Approved by
the Board of Directors of PJSC Rosseti
(Minutes of 22.02.2017 No. 252)

Approved by
the Board of Directors of IDGC of Centre, PJSC
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The Regulation of PJSC Rosseti "About unified technical policy in the power grid complex" in a new edition

Moscow, 2017.

Contents

1. Introduction

1.1. The Regulation of PJSC Rosseti "About unified technical policy in the power grid complex" (hereinafter – the Regulation) is an internal document of PJSC Rosseti (hereinafter - the Company), is developed according to the current legislation and is the fundamental document obligatory for application in activity of the affiliated and dependent companies of PJSC Rosseti (hereinafter - SDC) performing activities for transmission and distribution of electric energy.

1.2. Observance of requirements of the Regulation is obligatory for structural divisions of the Company and SDC.

1.3. Concerning SDC this Regulation as the internal document of the Company, is obligatory regarding the general description of the mechanism of interaction of the Company and SDC and is obligatory for execution by the third parties involved on a contractual basis for the purposes of performance of works (services, deliveries) at power grid facilities of SDC (including, by inclusion of requirements of the Regulation in the signed agreements).

1.4. On the basis of requirements of the Regulation the Company has to develop (review) the specifications and technical documentation (standards of the organization, regulations, instructions, sets of rules, etc.) defining priorities and rules of application of technical solutions of the Regulation during operation of power grid facilities, program implementation of new construction, complex modernization and reconstruction of power grid facilities of SDC and also at innovative and perspective development.

1.5. The status of the Regulation concerning the third parties which joined the Regulation is defined by the agreement on connection between the Company and the organization.

1.6. The concepts "should", "follows", "it is necessary" and their derivatives are applied to designation of obligation of fulfillment of technical requirements in the Regulation.

1.7. Requirements of obligation do not extend to legal independence of governing bodies of SDC at adoption of decisions by them within their competence according to the current legislation and charters of SDC.

1.8. The concept "as a rule" is meant that this technical requirement is prevailing, and derogation from it should be proved.

1.9. The concept "is allowed" means that this technical requirement or the decision is applied by way of exception as forced at the corresponding justification (owing to the constrained conditions, limited resources, lack of the necessary electrotechnical equipment, products and materials, etc.).

1.10. The concept "is recommended" means that this technical solution is priority, but not obligatory.

1.11. The Regulation is subject to revision as required, but at least once in five years.

1.12. When using the Regulation it is reasonable to check action of reference regulatory legal acts and standards in public official information systems. If the reference document is replaced (changed), then when using this Regulation it is necessary to be guided by the replacing (changed) document. If the reference document is cancelled without replacement, then the provision in which the reference to it is given is applied, in the part which is not affecting this reference.

2. Terms and determinations

№	Term	Determination
1.	Failure	a technology violation at a power facility and (or) a power installation which led to destruction or damage of constructions and (or) technical devices (equipment) of the power facility and (or) power installations, to uncontrollable explosion and (or) emission of dangerous substances, a deviation from the set technology working hours of electric power facilities and (or) power installations, to complete or partial restriction of the mode of consumption of electric energy (power), emergence or threat of emergence of an emergency electrical power operating mode of a power supply system
2.	Automated system of monitoring and technical diagnosing (ASMD)	a system providing collecting, storage, information processing and technical diagnosing in the mode of continuous control of parameters of a facility using automated systems of real time and participation of the person
3.	Act-instruction	a document of the established sample issued, approved and accepted to execution, containing results of the carried-out inspection, including the list of the main revealed violations, actions and terms for their elimination, conclusions and offers following the results of check
4.	Outsourcing	transfer by the Company or SDC of certain types or functions of activity to another company on the basis of the agreement
5.	Unity of measurements	condition of measurements at which their results are expressed in units of sizes allowed to application in the Russian Federation and indicators of accuracy of measurements do not overstep the established boundaries
6.	Replacement	replacement of the operated equipment for similar in functionality within the retrofitting and reconstruction program

7.	Engineering infrastructure (systems)	a set of hardware and\or software providing normal functioning of information and telecommunication infrastructure. Engineering infrastructure includes: – climatic subsystem; – power supply subsystem; – subsystem of automatic fire extinguishing; – subsystem of the security and fire alarm system; – subsystem of control and management of access; – video surveillance subsystem; – monitoring subsystem; – subsystem of water supply and sewerage.
8.	Insourcing	a set of operations which are carried out for determination of quantitative value of size
9.	Inspector	an employee of the Technical Supervision Centre performing functions of technical supervision concerning the subject of power industry
10.	Intellectual Network (IN)	qualitatively new type of electric grid allowing to exercise in real time monitoring and control over the network, to perform communications between consumers and suppliers, giving an opportunity to consumption optimization, reducing electric power cost, thereby providing the new level of reliability and profitability of power supply which allows to: – integrate all types of generation (including small generation) and any types of consumers (from households to large-scale industry) for situational management by demand for their services and for active participation in work of a power supply system; – change in real time parameters and topology of network on the current mode conditions, avoiding emergence and development of failures; – provide expansion of market opportunities of infrastructure by mutual rendering full range of services by subjects of the market and infrastructure; – minimize losses, expand systems of self-diagnostics and self-recovery at observance of conditions of reliability and quality of electric power; – integrate power grid and information infrastructure for creation of a management system with full-scale information support.
11.	Information telecommunication infrastructure	a set of decisions, such as servers, switching equipment, communication channels, LAN, monitoring systems, etc. providing processing and data storage, and also data transmission to users

12.	Information technologies and telecommunications (ICT)	a set of organizational, technical, program and language means providing implementation of an information process such as: – An ACS (including in automatic process control system) – systems and communication networks – computing infrastructure, DPC
13.	Test equipment	means of tests representing the technical device for reproduction of test conditions
14.	IT service	a set of IT components (equipment, software, etc.), processes and people providing accomplishment of separate business challenges or business processes
15.	IT, information technologies	a set of methods, ways, techniques and means implementing an information process according to set requirements
16.	Cybernetic security	wide range of practical techniques, tools and concepts which are closely connected with technologies of information and operational security
17.	Local IT service	The IT service provided to users only of the Company or separate SDC
18.	High-level electric grids	the electric grid intended for transmission of electric energy from the producer to points of connection of distribution electric grids
19.	Monitoring	continuous control of parameters of a facility using automated systems providing collecting, storage and information processing in real time
20.	Normative reference information of an automated system	information borrowed from regulating documents and reference books and used when functioning automated systems. (GOST 34.003-90). A set of conditional and permanent basic information used by many users in different applications unlike transactional data relating only to a specific event belongs to normative reference information (to a specification, master data)
21.	Operational instruction	a document of the established sample issued by results of checks or scheduled works, containing the description of urgent measures directed to liquidation of revealed violations which can lead to an industrial trauma or failure (technology violation)

22.	Main equipment	equipment which directly participates in transmission, distribution, transformation of electric power
23.	Fault	an event consisting in violation of operating state of a facility (GOST 27.002-89)
24.	Parameters (indicators) of power efficiency	quantity and/or quality characteristic of planned and implementable energy conservation features expressed in absolute and/or relative units
25.	Fault effects	losses which are incurred by the Company and SDC in case of unplanned interruption of power supply of consumers. Character of effects can be different (economic, social, ecological, reputation, etc.)
26.	Check	a set of events for technical supervision for the location of a facility of check and/or the place of the actual implementation of its activity by employees of the Technical Supervision Centre performed concerning the subject of check
27.	Program of energy saving and increase in power efficiency (program of energy saving)	the document defining recommendations, specific actions, volume and terms of their accomplishment for energy saving and increase in power efficiency directed to achievement of target indicators of energy saving for a certain period and also executives in charge
28.	Production program	a set of the maintenance and repair and retrofitting and reconstruction programs (work plans on maintenance, repair, modernization, retrofitting and reconstruction, clearing of ROWs and expansion of ROWs of Conductor)
29.	Production assets	a set of tangible assets which directly participate in transmission and distribution of electric power, and also being in an emergency reserve, used as reserves. Power grid facilities - power lines, transformer and other substations (SS), distribution substations (DS) and other equipment intended for ensuring electric connections and implementation of transmission of electric energy, buildings, constructions, systems of technology management belong to production assets
30.	Working documentation	documentation consisting of documents in a text form, working drawings, specifications of equipment and products, developed for the purpose of implementation in the course of construction of the architectural, technical and technology solutions which are contained in the project documentation on a capital construction project

31.	Distribution electric grids	the electric grid providing distribution of electric energy between consumption points
32.	Reconstruction of capital construction projects (except for line facilities)	change of parameters of a capital construction project, its parts (height, the number of floors, the area, volume), including a superstructure, reorganization, expansion of a capital construction project, and also replacement and (or) recovery of the bearing building constructions of a capital construction project, except for replacement of separate elements of such designs by the similar or other improving indicators of such designs elements and (or) recovery of the specified elements (parts) which involves change of a class, category and (or) that it is originally established
33.	Reconstruction of line facilities	change of parameters of line facilities or their sites (parts) which involves change of a class, category and (or) originally established indicators of functioning of such objects (power, loading capacity and others) or at which change of borders of strips of branch and (or) security zones of such objects is required
34.	Relay protection; RP	a set of devices intended for automatic identification of short circuits, earth short circuits and other abnormal operating modes of the power transmission line and the equipment which can lead to their damage and/or violation of stability of a power supply system, forming of corrective actions on shutdown of switching devices for the purpose of disconnection of these power transmission lines and the equipment from a power supply system, formations of warning signals
35.	Relay protection and automatic equipment; RPA	relay protection, network automatic equipment, emergency automatic equipment, mode automatic equipment, recorders of emergency events and processes, technology automatic equipment of electric power facilities
36.	Repair	a set of operations on recovery of operability or operability of a product and recovery of a resource of products or their components (GOST 18322-78)
37.	Repair on technical condition	repair at which the volume and the moment of the beginning of repair are defined by technical condition, at the same time, control of technical condition is carried out with frequency and in volume established by documentation of the producer of the equipment or requirements of the specifications and technical

		documentation (GOST 18322-78)
38.	Repair program	the set of schedules and scheduled plans of accomplishment of repair work as a part of the main characteristics and the amount of financing made for one year (short-term) within the period of tariff regulation and for not less than five years (long-term), created on the basis of regulating documents and approved in accordance with the established procedure
39.	Risk of equipment failure (risk)	probabilistic indicator (quantity characteristic, measure) of danger and sizes of negative effects (economic, ecological, social) from failure of a unit of equipment
40.	Monitoring system	a system providing collecting, storage and information processing in the mode of continuous control of parameters of a facility using automated systems of real time
41.	Management System of Production Assets (MSPA)	interconnected and shared schemes of processes, indicators of their efficiency, a rule, technique, algorithms, normative reference information, information systems and databases for systematic impact on assets, reliability of their use, risks and expenses for all lifecycle taking into account strategic objectives of the company
42.	Measuring Instrument (MI)	a technical tool intended for measurements, having rated metrological characteristics, reproducing and (or) storing unit of physical quantity which size is accepted invariable (within the established error) during the known interval of time
43.	Structural elements (clusters)	consolidation of several independent DPCs of the operator which can be considered as an independent unit
44.	Telecommunication infrastructure	a set of hardware and\or software of elements of information infrastructure providing interrelation, and also data transmission between information infrastructure and users

45.	Technical diagnostics (Diagnostics)	the knowledge domain covering the theory, methods and means of determination of technical condition of facilities
46.	Technical supervision	a set of actions directed to prevention, identification and suppression of violations of the requirements of reliability and safety in the field of power industry established by the federal laws, other regulatory legal acts of the Russian Federation in the field of power industry adopted according to them, and also local legal acts by means of organization and conduct of checks (complex, target, documentary) and scheduled works, taking measures to suppression and/or elimination of effects of revealed violations, analysis and forecasting of a condition of execution of mandatory requirements at implementation of productive activity of the subject of power industry
47.	Technical diagnosing (Diagnosing)	determination of technical condition of a facility
48.	Maintenance	a set of actions or an action on maintenance of working capacity or operability of a product at proper use, waiting, storage and transportation (GOST 18322-78)
49.	Modernization	a set of activities at operating facilities of electric grids (power lines, substations, distribution and switching points, technology necessary buildings, communications, auxiliary constructions, repair and production bases) for increase in their technical and economic level consisting in replacement morally and physically outdated equipment and designs for new and more perfect, mechanization of works and implementation of automated control systems and control and other modern controls of a production process, improvement of subsidiary and auxiliary means of a facility when saving the main construction solutions within earlier allocated land plots. (RD 153-34.3-20.409-99)

50.	Technical condition	a set of properties of a facility subject to change in a production process or operation, characterized at a given time by signs established by technical documentation on this facility (GOST 19919-74)
51.	Technology room	a room with specially created and supported conditions for placement and functioning of a server and telecommunication hardware. It is used for placement of noncritical or reserved in DPC server hardware, and also active network equipment of the Company
52.	Fuel and Energy Resource (FER)	a set of natural and made energy carriers whose reserved energy at the existing level of development of the equipment and technology is available to use in business activities. FER used at facilities of the Company's SDC refers to: electric energy, thermal energy, natural gas, coal, oil products, including gasoline, diesel fuel, fuel oil, kerosene
53.	Service	a method of providing value to Users of the Company through assistance to them in obtaining the end results which users of the Company want to reach without ownership of specific costs and risks
54.	Target indicators	predicted end results of activity having quantitative assessment
55.	Data-processing Centre (DPC)	a specialized building or a room in such building for placement of the main server and telecommunication equipment of the Company and connection it to communication channels
56.	Centralized IT service	The IT service provided on a centralized basis within the Company and SDC
57.	Digital substation (DSS)	SS with a high level of management automation by technology processes equipped with the developed information and technology and managing systems and means (Information acquisition & transmission system, AMI, RP, EAE, detectors of emergency events, fault location devices, etc.) in which all processes of information exchange between the SS elements, information exchange with external systems, and also managements of work of SS are performed in a digital form on the basis of the IEC 61850, 61968/61970 protocols. Primary power equipment of SS, and components of information and technology and managing systems are oriented to support of digital data exchange

58.	Operational state	operational condition of a power line or equipment: in work (including in an automatic reserve and energized), in a reserve, in forced idle time, under repair or in preservation
59.	Operation	stages of lifecycle of a facility of power grid economy or unit of equipment at which its quality is implemented, supported and recovered. Operation of a product includes generally transportation, storage, proper use (operational and technology management), maintenance (including diagnostics) and repair (GOST 25866)
60.	Construction stage	construction of one of capital construction projects which building is going to be performed on one land plot if such object can be put into operation and is operated independently, that is irrespective of construction of other capital construction projects on this land plot, and also construction of a part of a capital construction project which can be put into operation and be operated independently, that is irrespective of construction of other parts of this capital construction project

3. Strategic tasks of technical policy

3.1. The technical policy is a set of obligatory and recommended for application technical solutions and technologies, and also directions of their development developed on the basis of the approved and checked principles and criteria allowing to provide planned change of the electric grids which are under control of the Company and its SDC.

3.2. The technical policy is developed for achievement of the main objectives defined in the Strategy of development of electric grid facilities for the Russian Federation approved by Order of the Government of the Russian Federation of 03.04.2013 No. 511-r and in the Long-term program of development of PJSC Rosseti Minutes of 19.12.2014 No. 174, is approved by the Board of Directors.

3.3. The purposes of technical policy are determination of the main directions of development of equipment and technologies, unification of the technical solutions providing increase in reliability and efficiency of functioning of electric power facilities in the short-term and long term when ensuring proper industrial and ecological safety on the basis of the innovative principles of development providing non-discriminatory access to electric grids to all participants of the market.

3.4. The main objectives to which solution the technical policy is directed:

- increase in efficiency and development of electric grid facilities of the Russian Federation for ensuring reliable supply of consumers, functioning wholesale and retail markets of electric energy, parallel work of an integrated power grid of the Russian Federation with power supply systems of the foreign states;
- overcoming a tendency of aging of fixed assets of the power grid organizations due to their modernization and use of the innovative equipment and technologies at reconstruction, modernization and construction of electric grids;
- development of recommendations about increase in transmission capacity of electric grids and to decrease in losses of electric energy;
- increase in energy efficiency of the applied technologies, the equipment, materials, systems, forming of the program of energy saving and reduction of technology losses of electric energy in electric grids;
- reduction of aggregate value of ownership of power grid facilities due to optimization of technical solutions when developing the project documentation, application of modern types of the equipment, building constructions, reductions of the spaces occupied by power grid facilities;
- ensuring supply of power of facilities for production of electric energy in network;
- creation of conditions for connection to electric grid of participants of wholesale and retail markets on the terms of non-discriminatory access if technically possible for this purpose and observance of statutory rules of access by them;
- development of structure of operational and technology management of electric power facilities of PJSC Rosseti and consumers of electric power;
- development together with JSC SO UES of technologies of management of operating modes of flexible elements of network infrastructure;
- development of information and telecommunication infrastructure, increase in observability of electric grid and quality of information exchange with JSC SO UES and other subjects of wholesale and retail markets of electric power;
- automation of SS, implementation and development of modern control systems of technical condition, RPA and EA systems, communication systems, engineering systems, commercial and technical metering of electric power;
- transition to creation of DSS without permanent operation personnel;
- improvement of technologies of operation, maintenance and repair. Ensuring professional training of operational and repair personnel taking into account implementation of new technologies and innovative equipment;
- development of the direction of diagnostics for ensuring receiving reliable information about a condition of electric equipment;
- improvement of normative and technical base and methodical provision;

- prevention of threats of commission of acts of terrorism and neutralization of cyberthreats;
- determination of the main directions for development and planning of activity of the research organizations, manufacturing plants of the electrotechnical equipment and materials;
- forming of incentives for development in the territory of the Russian Federation productions of modern types of the equipment, the building constructions applied at new construction, reconstruction, operation and repair of objects and directed to minimization of negative impact on the environment;
- process optimization on loading of capacities of power grid assets, effective use of reserves of network power, a possibility of redistribution of power for benefit of interested consumers, development of new approaches when forming investment programs which result in construction of power grid facilities demanded in full.

3.5. The target indicators on which development of electric grid facilities is estimated are:

- indicators of reliability SAIDI, SAIFI;
- loss rate of electric energy;
- equipment by systems of intellectual metering of points of delivery of electric energy;
- payments for admissible and above-standard emissions, dumpings, placement of waste.

3.6. Values of target indicators are established by the corresponding regulatory legal acts of the Russian Federation and internal documents of the Company and SDC.

3.7. The main mechanisms of implementation of technical policy are:

- R&D;
- development of specifications and technical documentation;
- control of observance of requirements of the Regulation at implementation of investment projects at design of power grid facilities;
- development of functional concepts and strategy of technical development;
- confirmation of indicators of purpose of the equipment, materials and systems.

3.8. The technical policy describes approaches which should be applied by preparation and implementation of the following programs of the Company and SDC:

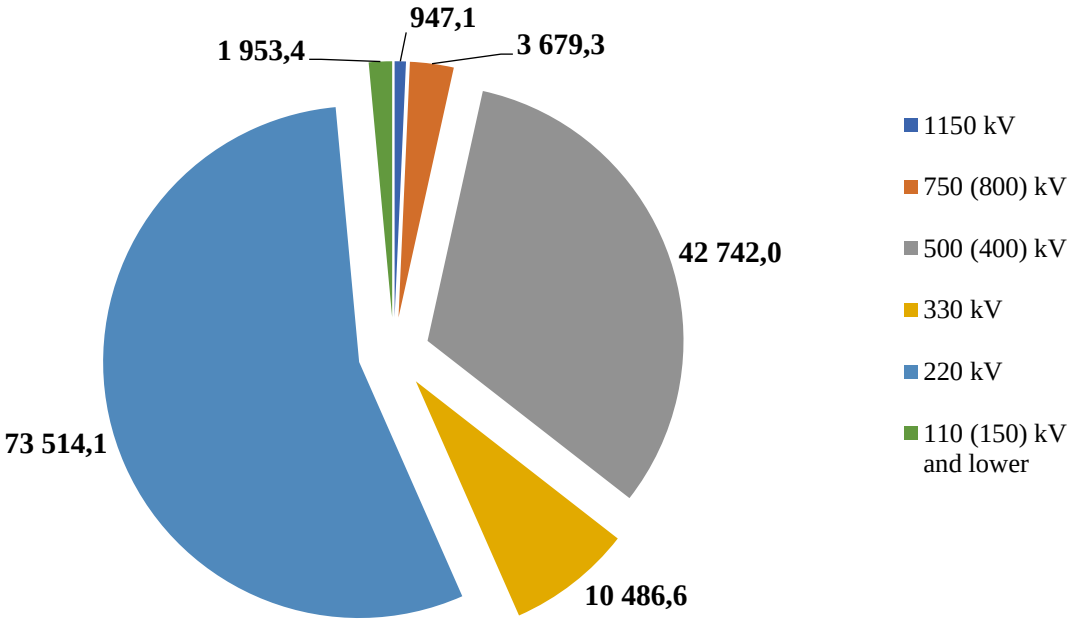
- investment programs;
- production programs;
- programs of innovative development;
- programs of energy saving and increase in power efficiency;
- the target programs connected with implementation of technical concepts and the strategy of technical development;
- Research and Development programs;
- programs for development and updating of specifications and technical documentation;
- import substitution programs.

4. Analysis of a current status of facilities of the power grid complex

4.1. Analysis of a condition of transmission electric grids

4.1.1. On 01.01.2016 the total length (ROW) of power transmission lines of the main electric grid facilities is 133 322,5 km. The structure of the length of the power transmission lines by voltage classes is given in Chart 1.

Chart 1. Structure of the length of the power transmission lines of PJSC Rosseti operated by PJSC FGC UES by voltage classes, km (design voltage).



4.1.2. The total quantity of SS of 35 kV and above, being in operation (including rented), is 861 units, including:

- of 1150 kV - 3 units;
- of 750 kV - 9 units;
- of 500 kV - 111 units (including 1 unit of SS of 400 kV);
- of 330 kV - 71 units;
- of 220 kV - 620 units;
- of 35-110 kV - 47 pieces.

4.1.3. In addition, in operation there are TS 10 (6)/0.4 kV.

4.1.4. The condition of ENES is characterized by the following volume of the equipment with above-standard service life: 59% for SS (more than 25 years) and 49% for the power transmission lines (more than 35 years), at the same time the share of the equipment which is in operation more than 50 years for SS makes 4%, for the power transmission lines - 18%.

4.1.5. On 01.01.2016 the share of the power transmission lines which are in operation more than 35 years by voltage classes is:

- The power transmission line of 1150 kV - 0%;
- The power transmission line of 750 (800) kV - 28%;
- The power transmission line of 500 kV - 38%;
- The power transmission line of 330 kV - 56%;
- The power transmission line of 220 kV - 56%;
- The power transmission line of 110 kV and below - 50%.

4.1.6. On 01.01.2016 the share of the SS capital equipment which is in operation more than 25 years by voltage classes is:

- SS of 1150 kV - 73%;
- SS of 750 kV - 47%;
- SS of 500 kV - 52%;
- SS of 330 kV - 47%;
- SS of 220 kV - 74%;
- SS of 110 kV and below - 57%.

In 2015 negative dynamics of aging of the fleet of the equipment is recorded – the share of the fleet of the equipment which passed the normative service life in comparison with 2014 increased by 2% both on the overhead power transmission lines, and on the equipment of SS. This fact testifies to need of increase in volumes of modernization and reconstruction of power grid facilities.

4.1.7. In the main power grid complex for assessment of a condition of the equipment of SS, the power transmission line the three-level system "working-worsened-preemergency" is used[1].

4.1.8. On 01.01.2015 the condition of 78% of the equipment of SS was estimated as "working", 22% - "worsened". In case of assessment of a condition of the equipment as "preemergency" events for its repair or replacement for the purpose of ensuring necessary level of reliability of functioning of electric grid facilities are held.

4.1.9. The condition of Conductors of ENES was characterized on 01.01.2015 by the following ratio (by length):

- the "working" state - 42%;
- the "worsened" state - 56%;
- the "preemergency" state - 2%.

4.1.10. The capital electrotechnical equipment installed at ENES facilities is manufactured, generally in sixtieth or seventieth last century and is inferior to modern analogs on technical characteristics, mass-dimensional indicators, demands the costs for maintenance and repair increasing with growth of service life.

4.1.11. 79% of RPA devices are executed with use of electromechanical relays. On microelectronic base 3%, on microprocessor - 18% of devices are executed. The general share of RPA devices with above-standard service life (25 years for electromechanical, 12 years for microelectronic, 15 years for microprocessor devices) is 53,2%.

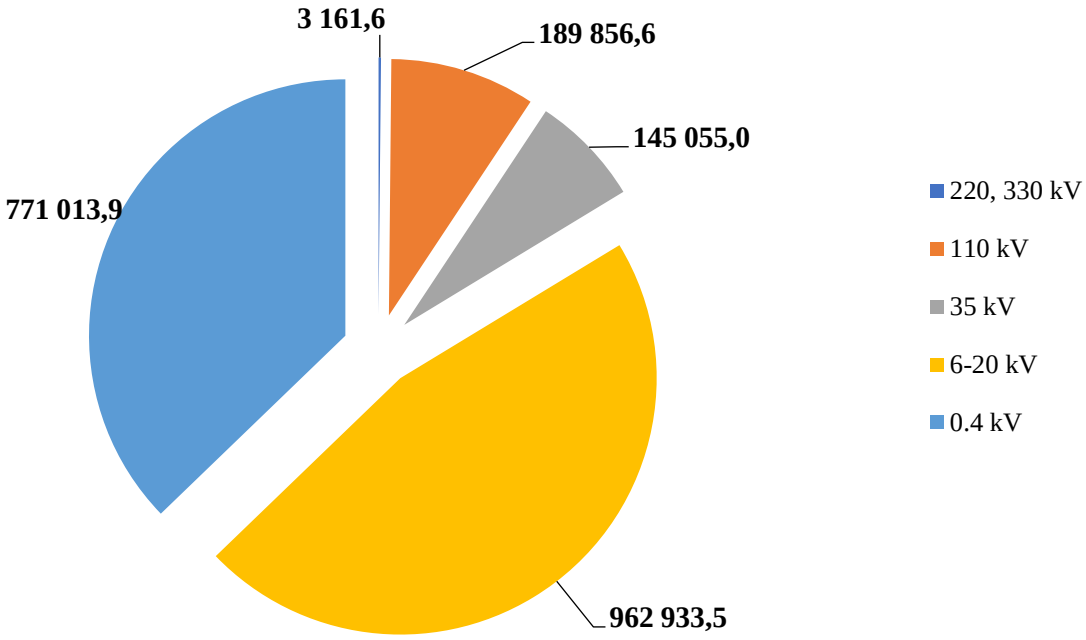
4.1.12. The general share of technology violations in the power grid complex for the reasons connected with aging (wear) of the equipment following the results of 2015 was 24%. With respect thereto it is necessary to provide upgrading of production assets in the volumes sufficient for prevention of growth of the share of the equipment with long service life cycles.

4.2. Analysis of a condition of distribution electric grids

4.2.1. On 01.01.2016 the total length (ROW) of Conductors and CL of SDC performing operation of objects of distribution electric grid facilities is 2 072 020,6 km. The structure of the length of the power transmission lines by voltage classes is given in Chart 2.

Chart 2. Structure of the length of power lines of SDC of PJSC Rosseti performing operation of objects of distribution electric grid facilities by voltage classes, km.

[1] *Working - a condition of the equipment at which its capability remains to perform given functions, and operational parameter values conform to requirements of the specifications and technical documentation;*
Worsened - a condition of the equipment at which value at least of one parameter characterizing capability to perform given functions, reached the extreme value established by the specifications and technical documentation.
Preemergency - a condition of the equipment at which its further operation should be stopped because of violation of safety requirements or when value at least of one of the parameters characterizing capability to perform given functions exceeded the extreme value established by the specifications and technical documentation.



4.2.2. The total quantity of SS and TS of distribution electric grid facilities which are in operation is 489 341 units,

including:

- 110-220 (330) kV - 6 982 units;
- 35 kV - 7 332 units;
- 6-20 kV - 475 027 pieces.

4.2.3. The condition of facilities of distribution electric grid facilities is characterized by the following share of the equipment with above-standard service life: 63% for SS (more than 25 years) and 51% for the power transmission lines (more than 35 years), at the same time the share of the equipment which is in operation for more than 50 years for SS is 3%, for the power transmission lines - 5%.

4.2.4. On 01.01.2016 the share of Conductors which are in operation for more than 35 years by voltage classes is:

- Conductor of 220 (330) kV - 52%;
- Conductor of 110 kV - 61%;
- Conductor of 35 kV - 63%;
- Conductor of 6-20 kV - 50%;
- Conductor of 0.4 kV - 46%.

4.2.5. On 01.01.2016 the share of the SS capital equipment which is in operation for more than 25 years by voltage classes is:

- the equipment of 220 kV and above - 34%;
- the equipment of 110 kV - 75%;
- the equipment of 35 kV - 81%;
- the equipment of 6-20 kV - 62%.

In 2015 negative dynamics of aging of the fleet of the equipment is recorded – the share of the fleet of the equipment which passed normative service life in comparison with 2014 increased by 2% both on the overhead power transmission lines, and on the equipment of SS. This fact testifies to the need of increase in volumes of modernization and reconstruction of power grid facilities.

4.2.6. Within implementation and development in SDC performing operation of objects of distribution electric grid facilities, SUPA the functionality of calculation of a numerical index of technical condition of the capital equipment, the power transmission line is implemented. When calculating indexes

both equipment service life, and conditions of its operation, results of diagnostic tests and other data is considered. Results of calculations of indexes are used when planning production and investment programs.

4.2.7. The capital electrotechnical equipment installed on objects of distribution electric grid facilities in large part passed normative service life and, as well as in the main power grid complex, is inferior to modern analogs on technical characteristics to mass-dimensional indicators and indicators of reliability, demands the costs for maintenance and repair increasing with growth of service life.

4.2.8. The overhead power transmission lines of 0.4-20 kV are built by the radial principle with use, generally, of aluminum, uninsulated wires of small sections, and also wooden and steel concrete poles with mechanical durability no more than 27-35 kN×m.

4.2.9. The power transmission lines of 0.4-110 (220) kV were designed by criterion of a minimum of costs, and calculation climatic conditions were accepted with repeatability once in 5-10 years.

4.2.10. Cable networks are built according to the loopback scheme or in the form of the dual-beam scheme with one - or two-transformer SS. As the power cable the cable with BMI, with aluminum cores was used generally.

4.2.11. SS of 35-110 (220) kV are generally completed with two power transformers with a bilateral feed on the high side (about 70% of total number of SS).

4.2.12. The main share of RPA is executed with use of electromechanical relays - 79%. On microelectronic base 5%, on microprocessor - 16% of devices are executed. The general share of the RPA and EAE devices which passed service life (25 years for electromechanical, 12 years for microelectronic, 15 years for microprocessor devices), is 54%.

4.2.13. The average technological level of the installed substation equipment in distribution networks in a number of parameters corresponds to the equipment which was operated in technically developed countries of the world 25-30 years ago.

4.2.14. Since 1990, owing to objective economic conditions, rates of reconstruction, modernization and new construction of facilities of distribution electric grid facilities were reduced. Noticeable aging of the fleet of the operated equipment became resulting.

4.2.15. The general share of technology violations in the power grid complex for the reasons connected with aging (wear) of the equipment following the results of 2015 was 24%. With respect thereto it is necessary to provide upgrading of production assets in the volumes sufficient for prevention of growth of the share of the equipment with long service life cycles.

5. Substations and distributing devices

5.1. Basic electric circuits of distributing devices of substation

5.1.1. Electric circuits should provide basic DD SS:

- reasonable reliability of functioning of specific SS and adjacent network taking into account reservation from other feeding centres;
- the convenience of operation consisting in simplicity and visualization of the schemes reducing probability of wrong actions of operational personnel, minimization of quantity of commutation in primary and secondary circuits at change of an operating mode of an electric installation;
- the technical flexibility consisting in a possibility of quick adaptation of an electric installation to the changing electric installation operating modes including, at planned and emergency and recovery repairs, performance of works on expansion and/or reconstruction of DD, and also when carrying out tests of the DD elements;
- compactness;
- technically reasonable profitability.

5.1.2. Electric circuits basic DD SS should be standard, at the same time, as a rule:

- at a construction of DD in design of GIS, the simple schemes providing including, optimization of placement of GIS modules should be applied;
- schemes with switching of the power transmission line with two switches or with switching of connections through one-and-a-half circuits (at initial stages of construction it is reasonable to apply the schemes "triangle" and "pentagon") should be applied to DD of 330-750 kV;
- are, as a rule, applied to DD of 35-220 kV:
  - at four connections (two lines and two transformers) - bridge connections and schemes of a quadrangle;
  - at five and more connections – schemes with one switch on connection.

In the presence of the corresponding justification application is allowed:

- for DD of 35-220 kV - bypass system of buses (on condition of sectioning of a system of buses), two systems of buses or two systems of buses with bypass system of buses;
- for DD of 220 kV - schemes with switching of the power transmission line through one-and-a-half circuits.

5.1.3. Use of bypass systems of buses in ODD of 35-220 kV, from which melting of ice on wires and lightning-protective cables of the departing Conductor is performed, is allowed;

5.1.4. The choice of quantity and power of AT 220 of kV and below, and also transformers of own needs it is necessary to carry out taking into account their reloading capability;

5.1.5. On SS ENES (voltage of 220-1150 kV) feeding of third-party consumers of 6-35 kV is recommended to be performed from separate transformers of 110 or 220 kV;

5.1.6. Tertiary windings of AT of 220-750 kV taking into account feasibility justifications should be carried out on the rated voltage of 20 - 35 kV for the purpose of minimization of volume of the capital equipment, decrease in short circuit values and increase in reliability of feeding of own needs of SS;

5.1.7 The applied schemes should provide a possibility of the DD expansion in the long term; in the absence of basic data by the number of perspective connections it is necessary to envisage a possibility of expansion:

- for DD of 220 kV and above - not less than on two connections;
- for DD of 35-110 kV - not less than on four connections;
- for DD of 6-20 kV feeding power stations of consumers - not less than on 8 connections.

5.1.8. At the choice of the mode of grounding of a neutral in networks of 6-35 kV it is necessary to carry out the feasibility justification on different options. Within intended for building territories preference should be given to the modes of grounding of a neutral through the low-impedance active or inductive resistance.

5.2. Design and construction solutions at new construction, modernization, reconstruction of substations

At construction of SS (DS) it is recommended to be guided by the following basic principles:

5.2.1. Building structures of buildings and engineering constructions of the electric SS, indoor TS and DS should provide required reliability at their life not less than 50 years;

5.2.2. At construction of SS the prototype solutions considering influence on building constructions of electric installations (power grid designs) of electromagnetic, thermal and electrodynamic influences in normal and emergency operation of work of electric grid should be applied, as a rule;

5.2.3. Reduction of the areas of SS by optimization of circuit and layout solutions, on condition of preserving of reliability and maintainability;

5.2.4. In the cities with a high density of building, at the feasibility justification, construction of the buried or underground SS, and also SS integrated into process and/or office buildings is allowed;

5.2.5. For the purpose of increase in reliability of functioning of SS ENES due to increase in readiness of the equipment, influence minimization of "a human factor", an exception of influence of external climatic factors, and also for the purpose of increase in safety of operation and repair personnel, minimization of negative impact of SS on the environment, their compaction and increase in an esthetic type, operation optimization, it is necessary:

- newly constructed and reconstructed DD of 6-35 kV, with the number of the fed connections 4 and more, and also DD from which feeding of MV SS is performed to carry out closed using vacuum or, at reasonable technical need, gas-insulated switches;
- and to carry out newly constructed and reconstructed DD of 110 kV with use of the equipment with the main gas-insulated or vacuum insulation (switches or the combined switching devices, measuring transformers) above, and at the corresponding feasibility justification considering costs for all lifecycle of the equipment to carry out using GIS taking into account ensuring reliable protection of the equipment of GIS against high-frequency switching overvoltage and the solution of questions of electromagnetic compatibility of RPA, industrial Control System devices and communication, etc.;
- newly constructed and reconstructed DD 330 and above SS located in the cities with dense building in areas of megalopolises (the city and the built-up suburb), in areas with an absolute minimum of temperatures lower than minus 45ºC, in national parks and reserves, in areas with the IV APD and above, in coastal areas in a priority order should be carried out closed using the GIS equipment and be confirmed by the feasibility justification;
- in buildings of GIS to provide cable bayars for entering of cables of 110-500 kV in GIS at accomplishment of connections to IDD by cable lines or inserts;
- in the territory of SS for entering of the power transmission line of 35-500 kV to implement transitional points by the open type, and behind SS territory - the closed type, or on the power transmission line pole;
- across the territory of SS to apply to laying of cables of 110-500 kV platforms, galleries, collectors, cable channels.

