ERSO
ENERGY SOLUTIONS

PRODUCT CATALOG

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ERSO
ENERGY SOLUTIONS

Moscow

Ufa

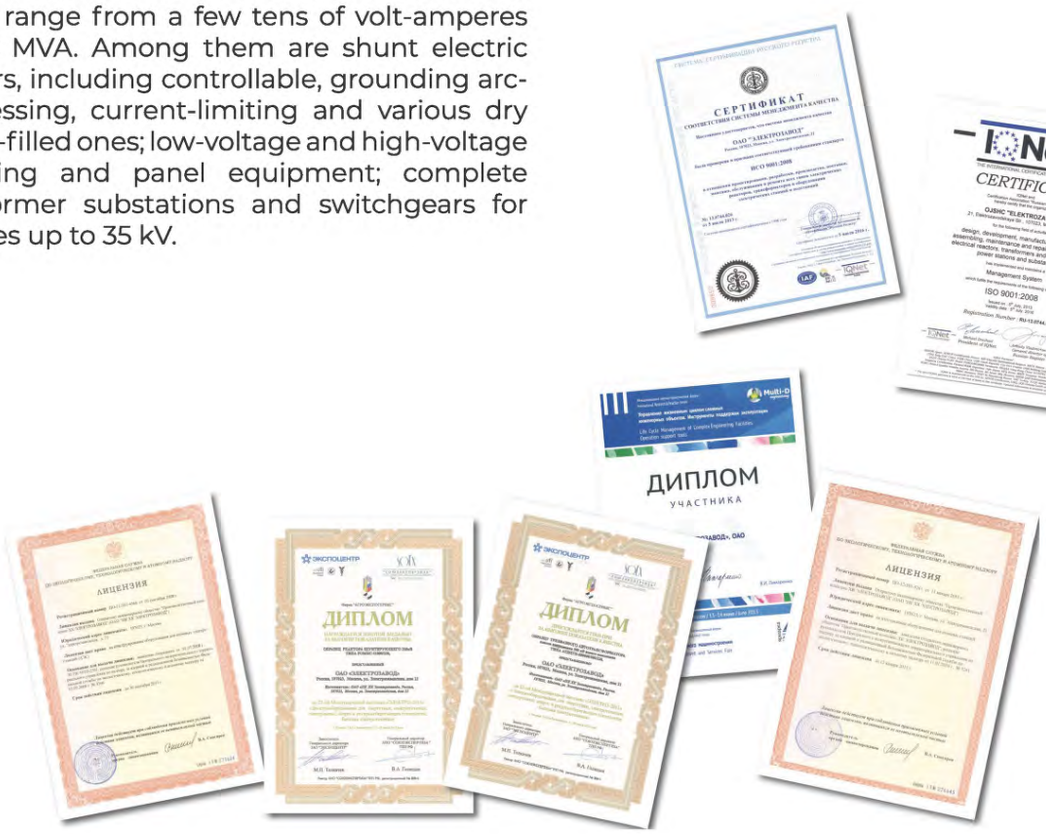
JSC "ERSO HOLDING" (ERSO Holding) is the founder of the domestic transformer industry, one of the largest manufacturers of electrical equipment in Russia. The holding company operates several production sites: Moscow Electrozavod and Ufa Transformer Plant.

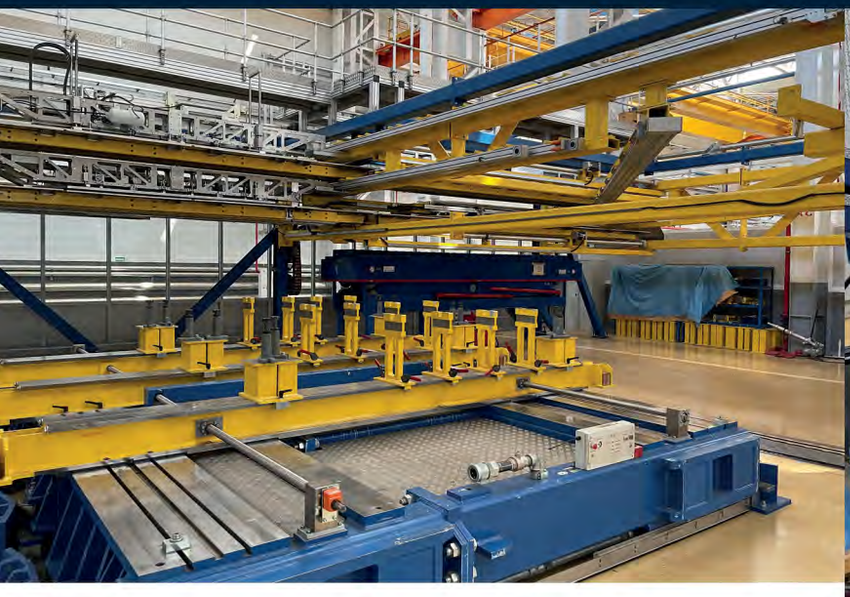
The company develops and manufactures shunt and network reactors, transformers for metallurgical, mining, oil, nuclear and other industries and important infrastructure facilities.

The nomenclature range includes more than 3500 types and versions of transformers (both dry and liquid dielectric) with voltage range from a few tens of volts to 1150 kV and power range from a few tens of volt-amperes to 630 MVA. Among them are shunt electric reactors, including controllable, grounding arc-suppressing, current-limiting and various dry and oil-filled ones; low-voltage and high-voltage switching and panel equipment; complete transformer substations and switchgears for voltages up to 35 kV.

The products are used both throughout Russia and abroad. The equipment is characterized by high quality and reliability.

ERSO has a quality management system according to ISO 9001 international standard. The company has licenses from the Federal Service for Environmental, Technological and Nuclear Supervision for the right to design, manufacture and supply electrical equipment; it is an official supplier to the Russian nuclear industry; it meets the requirements of the state supply standard.





