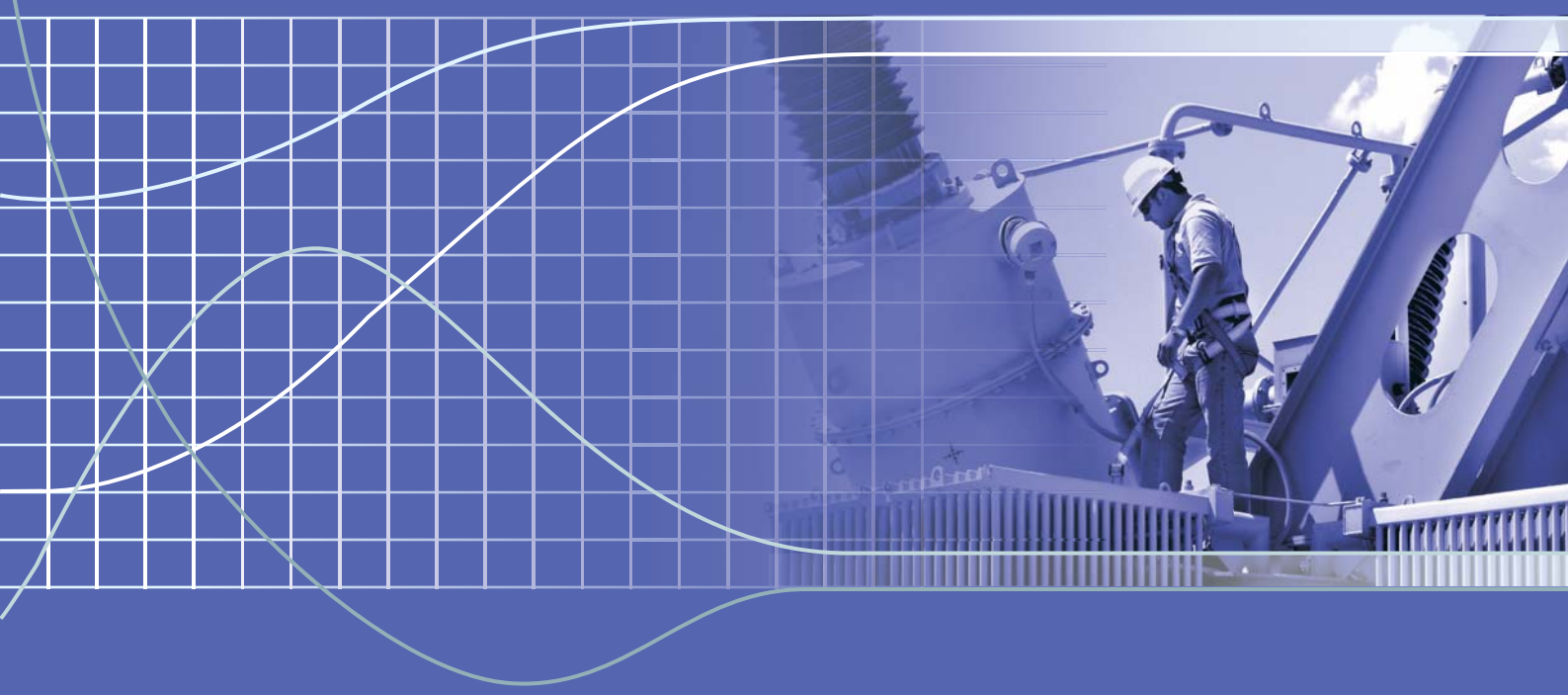


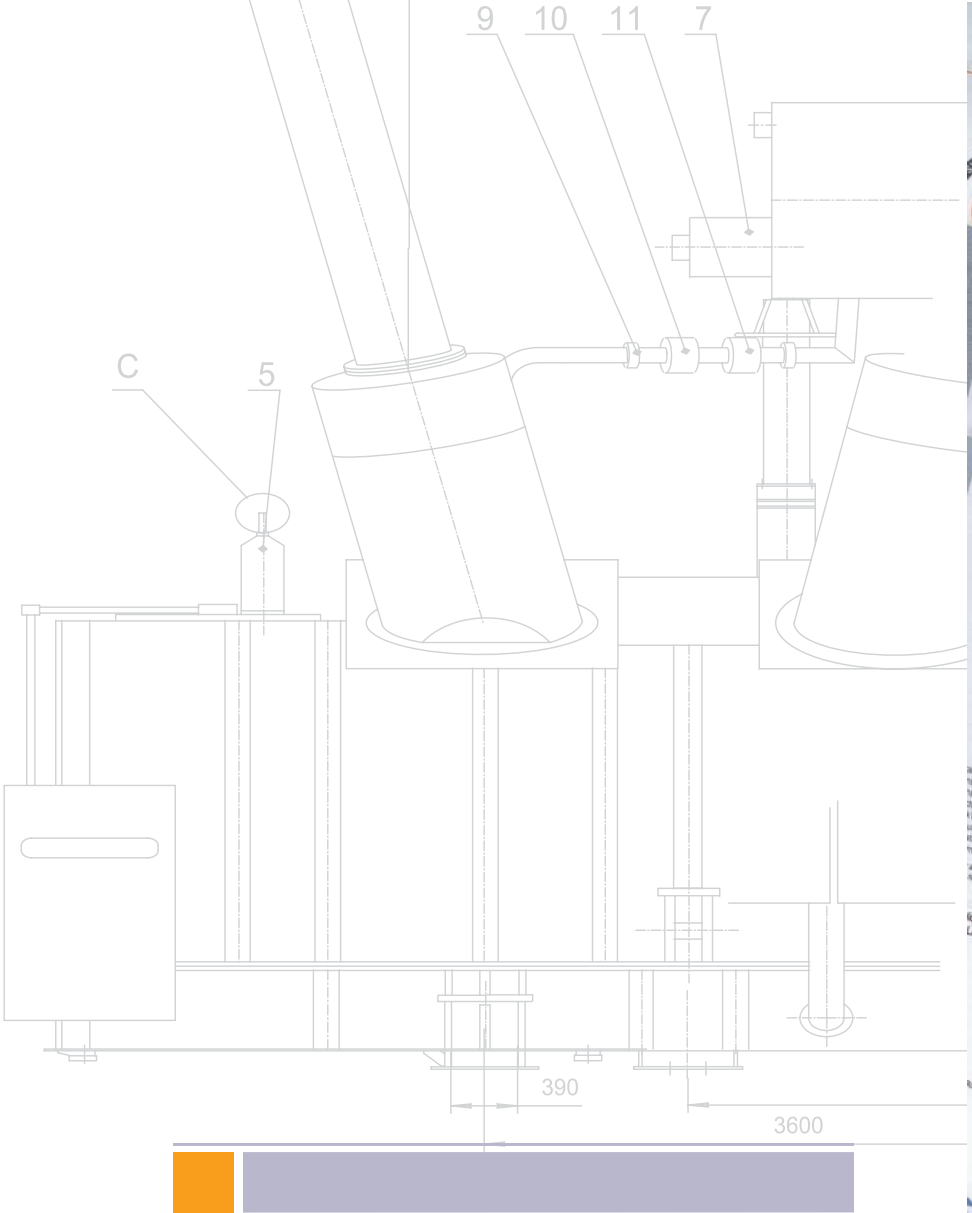
ZTR
ZAPOROZHTRANSFORMATOR

AFTER-SALE SERVICE

- Together we create reliable products, thus ensuring development of power industry of continents.
- By continuous improvement we transform our knowledge, energy and experience of the generations into common success.
- We enjoy what we do and are proud of it.

AFTER-SALE SERVICE

CONTENT








DIRECTIONS OF SERVICE ACTIVITY

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Transformers and reactors, supplied by ZTR to the Clients all over the world, have gained a reputation of high quality equipment with high operation reliability due to advanced technologies, high production standards, as well as state-of-the-art services.

Safety and reliability of power objects and functioning of entire power systems depends on the faultless operation of transformer equipment.

ZTR service activity aims to ensure uninterrupted and long-term operation of supplied equipment during its whole service life.

MODERN SERVICE OF TRANSFORMERS AND REACTORS

The history of ZTR Service Centre has started since supervision and operation department created in 1954.

At present, the Service Centre is the scientific and production complex with its own industrial and engineering department, commercial service, separate subdivision for developing complex projects and mobile diagnostic laboratories in Ukraine and Russia.

Service department provides the Clients with services and consultations at power objects in 86 countries of the world, including warranty and post-warranty services of manufactured equipment. All services offered by ZTR comply with the requirements of international standard ISO 9001, that is confirmed by certificates, awarded by SGS, Russian register (GOST R) and UkrSEPRO.