5.2.6. At new construction and reconstruction of SS the possibility of their expansion in the long term should be provided for the account of:

- increase in power by replacement of AT/T by more powerful (from a number of rated power) or installation of additional AT/T (with the corresponding justification);
- increases in number of connections by reservation of the place; and if expansion is planned before five years from the moment of input of SS, - by ensuring readiness of bays;

5.2.7. For heating of buildings of SS, in the absence of a supply of thermal engineering communications, it is recommended to use fireproof energy saving electric heaters with temperature regulators;

5.2.8. On SS with the closed installation of power AT/T of 110-500 kV it is recommended to provide use of heat of AT/T for heating of rooms, it is also allowed to use heat of AT/T for heating of SS of buildings of urban (settlement) development, adjacent to territory;

5.2.9. Use of a system of utilization of heat of power transformers for heating of buildings and constructions of SS for the purpose of decrease in a power consumption for own needs is possible;

5.2.10. For feeding of own needs of SS, including electric heating, it is recommended to consider use of modern technologies, including solar power engineering;

5.2.11. At construction of SS within urban development it is reasonable to place the equipment of ventilation, conditioning, solar batteries and heaters (in areas with sufficient solar activity) on flat roofs in case of their use;

5.2.12. For maintenance of favorable climatic conditions in rooms of large-size buildings of SS (including office and technical buildings) is recommended to use the centralized climatic installations;

5.2.13. Reconstruction of DD of 110-750 kV of SS should be carried out, as a rule, on the new place with the organization of re-laying of connections in them; bay-by-bay reconstruction of ODD is allowed in the presence of special justifications;

5.2.14. At design of the closed SS and to install transformers (AT, shunt reactor) with a rated voltage of 110 kV on the open areas, if necessary with an antinoise obstacle above; installation of transformers (AT, shunt reactor) in buildings is allowed at special justification and development of exhaustive fire-prevention actions;

5.2.15. As the bases under the equipment it is necessary to apply the facilitated preliminary and intense steel concrete racks, steel concrete piles, the monolithic and combined and monolithic bases;

5.2.16. As the bases under portals it is necessary to apply monolithic and assembly, including superficial and pile steel concrete (bored, including with broadening and without broadening) bases;

5.2.17. At new construction, complex modernization and reconstruction of AT/T it is recommended to establish on carriages (with their fixing to rails) in the presence of railway lines for reskating rinks or the access railroad, in the absence of ways for reskating rinks and the corresponding justification trackless (without carriage) installation using special supports, for a possibility of access to a bottom of a tank of AT/T taking into account requirements of division into districts for seismicity is allowed;

5.2.18. Minimization of production of earthwork due to application of different types of the combined reinforced concrete and pile foundations (prismatic steel concrete piles, screw piles, piles of an open profile, the pile cover, bored and bore dropping piles) low-buried and superficial bases, thermopiles and screw piles in permafrost soil, rod seals in rocky soil; application of highly effective working boring bodies for driving of wells in strong breeds and rocky soil;

5.2.19. At construction of buildings of SS (IDD, storage facilities, buildings of tanks of fire extinguishing, etc.) it is preferential to apply frame or modular structures of buildings with facing a sandwich panels, application of a brick at construction of large-size buildings is allowed at special justification, including according to safety requirements;

5.2.20. At construction of office and technical buildings or buildings of substation control along with use of brick, foam-concrete and slag-concrete blocks with exterior finish of buildings with the facing brick, porcelain tile or ventilated facade, hinged facing panels with a corporate coloring, allow application frame or modular buildings of a design with sandwich panels facing;

5.2.21. Use of new highly effective materials for protection against corrosion of building constructions, corrosion-resistant steels with increased durability for production of a metalwork of portals and supporting frameworks under the equipment;

5.2.22. For distributing of cables of secondary systems in rooms of office and technical buildings, substation control and switchboard it is preferential to use cable mines and hollow floors, cable floors are allowed at the feasibility justification;

5.2.23. Production and economic tanks should be made of monolithic steel concrete with brand on water tightness of not less W8 or from combined concrete blocks with a waterproofing by means of a steel shirt, as an outside and internal waterproofing of tanks to apply materials of the penetrating action, to carry out overlapping of tanks to the built in sections steel concrete with backing superficial waterproofing application of steel tanks with a complex of necessary measures for a waterproofing is allowed;

5.2.24. Treatment facilities can be constructed in a metal framework with facing a sandwich panels. Treatment facilities in areas with an absolute minimum of temperatures below –45ºC are recommended to be made in metal tanks with warming of sprayable polyurethane foam, a waterproofing by means of a steel

shirt, with use of an electrical heating of treatment facilities of outside installation, drain tubes with automatic adjustment of temperature;

5.2.25. Tanks of water fire extinguishing can be carried out:

- buried one depth below than the level of frost penetration in soil. The buried tanks are made of monolithic steel concrete;
- land, in tanks from steel, composite or polymeric materials.
- tanks in tanks can be placed together with pumping fire extinguishing in the easy frame building with heating and facing a sandwich panels or is opened. At open placement in areas with an absolute minimum of temperatures below – 45ºC it is recommended to be used the built-in system of an electrical heating of tanks of fire-water supply with control of level and water temperature, and also information transfer on the panel of SS on duty;

5.2.26. Outside networks of an economic and drinking water supply system of low pressure should be provided from bell-shaped pressure head pipes from polyvinylchloride like "T" completely with rubber rings. For areas with a frigid climate it is recommended to use system of flexible polyethylene pipelines with heat insulation with polyurethane foam with the built-in system of an electrical heating;

5.2.27. Outside networks of the household sewerage from free-flow pipes from polyvinylchloride completely with sealing rings. For areas with a frigid climate outside networks of the household sewerage are recommended to be carried out from the pipes made of polyethylene of low pressure with the built-in system of an electrical heating;

5.2.28. At the design of oil receiving devices of the oil-filled equipment to use a method of the jellied reinforced concrete with use of polymeric additives for improvement of characteristics of concrete;

5.2.29. To perform coloring of concrete surfaces with oilproof paint for protection of a surface against transformer oil;

5.2.30. Use of new effective materials for the protecting and roofing structures, floors and finishing of rooms of buildings;

5.2.31. Seamless floors should conform to requirements: insignificant wearing capacity, dusting resistance, chemical firmness, high speed of work on installation (floors can keep within at above-zero and negative temperatures), ease of updating and repair;

5.2.32. A concrete floor (concrete 200-300 brand) should be the basis for a seamless floor, on a surface there should not be cracks and chips, humidity of the basis no more than 4-5%; at placement of GIS arrangement of concrete floors with cutting of "cards" of shrinkable seams is recommended;

5.2.33. At repair of facades of office buildings, except traditional use of front paints, use of "ventilated facade" technology is possible;

5.2.34. Accomplishment of actions in the field of environmental protection according to the existing nature protection legislation of the federal and regional level, departmental and local regulatory legal acts in the directions of nature protection activity;

5.2.35. Consolidation of project decisions in a uniform architectural and industrial complex, use of uniform corporate style of registration of facades of buildings and constructions with use of elements of the approved corporate style (color schemes, emblems, etc.);

5.2.36. Accomplishment of actions for anti-terrorist security and physical protection against unauthorized access to objects.

5.2.37. The master plan and layout solutions of SS, and also volume planning solutions of the buildings and constructions located in its territory should provide:

- convenience of operation;
- a possibility of carrying out the scheduled and repair work including connected with replacement of the large-size equipment;
- conditions for operational liquidation of emergency situations.

5.2.38. At specific design of SS it is necessary to approach individually the choice of the scheme DD, structure and design of the equipment to provide convenience of operation, maintainability of the scheme, to exclude a possibility of wrong actions when operating, to fit into the allocated platform of construction and, at the same time, to incur the minimum costs in comparison with other possible options of construction (reconstruction) of SS by carrying out their technical and economic comparison and taking into account assessment of possible environmental risks.

5.2.39. On SS of 110 kV and above the water supply system and sewerages should be, as a rule, provided.

5.2.40. HF band-elimination filters and cables to be performed with a suspension bracket using the technical solutions excluding whipping and a break of edges and cables.

5.2.41. At a stage of forming of projects of construction of buildings with the number of floors 2 and more it is necessary to provide availability of fire-escapes.

5.3. Buildings and constructions of substation with the highest voltage of 6-110 kV

5.3.1. At construction of buildings and constructions of SS the design of a roof should be two (or more) inclines. At construction of SS within urban development the flat roof is allowed.

5.3.2. Buildings and constructions of SS, without service personnel, should be executed in block and modular design.

5.3.3. SS buildings with service personnel or at certain requirements of authorized organizations can be executed from bricks.

5.3.4. Buildings of any execution should be equipped with heating, ventilation, the fire and security alarm system according to acting with the specifications and technical documentation. Entrance outside doors of all premises of SS should be metal with an additional heater and internal locks. The quantity of outside doors should be minimum. The glazing of buildings in the territory of SS also should be reduced to a minimum. In case of need in natural illumination of a window of the first floor are equipped with protective grids and other windows - anti-vandal lattices.

5.3.5. The choice of the constructive solution of a floor needs to be performed taking into account providing:

- reliability and durability of the accepted design;
- economical expenditure of construction materials;
- the most complete use of physicomechanical properties of the applied materials;
- optimal hygienic conditions for people;
- the fire - and explosion safety.

5.3.6. For timely detection of malfunctions in building constructions of buildings of switchgear, IDD, ITS and DS facades are allowed to be repaired without shelter of walls with frame front materials.

5.3.7. For creating favorable conditions of operation of buildings and constructions it is necessary to control that at construction new both reconstruction of old buildings the design and improvement of the territory, system of a drainage system of an atmospheric precipitation and ground waters were executed according to the project documentation and further were supported in good repair in compliance to requirements of the standard instruction.

5.3.8. Front parts of buildings and constructions of the closed SS, TS and DS which are located in a zone of urban development should fit into a surrounding architectural landscape.

5.3.9. At construction of buildings and constructions of SS to consider need of accomplishment of the project decisions directed to anti-terrorist security and physical protection against unauthorized access to rooms.

6. Main equipment

6.1. Power autotransformers, transformers and reactors

6.1.1. General requirements:

- lack of need of capital repairs during all service life;
- lack of need of repressing of windings during all service life;
- sufficient resistance to transportation (obligatory availability of the sensor of accelerations);
- ensuring electrodynamic resistance of windings to short circuit, confirmed with tests in the accredited test centres or settlement comparison, according to requirements of GOST R 52719-2007;
- ensuring explosion safety due to design of tanks (valves of dumping of pressure and so forth);
- a warranty period – not less than 5 years from the date of commissioning;
- service life - not less than 30 years;

6.1.2. AT/T of 220 kV and above, the shunting managed and uncontrollable (controlled shunt reactor, shunt reactor) reactors should be equipped:

- sensors of control of a condition of insulation of inputs of HV, MV;
- sensors of temperature of high layers of oil of a tank of the equipment;
- oil temperature sensors on an entrance and an exit of coolers (at justification);
- LTC position sensors;
- sensors of content of gases dissolved in oil and moisture content of transformer oil (at justification);
- outputs of relay signals of technology protection of cooling systems, LTC devices, relay signals of feeding of protection of the transformer for industrial control system and systems of automatic diagnostics (monitoring).

6.1.3. In a design of AT/T of 220 kV and above, the shunting managed and uncontrollable (controlled shunt reactor, shunt reactor) reactors should be applied:

- inputs of 110 kV and above tight, with paper-oil or solid insulation;
- oil pumps of direct-flow type;
- the combined cooling systems of ONAN/ONAF and ONAN/ONAF/OFAF with manual and automatic control modes having control systems with the following functions:
    - control of the cooling system on indicators of load capability and control of a condition of each electric motor of the cooling system separately;
    - possibility of smooth start-up and reduction of starting currents;
    - protection of electric motors against an overload and short circuit;
    - protection of electric motors of coolers against disappearance of a phase and against asymmetry of phases;
    - the algorithm of turning on of pumps of coolers (for lamellar radiators) should exclude a false operation of gate-type valves.
- radiators with the covering providing protection against corrosion on all service life. Coolers of the OFAF cooling system are recommended to be applied in design with the opening diffusers to washing of tubes of the heat exchanger on both sides.

6.1.4. Application of AT with a rated voltage of a LV winding, as a rule, of 20-35 kV for the purpose of decrease in short circuit values taking into account the feasibility justification is preferable.

6.1.5. AT/T, controlled shunt reactor, shunt reactor and compensation reactors should have the lowered noise level and vibrations:

- no more than 85/100/115 dB for transformers during the work in the modes of the ONAN/ONAF/OFAF cooling system respectively;
- no more than 90 dB – for controlled shunt reactor and shunt reactor;
- level of vibrations for shunt reactor no more than 60 microns.

6.1.6. Cases of automatic control of cooling of the transformer should conform to the following requirements:

- are executed by galvanized or are made of corrosion-proof materials (degree of protection not lower than IP55 in accordance with GOST 14254-96);
- provide automatic maintenance of the set temperature in a case;
- provide availability of access control in a case with the alarm system, manual control to each of the established oil pumps and cooling fans, control of a state (operability) of the switching devices managing engines, integration into industrial control system of SS (in case of absence – equipment by a separate automated workplace) for operational management and visualization of a condition of a monitoring system of the transformer equipment (in the presence of justification).

6.1.7. On distribution TS 6-35/0.4 kV power transformers should be used:

- tight oil or dry with cast insulation (including with windings with cast insulation) with reduced losses (including due to application in transformers of magnetic conductors from amorphous steel), and also the transformers of a special design with power up to 100 kVA intended for installation on the Conductor support;
- with the symmetrizing devices;
- with the scheme of connection of windings Δ/Yn or Y/Zn (use of the scheme of connection of windings of power Y/Yn transformers in the presence of the corresponding justification, for example, replacement of the failed transformer on two-transformer TS is allowed).

6.1.8. In TS which are built in buildings or constructed in the constrained conditions of urban development small-size transformers with the lowered noise level and vibrations should be used, as a rule. At the same time insulation of transformers should be dry or the tank of the transformer should be filled with ecologically safe nonflammable liquid dielectric and is supplied:

- system of automatic control of temperature of the transformer;
- temperature sensors in the transformer enclosure.

6.1.9. At new construction placement of TS, DS and DTS in buildings is allowed in the presence of the corresponding justification.

6.1.10. At new construction of DS of 6-10 kV with the number of connections no more than 4 are recommended to apply small-size modular DS of 6-10 kV based on monoblocks with solid or gas-insulated insulation.

6.1.11. Regulating transformers are allowed to be installed:

- in the presence of the corresponding justification - on AT of 500-750 kV for regulation of flows of active power;
- on SS of 35-220 kV with the transformer equipment equipped with LTC devices where regulation of voltage does not meet the initial requirements when using LTC.

6.1.12. Line voltage boosting transformers (VDT) are allowed to be used to adaptation of distribution electric grids of 0.4-20 kV to change (increase) of electric loadings and providing required electricity quality, on the basis of the feasibility justification in comparison with other options of providing electricity quality.

6.1.13. Points of critical power failure (more than 10% of nominal rate of voltage) of the power transmission line or directly the consumer's bus can be an installation site of VDT. VDT should have the range of regulation of voltage not less than ±10%. Regulation of voltage of VDT should be performed in the automatic mode. At change of the direction of power (upon transition to the reserve power supply), VDT should not change an operating mode in relation to the direction of a flow of power.

6.1.14. It is necessary to consider the VDT installation:

- on the power transmission line of 6-20 kV which do not provide quality of electric energy at consumers, with regulation of voltage of ±10%;
- on SS of 35-110 kV, the equipped LTC devices where regulation of voltage does not meet the normative requirements, with regulation of voltage of ±15%;
- on DS and SS of 6-20 kV, with regulation of voltage of ±15%.

6.1.15. VDT should be equipped with the built-in CT and VT programmed by control units with a possibility of registration of processes and working hours of VDT.

6.1.16. In networks of 6-220 kV, in the presence of the corresponding feasibility justification, it is necessary to apply dry current limiting reactors with sufficient electrodynamic resistance to short circuit.

Reactors of similar type should be used to installation on inputs 6-20 kV of power transformers or on connections of the departing lines.

6.1.17. At the choice of the mode of a neutral in networks of 6-35 kV it is necessary to carry out the feasibility justification on different options (application of arc suppression coils, the resistor or the combined devices).

8.1.18. At making decision on expediency of application of the mode of grounding of a neutral of network of 6-35 kV via the arc suppression coil it is recommended to apply smoothly regulated arc suppression coils with automatic regulators of setup.

6.1.19. At reconstruction and new construction to establish SW in the SS enclosures of the closed type or modules of container execution in ODD territory.

6.1.20. When carrying out replacement of SW by big power on SS of the closed type with increase in volume of oil in the conditions of lack of a possibility of the organization of an oil receiving bowl and oil drain, it is necessary to consider the possibility of application of SW of "dry" execution.

6.1.21. On the side of 0.4 kV power transformers of 6-20/0.4 kV should be equipped with hardware clips.

6.1.22. The oil transformers of own needs installed out of rooms it is necessary to have so that in case of the fire to exclude probability of damage of the next transformer.

6.2. Switching equipment

6.2.1. General requirements:

- should not demand capital repairs during fixed term of operation or before exhaustion of a switching resource;
- a warranty period – not less than 5 years from the date of commissioning;
- service life - not less than 30 years;

6.2.2. In networks of 110 kV and above as the switching equipment it is necessary to apply:

- gas-insulated switches live tank and tank explosion-proof (availability of valves of dumping of pressure is obligatory), it is preferential with spring drives;
- in process of development of technologies use of vacuum switches, and also switches disconnectors is allowed;
- in a circuit (U) shunt reactor and capacitor batteries the switches intended for switching of current of the reactor and capacitor batteries, respectively;
- gas-insulated switches at pressure decrease of SF6 in which body their automatic shutdown is not required. The two-level precautionary/alarm system of pressure decrease (density) of SF6 in high-voltage gas-insulated switches (at operation of the second step of the specified alarm system the automatic electric blocking of control of the switch prohibiting transactions of switching off and shutdown of the switch is carried out) should be executed.

6.2.3. The technical actions directed to an exception of risks of damage of gas-insulated switches of power lines with the shunting reactors during switching of an aperiodic component of electric current should be developed.

6.2.4. At justification calculations and confirmation by results of tests allow use of switches with UPNKP.

6.2.5. Application is recommended:

- live tank gas-insulated switches of 330-750 kV with longitudinal insulation corresponding not less than II* degree of pollution (2,25 cm/kV);
- live tank and tank gas-insulated switches with polymeric external insulation at operation in difficult climatic conditions and areas with the increased pollution;
- disconnectors of 110 kV and above pantograph, semi-pantograph and horizontally rotary type, equipped with electromotive drives including for the grounding switches, porcelain or polymeric basic insulators, the highly reliable switching devices for implementation of schemes of operational blocking;

6.2.6. In networks of 35 kV it is necessary to apply:

- vacuum and gas-insulated switches (in the kV closed and opened by DD-35);

- recloser on Conductor;
- vacuum switches of load of outside installation of Conductor and SS;
- vacuum switches of outside installation (recloser) on Conductor and SS;
- the vacuum switches of loading of internal installation equipped with electromotive drives;
- safety locks disconnectors to 20 kV.

6.2.7. In distribution networks of 6-20 kV it is recommended to apply:

- vacuum switches, in some cases at need justification – gas-insulated switches (for example on connections with big currents or in the constrained conditions) – DD of 6-20 kV;
- recloser on Conductor;
- safety locks - disconnectors;
- disconnectors of outside installation on Conductor with remote control;
- loading switches.

6.3. Complete distributing devices

6.3.1. General requirements:

- should not demand capital repairs for all service life;
- a warranty period – not less than 5 years from the date of commissioning;
- service life - not less than 30 years;

6.3.2. Requirements to GIS of 110-500 kV:

- GIS should be completed:
  - a monitoring system and diagnostics (measurement of density of SF6 with a possibility of visual inspection by means of densitometers of indicator type);
  - the PD built-in sensors with system of the continuous alarm system and/or a possibility of connection of portable devices for registration of the PD levels and interpretation of character and dynamics of development of malfunction of the GIS elements. In the presence of microprocessor devices of monitoring, diagnostics and alarm system as a part of GIS, ability to integrate such devices into the SS PCS with the digital duplicated optical interface with support of the IEC 61850 and PRP protocol should be provided);
- in bays of GIS of 110-500 kV it is necessary to apply inputs to connection of connections "air-SF6", cables with insulation from cross-linked polyethylene, depending on the number of connections and the feasibility justification connection via gas-insulated current-conducting wires is possible;
- in regions with an absolute minimum of temperatures minus 45ºC is lower in bays of GIS to apply to connection of connections, as a rule, air calling; at the corresponding feasibility justification - gas-insulated current-conducting wires.
- in case of the closed installation of power AT/T and shunt reactor if necessary it is allowed to carry out their connection to GIS with use of inputs oil-SF6;
- GIS of internal installation should provide nominal parameters at the lower value of temperature of air to minus 10 ºC, GIS of outside installation (GISO) – to minus 60 ºC, gas-insulated current-conducting wires of outside installation to minus 60ºC taking into account cooling wind action;
- the compensating devices in borders of difference of temperatures and in border of separation of building foundations of GIS and outside support of current-conducting wires by temperature seams should be provided in a design of gas-insulated current-conducting wires;
- sales opportunity of schemes of operational blocking should be provided in GIS;
- design of GIS:
  - the design and the gas scheme GIS should provide a conclusion in repair of any gas volume without blackout of GIS;

- should provide a possibility of access for service personnel to all structural elements which are subject to maintenance (including mobile or stationary platforms of service should be provided);
- should provide a possibility of joining of bays (perspective expansion of the scheme DD) with the minimum repayment of the existing connections;
- provide technology video surveillance in bays of switching devices GIS;
- it is executed using counters of a switching resource;
- establish explosive membranes in each gas-insulated volume;
- provide execution both with cable, and with air input;
- provide factory information stickers on work with elements of the equipment for minimization of wrong actions of personnel;
- provide an arrangement of drives and GIS switches taking into account free access for their service;
- it is necessary to complete GIS with stationary, mobile platforms of service of factory production for control of provision of devices through "viewing windows", for transactions with disconnectors, ZN manually, for feed of amounts SF6 at height;
- consider in picking the compact mobile feeding installations for an SF6;

- give preference to GIS in three-phase execution in one amount;

6.3.3. Requirements to switchgear(E) of 6-35 kV:

- apply switchgear of 6-35 kV with air, including combined, insulation, at the corresponding feasibility justification with gas-insulated insulation, and also switchgear of unilateral maintenance(SF6) with vacuum switches or switches of loading, including performed by "monoblock";
- apply metal protective blinds of bays;
- use a CT with cast insulation, VT of anti-resonant execution;
- for the organization of power metering it is recommended to establish a CT in each phase.

To switchgear (SF6) it has to be provided:

- possibility of remote shutdown of the switch;
- four insulated compartments (for compartments with high-voltage switches);
- high-speed protection against arc short circuits;
- it is recommended to apply switchgear of 6-20 kV with an upper arrangement of combined buses, with bilateral service;

6.4. Current-conducting wires and busbar

6.4.1. On SS on the party of 6-500 kV at technical capability the rigid busbar as uninsulated, and in the protected execution should be applied. When using rigid buses it is necessary to use compensators of temperature deformations, flexible branches from buses, and also bus structure and connections to devices with use of nodes of blooming type (preferably cast). Are not allowed to application of a branch of flexible communications (including temperature compensators) from rigid buses of DD of 35 kV and above with use of the pressed clips.

6.4.2. In block and complete TS of 6-20/0.4 kV, with transformers with power up to 630 kVA, it is recommended to apply the insulated transformer busbar.

6.4.3. In distribution networks at the power of transformers of 1000 kVA and more on the party of 0.4 kV it is recommended to use insulated (three-phase and single-phase) current-conducting wires (at the corresponding feasibility justification).

6.4.4. At air inputs on sites of lines from insulators of bays through passage of switchgear to the first Conductor 6 (10) support of kV, as a rule, it is necessary to apply the protected (insulated) wire with the insulation which is flame-retardent (MIWN type).

6.4.5. On SS of 110-500 kV use of the gas-insulated current-conducting wires with the isolating environment on the basis of SF6 at the corresponding feasibility justification is allowed.

6.4.6. Accession of a flexible busbar to electric equipment is recommended to be performed hardware clips without welded connection of a contact plate and "leg" of a clip, with a thermodynamic method of drawing a copper covering and drainage openings for prevention of pushing out of the pressured-up wire from the body of a clip the frozen moisture.

6.5. Electromagnetic measuring transformers

6.5.1. Electromagnetic measuring transformers should conform to the following requirements:

- application of measuring CT and VT with the increased interval between checkings (not less than 8 years), with service life not less than 30 years;
- a warranty period of operation not less than 5 years from the date of commissioning;
- lack of need of procedural repair during all service life;
- oil-filled tight, cast and gas-insulated CT;
- anti-resonant electromagnetic inductive VT of 6 - 35 kV;
- for networks of 110 kV and above, including GIS, allows application of electromagnetic inductive VT at the corresponding project justification, including for installation on objects of expansion and reconstruction with considerable secondary loading;
- A CT and VT providing the increased reliability, explosion-and fire safety;
- application of capacity dividers with the lowered value of temperature coefficient of capacity;
- use of the cast corrosion-resistant body;
- at pressure decrease of SF6 in the body of gas-insulated measuring transformers their automatic shutdown (removal of voltage) should not be required. In gas-insulated measuring transformers the two-level precautionary/alarm system of pressure decrease (density) of gas should be executed.
- measuring transformers should have a separate winding for the purposes of metering of electric power;
- the actual secondary loadings of measuring CT and VT should conform to requirements of the specifications and technical documentation and ensure functioning of a CT and VT in a required class of accuracy;
- the coefficient of transformation of windings of AMI, industrial control system and measurements should provide measurement of working current with a rated accuracy in the range of its change from minimum to the maximum value, the electrical power modes defined on the basis of calculations;
- for the purpose of reduction of the occupied space and optimization of layout solutions it is recommended to apply the combined measuring CT and VT of 110-500 kV;
- The CT of 110 kV and above with a class of accuracy of windings for the purposes of metering of electric power (including AMI) is not worse 0,2S, for the purposes of industrial control system and measurements – not worse than 0,2;
- for other connections of a CT with a class of accuracy of windings for the purposes of commercial metering of electric power – not worse than 0,5S, than measurements and industrial control system - not worse than 0,5.
- VT of 110 kV and above with a class of accuracy of windings for the purposes of metering of electric power (including AMI), industrial control system and measurements is not worse than 0,2;
- for other connections of VT with a class of accuracy of windings for the purposes of metering of electric power (including AMI), industrial control system and measurements not worse than 0,5;

6.5.2. Recommendations about use of electromagnetic measuring transformers:

- application of hydrophobic coverings or external polymeric insulation for decrease in operating costs and increase in explosion safety;
- the measuring CT and VT applied in networks of 6-35 kV should have:

- cast insulation;
- not less than two secondary windings.

6.5.3. It is necessary to apply a CT of 0.4 kV for the purposes of AMI, industrial control system and measurements in cases when the measured current exceeds 60 A, and the connected power – more than 25 kW.

6.5.4. For metering of an error of all measurements at frequencies above the main frequency it is necessary to be guided by use of measuring transformers with the rated frequency characteristic in a strip of frequencies to the 50th harmonic of the main frequency.

6.6. Limiters of overvoltage nonlinear

6.6.1. At new construction, reconstruction and modernization of power grid facilities for protection against storm and switching overvoltage limiters (including with discharge gaps on Conductor) on the basis of oxide-zinc varistors for all voltage classes, explosion-proof with sufficient power consumption and protective level, with service life not less than 30 years and warranty life not less than 5 years from the date of commissioning should be established.

6.6.2. Limiters of 220 kV should be completed with devices of control of current of conductivity under the working voltage of leak for identification of digit processes and prevention of an emergency exit of limiters out of operation also above.

6.7. Devices of compensation of reactive power

6.7.1. The following types of devices of compensation of reactive power should be applied:

- uncontrollable static means of longitudinal and cross compensation;
- the shunting bus and linear reactors of 110-500 kV;
- shunt batteries of static capacitors;
- devices of longitudinal compensation;
- the managed means of longitudinal and cross compensation;
- the shunting bus reactors of 110-500 kV (shunt reactor) managed by excitation;
- the managed by thyristor gates with use of transformers with voltage of short circuit, equal 100% shunting bus and linear reactors of 110-500 kV (controlled shunt reactor);
- the static thyristor compensators (STC) and static compensators based on converters of voltage (static compensator);
- the vacuum and reactor and thyristor and reactor groups switched by the switches with the raised switching resource equipped with the device of synchronous switching;
- batteries of static capacitors of the filter-compensating devices. At the same time dry capacitors or impregnated with ecologically safe liquid synthetic dielectric should be used;
- the managed devices of longitudinal compensation,
- asynchronized control compensators on converting substations of electricity transmissions and inserts of direct current, and also substations in power supply systems of megalopolises in a zone of an arrangement of service infrastructure of the generation companies.

6.7.2. Application of capacitor installation is allowed on condition of an exception of the resonant phenomena at all working hours of electric grid.

6.7.3. In distribution networks at impossibility of placement of regulated capacitor batteries and at the corresponding justification installation of the separate capacitors designed only for compensation of the magnetizing transformer current in a basic part of the schedule of reactive loading is allowed.

6.8. Own needs

6.8.1. At the organization of own needs of SS it is necessary:

- perform feeding of MV power-consuming units of alternating current of SS from two independent sources (for SS of 330 kV and above - from three, at the same time, uninterruptible power system can be considered as the third independent source);
- have 110 kV on SS and own sources of the electric power ensuring autonomous functioning of power-consuming units of own needs which directly participate in technology process not less than one hour at complete loss of an external power supply of MV and the subsequent start-up of SS "from scratch" are higher (power supply type: DDG or the uninterruptible power system, including, based on high power electric battery, should be defined on the basis of technical and economic comparison of options);
- apply cables over 1 kV with insulation from cross-linked polyethylene, it is lower than 1 kV - with the insulation which is not sustaining combustion;
- ensure separate functioning of sections of 0.4 kV of own needs with AVR, provide separate work without AVR of the circuits having feeding from different sections of 0.4 kV (feeding of drives of disconnectors, winding of springs of drives of switches and so forth);
- use the protective switching equipment with a possibility of creation of visible gaps;
- use as introduction and section protective devices on the party 0.4 kV the selection automatic switches;
- in TS and DS with the variable and rectified operational current of TMV should join through safety locks, from the power supply, to the main switch.

6.8.2. Power supply of operational current from buses of own needs should be performed via stabilizers with voltage of 220 V in output.

6.8.3. A centralized system with a switchboard and a control panel for emergency and evacuation illumination of the main control panel of SS with a possibility of use of standard lighting installations for emergency lighting and integration into SS operating with industrial control system, the warning system about the fire, with autonomous testing of nodes and units, both the system, and the loading (networks of lighting) connected to it, with a possibility of the analysis of control of a condition of networks of lighting.

7. Electricity transmission overhead-lines

7.1. General provisions

7.1.1. The main directions of the Regulation at design, construction, modernization and operation of Conductor are:

- ensuring reliability and overall performance;
- reduction in cost of construction and operation;
- minimization of influence of Conductor; on the environment, including reduction of width of forest ROWs and borders of security zones, due to application of high-rise assistance and support with a vertical suspension bracket of wires, creations of compact Conductor – when passing Conductor across especially protected natural territories;
- application of the designs, elements and the equipment keeping the calculated parameters characterizing reliability of Conductor during all service life;
- application of the designs and materials providing resistance to plunders and causing damage by the third parties;
- reduction of the area of allocation of land under Conductor in permanent use, application steel many-sided, narrow based trellised, steel concrete sectioned or the Conductor composite support;
- use of the advanced, safe methods of construction, operation and repair;
- development of technologies of diagnostics with use of the methods of nondestructive control allowing to make assessment of technical condition of the power transmission line without a removal from operation, monitoring of a current status of the Conductor elements, equipment of Conductor of 6-1150 kV high-precision systems for determination of places of damage to lines;
- application of monitoring systems and diagnostics of a condition of Conductor of 110 kV and above, including with use of the fiber-optical cable placed on Conductor (which is built in a lightning-protective cable or a phase wire);
- complex providing an emergency reserve of the equipment and materials, its optimum placement and development of routes of its delivery;
- implementation of geographic information systems on the basis of systems of satellite positioning (GSS, GLONASS).

7.2. Methodical approaches at design

7.2.1. It is necessary to apply to Conductor 35-750 (1150) kV, as a rule, the unified designs of support and the bases modified and adapted according to requirements acting with the specifications and technical documentation.

7.2.2. At design of Conductor of 35-220 kV passing in difficult climatic conditions, in special conditions (mountain, the marshland, permafrost soil, saline soils, the region of the Far North), and also Conductor of 330 kV and it is necessary to apply, as a rule, individual design of support and the bases for the purpose of ensuring required resistance of Conductor to external influences, cost efficiency of construction and operation above, including, the device of grounding conductors of the support providing normative lightning-surge proofing of Conductor in areas with bad conducting soil.

7.2.3. Accounting of danger of atmospheric and soil corrosion to the Conductor elements should be made by results of engineering researches.

7.2.4. At design of Conductor of 110 kV and above, not having year-round access for carrying out their maintenance and repairs, in special conditions, it is necessary to apply the technical solutions providing their increased reliability, minimization of costs at operation.

7.2.5. The Conductor route should be chosen, whenever possible, the shortest, taking into account conditions of alienation of the earth, cutting down of ROWs, complex use of a security zone and approach to other line facilities (automobile and to the railroads) and the operating Conductor. At the choice of routes Conductor not forest lands, and in the absence of those lands – sites not renewed fire-site, waste grounds, a

ROW, cuttings down and also squares on which low-density and least valuable forest plantings grow should be used, first of all.

7.2.6. At design of crossings of newly constructed and reconstructed Conductor of 220-500 kV with routes of categories IA, IB, IV dimensional distances down from phase wires of Conductor to a cloth of the crossed routes it is necessary to accept for Conductor 35-150 kV - not less than 12 m, for Conductor of 220-500 kV - not less than 14 m; the minimum dimension down at the greatest arrow of pro-weight of wires for Conductor 35-110 (150) of kV to the earth should be not less than 10 meters, for Conductor of 220-500 kV to the earth should be not less than 12 meters.

7.2.7. At design of Conductor of 110 kV and above, taking place in the area which is characterized by frequent and intensive "dancing" of wires it is necessary to consider their one-circuit execution with a horizontal arrangement of phases and refusal of a lightning-protective cable for benefit of linear protective devices lowered (to 25% of rated explosive effort) tension of wires and cables with simultaneous reduction of lengths of spans of Conductor.

7.2.8. For Conductor of 6-35 kV when passing the line in the constrained conditions, on forests application of wires with the protective isolating cover is recommended. At design of Conductor of 6-35 kV with the protected wires (ConductorProtected of 6-35 kV) in areas with the increased storm activity on the basis of the feasibility justification it is recommended to install devices of protection against burning-out of wires and shutdowns at influences of storm overvoltage.

7.2.9. Application of designs of the support in the inhabited area which are characterized by the increased reliability, durability, security from influence of the third parties.

7.2.10. For Conductor 6-110 (150) of the kV passing in the area which is characterized by intensive icing, snow sticking, frequent and intensive dancing of wires for the purpose of decrease in damage from mass damages to consider use of the reduced lengths of anchor spans (to 1 km) and use of designs of support, including, made of composite materials, wires, lightning-protective cables and linear fittings with the increased mechanical durability;

7.2.11. For Conductor 35-110 (150) of kV on the basis of the feasibility justification at new construction and reconstruction it is necessary to consider the possibility of application isolating a traverse.

7.2.12. During the developing and the feasibility justification on construction projects and reconstruction of Conductor it is recommended to apply the certified computer-aided engineering systems along with traditional (engineering) methods of calculation of Conductor.

7.2.13. At design of the power transmission line of 110 kV and above, equipped with means of cross compensation of reactive power, calculations of operating modes at shutdown of the power transmission line after unsuccessful ACR or unsuccessful inclusion of the power transmission line from a key of management should be carried out. The purpose of calculations - determination of possibility of an aperiodic component of current in the unimpaired phases at asymmetrical short circuits. In case of an aperiodic component - assessment of its share in total current of idling of the line and, in case of need, development of system technical solutions on its minimization or an exception, and also requirements to switches for ensuring successful shutdown of the power transmission line.

7.2.14. At design of the power transmission line of 110 kV and above not to apply ACR to the following types of the power transmission line:

– CableConductor of 110 kV and above, executed by an oil-filled cable of high pressure and an oil-filled cable of low pressure, in a type of a possibility of development of emergencies with increase in volumes of the damaged equipment and emergence of fires;

– CableConductor of 110 kV and above, made by a cable of cross-linked polyethylene of the first generation, in a type of growth of the actual damageability of cable sections caused by the accelerated wear of insulation of a cable connected with the increased hygroscopicity of the used material;

Cables of 110 kV and above, one type or several cable sections of one or several types consisting of a cable.

7.2.15. To carry out branches from Conductor 35-110 (150) of kV, as a rule, using special branch support.

7.2.16. Conductor of 0.4 kV should be carried out only with use of MIW, the corresponding GOST 31946-2012. When laying on buildings and the organization of input to buildings and constructions it is necessary to use MIW-4 with the insulation which is flame-retardent.

7.2.17. At design, construction new and operation of earlier constructed Conductor (including at their repair, modernization and reconstruction), at the corresponding justification measures for an exception of death of birds from electric current at their contact with wires, and also interfering their landing to traverses of support should be provided, to nesting in places of possible overlappings and to blocking of insulation because of its pollution by waste products.

7.2.18. At design, construction, reconstruction, maintenance and repair, operation of Conductor and in case of passing of Conductor across forests and green plantings the complex of requirements regulated by the existing nature protection legislation of federal and regional levels, departmental and local regulatory legal acts in the directions of nature protection activity should be observed.

7.3. Production technologies of installation and construction works in the course of construction, modernization and reconstruction of overhead-lines of an electricity transmission

7.3.1. By production of Construction and Installation it is necessary to adhere to the following principles:

- industrial methods of construction, application of designs of high factory readiness for the purpose of minimization of time and complexity of accomplishment of technology transactions in the conditions of the Conductor route, minimizing of amount of earthwork;
- the device and cleaning of a ROW using modern technical means: high-performance felling complexes, mulcher and so forth;
- use of technologies of the device of the bases of the support providing cost reduction of time for installation and minimizing of amount of earthwork – vibroimmersion, cave-in of piles of covers, screwing up of screw piles, rod seals in rocky soil, application of highly effective working boring bodies for a driving of wells in strong breeds and rocky soil;
- as a rule, use of the truck cranes providing installation of support without use of the falling arrow.
- in the conditions of the hardly accessible area or in the constrained conditions use of helicopters or installation of support by a building method;
- the installation of wires and lightning-protective cables under tension without lowering of a wire on the earth allowing to provide lack of mechanical damages and pollution of a wire or a cable;
- it is recommended at interaction with telecom operators for simultaneous carrying out reconstruction of Conductor of 6-35 kV and construction of communication channels for needs of the grid companies, to carry out reconstruction of Conductor with replacement of an uninsulated wire on protected with the adjoining module of the self-bearing FOC (at the justification corresponding technical and economic);
- at the design of crossings with the operating line facilities and engineering constructions use of the technologies providing minimizing of costs of time for shutdown of the crossed Conductor, contact network of the electrified railroad, change of the normal mode of functioning of the crossed engineering constructions.

7.4. Support

7.4.1. Steel support, and also steel details of steel concrete and wooden support and designs, a metalwork of the bases, *U-shaped* bolts, fasteners should be protected from corrosion on manufacturing plants by method of hot galvanizing. In addition to hot galvanizing it is necessary to apply resistant paint and varnish coverings to industrial and coastal areas, at the same time, fasteners should be protected a goryachetsinkovy covering or thermal diffusion galvanizing.