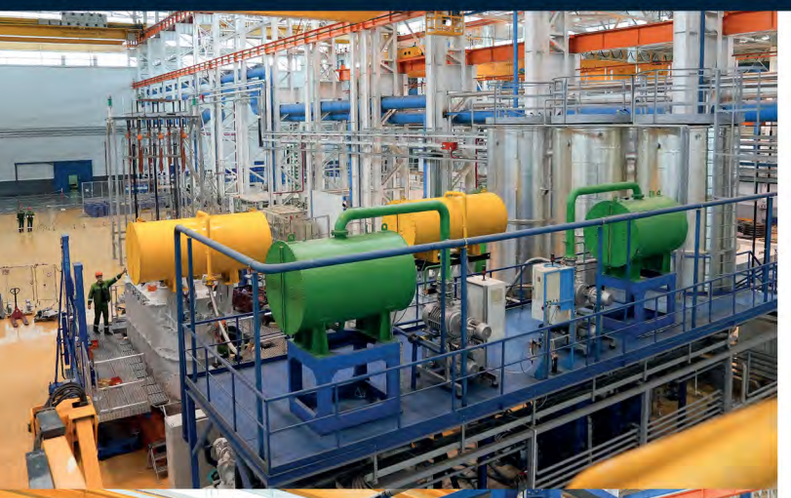
Power transformers and autotransformers of 110 - 750 kV voltage classes are developed using advanced design and technological solutions, modern materials and the company's long-term experience in the design and manufacture of transformer equipment. Application of electrical steels with low specific losses and step-lap charging scheme in the magnetic core, as well as improvements in the design of the main insulation provided **a 35% reduction in no-load losses** (compared to GOST) depending on the type and power of the transformer.

The use of special transposed wire with bonding of elementary conductors for windings and a number of other innovations provided a significant increase in the electrodynamic short-circuit resistance of windings. Optimization of bypassing and shielding scheme of metal structures of the frame and tank **reduced short-circuit losses in transformers (on average by 20-30% compared to GOST).**

The new generation of power transformers uses low-shrinkage electrocardboard, modern technology of winding stabilization, winding pressing with insulating ring made of laminated pressed wood instead of steel rings, simplified design of yoke beams. These solutions reduce the material and labor intensity of the active part of the transformers, as well as provide a given winding pressing force during the entire service life of the transformers. Thus, **there is no need for overhaul with winding pressing after 12 years, as stipulated by GOST.**

The use of modern methods of electromagnetic fields calculation, optimization of magnetic shunt design for magnetic flux localization, refusal from steel pressing rings allowed **to reduce losses in transformer design elements by 2 times.**

As a result of implementation of new technical solutions, the characteristics of new generation power transformers significantly exceed the GOST characteristics. **Total losses are reduced by 15-25% on average. Transportation weight and overall dimensions have been significantly reduced. Noise level is reduced by 10-15 dBA.**



Highly reliable switching devices of leading world manufacturers are used for voltage regulation under load. At the customer's request, the equipment can be equipped with high-voltage bushings: oil bushings of non-tensioned design (with shortened bottom part, with connection to the winding outlet at the level of the tank cover, which greatly simplifies installation and dismantling of bushings without draining oil from the transformer tank); with solid internal RIP-insulation (characterized by high reliability and long service life); cable or gas-insulated high-voltage bushings.

Depending on the transformer capacity and customer requirements, ONAN, ONAF, OFAF or OFWF cooling systems are used. Transformers can be manufactured with remote cooling system.

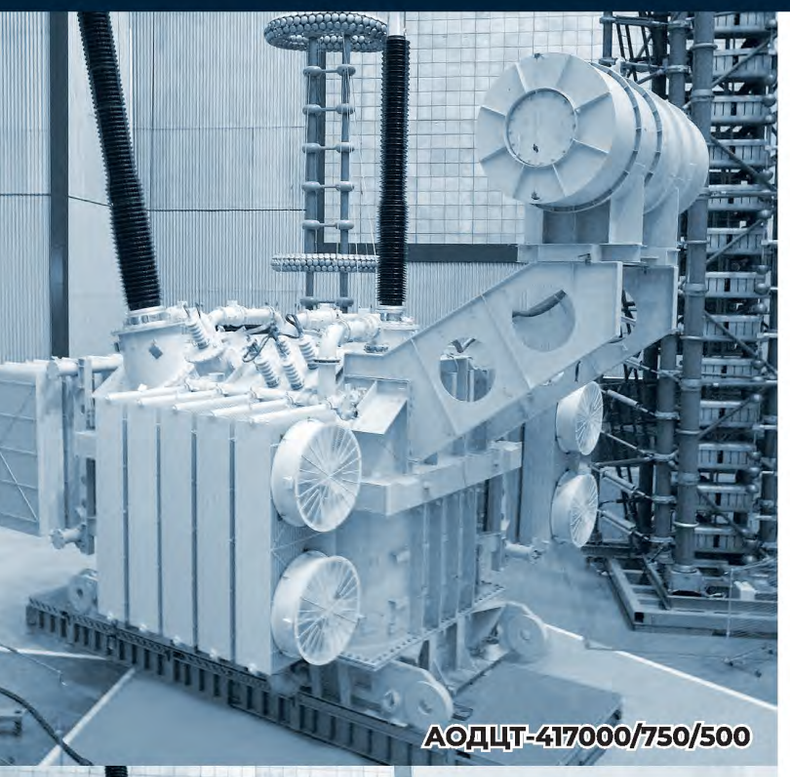
A new development of combined cooling system of ONAN/ONAF/OFAF type, which consists of several groups of plate radiators equipped with electric pumps and fans, has been widely spread. The system is controlled by an automatic control cabinet depending on the load value and temperature of the upper oil layers.