All resources are actively employed by the Company at service rendering:

- availability of the factory design documentation archives;
- own design sub-department;
- big staff of qualified specialists;
- data base with update information to the manufactured equipment and operation service details;
- electrotechnical and chemical laboratories, equipped with the modern measurement instrumentation;
- own diagnostics methods.

The Service Centre resources enable its experts to operatively respond and eliminate any malfunctions in order to extend the equipment service life by the most effective way at the minimum costs.

SERVICE CENTRE STAFF

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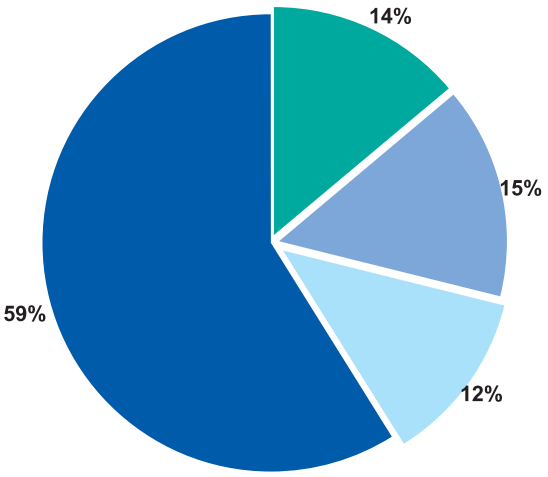

Service centre comprises:

- Field erection supervisors
- Office Engineers (designers)
- Commercial staff
- Administrative technicians

Service Centre unites more than 100 highly skilled professionals. The large number of service engineers allows the company to perform the works at 50 sites at the same time.

Service Centre has its own «school» for preparation and training of specialists. Thereby, the succession of quality labour as underlain in ZTR philosophy is ensured.

Service Centre staff regularly takes part in seminars and training courses.

Upgrading of qualification level, the professionals ensure the high quality of provided services for

Clients and that is a guarantee of satisfying their requirements in full scope.