7.4.2. The main requirements imposed to OPP (movable weld support) and OPP on support out of the intended for building territory (item 7.11 Construction Norms and Regulations 2.07.01-89):

- the prevailing requirement is the OPP organization with placement of each circuit of the power transmission line on a separate support, derogation from the decision should be proved;
- cable couplings, limiters, basic insulators should be placed on the special platform at one level at the height no more than 10 meters;
- cable couplings should be used, as a rule, in dry execution;
- the cable should climb a support body on the one hand and should be closed by a box on height not less than 3 meters;
- boxes of grounding should be located at the height of 1,5-2 meters;
- connection of the shield of a cable with the grounding conductor should be performed on the basic insulator with fastening of connection under a bolt;
- the grounding conductor should be insulated;
- transitional support should be used special, preferential factory production.
- barrier of software should be provided;
- for the software organization use of territories of the existing SS is reasonable.
- available approach / entrance should be provided.

7.4.3. On Conductor passing in the cities and areas with high risk of vandalism as intermediate it is recommended to apply self-supporting support, including many-sided, steel concrete sectioned.

7.4.4. Designs of support should provide: a possibility of maintenance and repair of Conductor energized, maximum efficiency of installation of wires and cables, lack of need of obtaining special permission when transporting across highways.

7.4.5. It is necessary to apply support with the increased wire suspension height to Conductor which route passes across the area which is characterized by the frequent local or peat fires (at the corresponding economic case), concerning requirements of tables 2.5.20 and 2.5.22 Electrical Installation Code. Material of support (steel concrete, metal, composite) should be chosen depending on the area, conditions and a method of installation on the basis of feasibility justifications taking into account minimization of effects of impact of fires in security zone of Conductor.

7.4.6. On Conductor passing across the territory of settlements, tourist and recreational zones near vacation spots, in national parks and reserves, on crossings with large thoroughfares in the neighborhood of the cities it is recommended to perform decorative coloring of metal and wooden support paint and varnish coverings with long service life, and also to apply the support of individual design developed taking into account the raised esthetic requirements. For composite support individual coloring should be provided by their production.

7.4.7. On steel trellised support it is necessary to provide accomplishment of the anti-vandal actions excluding untwisting of bolt connections.

7.4.8. Service life of the Conductor wooden support should make not less than 40 years, steel concrete not less than 50 years, steel trellised not less than 60 years, steel many-sided and composite – not less than 70 years.

7.4.9. Overhead-lines of electricity transmission of **220 kV and above.**

- on Conductor 220-750 (1150) kV the support of necessary height and durability corresponding to the existing regulating documents should be applied; one-circuit, two-circuit steel support of many-sided and trellised designs (including the latest unification), and also support on the basis of steel concrete centrifugated racks, including sectioned.
- as the Conductor 220-750 anchor and angular support (1150) kV steel self-supporting support of a rigid design should be applied.
- the geometrical scheme and mass of intermediate support, their arrangement should be optimized for specific Conductor, including due to broader application of brands of the steel of increased mechanical durability.
- on Conductor of 220-500 kV passing across lands of agricultural purpose it is necessary to apply self-supporting support.

- on Conductor of 220 kV application of composite support with the isolating traverses on condition of justification by the project of reliability, safety, efficiency of their application and constructive ensuring resistance to external influences is allowed.
- settlement climatic loads of a construction part - support and the bases - should be defined according to Electrical Installation Code, recommendations staticized Construction Norms and Regulations and STO 56947007-29.240.01.189-2014.
- application of the high-rise support mounted by method of building, providing passing of Conductor through the timberland with minimum possible width of a ROW.
- for safety (an insurance continuity for prevention of falling of the worker from a support) and conveniences of raising of electricians on the Conductor support and according to the order of Ministry of Labor of Russia of 28.03.2014 No. 155n "About the approval of Rules on labour protection during the work at height of" the Conductor 110-750 support (1150) kV" should be equipped with the stationary safety line.
- for the purpose of early detection of wires and cables when passing Conductor in an area of coverage of small aircraft, in a zone of a glide path of the airports, airfields and heliports, and also when crossing highways it is necessary to apply the alarm spheres markers mounted on cables and/or wires. Systems of light marking ("protecting fires") are applied to designation of wires and cables of Conductor in addition to alarm spheres markers at night.
- as stay-guys of the Conductor support it is necessary to apply steel ropes on STO of 71915393-TU062-2008 "Ground wire" zinced on the very rigid group (to especially severe conditions).

7.4.10. Overhead-lines of electricity transmission of **110 (150) kV and below**.

- the Conductor 110 (150) support of kV should provide required reliability of power supply and safety of personnel also below at operation (rise on a support, work on traverses, etc.).
- on Conductor 35-110 (150) of kV the support of necessary height and durability corresponding to the existing regulating documents should be applied; one-circuit, two-circuit steel support of many-sided and trellised designs (including the latest unification), and also support on the basis of steel concrete centrifugated racks, including sectioned.
- on Conductor 35-110 (150) of kV application of composite support with the isolating traverses in the conditions of high annual average relative humidity of air, on lands of agricultural purpose, in the conditions of the aggressive environment is recommended at strong air pollutions, and also on condition of justification of reliability, safety, efficiency of their application and ensuring resistance to external influences. In places of the possible local or peat fires, installation of the support made of composite materials is not recommended.
- on Conductor of 0.4-20 kV application of steel concrete support from the vibrated or centrifugated racks, and also composite and steel many-sided support is recommended.
- on Conductor of 0.4-20 kV passing across forests it is recommended to apply wooden antiseptizided support.
- if necessary, Conductor of 6-20 kV can be executed in dimensions of 35-110 kV.
- on ConductorInsulated of 0.4 kV and ConductorProtected of 6-10 kV it is recommended to install the stationary devices (puncturing clips with brackets, brackets for fastening on anchor clips, etc.) for control of voltage and installation of figurative grounding. Determine installation sites by the project or proceeding from local service conditions.
- on Conductor of 0.4 kV application of one-rack anchor and anchor and angular steel many-sided support is recommended:
    - instead of three-rack anchor and angular steel concrete or wooden support;
    - instead of two-rack anchor and anchor and angular steel concrete or wooden support at the corresponding feasibility justification.
- on Conductor of 0.4 kV it is necessary to apply steel concrete support with the bending moment not less than 30 kNm, on Conductor of 6-10 kV steel concrete and steel many-sided support with the bending moment not less than 50 kNm.

7.5. Bases

7.5.1. Conditions of application of the bases on Conductor are defined by the project documentation with the requirements existing with the specifications and technical documentation depending on results of researches of soil (engineering-geological, hydrogeological and other researches) in places of their installation.

7.5.2. At the choice like the bases of support it is necessary to give preference to the bases making the smallest destroying impact on structure of soil.

7.5.3. Should be applied:

- the unified combined reinforced concrete foundations (buried low-buried, superficial);
- monolithic reinforced concrete foundations, the pile reinforced concrete and metal foundations (the bases from steel concrete piles with metal grillages, screw piles, piles of an open profile, a pile cover, bored and bore dropping piles).

7.5.4. It is necessary to provide implementation on Conductor:

- industrial methods of works on installation of the bases in field conditions;
- modern corrosion-resistant materials and coverings for protection of steel concrete and metal designs against corrosion;
- the bases for stay-guys of support with removal of nodes of fastening U-shaped bolts over the soil's surface, especially, if on Conductor melting of ice with use of the earth is provided in the scheme of melting;
- for fixing of support in everfrost soil it is necessary to use, as a rule, the bases providing preserving of a frozen condition of soil in the course of construction and during the entire period of operation of Conductor. Use steel (displacement and driven) piles which internal cavity is filled with the light (foamed) material industrially, or application of the stub (surface) bases is recommended.

7.5.5. The fixing method in soil of the Conductor support of 0.4-20 kV on all route should be unified and correspond to the project.

7.6. Wires, lightning-protective cables

7.6.1. On Conductor of 220 kV and it is necessary to apply above:

- steel reinforced aluminium wires in accordance with GOST 839.
- the high-strength wires of new designs with the steel core which are characterized by smaller coefficients of aerodynamic resistance, the increased corrosion resistance and resistance to ice and wind influences, bigger tortional rigidity. Near a coastal zone of the seas and the polluted industrial zones to apply wires with the increased corrosion resistance of cores from the steel plated by aluminum.
- wires with the steel core with the pro-thinned-out wire of upper layer (Z-shaped, trapezoidal, arrow-shaped).
- in reasonable cases application of modern designs of the wires with the steel core allowing to increase significantly transmission capacity without increase in load of support, or the exceeding standard wires on technical characteristics is allowed.
- wires from aluminum alloys, composite non-magnetic materials – at the feasibility justification.
- at the sufficient feasibility justification – wires with the built-in optical cable.
- as lightning-protective cables should be applied:
    - steel cables: zinced on the very rigid group; plated by aluminum; from the low-alloyed steel;
    - the steel reinforced aluminium cables possessing a high lightning resistance, mechanical durability, corrosion resistance;

- lightning-protective cables with the built-in fiber-optic cable, including, with heat-resistant optical fiber.

7.6.2. Overhead-lines of electricity transmission of 110 (150) kV also should be applied below:

- on Conductor of 35-150 kV on the basis of technical and economic assessment the choice between standard steel reinforced aluminium wires and wires with the improved characteristics regarding the maximum working temperature, mechanical durability and also protected by wires (MIW-3 and MIW-7 brands) is performed.
- in areas with intensive wind and ice loadings, and also on big transitions of Conductor of 35-150 kV it is recommended to apply the new designs of wires exceeding standard the transmission capacity and technical characteristics on purpose:
  - decrease in loads of support and bases;
  - increases in length of spans;
  - reduction of coefficient of aerodynamic resistance;
  - decrease in probability of dancing of wires;
  - decrease in probability of wire breakage at influence of external mechanical loadings (counteraction to sticking of snow and to icing).
- the protected wires it is recommended to apply on Conductor 6-35 kV first of all:
  - when passing the Conductor route across the inhabited area;
  - when passing Conductor across forests;
  - when crossing Conductor of water barriers;
  - in the absence of a possibility of observance of dimensional distances when passing Conductor in the constrained conditions;
  - as loops for connection of TS of outside installation to the disconnector of 6-20 kV;
  - at a joint suspension bracket with ConductorInsulated of 0.4 kV.
- at new construction and reconstruction of Conductor of 0.4 kV MIW with the bearing core insulated zero, as a rule, should be applied.
- installation of wires of ConductorInsulated executed by MIW from insulated zero residential (MIW-2) can be performed, both on support, and on walls of buildings and constructions.
- service life of MIW should be not less than 40 years.
- service life of uninsulated wires and lightning-protective cables on Conductor not less than 50 years.

7.7. Insulators and linear fittings

7.7.1. Insulators:

7.7.1.1. The quantity and type of insulators in garlands of different function should be chosen to Conductor according to existing rules of design, and also taking into account local conditions, including availability of urgent cards of pollution of insulation.

7.7.1.2. On Conductor of 35-1150 kV it is necessary to apply:

- on Conductor of 330 kV and above, as a rule, glass insulators with the reduced level of radio interferences.
- to 220 kV inclusive the type of the insulator gets out to Conductor on the basis of technical and economic comparison of options.
- on crossings of Conductor of 220-330 kV with engineering communications to apply two-circuit voltage garlands of insulators with separate fastening to a traverse of support.
- on crossings of Conductor of 330 kV and above (at two and more split wires in a phase) with engineering communications to apply multicircuit voltage garlands of insulators with separate fastening of circuits to traverses of support.
- on Conductor of 220 kV and above a garland of insulators should be supplied with protective fittings.

- on Conductor of 330 kV - glass insulators with an aerodynamic profile (including with a hydrophobic covering) – for installation in the supporting garland from glass insulators (1 (one) insulator from above garlands).
- the polymeric console isolating traverses - for Conductor to 220 kV inclusive passing in the constrained conditions having a possibility of an entrance of elevators and towers to support for carrying out maintenance and repairs of fittings and insulators.
- on big transitions of Conductor of 110 kV and above – glass insulators.
- on Conductor of 110 kV and above on high-rise support use of long-rod porcelain insulators (is allowed at justification).
- service life of insulators should be not less than 30 years.

7.7.1.3. On Conductor of 6-20 kV it is necessary to apply:

- suspended polymeric, glass insulators;
- polymeric console (console with a delay) the isolating traverses;
- support-rod porcelain and polymeric insulators, including with an eye for the protected wires;
- pin glass of the tempered glass and porcelain insulators with an eye. On insulators of the protected and steel reinforced aluminium wires it is necessary to apply helical ties to fastening.

7.7.2. Line fittings:

7.7.2.1. On Conductor it is necessary to apply:

- the coupling, supporting, voltage, protective, connecting, branch (contact) fittings should be chosen to Conductor according to existing rules, taking into account requirements of the project documentation;
- for steel reinforced aluminium wires in accordance with GOST 839 as tensioning, as a rule, pressed, wedge linked, spiral and bolted fittings should be used. For lightning-protective cables - spiral fittings;
- for Conductor of 220 kV and above as a measure of strengthening of a welded seam in loops of anchor and angular support application of a spiral downlead clamp is recommended;
- linear fittings should not cause local overheats of a wire in places of its installation;
- on transitional intermediate support of big transitions - the supporting clips providing normative service life of wires and compensating seasonal changes of arrows of pro-weight of a wire;
- durability of seal of a specific wire in the voltage clips established on transitional anchor support of big transitions should be confirmed by obligatory carrying out monitoring tests;
- the supporting fittings installed on the Conductor support of 35 kV and above should provide additional protection of wires against impact of wind fluctuations;
- the design of tension fittings should not promote increase in length of the elements of the isolating suspension bracket necessary for its connection;
- on Conductor multifrequency quenchers of vibration (not less than 3 resonant frequencies) should be applied;
- on ConductorInsulated of 0.4 kV and Conductor of 6-35 kV with the protected wires it is necessary to use the linear fittings corresponding to a design of the wire self-bearing insulated or protected;
- connections and branches of wires on ConductorInsulated of 0.4 kV and ConductorProtected of 6-20 kV are allowed to be carried out only using the special clips corresponding to the MIW type or the protected wire;
- connection of wires of branches from ConductorInsulated of 0.4 kV to inputs of subscribers should be performed using the branch puncturing moisture-proof clips, including with separate tightening of bolts of the main and branch wires allowing repeated connection and shutdown of a branch wire;
- linear fittings should be unattended and not repaired;

- service life of fittings should correspond to service life of wires, cables for which it is intended;
- metal elements of brackets and hooks of ConductorInsulated of 0.4 kV should provide a possibility of bolted connection of conductors of repeated grounding;
- connection of the zero conductor to the grounding descent of the ConductorInsulated support of 0.4 kV at accomplishment of repeated grounding is recommended to be carried out using special flexible conductors;
- for the purpose of providing safety requirements at maintenance of ConductorInsulated of 0.4 kV at the beginning and at the end of the ConductorInsulated lead, and also at the beginning and the end of linear branches installation of stationary devices of short-circuiting and grounding of ConductorInsulated equipped with the separate grounding descent is recommended;
- on Conductor of 110 kV and the supporting fittings for phase wires – the deaf with the integrated protector are higher;
- on Conductor of 330-750 kV - the damping remote intra phase struts – in areas with frequent and intensive dancing of wires, and also together with wires of the new designs which are characterized by the increased rigidity.

7.8. Protection against storm overvoltage

7.8.1. Priority actions for lightning protection of Conductor of 110 kV and are application of hummock protection, grounding of support with rated values of resistance of grounding, application of insulation with the increased pulse durability above. Installation on support of protective devices is possible at the feasibility justification.

7.8.2. On sections of routes Conductor of 110-330 kV in ice areas with ice wall thickness more than 25 mm, at the feasibility justification, are allowed refusal of a cable suspension bracket for benefit of other technical solutions.

7.8.3. On ConductorProtected of 6-20 kV passing across the inhabited area and a zone with storm activity of 20 storm hours and more it is necessary to provide installation of devices of protection against storm overvoltage.

7.8.4. Application on Conductor of 6-35 kV of devices of protection against storm overvoltage should provide protection:

- wires from an overheat and a burning-out;
- approaches to DD SS;
- insulation of Conductor in areas with the increased storm activity;
- switching equipment;
- cable couplings;
- places of crossing of Conductor with engineering constructions;
- pole-mounted and mast SS, DS, TS.

7.9. Line switching equipment of 6-35 kV

7.9.1. For optimization of operating modes, increase in reliability of power supply of consumers, cost reductions on operation and rescue and recovery operations, it is necessary to automate networks of 6-20 kV by means of:

- ACR;
- sectionings of Conductor;
- the organizations of the ACR systems both on linear switches of the feeding centres, and on the partitioning points Conductor;
- shutdowns of branches of Conductor;

- equipment by fault location devices on Conductor, including malfunction indicators, with registration of the direction to the place of damage, Conductor transferring data on a condition to a workplace of the dispatcher;
- organizations of monitoring of a current status of wires, including their temperatures of heating.

7.9.2. Sectioning points with vacuum switches and points of automatic inclusion of a reserve need to be established on the main lines of 6-20 kV, and also on extended branches of Conductor in the presence of the feasibility justification.

7.9.3. Accessions of Conductor of 6-20 kV should be equipped with devices of single or double ACR on the head switch of the line and on the partitioning points.

7.9.4. Points AVR and the partitioning points should be equipped with vacuum switches and the RPA microprocessor devices.

7.9.5. It is necessary to use vacuum switches of outside installation to sectioning of the main lines of 6-35 kV (recloser), with microprocessor control units, allowing to program operation of switches under required operating modes.

7.9.6. Use of the partitioning disconnectors of 6-20 kV with use of an operational bar is allowed.

7.9.7. For disconnection of branches from the route which length makes more than 1,5 km it is recommended to install the modern switching equipment (in places of branches of Conductor).

7.9.8. For the purpose of increase in controllability and controllability behind work of electric grid, all systems of automation should provide information transfer on control office about a current status of the switching device, and also provide a possibility of telecontrol with this equipment.

7.10. Protection of overhead-lines against ice and wind influences

7.10.1. Again constructed, reconstructed and operated Conductor passing in areas with ice wall thickness 25 mm and above (the IV area on ice above), and also with frequent formations of glaze-ice and rime deposition in combination with strong winds, in areas with frequent and intensive dancing of wires, constants need to equip (preferential) managed installations of melting of ice on wires and lightning-protective cables (including pulse) current.

7.10.2. The refusal of melting of ice and a construction of Conductor in glaze ice resistant execution at the corresponding justification is allowed.

7.10.3. Questions of protection of Conductor of 110 kV and above from ice and wind influences should be considered in a complex with questions of lighting protection of this Conductor.

7.10.4. The realization of melting of ice should be enabled so that duration of melting did not exceed one hour in each scheme of melting.

7.10.5. The managed installations of melting of ice should be equipped with function of self-diagnostics with integration into industrial control system of SS (in the presence of industrial control system).

7.10.6. At the feasibility justification application of automated systems of early detection of icing and the distributed control of temperature of optical fiber when melting ice on a lightning-protective cable and a phase wire with the built-in fiber-optical cable and direct supervision of temperature of a wire when melting ice. Minimum necessary structure of automated systems of early detection of icing should consist of the following elements:

- the sensors of tension of a wire / cable issuing information on weight and diameter of ice;
- sensors of temperature of the melted wire/cable;
- sensors of ambient temperature;
- sensors of speed and direction of wind.

7.10.7. On Conductor or sites of Conductor passing in IV and above areas on ice:

- the glass isolating suspension brackets should be applied;
- at the corresponding justifications installation of the V-shaped supporting garlands of insulators with separate fastening is allowed to a support;
- one-modular polymeric interphase struts should be applied, as a rule;

- application of the wires having the increased resistance to ice and wind influences is recommended;
- use of the devices preventing twisting of wires, limiters of icing (OGK), and also the device for protection of wires against sleet sticking is recommended.

7.10.8. For prevention of shutdowns of Conductor of 110-220 kV because of approach of loops to metal elements of support at strong wind on anchor support it is necessary to consider the possibility of installation of bypass garlands of insulators.

7.10.9. For Conductor 6-110 (150) kV:

- in areas with frequent formation of ice in special ice areas, and also in areas with high wind loadings it is necessary to consider the possibility of construction of the cable line instead of Conductor;
- for prevention of mass destructions to reduce length of anchor spans by Conductor and to apply support and wires with the increased mechanical durability;
- apply melting of ice at the corresponding feasibility justification.

8. Cable lines

8.1. General principles of creation of power cable lines

8.1.1. It is recommended to apply cables to cable lines of all voltage classes:

- with the increased thickness of a cover of the increased hardness for decrease in risk of damage of a cover when laying;
- with an outer electroconductive layer, including as a part of the fireproof covering applied after laying of a cable on its cover made of materials of the lowered combustibility, including polyvinylchloride compositions with low smoke - gas emission and without halogen compositions with a high oxygen index for laying in engineering constructions;
- for underwater laying - cables armored (armored non-magnetic) with insulation from cross-linked polyethylene the axial, cross, mechanical loadings ensuring functioning during service life, maintaining in the conditions of hydrostatic pressure (only a uniform construction long underwater part of transition cable lines);
- in the mountain area, and also in zones of seismic activity to apply armored cables with insulation from cross-linked polyethylene to laying and to lay them in special engineering constructions. To determine a method of laying by the project, using special measures of protection against mechanical damages.
- at parallel laying of power cables of 110-500 kV and the FOCL cables for technology protection of SS and the power transmission line to carry out laying of FOCL out of trays with power cables or protective designs of power cables.

8.1.2. To CL of 110 kV and with a higher than length not less than 0,5 km cables with the built-in optical fiber, as a rule, should be applied to monitoring of temperature of heating of a conducting core.

8.1.3. Resource service life of cables not less – 30 years taking into account the operational actions regulated by the relevant regulating documents.

8.2. Fittings for power cable lines

8.2.1. The quantity and types of the used fittings of cables are determined by the project documentation by laying of CL. Fittings should have the maximum degree of factory readiness providing minimized influences of a human factor at installation and probability of damage of elements of a design of couplings at installation and transportation.

8.2.2. For CL **of 110-500 kV**:

- "dry" designs of gas-insulated inputs, connecting and trailer couplings adapted to installation of cables with the optical fibers integrated into the cable shield, the applications of liquid dielectric environments oriented to an exception except the cases stipulated in the project documentation;
- composite insulators for trailer couplings of outside installation with different lengths of a way of leak depending on extent of pollution of the atmosphere on an object;
- trailer fittings, can have special adapters for periodic control of the PD levels by means of mobile measuring installations.

8.2.3. For CL **up to 35 kV**:

- fittings on the basis of antitraking, nonflammable, flame-retardent heat-shrinking tubes and products;
- cable fittings of cold shrinkage on the basis of elastomeric elements which are previously made at the enterprises.

8.3. Requirements to shields of power cables

8.3.1 The choice of a design, section of the shield and a method of its grounding should be performed under the terms of admissible heating of CL in normal and after emergency operating modes, and also under the terms of its thermal firmness, including in the mode of course single-phase (in network with the insulated neutral) short circuit, with ensuring electrical safety of service of boxes of a transposition, taking into account

their number, the locations and design of CL by the principle of minimization of number of connecting transpositional couplings;

8.3.2. Check of admissibility of the chosen method of grounding of shields of cables and calculation of a transposition of shields, should be performed at design taking into account admissible voltage on shields of cables at course on a core of the maximum working current and short circuit in currents of time of course under the terms of work of RPA;

8.3.3. The choice of a method of arrangement of shields (partial ungrounding or use of systems a transposition) should be solved at design in each separate case taking into account specific conditions in dependence, first of all, on short circuit values and conditions of safe work at operation of CL and their maintenance and repair;

8.3.4. Transpositional wells should be serviced, with obligatory availability of an external waterproofing and have protection against access for strangers.

9. Systems of operational current

9.1. Requirements to systems of operational current

9.1.1. Technical solutions on the organization of a system of operational current of SS should provide uninterrupted power supply of consumers of operational current.

9.1.2. At new construction of SS of 110 kV and above operating DC voltage system should be applied. It is allowed applications of operating DC voltage system on SS 35 of kV in the presence of special justification.

9.1.3. The rectified operational current is allowed to apply on SS 6 - 110 kV in the presence of special justification and on the operating facilities before their reconstruction.

9.1.4. At reconstruction of electric power facilities creation of operating DC voltage system can be proved by need of installation of modern switching devices and RPA microprocessor devices, equipment of telemechanics and the organization of digital channels of communication. Application of the simplified option of operating DC voltage system based on operative current cabinet is allowed.

9.1.5. On SS of 220 kV and above, and also on nodal and/or transit SS of 110 kV (at the corresponding feasibility justification) with four and more VN switches should be applied:

- two AB;
- four protection devices - on two on each AB;
- two sectioned direct-current board (not less than 2 sections in each);
- cabinets of distribution of operational current (CDOC).

9.1.6. In other cases application of one AB with two protection devices and sectioned direct-current board (not less than two sections) is recommended.

9.1.7. Depending on conditions the system of operational current can be applied centralized (one set) or decentralized (two and more sets).

9.1.8. Decentralization system of operational current can be executed in the presence on SS of remote distributing devices, and also during reconstruction of electric power facilities proceeding from territorial placement of loads of SS or proceeding from character of loads of consumers. The positive moments of decentralization on a territorial sign are:

- reduction of length of cables in the territory of SS;
- improvement of an electromagnetic situation in a distribution network of direct current;
- reduction of the distributed capacity of network concerning the earth;
- reduction of failures of voltage on buses of feeding of RPA devices at turning on of high-voltage switches.

9.1.9. Power supply of circuits of operational blocking of disconnectors, and also discrete entrances of controllers of connection of the industrial control system systems, should be carried out from two separate mutually reserving converters (AC/DC or DC/DC), as a rule, voltage of 220 V having a galvanic outcome between entrance and output circuits, the selection protective devices and own control of availability of voltage and insulation.

9.2. Direct operational current

9.2.1. Operating DC voltage system should provide a working food of the following main power-consuming units:

- RPA devices;
- control units high-voltage switching devices (without feeding of drives of disconnectors and the grounding disconnectors, feeding of drives of switches is possible at justification);
- the communication devices and communication providing signaling and the RPA teams;
- devices of the bottom and average level of industrial control system, Information acquisition & transmission system (TM) using DC/DC converters;

- AMI (if necessary);
- drives of automatic main and section switches of the auxiliaries board of 0.4 kV (with technical need);
- devices of the central alarm system.

9.2.2. operating DC voltage system should provide a reserve food:

- inverters of a reserve food of the top level of industrial control system;
- communication devices (if necessary);
- lamps of emergency lighting of technology rooms.

9.2.3. operating DC voltage system should provide the stable size of voltage of 220 V within normal acceptable deviation on plugs of power-consuming units at ±5%. A maximum permissible deviation of voltage on plugs of operating DC voltage system power-consuming units, including at emergency categories AB and at accomplishment of the accelerated charges of AB should make no more than -15% +10 %. At application of operative current cabinet it is allowed to have voltage levels, other than 220 V.

9.2.4. At creation of operating DC voltage system stationary AB with service life should be applied not less than 20 years, as a rule, and capability to provide the maximum settlement jog currents after the two-hour category (not less) current of loading in the autonomous mode (at loss of own needs of SS) during all service life. As a part of operative current cabinet, it is allowed to apply AB with service life not less than 12 years taking into account accomplishment of the above-stated conditions.

9.2.5. Configuration of operating DC voltage system should be chosen taking into account accomplishment of the following requirements:

- possibility of accomplishment of control categories AB for determination of its actual capacity;
- a possibility of carrying out repair of any operating DC voltage system element when preserving in work of AB and all operating DC voltage system main power-consuming units;
- a possibility of providing a working hours of operating DC voltage system without galvanic communication between poles of two and more AB;
- separate power supply from different AB and/or through different sections operating DC voltage system at one AB of the main and the RPA backup devices of each connection and also the schemes circuit breaker opening solenoid1 and circuit breaker opening solenoid2 of each switch of 110 kV and above;
- section of cables has to be accepted from conditions of ensuring power failure in them in admissible limits, thermal firmness and not ignition at course of short circuit during the established time of operation of protective devices and ensuring sensitivity of protective devices.

9.2.6 Power supply of the main power-consuming units from protection devices without AB in normal working hours of operating DC voltage system is forbidden.

9.2.7. The system of diagnostics, monitoring and an emergency oscillography test of operating DC voltage system should provide:

- automatic control and registration of parameters of an operating mode of system with forming of the signals characterizing deviations of values of controlled parameters from admissible values and the warning system of operation personnel and/or transfer to industrial control system (TM);
- automatic control of level of resistance of insulation of one or at the same time two poles without shutdown of connections and without injection in operating DC voltage system network of currents more than 2,5 мА, capable to cause false operation of RPA devices. The stationary device should reveal connection of direct-current board on which there was a decrease in resistance of insulation, and the portable device defines the exact place of damage of insulation.

9.3. Circuit decisions on the organization of protection of a system of operational current

9.3.1. In operating DC voltage system there have to be, as a rule, three levels of protection.

- the first (upper) level – introduction protective devices AB. For each section operating DC voltage system it is recommended to install separate protective devices AB;
- the second (average) level – the group protective devices direct-current board feeding connectors of management or the alarm system of group of connections;
- the third (lower) level – the individual protective devices feeding the most responsible power-consuming units.

9.3.2. On SS of 35 kV, and also SS of 110 kV and above with three and less VN switches use of two levels of protection is possible (with an exception of the group protective devices direct-current board feeding connectors of management or the alarm system of group of connections).

9.3.3. As protective devices in operating DC voltage system automatic switches or safety locks should be used. Design of protective devices should provide their safe service.

9.3.4. Protection of the operating DC voltage system elements should conform to the following requirements:

- ensuring necessary sensitivity and selectivity of operation of protective devices at all operating DC voltage system levels;
- reservation of operation of protective devices protective devices of higher level towards the power supply;
- application of circuit decisions at which the emergency shutdown of any protective device, including the protective device AB, should not lead to reset or violation of working capacity at the same time all RPA devices of joining of 110 kV and above;
- application of the circuit decisions providing protection against the switching overvoltage and pulse hindrances getting through a distribution network from primary power circuits of SS and a contour of grounding;
- protection devices, the operating DC voltage system systems installed within each level, should be, as a rule, same.

9.3.5. Specifications of components and circuit decisions made when developing operative current cabinet also should conform to the above-stated requirements.

9.4. Chargers

9.4.1. Protection devices of operating DC voltage system should conform to the following requirements:

- feeding of all loading of SS connected to operating DC voltage system and at the same time accelerated charge of the AB within no more than 8 hours to 90% of capacity;
- providing charge and additional charge of AB with different methods (U, IU, IUI, equalizing charge, manual mode);
- compliance of quality of voltage and charging current to specifications on accumulators of specific type in the mode of the float charge;
- the maximum size of pulsation of current and voltage at the charger exit at the switched-off rechargeable battery (during the work on active loading) no more than 5% of Unom;
- accuracy of stabilization of voltage in the mode of the float charge from the set level is not worse than 1%;
- availability of thermal compensation of voltage in the mode of the float charge;
- automatic repeated inclusion at recovery of voltage of alternating current after its disappearance;
- the blocking which is not allowing carrying out the modes of the equalization or accelerated charge at the disconnected forced supply and exhaust ventilation in AB;
- availability of automatic control of integrity of circuits of connection of AB;
- possibility of parallel work of protection devices;
- ensuring remote control of an operating mode and management;
- ensuring operation of the automatic switch (safety lock) in a circuit of protection devices from the disconnected or discharged AB;

- service life not less than 20 years.

9.5. Rectified operational current

9.5.1. For the organization of the rectified operational current the stabilized power supply units connected to VT installed on the HV side of SS and also to transformers of own needs and the current power supply units connected to the sets (secondary windings) of a CT which are specially provided for this purpose should be used.

9.5.2. For fault location on the earth without shutdown of connections automatic devices or manual means of search should be provided in systems of the rectified operational current.

9.5.3. For feeding of operational circuits of RPA devices on SS all power supply units should work in parallel for connectors of operational current (except for the decentralized systems).

9.6. Alternating operational current

9.6.1. Should provide circuit decisions on the organization of a power supply system of alternating operational current:

- feeding from two different sources, including an independent source of external power supply;
- connectors of uninterruptible power supply to which consumers of alternating operational current are connected should have the individual scheme AVR and be connected via separate automatic switches to inputs of the party of NN of the transformer of own needs to the introduction automatic switch;
- feeding of operational circuits should be provided via dividing transformers with accomplishment of automatic control of insulation;
- necessary sensitivity and selectivity of devices of protection should be provided;
- use only of the transformer of own needs and VT for feeding of the RPA devices intended for action at short circuits or disappearance of voltage in the protected network is not allowed, for such RPA devices special schemes, for example, de-bridging of electromagnets of control of switching devices, use of independent current power supply units, previously charged capacitors, etc. should be used.

9.7. Perspective directions of development

9.7.1. On facilities of 6-35 kV of a system of alternating operational current it is necessary to develop group or individual devices of the guaranteed power supply of the RPA microprocessor devices for application, to the meeting following conditions:

- feeding from measuring CT is consecutive with measuring entrances of RPA devices, without decrease in metrological characteristics of a CT;
- providing the output current sufficient for feeding of circuits of management and the alarm system of drives of switching devices in cycle OFF-ON-OFF;
- maintenance of stable level of supply voltage at change of levels of entrance voltage or currents when switching feeding from the transformer of own needs on a CT and back;
- preserving of nominal parameters of output voltage at loss or deep decrease in the feeding voltage (currents) for a while sufficient for accomplishment of a cycle of management of OFF-ON-OFF;
- availability of functions of self-diagnostics;
- ensuring level of pulsation of voltage no more than 2%;
- ensuring admissible range of a deviation of output voltage-15%, +10%.
- service life not less than 20 years.

9.7.2. It is necessary to develop the automatic switches meeting the requirements of efficiency and reliability of functioning for all lifecycle for operating DC voltage system.

10.Relay protection and automatic equipment

10.1. General provisions

10.1.1. Reliable work of RPA provides preserving of steady work of UES of Russia, decrease in damage from damage of electric equipment and undersupply (reduction of volume of transmission) of the electric power at emergence of technology violations in an electrical power complex.

10.1.2. Reliability of work of RPA is defined:

- creation ideology;
- quality of calculation and choice of parameters of operation;
- ensuring operating state;
- information security support.

10.1.3. The ideology of creation of RPA should be based on:

- use of modern, technology compatible intelligent microprocessor devices with the increased time interval between service;
- creation of the RPA complexes in which malfunction of a separate element or the device does not lead to its refusal or misoperation;
- implementation of technical solutions regarding control of RPA devices - remote change of an operational condition of RPA or separate functions (switching of groups of settings, input-output of separate steps of protection and the device in general);
- application of prototype technical solutions and albums of standard schemes of secondary switching, application of standard cases;
- application of cases (panels) of high degree of factory readiness;
- implementation as a part of the RPA complexes of the built-in means of information protection conforming to requirements of the Company to the built-in means of information protection of an automatic process control system;
- ensuring near and far reservation of RPA;
- the principle of ensuring "survivability" of RPA (autonomy of accomplishment of the RPA main functions) regardless of operability of other automated systems;
- use of the RPA substitution microprocessor devices which are in a hot reserve with a possibility of remote input of parameters of the replaced terminal.

10.1.4. For the purpose of reduction of operating costs by advanced training of personnel, reduction of time for carrying out maintenance, decrease in risks of misoperation of RPA because of personnel within one SDC it is recommended to limit use of devices of different producers within one power facility.

10.1.5. The priority at the choice of the equipment of RPA should be given to the devices made in the territory of the Russian Federation.

10.1.6. The chosen equipment of RPA, including its software, should be certified by the Company for application on electric grid facilities, except for used within trial operation.

10.1.7. The implemented RPA complexes should provide:

- selectivity of identification of damages of elements of network due to application of modern algorithms and the principles;
- required speed;
- reliability of functioning, including, due to high-quality self-diagnostics of devices;
- the correct functioning taking into account work of electromagnetic CT in the transitional mode of short circuit;
- increase in efficiency of functioning of RPA in general due to use of adaptive properties on the basis of intellectual algorithms, including, using power supply system models with automatically specified parameters of the current mode.

10.1.8. Quality of calculations and the choice of parameters of operation of RPA devices should be provided:

- application of the existing methodical instructions by calculation and the choice of parameters of operation of RPA devices taking into account recommendations of producers of the equipment;
- use in services RPA of a software and hardware complex for maintaining model of a power supply system, calculation of parameters of the equivalent circuit of elements of a power supply system, calculation of parameters of emergency operation, calculation and the choice of parameters of operation of RPA devices.

- a possibility of modeling of the existing and perspective elements of network, intellectual elements of active and adaptive action: FACTS, static VAR compensator, controlled shunt reactor devices, devices of longitudinal compensation of the power transmission line, high voltage direct current link, current limiting reactors, energy storage devices, etc.

10.1.9. Operating state of devices and the RPA complexes should be provided:

- support of the high level of an operational condition of complexes and timely modernization of the fleet of RPA devices;
- organization and carrying out procedural technical and operational service;
- presence of highly qualified specialists in services RPA.

10.1.10. The organization of technical and operational service of RPA devices should provide:

- use of effective methods of check of RPA devices for timely identification and replacement of nodes, elements subject to malfunction during lifecycle of the RPA device, and also during prolongation of lives;
- combination of periodic maintenance and maintenance "on a condition" with establishment of technically reasonable between-repairs intervals;
- applications of remote control (monitoring) of a state and correctness of operation of RPA devices;
- application of automated systems of check and assessment of a condition of RPA devices.

10.1.11. Completing of the services RPA by highly qualified specialists which underwent specialized training and having the right of independent carrying out maintenance of the RPA corresponding devices should be one of priority tasks of the Company in the field of ensuring reliable work of electric grid facilities in general.

10.1.12. For the purpose of information security support special measures directed to prevention of implementation of destructive impacts on the equipment should be taken.

10.2. Devices of registration of emergency events

10.2.1. Devices of registration of emergency events and processes should provide:

- registration of events and processes in the volume necessary for their full analysis;
- record of electromagnetic transition processes (detectors of emergency events) and electromechanical (wide-area measurement system);
- automation of collecting, information processing and providing access to the database and oscillograms from control offices and control centres of networks;
- availability and visualization of information obtained from detectors of emergency events;
- required accuracy of automatic detection of places of damage of the power transmission line, automatic identification of the damaged connections at emergence of single-phase earth short circuits in networks of 6-35 kV;
- decrease in duration of shutdowns and risks of emergence of interphase short circuits due to sufficiency of information and efficiency of its providing (reduction of time of decision making by operation personnel in emergencies) at emergence of single-phase earth short circuits in networks with the insulated neutral.

10.2.2. The power transmission lines of 500 kV and above, and also the interstate power transmission lines of 220 kV and should be equipped with wide-area measurement system devices for functions above:

- performance monitoring of emergency control;
- checks of reliability of settlement models;
- sufficient reliability of assessment of the mode;
- improvement of emergency control based on synchronized measurements of parameters of the mode of power supply systems.