The products are equipped with a special sealing rubber **with a service life of 30 years,** compared to 10 years for ordinary rubber. Power transformers are equipped with sensors for connection of monitoring systems for protection against explosions and fires. Upon customer request, these systems can be supplied and installed together with the transformer equipment.

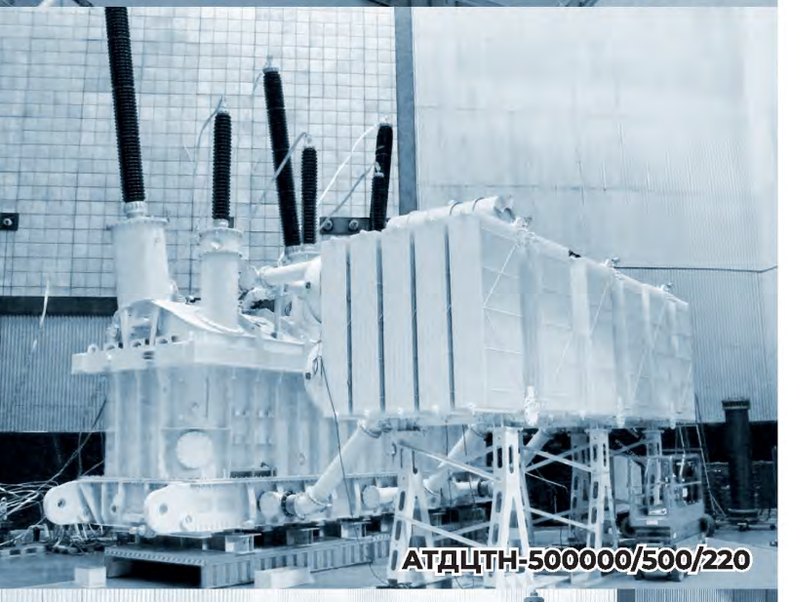
Transformers are designed for open or closed installation for operation in temperate climate. Upon request, it is possible to manufacture equipment in cold-resistant, earthquake-resistant version, as well as for tropical climates.

Modern equipment is used in production: installations for longitudinal and transverse cutting of electrical steel **"GEORG" (Germany), "Soenen" (Belgium)** and **"Tuboly-Astronic AG" (Switzerland);** horizontal and vertical winding machines **"Tuboly AG" (Switzerland)** and **"L.A.E.s.r.l." (Italy);** vacuum drying cabinets **"Hedrich" (Germany),** platforms on air cushions for moving equipment **"DELU" (Germany)** and others.

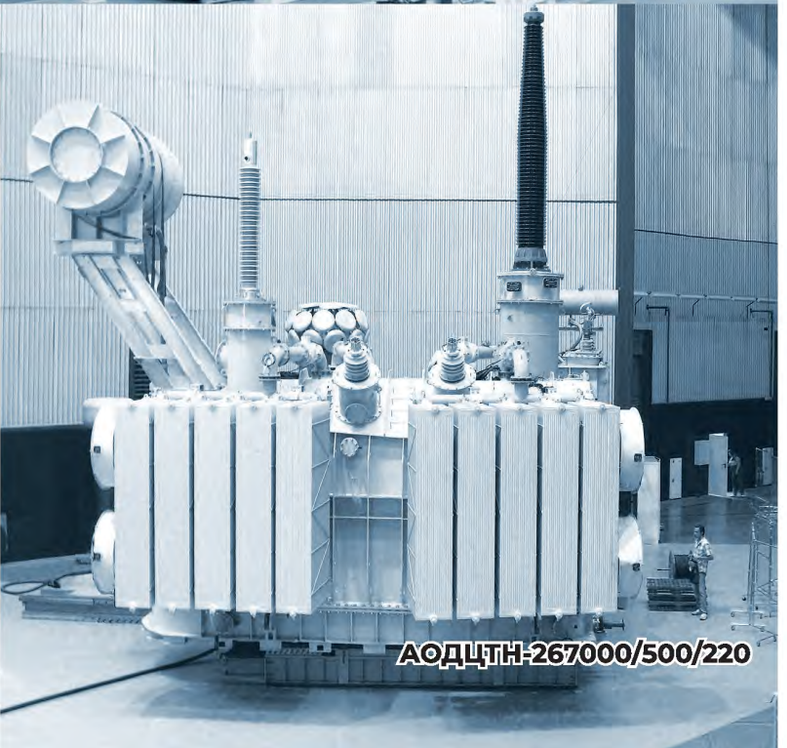
Type and special tests of materials, components, units and assemblies are carried out at all stages of production. All products undergo acceptance testing in accordance with **GOST R 52719-2007.**



АОДЦТ-417000/750/500



АТДЦТН-500000/500/220



АОДЦТН-267000/500/220

ERSO is one of the domestic manufacturers, which mastered the production of autotransformers of **ultra-high voltage class 750 kV, capacity 417 MVA** of type АОДЦТ-417000/750/500 (type and range of regulation - SWE in common neutral from -4,8% to +4,0%, ±1 stage). The first autotransformers of this type were manufactured for installation at the 750 kV Gribovo substation providing power transmission from Kalinin NPP to the Moscow power system.

The series of autotransformers of 500 kV voltage class with on-load tap-changer (OLTC) includes single-phase ones: type АОДЦТН-167000/500/330 - with OLTC in the MV line ±12%, with ±8 regulation stages, АОДЦТН-167000/500/220 and АОДЦТН-267000/500/220 - with OLTC in the MV line ±12%, with ±6 and ±8 regulation stages, respectively, and three-phase ones: type АТДЦТН-167000/500/220 - with OLTC in the HV neutral line from -11% to +9,3%, with ±8 regulation stages, and АТДЦТН-250000/500/110 type - with OLTC in the HV neutral from -11,8% to +11%, with ±8 regulation stages.