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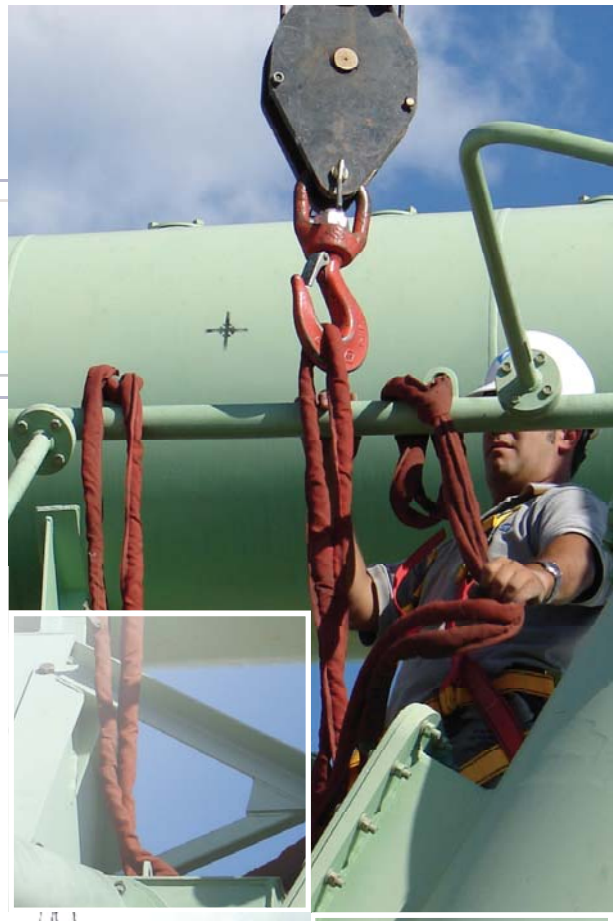
MOUNTING

8

- Field supervision of new products
- Organization and performance of equipment mounting and adjustment within the scope of «turn-key» contracts
- Modernization and adjustment of equipment manufactured before but been no commissioned.
- Development of the projects for work execution and technical assistance in mounting



DIAGNOSTICS

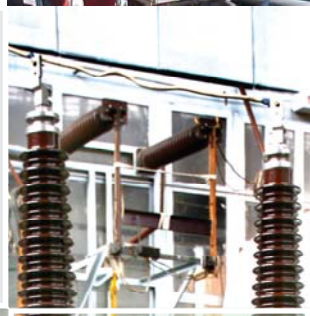
- Measurements at energized transformer
- Measurements and testing at de-energized transformer
- Estimation of residual life resource
- Transformer oil analysis
- Solid insulation analysis
- Test results Interpretation
- Development of recommendations and measures for state recovery and service life extension

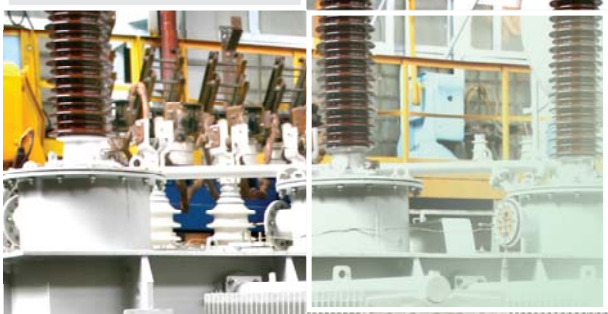
Our priority strategy is to ensure reliable operation of the transformers

At present, the ZTR diagnostics department offers new estimation methods and calculations to assist in analyses and revealing the defects in transformers. The high-precision mobile diagnostic laboratories (in Russia and Ukraine) are equipped with the unique modern instrumentation. Since the Service Centre has own electrotechnical and chemical laboratories and can provide diagnostics jointly with laboratories of power supply systems and regional partners, a full range of diagnostic services are available, including the extended diagnostic inspection: the analysis of transformer design, estimation of failures and defects of specific type transformers, analysis of operating conditions, assessment of technical condition of the transformer main units and systems. Additionally, the ZTR laboratory can make the specific analyses of oil and solid insulation, choose the technology and monitoring of transformer insulation drying and flushing processes.

It is also carried out estimation of insulation and electromagnetic systems condition, assessment the state of windings, leads, soldered points and contact joints, inspection of condition of bushings, tap changer, cooling system, assessment of condition of tank, oil preservation system, instrumentation, conservator and other auxiliary units, estimation of remaining life resource of the transformer.

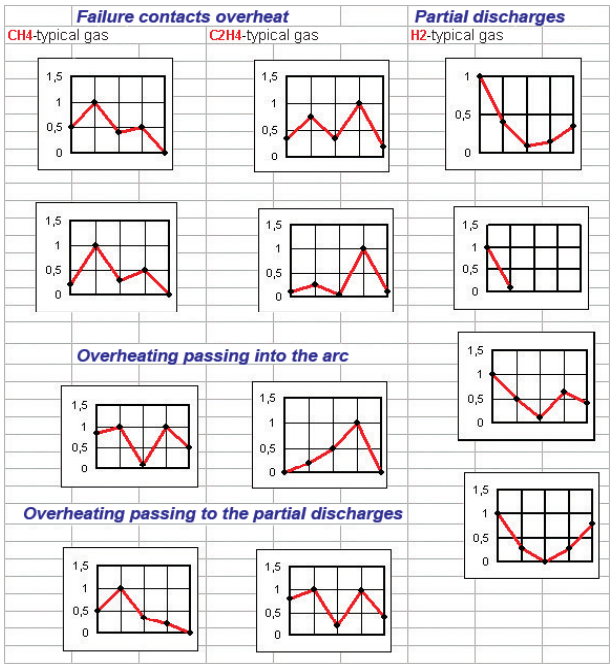
The qualified engineers, who have thorough knowledge about design, special operation features of all functional systems and structural units of operated transformer, apply an individual approach to diagnostics of each transformer. They also possess wide diagnostics and repair experience of power transformers manufactured by different producers and rated for various voltage classes, as well as able to work with sophisticated instrumentation.