10.2.3. At design decisions on integration of wide-area measurement system devices and detectors of emergency events from industrial control system or telemechanics, and also information transfer about emergency events and oscillograms in Grid Control Centre and Operator’s Centre in the automated mode should be worked out.

10.3. Main directions of development of relay protection and automatic equipment

10.3.1. Modern development of information technologies and computer aids, and also the latest developments in the field of development of the RPA equipment, measuring CT and VT allow to review approaches to implementation of the RPA functions.

10.3.2. High-voltage digital CT and VT, the capital and secondary equipment are equipped with the built-in digital communication ports of communication, including optical.

10.3.3. The international standard IEC 61850 regulating effective representation and data handling of a facility of automation, including, information exchange between microprocessor intelligent electronic devices is improved.

10.3.4. Signaling at all levels of automation and management allows to get a number of advantages in a digital form, including:

- increase noise immunity of the secondary equipment, thanks to transition to digital optical communication channels;
- unification of interfaces of devices;
- reduction of quantity of cases of inadmissible decrease in resistance of insulation in operating DC voltage system (optimization of architecture of operating DC voltage system in view of use of digital optical communications);
- simplification of operation and service of RPA devices due to effective diagnostics in real time, metrological characteristics, collecting and display of exhaustive information on a condition of facilities;
- unification of design processes and operation of SS.

10.3.5. It is necessary to provide gradual transition to creation of the RPA complexes according to the technology based on use of modern standards of transfer and data handling including on the basis of a series of the IEC 61850 standards and standards of safety for IEC 62351 power industry.

10.3.6. Implementation of innovative solutions in the field of RPA should not lead to unreasonable rise in price of a hardware-software part, decrease in reliability of functioning of complexes and the RPA systems, unreasonable increase in operating costs.

10.3.7. Development of the RPA complexes should be based on use of devices and computer aids of the last generation: the high-performance multiprocessor computing systems allowing to process big arrays of information and to implement in one device necessary algorithms of data transmission and RPA function of all connection (or SS) in the current mode at short circuits and other emergencies.

10.3.8. The possibility of use of the modern principles of transfer of technology information, high-performance computers and complexes demands review of ideology of creation of RPA, development of new algorithms.

10.3.9. Requirements for forming of uniform approach to creation (to modernization, reconstruction) and the organizations of operation of RPA are provided in the Concept of development of RPA of electric grid facilities.

10.4. Features of creation of RPA

Before obtaining results of the research works which are carried out now and entering of corresponding changes into the existing specifications and technical documentation at construction and/or modernization of RPA of high-voltage lines it is necessary to consider the following features:

10.4.1. Technical solutions at construction (laying) of CL (CableConductor) should exclude a possibility of damage of adjacent phases of a cable at emergence of damage on one of phases.

10.4.2. On CableConductor of 35 kV and above ACR should be applied if cable sections are used only for calling GIS. In other cases to use ACR CableConductor of 35 kV and above at absence on them cable sections with direct contact of cables of different phases. Availability on the cable section of transpositional couplings does not exert impact on application of ACR.

10.4.3. For CableConductor not to use the RP separate devices to identification of short circuit only on cable sections and shutdowns of CableConductor.

10.4.4. RPA from each side of the power transmission line of 110 (220) kV having feeding from two or more sides should include the main and reserve protection.

10.4.5. As the main protection of the power transmission line of 110 (220) kV having feeding from two or more sides high-speed protection against all types of short circuits with absolute selectivity should be provided.

10.4.6. If on the power transmission line of 110 (220) kV having feeding from two or more sides in the absence of the main protection the time of short-circuit breaking does not meet requirements of ensuring stability of a power supply system or load of consumers, then installation of two main protections should be provided.

10.4.7. On power lines of 110 (220) kV with a unilateral power supply from the feeding side step protection against all types of short circuits and current cut-offs without endurance of time should be established.

10.4.8. On CL (CableConductor) of an electricity transmission it is necessary to provide not less than two RPA devices, each of which provides shutdown by the damaged power transmission line at all types of short circuits over time at which thermal firmness of cores and covers of a cable is not broken (taking into account unsuccessful ACR and action of CBFP).

11.Technical diagnosing and monitoring of the power grid equipment

11.1. Main directions of development

11.1.1. Technical diagnosing and monitoring of the power grid equipment in modern conditions should be carried out generally under the working voltage without an equipment removal from work. In the conditions of preferential diagnosing under the working voltage the test system of the power grid equipment should be under construction at three main levels of diagnostic check.

11.1.2. **The first diagnostic level** assumes carrying out measurements of necessary number of the normalized parameters with the set frequency under the working voltage without shutdown of the equipment.

Diagnosing is carried out with use of automated systems of continuous control (monitoring) and/or means of periodic control, including cases when the organization of monitoring is impossible or inexpedient.

By results of technical diagnosing of the first level the decision on further operation of the equipment or expediency of holding extraordinary actions within the second diagnostic level is made.

11.1.3. **The second diagnostic level** assumes periodic control with an equipment removal from work.

Diagnosing is carried out by means of periodic control using modern highly effective diagnostic methods and the equipment by measurement of the normalized parameters with the set frequency directly after an equipment removal from work with the purpose of identification of degree and the nature of development of the defect recorded at the previous levels of diagnostic check.

By results of technical diagnosing of the second level the decision on further operation of the equipment or holding extraordinary actions within the third diagnostic level is made.

11.1.4. **The third diagnostic level** assumes comprehensive diagnostic examination with an equipment removal from work.

Diagnosing is carried out with attraction as the normalized means and methods of periodic control, and with attraction of additional special resources and methods of technical diagnosing on previously adopted agenda. When carrying out comprehensive diagnostic examination the greatest possible number of parameters measure on the working equipment under the working voltage. Parameters which are not possible for measuring under the working voltage measure directly after an equipment removal from work.

The report with recommendations of further operation of the inspected power grid equipment is result of comprehensive diagnostic examination.

11.1.5. **The modern test system of the power grid equipment is a diagnosing under the working voltage without an equipment removal from work.**

11.1.6. The test system of the Company and SDC should provide in the long term holding diagnostic actions generally within the first diagnostic level, i.e. by technical diagnosing under the working voltage without shutdown of the equipment.

11.1.7. Diagnostic check of technical condition of the equipment should be reliable and conform to requirements of regulating documents of the Russian Federation, the specifications and technical documentation and organizational and administrative documents existing in the Company and the industry on structure, volume and frequency.

11.1.8. The organization of diagnostic check of technical condition of the power grid equipment should conform to requirements "Concepts of development of the test system of the power grid equipment of PJSC Rosseti group of companies".

11.2. Equipment of substations

11.2.1. The power transformers, autotransformers shunting reactors and measuring transformers

11.2.1.1. Technical diagnosing of a condition of the equipment is possible on the basis of the analysis of results of the tests, analyses and measurements or data obtained in use by automated systems of monitoring and technical diagnosing (first and second diagnostic level).

11.2.1.2. Continuous control (monitoring) is carried out in real time by measurement of key indicators of technical condition of the capital power grid equipment.

11.2.1.3. Monitoring should transfer timely information on critical values of observed parameters. For different types and types of the equipment the optimum list of key parameters of monitoring should be chosen.

11.2.1.4. Development and deployment of reliable methodological approaches and decisions in technical diagnosing of a condition of the power grid equipment in limited number of controlled parameters and dynamics of their change is necessary.

11.2.1.5. Automated systems of monitoring and technical diagnosing (ASMD) should perform operational diagnosing of the current technical condition of the equipment, timely detection of the arising defects and forecasting of their development.

11.2.1.6. Main objectives of work of ASMD are:

- the prevention of emergence of emergency processes because of internal defects of the equipment and timely prevention of uncontrollable development of defects;
- determination of admissible load capability;
- increase in electrical safety of operation personnel, decrease in influence of a human factor in the course of collecting, processing and formation of results of technical diagnosing;
- integration of results of monitoring and technical diagnosing in industrial control system and enterprise information systems;
- use of results of work of ASMD for assessment of technical condition and planning of strategy of service of production assets.

11.2.1.7. Implementation of automated systems of monitoring and technical diagnosing should be performed on the basis of the corresponding feasibility justification.

11.2.1.8. On again under construction and reconstructed SS electric equipment in the design providing a possibility of installation and use of ASMD for assessment of technical condition under the working voltage should be used.

11.2.1.9. The automated diagnostic devices and ASMD should be equipped with function of remote access to operational information about the current technical condition of the equipment.

11.2.1.10. Under the working voltage continuous control of a condition of power AT, transformers should be provided, and shunting reactors with use of ASMD it is preferential on the following indicators:

- to electric parameters (currents, voltage, active, reactive capacities, cosφ) of the sides of HV, MV, LV;
- to moisture content and content of the diagnostic gases dissolved in transformer oil;
- to quality of insulation (tgδ, capacitance) of inputs of HV, MV (at the corresponding feasibility justification);
- to level of partial discharge (at the corresponding feasibility justification);
- to temperature of high layers of oil on an entrance and an exit of coolers (at the corresponding feasibility justification);

- to temperature of the most heated points of windings;
- to a condition of technology protection and the alarm system, cooling systems, the LTC (OLTC) device for AT.

11.2.1.11. On the equipment which is not equipped with ASMD it is necessary to carry out state assessment normative means of periodic control, and if necessary – comprehensive examination of technical condition according to the approved existing programs and standard specifications.

11.2.1.12. The purposes of comprehensive diagnostic examination (the third diagnostic level) of power transformers, AT and shunting reactors are:

- determination of a state, forecasting of development of defects, assessment of degree of their danger at operation;
- assessment of technical condition of the power equipment and its elements on the basis of diagnostic information (results of measurements, tests, analyses);
- development of recommendations of an order of further operation, possible repairs, terms (frequency) of control of nodes and systems of the inspected power equipment.

11.2.1.13. Comprehensive diagnostic examination of power transformers, AT and shunting reactors is recommended to be carried out:

- in case of lack of dynamics of changes of the diagnosed parameters towards deterioration after 12 years since the beginning of operation of the power equipment, and further 1 time in 4-6 years according to the decision of the technical lead on the basis of results of periodic control of the second diagnostic level;
- for the equipment with above-standard life according to the decision of the technical lead, regardless of classification of technical condition;
- for the equipment classified by technical condition as "worsened" and "preemergency";
- at detection of dynamics of changes of the diagnosed parameters towards deterioration within planned control or monitoring;
- when commissioning a reserve phase, or from an emergency reserve;
- in need of carrying out capital repairs.

11.2.1.14. High-voltage inputs control under the working voltage at the corresponding feasibility justification on change of absolute value of an angle of dielectric losses of tgδ and capacity of insulation, intensity of the partial discharge registered by an electric method, to conductivity current, results of thermovision inspection and other methods according to operational requirements.

11.2.1.15. Measuring CT control under the working voltage at the corresponding feasibility justification on quality of insulation (tgδ and capacity), partial discharge in insulation, to results of thermovision inspection.

11.2.1.16. Measuring VT control under the working voltage at the corresponding feasibility justification according to partial discharge in insulation and to results of thermovision inspection.

11.2.1.17. For basic and suspended insulation the following types of periodic diagnosing should be provided:

- thermovision inspection of porcelain and polymeric insulation;
- ultra-violet control of porcelain and polymeric insulation (optical-electronic control);
- acoustic-emission and vibroacoustic control of microcracks of porcelain insulation.

11.2.1.18. When carrying out technical diagnosing of the limiters of an overstrain of nonlinear (LON) means of remote diagnosing, systems allowing to take measurements in real time, wireless sensors (have preference at the corresponding feasibility justification). Under the working voltage for limiters measurement of current of conductivity in circuits of grounding and thermovision inspection should be provided.

11.2.1.19. Periodic diagnosing of buses, high-frequency choke, capacitors of communication, contact connections and hardware clips is performed with thermovision, optical and other methods of nondestructive control.

11.2.1.20. The purpose of diagnosing of the grounding device of a facility is check of efficiency of accomplishment of given functions by it. Diagnosing of the grounding DD SS device (working, protective, protection against a storm overstrain), should be carried out in a complex taking into account mutual

influence and distribution of current loading on all system of grounding. Frequency and volume of inspections are established by the existing regulating documents.

11.2.2. Monitoring systems of complete distributing devices gas-insulated

11.2.2.1. The operated and again entered complete distributing devices gas-insulated (CDDGI) should be equipped with ASMD at the corresponding feasibility justification.

11.2.2.2. ASMD GIS are applied to collecting, processing, display and storage of the current information on a condition of GIS in use and is intended for continuous monitoring of a condition of insulation of GIS.

11.2.2.3. ASMD GIS should provide control of the following modules:

- switching devices (switches and disconnectors);
- measuring CT and VT;
- limiters;
- connecting elements (combined buses, cable inputs, inputs through passage, gas-insulated current-conducting wires).

11.2.2.4. ASMD GIS should conform to the following general requirements:

- provide measurement of intensity of partial discharge in insulation;
- provide determination of the location of defect;
- provide control of leakages of SF6;
- create the conclusion about technical condition of the GIS controlled modules.

11.2.3. Switching devices (switches, disconnectors)

11.2.3.1. Diagnosing of switching devices is possible on the basis of the analysis of results of the planned tests and measurements or data obtained in the course of work of ASMD (the first and second diagnostic level).

11.2.3.2. Implementation of ASMD should be performed on the basis of the corresponding feasibility justification.

11.2.3.3. ASMD of switching devices perform the following functions:

- define a residual switching resource of contacts;
- define technical condition of the drive which should be sufficient for carrying out switching;
- control technical condition of insulating system.

11.3. Electricity transmission overhead-lines

11.3.1. At the corresponding feasibility justification, within the first diagnostic level it is recommended to apply ASMD on control of temperature, vibration and/or ice to control of technical condition of Conductor.

11.3.2. Within the first diagnostic level control of technical condition of Conductor with detection of defects energized by methods of nondestructive control is also exercised.

11.3.3. According to the decision of the technical lead comprehensive diagnostic examination of Conductor according to the existing programs and standard specifications (the third diagnostic level) can be conducted.

11.3.4. Within programs of comprehensive diagnostic examination treat main types of works:

- magnetometric control of a condition of metal designs of support, steel cables, steel cores of steel-aluminum wires;
- control of linear insulation of Conductor;
- measurement of distances down from wires (lightning-protective cables) to the soil's surface along the Conductor route;
- control of anchor fastenings of the bases;
- control of a condition of the bases and can of designs;

- defectoscopy of stay-guys of intermediate support;
- thermovision control of connections of wires, fittings and insulation;
- insulation UF-diagnostics;
- control of manifestations of high-voltage breakdown;
- determination of standard sizes of anchor plates;
- measurement of resistance of a contour of grounding;
- measurement of specific resistance of soil.
- control of a condition of U-shaped bolts and loops of anchor plates;
- determination of degree of aggression of the environment.

11.4. Cable lines

11.4.1. ASMD CL (the first diagnostic level) are intended for collecting, processing, display and storage of information characterizing a current status of the main insulation, trailer and the CL connecting couplings in use, determinations of emergency sites of cable lines.

11.4.2. A main objective of equipment of CL of ASMD is ensuring receiving reliable information about the current technical condition of CL and couplings, a possibility of forecasting of development of defects in dynamics of development of digit processes in insulation, detection of defects in insulation at early stages of their development, carrying out determination of places of appearance of defects in the line. Any refusals in monitoring systems should not lead to loss of diagnostic information.

11.4.3. Equipment of CL of ASMD is performed in the presence of the justification corresponding technical and economic.

11.4.4. ASMD CL carry out control of partial discharge in insulation of cable lines and couplings and/or control of temperature of cores of cables.

11.4.5. Technical diagnosing of trailer cable couplings should be performed using electric, electromagnetic and acoustic methods, thermovision inspection (the first diagnostic level).

11.5. General requirements to automated systems of monitoring and technical diagnosing

11.5.1. ASMD has the following architecture:

- primary sensors;
- controllers of collecting and processing of signals;
- the centralized software and hardware complex (SHC) for processing and information representation with a local and/or remote automated workplace of the operator intended for processing and the analysis of the obtained information.

11.5.2. Parameters of the software of ASMD should conform to the following main requirements:

- flexible setup of a configuration of system with display of placement of sensors on real drawings, photos, schemes, etc. of a specific object;
- possibility of change of the modes and order of poll of sensors;
- visualization of a graphic form of control of intensity of possible processes in insulation of the inspected equipment;
- automatic carrying out measurements, with a possibility of forming of signals of the precautionary and alarm system at exceeding of critical level of the measured parameters;
- when saving of the obtained data the possibility of the statistical calculation on the entire period of observation should be provided;
- ensuring data transmission in industrial control system and enterprise information systems.

11.5.3. In ASMD the licensed software products conforming to requirements of sections 14, 16 and 30 of this Regulation should be used.

11.6. Electrotechnical laboratories

11.6.1. Mobile and stationary electrotechnical laboratories (ETL) are intended for carrying out a complex of works on tests and technical diagnosing of the power grid equipment, to testing of remedies and

the special replacement tool. Mobile ETL are used at three diagnostic levels, including comprehensive diagnostic examination.

11.6.2. ETL should be equipped with the confided measuring instruments (MI), the certified test equipment (TE), the service equipment, component parts and remedies necessary for carrying out tests and measurements.

11.6.3. ETL should have necessary regulating and technical documents (the standards certified a measurement technique and tests, passports and the operation manuals MI and IO, instructions and other documents regulating carrying out tests, measurements and functioning of laboratories).

11.6.4. ETL should represent the hardware and software systems (HSS) allowing to use effectively the measuring and test equipment which is their part. PAK ETL should provide engineering data handling for preparation of protocols of measurements and tests.

11.6.5. Stationary ETL should be located in the laboratory and auxiliary rooms corresponding on the areas, a state and conditions supported in them to requirements of labour protection, electrical safety, ecological safety and sanitary standards.

11.6.6. For accomplishment of surveys and diagnostic works on Conductor and SS specially equipped mobile ETL on automobile base are used.

11.6.7. The choice of the chassis of the car and option of its execution carry out taking into account climatic conditions, geographical reliefs and category of a roadbed in expected places of operation of mobile ETL.

11.6.8. Arrangement of the ETL automobile van should provide fulfillment of requirements of labour protection, electrical safety, ecological safety and sanitary standards, including availability of a system of climate control in it.

11.6.9. The electrotechnical laboratory should be accredited (is certified) or registered in one of nation-wide or departmental (industry) accreditation systems (certification).

11.6.10. The list of objects, types of the measurements and tests which are carried out in ETL accredited (certified) or registered, is defined by area of its accreditation (certification).

11.7. Physical and chemical laboratories

11.7.1. Picking of physical and chemical laboratories should provide the reliable analysis results or tests assigned to laboratory of subjects of the physical and chemical analysis (PCA). Results of PCA are used at technical diagnosing of the operated high-voltage power grid equipment at three diagnostic levels, including comprehensive diagnostic examination.

11.7.2. The physical and chemical laboratory should have:

- the equipment and materials (the confided measuring instrument (MI), the certified test equipment (TE), the service laboratory equipment, component parts, remedies, standard samples, chemical reactants and consumable materials), PCA, necessary for carrying out;
- necessary regulating and technical documents (standards, the certified measurement techniques, passports and the operation manuals MI and IO, instructions and other documents regulating carrying out PCA and functioning of laboratory);
- the laboratory and auxiliary rooms corresponding on the areas, a state and conditions (temperature, humidity, illumination) supported in them, supply with the electric power, water, air (supply and exhaust ventilation), heat, etc. to requirements of labour protection, electrical safety, ecological safety and sanitary standards.

11.7.3. The physical and chemical laboratory should be accredited (is certified) or registered in one of nation-wide or departmental (industry) accreditation systems (certification).

11.7.4. The list of objects of PCA, analysis types and tests which are carried out in the physical and chemical laboratory accredited (certified) or registered, is defined by area of its accreditation (certification).

12. Automated control systems for the enterprise, enterprise information systems

12.1. Basic principles of development

12.1.1. For ensuring the approved development of automated control systems, enterprise information systems (hereinafter - IS) needs to use a uniform data model, the centralized reference books, the uniform principles and technologies of integration, the principles of momentariness of data entry. Input of the same data in different information systems is not allowed.

12.1.2. IS should develop by the following principles:

- on the basis of the existing information flows, their structure and structure, sources of emergence of information, requirements to its transfer, processing and storage the uniform data model of the Company and SDC should be created;
- creation of the centralized control system of corporate data;
- use of a uniform information model of the enterprise will allow to create uniform information and technology space, to perform transition to a uniform platform and the centralized IS;
- integration of IS into the centralized reference books and catalogs;
- creation of the IS modern user interfaces for performance improvement with simple access to internal resources and the interuser communications;
- ensuring required level of cyber security of IS and corporate data at all stages of lifecycle of IS, certification of IS for requirements of information security are applied taking into account actions for import substitution;
- preserving and increase in the current level of reliability and continuity of functioning of IS (availability);
- implementation and use of IS should be performed according to requirements of the legislation on protection of intellectual property and licensing;
- on the information systems developed for needs of the Company and SDC the exclusive rights of use should be issued;
- assistance and support of the centralized and local IS should be performed in uniform service centre.

12.2. General requirements to architecture to an information system of the enterprise level

12.2.1. Corporate IS should be designed with use of a multi-tier architecture "the client – the server" and "the server – the server", the set of the IS elements of the different presentation layer presenting an information system in the form:

- servers of databases;
- business logic servers;
- caching servers;
- application servers;
- servers of balancing of loading;
- client application or client interface.

12.2.2. The main benefits of separation in a separate component are the possibility of reuse of each IS element, ease of correction of separate components, performance improvement of the used server, a possibility of scaling and increase in availability of IS.

12.2.3. Components of three-level architecture:

- the presentation layer (implementing functions of input and display of data);
- the applied level (implementing universal services, and also the functions specific to a certain subject domain);
- the access level to information resources (implementing fundamental functions of storage and management of information resources).

12.2.4. The architecture of IS should correspond service – the oriented architecture – SOA (service-oriented architecture) and microservice architecture.

12.3. Requirements to a management system corporate data

12.4.1. IS should provide an exception of a possibility of unauthorized access and differentiation of access to the contents containing information of limited access.

12.4.2. IS should support enciphering of data by domestic cryptoalgorithms of GOST on the basis of the means of cryptoprotection certified by FSB of the Russian Federation.

12.4.3. For reliable storage of superdata arrays and a possibility of their reading at a high speed it is recommended to use the distributed Hadoop (HDFS) file system.

12.4.4. The information system of storage of files should provide a possibility of simultaneous connection of several information systems through API. It is necessary to exclude duplication of file storages at design of the information systems working with uniform content.

12.4. Integration tools of information systems

12.4.1. For creation of the integrated IT infrastructure it is recommended to use program interfaces of data exchange.

12.4.2. As the uniform standard of data exchange between appendices, irrespective of implementation language, it is recommended to use the text format of data exchange based on the JavaScript programming language – JSON (JavaScript Object Notation) and its version.

12.4.3. Basic functionality of program interfaces of data exchange should include means of the guaranteed delivery, ensure a guarantee of integrity and safety of transmitted data, routing of information messages between IS, management of routing of information messages, transformation of formats of messages according to requirements of IS of the recipient.

12.4.5. At integration the security mechanisms allowing to counteract mutual destructive influence of the connected IS or their subsystems including without limitation shall be used:

- mutual strict authentication;
- organizations of locks of safety;
- the digital signature of the betrayed data;
- cryptographic protection of the betrayed data;

12.5. Requirements to planning of architecture of an information system

12.5.1. When planning architecture of IS economically reasonable level of compliance of resources of an IT complex to the current and future demands of activity should be provided. At resource planning on IS it is necessary to consider all costs necessary for all lifecycle of IS, including need not of increase in volume of document flow.

12.5.2. The key principles influencing architecture of IS:

- Availability;
- Performance;
- Reliability;
- Safety;
- Scalability;
- Controllability;
- Cost.

12.5.3. Principle of "reasonable conservatism". During creation, implementation, modernization, the IS updating it is necessary to follow following provisions of the principle of "reasonable conservatism":

- implementation of new versions of SW should have reasonable advantages before the used versions of SW and should not worsen current situation;
- use of test versions of SW (an alpha, betas of SW, etc.) in the mode of commercial operation is inadmissible;
- when planning implementation of new versions of SW it is recommended to consider long-term plans of the producer on release of new versions / releases;
- implementation of new versions of SW should provide succession of historical data and should not lead to growth of labour costs on input in IS of basic data and their verification.

12.6. Recommendations about the choice of planning horizons for information systems

12.6.1. The choice of planning horizons of IS should be defined by the planning horizon defined in Strategy in information technologies, the automation and telecommunications of PJSC Rosseti approved by the Board of Directors of the Company, Minutes of 02.07.2012 No. 86. At the same time the planning horizon of IT infrastructure should be less, than planning horizon of IS.

12.6.2. It is recommended to proceed from the following planning horizons of IS:

- 8-9 years for appendices of the ERP class and appendices of management of IT, critical for business;
- 5-6 years for business applications and systems of operation management of IT;
- 3-5 years for office and system applications.

12.7. Requirements to suppliers and producers of information systems

12.7.1. The following requirements are imposed to suppliers and IS producers:

- the hardware platform and the software should be standardized and certified on compliance to standards, considered commonly accepted in subject domain of this hardware-software providing, to have flexible and scalable architecture, whenever possible to use domestic providing (to consider possibilities of import substitution);
- all IS program components should function normally in guest OS and to be compatible to virtualization platforms;
- preference should be given to SW developed in the Russian Federation;
- the warranty period for IS begins with the moment of acceptance of the IT decision in operation and should proceed not less than 12 months;
- the total ownership cost of SW designed for all normative life of this SW should serve as the main criterion at the choice of this or that supplier and SW;
- all custom software should be delivered with the documented code in electronic form;
- the acceptance procedure should include surely control compilation of the transferred source texts, with creation of completely efficient version of SW and accomplishment of a control example on this version;
- it is necessary to reflect in the SW development agreement distribution of copyright and related rights to an end product, and also restrictions for its further use by the parties.

13.Data-processing centres

13.1. General provisions of development of data-processing centres

13.1.1. For the purpose of providing high rates of reliability, availability of IT services and security of data, IT the assets used for providing IT services should be placed in specially prepared server rooms meeting the uniform requirements and standards of the Company. Server rooms in turn should be subdivided into the data-processing centres (DPC) and technology rooms.

For placement and ensuring work of IT services, the following supporting services of DPC should be provided:

- placement service: providing units, is permanent places or specially prepared rooms;
- engineering services: providing uninterrupted power supply and climatic mode;
- network services: ensuring network connectivity of components of DPC;
- services of defense of perimeter of DPC: control and restriction of physical access, video surveillance, SSWD, etc.;
- computing services: a complex of the means providing a platform for placement and functioning of components of information systems and data.
- services of backup and data recovery.

13.1.2. The specified services should conform to requirements of reliability and safety.

13.1.3. Any projects and purchases assuming forming or modernization of components of the specified services, and also acquisition of these services at providers should be carried out taking into account the specified requirements.

13.2. General structure of data-processing centre

13.2.1. For placement of the centralized IT services used by the Company and SDC the uniform DPC (UDPC) – the complex of technical means and the supporting services functioning on uniform algorithms, and DPCs which are completely conforming to standards managed by the uniform operator of the DPC is used.

13.2.2. Structural elements (clusters) of UDPC can be placed in server premises of operator of UDPC, or server premises of the Company and SDC conforming to requirements of standards of DPC.

13.2.3. Between central and regional clusters of UDPC mechanisms of georeservation of data and computing resources should be implemented. Services UDPC should be optimized on a geographical sign.

13.2.4. For placement of local IT services of SDC can use, both own (local) server rooms, and the UDPC resources. The compulsory provision of placement of the IT service in the server room, is its compliance to standards of DPC. It is strictly forbidden to place IT services in the rooms which are not conforming to standards of DPC.

13.2.5. A condition, the second for the importance, at the choice of the location of the IT service the cost of the supporting services is. At placement of new IT services, IT the division which is carrying out placement is obliged to carry out comparative analysis of costs on placement of service with use of the UDPC resources and own rooms and the supporting services. It is strictly forbidden to carry out placement without the specified comparative analysis or to use the methods of placement and the supporting services which are not optimized at cost.

13.2.6. DPCs should correspond "To the regulations on requirements in the field of equipment, standards of storage, backup and data protection of data-processing centres and technology premises of PJSC Rosseti approved by Order of 20.10.2015 No. 510r.

14.Automated systems of technology management

14.1. General principles of development of Automated systems of technology management

14.1.1. The Automated Systems of Technology Management (ASTM), provide implementation of a number of the main business processes of the electric grid company:

- management of the modes, technical operation and repair of the equipment, including execution of dispatching teams and orders of the dispatching centres of JSC SO UES;
- management of development of electric grids;
- vendor interaction and consumers regarding rendering services in connection to electric grids and power transmission.

14.1.2. The technical policy in the field of development of an automatic process control system is based on a combination of uniform methodology and standardization, and also carrying out the analysis of economic feasibility of application of technical solutions.

14.1.3. The community of a technology object of management, business objectives and tasks of technology management defines approach to forming and development of an automatic process control system as the uniform distributed complex in coordination of the functioning interconnected systems:

- operational and technology and situational management;
- technological management;
- monitoring and diagnostics of a condition of the equipment;
- monitoring of electricity quality and management of it;
- RPA;
- metering of electric energy and power, management of power consumption.

14.1.4. The uniform information model of electric grid in combination with a single system of identification of objects of model and a single system of management of normative reference information should be the cornerstone of their integration.

14.1.5. As the metamodel providing the general semantics of data it is necessary to use adapted to conditions of the Company and SDC the General Information Model standardized by IEC (IEC 61970-301 and 61968-11) (Common Information Model - CIM) power industry allowing to describe both actually electric grid, and system of measurement of parameters of its mode. The created metamodel should be brought into accord to industry requirements to the general information model of power industry in process of their statement.

14.1.6. Mutually synchronized models of the sites of electric grid controlled by separate control centres which are locally created according to CIM in total should form the uniform distributed information model of network in general.

14.1.7. The architecture of an automatic process control system should correspond to the Model of Reference Architecture of Intellectual Networks SGAM (Smart Grid Architecture Model) Framework developed by the International Organizations for Standardizations: CEN, CENELEC and ETMI.

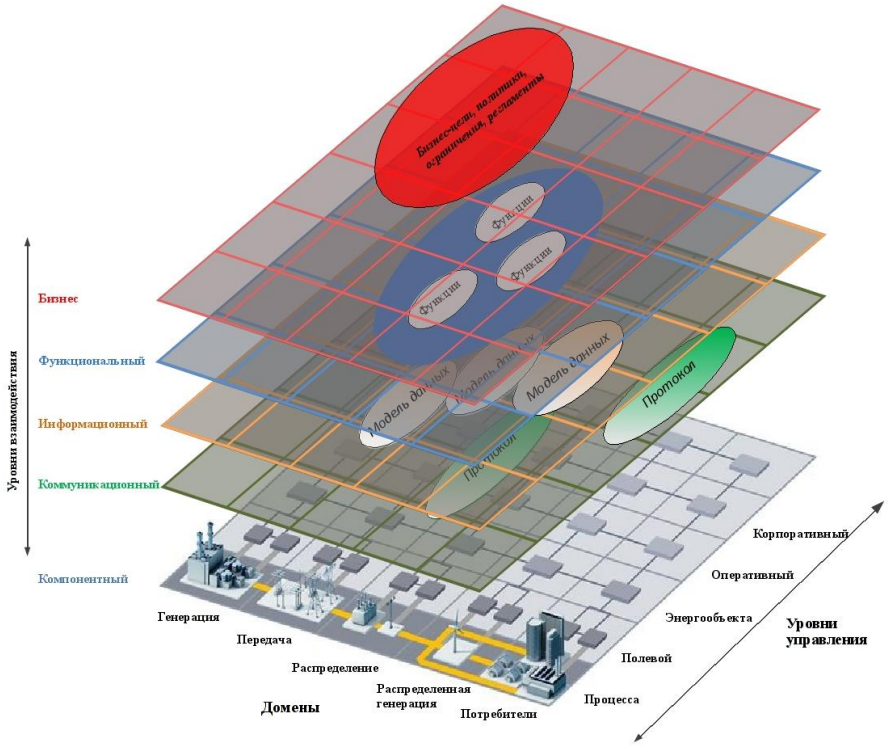


Figure 1 1Reference architecture of intellectual networks SGAM

14.1.8. According to this model at the process (managed) level there are a physical transformation, transmission, distribution and energy consumption realized by the capital electrotechnical equipment. Other levels of model represent management information systems. At the field level functions of protection, monitoring and process management of transfer, transformation and distribution of the electric power are performed (RPA devices, telemechanics controllers, counters of the electric power other). Level of the power facility provides aggregation of data from components of field level, all-substation functions and communication with higher levels of technology management.

14.1.9. At the field and object levels means of an automatic process control system solve problems of automatic control, collecting and transfer on higher levels of operational and technology information, data of metering of electric energy and power, control of electricity quality, monitoring of a condition of the equipment, and also implementation of the commands of management arriving from operational level. At these levels integration of the automatic process control system systems is possible as by aggregation in separate devices of the functions relating to different systems and by turning on of "single-function" devices in several systems.

14.1.10. At the operational level functions of operational and technology and technological management of networks, on corporate - commercial and organizational management processes material and a manpower, interaction with consumers, etc. are implemented.

14.1.11. Regarding the software of levels of operational and corporate management of an automatic process control system key aspects of integration are:

- service - the oriented architecture (SOA) allowing to reduce considerably duplication of functionality of components, having provided recurrence of application of one implementation of function in different appendices;
- standardization of procedures of information exchange on the basis of use of the general information model and the standardized protocols of data transmission (IEC 61850, GOST R IEC 60870-5-101/103/104).

14.1.12. Automatic process control system program technical means of level of operational management provide the automated solution of a complex of tasks of operational and technological management on the basis of the data delivered by means of collecting and information transfer, normative and help and other available information, including:

- processing, storage and display of technology information;
- modeling and analysis of the current, perspective and retrospective modes of electric grid;
- optimization of the modes on voltage and reactive power;
- optimization of a configuration of electric grid;
- control and analysis of the electricity quality parameters;
- forecast of energy consumption;
- management of switchings in electric installations, including telecontrol by switching devices, LTC devices and compensations of reactive power, and also RPA devices;
- management of failure elimination and technology violations, training and personnel training.

14.1.13. The automated system of technological management provides information and analytical support of work on maintenance and repair, the analysis of technical condition of the equipment, development planning of electric grid.

14.1.14. The monitoring systems concentrated, as a rule, within electric power facilities and diagnostics of a condition of the equipment and monitoring of electricity quality and management are integrated by it with other automatic process control system systems by means of not operational transfer on the higher level of the data of monitoring which are saved up by them used in addition to their direct appointment, as the additional information for the benefit of adjacent business processes.

14.1.15. Devices and systems of automatic equipment provide management of the technology modes of power grid facilities without participation of personnel on in advance set algorithms. Devices of relay protection are intended for automatic disconnection of the damaged element from other, unimpaired part of electric system (electric installation) by means of switches and/or the alarm system about emergence of damages, responses to dangerous, abnormal operating modes of elements of electric grid with action on a signal or on shutdown of those elements which leaving in work can lead to damage emergence.

14.1.16. Systems of metering of electric energy and power belong to systems of technology management as perform functions of collection of data on parameters of the technology mode, and also managements of electricity consumption by means of partial or blackout of consumers. Besides, the possibility of use of the data of metering collected for determination of volumes of the rendered services in power transmission and power in system of operational and technology management where they play an important role as addition or an alternative of information collected by means of telemechanics that is especially urgent for distribution networks of an average and low voltage which "classical" telemechanization appears, as a rule, unfairly expensive decision should be implemented.

14.1.17. The organization of information exchange of subsystems of an automatic process control system and storage of information should conform to the requirements established by industry normative and technical documents.

14.1.18. At all levels of management, since power facility level, reliability diagnostics should be made (validation) of the collected data. In case of availability of technical capability check of admissibility of teams of management should be made.

14.1.19. In modern conditions approach to determination of functionality of an automatic process control system in general, its structure and structure, and also communication methods

between separate components on the basis of the technical and economic analysis is especially urgent.

14.1.20. The Regulation provided implementation of such approach at a stage of development of standard technical requirements to SHC of control centres of all levels and to automation of technology management of power grid facilities of the different importance: from SS of ultrahigh voltage to TS of a distribution network.

14.1.21. During creation of an automatic process control system and all its subsystems, it is required to use the methodology established by the state standard specification 34 series. Are obligatory to application: GOST 34.201-89, GOST 34.601-90, GOST 34.602-89, GOST 34.603-92, RD 50-34.698-90.

14.1.22. Detailed technical requirements to the automatic process control system software and hardware complexes, including requirements to the accuracy of counting of time and measurement of parameter values of the technology mode, speed and reliability, should be determined by the corresponding industry standards or standards of PJSC Rosseti.

14.2. Automated systems of metering of electric power

14.2.1. General provisions of development of a system of metering of electric power

14.2.1.1. The Regulation purpose in the field of metering of electric energy (power) is creation of systems of commercial metering providing subjects of wholesale and retail market reliable, corresponding to the existing regulating documents, information on delivery of products (electric energy, power) for the organization of commercial calculations according to rules of work of the wholesale and retail markets of electric power.

14.2.1.2. The systems of metering of electric power with remote data collection used for commercial calculations in retail markets should form as intellectual systems of metering of electric power (hereinafter – electric power metering system at the retail electricity market), and systems of metering of electric power used in SDCs of the Company for commercial calculations in wholesale market - as the automated information and measuring system of commercial metering of electric power (hereinafter - AMI).

14.2.1.3. The created systems of metering of electric power should provide the necessary level of security from unauthorized intervention in processing of information, at the expense of the built-in means of information protection.

14.2.2. Strategy of development for systems of metering of electric power

14.2.2.1. The basic principle of the organization of commercial metering of electric power is the organization of settlement systems of metering of electric power of retail markets of the electric power in electric installations of the network organization, creation of the automated information and measuring system of commercial metering of electric power of wholesale market of the electric energy and power.

14.2.2.2. For the purpose of forming of reliable balances of the electric power, at new construction or reconstruction of power grid facilities, metering of electric energy is organized on inputs of the SS and TS power transformers, bypass switches, and on each departing power transmission line.