Autotransformers of 220 kV voltage class of АТДЦТН-250000/220/110, АТДЦТН-125000/220/110, АТДЦТН-200000/220/110, АТДЦТН-63000/220/110 types, as well as for 330 kV of АТДЦТН-125000/330/110 and ATDTSTN-200000/330/110 types are made in three-phase. Autotransformer АОДЦТН-133000/330/220 is single-phase. Autotransformers of voltage class 220 kV and 330 kV have voltage regulation under load in the line CH ±12% with ± 6 regulation steps, except for АТДЦТН-63000/220/110 - with ± 8 regulation steps.

Autotransformers are manufactured with OFAF and ONAN/ONAF/OFAF cooling system.

ОРЦ-417000/750

ТЦ-630000/500

Power three-phase two-winding and single-phase two- and three-winding step-up generator transformers are designed for operation in block with electric generators of power plants.

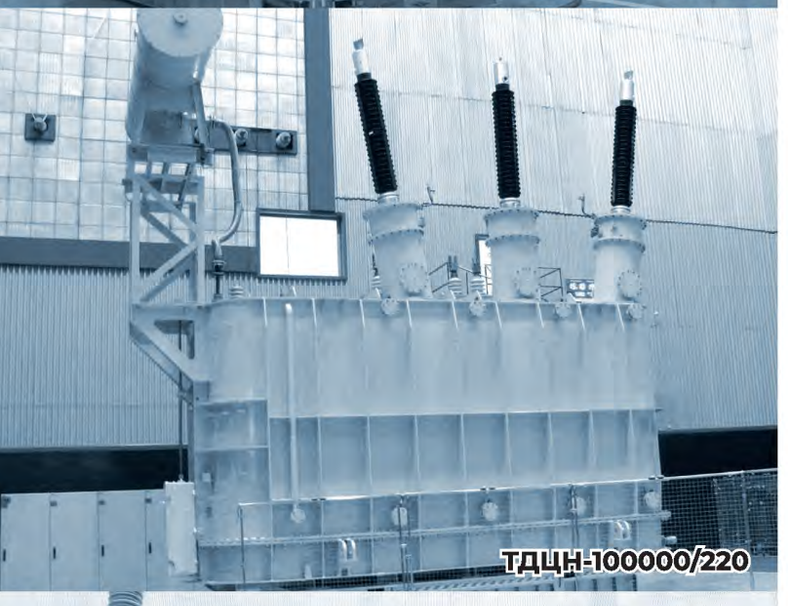
ERSO produces generator three-phase transformers with capacity up to 630 MVA of 110 - 500 kV voltage class and single-phase transformers with capacity up to 533 MVA of 110 - 750 kV voltage class. The Holding was the first in Russia to develop and manufacture transformers of **ultra-high voltage class 750 kV with a capacity of 417 MVA of ORC-417000/750 type.** The equipment was developed for Kalinin NPP. The new generation transformers are fully interchangeable with their old analogs, which simplifies their application at operating and under construction facilities.

On request, transformers can be designed with voltage regulation on the HV side (±2 x 2.5% SWE) with a solidly earthed neutral. Cooling system of ДЦ type with mounted coolers. At the customer's request, the equipment can be manufactured with a remote ДЦ cooling system, as well as with ONAF, OFWF and ONAN/ONAF/OFAF cooling systems.

ОРДЦ-533000/500

ТЦ-630000/330

ТРДН-25000/330



ТДЦН-100000/220

ТДЦН-160000/220

Three-phase power transformers for voltages 110 - 330 kV with voltage regulation under load are designed for power distribution in high-voltage electrical networks, as well as for power supply of facilities at industrial enterprises (compressor stations, mining, metallurgical, chemical plants, etc.) and auxiliary needs of power plants.

Two-winding transformers of 110 kV voltage class are produced with split LV windings for capacities from 25 MVA to 125 MVA, with single LV winding - for capacities from 10 MVA to 63 MVA. Two-winding transformers of 220 kV voltage class are produced with split LV windings for capacities from 25 MVA to 100 MVA, with single LV winding - for capacities from 100 and 160 MVA. Transformers of 330 kV voltage class are produced with split LV winding for 25 MVA capacity. Each of the two parts of the split winding is designed for 50% of the rated power of the transformer. When the transformer is in operation, one or two parts of the winding can be switched on at the same time, and the load of each part can be varied independently. Voltage regulation under load ±16% (±9 steps) for 110 and 330 kV transformers, and ±12% (±8 or ±12 steps) for 220 kV transformers is performed in the neutral of the HV winding.

Three-winding transformers of 110 kV voltage class are available in capacities from 10 to 80 MVA, 220 kV voltage class - in capacities of 100 and 125 MVA. Three-winding transformers are provided with additional voltage regulation by switching without excitation (SWE) on the medium voltage side (38.5 or 34.5 kV ±2 x 2.5%).

JSC ERSO HOLDING also produces two- and three-winding transformers 110 - 330 kV with boosted capacity for operation under the conditions of jolting loads of metallurgical plants. Transformers are manufactured with cooling system of ONAF, OFAF and ONAN/ONAF/OFAF types. If required, single-phase two- and three-winding transformers of 220 kV voltage class can be supplied.

ТРДН-40000/110

A SERIES OF ENERGY-SAVING SMALL-SIZED 110 KV TRANSFORMERS

Development of power transformers of 110 kV voltage class with reduced losses and mass-size parameters is caused by the need to increase the capacity of existing power substations during their reconstruction due to increased loads of power systems.

