aim is to supply our customers with reliable, environment-friendly products. Thus, transformers manufactured in KOLEKTOR ETRA have low losses and low noise levels.



*Numerical simulation of mechanical stresses in transformer tank*



# Environment

## Our contributions to the protection of environment

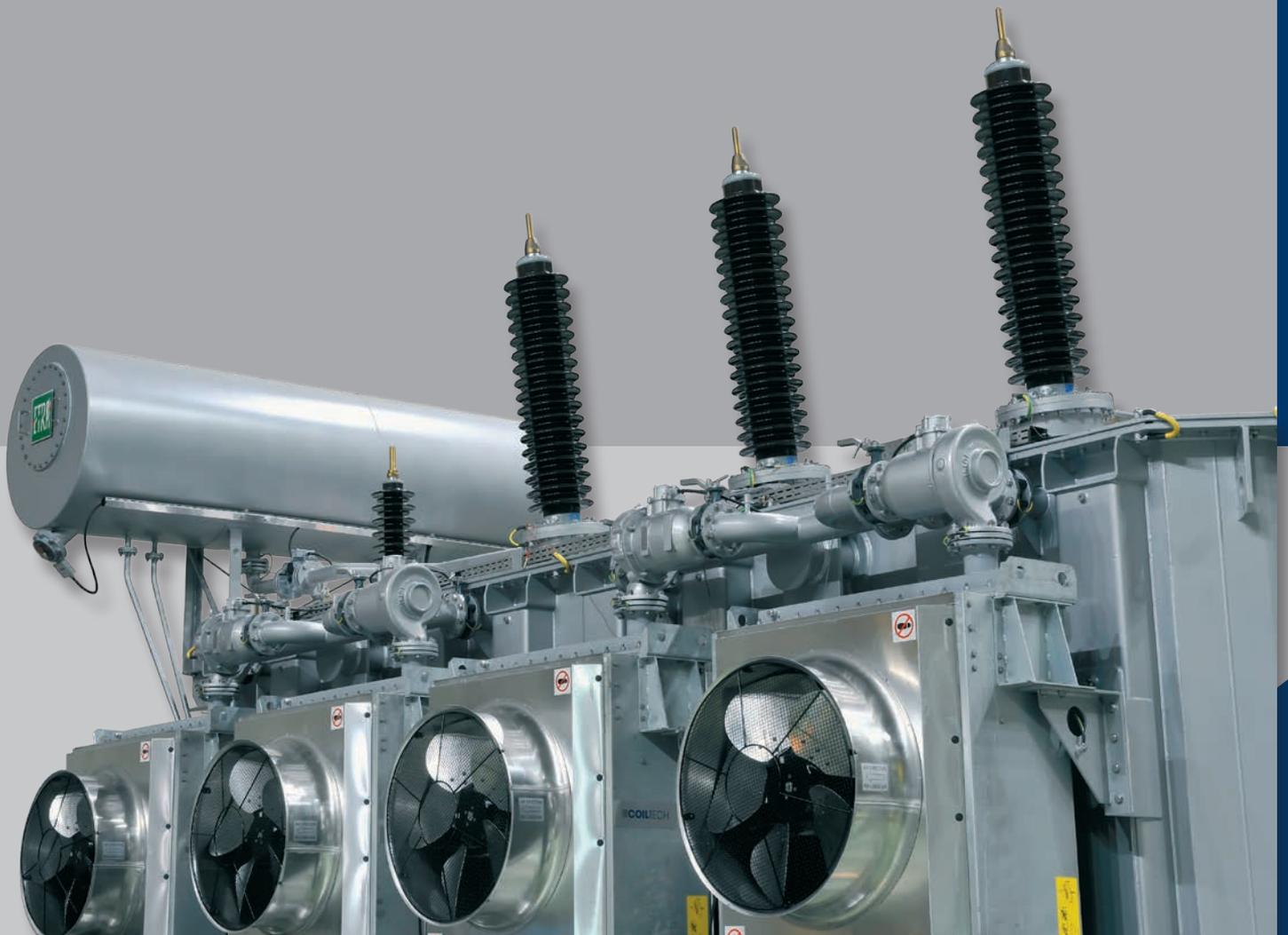
In modern society human beings and machines often share their common life and working space. Operation of each machine or appliance is felt by human beings and the nature as a disturbance. In our factory we do our best that the operation of our transformers is safe, long-lasting, economic and with least possible effects upon environment.