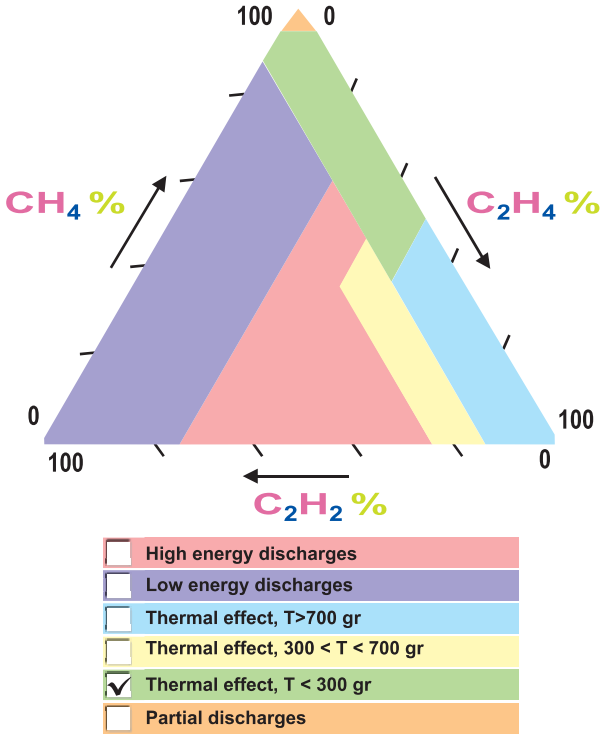


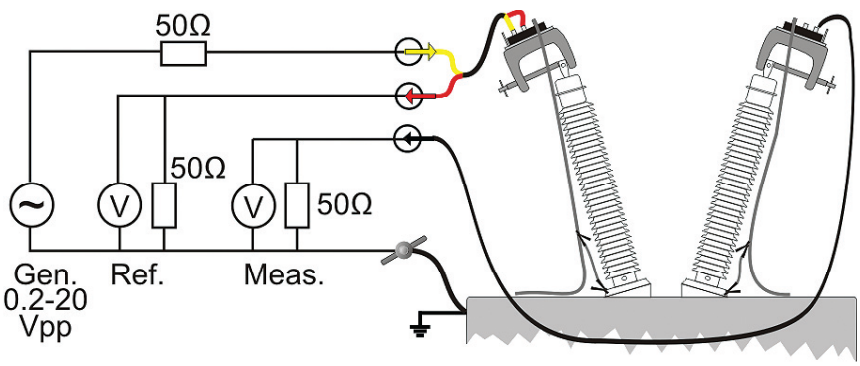


The transformers diagnostics is necessary and economically feasible, if

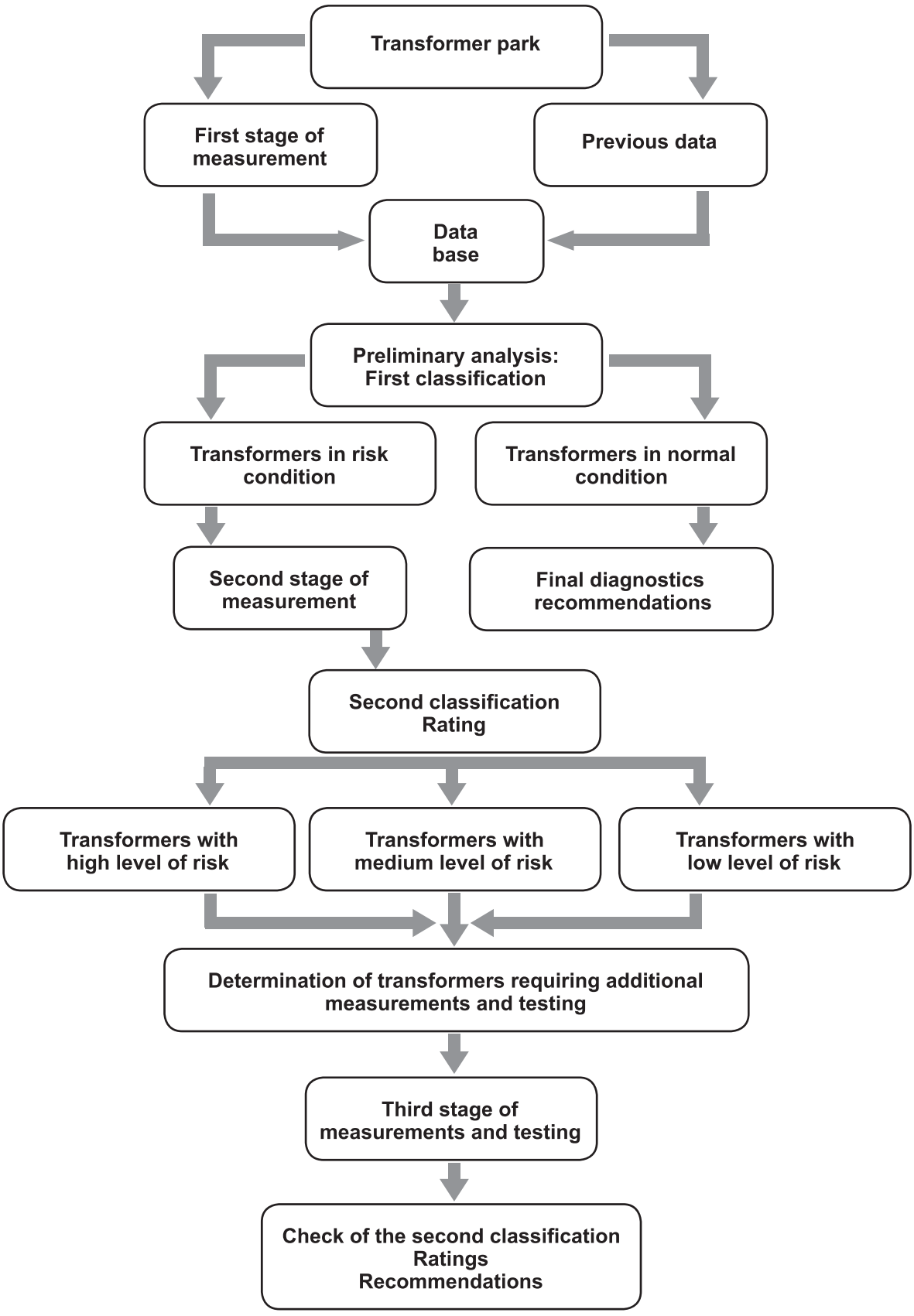
- there are evident indictors of deterioration of transformer operation;
- transformer needs the scheduled preventive maintenance and overhaul due to its operation period, - based on inspection it is possible to correct terms of overhaul execution;
- the transformer has worked-off its rated service life (20-25 years) – inspection results can indicate a degree of the main units wear, estimate the design safety and assist in conducting the complex of actions to extend service life of the equipment;
- transformer has been out of operation for a long period of time – inspection results will provide estimation of ability of commissioning and determination of the works scope for reconstruction.