14.2.2.3. At the organization of metering of electric energy it is necessary to be guided by the following principles:

- to installation integral metering devices of the electric power, and also the electric power metering devices which are not equipped with communication interfaces are prohibited;
- on a condition of mechanical durability, at the organization of metering of electric power copper connecting conductors should be applied;
- application of aluminum conductors at new construction and reconstruction is forbidden;
- power failure in secondary circuits of VT should not exceed 0,25%;
- at new construction connection to a secondary winding measuring the CT to which the consecutive circuit of the metering device of the electric power is attached, any other measuring devices and means of RPA is forbidden, on the existing objects allocation of circuits of metering of electric power on separate windings of measuring CT needs to be carried out proceeding from availability of technical capability;
- metering devices should possess the built-in means of information protection, including the means of ensuring of reliability of the transferred technology information conforming to requirements of the Company.

one of the priority directions of development of intellectual systems of metering of electric power is transition to standard protocols of data transmission of the metering devices of the electric power providing data protection from unauthorized intervention for the purpose of ensuring integration of data into higher levels of a system of metering of electric power by the principle "plug&play".

14.2.3. Structure of systems of metering

14.2.3.1. The intellectual system of metering of electric power represents the set of functionally integrated devices intended for measurement of quantity and other parameters of electric energy, scoping of power, the automated collecting, transfer of indications of metering devices of electric energy (power), providing information exchange, storage of indications of metering devices of electric energy (power), providing information on results of measurement of quantity and other parameters of electric energy, scoping of power to subjects of power industry and consumers of electric energy (power) implementing controlling mechanisms a power consumption. Technical requirements to devices of intellectual system of metering of electric energy (power) are established in accordance with the legislation of the Russian Federation about technical regulation and the legislation of the Russian Federation on ensuring unity of measurements.

14.2.3.2. Intellectual systems of metering of electric power in the power grid complex include the following subsystems:

- The information and measuring complex (hereinafter – the IMC) - combines the functions which are carried out by measuring transformers and metering devices and also functions of measurement of values of the electric energy and power, their storage during the established time and issue according to requests of a data processing system or is initiative, and also functions of a facility of dispatching management.
- The information complex of the power facility (hereinafter – the data processing system of a power facility) - performs functions of collecting, the preprocessing and data storage of metering received from IMC and also functions of transformation of formats and protocols of data transmission and issue of data of metering on requests of a data processing system. Devices of collecting and data transmission (Data Acquisition and Transmission Devices), the concentrators, controllers providing an information access on metering of electric power at the level of IMC can act as data processing system of a power facility. The organization of remote data collection without application of a data processing system of a power facility according to the project decision is allowed.
- The information complex of collecting and data handling of the top level (hereinafter - data processing system of top level) – performs functions of the request of data of metering and

auxiliary information from data processing system of a power facility or IMC, their verification, consolidation, storage, the analysis and representation, and also function of remote management of IMC and data processing system of a power facility.

- The system of collecting and data transmission (SSPD), technical means of reception-transmission of data (the equipment of a LAN of AMI, cable infrastructure, information transmission media) - perform functions of data transmission of metering and auxiliary information between functional elements of a complex of metering with the required level of reliability and speed of transfer.
- System of providing uniform time – providing synchronization of uniform time in all elements of a system of metering according to uniform calendar time.

14.2.4. Requirements to the organization of systems of metering

14.2.4.1. For the purposes of ensuring unification of the program platforms operated in the Company, data processing system of top level should be organized one for a branch or SDC, the Company according to the Strategy in information technologies, the automation and telecommunications of PJSC Rosseti, approved by the Board of Directors of the Company, Minutes of 02.07.2012 No. 86 and to provide in full implementation of functional requirements of the Company to a hardware and software system of a data processing system.

14.2.4.2. The structure of a system of metering and communication channels should allow users of the Company to have access to any level of the system.

14.2.4.3. Systems of metering of electric power in the power grid complex should cover all points commercial (settlement and control) and technical metering of the active and reactive electric energy and power for the purpose of obtaining complete balance of the electric power on an object, including balances on voltage levels, sections of buses and own needs.

14.2.4.4. Intellectual systems of metering of electric energy should include or provide integration with remedies from unauthorized access, including identification, authentication and authorization of personnel at access to system, monitoring of actions of personnel, means of anti-virus protection and control facilities of integrity of a hardware-software part.

14.2.4.5. Metrological support of the MI which are components of the electric power metering system at the retail electricity market and AMI measuring channels of subjects of wholesale market of the electric power and intellectual systems of metering of electric power of subjects of retail market should correspond to provisions of the section "Metrological support".

14.2.4.6. The intertesting interval of metering devices of electric energy should be not less than 10 years.

14.2.4.7. Systems of metering of electric power on the connections which are a part of sections of delivery in wholesale market of the electric energy and power (at the wholesale electricity market) should conform to the existing requirements to AMI at the wholesale electricity market imposed by NP «Market Council» and other regulating technical documents and regulatory legal acts operating in the field of regulation of commercial metering at the wholesale electricity market.

14.2.4.8. Intellectual systems of metering of electric power in a distribution power grid complex (electric power metering system at the retail electricity market) should correspond to rules of functioning of retail markets of electric energy, requirements of the specifications and technical documentation and regulatory legal acts.

14.2.4.9. At work on modernization of systems of metering of electric power the following criteria should be carried out:

- modernization of metering of electric power on substations of 35-110 kV, DS and TS of 6-10 kV for the purpose of forming of reliable balances of the electric power on objects;

- creation of the closed hierarchical contours (technology platforms) with a possibility of forming of balances of the electric power in a contour with a margin error, not exceeding admissible;
- receiving remote poll of metering devices, at the same time its level there should not be less than 95% a day (saved up in a day and since the beginning of month of energy totally and separately on all rates, collecting of values of the active power average for last 60th minute interval);
- integration of data of commercial metering into uniform data processing system of top level of a branch (SDC).

14.2.4.10. The communication channels intended for information transfer should provide steady connections between devices of different levels of automated systems. Use of GSM of communication is allowed as the main communication channel only in cases of lack of other communication channels providing steady connection at a sales term of protection of the specified channel.

14.2.4.11. On connections of transformer SS 6-10/0,4 of the kV registered on at the wholesale electricity market provided that the measured current on connection does not exceed 60 A, and the connected power – no more than 25 kW, are allowed to use metering devices of electric energy of live broadcast, that is included in network without measuring transformers.

14.2.4.12. The electric power metering devices used as a part of intellectual system of metering should act preferential as primary converters for systems of technology management. At the same time on substations of 10 kV and below metering devices should have necessary interfaces and functional characteristics for use as a part of the specified systems.

14.2.4.13. The intellectual system of metering of electric power in a distribution power grid complex should have a possibility of data transmission in automatic process control system with the subsequent integration into industrial control system of SS regarding receiving from industrial control system of provision of a condition of switches and disconnectors (when using this information for calculation of metering ratios), transfers to industrial control system of information on malfunction of elements of a system of metering (an automated workplace, Data Acquisition and Transmission Devices, metering devices of electric energy, the channel-forming equipment), to have ability to integrate with other systems of the Company.

14.2.4.14. The system should possess remedies from unauthorized change of the processed information and unauthorized access at the program and hardware level.

14.2.4.15. Operational documentation on devices of system and all equipment, including the menu, texts and the displayed messages on metering devices and Data Acquisition and Transmission Devices should be in Russian (including configuring, settings and notifications), units of measure of parameters on a single system of measurements – the MI displayed on the display can make an exception.

14.2.4.16. Protection of technical means of system against influence of outside electric and magnetic fields, and also hindrances on power-supply circuits should be sufficient for effective implementation technical means of the appointment when functioning system.

14.2.4.17. Technical and functional requirements are provided:

- In general to intellectual system of metering of electric power in the standard PJSC Rosseti of STO 34.01-5.1-002-2014 "Technical policy. Systems of metering of electric energy with remote data collection wholesale and retail markets of electric energy on objects of affiliated and dependent companies of PJSC Rosseti";
- To the software of a data processing system in the standard of the PJSC Rosseti organization STO 34.01-5.1-001-2014 "The software of an information complex of a system of metering of electric power with remote data collection. Standard functional requirements".
- To operation and maintenance of systems of metering of electric power in the standard of the PJSC Rosseti organization STO 34.01-5.1-004-2015 "The automated information

and measuring systems of commercial and technical metering of electric power and system of metering of electric power with remote data collection. Organization of operation and maintenance".

14.2.4.18. Classes of accuracy and characteristic of the IMC components

Subject to measurements	Accuracy classes, not below (not worse), for:	
	Metering device	
	metering of active energy	metering of reactive energy
Objects of the network enterprises		
Power transmission line of 110 kV and above	0,2S	0,5 (1,0)
Power transmission line and inputs of 35 kV	0,5S 0,2S * (preferably)	1,0 0,5 * (preferably)
Power transmission line and inputs of 6 - 10 kV with the connected power of 5 MW and more	0,5S	1,0
Departing lines and input of 0.4 kV	0,5	1,0
Objects of consumers of electric energy		
100 MW consumers and more	0,2S *	0,5 (1,0)
The 670 kW consumers ≥(to 100 MW)	0,5S	1,0
Consumers power <670 kW at connection:		
– to networks of 110 kV and above	0,5S	1,0
– to networks 6 – 35 kV	0,5S *	1,0
– to networks 0,4 (0,2) of kV	1,0 *	2,0
* - at new construction or modernization.		

14.3. Automated systems of operational and technology and situational management

14.3.1. According to the general principles of development of operational and technology management stated in the section of 21 these provisions, control centres of networks and control offices of all levels of hierarchy of operational and technological management should be equipped with automated systems of operational and technology and situational management (ASOTSU).

14.3.2. Should be a part of the software and hardware complexes (SHC) of ASOTSU:

- system of collecting and information transfer (Information acquisition & transmission system);
- system of maintaining database;
- operational and information managing complex (OIMC);
- planning system and analysis of the modes of electric grid;
- an information protection subsystem (including the built-in means of information protection).

- SHC ASOTSU should provide:
  - receiving from process level devices (according to SGAM) controlled electric grid subjects of the operational technology information (OTI) and its preprocessing, exchange of OTI with ASOTSU of adjacent DP (Grid Control Centre), adjacent subsystems of an automatic process control system (AMI, RPA, etc.), automated dispatch management system JSC SO UES and other automated systems of adjacent subjects of power industry;
  - an archiving and storage of the accepted data;
  - transfer of commands of telecontrol and teleregulation on controlled objects of electric grid;
  - maintaining the database containing an information model of controlled electric grid, normative and help and other not operational necessary information;
  - operating control of the technology mode of objects of electric grid;
  - exchange of not operational technology and office information with adjacent subsystems of an automatic process control system and other automated systems;
  - event management;
  - maintaining in electronic form the operational log and other operational documentation, report generation;
  - modeling and analysis of the technology modes of electric grid;
  - interaction with operation and other personnel by means of an automated workplace and systems of collective display.

14.3.3. The technical policy regarding ASOTSU is directed to increase in level of automation and improvement of processes:

- managements of switchings;
- managements of transfer, transformation and distribution of power;
- managements of liquidation of technology violations;
- training of operation personnel, reached in the way:
  - development of Information acquisition & transmission system for the purpose of receiving operational and technological management of information, necessary for the solution of tasks, on the technology mode of controlled network. The number of teleinformation coming to operative-information complex should provide observability in real time of the set mode of controlled electric grid.
  - the architecture of Information acquisition & transmission system should correspond to "Target model of passing of teams and the organization of communication channels and transfer of telemetric information between Operator’s Centre and the Grid Control Centre of grid organizations, substations", approved by JSC SO UES and PJSC FGC UES. Increase in completeness and quality of information on the mode at the same time should be provided with use of these systems of metering of electric power, RPA and other systems of technology management;

- forming and maintenance in an urgent condition of the adequate uniform distributed information model of electric grid of the network company on the basis of the IEC 61968 and IEC 61970 standards and the single system of classification and coding approved with them in the volume necessary for the solution of tasks of operational and technological management;
- integration of separate ASOTSU among themselves, with other subsystems of an automatic process control system and adjacent automated systems with formation of the uniform distributed automatic process control system of the electric grid company on the basis of use of the uniform distributed information model of electric grid, exchange operational and not operational technology and normative reference information and joint use of the centralized equipment rooms and program resources;
- improvement of methods and algorithms, implementation and development of the program complexes providing the solution of settlement and analytical tasks of operational and technological management.

14.3.4. SHC ASOTSU should provide the automatic and/ or automated accomplishment of functions:

14.3.4.1 Regarding Information acquisition & transmission system:

- exchange of technology information between power grid facilities of the electric grid company and dispatching centres of JSC SO UES;
- periodic and sporadic at the initiative of sending devices and at the request of the operator collecting and transfer to OIUK of the set data set from devices of telemechanics and industrial control system of controlled objects of electric grid, exchange of OTI with SHC ASOTSU of adjacent DP (Grid Control Centre), adjacent subsystems of an automatic process control system (AMI, RPA, etc.), automated systems of other subjects of power industry with use of the IEC-60870-5-101/104 protocols;

14.3.4.2. Regarding operative-information complex:

- acceptance, processing and storage of operational data from Information acquisition & transmission system and adjacent AS with use of the IEC-60870-5-101/104, IEC 60870-6-503 protocol (TASE.2 ICCP);
- control of reliability of telemetry and telesignals, substitution doubtful and completion of missing values data from alternative sources;
- filtering and smoothing of telemetry;
- control of violation of technology limits;
- forming of statistical characteristics of operational data:
  - extrema;
  - statistical moments;
  - characteristics of dynamics of change, exits out of limits, etc.
- monitoring of a condition of SW and computing infrastructure of SHC ASOTSU;
- "management" of events:
  - forming of the description: logic function, methods of the notification and processing;
  - control, registration, notification, acknowledging, archiving.

14.3.4.3. Regarding management of switchings:

- telecontrol by switching devices;
- management of change orders of an operational state or/and technology operating mode of objects of management;
- forming of the sequences of transactions when switchings;
- program blocking of wrong actions of operation personnel;
- control of RPA devices.

14.3.4.4. Regarding modeling, the analysis and optimization of the modes of electric grid:

- the automated forming of settlement schemes for modeling and the analysis of the set and emergency operation of electric grid according to the continuous, retrospective and forecast data about an operational condition of the equipment, loadings, provision of regulators of voltage and reactive power;
- assessment of a condition of network, diagnostics of accuracy of the information;
- modeling of the set modes the topological analysis of the technology mode of electric grid;
- control of loading of the equipment and the power transmission line, voltage in electric grid;
- optimization of the scheme of electric grid;
- optimization of the modes of electric grid;
- calculation and loss analysis of power in electric grid;
- calculation of short circuit;
- determination of the restrictions connected with change of an operational condition of the equipment;
- determination of places of damage of the power transmission line;
- job analysis of protection;
- control of power consumption and management of loading;
- short-term and mid-term forecasting of loading.

14.3.4.5. Regarding management automation by liquidation of technology violations:

- identification and localization of damages;
- forming of the sequence of switchings for insulation of damage and recovery of power supply after completion of recovery work;
- planning of recovery work;
- forming and submission of change orders of an operational state or/and technology operating mode of objects of management;
- management of recovery work;
- management of recovery of the normal scheme of power supply.

14.3.4.6. The ASOTSU human-machine interface should provide:

- display of schemes of electric grid and its components created according to the continuous and/or retrospective data of telemetry, data of manual input, results of the solution of settlement and analytical tasks;
- display of information in a tabular form, with use of schedules, charts;
- data representation of telemetry, data on an operational condition of the equipment, passport data, dispatching marks, results of the solution of settlement and analytical tasks and other operational and not operational technology information on the scheme of electric grid with a binding to the image of objects, on a geographical background according to a coordinate binding of the characterized objects of electric grid;
- management of display, including scaling, change of extent of detailing of the image of objects, visualization / concealment and change of priority of information output of different types;
- the automated maintaining operational documentation;
- maintaining logs and actions of the dispatcher, report generation.

14.3.4.7. For ensuring training of operation personnel of SHC should be a part of SHC ASOTSU:

- "simulator of operational switchings";
- mode simulator.

14.3.4.8. The software providing preparation of display with a possibility of forming of graphic elements of any type, configuration of forms of display, setup of data representation, maintaining object model of electric grid, management of an archiving, administrations of a complex should be a part of SHC.

14.3.4.9. Measures for protection against mistakes at input and information processing should be implemented.

14.3.4.10. Concerning safety of functioning of SHC it should correspond to GOST R IEC 61508-1.

14.3.4.11. Should be a part of SHC the engineer's automated workplace, the providing management of settings of a complex, observation of process of its functioning, diagnostics of components.

14.3.4.12. Sensors and/or the failure handling breaking integrity of software and data, notifications of users, protection of main components of SW and this from random or inadvertent changes which can be caused by unpredictable physical impacts, actions of the user should be provided;

14.3.4.13. The system of information security support should conform to requirements of the section "Information security" and provide (including without limitation):

- identification, authentication and authorization of users;
- registration:
    - an entrance (exit) of users to system (from system);
    - start (end) of programs and processes;
    - attempts of unauthorized access to SW and information.

14.3.4.14. Increase in effective management of the modes and liquidation of technology violations should be provided due to integration with a geographic information system, systems of positioning of mobile objects, material resource metering, information address system on the basis of the Federal Information Address System (FIAS), systems of the registration of addresses of consumers and other AS providing respectively:

- submission of technology information on a cartographic basis according to a coordinate binding of objects of electric grid, including parameters of the technology mode, passport data of the equipment, the location information of motor transport and special equipment of mobile crews, information on their status, availability of the equipment and materials;
- localization of damages on the basis of combination of operational and technology information, messages of personnel of the network company and consumers.

14.3.4.15. SHC ASOTSU of separate Grid Control Centre and DP and implementation of their integration from adjacent ASOTSU, automatic process control system and AS should provide technical and economically the reasonable level of reliability of accomplishment of separate functions of operational and technological management.

14.3.4.16. Concerning operative-information complex the requirements established in CO 153-34.20.501-2003 for operative-information complex of the automated dispatch management system should be fulfilled.

14.3.4.17. In the part implementing functions, critical by the time of accomplishment, SW ASOTSU should provide their accomplishment during a rated time frame.

14.3.4.18. Virtualization of the SHC ASOTSU servers is not allowed if only documentation on SW do not contain data on a possibility of its application.

14.3.4.19. Use of WEB technologies for connection of stationary automated workplaces of operation personnel to a server part of SHC ASOTSU is not allowed.

14.3.4.20. Operability of an application software of ASOTSU should not be broken owing to the following emergency situations:

- the failures of feeding leading to reset of OS;
- mistakes in operation of hardware (except carriers of data and programs);
- failures in work of the general software (OS and drivers of devices). After their liquidation functioning of application SW of ASOTSU should be revolved or actions of personnel.

14.3.4.21. Automated workplaces as a part of SHC ASOTSU should correspond the SanPiN 2.2.2/2.4.1340-03.

14.3.4.22. As systems of display of information of collective use in Grid Control Centre it is necessary to use video walls on the basis of the projective video cubes or liquid crystal monitors providing, as a rule, the seamless image. The management system should support by a video wall the full-screen, zone and multiwindow modes of display.

14.3.4.23. In Distribution Enterprise and Distribution Zone it is allowed to use video walls on the basis of LCD monitors and video cubes, the mosaic dispatching boards (DB) and their combinations. In Distribution Zone it is allowed to apply the simplified DB with static passive symbolic circuits with a possibility of manual installation of dynamic elements for display of provision of switching devices and drawing dispatching marks, and also to use instead of DB polyscreen automated workplaces with LCD - monitors of high or ultrahigh resolution.

14.4. Systems of automation of substations

Systems of automation of substations (the abbreviation of SAS will be used further2) are based on use of the microprocessor equipment. Use of microprocessors was resulted by evolution of the secondary equipment of substation – from electromechanical devices to digital. In turn it provided sales opportunity of the SAS required functions (protection, local and remote monitoring/management etc.) by means of intelligent electronic devices (IEU, IED). With respect thereto there was a need for ensuring effective interaction between IEU by replacement of earlier used various protocols of communication drafted by different producers by standard protocols.

The Regulation in the field of SAS it is directed to implementation of the decisions giving the chance of joint operation of IEU of different producers, providing data exchange and teams. Application of the IEC 61850 standard creates conditions for a possibility to replace the structure of one producer with the device of another, without making changes in other elements of system.

At design of SAS should be used: functional decomposition, description of data streams and information modeling.

Functional decomposition should establish logical relationship between components of the distributed function in terms of logical nodes by means of which functions, subfunctions and functional interfaces are described. The description of data streams should contain determination of interfaces of communication which should support exchange of information between functional components, and also meet functional requirements.

Information modeling should define an abstract syntax and semantics of the transmitted data, and it is provided in terms of classes and types of data objects, attributes, methods of abstract objects (services) and their relationship.

14.4.1. General requirements to creation of systems of automation of substations

14.4.1.1. The system of automation of substation (SAS) as one of types of automated systems, consists of personnel and a complex of the automation equipment of its activity, implementing information technology of accomplishment of the established functions (according to GOST 34.003-90).

14.4.1.2. The purpose of creation of SAS is increase in efficiency of technology management of SS directed on:

- ensuring required level of reliability of electric grids;
- safety of electric grids;

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[2] For compatibility with the English-language term Substation automation system (SAS)" from IEC 61850.

- increase in process performance of transfer, transformation and distribution of the electric power;
- increase in investment soundness - decrease in specific capital expenditure for development of networks;
- providing with information on electric grid and mode of its work of other automated systems of the company and adjacent subjects of power industry.

14.4.1.3. SAS should provide automated management of all technology processes of SS, including:

- monitoring and management of working hours of electric grid, information exchange with Grid Control Centre and Operator's Centre of JSC SO UES;
- automatic shutdown of the damaged elements of electric grid and/or the alarm system about emergence of damages;
- detection of dangerous, abnormal operating modes of elements of electric grid with action on a signal or on shutdown;
- metering of electric energy and power, management of power consumption;
- quality control of electric energy;
- monitoring of a state and diagnostics of the capital equipment;
- auxiliary processes: water supply, sewerage, heating, ventilation, air conditioning or safety.

14.4.1.4. Generally[3] SAS can consist of the following subsystems:

14.4.1.4.1. Main subsystem (industrial control system of SS). SAS

14.4.1.4.2. The insulated subsystems:

- RPA;
- subsystem of registration of emergency signals and events;
- subsystems of automated management of installations (controlled shunt reactor, ASK, static VAR compensator, etc.);
- subsystem of determination of the place of damage of the power transmission line (fault location devices);
- subsystem of information security;
- automated power consumption measurement system;
- subsystem of management of electricity quality;
- subsystem of monitoring and diagnostics of the equipment;
- subsystem of control of ice loading;
- complex of management systems of auxiliary processes.

14.4.1.5. Accomplishment of the main functions of devices and the RPA complexes should be provided irrespective of an operational condition of other subsystems of SAS.

14.4.2. Main subsystem of SAS

14.4.2.1. In this section requirements to the main subsystem of SAS (Industrial control system) and the organization of its interaction with the insulated subsystems are provided. The Regulation concerning other questions of creation and operation of the insulated subsystems of SAS it is defined in appropriate sections: "Relay protection and automatic equipment", "Automated power consumption measurement system", "Monitoring and diagnostics of the equipment", "Quality control of the electric power", "Information security".

14.4.2.2. The subsystem includes the following technical means:

- servers and controllers (software and hardware);
- Automated workplaces (software and hardware);
- communication network equipment (including local area network) of SS;

[3] The structure of subsystems for each PS is defined at design.

- means of collective display of information (creation of systems of collective display to SS is allowed in exceptional cases);
- multipurpose measuring converters;
- means of a system of providing uniform time of SS.

14.4.2.3. The main subsystem of SAS should provide accomplishment of the following functions:

14.4.2.3.1 Technology:

- measurement, collecting of values of analog and discrete parameters of the SS technology mode;
- registration of technology information (parameter values, events and so forth);
- information exchange with adjacent automated systems (including from ASOTSU TSUS SDC, automated dispatch management system JSC SO UES);
- human-machine interface:
  - the interface for control of the equipment of SS;
  - the visual and sound alarm system about events;
  - display:
    - results of determination of the place of damage on Conductor (fault location devices);
    - results of diagnostics of the equipment;
    - information on operation of RPA devices;
    - information on operation of the security and fire alarm system;
    - results of monitoring of subsystems of SAS;
    - submission of the current and retrospective information to operation personnel (symbolic circuits, information on events, reports, schedules);
- maintaining scheme of SS;
- control of parameters – determination of the fact of an exit out of precautionary or emergency limits with forming of the corresponding event;
- remote control of the equipment of SS: switching devices (the switches, disconnectors grounding switches), LTC drives, processing equipment (pumps, latches, etc.), including:
  - automated management according to standard forms of switchings;
  - program blocking of control of the switching equipment (operational logical blocking);
- monitoring of primary equipment, metering of its resource;
- monitoring of a state and management of the mode of functioning of the insulated subsystems, including without limitation:
  - RPA - switching of groups of parameters (settings) of devices, shutdown inclusion of separate functions;
  - local systems of automatic control;
- maintaining operational documentation.

14.4.2.3.2. System-wide:

- ensuring intrasystem communications;
- monitoring of a state program and the SHC hardware components, (including the insulated subsystems), communication channels;
- synchronization of the SHC components;
- an archiving and storage of information registered by system;
- maintaining an information model of SS and adjacent network;
- providing reports of the set form (official reports, sheets, protocols, etc.);
- information protection;
- configuring and parameters setting of the SHC components.

14.4.3. Architecture of SHC SAS

14.4.3.1. SHC SAS includes the following levels.

- Field level or the bottom level – turns on the equipment intended for transformation and direct measurement of physical quantities and also for interface to objects of management (sensors, microprocessor measuring converters, counters of electric energy, controllers of switches and other similar equipment).
- Connection level[4] – the equipment and SW intended for concentration and unification of diverse information flows from the bottom level and insulated subsystems of SAS, their processing and interaction with higher levels of automation.
- Level of the power facility (SS) or the top level – the equipment and SW intended for processing and storage of information, and also the organization of the automated jobs of personnel of SS.

14.4.3.2. The channel-forming equipment of a communication network between objects (SS-SS, SS-Grid Control Centre, SS-Operator's Centre, etc.) does not enter SHC SAS. The border of SHC SAS is the interface of the channel-forming equipment – port of connection to a communication network between objects. In case of use of the combined equipment of SAS which is turning on channel-forming modules, border is the external interface of the channel-forming module. Questions of creation of communication networks between objects are considered in the section "Communication networks".

14.4.3.3. In some cases, for example, for SS which does not have permanent operation personnel, the top level of SHC SAS cannot be organized. In such cases a role of the top level of SHC SAS is played by higher control centre (Grid Control Centre).

14.4.3.4. The following main options of architecture of SAS are allowed:

- IEC 61850 (Figure 2. Architecture of IEC 61850);
- centralized (Figure 3. The centralized simplified architecture) – integration of all automated subsystems at SS;
- combined – regarding operational information is carried out consolidation of subsystems, regarding not operational information all subsystems are insulated from each other at the level of SS. In case of lack of the SAS servers, the main subsystem of SAS is the device of telemechanics of remote station (UTM KP).

[4] Level is specific to IEC 61850, in reference architecture of SGAM is not used. The equipment of this level can belong to the field level or level of the power facility of reference architecture of SGAM.

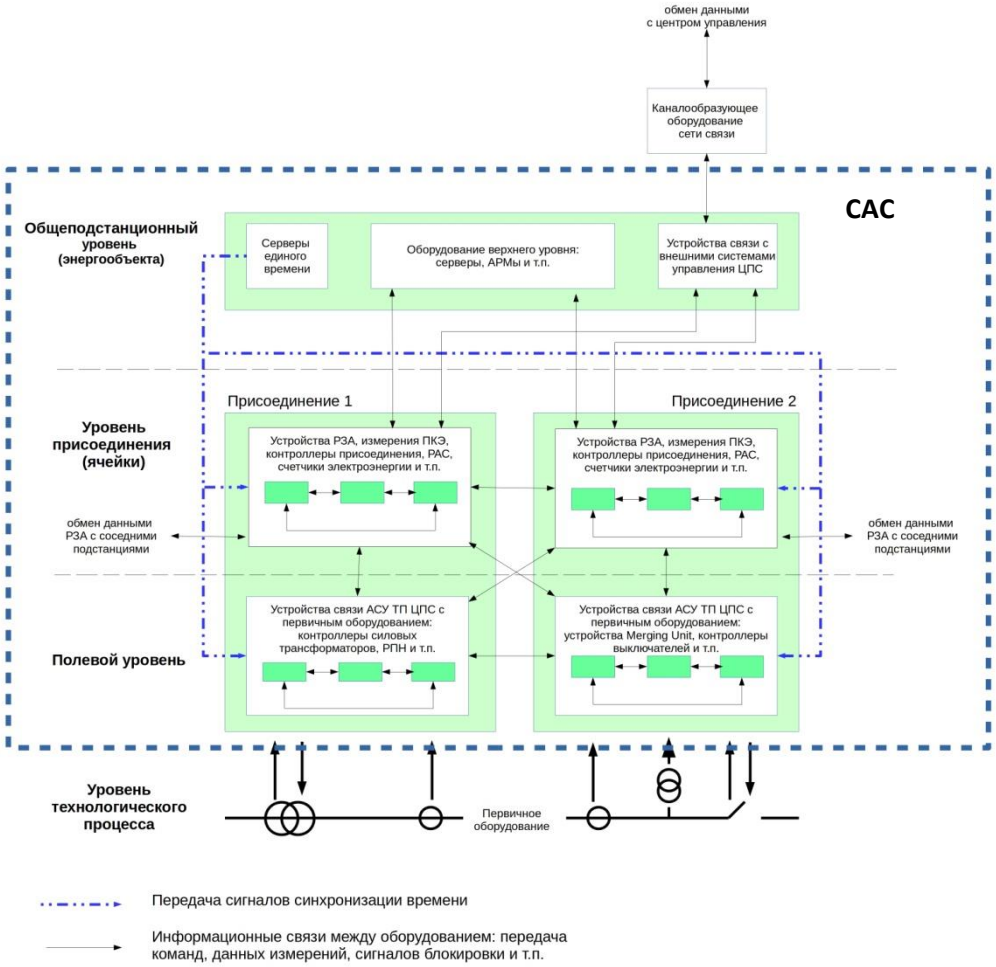

Figure 2. Architecture of IEC 61850

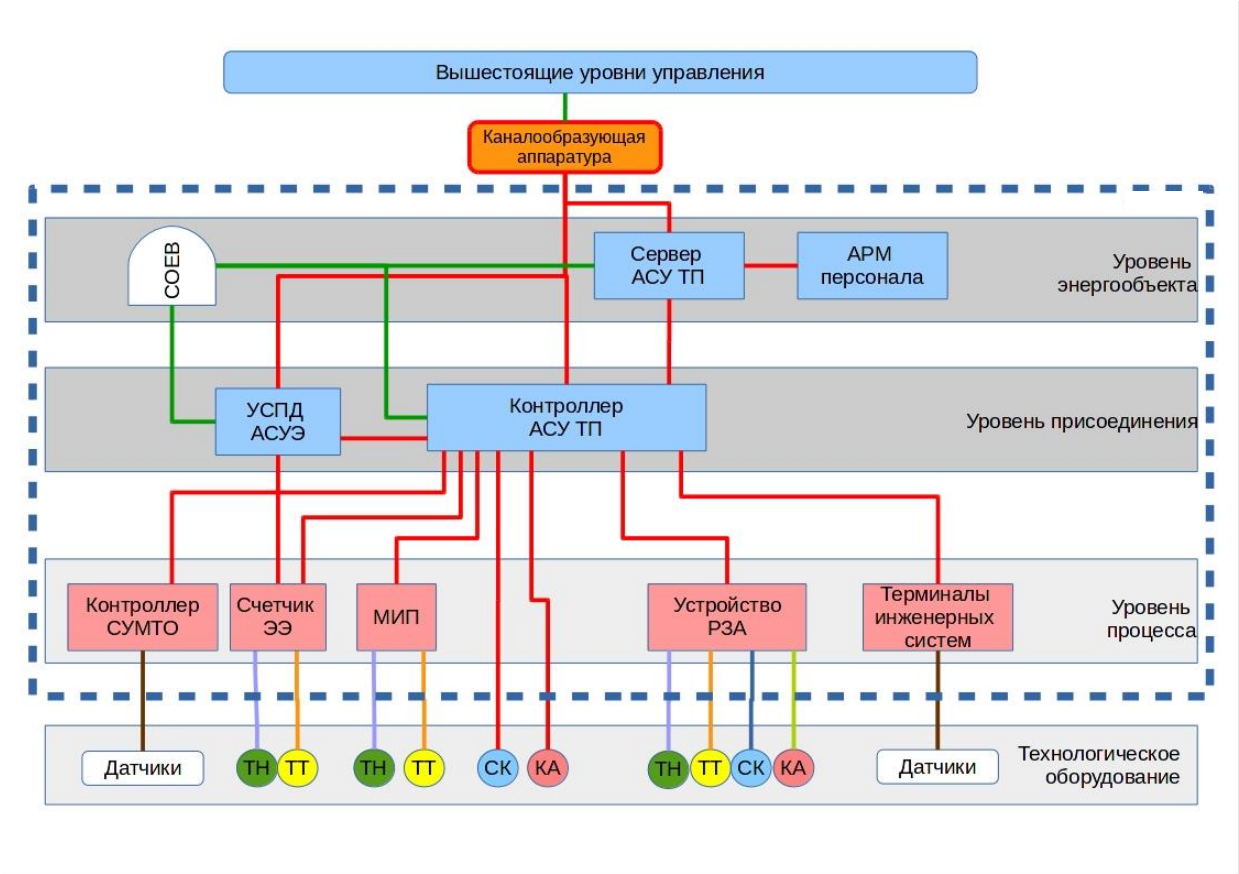

Figure 3. The centralized architecture

14.4.3.5. The choice of architecture of SHC SAS is defined and proved at design.

14.4.3.6. At new construction and complex reconstruction of objects it is recommended:

- for substations of high-level networks – architecture of IEC 61850;
- for substations of distribution networks – the centralized architecture.

14.4.3.7. The principles to which SHC SAS has to correspond to:

- open scalable architecture;
- application of standard, open protocols of information exchange;
- modularity technical and software;
- standardization of the human-machine interface of devices;
- ensuring unity and accuracy of measurements;
- information security support.

14.4.3.8. SAS should be under construction taking into account the following requirements:

- the mode of functioning of SAS — continuous;
- providing necessary and sufficient information for different categories of personnel (operation personnel, personnel of services industrial control system, RPA, automated power consumption measurement system, etc.), providing, if necessary, filtering of information;
- providing reliable power supply of SAS;
- metrological support of SAS should correspond to provisions of the section "Metrological support";
- information security of SAS should be organized according to provisions of the section "Information security".

14.4.3.9. Simplified SAS should be applied to SS of 110 kV below for which:

- in case of SS without permanent operation personnel — creation of the top level (servers, stationary automated work places) is not recommended;
- hardware reservation of controllers is carried out only in case of its justification;

- architecture of IEC 61850 should be applied only in case of the feasibility justification.

14.4.4. Perspective directions of development of SAS

14.4.4.1. Optimization of structure of the SAS technical means due to assignment of a number of functions of the insulated subsystems on the main when saving requirements to survivability, reliability and time of accomplishment of these functions.

14.4.4.2. Development analytic and the SAS expert functions allowing to give support to personnel at decision making in emergency situations.

14.4.4.3. Implementation of functions of diagnostics of subsystems of SAS (including measuring instruments, RPA) on the basis of comparison of the data obtained from its different subsystems, and also from automated systems of adjacent electric power facilities.

14.4.4.4. Development of functions of automatic control.

14.4.4.5. Implementation of methodology of system engineering of SAS founded on IEC 61850 (even in case of use of the devices which are not supporting the IEC 61850 protocols) using CAD.

14.4.4.6. Further it is planned that SAS should become the technical centres based on which intellectual networks should be under construction.

15.Metrological support

15.1. General provisions

15.1.1. The purpose of metrological support of production is ensuring unity and required accuracy of measurements in all production processes at implementation of activities for transmission of electric energy (control of the modes and parameters of network, electricity quality, metering of energy resources, monitoring and diagnostics of a condition of the equipment, etc.) according to the operating regulatory legal acts of the Russian Federation.

15.1.2. Metrological support of production is performed at all stages of lifecycle of electric grid facilities (design, commissioning, continuous operation).

15.1.3. The priority directions of technical policy in the field of metrological support are:

- reduction of the industry regulating documentation and standards of the organization in the field of metrological support in compliance to requirements of the legislation of the Russian Federation and the changed structure of the industry;
- implementation of modern methods and the MI, the automated control and measuring equipment, equipment of metrological laboratories modern installations for calibration/checking by the MI and reference means, necessary computer facilities, vehicles;
- implementation of the latest MI based on innovative technologies and methods of the measurements providing the required accuracy of measurements with the broad range of change of parameters, stability of metrological characteristics during all service life, the increased interval of periodic metrological control;
- confirmation of technical competence of metrological divisions of all levels of subordination performing works on calibration of the MI in system of calibration of the Company, and also in case of establishment of economic feasibility, their accreditation in the field of ensuring unity of measurements on the right of performance of works on checking (calibration) of the MI;
- implementation of automated systems of metering of the MI, planning and control of their metrological service, transition to electronic passports on measuring instruments in the power grid complex.

15.2. Requirements to measurements

15.2.1. Measurements should be carried out according to regulations of accuracy of measurement of the specific measured parameter.

15.2.2. Regulations of accuracy of measurements can be established:

- state and industry normative documents;
- to standards or ORD of the Company. If are not established by any of the above-stated documents of regulation of accuracy of measurements, establishment of missing regulations of accuracy is temporarily allowed by standards or ORD of SDC.

15.2.3. Measurements (except for direct measurements) should be carried out by the techniques (methods) of measurements certified in accordance with the established procedure.

15.3. Requirements to units of sizes

15.3.1. Units of sizes need to be applied according to GOST 8.417-2002 and "Regulations on units of the sizes allowed to application in the Russian Federation", approved by Order of the Government of the Russian Federation of October 31, 2009 N 879.

15.4. Requirements to techniques (methods) of measurements

15.4.1. MI applied in the field of state regulation of ensuring unity of measurements should meet the following requirements:

- are developed according to GOST R 8.563-2009;
- are certified in the order established in the field of ensuring unity of measurements and are registered in the Federal register of MI (Federal information fund for ensuring unity of measurements) or are put into operation as state standard;
- are put into operation by one of methods: as state, industry standard or standard of the organization, ORD of the Company.

15.4.2. If MI is not entered by any of above-mentioned methods, its temporary introduction as standard or ORD of SDC is allowed.