- Mineral oils used for oil immersed transformers do not contain PCBs or other harmful substances.
- In transformers located in fire-resistant and water conservation areas we use synthetic oils, i.e. environment-friendly liquids. Main characteristics of these liquids are: higher flash point and biodegradability.
- We are qualified for repair works, reconstructions, different reworks of transformers, their constituent parts and equipment.
- Our special attention is paid to reduction of noise level of the transformer. Noise levels, achieved for transformers are low enough to decrease substantially the costs for the construction of anti-noise barriers in transformer stations.
- Our special contribution to preservation of the environment is safe and environmental friendly decommission of transformers after their life cycle expiration.



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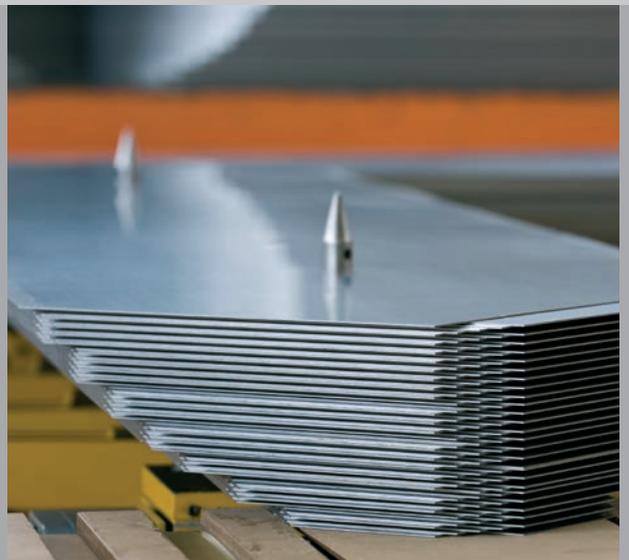


# Magnetic core

Three quality classes of magnetic steel sheets are in use: oriented conventional magnetic steel sheets of class C.G.O., steel sheets of high magnetic orientation HI-B and laser treated magnetic steel sheets. Magnetic core is stacked by overlapping of individual steel sheets according to the step-lap system. So called core type with two, three or five limbs is used. With accurate cutting and careful stacking of the magnetic steel low no-load loss, low no-load current, low amplitudes of the in-rush current and low noise level is obtained.



The core laminations are securely held together by means of heat shrinkable polyglass bands and tightening facilities made from anti-magnetic steel in such a way that movement of laminations during transportation and vibrations during operation are prevented.



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The lower yoke and the limbs are coated with glue varnish. Oscillations and vibrations caused by magnetostriction forces are thus reduced to minimum. The frame formed by yoke and limb clamps around the magnetic core enables safe transporting of the transformer and adequate resistance to electromagnetic short-circuit forces.

Big units have individual packages of steel separated with insulation barriers and those with higher flux density in core with cooling channels. In such cases all with insulation separated packages are galvanically connected and earthed. Earthing of all iron parts on the magnetic core is performed separately.



# Windings

The windings are made from electrolytic copper of high purity, Cu-ETP signed. Specific electric conductivity is  $58 \text{ Sm/mm}^2$ . Conductors are in strength by RP0,2 from 90 to  $160 \text{ N/mm}^2$ . For higher currents are used foil and rectangular conductors insulated with paper or enamel. For the highest powers and currents is used transposed cable.

Three thermal classes of insulation are in use:

- enamel insulation (PVA), thermal class E ( $120^\circ\text{C}$ ), in compliance with standard IEC 60317-0-2.
- Paper insulation 5A2-1M3, thermal class A ( $105^\circ\text{C}$ ), in compliance with standard IEC 554-3-5.
- Thermal upgraded paper insulation 5B1-2M3, thermal class E ( $120^\circ\text{C}$ ), in compliance with standard IEC 554-3-5.



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The windings are manufactured in different variants.

**Single-layer or multi-layer windings** are used for phase currents up to 1000 A and rated voltages up to 72,5 kV.

For higher and the highest voltage classes disc windings are used: helical, continuous disc or interleaved.