Client flow chart for equipment diagnostics



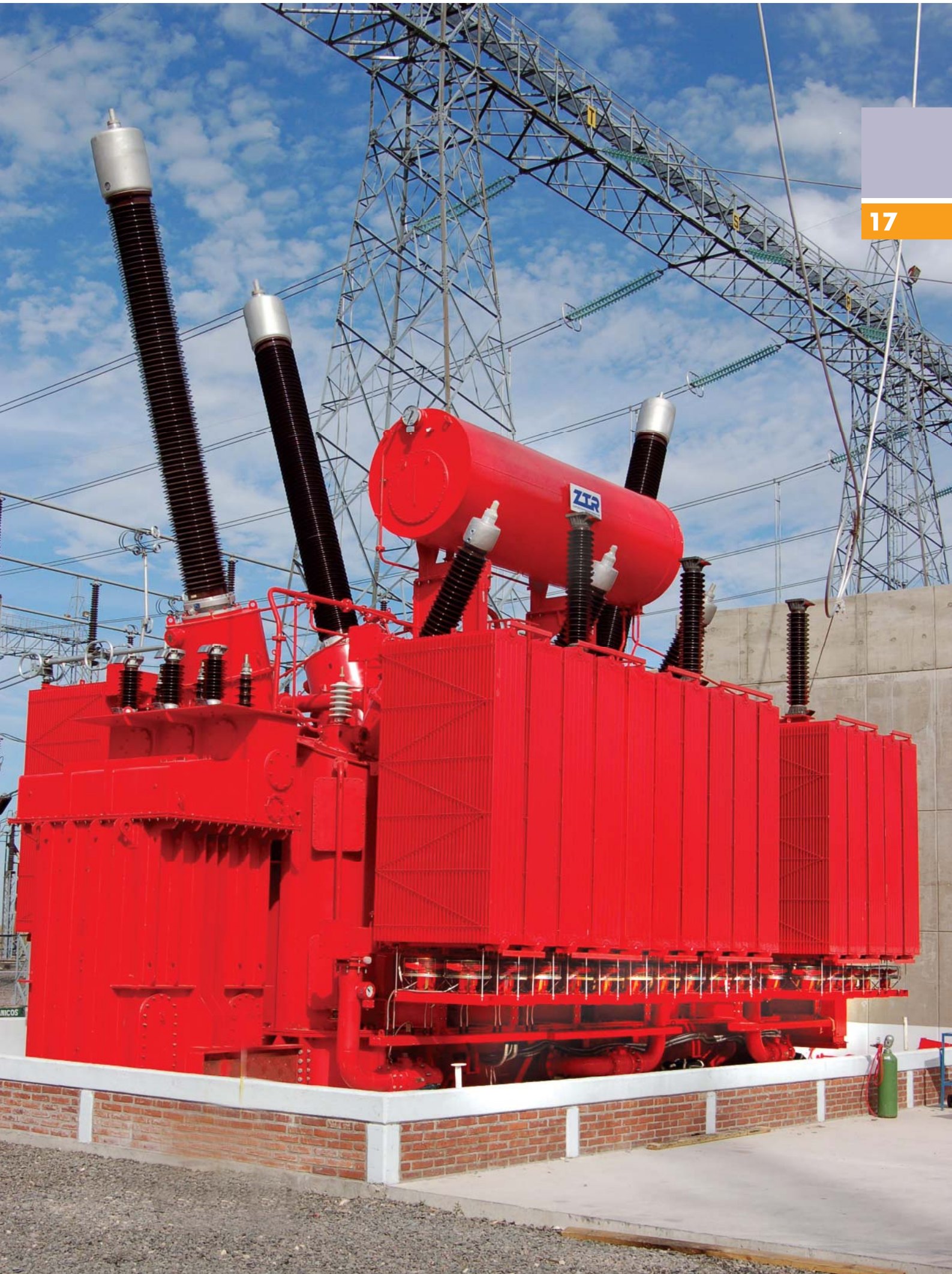
MEASUREMENTS AT ENERGIZED EQUIPMENT

№	Diagnostics type	Purpose	Equipment	
1	AC Measurement of dielectric characteristics	Estimation of insulation condition; well-timed localization of local defects in insulation; forecasting of operating life and load capacity of transformers		Complex UPDA Twins, «Cutler-Hammer», USA; VV-Tester and AR-200 «Vibro centre», Russia
2	Estimation of radiated thermal energy, defect revealing by variation of temperature field and disturbance of thermal balance	Identification of defect series: local heating of structural elements, presence of oil stagnation zones, inefficient operation of cooling system, deterioration of contact joints condition, occurrence of shorted circuits, deterioration of HV bushing insulation and current transformers, etc.		Thermal camera TH9100WV, «NEC Sanei», Japan
3	Vibration measurement	Check of correspondence of equipment vibration parameters to the requirements of Standards; estimation of mechanical stresses on insulation, metal structures, fasteners occurred at equipment vibration; development and reasoning of structural measures to reduce vibration and noise		Data adjuster Series 2526, «Bruel & Kjear Vibro», Denmark; SVAN-956, «SVANTEK», Poland
4	Inspection of acoustic characteristics	Noise estimation at the workplaces; selection of protective means for hearing organs; quality control of products; octave and one-third-octave sound analysis in the real time mode		Portable analyzer Type 2250, «Bruel & Kjear», Denmark
5	Express-analysis of gazes, dissolved in the oil	Check of thermal and discharge character abnormal processes in theequipment		Gaze analyzer TransportX, «Kelman», Northern Ireland

MEASUREMENTS AND TESTING AT DE-ENERGIZED EQUIPMENT				
№	Diagnostics type	Purpose	Equipment	
1	AC measurement of dielectric characteristics	Estimation of insulation condition according to measured parameters: dielectric loss tangent and capacitance of insulation		Insulation analyzer M4000, «Doble», USA
2	Measurement of insulation resistance	Estimation of insulation condition related in particular to absorption. Determination of insulation condition in electric plants with grounds for further preventive actions		Megohmmeter CA 6547, «CHAUVIN ARNOUX», France; MIC-5000, «SONEL», Poland