15.4.3. MI applied out of the sphere of state regulation should meet the following requirements:

- are developed according to methodical instructions state standard specifications P 8.563-2009;
- are put into operation as the state, industry standard or the standard of the organization, ORD of the Company.

15.4.4. If MI is not entered by any of above-mentioned methods, its temporary introduction as standard or ORD of SDC is allowed.

15.5. Requirements to measuring instruments

15.5.1. The MI established in buildings and constructions, DD of all levels of voltage on the equipment (including, as a part of technical complexes) applied to diagnostics and monitoring of technology parameters of the equipment and network, which are a part of IIS should conform to requirements of this section.

15.5.2. MI should be the approved type (are registered in the Federal information fund for ensuring unity of measurements);

15.5.3. MI should be verified (calibrated) in accordance with the established procedure and to have the existing certificate (certificate) and/or a sign about checkings/calibrations, for the MI applied to control of technical parameters which accuracy of measurement is not normalized operability control should be carried out, entry in operational documents for the MI is executed;

15.5.4. All again purchased MI should be confided at release from production and have the existing certificate on checking (or a checking sign in the passport of the MI).

17.5.5. Design of the MI should allow to carry out checking and calibration in the course of all term of their operation.

17.5.6. As a rule, the possibility of checking or calibration of the MI in the region of its operation should be provided.

17.5.7. The MI which are a part of technical devices and being their integral part should have a possibility of checking/calibration on site of operation without dismantle or have the intertesting interval equal to service life of the equipment on which it is installed.

15.6. Requirements to information and measuring systems

15.6.1. IIS (including components) should be metrological provided at all stages of lifecycle according to the requirements of GOST R 8.596-2002 existing with standards and ORD of the Company;

15.6.2. The standard SHC used for creation of IIS applied in the field of state regulation of ensuring unity of measurements should be the approved type (are registered in the Federal information fund for ensuring unity of measurements – Data on the approved MI types).

15.7. Requirements to standard samples

15.7.1. The standard samples applied at measurements should:

- have the certificate on the statement like a standard sample;
- be suitable for application (to have not expired expiration date);
- be applied according to requirements of MI and regulating documents of conditions of its operation.

15.7.2. It is not allowed to application for measurements:

- the technical devices which are not the MI;
- MI, MI, units of sizes, the measurements which are not conforming to requirements of the Regulation.

15.7.3. Actions for improvement of the MI fleet, having above-standard wear, the modernizations of the MI realized within the program for the following directions:

- complete modernization of the MI in the field of state regulation of ensuring unity of measurements;
- modernization of the MI used for monitoring of technology parameters of the equipment and network.

15.7.4. A priority is replacement of worn-out MI by multipurpose MI of new generation (the digital, having an opportunity to transmit signals at distance) with the increased intertesting /between calibration interval.

16.Monitoring and quality management of the electric power

16.1. Monitoring and quality management of the electric power in ENES

16.1.1. The Regulation in the field of management of electricity quality in electric grids is focused on:

- providing consumers with electric energy which quality conforms to the established requirements;
- increase in the general reliability of power supply of consumers;
- decrease in the damage to machinery of consumers and electric grids caused by a deviation of electricity quality indicators;
- decrease in level of technology losses of electric power.

16.1.2. Management of electricity quality is directed to improvement of quality of power supply of consumers, decrease in number of damages to machinery at consumers and in electric grids, and also minimization of damage of consumers owing to the low electricity quality which does not conform to the established requirements. In electric grid it is necessary for management of electricity quality:

- create information base about a condition of electricity quality in ENES;
- create SHC for the automated forming of the reporting on electricity quality in ENES, and also for the automated analysis of electricity quality in network for the purpose of determination of the possible reasons of the lowered electricity quality in network and development of actions for its maintenance in required limits;
- define the principles of interaction of subjects of power industry directed to maintenance of electricity quality in the set limits;

- develop and put into operation a set of the standards directed to maintenance of electricity quality in electric grids in the set limits;
- develop and put into operation the regulatory legal acts providing mechanisms of interaction between subjects of the market of the electric power for maintenance of electricity quality in electric grids in the set limits including taking into account differentiation of extent of influence and responsibility including financial, subjects of the market for influence on electricity quality indicators;
- define contractual commitments regarding electricity quality between PJSC FGC UES and subjects of the market whose power accepting devices are attached to the ENES electric grids;
- develop recommendations about calculations and maintaining the mode of network for maintenance of electricity quality conforming to the established requirements;
- create and regulate in PJSC FGC UES the business processes on management of electricity quality in electric grids creating a complete management system of electricity quality in PJSC FGC UES.

16.1.3. Accomplishment of the listed tasks requires creation of a system for monitoring and managing the quality of electricity which will provide:

- information support and interaction with consumers of service in transmission of electric energy, including at settlement on electricity quality, within agreements of rendering services in power transmission;
- the automated control of the normalized electricity quality indicators in electric grids of different voltage classes on compliance to requirements of regulatory legal acts, standards, agreements of rendering service in power transmission, and also additional electricity quality indicators;
- information support of personnel of PJSC FGC UES for the analysis of electricity quality and development of actions for maintenance of the electricity quality indicators required levels in electric grids.

16.1.4. Technology functions of a system for monitoring and managing the quality of electricity:

- continuous measurements of electricity quality indicators and additional characteristics of electricity quality in electric grid of different voltage classes, including at implementation of interstate overflows of electric power, by means of stationary MI of electricity quality indicators established on SS of electric grids of PJSC FGC UES;
- automatic collecting, transfer from the SS level to the level of the Executive Office of PJSC FGC UES and storage of results of measurements of electricity quality indicators and additional characteristics of electricity quality;
- processing of results of measurements of electricity quality indicators and automatic creation of the standardized reporting on electricity quality in network;
- providing the automated analysis of electricity quality in network for the purpose of determination of the possible reasons and an arrangement of sources of the lowered electricity quality in network;
- visualization of the current and archive results of measurements of electricity quality indicators and additional characteristics of electricity quality;
- ensuring information exchange with other SHC of PJSC FGC UES (industrial control system of SS, automatic process control system and so forth);

metrological support of control of electricity quality.

16.1.5. The system for monitoring and managing the quality of electricity should be under construction as a hierarchical information system taking into account the following requirements:

- ensuring observability of transmission electric grid at the voltage of 110 kV and above on electricity quality indicators established by standards on the basis of specialized MI of electricity quality indicators established permanently on SS of PJSC FGC UES;

- ensuring control of electricity quality on all borders of balance participation of PJSC FGC UES with consumers on the basis of use of multipurpose measuring systems;
- application of the commonly accepted standard protocols of information exchange at automatic control of electricity quality indicators;
- a possibility of scaling of system by integration into it of a large number of the MI of electricity quality indicators;
- measurement of a full range of electricity quality indicators necessary for determination of the possible reasons and an arrangement of sources of the lowered electricity quality in network;
- use of the existing information infrastructure of PJSC FGC UES;
- providing with reference and normative information;
- creation of metrological support of control of electricity quality.

16.1.6. Upon transition to digital architecture of SS functions of a system for monitoring and managing the quality of electricity should be implemented on new technical means of digital SS.

16.2. Monitoring and quality management of the electric power in networks of a distribution network complex

16.2.1. The Regulation in the field of control, monitoring and management of electricity quality in networks of a distribution network complex is directed on:

- providing consumers with electric energy which quality conforms to the established requirements;
- decrease in the damage to machinery of consumers and electric grids caused by a deviation of electricity quality indicators;
- decrease in number of claim addresses (complaints) in consumers to electricity quality
- decrease in level of technology losses of electric power.

16.2.2. Management of electricity quality is directed on:

- timely detection and elimination of the reasons of transmission of electric energy which quality does not conform to the established requirements;
- taking note of electricity quality indicators for work of electric grids and electric equipment of adjacent owners.

16.2.3. For implementation of technical policy accomplishment of the following events is provided:

- the organization of continuous monitoring of electricity quality in networks;
- use of means of metering of electric energy with the certified functions of measurement of electricity quality indicators;
- providing electricity quality, according to the established requirements for consumers and the adjacent network organizations at development and expansion of network;
- completion of the existing standards directed to maintenance of electricity quality in electric grids in the set limits for the purpose of establishment of rated limits of electricity quality indicators for all levels of voltage of a distribution network complex;
- completion of the regulatory legal base regarding determination of necessary and sufficient requirements for differentiation of extent of influence and responsibility, including and financial, subjects of power industry for influence on electricity quality indicators;
- determination of contractual commitments regarding electricity quality between the grid companies and the partner.
- monitoring procedure and monitoring of electricity quality in networks of a distribution network complex;
- holding actions for improvement of electricity quality in networks of a distribution network complex;

- installation of the compensating devices for improvement of indicators of technical and economic efficiency of distribution networks on the basis of management of flows of reactive power;

16.2.4. For implementation of continuous control of electricity quality the technical policy is directed to creation of a monitoring system and management of electricity quality which will allow to solve the following problems:

- operational decision making on implementation of the corresponding plans of the reasons of decrease in electricity quality directed to elimination or localization of influence of these reasons;
- ensuring information support at interaction with consumers on the basis of reliable and legitimate results of measurements;
- creation and maintaining the uniform database on electricity quality.

16.2.5. Technology functions of a monitoring system:

- continuous measurements of the normalized and additional electricity quality indicators in electric grid of different voltage classes, by means of stationary MI of electricity quality indicators established on SS of a distribution network complex;
- collecting and data transmission from all levels of carrying out measurements on the level of management and storage of results of measurements of electricity quality indicators;
- processing of results of measurements and the automated forming of the standardized reporting on electricity quality in network;
- providing the automated analysis of electricity quality in network for the purpose of determination of the possible reasons and an arrangement of the sources influencing lowering of electricity quality in network;
- visualization of the current and archive results of measurements of electricity quality indicators and additional characteristics of electricity quality, including the alarm system of violations of the set limits of electricity quality indicators (contractual, etc.);
- ensuring the automated information exchange with adjacent owners of the power grid equipment regarding electricity quality;

16.2.6. The monitoring system and managements of electricity quality should be under construction taking into account the following requirements:

- measurement of the electricity quality indicators set necessary for determination of probable responsible or the direction on a source of violation of electricity quality indicators,
- metrological support of activities for control of electricity quality;
- a possibility of system operation with permanent or periodic data transmission, and also a possibility of operation of the equipment in the autonomous mode with a sufficient depth of storage of information.

16.2.7. Within creation of information resource in the field of electricity quality in RSK it is necessary to keep the database of a monitoring system and management of electricity quality which should contain:

- information on distribution networks, including schemes of distribution networks, parameters of the capital equipment, and also character and size of loads of consumers;
- results of seasonal calculations of losses of voltage in distribution networks;
- results of control and monitoring of electricity quality;
- information on actions for providing electricity quality to the established requirements in distribution networks with reflection of the schedule of their implementation.

16.2.8. At creation of active and adaptive network control of electricity quality and monitoring should be provided with the technical means implementing this network.

16.2.9. For accomplishment of the Regulation in the field of electricity quality programs of specific actions should be developed and be affirmed and be provided structural support of implementation and operation of necessary systems.

17.Communication networks

17.1. General principles of development of communication networks

17.1.1. The main objectives to which solution the technical policy in the field of development of a communication network is directed:

- coordination of development of telecommunication infrastructure of SDC by the Company and their interaction among themselves;
- the accelerated rearmament and modernization;
- implementation of modern telecommunication and information technologies and expansion of a range of new services
- creation of a single system of management of network resources;
- implementation of advanced technologies of operation with use of modern diagnostic aids, monitoring;
- improvement of normative and technical base and methodical providing.

17.1.2. The communication network of electric grid facilities is a telecommunication infrastructure (software and hardware and communication channels) which provides providing modern information and communication services.

17.1.3. The communication network of electric grid facilities includes a communication network of the main electric grid facilities with access to facilities of ENES and a communication network of the distribution grid companies. The key principle of planning of communication networks of the enterprises of the power grid complex is providing an agreement and synchronization of development plans, and also mutual use of network resources for ensuring uniform technology process and increase in reliability of communication networks.

17.1.4. The communication network is intended for transfer of all types of information (a voice, data, video) for the purpose of ensuring management of technology processes by transmission and distribution of electric power, supervisory control, productive and administrative activity of the Company.

17.1.5. For an exception of influence of administrative activity on management of technology processes of power industry as a part of a communication network distinguish technology and corporate segments which are separated from each other at the physical or logical levels.

17.1.6. The technology segment of a communication network should provide a modern set of communication services with the set service quality indicators, including reliability level necessary and sufficient for normal functioning of the following systems:

- operational and technology systems (most critical quality of network to parameters):
    - systems of relay protection, mode and emergency automatic equipment;
    - subsystems of detectors of emergency events and fault location devices;
    - systems of operational and dispatching office and technology voice communication;
    - automated systems of dispatching and technology management;
    - industrial control system of SS.
    - other technology systems:
    - automated systems of monitoring and quality management of electric power
    - AMI (wholesale market and retail market of electric power, technical metering);
    - monitoring systems and diagnostics of a condition of equipment;
    - an automated system of a digital radio communication with mobile repair personnel.

17.1.7. The technology segment of a communication network should provide transfer of the following types of information:

- telemetry, remote signaling and teams of telecontrol;
- speech information and data for ensuring personnel management on electric power facilities and crews;
- these registration of emergency events and processes, determinations of the place of damage;
- given metering of electric power, configuring and parameters setting of AMI;
- signals and RP and EA commands, these configuring and parameters setting of a system of relay protection of power plants and electrical substations;
- indicators of quality of electric power;
- data of intermachine exchange of systems of technology management.

17.1.8. The corporate segment of a communication network is intended for ensuring management and administrative activity:

- management of financial and economic activity;
- management of maintenance and repairs of the equipment (certification of the equipment, these diagnostics, planning of service and repairs, control of carrying out service and repairs, forming of dresses);
- registration of personnel and payroll calculation;
- inventory management;
- metering of useful issue, calculation of balances and losses of electric power;
- management of new connections;
- document management and maintaining electronic archive;
- means of corporate communications (security video surveillance, video conferencing, voice, text).

17.1.9. The corporate segment of a communication network should provide transfer of the following types of information:

- data of corporate information management systems;
- data of video conferencing and security video surveillance systems;
- data of systems of telephone communication and other types of corporate communications.

17.1.10. At creation and development of a communication network it is necessary to follow the following basic principles:

- construction of networks on technology of switching of packages, on condition of fulfillment of technical requirements on the organization of exchange of technology information between power grid facilities of the Company;
- a possibility of selective change of speed of information transfer according to the simplified procedure for a specific subsystem or service, depending on current demands;
- scalability of network - a possibility of expansion of network without change of the fundamental technical principles of its creation and complete replacement of the channel-forming equipment;
- separation of technology and corporate segments of a communication network at the physical or logical levels;
- ensuring prioritization of data types, critical to delays, due to implementation of mechanisms on quality assurance of service (QoS);
- information security support for the purpose of an exception of unauthorized access to communication network resources;
- invariancy of access - ensuring access of users to the automated and information systems irrespective of the used technology of the organization of communication channels;
- multi-play offerings – simultaneous transfer on network of all types of traffic (voice, data, video);

- intellectuality - a possibility of management of service, a challenge and connection from the user, and also the order of new services with use of automated control systems;
- modernization of network only with technical and economic feasibility;
- decrease in capital and operating costs due to use of the unified prototype solutions and automation of processes of diagnostics and management;
- the organization of interaction with the existing and created communication networks of subjects of power industry, and also with networks of telecom operators;
- use only the opened and standardized protocols and interfaces;
- accounting of forecasts of potential needs for telecommunication and information services for 5-year perspective.

17.1.11. The communication network is divided into the following components:

- primary (main and access) the communication network representing set of the networks, lines and communication channels providing delivery of all types of information;
- the secondary (imposed) networks representing set of the means providing transfer, switching, and distribution of information of a certain type.

17.1.12. For creation of primary communication network and ensuring reservation the following types of networks, lines and communication channels can be used:

- wire:
  - fiber-optic communication links (FOCL);
  - high-frequency communication channels on Conductor (HF-communication);
  - cable communication lines (CCL);
- wireless:
  - radio relay communication lines (RRL);
  - networks of wireless broadband access (BBA);
  - network of a mobile VHF radio communication;
  - network of satellite communication;
  - network of mobile bayular communication.

17.1.13. Besides, in the absence of own telecommunication infrastructure use of leased telecommunication resources of third parties is allowed.

17.1.14. Primary communication network should be organized preferential on ring topology. Besides the following topology of creation of primary network is allowed:

- bayular;
- a point - a point;
- the point - is a lot of points;
- circuit;
- multiple ring.

17.1.15. For ensuring fault tolerance of a communication network technologies of duplication or reservation of the equipment and channels, depending on the used technologies, restrictions on information exchange or economic feasibility should be used.

17.1.16. On the sites of transmission network which are demanding big transmission capacity and/or having perspectives on increase in a traffic use of the equipment of spectral consolidation of xWDM is reasonable. Besides, use of WDM technology is one of methods of logical separation of technology and corporate segments of network, and allows to organize the necessary number of SDH and/or Ethernet channels with a required transmission capacity.

17.1.17. For ensuring the subsequent transfer of a communication network into IP/Ethernet with preserving of earlier made investments it is recommended to use the equipment of communication of SDH or OVT technologies, having the number of Ethernet interfaces, necessary for specific topology of network.

17.1.18. The communication network at all levels of hierarchy of operational and dispatching, technology and corporate management should provide exchange of all types of information (a sound, video, data) with guaranteed quality.

17.1.19. Requirements to the organization of information exchange between electric power facilities of the Company, Grid Control Centre and dispatching centres of JSC SO UES, including requirements to telephone communication for operational talks, should conform to the requirements provided in relevant provisions about information exchange between JSC SO UES and the electric grid companies in the field of exchange of technology information.

17.1.20. Communication channels with electric power facilities are characterized by the following parameters of quality:

- availability;
- availability quotient;
- transmission capacity.

17.1.21. Availability of a communication channel is defined by compliance of parameters of signaling of telecommunication to requirements of regulations of electric parameters of the main digital channels and paths main and intra-zone primary networks of interconnected communication networks of the Russian Federation.

17.1.22. The availability quotient of each direction of exchange of information for technology and corporate segments of a communication network should meet requirements for reliability of the working subsystems of management.

17.1.23. Bandwidth of digital channels should be chosen so that transfer of all traffic of tasks of management with the set quality parameters, including functioning of telephone communication of operation and dispatching personnel, production and technology telephone communication, transfer of telemetric information on technology operating modes of the equipment, the Centralized emergency control systems, etc. was provided.

17.1.24. The equipment and materials used at creation of a communication network should conform to requirements acting with the specifications and technical documentation. Compliance of the equipment should be confirmed with certificates of conformity, and compliance of materials the declarations of conformity issued by federal executive authority in the field of communication.

17.2. Cable communication lines

17.2.1. Continuation of operation of copper CLS is allowed only in economically reasonable cases. At development and modernization of network of communication it is necessary to take CLS out of service with replacement by FOCL, or other types of communication lines.

17.2.2 In exceptional cases applications of CLS for the organization of communication channels should be used xDSL modems. For simplification of routing, unification of network devices and ensuring centralization of management and routing, preference should be given to the xDSL-modems which are built in the network equipment in the form of the interface modules.

17.2.3. Area application of CLS - the main and alternative channels of network of access to objects of all voltage classes.

17.3. Fiber-optic communication links

17.3.1. FOCL are the main method of creation of transmission network of communication.

17.3.2. Construction of FOCL on Conductor 35 of kV above and is performed generally by a suspension bracket of the optical cable which is built in a lightning-protective cable (OPGW).

17.3.3. At construction of FOCL use of the optical self-bearing cable (OKMV), the optical cable which is built in a phase wire of Conductor (OKFP), the optical cable cast over a phase wire or a lightning-protective cable of Conductor (OKNN) is allowed.

17.3.4. Application of OKMV in areas with high extent of industrial pollution, in areas to 5 km from sea and oceanic coasts, and also in areas in a climate zone with the long periods of a drought and the rare periods of rain rainfall and fog is not recommended.

17.3.5. The technology of winding of OKNN on phase wires or the lightning-protective cable (LPC) also has a limited scope. It is allowed having wound an optical cable on a phase wire on Conductor up to 150 kV or GT in areas with an annual average duration of thunder-storms less than 20 watch.

17.3.6. At the FOCL organization on CL it is allowed to apply high-voltage cables of underground or underwater laying with the built-in OK.

17.3.7. The choice like the used cable should be defined by economic feasibility with a condition of Conductor and a possibility of its shutdown for the period of construction and possible repairs of FOCL.

17.3.8. The number of optical fibers in an optical cable and the capacity of systems of transfer is defined at a development stage of a design assignment or design with the current and perspective demand.

17.3.9. The FO parameters should correspond to GOST R IEC 793 and recommendations of MSE-T G.652, G.653, G.654, G.655. Individual requirements to the FO parameters should be specified at a development stage of the project documentation of a system of the information transfer realized by specific FOCL-Conductor.

17.3.10. Construction of FOCL-Conductor with attraction of extra tariff investments of third parties (telecom operators) by providing by it in temporary limited use of power grid infrastructure for the purpose of a suspension of FOCL is allowed.

17.3.11. Construction of FOCL should be performed preferential by the ring principle of consolidation of communication centres for ensuring physical reservation of communication channels.

17.3.12. For a construction of FOCL use of several Conductor of a different class of voltage matching in the directiROW FOCL is allowed.

17.3.13. At placement on Conductor of a fiber-optical cable, by production of design and exploration work inspection of a condition of the bases and a metalwork of support and their fixing in soil taking into account the additional loadings arising at installation of a fiber-optical cable should be executed.

17.3.14. During creation of FOCL the choice of technology for information transfer is performed at a design stage taking into account the current and perspective purpose of the communication line and types of the transferred traffic.

17.3.15. Design, construction and operation of FOCL-Conductor should be performed according to the following regulating documents:

- "Rules on labour protection at operation of electric installations" (N 328 N are approved by the Order of Ministry of Labor of Russia of 24.07.2013);
- Regulations for electrical installation (Electrical Installation Code, the acting heads);
- CO 153-34.48.519-2002 "Rules of design, construction and operation of fiber-optic communication links on overhead-lines of electricity transmission of 0.4-35 kV";
- CO 153-34.48.518-98 "Rules of design, construction and operation of fiber-optic communication links on overhead-lines of electricity transmission of 110 kV and above";
- STO 56947007-33.180.10.172-2014 "Technology communication. Rules of design, construction and operation of FOCL on overhead-lines of electricity transmission of 35 kV and above";
- STO 56947007-33.180.10.173 – 2014 "Methodical instructions by calculation of thermal influence of the currents of short circuit and thermal stability of the lightning-protective cables and optical cables which are built in a lightning-protective cable, suspended on electricity transmission overhead-lines";

- STO 56947007-33.180.10.171-2014 "Technology communication. A standard of the project documentation on construction of FOCL-Conductor with OKMV and OPGW";
- STO 56947007-29.060.50.122-2012 Guide to calculation of the modes of melting of ice on a lightning-protective cable with the built-in optical cable (OPGW) and to use of the distributed controller of temperature of OPGW in the melting mode;
- STO 56947007-33.180.10.174-2014 "The optical cable which is built in a lightning-protective cable, the voltage and supporting clips, couplings for the FOCL-Conductor organization on power lines of 35 kV and above. General specifications";
- STO 56947007-33.180.10.175-2014 "The optical nonmetallic self-bearing cables, the voltage and supporting clips, couplings for the FOCL-Conductor organization on power lines of 35 kV and above. General specifications";
- STO 56947007-33.180.10.176-2014 "The optical cable which is built in a phase wire, the voltage and supporting clips, couplings for the FOCL-Conductor organization on power lines of 35 kV and above. General specifications";
- STO 56947007-29.240.55.192-2014 of "Regulation of process design of overhead-lines of electricity transmission of 35 - 750 kV".

17.3.16. Executive documentation should be executed according to requirements leading documents RD 45.156-2000 and RD 45.190-2001.

17.3.17. Taking into account increased requirements to reliability of operation of transmission network, determination of expediency of installation of automated systems of monitoring of the optical fibers allowing to conduct in real time monitoring of a condition of physical parameters of optical fibers is necessary.

17.3.18. For the purpose of unification of technical operation and for a possibility of carrying out certification, planned measurements and measurements in the course of carrying out emergency recovery operations optical fibers and modules in FOC should have the following coloring: blue, orange, green, brown, gray, white, red, black, yellow, violet, pink, turquoise.

17.3.19. The basic principles and directions of development of FOCL are:

- creation of new physical high-speed communication channels for power infrastructure facilities;
- providing and control of quality of performance of works at design stages and implementation of construction of FOCL on Conductor;
- at construction and development of FOCL attraction of extra tariff investments of telecom operators, the energy industries organizations and others - FOCL having own infrastructure with which long-term mutual exchange of optical fibers and telecommunication resources on a contractual basis is also possible is allowed;
- transition from the TDM equipment to systems of transfer with switching of packages.

19.3.20. A scope of FOCL - a priority type of infrastructure for creation of transmission network and network of access of communication to objects of all voltage classes.

17.4. Radio relay lines and networks of wireless broadband access

17.4.1. Application of digital RRL in cases of technical and economic feasibility is allowed. For example, at the organization of communication in the remote and hardly accessible area where construction of FOCL is complicated.

17.4.2. Methods of reservation of RRL:

- according to the scheme 1+0 for the organization of alternative channels of communication on the main directions at impossibility, or economic inexpediency of construction of FOCL on ring topology;
- according to the scheme 1+1 for the organization of channels of network of access to the most significant objects.

17.4.3. The main requirements to RRL are regulated by GOST R 53363-2009, besides:

- speed of transfer of the main traffic on sites of transmission network: not less than 100 Mbps, at the same time in cases of technical and economic feasibility are allowed application of digital RRL of smaller transmission capacity;
- the used technologies: switching of packages, channels (TDM), or hybrid.

17.4.4. Obtaining permissions about allocation and assignment (appointment) of radio frequencies for power grid facilities is performed according to Decisions of State Committee of Radio Frequencies:

- The decision of State Committee of Radio Frequencies of 20.12.2011 No. 11 - 13-01 (edition of 10.02.2015) "About the statement of the Order of consideration of materials and decision makings about allocation of strips of radio frequencies, renewals of decisions and introduction of changes in them";
- The decision of State Committee of Radio Frequencies of 20.12.2011 No. 11-13-02 (edition of 10.02.2015) "About the statement of the Order of conducting examination of a possibility of use of the declared radio-electronic means and their electromagnetic compatibility with the radio-electronic means operating and planned for use, considerations of materials and decision making about assignment (appointment) of radio frequencies or radio-frequency channels within the allocated strips of radio frequencies".

17.4.5. Scope of RRL: main and alternative channels of communication of transmission network and network of access to objects of all voltage classes.

17.4.6. Use of the equipment of BBA is most reasonable in the presence of the existing infrastructure: the antenna and mast constructions, buildings and other constructions suitable for placement of antennas and the radio-transmitting devices at necessary height, proceeding from economic and technical case.

17.4.7. Requirements to the equipment of BBA:

- possibility of work on the scheme "point-to-point" and "point multipoint";
- range of working frequencies: is defined by design. The recommended range: 5150 – 5350 MHz and 5650 - 6425 MHz.

17.4.8. The equipment of BBA is recommended to be used at creation of network of access to objects of all voltage classes, to the organization of technology and corporate communication channels, and also to the organization of "the last mile" with administrative and economic objects of power supply systems, to nodes of telecom operators.

17.5. Systems of high-frequency communication on electricity transmission overhead-lines

17.5.1. Systems of high-frequency communication are applied to management of technology processes, both in normal conditions, and at emergencies. On these channels all types of information necessary for this management are transferred:

- Speech (telephone communication);
- Telemechanics signals;
- Data of intermachine exchange;
- Data of the automated process control system (Industrial control system);
- Data of the automated information and measuring system of commercial metering of electric power (AMI);
- Signals of differential and phase protection and protection with HF blocking (remote and directed);
- Commands of a device for transmission of emergency and control signals (relay protection (RP) and emergency automatic equipment (EAE)).

17.5.2. HF channels of communication use as the environment of transfer (communication line) phase wires and lightning-protective cables of Conductor from 6 kV and above.

17.5.3. Application of digital HF of communication is reasonable on network sites where it is required to transfer the limited amount of information, and application of other types of communication does not provide necessary reliability of information transfer or is economically inexpedient. Handling capacity of digital paths of HF of communication is defined by a settlement way at a design stage, with features of the equipment, a condition of Conductor, availability of taps and additional attenuation caused by weather conditions and breaks of Conductor. On Conductor 35 of kV and higher the speed of transfer is also limited to availability of free frequencies in the range of 16 - 1000 kHz.

17.5.4. Depending on the used strip of frequencies the HF equipment allows to provide information transfer with a speed up to several hundred kbps.

17.5.5. In economically reasonable cases use of the combined HF-communication equipment (simultaneous voice transfer, data, signals of relay protection and emergency automatic equipment) with a condition of priority signaling and the RP and EA commands is allowed.

17.5.6. HF communication channels should be organized taking into account providing a stock on the blocked attenuation at adverse weather conditions (fog, a drizzle, ice, a rain). For signaling and the RP and EA commands HF channels should provide communication on Conductor in addition a stock on the blocked attenuation at possible short circuit on Conductor. At the organization of communication channels conditions on ensuring electromagnetic compatibility should be satisfied.

17.5.7. The basic principles and directions of development of the HF lines of communication is increase in functionality, reliability and quality of HF of communication, namely:

- implementation of the multipurpose digital systems meeting modern increased requirements to HF channels of communication (progressive types of modulation, algorithms of noiseproof coding, etc.);
- implementation of the HF specialized channels of communication for HF of protection and emergency automatic equipment with digital processing of the signals meeting modern increased requirements to channels of such type;
- a removal from operation of the HF outdated analog equipment of communication and step-by-step replacement with the HF modern systems of communication allowing to work both in digital and in analog the modes;
- application of digital processing of a signal in the paths of transfer and acceptance of the equipment providing effective use of a frequency resource of HF channels of communication due to increase in selectivity of the equipment and more effective use of a nominal strip of frequencies of the channel;
- creation of the Unified information system at the choice of frequencies of HF channels of communication.

17.5.8. Networks 6-10kB of the HF system of communication are applied to the organization of communication channels with electric power facilities and with electric power metering devices.

17.6. Network of a mobile radio communication

17.6.1. The network of a mobile radio communication should develop by expansion of a zone of a radio covering and replacement of outdated analog radio stations by modern digital. At modernization of analog systems of a mobile radio communication for creation of a radio network of the PD level (Distribution Zone, PMES) the digital DMR standard allowing to perform gradual refusal of analog network of a VHF radio communication with preserving of earlier made investments should be the fundamental standard.

17.6.2. The system of a mobile radio communication of the DMR standard should incorporate a subsystem of determination of location of terminals (both wearable radio stations, and

established in motor transport) and displays of locations on the screen of a workplace of the dispatcher.

17.6.3. The applied radio stations should have a possibility of operational change of working frequencies for the purpose of their use in other radio networks at elimination of emergencies. Radio stations of the DMR standard should have the GLONASS receiver for determination of location of the terminal.

17.6.4. The resource of the charged accumulator of wearable radio station should ensure its autonomous functioning within 12 hours during the work in a cycle 5/5/90 (transfer/reception/standby).

17.6.5. Obtaining permissions about allocation and assignment (appointment) of radio frequencies for power grid facilities is performed according to Decisions of State Committee of Radio Frequencies:

- The decision of State Committee of Radio Frequencies of 20.12.2011 No. 11 - 13-01 (edition of 10.02.2015) "About the statement of the Order of consideration of materials and decision makings about allocation of strips of radio frequencies, renewals of decisions and introduction of changes in them";
- The decision of State Committee of Radio Frequencies of 20.12.2011 No. 11-13-02 (edition of 10.02.2015) "About the statement of the Order of conducting examination of a possibility of use of the declared radio-electronic means and their electromagnetic compatibility with the radio-electronic means operating and planned for use, considerations of materials and decision making about assignment (appointment) of radio frequencies or radio-frequency channels within the allocated strips of radio frequencies".

17.6.6. The mobile radio communication is a fixed asset of communication of dispatching and operation personnel with personnel of linear and emergency and recovery crews, and also the reserve means of communication for operational and technology management of distribution electric grid.

17.6.7. Application of stationary radio stations and VHFs radio modems for the organization of the main and alternative channels of data transmission with objects of low and middle voltage, for the organization of alternative channels of communication with objects 35 – 110 kV is allowed if use of other technologies of data transmission, it is impossible, or it is economically inefficient.

17.7. Network of satellite communication

17.7.1. Channels of the fixed satellite service can be used as one of the communication channels (no more than one channel in one direction) on condition of fulfillment of requirements shown to the organization of telephone communication for operational talks and information transfer to the automated and automatic management systems if use of other technologies of data transmission, it is impossible, or is economically inefficient.

17.7.2. Besides, the network of satellite communication is reserve means, and in the absence of network of a mobile radio communication is a fixed asset for communication of dispatching and operation personnel with personnel of linear and emergency and recovery crews.

17.7.3. The basic principles and directions of development of network of satellite communication are**:**

- implementation of the modern systems conforming to the requirements established by the Ministry of information technologies and communications of the Russian Federation;
- rigid control of qualitative indexes of channels (agreement on the level of services of service, SLA);

- transfer of channels of satellite communication in the mode of operational readiness in case of availability of channels of a fixed telephony;
- regional development based on one operator and uniform technology.

17.8. Network of telephone communication

17.8.1. The network of telephone communication also consists of corporate and technology segments.

17.8.2. The corporate segment of network of telephone communication is intended for ensuring productive (administrative) activity of power industry, including voice transfer. The corporate segment should develop by substitution of subscriber devices IP terminals and use of the switching equipment interacting with terminals under the MIW and H.323 protocol.

17.8.3. The main objectives of development of a corporate telephone network are:

- creation of uniform corporate network of telephone communication on the basis of a corporate multiservice communication network;
- implementation of a unified plan of numbering;
- implementation of the distributed IP-ATC consisting of the central module of system and media gateways. At the same time in case of temporary unavailability of the central automatic telephone exchange media gateways should independent IP-ATC with providing basic voice services;
- use of the MIW and H.323 protocols;
- application of rated compression (G.726 and G.729 codecs);
- implementation and development of a single system of management and monitoring at the level of the central automatic telephone exchange;
- convergence with other types of communications (implementation of technologies of the unified communications).

17.8.4. The technology segment of network of telephone communication, including communication for conducting operational talks, is intended for ensuring management of technology processes.

17.8.5. Telephone communication for conducting operational talks should provide transfer of commands and operational interaction of operation personnel of Grid Control Centre, operation personnel of electric power facilities, dispatchers of JSC SO UES. Not less than two telephone communication channels should be provided for its organization.

17.8.6. Telephone communication for conducting operational talks should be constructed on technology of circuit switching (TDM – Time Division Multiplexing) with forced release of the busy channel with an opportunity in the subsequent smooth and phased transition to technology of package switching (MPLS VPN, Traffic Engineering). At the same time strict requirements on reliability and fault tolerance, both separate nodes, and all network in general are imposed to telephone communication for operational talks. The channel and technical resources allocated under these tasks should provide the guaranteed delivery and quality in normal and emergency operation of work of electric power facilities with use of technology of switching of packages.

17.8.7. The equipment used for creation of a technology segment of network of telephone communication should have 100% reservation in the "hot" mode of processor resources of the station, the interface cards, interfaces and power supply units, and also should be certified for application on electric grid facilities.

17.8.8. For the organization of telephone communication for conducting operational talks the radial and nodal topology with addition of ring topology is used that most fully reflects hierarchy of dispatching and technology management of power industry.

17.8.9. At digitalization of technology and corporate segments of a telephone network of networks transition to an open numbering system with exit prefixes should be implemented: two -

three - or the four-digit reduced numbering at intra station communication and uniform seven-digit numbering at interexchange communication. The principles of forming of a unified plan of numbering should correspond to STO 56947007-33.040.35.203-2015 "Technology communication. Guidelines on a single system of numbering of automatic telephone exchange of power grid facilities".

17.9. Data transmission network

17.9.1 Infrastructure of a data transmission network carries out a role as primary (main and network of access), and secondary network, providing applied tasks of transfer of different types of data.

17.9.2. At implementation of separation of segments of a data transmission network at the logical level actions for safe interface of networks, including segmentation and firewalling should be provided. At the same time the organization of interaction of systems in different objects should expel initiation of connections from one network in another.

17.9.3. Requirements to the equipment of data transmission of a node of transmission network:

- reservation of processor modules and power supply units;
- support of MPLS and MPLS L2/L3 VPN technologies;
- support of MPLS TE and TE FRR technology;
- support of big tables of routing of IPv4 and IPv6 (> 100 000 routes);
- support of mechanisms of service quality of a network traffic (QoS) and hierarchical politician of service quality (H-QoS);
- support of protocols of quick detection of breaks of communication channels of linear reservation by means of aggregation of communication channels (LAG, mcLAG, etc.);
- when using ring topology time of transition to an alternative channel should make no more than 100 ms;
- support of dynamic routing under the OSPF, BGP protocols;
- a possibility of work on copper and optical communication channels, including on one-fiber;
- support of the standard MVMP protocol with a possibility of remote management;
- classification of a traffic of IEC 61850 MMS, GOOSE;
- power supply from network of direct current of 24 or 48 V, and also from the alternating current main from 190 to 250 Century.

17.9.4. Requirements to the equipment of data transmission of a node of network of access:

- support of mechanisms of service quality of a network traffic (QoS);
- a possibility of work on copper and optical communication channels, including on one-fiber;
- support of the standard MVMP protocol with a possibility of remote management;
- classification of a traffic of IEC 61850 MMS, GOOSE.

17.9.5. Additional requirements to the data transmission equipment:

- at installation on SS - compliance to requirements of the IEC-61850-3 and IEEE-1613 standards, in case of the feasibility justification;
- expanded set of interfaces: Gigabit Ethernet, Fast Ethernet, FastEthernet with POE (for access nodes), RS-232, RS-485, E1Channelized;
- support of lists of access for filtering of a network traffic (ACL – Access Control List).

17.9.6. The data transmission network should develop according to the following basic principles and directions:

- use of prototype solutions;

- distribution of a traffic on all available network resources at an overload of the main channel (balancing of loading);
- classification of a traffic by degree of criticality and corresponding prioritization;
- creation and implementation of a single system of management and monitoring at the level of the branch of the Company with the notification of executive office of the Company about critical events;
- use for all enterprises of the unified standard plan of IP addressing.