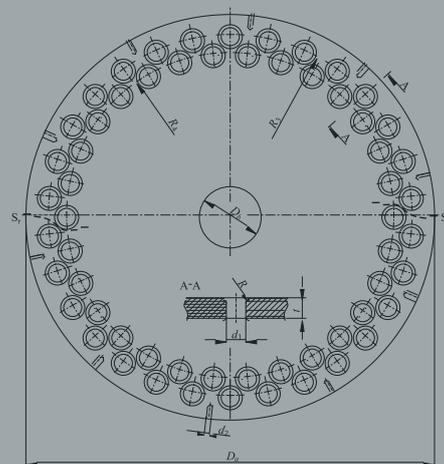
**Interleaved windings** are used in case when the transformer has to be tested by lightning impulse voltage above 550 kV. Similar as continual disc windings are made of equal coils composed of higher number of equal disks and sections respectively. The connections between the disks are interleaved. After the completion of windings the procedure of thermal stabilization of insulation and the adjustment of specified dimensions follows. Windings are first dried in the drying furnace, after that their height is set by hydraulic pressing device.

**Helical windings** are made in form of single or double spirals across the total height of windings. They are suitable for the currents up to 2000 A and rated voltage up to 36 kV.

**Double helical winding with effects of continuously transposed conductor. ETRA Patent pending.**

This high-current engineering invention belongs to the field of production of lowvoltage high-current winding. Double helical winding with a rectangular wire, made according to the described winding technique has higher spatial efficiency and therefore a better winding filling factor. Double helical winding with effects of continuously transposed conductor eliminates the technological limits common in the technique of making the continuously transposed conductor type NTCTC.

The double helical winding enables the formation of more effective cooling



**Continuous disc windings** are made of several numbers of equal coils or sections connected in series. These windings are of advantage when used for transformers rated above 2500 kVA and rated voltages upto 145 kV.

channels in the winding. Moreover, it does not set high limits for the trans position factor, the crossing wires between stacks can be additionally protected and the winding does not need the polyester netting tape.

# Assembly of active part

After thermal and mechanical stabilization of windings, follows the assembly of all windings forming one phase of the transformer. They are clamped between special laminated wooden plates, enabling simple installation of windings on the magnetic core limbs. After closure of the upper magnetic core yoke follows the insertion of both yoke clamps, and afterwards of screws and shock absorbers between both yoke clamps and windings for permanent pressure of windings.



Plates and screws for longitudinal pressing of all windings for one phase and the radial tightening cylinder form a compact unit resistant to forces in case of eventual short circuit in the network



Clamping of windings and of the magnetic core is also important for the transport, where compactness of design assures safe transport without damages, internal movements or slipping transformer within the active part.