3	Adjustment of OLTC diverter switches, accumulation and storage of switching oscillograms	It is purposed for measurement of time parameters and adjustment of tap changers at site and stationary conditions (OLTC diverter switches)		Current recorder «Parma RT 1.16», «Parma», Russia
4	Inspection of hard-to-reach transformers areas	Measurement and revealing of defects		Video system IPLEX, «Olympus», Japan
5	Amplitude-frequency analysis (FRA) of transformer	Determination of mechanical condition of windings and magnetic core, reveal of defects in earthing circuit and lead fastening		Diagnostics complexes: FRAnalyzer «Omicron», Austria
6	Other typical measurements of transformers parameters	Estimation of condition of transformer and its components according to no-load characteristics at reduced voltage, DC windings resistance, short circuit impedance		Multimeters: UNIGOR 380, UNIGOR 390, «LEM», Germany

Transformer oil and solid insulation analysis

Transformer oil analysis	Methods
Dielectric loss factor	IEC 60247, GOST 6581
Breakdown voltage	IEC 60156,GOST 6581
Moisture content	IEC 60814,GOST 24614, GOST 7822
Content of mechanical impurities	IEC 60970,GOST 6370, WD 34.43.202
Flesh point in closed cup	ISO 2719,GOST 6356
Measurement of kinematic viscosity	ISO 3104,GOST 33
Chromatographic analysis of gasses dissolved in oil	IEC 567, WD 34.43.303
Density	ISO 3675, ASTM D 1481
Light reflection index	ASTM D 1807
Acid number	IEC 602296,GOST 5985
Aniline point	GOST 12329-77
Oxidation stability	IEC 1125 B, IEC 1125 C,GOST 981
Inhibitor content – using a thin-layer chromatography	GKD 34.46.101-97
Surface tension	ISO 6295, ASTM D 2144, GKD34.46.101-97
Specific bulk resistance	IEC 247,GOST 6581
Content of furan compounds	IEC 61198
Saponification number	ASTM D 94,GOST 17362
Light transmission	ZTR technique
Corrosive sulfur	GOST 2917
Polarity	Calculation
Content of aromatic hydrocarbons	IEC 666, IEC 590, ASTM D 2144
PCB content	IEC 997
Structural-group composition	ASTM D 2140
Analysis of solid insulation	**Methods**
Moisture content in solid insulation	GOST 14870 (4)
Polymerization degree of solid insulation	IEC 60450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Assessment of remaining life resource

In order to make the strategic planning of further operation of the transformer park, it is required to have an exact assessment of each equipment unit. Determination of remaining life resource allows to take the decision of equipment updating, repair or replacement.