The design of transformers intended primarily for installation in enclosed spaces at power substations with enclosed switchgears of the Moscow power complex was carried out in accordance with the requirements of PJSC Rosseti Moscow Region. The reconstruction of substations provides for the placement **of new transformers with capacities of 80, 100 and 125 MVA** replacing them in the existing cells with 110 kV oil-filled power transformers of up to 63 MVA. These products meet more stringent requirements in terms of electrical losses.

For the 110 kV transformer a simplified design of magnetic core yoke beams for winding fixation has been developed, insulation sets of high quality low-shrinkage electrocardboard have been used, technologies of winding stabilization in the process of their thermal vacuum drying, winding pressing with rings made of electrically insulating laminated plastic instead of steel rings have been used. **These solutions reduce the material consumption of active parts of transformers, ensure the specified pressing force of windings during the entire service life, allow not to carry out overhauls of windings after 12 years (according to GOST requirements).**

New technical solutions minimize the equipment's own electrical losses during operation.

The following types of cooling systems are available, depending on the cells: hinged system on the transformer tank or remote system (free-standing connected set of coolers). The layout of the cooling system provides for the possibility of equipping with DC coolers or plate radiators for M/D/DC type for different loads - in order to reduce auxiliary losses.

The transformers are equipped with: film protection of oil from the ambient atmosphere; continuous oil regeneration and moisture absorption devices; control, signaling and protection devices; monitoring system (if required by the customer). Reliable high voltage bushings with solid RIP/RIN insulation are used.

The products are equipped with special sealing rubber **with a service life of 30 years.** At the customer's request the transformers can be equipped with fire extinguishing system, the list of devices and accessories is extended, and it is also possible to manufacture in reinforced earthquake-resistant version, with various combinations of low voltage. The standardized **service life of transformers has been increased from 25 to 30 years.**

The transformers are characterized by high reliability indicators, including resistance to short-circuit currents, overvoltages and overloads. In terms of technical parameters, reliability, ease of installation and operation, the new energy-saving small-size 110 kV transformers fully comply with the modern world technical level.

ТМНЛ-16000/10

Three-phase linear regulating transformer units with nominal passing capacities of 16, 40 and 63 MVA are designed for longitudinal (in phase and counter-phase) regulation under load of autotransformer voltages of voltage class up to 750 kV. They are included in the line section in series with the LV winding of a power transformer (autotransformer) of voltage class 220, 330, 500 or 750 kV. They are designed for operation in temperate climate conditions in open areas.

The regulating transformer unit consists of a series transformer, an autotransformer with regulating winding, a reactor and a switching device, combined structurally and placed in a common oil tank. The load voltage is regulated within a range of ±15% of the nominal voltage (±10 steps of 1.5%) by means of a device consisting of a switch with a preselector, a current limiting reactor, contactors and a drive. The contactors are located on the tank wall in a separate oil chamber, the drive is mounted on the transformer tank.

The cooling system of transformer units is made with plate radiators mounted on the tank, for 16 MVA units - with natural circulation of air and oil (ONAN), for 40 and 63 MVA units - with forced blowing of radiators by fans and natural circulation of oil (ONAF). Upon customer's request transformer units can be equipped with a cooling system of type OFWF with forced circulation of oil and cooling water. As standard, the "A" and "C" phases of the series transformer are equipped with built-in current transformers: for relay protection and for measurement.

NOMENCLATURE OF THE ENTERPRISE

GROUP	SUBGROUP	POWER, kVA	VOLTAGE CLASS, kV
1. POWER TRANSFORMERS	1.1 AUTOTRANSFORMERS	63 000 - 500 000	150 - 750
	1.2 GENERATOR RANSFORMERS	20 000 - 630 000	110 - 750
	1.3 NETWORK TRANSFORMERS	10 000 - 400 000	110 - 500
	1.4 TRANSFORMERS FOR METALLURGY	40 000 - 320 000	110 - 220
	1.5 TRACTION TRANSFORMERS FOR RAILWAY SUBSTATIONS	16 000 - 40 000	27 - 220
	1.6 REGULATING RANSFORMERS	16 000 - 240 000	6 - 150
	1.7 MV TRANSFORMERS AND AUXILIARY TRANSFORMERS	4 000 - 80 000	6 - 35, 110 - 330
2. POWER TRANSFORMERS WITH NON-FLAMMABLE LIQUID DIELECTRIC		16 000 - 250 000	35 - 330
3. REACTOR EQUIPMENT	3.1 SHUNT REACTORS	10 000 - 300 000	110 - 1 150
	3.2 CONTROLLED SHUNT REACTORS WITH OLTC	25 000 - 180 000	110 - 500
	3.3 CONTROLLED SHUNTING REACTORS WITH MAGNETIZATION	60 000	500
	3.4 CONTROLLED SHUNT REACTORS WITH VALVE (SCR) CONTROL	25 000 - 100 000	110 - 500

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GROUP	SUBGROUP	POWER, kVA	VOLTAGE CLASS, kV
4. ELECTRIC FURNACE TRANSFORMERS	4.1 ELECTRIC FURNACE TRANSFORMERS FOR POWERING STEELMAKING FURNACES	1 000 - 200 000	6 - 110
	4.2 ELECTRIC FURNACE TRANSFORMERS FOR POWERING INDUCTION FURNACES	1 000 - 12 500	6 - 10
	4.3 ELECTRIC FURNACE TRANSFORMERS FOR SUPPLYING ELECTROSLAG REMELTING FURNACES	1 000 - 30 000	6 - 10
	4.4 ELECTRIC FURNACE TRANSFORMERS FOR POWER SUPPLY OF ORE-THERMAL ELECTRIC FURNACES	1 000 - 83 000	6 - 220
	4.5 ELECTRIC FURNACE TRANSFORMERS FOR POWERING ELECTRIC FURNACES FOR VARIOUS APPLICATIONS	2 000 - 10 500	6 - 35
	4.6 ELECTRIC FURNACE TRANSFORMERS FOR SUPPLYING DC ELECTRIC FURNACES	1 000 - 10 500	6 - 10
5. TRACTION TRANSFORMERS FOR RAILWAY TRANSPORTATION		до 10 000	3; 25
6. CONVERTER TRANSFORMERS		1 000 - 100 000	6 - 20
7. MOBILE TRANSFORMERS		16 000 - 63 000	35 - 220
8. PHASE-SHIFTING TRANSFORMERS		до 250 000	110 - 330
9. HIGH VOLTAGE TANK CIRCUIT BREAKERS		40; 50 кА	110; 220
10. MOBILE SUBSTATIONS	10.1 MOBILE MODULAR SUBSTATIONS FOR 35 KV VOLTAGE	10 000 - 80 000	35
	10.2 MOBILE MODULAR SUBSTATIONS FOR 110 (220) KV VOLTAGE	10 000 - 80 000	220