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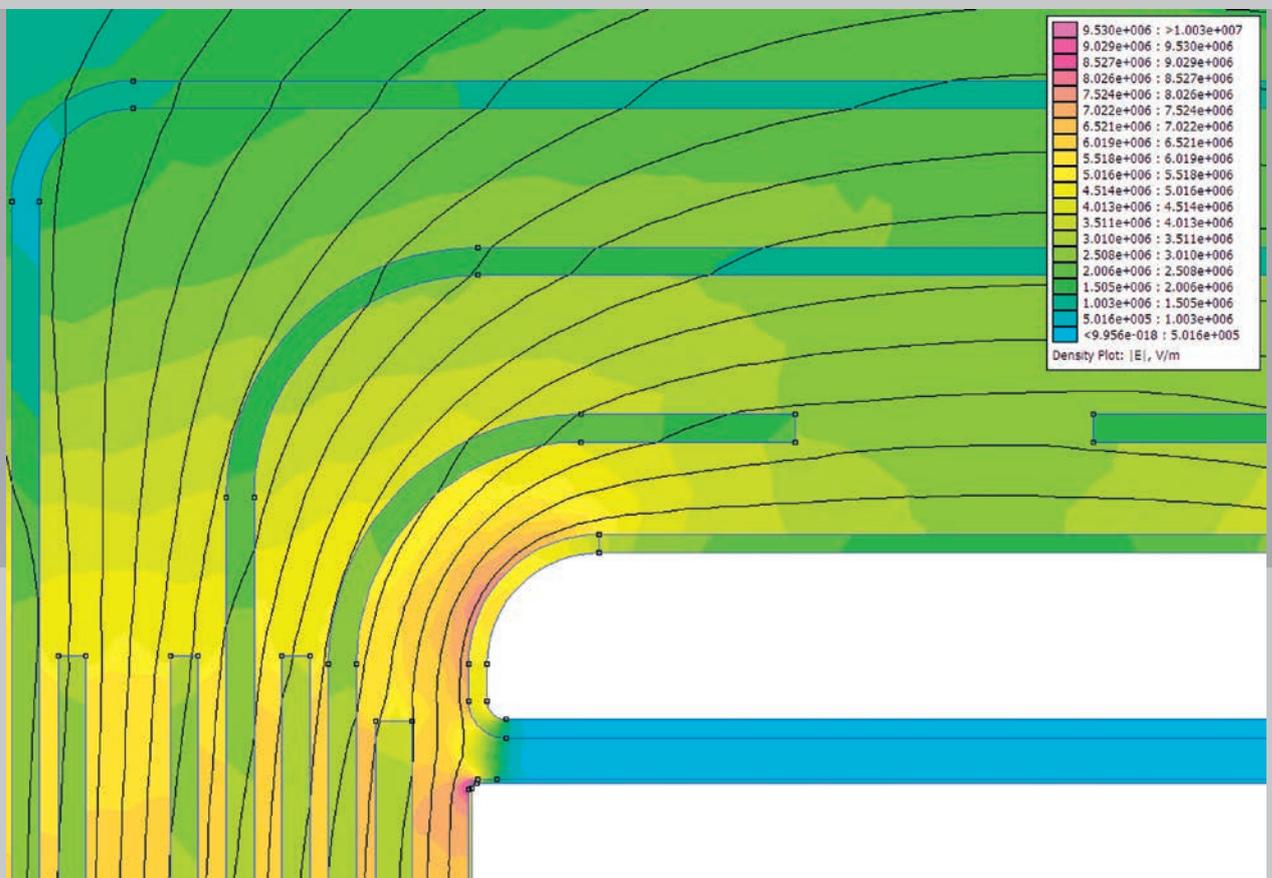
Adequate drying of insulation according to vapour phase system and filling of the active part with oil under vacuum are the final phases determining the high dielectric, thermal and dynamic strength of the transformer.



# Insulation system

The insulation system in oil-immersed transformers is made of hard insulation and liquid dielectric. The liquid dielectric is usually mineral or synthetic oil. Hard insulation is made of concentric cylinders or barriers from special high-pressure cardboard. We use only high-quality, stabilized insulation produced by renown producers.

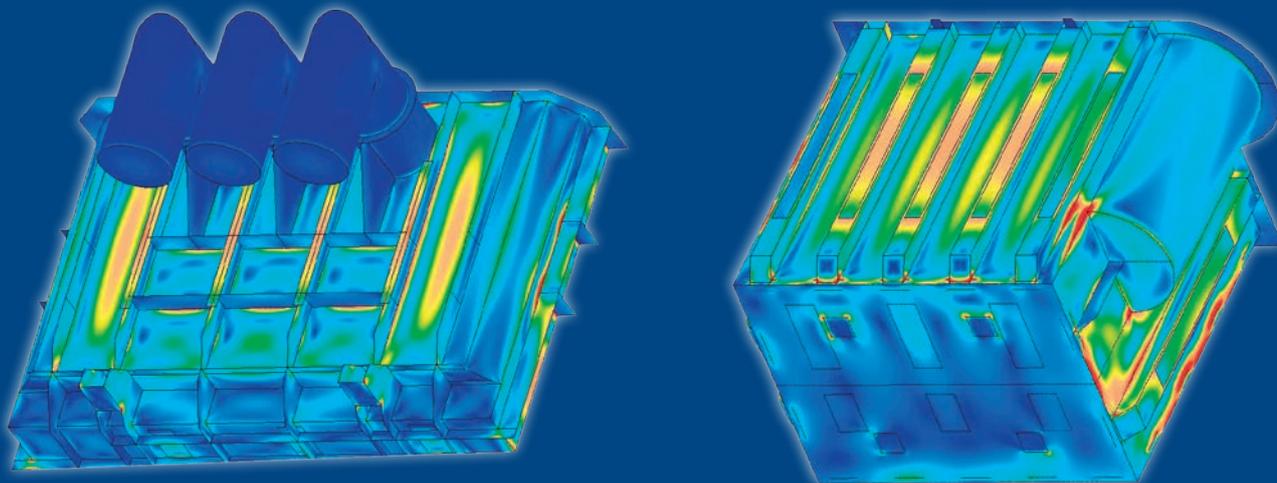
Calculations of dielectric insulation loads are performed according to modern methods based on computer aided design. This enables a fast and more accurate calculation and optimum design of insulation, especially for highvoltage transformers.