Estimation of actual equipment remaining life resource

↓

Expanded diagnostic study

↓

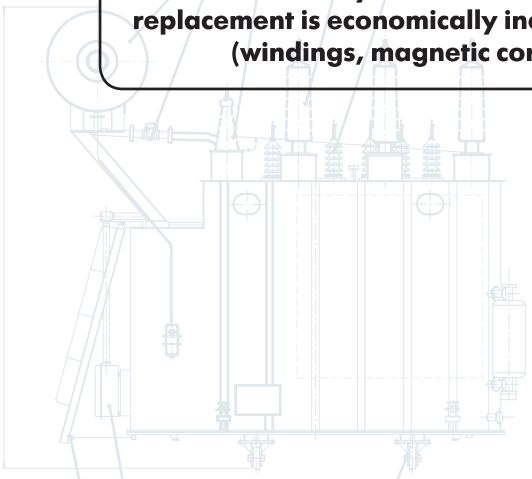
Identification of operation conditions

↓

Estimation of technical condition of the main equipment systems and units as a whole

↓

Assessment of wearing degree of the main functional systems and units, which replacement is economically inexpedient (windings, magnetic core)



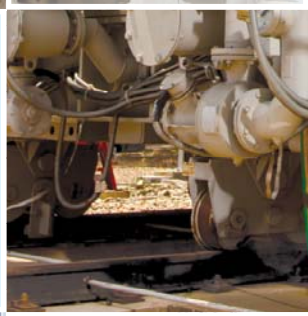
SERVICES OF EQUIPMENT REPAIR

- Scheduled overhauls
- Emergency recovery repairs at site conditions
- Technical management over repair at site
- Repair at the factory
- Repair of other manufacturers equipment

- The scheduled overhauls at site are required for the purpose of improving the operational safety of the transformers by means of restoration their operational characteristics and elimination of predictable defects revealed at diagnostic studies and within repair. Overhauls are performed under supervision of skilled specialists of our Service Centre according to developed technological programs with modern technological processes employed for restoration of insulation parameters of the transformers up to the level of new ones. Annually, the experts of Service Centre realize the technical supervision of overhauls up to 50 transformers.

- Emergency and recovery repair at site conditions is one of the most complicated type of repair. It requires a thorough preparation of repair base and availability of qualified experts, and is to be performed with replacement of damaged parts or units by new ones, participation of the factory specialists for execution of the most sophisticated operations to ensure further safety operation of the transformers within entire statutory period.

- Repair at the factory conditions means the complete restoration of the transformer, with the replacement of worn units, execution of full scope of tests to prove the quality of the performed repair, to be resulted in the transformer further life period equal to the service life of new transformer. Annually, 4-5 transformers been damaged within transportation, unloading or long-time operation are repaired at the factory.

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EQUIPMENT MODERNIZATION SERVICES

- Development of modernization project for «old» transformers
- Equipment update of other manufacturers
- Services purposed for extension of equipment life
- Legitimacy of projects and design solutions
- Design support of modernization works at site

Modernization of the transformers been operated for long time period, with replacement of life-expired and physically and morally outdated systems and units, and thus being unreliable, by means of introduction of up-to-date monitoring and protective systems has become urgent within the last years due to necessity of the transformer replacement and financial challenges for purchase of ones.

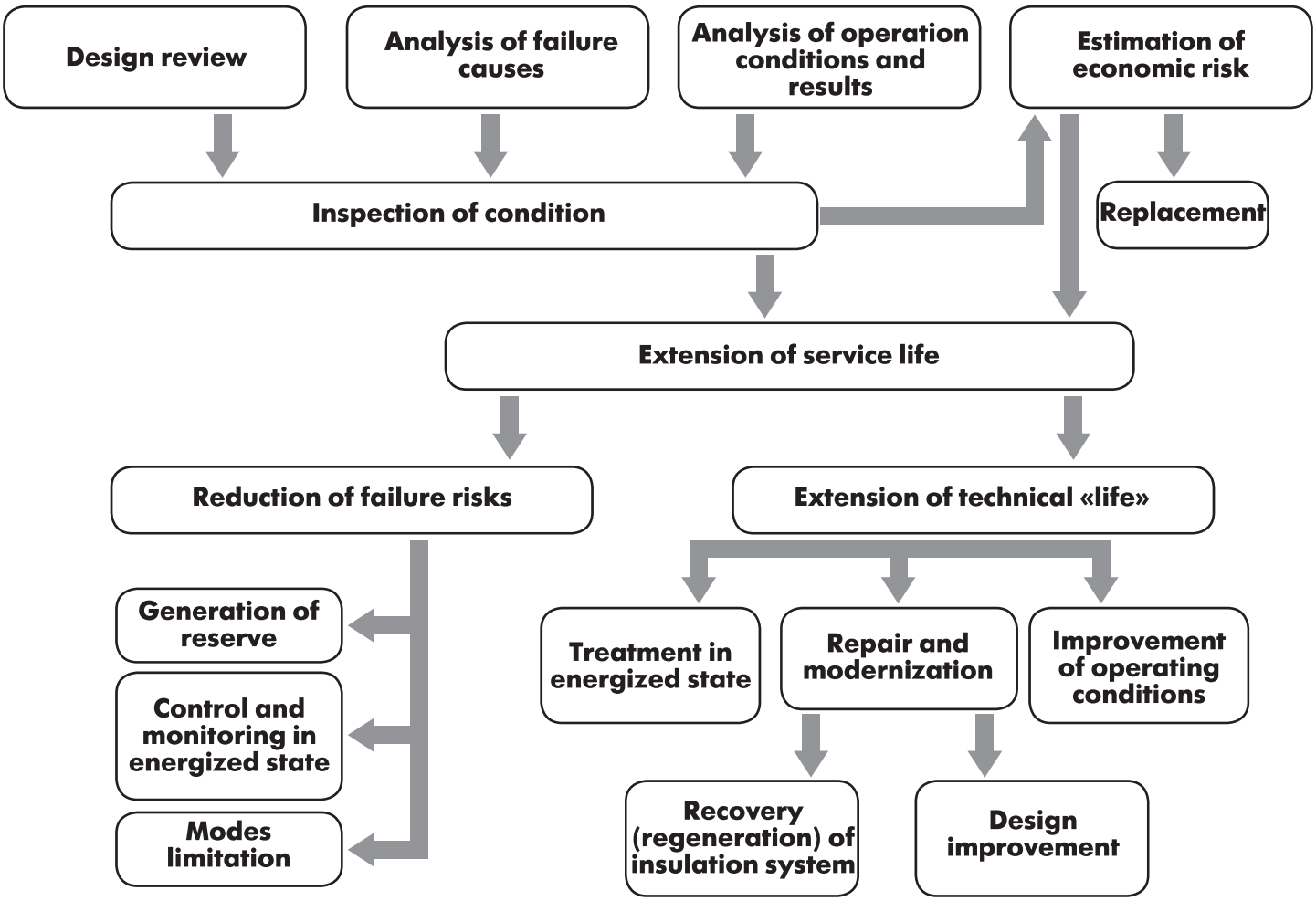
All projects for modernization of the transformer equipment are executed on the base of the newest technical solutions according to methods and programs valid at the factory, with employment of modern materials used at production of new transformer equipment.