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1. POWER TRANSFORMERS

1.1 AUTOTRANSFORMERS

A series of autotransformers for electrical networks.

Series identification	АТДЦТН, АТДЦН, АТДТ; АОДТН, АОДЦТ, АОДЦТН
Voltage class, kV	150; 220; 330; 500; 750
Rated power, MVA	133; 167; 267; 333; 417 (single-phase) 63; 100; 125; 200; 250; 400; 500 (three-phase)
Voltage regulation	OLTC in the MV line or neutral in the HV or SWE
LV voltage, kV	6,3; 6,6; 10,0; 10,5; 11,0; 13,8; 15,75; 20,0; 38,5; 165; 230
Cooling system	ONAN; ONAF (ONAN/ONAF); OFAF; ONAN/ONAF/OFAF

1.2 GENERATOR TRANSFORMERS

Block double-winding transformers for operation in generating power plants and block transformers with split LV winding with different voltages and connection schemes.

Series identification	ТД, ТДЦ, ТЦ; ОД, ОДЦ (ОНДЦ), ОЦ, ОРЦ, ОРДЦ (ОРНДЦ)
Voltage class, kV	110; 150; 220; 330; 500; 750
Rated power, MVA	20; 30; 33; 40; 53; 63; 80; 135; 210; 333; 417; 533 (single-phase) 63; 80; 100; 125; 160; 180; 200; 225; 250; 320; 400; 520; 630 (three-phase)
Voltage regulation	SWE or without regulation
LV voltage, kV	6,3; 10,5; 13,8; 15,75; 18; 20; 24; 36,75
Cooling system	ONAN; ONAF (ONAN/ONAF); OFAF; ONAN/ONAF/OFAF

1.3 NETWORK TRANSFORMERS

Series of two and three winding transformers and transformers with split LV winding for electrical networks.

Series identification	ТДН, ТРДН, ТДЦН, ТРДЦН, ТДТН, ТДТНШ, ТДЦТН
Voltage class, kV	110; 150; 220; 330; 500
Rated power, MVA	10; 16; 25; 32; 40; 63; 80; 100; 125; 160; 200; 400
Method (range) of voltage regulation	OLTC in neutral HV (± 12% or ± 16%) SWE on the MV side (±5% for three-winding transformers)
MV voltage, kV (for three-winding transformers)	6,6; 10,5; 11,0; 11,5; 16,5; 22; 24; 34,5; 35; 38,5
LV voltage, kV	6,0; 6,3; 6,6; 10,0; 10,5; 11,0; 11,5; 15,75; 20; 22; 24; 38,5
Cooling system	ONAN; ONAF (ONAN/ONAF); OFAF; ONAN/ONAF/OFAF

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1.4 TRANSFORMERS FOR METALLURGY

Transformers for metallurgical enterprises that withstand short-term excess power.

Series identification	ТДНМ, ТРДНМ, ТРДЦНМ, ТРДЦМ, ТДЦНМ
Voltage class, kV	110; 150; 220
Rated (short-term) power, MVA	40 - 320
LV voltage, kV	10,5; 11; 15; 20; 22; 24; 35; 38,5
Cooling system	ONAN; ONAF (ONAN/ONAF); OFAF; ONAN/ONAF/OFAF

1.5 TRACTION TRANSFORMERS FOR RAILWAY SUBSTATIONS

A series of two-winding and three-winding transformers for powering railway substations.

Series identification	АОМЖ,ОРДТНЖ; ТДНЖ, ТДЦНЖ, ТДТНЖ, ТДЦТНЖ
Voltage class, kV	27; 110; 150; 220
Rated power, MVA	16; 25; 40
MV voltage, kV (for three-winding transformers)	27,5; 35; 38,5
LV voltage, kV	6,3; 6,6; 10,5; 11,0; 27,5
Cooling system	ONAN; ONAF (ONAN/ONAF); OFAF; ONAN/ONAF/OFAF

1.6 REGULATING TRANSFORMERS

Transformers (transformer units) for regulation within the same-class voltage.

Series identification	ТМНЛ (ЛТМН), ТДНЛ (ЛТДН); ВДТ, ВРТДНУ, ОДЦТНП
Voltage class, kV	6; 10; 35; 150
Rated power, MVA	16; 25; 40; 63; 92; 100; 240
Voltage regulation method (number of steps)	OLTC (± 10 steps, ± 15%)
Rated voltage of the sides, kV	6,6; 11,0; 38,5
Cooling system	ONAN; ONAF (ONAN/ONAF)

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1.7 MV TRANSFORMERS AND AUXILIARY TRANSFORMERS

Transformers for 6-35 kV networks and auxiliary power of electric power plants.