17.9.7. Planning of address space of IP network should be performed according to the following basic principles:

- ensuring the hierarchical centralized distribution of addresses with allocation of subnets for different technology and corporate segments of a communication network, and also for groups, categories of objects and users;
- ensuring sufficiency of quantity of IP addresses taking into account perspective development of enterprise and technology systems, and also communication networks in general;
- ensuring minimization of a traffic and influence of separate segments, nodes of network or groups of devices on performance of all network in general.
- ensuring controllability of network, both in the normal mode of network, and in case of failures;
- prohibition on broadcast of addresses of a technology segment and a segment of management of network in addresses of public networks.

17:10. Network of a video conferencing

17.10.1. The system of a video conferencing (VCS) should provide the organization of video conferences for the hierarchical principle according to an organizational structure of the grid companies.

17.10.2. For ensuring optimum quality in the equipment of VCS mechanisms of automatic adaptation of parameters of coding depending on available bandwidth and quality characteristics of a communication channel should be implemented.

17.10.3. The VCS system should provide:

- registration of program and hardware video terminals and management of calls for digital exchange;
- connection of removed video clients from external networks, including the Internet;
- carrying out video conferences in the mode of multi-address mailing (multicast);
- the uniform and centralized management of use of bandwidth of communication channels for services of telephony and VCS;
- an opportunity for users of interactive management from the video terminal panel the layout of the screen, content and the participant list;
- central planning, management of sessions of VCS and monitoring of the equipment of VCS;
- record on electronic media of the carried-out video conferences;
- ensuring confidentiality of the carried-out video conferences;
- use of the equipment of VCS for carrying out interactive training;
- support of quality of voice transfer and video HD (720r) at the level of executive office of the Company and not below 4CIF at the level of branches is not lower;
- support of joint operation with documents.

17:11. Communication network management system

17.11.1. Control of communication networks of the grid companies should be exercised with use of centralized systems of the PE (Distribution Zone/MES/PMES) level in which the following functions should be implemented:

- configuring, monitoring and management of malfunctions;
- management of inventory (metering of physical and logical resources of network);
- management of performance (monitoring of parameters of network and productivity analysis);
- control of accomplishment of tasks of elimination of malfunctions;
- quality management of the provided services (SLA);
- security management (access control to resources of network).

17.11.2. In a management system two logical levels of network management described in the concept of TMN should be supported by a communication network (A management system networks of operators of telecommunication):

- Network management layer (NML) – the level of management of network;
- Element management layer (EML) – the level of management of elements of network.

17.11.3. Level of management of network should allow to see all network in general, to manage it and its separate elements, to control its state in general.

17.11.4. Level of monitoring and management of elements of network should allow to perform tracking parameters and management of separate elements of network, including event management and mistakes, reservation, collecting, primary diagnosing and storage of events from elements of network, ensuring support hardware and the software.

17.11.5. All information, necessary for management of network, should be had in the uniform database which can change and be replenished with descriptions of new objects of management, and all exchange of office data of a management system should be performed with use of the existing managed network.

17:12. Network of clock network synchronization

17.12.1. For a communication network of the main electric grid facilities CNS network with the primary reference generator and secondary reference generator should be created, at the same time CNS network should work with basic network of CNS of PJSC Rostelecom in the pseudo-synchronous mode and together with it to make system of clock network synchronization of a communication network of the Company. On a communication network of a distribution network complex it is inexpedient to install own primary reference generators (PRG) and the secondary master frequency generators (MFG). The basic network in branches of the Company is recommended to be connected to CNS of PJSC Rostelecom, or to CNS of the main power grid complex.

17.12.2. The network of the clock network synchronization (CNS) should be designed for a long-term outlook, be based on the most advanced technology solutions and represent extensive homogeneous network of forming, delivery and distribution of synchronization signals.

17.12.3. Basic purpose of the CNS network is ensuring installation and maintenance of a certain clock frequency of digital signals which are intended for digital switching and digital transit temporary ratios between these signals did not go beyond certain limits.

17.12.4. Reliability and survivability of the CNS network should be guaranteed by uniformity of a communication network, availability of direct and reserve ways of synchronization,

additional signals from the GLONASS receivers as a part of primary reference generator and secondary reference generator, use in emergencies of the combined CNS system operating mode - on hierarchies "the leader - conducted" and "the distributed primary reference generator". Synchronization should be performed on a forced method with respect for the hierarchical principle according to the tree (radial and nodal) chart without the closed rings.

17.12.6. The basic principles of creation of the CNS network of digital communication networks should conform to the requirements of the Leading technical material for creation of CNS on a digital communication network of the Russian Federation approved by the decision of State Commission on Telecommunications of Russia 01.11.1995.

17.12.7. The quality determined by a source of these signals should be appropriated to signals of synchronization. Qualitative indexes of the CNS network should correspond to RD. 45.230-2001, to recommendations of MSE-T 6.811. 6.812, 6.813 and to the ESE 300 462-1.23.4.5.6 standards.

18.Management of production assets

Management of production assets of the Company and SDC is understood as systematic, regular and coordinated activities for finding of optimum balance between costs, observance of normative requirements to assets, perspectives of development of network, on the one hand, and the risks connected with ensuring reliable power supply of consumers, and also requirements of regulating authorities, on the other hand, for achievement of strategic objectives of the Company.

18.1. Purposes of management of production assets

18.1.1. The purposes of management of production assets are:

- ensuring the established level of reliability of the rendered services and quality of electric energy;
- increase in efficiency of the operating and investment costs connected with production processes;
- increase in transparency of productive activity;
- ensuring transparent justification of price level on the basis of a ratio of dynamics of indicators "reliability – costs";
- ensuring innovative development of electric grid facilities.

18.2. Principles of management of production assets

18.2.1. The principles of management of production assets of the Company created on GOST R 55.0.01-2014, GOST R 55.0.02-2014, GOST R 55.0.03-2014:

- orientation to achievement of strategic objectives of the Company and SDC;
- unambiguous distribution of powers and spheres of responsibility for performance of works on processes of management of production assets;
- making decision on impact on the equipment and its inclusion in schedules and plans of repairs and maintenance, and also investment programs (the subsections "Modernisation and Reconstruction" (hereinafter – retrofitting and reconstruction)) on the basis of an optimum ratio between costs, production characteristics of assets and risks for lifecycle with observance of normative requirements to assets, conditions of perspective development of network and requirements of ensuring reliable rendering services;
- systemacity of decision making on management of production assets on the basis of the uniform principles and rules;
- uniformity of processes and control techniques production assets;
- orientation to obtaining steady result of management of production assets due to obtaining positive effects as in short-term, so in medium-term and long-term perspectives and formations is more whole in the operational and investment directions of management of production assets in total for all lifecycle of assets.
- creation and implementation of a management system of production assets (hereinafter – SUPA) in all SDCs of the Company. SUPA is an integral part of the general management system of the Company and SDC.

18.3. Problems of development of a management system of production assets

18.3.1. Problems of development of SUPA:

- development and unification of organizational and normative and methodical base of management of production assets;

- removal of the existing restrictions of regulatory legal acts and the specifications and technical documentation on a possibility of change of frequency of service and repairs of the equipment and the power transmission line depending on technical condition;
- consecutive transition from system of scheduled preventive rendering impact on assets to risk to the oriented asset management;
- development of a system of indicators of the activity regarding management of production assets at the corporate, functional and operational organizational levels allowing to carry out assessment and comparison of companies on separate processes, and also system technical and economic characteristics for the subsequent adoption of management decisions;
- automation of the main and SUPA providing functioning processes according to the principles of management of production processes.

18.3.2. The organization of development of SUPA and the sequence of accomplishment of tasks of SUPA are defined by the Concept of development of SUPA of PJSC Rosseti and SDC, the Standard development plan for SUPA of PJSC Rosseti and its SDC, and also scheduled plans of development of SUPA of SDC.

18.3.3. Control of implementation of the Regulation regarding management of production assets should be provided due to carrying out internal audits, the regular reporting of SDC on accomplishment of scheduled plans of development of SUPA and building of a system of assessment of the key performance indicators (KPI) of processes at all levels of management of the Company and SDC. Assessment of the level of development, degree and quality of objectives within development of SUPA is performed on the basis of models of assessment of maturity and efficiency of SUPA.

18.4. Main functional areas of a management system of production assets

- management of operating activities regarding maintenance and repair (hereinafter – maintenance and repair) and the investment management regarding retrofitting and reconstruction (on planning and assessment of effectiveness of performance of works);
- management of normative and methodological and procedural ensuring processes of management of production assets;
- management of databases of automated control systems for production assets;
- management of technology solutions and IT infrastructure;
- personnel management and organizational support of processes of maintenance and repair and retrofitting and reconstruction.

18.5. Management of operating activities regarding maintenance and repair and the investment management regarding modernization and reconstruction

18.5.1. High-quality planning and timely carrying out maintenance and repair and retrofitting and reconstruction of the equipment is the key to maintenance of electric grids being able, capable to provide the required level of reliability and quality of power supply of consumers.

18.5.2. Increase in efficiency of maintenance and repair and retrofitting and reconstruction is provided due to implementation of the uniform principles and approaches to planning processes, the organization and performance of works for repairs, maintenance (including to diagnostics, inspection and survey of the equipment), and also to processes of control and efficiency evaluation of accomplishment of maintenance and repair and retrofitting and reconstruction.

18.5.3. Long-term schedules, annual and monthly plans of repairs and maintenance of production assets, and also investment programs for tariff regulation taking into account technical condition of assets, and also requirements for frequency of service and repairs, requirements of

manufacturing plants, requirements and instructions of supervisory authorities, actions of target programs for increase in reliability are developed and are affirmed as SDC.

18.5.4. Planning of maintenance and repair and retrofitting and reconstruction should be performed on the basis of the following principles:

- evaluating and the analysis of parameters and indicators of technical condition of the equipment, buildings and constructions by results of diagnostics before rendering impact on the equipment;
- evaluating and analysis of effects and risks of equipment failures and technology violations;
- prioritizing of the equipment on the basis of assessment of technical condition and effects of refusal;
- decrease in level of risks at equipment failures;
- observance of budget restrictions;
- metering of target programs for increase in reliability;
- providing cost optimization on maintenance and repair and retrofitting and reconstruction by means of a combination of outsourcing or insourcing (economic method) during the choice of suppliers (internal and external) resources and services;
- prioritizing of investment projects taking into account criteria of technical condition, economic feasibility, change of requirements to reliability of power supply, perspective and innovative development of network;
- providing address orders for material resources for the maintenance and repair and retrofitting and reconstruction programs;
- minimization of illiquid warehouse stocks;
- metering of need for motor transport and specialized equipment, and also justification of requirement of their acquisition;
- control of results of accomplishment of maintenance and repair and retrofitting and reconstruction.

18.5.5. Development and improvement of uniform normative and technical, procedural, methodical documentation, and also documentation on accomplishment of repairs in SDC, optimization of an emergency reserve of the equipment and elements of the power transmission line are performed within SUPA on the basis of the general principles of SUPA established by the Regulation.

18.5.6. The organization and accomplishment of maintenance and repair and retrofitting and reconstruction are performed on the basis of the following principles:

- accomplishment of long-term schedules, annual and monthly plans of maintenance and repair, investment programs with the minimum deviations of the actual technical and economic performances from planned before transition to risk to the oriented asset management;
- organization of emergency and recovery repairs;
- organization of operational service of power grid facilities;
- ensuring safe works, including providing operational personnel with all necessary remedies for safe operation;
- carrying out engineering certification of the equipment, the power transmission line, buildings and constructions which passed normative service life for prolongation of life;
- performing comprehensive examination of buildings and constructions on power grid facilities;
- application for work of modern, hi-tech and safe tools, devices and the equipment;
- accomplishment of repairs of electric grids energized;
- according to design features, technology and conditions of production of works, a management structure in SDC the maintenance and repair organization needs to be performed by forces of the personnel prepared and undergone certification specializing in carrying out all work types;

- availability of normative and technical and organizational and administrative documentation, maintaining operational documentation in full according to requirements of "Rules of technical operation of power plants and networks of the Russian Federation", factory maintenance instructions of the equipment, instructions for repair and other technical documentation;
- availability in the required volume of necessary processing equipment, tools and devices, materials and spare parts for accomplishment of maintenance and repairs of the equipment, buildings and constructions;
- application of modern techniques and technologies (including mechanization) at performance of works;
- organization and performing diagnostics and control of technical condition of the equipment;
- implementation of modern methods and tools for performing diagnostics and control of technical condition of the equipment, buildings and constructions;
- availability of effective system of internal technical control.

18.5.7. Improvement of methods of the organization and process management of accomplishment of maintenance and repair and retrofitting and reconstruction is carried out taking into account the general principles of SUPA established by the Regulation.

18.5.8. Control of accomplishment and efficiency evaluation of management of production assets are performed on the basis:

- control of results of achievement of goals of SUPA on processes of maintenance and repair and retrofitting and reconstruction;
- formations of model of a maturity and criteria of efficiency of maintenance and repair and retrofitting and reconstruction, and also assessment of observance of achievement of key performance indicators on all processes and subprocesses of SUPA at the different levels of management;
- developments and deployments of criteria for efficiency evaluation of maintenance and repair and retrofitting and reconstruction;
- organizations of assessment and analysis of indicators of reliability and quality of power supply of consumers;
- modeling of indicators of reliability of rendering services when planning retrofitting and reconstruction;
- organizations of control and analysis of breakdown rate of the equipment;
- carrying out collecting and the analysis of parameters and indicators of technical condition, risks (effects and probability) of equipment failure, technical condition of buildings and constructions before rendering influence;
- ensuring address metering of orders for material resources, time and the volume of performance of works according to the maintenance and repair and retrofitting and reconstruction programs;
- review of approaches to forming and resuming of a reserve of the materials and spare parts necessary for work on the basis of a technical state and risks.

18.5.9. Results of assessment and efficiency analysis of maintenance and repair and retrofitting and reconstruction are a basis for statement of the KPI target values on processes of maintenance and repair and retrofitting and reconstruction of future periods.

18.6. Management of normative and methodological and procedural ensuring processes of management of production assets

18.6.1. Function of normative and methodological providing consists in requirements management to assets and network through creation of technical and financial scenario conditions, and also through creation of harmonious system of the documents covering processes of SUPA on all organizational vertical of the Company and SDC for achievement of acceptable performance

indicators, technical parameters of network, reliability, safety and quality of power supply of consumers.

18.6.2. The normative and methodological documents developed within processes by SUPA should conform to requirements of transparency, addition of each other and consistency, to be reviewed regularly according to change of level of a maturity of SUPA.

18.6.3. Development and unification of the SUPA normative and methodical base is one of controlling mechanisms production assets. Work in the field of improvement of normative and methodical documentation assumes participation of specialists and experts of the Company and SDC, and also involvement of the research organizations for use in the power grid complex of the best practice of asset management, including regarding forecasting of reliability of transmission and distribution networks and reliability of rendering services depending on technical condition of the equipment and limits of financing of maintenance and repair and retrofitting and reconstruction.

18.6.4. One of key tasks regarding normative and methodological providing is creation of normative fixed possibility of change of frequency of service and repairs of the equipment and the power transmission line depending on technical condition through the proof of efficiency and the maximum use of opportunities and benefits of rendering impact on assets on technical condition.

18.7. Management of databases of automated control systems for production assets

18.7.1. Management function and development of the SUPA databases is assigned to the operating units which are responsible for collecting and maintaining data on profile questions and also to the divisions which are responsible for information technological support of processes of SDC. Function of unification and creation of uniform reference books and qualifiers of the normative reference information (NRI) for Company and SDC is assigned to the relevant operating units of the Company.

18.7.2. Generally, qualifiers and reference books of normative reference information can be the following types:

- qualifiers and reference books of level of the Company on the basis of which control of the main production indicators will be carried out and to be carried out carrying out a benchmarking of SDC;
- qualifiers and reference books of the SDC level of the Company which are addition of NMI of the Company and are intended for implementation of the SDC managerial function of the Company and operating activities of branches;
- system reference books – reference books which updating is made upon change of regulatory legal acts and the specifications and technical documentation (All-Russian Classifier of Political Subdivisions, Russia Classifier of Building Construction Materials, units of measure, etc.).

18.7.3. Forming of databases should be based on the principles of systemacity of storage, integrity and safety of use, not duplication for use in different information systems, reliability, qualities of entering and display of data, not distortions, relevance, timeliness of entering and issue, a regularity, simplicity and speed of updating, sufficiency and not redundancy, a data acquisition possibility according to all required and described requests.

18.8. Management of technology solutions and IT infrastructure

18.8.1. Main objectives of implementation of new information technologies in processes of SUPA and automation of SUPA are:

- work performance improvements, decrease in use of "human resource" for accomplishment of unproductive handwork when carrying out calculations and filling required reports;

- increase in "transparency" of adoption of technical and economic decisions on need, terms and volumes of rendering impact on assets;
- increase in "transparency" of costs for accomplishment of maintenance and repair;
- need of planning and metering of carrying out repairs, maintenance, modernization or replacement of the equipment.

18.8.2. The SUPA main directions regarding automation are:

- integration of information systems SDC by means of which automation of processes of SUPA with information systems of the adjacent and providing SUPA of processes is performed;
- automation of planning of physical volumes, costs and resources for the organization, accomplishment and control of implementation of the production program;
- automation of primary technical documentation at the level of SW/Distribution Zone, including automation of forming of electronic passports of SS and the power transmission line;
- implementation of automation of processes of assessment of technical condition, effects of refusal and probability of equipment failure on the basis of creation of uniform databases of results of measurements, tests, databases on SDC about consumers and databases of financial and economic activity, forming of production programs and control of their accomplishment;
- automation of processes of collection of information for reasonable planning, operational planning of works and resources on places, operational data collection upon the performed works, to the used time of resources and applied in processes of maintenance and repair and retrofitting and reconstruction of materials;
- implementation of automation of processes of forming and approval of acts of the performed works, related documents, source metering documents by means of the existing automated systems of document flow;
- building of a system of the analytical reporting of the top level of SUPA.

18.9. Personnel management and organizational support of processes of management of production assets

18.9.1. Management functions by personnel within SUPA provide:

- fixing of an organizational structure, role, duty and powers of the personnel participating in processes of SUPA at the different levels should be documentary recorded, the personnel should be informed on them;
- ensuring compliance by personnel and contractors of the Regulation regarding management of production assets and provisions of other normative and methodological and regulatory documents of SUPA;
- ensuring processes of management of production assets with qualified personnel at the expense of the organization of regular activities for training, advanced training of personnel, refining of roles, tasks, requirements to the number of personnel and requirements to the volume of the general and special knowledge;
- building of information exchange between the employees involved in processes of management of production assets on all organizational vertical of the Company and SDC and also with the outer concerned parties;
- safety of personnel.

18:10. The expected effects of implementation of a management system of production assets

18.10.1. The following effect of implementation of SUPA is expected:

- ensuring the level of reliability of power supply of consumers established by the regulator (SAIDI, SAIFI for the distribution grid companies; the volume of undersupply of electric energy to consumers of services during the settlement period of regulation for uniform national (all-

Russian) electric grid); increase in efficiency operational and investment (regarding the retrofitting and reconstruction programs) the costs connected with production processes for the account:

- purposeful short-term, average and long-term planning of maintenance and repair and retrofitting and reconstruction depending on perspectives of development of network, providing requirements of reliable power supply of consumers, observance of normative requirements for ensuring safe operation of production assets and technical condition of assets;
- high-quality change of accuracy of costs planning on maintenance and repair and retrofitting and reconstruction;
- increases in technology discipline owing to personification of responsibility and improvement of quality of the performed works;
- reduction of a share of unplanned and emergency repairs;
- reductions of quantity of occupational failures;
- process improvements of logistics of productive activity according to the principles of SUPA.

- work performance improvement;
- increase in reputation of the Company and ensuring achievement of other benefits which can include growth of share value and attractiveness for shareholders, growth of satisfaction of personnel.

19.Operational - technology management

19.1. General principles of development of operational and technology management

19.1.1. According to Federal law of 26.03.2003 No. 35-FZ "About power industry" "operational and technology management" is included in a complex organizationally and technology connected actions providing transmission of electric energy via technical devices of electric grids according to mandatory requirements - "services in transmission of electric energy".

21.1.2. As operational and technology management of the power grid complex (operational and technological management of electric grid facilities) it is understood. the package of measures for management of technology working hours of electric power facilities and (or) the power installations of consumers of electric energy performed by owners or other legal owners of such objects and (or) installations according to requirements of the subject of supervisory control in power industry concerning power lines, the equipment and devices of electric power facilities and the power installations which technology operating mode and an operational state influence an electrical power operating mode of electrical power system and the distribution of subjects to scheduling established by it the subject on a method of management and maintaining - concerning subjects to scheduling, and independently - concerning other power lines, the equipment and devices.

19.1.3. electric grid facilities are the purposes of operational and technological management:

- ensuring reliability of power supply and electricity quality of energy according to requirements of regulating documents, technical regulations and conditions of agreements of rendering services in transmission of electric energy;
- ensuring proper quality and safety of operation of power grid facilities;
- providing effective, with the smallest technical losses, transfers of electric energy on electric grids.

19.1.4. operational and technological management is performed by electric grid facilities by means of accomplishment of operational and not operational functions.

19.1.5. Operational functions are directed directly to change of a technology operating mode or operational condition of a facility of power grid economy.

19.1.6. Not operational functions include:

- planning of repairs;
- study of dispatching requests;
- development of operational documentation;
- organization of work with personnel;
- investigation of failures;
- ensuring safe works on the power transmission line, devices and the equipment of SS.

19.1.7. It agrees to the order operating in power industry control of technology operating modes of power grid facilities is exercised according to distribution of such objects on a method of management (dispatching management / maintaining and (or) technology management / maintaining).

19.1.8. One of the main objectives regarding the organization of productive activity is development and improvement of the electric grid facilities operational and technological management system. Within execution of the specified task:

- system approaches in development and optimization of the electric grid facilities operational and technological management system should be provided;

- the uniform technical policy regarding technology equipment and information support of structural divisions of the electric grid facilities operational and technological management system at all levels of management should be implemented;
- the formation of Grid Control Centres (GCC) should be completed and their further development is provided;
- protection of Grid Control Centre against the threats of information security realized for the purpose of interception of management functions should be provided;
- safety issues at implementation of functions of operational and technological management for the purpose of an exception of a possibility of commission of cyber attacks should be handled.

19.1.9. A main goal of creation of Grid Control Centre in the power grid complex is forming of the centres of responsibility in which functions on operational technology management of electric grid facilities, and also the organization of effective interaction with external partners in the field of operational and dispatching and operational and technology management are concentrated (JSC SO UES, other subjects of power industry, consumers of electric energy, etc.).

19.1.10. For each level of the electric grid facilities operational and technological management system interaction with system of situational management in the power grid complex which implementation of functions is assigned to situational and analytical divisions (SATs, OSTs) and the Grid Control Centre of grid organizations should be organized.

19.1.11. Situational management in the power grid complex (hereinafter – SM of electric grid facilities) is understood as the activity directed to the prevention of emergence and mitigation of consequences of failures and other emergency situations by means of the analysis, acceptances and implementations of the relevant management decisions taking into account the current operational situation, the located resources and forecasts of effects of the accepted managerial influences.

19.1.12. The purposes of SM of electric grid facilities are:

- prevention of emergence of failures and emergency situations in the power grid complex;
- reduction of quantity and duration of breaks of power supply of consumers;
- reduction of time of mitigation of consequences of failures;
- increase in efficiency of use of the available and attracted resources;
- minimization of financial and reputation risks of grid organizations;
- building of a system of effective interaction with subjects of power industry and other organizations and departments regarding situational management.

19.1.13. The structure of operational and technological management and SM of electric grid facilities is multi-level, vertically integrated, at the same time the number of levels should be optimum reasonable. At each operational and technological management and SM level the organizational structure of systems including the relevant divisions of operational and technological management and SM forms and organizational and administrative documentation is developed.

19.1.14. For implementation of functions on operational and technological management and SM of electric grid facilities structural divisions of operational and technological management and SM of all electric grid facilities levels should be equipped with automatic process control system including communication channels for transfer of technology information and SHC.

19.2. Functional requirements to automated systems of operational and technology and situational management

19.2.1. For implementation of functions on operational technology and situational management of electric grid facilities Grid Control Centre of all levels of operational and technological management of electric grid facilities should be equipped with automated systems of operational and technology and situational management (ASOTSU).

19.2.2. ASOTSU is one of subsystems of the automated systems of technology management (ASTM) intended for automation of the solution of tasks of operational and technology and situational management in electric grid facilities.

19.2.3. ASOTSU should provide the automated support in a part of the solution of the following main objectives of operational and technological management:

- safe and effective operational and technology management of electric grid facilities;
- minimization of damage at technology violations, reduction of terms of failure elimination.

19.2.4. The functional requirements imposed to ASOTSU form proceeding from the functions which are carried out by structural divisions of operational and technology management of different level (Grid Control Centre, PD, Distribution Zone).

19.2.5. The minimum functional requirements imposed to ASOTSU:

- collecting, processing, display and storage of technology information, creation and editing schemes of electric grids and electric power facilities and dynamic display of parameters of the electrical power mode to them;
- control of parameters and working hours of electric grid: automatic control of loading on current of electric equipment and the power transmission line, control of voltage and power in control points of network, control of provision of switching devices, conditions of RPA devices, etc.;
- management of operational switchings: control of switching devices, the automated forming and storage of forms and programs of switchings, control of time of recovery of power supply;
- control of processes of operation and repair of electric grids: maintaining requests for an equipment conclusion in repair, coordination of repair crews when carrying out emergency recovery operations;
- maintaining the online operational log: fixing and transfer on higher and adjacent levels of operational and technology management of operational information, maintaining logs according to the existing requirements of normative and technical documents;
- maintaining the normative and technical and reference documentation of the dispatcher;
- information exchange with the adjacent network and generation companies, dispatching centres.

19.2.6. One of the main directions of development of ASOTSU is the organization of remote (tele) control switching devices and functions of RPA devices, and also monitoring of a condition of RPA devices from Grid Control Centre, ODS and Operator’s Centre (in the presence of subjects to scheduling).

At new construction or modernization of SS it is necessary to apply the relevant technical solutions taking into account the standard documents approved between PJSC Rosseti and JSC SO UES to implement this direction:

- The standard principles of switchings in electric installations at telecontrol implementation by the equipment and RPA devices;
- A standard order of switchings in electric installations at telecontrol implementation by the equipment and RPA SS devices;

20.Ecological safety

20.1. Basic principles of ecological safety

20.1.1. The Regulation in the field of ecological safety is directed on:

- observance of requirements in the field of environmental protection, the standards of admissible impact on the environment established by the nature protection legislation of the Russian Federation;
- protection, reproduction and rational use of natural resources at design, construction, reconstruction, operation and liquidation of power grid facilities;
- restriction of conducting productive and construction activity in especially protected natural territories;
- adoption of management and investment decisions taking into account the analysis and assessment of ecological effects, development of measures for reduction and prevention of negative impact on the environment;
- application in production process of the best available technologies directed to minimization of impact of productive activity on the environment;
- reduction of volumes of formation of waste, the address with all types of waste and the dismantled equipment according to sanitary and hygienic regulations and requirements of ecological safety.

20.2. The technologies and actions aimed at providing requirements of ecological safety

20.2.1. Main actions:

- recovery and recultivation of the lands broken in the course of construction, reconstruction, modernization and operation of power grid facilities;
- implementation of the modern "eco-friendly" equipment (dry-type reactors, transformers and capacitors and the similar equipment) certified in accordance with the established procedure;
- a step-by-step removal from operation PCB-containing equipment with replacement by ecologically safer till 2025, transfer of the waste containing PCB, to the specialized organizations having the corresponding license;
- ensuring utilization of the fulfilled SF6 generally by return on the manufacturing plant of this equipment, for the purpose of fulfillment of requirements of the nature protection legislation;
- arrangement of a system of the SS oil receiving devices with use of modern technologies (including polymeric coverings of oil receivers);
- construction and reconstruction of systems of the sewerage, treatment facilities for the purpose of minimization of impact on water objects and catchment areas;
- ensuring normative sizes of acoustic impact on zones of the housing estate (construction of noise screens, etc.);
- application of the self-bearing insulated wires without cutting down of a ROW when passing the ConductorInsulated route through green plantings;
- application of the protected wires allowing to reduce significantly width of the cut-down ROW in forests;
- application of MIW and the protected wires of Conductor in places of mass seasonal migration of the birds preventing their death from defeat by electric current;
- application of the raised support with an arrangement of wires over kroner of forests with trees of valuable breeds;

- accomplishment on power grid facilities of actions for protection of fauna (equipment of the Conductor pole with special devices interfering nesting of birds on structural elements of support, use of the frightening-off and bird protecting devices);
- ensuring proper technical condition of vehicle fleet for the purpose of observance of technical standards of emissions, and also pollution of the soil automobile oils and technology liquids;
- ensuring proper technical condition of the local treatment facilities intended for sewage treatment;
- ensuring proper technical condition of the operated water wells, including artesian;
- arrangement of places of accumulation of production wastes and consumption according to requirements of the nature protection legislation and health regulations.

21.Labor protection

21.1. Main objectives in the field of labour protection

21.1.1. The Regulation in the field of labour protection is directed on:

- exception of cases of an industrial traumatism and occupational diseases;
- forming at employees of safe behavior on production and skills of the prevention of dangerous situations;
- permanent improvement of conditions and labour protection.
- providing a priority of preserving of life and health of employees in productive activity;
- development and deployment of systems of management of labour safety and health protection according to GOST R 54934 - 2012/OHSAS 18001:2007;
- ensuring training of employees in labour protection, with assignment not less than 50% of volume of the program of preparation for a new position and periodic training of production personnel for practical preparation in acceptances of safe performance of works on educational and training centres, laboratories, stands;
- ensuring training and the admission to independent work of again accepted drivers after training in specialized training centre in volume of not less than 72 hours of practical driving, including not less than 40 hours - according to the program of defensive driving;
- providing employees with the certified qualitative and ergonomic special clothes, special footwear and other means of individual and collective protection which are washing away and (or) the neutralizing means, high-quality electric protective equipment, the operational tool, devices, instructions;
- ensuring complex thermal protection of the worker at the choice of sets for protection against thermal influence of an electric arch. Complex thermal protection should be not below a calculated value of size of the falling energy of an arch;
- equipment of educational and training centres for carrying out personnel training to safe methods of performance of works on the power equipment;
- organization and implementation of internal control behind observance of requirements of labour protection on power grid facilities and at operation of vehicles;
- ensuring implementation of a system of the motivation stimulating employees to unconditional observance of requirements of labour protection;
- ensuring compliance with legal and other regulatory legal acts of the Russian Federation in the field of labour protection;
- ensuring identification, identification, assessment and decrease in risks of traumatizing personnel;
- ensuring implementation and use of the technologies providing safe working conditions in workplaces;
- ensuring effective functioning and continual improvement of a management system with labour protection;
- monitoring and implementation of the advanced developments in the field of labour protection;
- carrying out special assessment of working conditions for providing normal and safe working conditions in workplaces;
- providing the admission to implementation of productive activity of employees, on the basis of results of obligatory periodic medical examinations (inspections), and also before shift medical examinations (inspections) of employees performed upon the demand of employers;
- carrying out production control over observance of health regulations and accomplishment of sanitary and anti-epidemic (preventive) actions.

21.2. The technologies and actions aimed at providing requirements of labour protection and safety of personnel

21.2.1. Main actions:

- acceptance at design of power grid facilities, buildings and constructions of the technical solutions ensuring safety of their operation, including safe works at height by the device:
  - stationary ladders with use of remedies of slider type as safety system at rise on the equipment, stationary anchor points (anchor columns), or with preset of the anchor line and use of remedies of the involving type, or using telescopic anchor columns for work on SS of 35 kV and above where there is a risk of falling from height of more than 1,8 m;
  - stationary rigid anchor lines and stationary ladders of rise on metal support with a possibility of further application of a remedy of slider type, and also stationary anchor points for use as safety system during the work at height on a support;
  - stationary anchor points on can support, many-sided and other types of support with a possibility of installation of flexible anchor lines without rise on a support using bars, elevators, with a possibility of further application of remedies of slider type and for use as safety system during the work at height on a support.
- decrease in a share of a manual work, weight of work and performance improvement of work due to increase in level of mechanization and automation;
- decrease in a share of the works connected with rise on power transmission line pole without use of special cars and mechanisms;
- a rise exception using manholes and climbers on the support which are in operation of more established normative term;
- provision of equipment with safety automatic devices, blocking, on newly commissioned SS of 35-110 kV equipment by systems of remote control for the purpose of an exception of finding of the person directly near the switching device when switchings;
- equipment in necessary volume special mechanisms, a car - and special equipment (hydroelevators, telescopic towers, mobile laboratories, boring and crane cars), and also the modern equipment, the tool and devices for ensuring mechanization of works on maintenance and repair, first of all, the most injury-causing and labour-consuming;
- use during the works at height of the shock-absorbing brake mechanisms blocking and lock devices;
- use of the insulated current-conducting wires, buslines, loops in places of possible pass of people;
- at input of new objects application built in the equipment (including TS of 6-20 kV) voltage signaling devices, with a possibility of their integration into system of remote signaling and the scheme of blocking of safety;
- use of electric equipment and technologies, safe for life and harmless to health of personnel;
- use of the devices of safety controlling concentration of harmful substances in explosive and gas dangerous air environment;
- acquisition of vehicles for transportation of personnel (buses, brigade cars, elevators (towers), etc.) equipped with seat belts and anti-blocking system of brakes;
- implementation on new vehicles of onboard monitoring systems of the vehicle, except the vehicles working at the enterprise territory (loaders, self-propelled elevators, etc.);
- creation for personnel of modern sanitary living conditions;
- equipment of linear crews the motor transportation equipment equipped for creation of normal working conditions and rest of personnel at long stay in field conditions;

- use of modern devices for safe operation (fiberglass ladders, devices for breaking-out of support based on boring and crane cars, lifting devices, safety systems);
- application for work on Conductor of 0.4-20 kV of sets of the remedies and devices providing a possibility of installation of figurative grounding and accomplishment of separate work types (cutting of branches, removal having outlined) without rise on the Conductor support;
- implementation of safe repairs of technology of Conductor of 0.4 kV energized (without shutdown);
- restriction (where it is possible on technology) of contact of employees with harmful substances, such as asbestos, bitumen, acids and the other substances doing harm to health.

22.Fire safety

22.1. The basic principles in the field of fire safety

22.1.1. The Regulation in the field of fire safety is directed on:

- ensuring fire safety of power grid facilities according to requirements of the Federal legislation, existing rules and rules;
- use in production process of the most effective existing available technologies providing increase in level of fire safety of objects;
- application at construction of power grid facilities, buildings and constructions of materials and designs, and also the equipment which underwent certification in accordance with the established procedure;
- prevention of impact on people of dangerous factors of the fire, including their accompanying manifestations;
- preserving and protection of property at the fire;
- prevention of emergence of the fire;
- prevention of distribution of the fire on property of the third parties.

22.1.2. The system of ensuring fire safety of a facility includes a complex of the actions directed on:

- prevention and localization of the fire;
- ensuring fire protection of objects (including use of systems of the fire alarm system and automatic fire extinguishing), according to regulatory legal acts and the specifications and technical documentation;
- providing the established requirements regarding fire safety, including an exception of exceeding of admissible fire risk.

22.1.3. The system of prevention and localization of the fire is provided:

- restriction of weight or volume of combustible substances, materials, greatest possible under the terms of technology and construction:
- application at construction of buildings and constructions of nonflammable and slow-burning substances and materials with the normalized limit of fire resistance and a class of fire danger;
- replacement of the oil-filled equipment by the equipment with nonflammable dielectric (vacuum, SF6, solid insulation);
- replacement of power oil-filled cables of 110-220 kV by power cables with insulation from cross-linked polyethylene, with the insulation which is flame-retardent.

22.1.4. At design of roofing coverings and building constructions of roofs of buildings of SS of 110 kV and above nonflammable materials with a class of fire safety of building constructions - K0 should be applied.

22.1.5. The class of fire danger of building constructions should correspond to the accepted class of constructive fire danger of buildings, constructions and fire compartments.

22.2. Facility fire protection system

22.2.1. The system is provided with the help:

- use of photoluminescent evacuation systems for buildings (constructions) at equipment of SOUE 3 types above in compliance with the operating national state standards and sets of rules;
- application of automatic installations of fire extinguishing:
    - sprayed water (automatic installation of fire extinguishing with fine sprayed water on the basis of an aggregate unit) for protection of cable constructions through passage on electric power facilities, and also suppression of seats of fire of the classes A, B, superficial and local on a surface, in accordance with GOST 27331-87 (ST of SEV 5637-86);

- with deck pipes for protection of open power AT/T (reactors) located in the territory of ODD of SS of 220-330 kV with a single power of 200 MVA and above, SS of 500 kV and above irrespective of the single power, and also roofs of SS of the closed type;
- low-multiple film-forming foam using water foam mouthpieces for prevention of repeated ignition (extinguishing) of the power AT/T and reactors located in the closed SS enclosures of 220-500 kV with a single power of 200 MVA and above, SS of deep input of 110 kV and above with a single power of 63 MVA and above, SS of 110 kV and above in the closed distributing devices with a single power of 63 MVA and above;
- gas fire extinguishing (AUGPT) for protection of the power AT/T and reactors located in the closed SS enclosures of 220-500 kV with a single power of 200 MVA and above, SS of deep input of 110 kV and above with a single power of 63 MVA and above, SS of 110 kV and above in the closed distributing devices with a single power of 63 MVA and above, and also liquidation of fires of classes A, B, C in accordance with GOST 27331-87 (ST of SEV 5637-86) and electric equipment with voltage stated not above in technical documentation on the used gas fire extinguishing substances (GOTV);
- AUGPT on the basis of GOTV, safe for the person, for protection of cable mines through passage and spaces under double floors and ceilings when laying cables (wires) like nonflammable with a total amount of combustible mass from 1,5 to 7 l on meter of CL, the industrial control system halls;
- automatic installations of aerosol fire extinguishing (AUAPT) for suppression (liquidation) of fires of subclass A2 and class B in accordance with GOST by 27331 volume methods in rooms up to 10000 m3, no more than 10 m high and with the parameter not of tightness which is not exceeding the requirements specified in standards and acting with the specifications and technical documentation;
- autonomous installations of fire extinguishing for suppression (liquidation) of fires of the electrotechnical equipment, with voltage not above stated in technical documentation on the used fire extinguishing substances of autonomous installation, and also ignitions of other substances and materials for which suppression autonomous installation according to technical documentation is designed.