Development of projects for up-to date of «old» transformers, with realization of the following tasks:

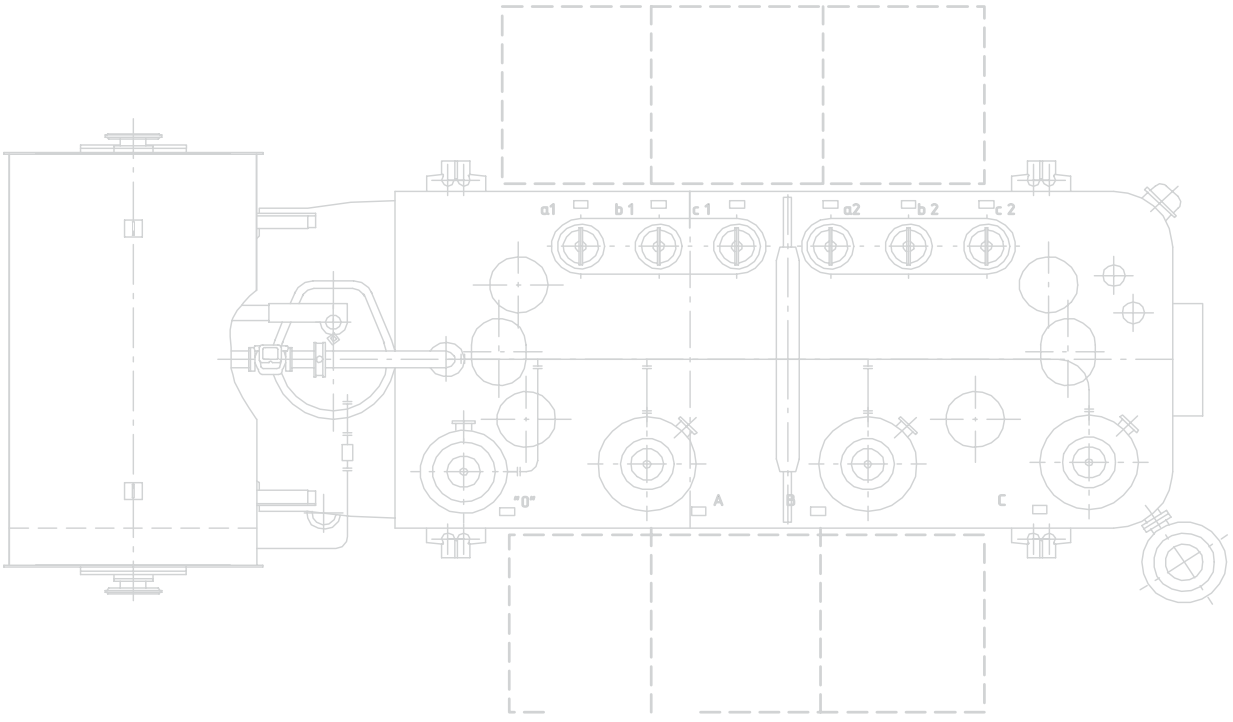
- increase of transformer capacity by 10-15%;
- installation of modern sealing system;
- modernization of cooling systems with the conversion to maintenance-free systems;
- replacement of bushings and tap changers for modern devices produced by leading global manufacturers;
- installation of monitoring systems with various functions, including the upper level;
- installation of explosion and fire warning system «SERGI»;
- regeneration of insulation system;
- improvement of transformer oil condition (oil drying, degassing, filtration).

Collaboration with ZTR Service Centre ensures for the Customers to obtain the completely renewed and updated equipment.

Service life extension for transformers and reactors



Task	Procedures
Elimination of potential defects	Insulation, improvement of electromagnetic shield fastening and earthing
Renewal of insulation dielectric strength	Replacement of insulation areas, contaminated by Al parts. Drying, washing and regeneration of insulation
Reduction of aging rate	Installation of oil film protection. Filling of oil with improved stability to oxidation. Removal of aging products from insulation by means of regeneration oil “Regenol”
Improvement of inspection ability	Modification of electrostatic shields with drawing-out the earthing buses outside the tank Separation of neutral leads for installation of highly sensitive traverse differential protection
Reduction of operating costs	Replacement of OFAF cooling system by ONAN and ONAF types of cooling



SUPPLY OF PARTS AND COMPONENTS

- Supply of control and monitoring systems
- Supply of control cabinets with cooling systems of any types and desired control algorithm
- Supply of tap changers of OCTC and OLTC types
- Supply of bushings for various applications and rated for different voltage classes
- Supply of cooling systems and fans of different types
- Supply of safety and shut-off valves, shutoff fittings, conservators
- Supply of windings

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