Series identification	ТМ; ТМН; ТДН, ТРДН, ТМНС; ТДНС; ТРДНС
Voltage class, kV	6; 10; 15; 20; 24; 35; auxiliary power 110; 220; 330
Rated power, MVA	4; 6,3; 10; 16; 25; 32; 40 45; 63; 80
Methods of voltage regulation	OLTC, SWE or without regulation
LV voltage, kV	6,0; 6,3; 6,6; 10,5; 11,0; 15,75; 20; 24; 38,5
Cooling system	ONAN; ONAF (ONAN/ONAF)

2. POWER TRANSFORMERS WITH NON-FLAMMABLE LIQUID DIELECTRIC

Series of two and three winding transformers and transformers with split LV winding for electrical networks with non-flammable liquid dielectric.

Series identification	ТДН; ТРДН; ТРДЦН; ТДТН; ТДЦТН
Voltage class, kV	35; 110; 220; 330
Rated power, MVA	16 - 250
Method (range) of voltage regulation	OLTC in neutral HV (± 12% or ± 16%) SWE on the MV side (±5% for three-winding transformers)
MV voltage, kV (for three-winding transformers)	10,5; 11,0; 15,75; 20; 24; 35; 38,5
LV voltage, kV	6,0; 6,3; 6,6; 10,0; 10,5; 11,0; 15,75; 20; 24; 38,5
Cooling system	ONAN; ONAF (ONAN/ONAF); OFAF; ONAN/ONAF/OFAF

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3. REACTOR EQUIPMENT

3.1 SHUNT REACTORS

A series of shunt reactors to compensate for reactive power in the network without regulation.

Series identification	РТМ; РТД; РТДЦ; РОМ; РОМБС; РОМБСМ; РОДЦ
Voltage class, kV	110; 220; 330; 500; 750; 1150
Rated power, MVAr	11; 60; 110; 300 (single-phase) 10; 25; 50; 60; 65; 75; 80; 100; 128 (three-phase)
Neutral voltage class, kV	6; 10; 35
Cooling system	ONAN; ONAF (ONAN/ONAF); OFAF; ONAN/ONAF/OFAF

3.2 CONTROLLED SHUNT REACTORS WITH OLTC

An innovative series of shunt reactors with reactive power control using OLTC in one piece of equipment.

Series identification	РОМУ, РОДУ, РОДЦУ, РТМУ, РТДУ, РТДЦУ
Voltage class, kV	110, 220, 330, 500
Rated power, MVar	33,3; 60 (single-phase) 25, 40, 63, 80, 100, 180 (three-phase)
Speed, no more, sec	200
Power control range	30 - 100%
Cooling system	ONAN; ONAF (ONAN/ONAF); OFAF; ONAN/ONAF/OFAF

3.3 CONTROLLED SHUNTING REACTORS WITH MAGNETIZATION

The electromagnetic component of the controlled oil shunt reactor complex regulates reactive power changes through field magnetization.

Series identification	РОУД (УНШРТД)
Voltage class, kV	500
Rated power, MVar	60
Power control range	0 - 100%
Speed, no more, sec	2
Cooling system	ONAF; ONAN/ONAF

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3.4. CONTROLLED SHUNT REACTORS WITH VALVE (SCR) CONTROL

The electromagnetic section of the controlled shunt reactor, which controls reactive power using (thyristor) valves, is available in both single-phase and three-phase versions.

Series identification	РОКВД; РКТРВД, РКТВДЦ, РТВД, УШРТД
Voltage class, kV	110; 220; 330; 500
Rated power, MVar	25; 40; 50; 60; 100
Power control range	0 - 100%
Speed, no more, sec	0,03
Cooling system	ONAF; ONAN/ONAF

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4. ELECTRIC FURNACE TRANSFORMERS

4.1 ELECTRIC FURNACE TRANSFORMERS FOR POWERING INDUCTION FURNACES

Series identification	ЭТЦПК, ЭДЦПК, ЭТДЦП, ЭТЦНКВ, ЭТЦНДТ, ЭТЦНД, ЭТЦНК, ЭТЦНКМ, ЭТЦП, ЭТМН; ЭОДЦ, ЭОДЦН, ЭОЦН, ЭОЦНР, ЭОДЦНК
Voltage class, kV	6 - 110
Rated power, MVA	1 - 200
Overcurrent and voltage overload (special execution)	1,2 (current) 1,1 (voltage)
Number of positions, no more (regulation method)	35 (OLTC) 12 (SWE)
Cooling system	ONAN; OFAF; OFWF

4.2 ELECTRIC FURNACE TRANSFORMERS FOR POWERING INDUCTION FURNACES

Series identification	ЭОМПИ, ЭОМНИ, ЭТМ(НИ)(Н)(П), ЭТЦНКИ
Voltage class, kV	6 - 10
Rated power, MVA	1 - 12,5
Overcurrent and voltage overload (special execution)	1,2 (current) 1,1 (voltage)
Number of positions, no more (regulation method)	23 (OLTC) 11 (SWE)
Cooling system	ONAN; OFWF

4.3 ELECTRIC FURNACE TRANSFORMERS FOR SUPPLYING ELECTROSLAG REMELTING FURNACES

Series identification	ЭОМНШМ, ЭОДЦН(Ш)(ШМ), ЭОЦНШ
Voltage class, kV	6 - 10
Rated power, MVA	1,0 - 30
Overcurrent and voltage overload (special execution)	1,2 (current) 1,1 (voltage)
Number of positions, no more (regulation method)	90 (OLTC)
Cooling system	ONAN; OFAF; OFWF

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4.4 ELECTRIC FURNACE TRANSFORMERS FOR POWER SUPPLY OF ORE-THERMAL ELECTRIC FURNACES

Series identification	ЭОДЦНР, ЭТЦНКР, ЭОМПР, ЭТМПКР
Voltage class, kV	6 - 220
Rated power, MVA	1 - 83
Overcurrent and voltage overload (special execution)	1,2 (current) 1,1 (voltage)
Number of positions, no more (regulation method)	35 (OLTC) 12 (SWE)
Cooling system	ONAN; OFAF; OFWF