# Tank

Tanks are designed with reinforced plane walls to withstand full vacuum and 70 kPa overpressure. We manufacture two types of tanks: the classic tank and the tank in the shape of a bell. The active part in the classic tank is lifted together with the cover while in the bell-shaped tank only the bell is lifted without the bottom and active part. Corrosion protection of the tank and equipment is standardized and is defined in dependence on climatic conditions in which the transformer shall be in operation or according to the customer's requirements.

climatic conditions. Materials used for the production of tanks are classified into the category of construction steels. The required strength calculations for the tank are performed in accordance with modern methods. With the help of computer aided engineering work and numerical strength tests we assure optimal construction design, perfect safety and safe transport of the transformer to the location of its installation.



The standard corrosion protection is often adapted to the requirements of our customers, thus they can choose the thickness of individual layers, their combination and the top coat shade. Parts of equipment for large transformers and radiators are often protected with the hot-zincking procedure enabling transformers to operate under hardest

# Cooling system

Transformers are equipped with a cooling system which can efficiently dissipate the heat emerging during operation. The cooling system is designed and tested for permanent operation with declared capacity within the limits of specified temperature rises. If there are no special overloading requirements, the cooling system is designed in correspondence with the IEC 60076-7. It comprises radiators, varied types of oil coolers or heat exchangers.

They can be separated from the tank and divided into several batteries or coolers, what enables fast assembly or dismantling of installations. The cooling system can be separated from the tank and situated in separate facilities with better conditions for the heat dissipation. In such cases the system has installed pumps for faster circulation of oil. Only the OF and OD types of cooling can be applied.



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# Testing and quality assurance

Each individual core, winding, tank and other parts are subjected to the mechanical and electrical inspection prior to mounting. During the mounting procedure the following is performed: interphase measurement of voltage ratio, measurement of resistance, insulation resistance, measurement of short circuit loss prior to drying process, supervision of drying process and transformer oil dielectric strength testing.

The interphase measurements are carried out in the workshops. The final testing of transformers is carried out in our own, well equipped, up to date designed high-voltage laboratory located near the production plant. By using the metal plate cage in the laboratory walls and electrical supply through filters a very low frequency disturbance is achieved which is of great importance when partial discharges are tested, corona measured etc.



Upon the completion the transformer is subjected to routine test and measurement required by the standards, while each new transformer type also demands type testing.

**With highly experienced and professionally trained group of employees we can perform routine, type and special tests, required by international standards.**



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The main equipment of the high-voltage laboratory is:

- Motor-generator group 3500/1200/500 kVA, 12/6/6 kV, 50/200/300 Hz.
- Test transformer 500 kV, with a regulation transformer, compensating reactor, capacity divider and control panel with digital measuring instrument.
- Computer controlled impulse voltage generator 2000 kV, 200 kJ provided with a RC divider and chopped wave device.
- Mobile equipment for measurement of resistance and temperature rise test with automatic temperature readings.
- Digital partial discharge measuring system.
- Equipment for measuring  $\text{tg}\delta$  and the transformer capacitance.



- Precision wide band power analyser.
- Frequency response analyser (FRA).
- Three phase transformer turns ratio meter
- Noise source identification system with automated microphone positioning system,
- Sound intensity analyser
- Sound level meter.
- Automated test unit for testing of transformer oil dielectrical strength.
- Testing unit for dissolved gas analyses.

# Service activities

Our factory performs also various service activities such as: repair of transformers of different manufacturers, reconstruction of vital parts of used transformers and reworking of transformers, maintenance of transformers and reactors, supervision of installation and putting into operation of transformers, execution of measurements on transformers and reactors in our own HV laboratory or at site, replacement of transformer oil with new oil or treatment of used oil, and organization of transport, installation and dismantling of transformers and reactors.

Our service department has several service groups always ready for fast interventions at site. Special service vehicles are equipped with the required equipment, tools and spare parts for fast interventions.



Advantages of our service groups are: fast reaction, professional inspection and diagnosis of failure, performance of repair works within the agreed-upon terms and quality technical documentation referring to the performed work.



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