4.5 ELECTRIC FURNACE TRANSFORMERS FOR POWERING ELECTRIC FURNACES FOR VARIOUS APPLICATIONS

Series identification	ЭТЦХ, ЭТЦН
Voltage class	6 - 35
Rated power, MVA	2 - 10,5
Number of positions, no more (regulation method)	10 (OLTC) 8 (SWE)
Cooling system	OFWF

4.6 ELECTRIC FURNACE TRANSFORMERS FOR SUPPLYING DC ELECTRIC FURNACES

Series identification	ТРДЦП, ТЦПУ
Voltage class, kV	6; 10
Rated power, MVA	1 - 10,5
Voltage of the converter unit, V	120 - 480
Number of positions, no more (regulation method)	12 (SWE)
Cooling system	OFAF; OFWF

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5. TRACTION TRANSFORMERS FOR RAILWAY TRANSPORTATION

Transformers, reactors and chokes for installation in the bodies of freight and passenger locomotives and electric trains.

Series identification	ОДЦ(Ц)Э, ОНДЦ(Ц)Э, ОНДЦ(Ц)В
Voltage class, kV	3; 25
Rated power, MVA	In accordance with the requirements for the locomotive
Liquid dielectric	Transformer oil or a non-flammable liquid dielectric
Cooling system	OFAF, OFWF

6. CONVERTER TRANSFORMERS

Transformers for operation in rectifier and inventory systems converting alternating voltage to direct voltage and vice versa.

Series identification	ТМП, ТЦП, ТДЦПФУД, ТДЦНПУ
Voltage class, kV	6; 10; 20
Rated power, MVA	1,0 - 100
Number of positions, no more (regulation method)	19 (OLTC) 4 (SWE)
Liquid dielectric	Transformer oil or a non-flammable liquid dielectric
Regulation	Changing the circuit and connection group
Cooling system	ONAN; OFAF; OFWF

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7. MOBILE TRANSFORMERS

Transformers for mounting on a road or railroad platform to quickly supply power to remote consumers or restore emergency power.

Series identification	ТМНМ; ТДНМ; ТДЦНМ; ТРДЦНМ; ТЦТНМ
Voltage class, kV	35 - 220
Rated power, MVA	16 - 63
Combination of voltages	Two-winding, three-winding, with split LV winding (including different voltages)
Liquid dielectric	Transformer oil or a non-flammable liquid dielectric
Cooling system	ONAN; OFAF; OFWF

8. PHASE-SHIFTING TRANSFORMERS

Transformers to forcibly change the phase characteristics of the voltage transmitted on the network.

Series identification	ТДНФ, ТДЦНФ, ТДЦЛФ, ТДТНФ, ТДЦТНФ (ЛТДЦТНФ), ФПТ
Voltage class, kV	110, 220, 330
Voltage regulation	OLTC
Cooling system	ONAN; ONAF (ONAN/ONAF); OFAF; ONAN/ONAF/OFAF

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9. HIGH VOLTAGE TANK CIRCUIT BREAKERS

A switching device widely used in 110-220 kV voltage class electrical installations. The insulating and arc-quenching medium of the circuit breaker is gas (electric gas). The latter is a harmless, chemically inactive, non-flammable gas, which has high electrical strength and thermal conductivity.

Rated voltage, kV	110	220
Rated current, A	3 150	3 150
Rated frequency, Hz	50	50
Rated switch-off current, kA	40	50
Root mean square value of the through short-circuit current during its flow duration (short-time thermal current), in kA	40	50
The flow time of the thermal resistance current, sec	4	3
The highest peak of the through-current short circuit (current of electrodynamic resistance), kA	100	125
Test voltage of industrial frequency 50 Hz, kV	230	460
Test voltage of the lightning pulse, kV	550	1 050
Mechanical service life, cycles	10 000	10 000
Electrical life of the switch, cycles	20	20

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10. MOBILE SUBSTATIONS

Mobile modular substations for rated voltage 35-220 kV are designed to receive, convert and distribute electrical energy of alternating three-phase current with a frequency of 50 Hz.
Mobile modular substations are used to solve the following tasks:

- redundancy of the main equipment of a stationary substation in case of emergency shutdowns;
- temporary connection to the power grid of facilities under construction in case of lack of power supply during the construction period;
- temporary connection of consumers to the power grid during the reconstruction of the existing stationary substation;
- unloading of power grids during peak loads.

10.1 MOBILE MODULAR SUBSTATIONS FOR 35 KV VOLTAGE

Rated voltage, kV	
- high	35
- middle	20, 10, 6
- low	0,4
Power transformer capacity, MVA	up to 35
Frequency of alternating current, Hz	50
Rated current of busbars, A	630, 800, 1000, 1250, 1600, 2000, 2500, 3150
Rated voltage of auxiliary circuits, V	
- direct	220
- alternating	220, 380
Parameters of the 110 kV switchgear:	
- rated current of thermal resistance (1c), kA	up to 50
- rated current of electrodynamic resistance, kA	up to 128
- switch-off current, kA	up to 50

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10.2 MOBILE MODULAR SUBSTATIONS FOR 110 (220) KV VOLTAGE

Rated voltage, kV	
- high	110 (220)
- middle	35, 20
- low	35, 20, 10, 6
Power transformer capacity, MVA	up to 40
Frequency of alternating current, Hz	50
Rated current of busbars, A	630, 800, 1000, 1250, 1600, 2000, 2500, 3150
Rated voltage of auxiliary circuits, V	
- direct	220
- alternating	220, 380
Parameters of the 110 kV switchgear:	
- rated current of thermal resistance (1c), kA	up to 50
- rated current of electrodynamic resistance, kA	up to 128
- switch-off current, kA	up to 50

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