- observance of the minimum distances from pumping fire extinguishing or enclosures of switching of latches to the protected equipment or the room;
- use of fireproof paints (structures) having the certificate confirmation of conformity to requirements of Federal law No. 123-FZ of 22.07.2008. "The technical regulation about requirements of fire safety" in the declaration form of compliance or in the form of obligatory certification, including application for protection of CL of fireproof structures with service life of a fireproof covering not less than 15 years;
- restriction of distribution of the fire out of borders of the seat of fire:
  - application for SS of 35 kV and above cables with the insulation which is flame-retardent in compliance with GOST 31565-2012 for laying of CL in ODD of cables with the insulation which is flame-retardent at single laying and with the insulation which is flame-retardent at group laying (nonflammable (A F/R)) (the choice of category of fire danger of cable lines (A F/R, A, V, S or D), at group laying, should be confirmed by the corresponding calculations and be a part of the project);
  - installation of the fire-dangerous equipment whenever possible in the insulated rooms with a direct exit outside or on the open areas;

- the device of fire-prevention barriers with the normalized fire resistance limit.

- use of individual protection equipment of people from dangerous factors of the fire. Individual protection equipment of respiratory organs should ensure safety of people during time of action of dangerous factors of the fire, on the way of evacuation, but not less than 20 minutes.

22.3. The technologies and actions aimed at providing requirements of fire safety and the prevention of the technology violations connected with fires

22.3.1. On power grid facilities should be applied:

- fire-resistant CL which are flame-retardent at group laying with lowered smoke-and gas emission (nonflammable (A F/R-FRLS), and when laying in the serviced cable constructions of 220 kV and above - fire-resistant, flame-retardent at group laying and not allocating corrosion and active gaseous products during the burning and decay (nonflammable (A F/R-FRHF));
- for cable constructions of 6-110 kV of CL with the insulation which is flame-retardent at group laying with lowered smoke-and gas emission (nonflammable (A F/R-LS);
- power cables of 1 kV and above with the insulation which is flame-retardent except for the cables laid in the earth at single laying;
- laying of control cables in DD of 6 kV and above in compliance with requirements of "Regulations for electrical installation" (Electrical Installation Code), at the same time ensuring availability of fire-resistant consolidations in places of passes of cables through walls, partitions and overlappings with a limit of fire resistance is not lower than a limit of fire resistance of the most building construction;
- protection of power and control cables against distribution of the fire by design of trays from continuous cans of designs with a limit of fire resistance of not less REI 45 which do not have gaps using removable fireproof plates and application of power and control cables, including symmetric high-frequency and coaxial cables of communication, with the insulation which is flame-retardent;
- laying of power cables of 6 kV and above with a row the control cables laid in elevated cable trays at observance of distance not less than 1,2 meters between them and availability of a fireproof covering of control cables;
- inputs of control cables DD-6 of kV and above, feeding operational circuits of management, RPA and alarm system on different cable trays with observance of the conditions excluding simultaneous damage of the main and reserve food in case of fire;
- the principle of separation of the main and reserve protection (or two sets of protection) on circuits of alternating current and voltage, on circuits of operational current and executive circuits by placement them on different cables, and also, on different routes;
- application on the power grid facilities which are sources of strong electromagnetic hindrances (EMP), systems of the automatic fire alarm system having degree of rigidity (resistance) to EMP not lower than III;
- application in systems of the automatic fire alarm system (AFAS) of buildings:
    - digital installations of the fire alarm system with the distributed architecture and signaling of a condition of elements of system from fire alarm control panels (RCD) to the general panel of control (PSW) and management on the wire digital interface of communication;
    - fiber-optical channels of digital data transmission from PKP to PSW (at the high level of EMP in places of passing of the digital interface of communication);
    - dot smoke detectors with digital microprocessor processing of a signal;
    - linear optical smoke detectors for rooms of the big area and more than 4 m high (for example, in the GIS halls);
    - linear thermal detectors (thermocable) in zones with severe conditions of the operation (increased by potential of explosion with the increased or lowered

temperature, chemically hostile environment, high humidity/dampness and pollution), and also for protection of extended constructions and outside installations.

- application of floors of self-quenching for covering of oil receivers in the closed enclosures of power transformers;
- use of fire prevention devices in systems of removal of oil;
- equipment by the fire alarm system of all rooms, except for the rooms belonging to the category B4 and D on fire danger, ventilation chambers (air supply, and also exhaust, not servicing production rooms of category A or B), pumping water supply, boiler rooms and other rooms for the engineering equipment of the building in which there are no combustible materials; rooms with wet processes (shower, bathrooms, rooms of washing, etc.); staircases;
- application for finishing of evacuation ways of materials of the following categories of fire danger:
    - G1, B2, D2, T2 - for finishing of walls and ceilings in lobbies, staircases, lift halls;
    - G2, B2, D3, T2 - for finishing of walls and ceilings in the general corridors, halls and the foyer;
    - G2, V2, D2, T2 DS2 - for a covering of floors in lobbies, staircases, lift halls;
    - G3, V2, D3, DS2 T3 - for a covering of floors in the general corridors, halls and the foyer;
    - nonflammable or G1 - for a covering of floors in rooms of buildings of production or warehouse purpose of categories A, B and B1;
- use of nonflammable materials for the device of frameworks of false ceilings in rooms and on the ways of evacuation (the frameworks painted by paint and varnish coverings from nonflammable materials should have group of combustibility of nonflammable or G1), and also rooms for visitors of the organizations of consumer and public service with off-design number of seats (Customer service centres, etc.);
- use of materials for finishing of walls and ceilings with a class of fire danger of KM0 and (or) rooms KM1 for of book-depositories and archives, and also rooms which contain office catalogs and inventories;
- equipment of systems of ventilation and air conditioning of rooms of industrial control system the devices providing their shutdown at the fire both in the place of their installation, and from a control panel;
- a device of fire-prevention partitions, from fireproof materials in places of pass of cables from cable constructions in trays with a limit of fire resistance of not less EI 45, and also in places of taps in the territory of ODD and through each 50 m on length. As fireproof coverings of building constructions, cables and the device of cable passes in walls and the bases the fireproof materials having certificates of conformity to requirements of Federal law No. 123-FZ of 22.07.2008 should be applied. "The technical regulation about requirements of fire safety";
- a device of an oil pan of power oil transformers, outside the building on SS equipped with GIS;
- application of the space-planning decisions and means providing restriction of distribution of the fire out of centre limits;
- use of systems of collective protection (including antismoke) and remedies of people from influence of dangerous factors of the fire;
- construction of networks of a fire-prevention water supply system:
    - on SS of 500 kV and above irrespective of the power of the installed power transformers, SS of 220-330 kV with a power of power transformers of 200 MVA and above, the closed SS of 110 kV both above with a power of power transformers of 63 MVA and above, SS of 220-330 kV with a power of power transformers from 40 to 200 MVA, SS 110-154 of kV with a power of power transformers of 63MVA and above, and also on SS with synchronous

compensators, for fire extinguishing it is necessary to provide a fire-prevention water supply system with feeding from the existing external network or from an independent source of water supply;

- on SS of 220-330 kV with a power of power transformers from 40 to 200 MVA, SS 110-154 of kV with a power of power transformers of 63 MVA and above the outside fire-prevention water supply system of low pressure with two fire-prevention tanks should be provided. At approval of city services it is allowed to use the existing networks of a city water supply system for needs of outside fire extinguishing;

- ensuring control of availability of a fire-prevention water-supply in tanks from a control panel;

- application of high support for the prevention of technology violations because of fires in security zone of Conductor in fire-dangerous areas (is recommended).

23.Industrial safety

23.1. The basic principle of the Regulation in the field of industrial safety a priority of life and health of staff of the Company, the personnel which are on hazardous production facilities (hereinafter HPF) Company and the third parties in relation to results of productive activity, and also ensuring level of security from failures on HPF and effects of the specified failures according to requirements of Federal law of the Russian Federation of 21.07.97 No. 116-FZ "About industrial safety of hazardous production facilities".

23.2. Implementation of requirements of industrial safety requires accomplishment of the following key events:

- the organization and implementation of production control on hazardous production facilities over observance of requirements of industrial safety;
- ensuring obtaining licenses for implementation of the specific type of activity in the field of industrial safety which is subject to licensing in accordance with the legislation of the Russian Federation;
- ensuring expertise of industrial safety of the buildings, constructions and technical devices used on hazardous production facility and also performing diagnostics, tests, surveys of the constructions and technical devices used on hazardous production facility, at the scheduled time;
- ensuring obtaining the positive judgment of industrial safety of the project documentation on modernization, preservation and liquidation of hazardous production facility, and also implementation of registration of hazardous production facilities in the state register of hazardous production facilities;
- -planning and implementation of an action for localization and mitigation of consequences of failures on hazardous production facilities of II, III classes of danger provided by paragraphs 1, 4, 5 and 6 of appendix 1 to No. 116-FZ "About industrial safety of hazardous production facilities";
- providing the conclusion of insurance contracts of the civil responsibility for damnification as a result of failure on a dangerous object;
- ensuring carrying out preparation and employee assessment in the field of industrial safety, training and an examination of the personnel servicing technical devices of hazardous production facility;
- renewal of licenses for operation fire and explosion hazardous and chemically hazardous production facilities of I, II and III classes of danger, according to article 22 to paragraph 6.1, the law No. 99-FZ (edition of 30.12.2015) "About licensing of separate types of activity" in time, not later than 30.09.2017.
- implementation of interaction concerning industrial safety with state bodies of control (supervision).

24.Traffic safety

24.1. A main objective of work on safety of traffic is reduction of road and transport injury rate, decrease in weight of its effects, and also the prevention of the road collisions and decrease in weight of their effects, by implementation of systematic system of actions.

24.2. For achievement of the main objective the following problems should be solved:

- advanced training and responsibility of the driver's structure and personnel which are responsible for release to the line of the operational vehicle;
- ensuring operation of vehicles in technically serviceable condition according to their technical characteristics and use;
- organization of practical practicing of skills of driving, including using special simulators, involvement of the relevant educational institutions;

- implementation of a system of the organization of transportations excluding possible dangerous actions of drivers;
- establishment of the minimum requirements to an experience, experience and qualification of drivers of the vehicle taking into account the corresponding type of the vehicle and to the general experience of driving of the vehicle - not less than three years;
- ensuring pretrip medical examination of driver's structure;
- providing safe working conditions of drivers on the line;
- providing conditions for observance by drivers of a work-rest schedule (especially at stay in business trips);
- decrease in weight of effects of road collisions by providing vehicles with devices of passive safety;
- organization of management of activities for safety of transportations;
- a training in a workplace, with fixing of the driver to the specific car;
- training in safe methods and techniques of performance of works, methods of first-aid treatment at the road collisions;
- notification of drivers about deterioration in weather conditions and prohibition of departure out of borders of the settlement;
- training responsible persons for traffic safety;
- passing of periodic medical examination.

25.Requirements to skills training of production personnel

25.1. Skills training of production personnel[5] is aimed at effective staffing of tasks of the Regulation, acquisition by employees of new or improvement of the available skills of safe performance of works and is performed for the purpose of:

- ensuring compliance of production personnel to requirements to professionally important knowledge, skills and competences determined by professional standards and the relevant regulating documents according to levels of positions and types of activity of employees;
- safety of activity of personnel during the work on electric power facilities;
- ensuring the advancing personnel training for the under construction, expanded, reconstructed and technically retrofitted electric grid facilities.

25.2. Skills training of production personnel is understood as implementation of active forms of education, including working out of practical skills based on educational and training centres, training complexes, the automated (virtual) training systems, equipment samples; passing of training, duplications; holding educational emergency and fire-prevention trainings.

The organization of skills training in the electric grid facilities companies is performed taking into account the following requirements:

- training of production personnel is performed on the basis of systemacity, timeliness, the sequence;
- obligation of turning on of the block of skills training in all programs of training of production personnel;
- ensuring an integrated approach to training of production personnel regarding use of active and academic forms of education;
- priority of training of employees in industrial safety rules and production safety, acceptances of safe performance of works on electric power facilities;
- ensuring basic needs in training of production personnel by forces of corporate training centres, and at their absence - the organizations licensed in the field of additional professional education – partners in the respective regions meeting the requirements to equipment of educational process and teachers;
- compliance of training programs of production personnel to the existing professional standards and/or qualification requirements regarding training requirements of employees, to their knowledge and abilities;
- ensuring compliance of the developed training programs of production personnel to features of technologies, the equipment and production organization in the company;
- ensuring necessary level of material and technical resources of skills training of production personnel, including compliance of equipment of educational and training centres to the requirements given in the Appendix to this Regulation;
- the key direction of development of skills training of production personnel - development and deployment of the training systems automated (virtual) and models of the main production processes of electric grid facilities;
- the conclusion of agreements with suppliers of the power grid equipment and technologies on the terms of the organization of personnel training to work on the new equipment, a possibility of practicing of skills of operation and repair on the training resources;
- efficiency evaluation of skills training of production personnel on a regular basis taking into account achievement of goals of skills training, and also results of holding control emergency and fire-prevention trainings, competitions of professional skill, including by a technique of WorldSkills, professional contests.

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[5] Personnel of production departments, districts, substations, groups of substations, territorial production subdivisions or certain employees of executive offices of the companies, administration offices of branches which according to the staff list, the job description are engaged into implementation of core activities of the company and are direct work performers.

25.3. Implementation of tasks of technical policy in the field of skills training of production personnel is defined by provisions of HR and social policy of PJSC Rosseti (approved by the decision of the Board of Directors of PJSC Rosseti of 17.06.2014, Minutes No. 158 of 20.06.2014).

26. Technical supervision concerning facilities of the power grid complex

26.1. The purposes of technical supervision are:

- implementation of the main requirements of the Regulation and strategic documents of the Company on increase in reliability of power supply of consumers of electric energy, efficiency and safety of electric grid facilities,
- development and implementation of actions for the prevention of failures (technology violations), fires and failures on electric grid facilities;

26.2. Technical supervision is exercised in the following main directions:

- supervision of implementation of the Regulation;
- supervision of production safety (labour protection, fire, industrial and ecological safety);
- supervision of technical condition and operation of the operating electric power facilities, including control of program implementation on energy efficiency and energy saving;
- supervision of objects of new construction, reconstruction and modernization.

26.3. Technical supervision at facilities of SDCs of the Company is exercised by the Branch of the Company - the Centre of technical supervision (hereinafter - Technical Supervision Centre).

26.4. Results of the inspections which are carried out within implementation of technical supervision are made out by the act - instruction or the operational instruction which are obligatory for execution of SDCs of the Company, including their separate divisions (branches).

26.5. The order of registration and the document form, the carried-out inspections which are made out by results of, SDCs of the Company, uniform for all, is established by ORD of the Company;

26.6. The employees of the Technical Supervision Centre organizing and exercising technical supervision have the right including to:

- perform planned and at the request of the management of the Company unscheduled inspections of objects of SDCs of the Company;
- participate in the commissions on investigation of the reasons of the technology violations, fires and failures which happened at facilities of SDCs of the Company;
- carry out control of accomplishment of the emergency and other actions specified in acts of investigation of technology violations (failures), fires, failures and directed to their prevention. The order of investigation of technology violations (failures), fires, and failures at the enterprises of the company, registration of results of investigation is established by the Company;
- freely visit the checked facilities at accomplishment of functions for implementation of supervising activity;
- request necessary information on questions of the performed checks in SDCs of the Company;
- issue to heads the instructions, obligatory for execution, directed to prevention, the termination of the wrong actions or elimination of the revealed violations of the established requirements of normative and technical and organizational and administrative documents of the Company checked by SDCs of the Company and also to demand reports on their execution;
- issue to heads of SDCs of the Company operational instructions about a removal from operation of the equipment and constructions in the presence of threat, and also it is risk for safety of personnel and third parties, damage of the specified objects, safety of other equipment;
- stop works, including on capital construction projects, reconstruction and modernization of SDCs of the Company, in cases of identification of violations by employees of SDCs of the Company of requirements of industrial safety rules, fire, industrial and ecological safety if these violations threaten safety of life and human health, integrity (safety and working capacity) the equipment and safety of the environment;
- carry out sudden inspections of the crews performing works on electric grid facilities;

- take part in check of the organization and carrying out days of labour protection, emergency and fire-prevention trainings;
- carry out an inspection of fulfillment of duties on OHSAS and internal technical control by officials;
- participate in work of the commissions on check of readiness of SDC for work during the special periods (flood, fire-dangerous, storm, autumn and winter, etc.);
- participate in work of the commissions on an examination of employees of SDCs of the company and the branches;
- develop the offers directed to the prevention and elimination of violations of requirements of regulatory legal acts in the field of production safety, technical operation and work with personnel including on accountability of the persons which allowed violations.

27.Safety and anti-terrorist security of facilities of the power grid complex

27.1. Ensuring anti-terrorist security of electric grid facilities is performed according to requirements of Federal law of 21.07.2011 No. 256 "About safety of facilities of fuel and energy complex".

27.2. The organization of physical protection, equipping of electric grid facilities with technical means of protection are defined and implemented according to requirements of the Federal legislation, Orders of the Ministry of Energy of the Russian Federation, organizationally administrative documentation of the Company.

27.3. Safety of electric grid facilities is performed by determination of threats of commission of acts of illegal intervention and their prevention, and also by categorization of objects, development and implementation of measures for creation of a system of their physical protection.

27.4. At implementation of the specified package of measures for the purpose of ensuring smooth and effective functioning of electric grid facilities advanced technologies of safety should be used.

27.5. Design and creation of the technical security equipment systems should be performed on the basis of prototype technical solutions.

27.6. The following should be a part of technical security equipment:

- technical security (engineering obstacles, engineering means and constructions, check-points);
- technical means of protection (alarm system, system of the disturbing alarm system, system security television, control and management system for access; system of data collection and processing, technical means of examination);
- auxiliary systems (warning system, system of security lighting, power supply system).

27.7. Target model is consolidation of all subsystems of technical security equipment in a single system of safety management of electric grid facilities.

27.8. Technical security equipment is intended for prevention of acts of illegal intervention in functioning of electric grid facilities, timely detection and suppression of infringement of integrity and safety of the protected facility.

27.9. Main requirements to technical security equipment:

- Technical security equipment is intended:
    - for creation of physical barriers to unauthorized actions concerning an object;
    - for creation of obstacles in a way of the movement (a way of departure) of the violator or difficulty (delay) of his approach to weak spots, critical elements;
    - for ensuring pass to the protected zone only in the established points (points) of access;
    - for designation of borders of the protected zones and the warning of responsibility for violation of the property rights;
    - for protection of service personnel and visitors of a facility.
- Technical security equipment should provide:
    - detection of unauthorized penetration of the violator into a detection zone technical means of protection with probability not lower than 0,95;
    - issue of the notice on malfunction at damage of security detectors, circuits of their power supply and communication channels with reception and control devices;
    - preserving of operating state at influence of the adverse factors of the environment corresponding to a climatic zone in which an object is operated;

- recovery of operating state after influence of the adverse factors of the environment provided by technical documentation of manufacturers;
- preserving of operating state at shutdown of the main network of power supply during the time conforming to requirements to a power supply system.

28.Information security

28.1. Purposes and tasks of information security

28.1.1. Main objectives of the Regulation in the field of information security support of electric grid facilities are:

- creation of conditions for steady functioning of UES of Russia regarding safe management of electric grid facilities;
- increase in safety of electric grid facilities at use of modern information technologies;
- protection of interests of subjects of electric grid facilities by prevention of a possibility of causing damage or causing other harm to subjects of the information relations as a result of violation of the set modes of information processing of limited access, destruction, distortion and blocking of information used for adoption of management decisions.

28.1.2. For achievement of goals of information security support of electric grid facilities the solution of the following main objectives is required:

- creation of a vertically integrated complex information security system;
- forecasting, identification and assessment of threats of information security and their sources;
- development and deployment of modern methods and means of ensuring of information security;
- organization of control of a state and efficiency evaluation of a system of information security support and implementation of measures for its improvement;
- maintenance of a system of information security support in the state steady against the existing and again revealed threats in the information sphere.

28.1.3. Implementation of the specified tasks will allow to reach target model of a complex information security system of electric grid facilities

28.2. Basic principles of development

28.2.1. The basic principles of development of a complex information security system of electric grid facilities is forming of trust to automated systems, and information processed in them in working conditions in not entrusted environment of both the high potential of the violator, and not crossing of functionality on creation, modernization and operation of automated systems and information security support at the specified stages of lifecycle of automated systems.

28.2.2. The specified principles is implemented by means of development of requirements to the built-in means of information protection of corporate and technology ACS of electric grid facilities of the Company and SDC, and to processes of management of information security for providing conditions under which creation, modernization and application on electric grid facilities of the Company and SDCs of corporate and technology ACS and the equipment which is a part of the specified systems does not attract to emergence of threats of information security or decrease in level of security of electric grid facilities from destructive influences from the outside, and on the contrary, considerably increased capability to resist to them with simultaneous reduction financial, material and the manpower spent for information security support of electric grid facilities by means of implementation as a part of automated systems and the equipment of functions and mechanisms of safety.

28.2.3. It becomes possible due to establishment of uniform and transparent criteria for evaluation of a possibility of application on electric grid facilities of the Company and SDCs of these or those automated systems and their subsystems, including the equipment from a position of information security support.

28.2.4. The accent in activity of information security during creation new or modernizations of old power grid facilities, including automated systems and their subsystems in the short term should will be displaced towards protection of final automated systems and an automated workplace.

28.3. Main technical requirements

28.3.1. The certificate of an open key and the related closed key made by the certification centre of the Company placed on protected from copying the key carrier is accepted by the main unit of trust.

28.3.2. Components of IS / automatic process control system with technical specifications of assets to be information protected:

- automated jobs,
- industrial servers,
- telecommunication equipment,
- communication channels,
- protocols of data transmission,
- programmable logical controllers, actuation mechanisms with the established microprogram providing,
- software (including microprogram, system-wide, applied),
- means of information protection.

28.3.3. The complex of organizational and technical measures of protection of information should provide in automated systems:

- identification and authentication of subjects of access and access objects;
- management of access for subjects of access to access objects;
- restriction of the program environment;
- protection of machine data carriers;
- registration of events of safety;
- anti-virus protection;
- detection (prevention) of invasions;
- control (analysis) of security of information;
- integrity of an automated control system and information;
- availability of technical means and information;
- protection of the environment of virtualization;
- protection of technical means and equipment;
- protection of an automated system and its components;
- safe development of the applied and special software;
- management of updates of the software;
- planning of actions for ensuring information protection;
- ensuring actions in emergency (unexpected) situations;
- informing and personnel training;
- analysis of threats to security of information and risks from their implementation;
- identification of incidents and response to them (incident management);
- configuration management of an automated control system and its system of protection.

28.3.4. The taken organizational and technical measures of protection of information should not exert negative impact on the normal mode of functioning of an automated control system. The choice of means of information protection is performed taking into account their cost, compatibility with the software and technical means, functions of safety of these means and features of their implementation.

28.3.5. For the most critical automated control systems it is recommended to organize the authorized input of managing teams in automatic process control system by two employees with the subsequent program verification of results of input on coincidence (the principle of "dual control").

28.3.6. At information security support of automated systems should act as the main technical mechanisms:

- strict multifactorial identification and authentication of the interacting subjects and objects, including communications between objects based on the main unit of trust;
- the digital signature and cryptographic data protection, transferred on communication channels, from interception and modification;
- differentiation of access at all technology levels (physical, network, etc.);
- the centralized registration of events of safety via secure channels;
- built-in mechanisms of reservation and recovery of a configuration and data.

28.3.7. As protected network protocols should be applied the TLS 1.3 protocol above, protection of channels of data transmission networks should form with observance of the standard of the IPSec protocol (RFC 2401 – RFC2412, RFC2451), IKE (RFC2409) standard with use of certificates of X.509 v3 (RFC2459), with support of a possibility of connection of remote users with use of TLS VPN technologies. At the same time ensuring access to network should not be the basis for access to automated systems using the unprotected mechanisms.

28.3.8. As secured network protocols of wireless transmission of data on the IEEE 802.11 standard to use an algorithm of enciphering of WPA2.

28.3.9. Transfer of security events to information security monitoring systems should be performed using the protected network protocols.

28.3.10. When using cryptographic means of information protection (including implementation of secure channels and network protocols) application only of the Russian standards of cryptography is allowed (and also acting at the time of forming or implementation of requirements for information security of updates of the specified standards): GOST R 34.10-2012, GOST R 34.11-2012.

28.3.11. Forming of requirements to information protection in automated control systems for the enterprise, operational and technology management, technology management in the protected execution is performed according to GOST R 51583-2014 "Information protection. An order of creation of automated systems in the protected execution. General provisions", GOST R 51624 "Information protection. Automated systems in the protected execution. General requirements", and standards of the PJSC FGC UES organization STO 56947007-29.240.01.147 – 2013 - STO 56947007-29.240.01.151 - 2013.

28.3.12. Development of automated systems in the protected execution is performed according to GOST R 56939-2016 "Development of safe SW" of GOST 34.601, GOST R 51583, GOST R 51624 and standards of the organization.

28.3.13. Results of a system design of protection of an automated control system are reflected in the project documentation (the outline (technical) sketch and (or) in working documentation) on an automated control system (system of protection of an automated control system), developed taking into account GOST 34.201 "Information technology. A complex of standards on automated systems. Types, completeness and designation of documents during creation of automated systems" (hereinafter – GOST 34.201) and standards of the organization.

28.3.14. Protection of a communication network is performed according to GOST R 62443 of Network communication industrial. Security (cyber security) of network and system.

28.3.15. Information protection when using technologies of virtualization is performed according to GOST R 56938-2016 "Information protection at use of technology of virtualization"

28.3.16. Safety requirements of personal data are defined by Order of the Government of the Russian Federation No. 1119 of November 1, 2012 depending on the required level of security of

personal data at their processing in the IS / ACS. Protection of personal data is provided according to Structure and the maintenance of organizational and technical measures for safety of personal data at their processing in the IS / ACS approved by Order of FSTEC of Russia of February 18, 2013 No. 21.

28.3.17. Security requirements of the state secret are defined by Order of FSTEC of Russia of February 11, 2013 N 17

28.3.18. Requirements for functional safety of automated control systems for the enterprise, operational and technology management, technology management should correspond to GOST R IEC 61508-1-2012, 61508-2-2012, 61508-3-2012.

28.3.19. The means of information protection which underwent assessment of conformity in accordance with the legislation of the Russian Federation about technical regulation should be applied.

28.3.20. As a part of automated systems of technology management, operational and technology management operating systems of general purpose, an application software, the software should be applied to diagnostics and adjustments, the built-in operating systems and the built-in software of the devices transmitting signals of telemetry, remote signaling and (or) forming managing teams and (or) allowing the remote configuring and parameters setting, operating systems of real time which underwent assessment of conformity in system of certification of FSTEC of Russia on compliance to the Task on security (GOST ISO/IEC 15408) with evaluation assurance level 4 and undocumented feature class 4.

28.4. Assessment of conformity according to requirements of information security

28.4.1. Assessment of conformity of the purchased equipment and systems to be carried out within the System of certification in the power grid complex (item 36).

28.4.2. The certificate is understood as the document confirming efficiency of the organizational and technical measures of protection taken by the Operator. This term is entered in paragraph 4 of part 2 of article 19 FZ-152.

28.4.3. Certification of the IS / ACS processing public data is not required.

28.4.4. Certification of the IS / ACS processing personal data to be carried out according to the decision of the customer regarding efficiency evaluation of the taken measures for safety of personal data.

28.4.5. Certification of the IS / ACS processing personal data for safety requirements of information is carried out by the organization having the right to activity in the field of technical confidential information protection. FZ-152

28.4.6. Certification of the IS / ACS processing a state secret or interacting with GIS to be carried out without fail regarding efficiency evaluation of the taken measures for safety of information.

28.4.7. Certification of the IS / ACS processing a state secret or interacting with GIS to be carried out by body for certification. Order of FSTEC of Russia of 11.02.2013 No. 17

28.4.8. Certification of automated systems of technology management on compliance to requirements for information protection regarding the applied operating systems of general purpose, an application software, the software for diagnostics and adjustment, the telecommunication equipment, the built-in operating systems and the built-in software of the devices transmitting signals of video surveillance and (or) forming managing teams, operating systems of real time to be carried out by testing laboratories in system of certification of FSTEC of Russia on compliance to the Task on security (GOST ISO/IEC 15408) with evaluation assurance level 4 and undocumented feature class 4.

28.4.9. The evaluation assurance level 4 (EAL4) provides methodical design, testing and viewing. The analysis is supported by independent testing of the facility security feature, the certificate of the developer on the tests based on the functional specification and the project of the top level, selective independent confirmation of results of testing by the developer, the analysis of firmness of functions, the evidence of search by the developer of vulnerabilities and the independent analysis of vulnerabilities showing counteraction to attempts of penetration of violators with low attack potential. The 4th level of credibility (undocumented feature class 4) assumes actions only for static analysis of SW.

28.4.10. Further, in the course of recertification, depending on extent of modernization of the certified sample, declaring by the producer of observance of requirements to safety of an initial product is allowed.

28.5. Restrictions on use of the technologies/equipment

28.5.1. In the short-term authentication mechanisms in automated systems and their subsystems on the basis of passwords should be excluded.

28.5.2. Mechanisms of identification and authentication should be implemented by the independent modules implemented directly in automated systems.

28.5.3. At implementation of technical measures of protection of information application of an algorithm of cryptographic hashing of SHA-1 is not allowed.

30.5.4. The systems and devices certified on undocumented feature class 4 and above should not be applied at the information processing which is the state secret

29.Energy saving and increase in power efficiency

29.1. The Regulation in the field of energy saving and increase in power efficiency is directed to implementation of requirements of the legislation of the Russian Federation in this sphere, the comprehensive equipment of achievement of strategic objectives and tasks of electric grid facilities in the field of energy saving and increase in power efficiency, rational use of natural and fuel and energy resources (FER) at implementation of productive and business activities.

29.2. Strategic objectives of the power grid complex in the field of energy saving and increase in power efficiency are:

- reduction of operating costs, identification and elimination of non-productive expenses (decrease in losses of electric energy, expense reduction of FER and natural resources for production and economic needs, and also decrease in a consumption of motor fuel by motor transport and special equipment);
- achievement of the target indicators and indicators of power efficiency accepted in programs of energy saving and increase in power efficiency of SDC;
- creation of an effective management system activity in the field of energy saving and increase in power efficiency according to the best world practices.

29.3. Achievement of strategic objectives of electric grid facilities in the field of energy saving and increase in power efficiency should be provided by means of the solution of the following main objectives:

- development and usage of innovative and energy efficient technologies in the field of transfer and distribution of electric energy;
- use of the modern electrotechnical equipment;
- implementations of the innovative pilot and demonstration projects providing increase in power efficiency of electric grid facilities for the purpose of their further scaling, and also implementation of prototype technical solutions;
- implementations of energy efficient technologies, the equipment, materials and managerial practices on analysis results of the best domestic and foreign practices;
- improvement of normative and technical base, development of internal regulations and standards of the electric grid facilities organizations in the field of energy saving and increase in power efficiency;
- optimization of management systems the business processes connected with energy saving and increase in power efficiency;
- development of power service activity.

29.4. Implementation of the purposes and tasks in the field of energy saving and increase in power efficiency should be performed with use of the following main tools:

- implementation in SDCs of the Company of a system of power management according to requirements of GOST R ISO 50001-2012.
- carrying out obligatory power inspections in SDCs of the Company;
- implementation and control of execution of the program of energy saving and increase in power efficiency (program of energy saving);
- consecutive accomplishment of actions from the list of the projects in the field of energy saving and increase in cost efficiency provided to implementation within power service agreements (project in the field of energy saving and increase in cost efficiency);
- promoting of the principles of energy saving and increase in power efficiency.

29.5. Within implementation of a system of power management the necessary regulating documentation regulating the main procedures in the field of energy saving and increase in power efficiency should be developed, including:

- forming, approval, monitoring of execution and correction of the program of energy saving;

- carrying out the power analysis of balances of electric energy with simultaneous assessment of technical condition of power grid assets;
- monitoring and assessment of indicators (indices) of power efficiency.

29.6. Carrying out power inspections should provide reliability at determination of actual expenses of FER, receiving and updating of information on a reserve of decrease in an expense of FER, and also to create trends in the directions of implementation of potential of energy saving and increase in power efficiency.

29.7. The program of energy saving created on the basis of results of the conducted power examination should include:

- the list of actions which implementation, provides decrease in losses of electric energy and expenses of FER, with determination of financing sources, justification of technical capability and economic feasibility of their implementation;
- dynamics of change of volumes of consumption of FER taking into account the actions planned to implementation;
- values of target indicators for the 5-year period by all types of the consumed FER taking into account the actions planned to implementation;
- on the object list of actions of SDC branches of the Company in the field of energy saving and the increase in power efficiency providing achievement of the set target indicators.

29.8. The list of target indicators on energy saving and increase in power efficiency in general for the Company is established by legal acts of the Russian Federation and the regulating documents of the Company and SDC.

29.9. Values of the Target indicators on energy saving and increase in power efficiency on each SDC are established by business plans of SDC and programs of energy saving and increase in power efficiency taking into account target indicators in general for the Company.

29.10. The realization of power service projects should be enabled according to the project in the field of energy saving and increase in cost efficiency, the approved decisions of Boards of Directors of SDCs of the Company.

29.11. Power examinations in SDC should be conducted 1 time in 5 years in accordance with the legislation of the Russian Federation.

29.12. The system of power management should be implemented in executive office of the company and its SDC at all levels.

29.13. The detailed directions of implementation of actions for increase in power efficiency and to energy saving are reflected in the Policy of innovative development of energy saving and increase in the power efficiency of PJSC Rosseti approved by the Board of Directors of PJSC Rosseti, Minutes of 23.04.2014 No. 150.

30.Import substitution

30.1. Import substitution, as a type of economic strategy and industrial policy of the state, is directed to replacement of import of industrial goods, best-selling in domestic market, by goods of national production.

30.2. Import substitution serves as the mechanism of innovative development of power and allied industries and as the development mechanism of domestic power plant engineering, the electrotechnical industry and industry and fundamental science for ensuring technology safety of the Russian Federation.

30.3. Within import substitution implementation Order of the Government of the Russian Federation No. 719 defined of 17.07.2015 requirements to industrial output imposed for the purpose of its reference to products manufactured in the Russian Federation.

30.4. The energy strategy of Russia, establishes target indicators of the level of development of import-substituting productions in the industry.

30.5. Order of the Ministry of Industry and Trade of Russia No. 653 of 31.03.2015 approved "The actions plan on import substitution in the industry of power mechanical engineering, the cable and electrotechnical industry of the Russian Federation establishing priority groups of the equipment and a target indicator of a share of import in purchases by 2020".

30.6. Implementation of import substitution in the power grid complex on the basis of development of competences of domestic manufacturers and a transfer of technologies is performed by:

- formation of conditions for providing electric grid facilities with the modern domestic equipment;
- identification of the modern and innovative technologies necessary for implementation of the Regulation, their transfer with ensuring required level of localization of production and Research and Development.

30.7. The main directions of import substitution in the Company stimulating development of domestic scientific and potential electrotechnical production should be implemented:

- within investment and repair programs of the Company due to increase in extent of participation of already existing domestic manufacturers and their products;
- within programs of innovative development of SDCs of the Company by creation of conditions for development and deployment in the power grid complex of new samples of electrotechnical products.

30.8. Within implementation of import substitution work on minimization of use of the import equipment and materials when forming project decisions and specifications should be carried out. Use of import products should be possible only in emergency cases when calculation of parameters of a network/facility is demanded by use of the import equipment which does not have analogs of domestic production.

30.9. One of the directions of implementation of import substitution is typification of the equipment used in the power grid complex due to development and deployment of standards of the organization on electrotechnical products, for the purpose of metering of production capabilities of domestic manufacturers and an exception of the excess requirements to the equipment resulting in need to buy the import equipment.

30.10. Work on standardization of technical requirements to the equipment due to centralization of purchases of the main electrotechnical equipment for needs of SDCs of the Company at the level of the managing company acts as not less important activity at implementation of import substitution.

30.11. Within development of cooperation with global manufacturers of electrotechnical products it is necessary to provide development of localization of production of the hi-tech

equipment and components in the territory of the Russian Federation. One of key methodical questions of localization of production of the equipment is development of the principles and criteria for evaluation of the admissible level of localization promoting development of the domestic industry.

30.12. Implementation of the specified actions will allow to reduce considerably terms from development to implementation in operation of the latest advanced domestic technologies, and also to reduce a share of the used import equipment and materials on electric grid facilities.

30.13. Import substitution in the power grid complex is the instrument of implementation of the long-term development strategy of the Company on condition of availability of real mechanisms. At the same time use of import-substituting products should be based on economic feasibility. Again mastered goods should correspond to the best import analogs on consumer properties, technical characteristics, the carried-out functions, design and price indicators.

31.Long-term investment program

31.1. Forming of an investment program is based on the principles of transparency and accuracy of the information, efficiency of the made investment decisions, ensuring reliability and availability of power supply of consumers.

31.2. The planning period of an investment program makes not less than 5 years and can be longer taking into account the period of tariff regulation.

31.3. The investment program forms according to:

31.3.1.1. The financing sources of an investment program created taking into account parameters of tariff regulation.

31.3.1.1.1. Financing sources of investment programs of SDC form the economic block of the Company and are led up to SDC according to the Method of calculation of financing sources of investment programs of SDCs of PJSC Rosseti (Order of PJSC Rosseti of 28.07.2014 No. 176r) and Regulations of approval of volumes and financing sources of investment programs (Order of PJSC Rosseti of 28.07.2014 No. 317r).

31.3.2.1. The lists of investment projects ranged on importance degree.

31.3.2.1.1. Lists of investment projects on all activities of the network company, including the lists of projects providing development, reliability, new connection, metering of electric power, Research and Development, an innovation, safety, consolidation of power grid assets, automation and communication, etc. form the SDC technical units.

31.3.2.1.2. At a stage of forming of lists of investment projects an inspection of their compliance to technical requirements, including this Regulation, to standards of PJSC Rosseti and the industry specifications and technical documentation, the program of innovative development of SDCs of the Company which are carried out, centralized based on Company of certification of equipment and materials is carried out.

31.3.2.1.3. Contains a list of investment projects on each object of value of target and quantitative indices of an investment program and information provided by standards of disclosure of information by the subjects wholesale and retail markets of electric energy approved by Order of the Government of the Russian Federation of 21.01.2004 No. 24 and of 01.21.2009 No. 977, orders of the Ministry of Energy of the Russian Federation of 05.05.2016 No. 380 and of 14.03.2016 No. 177 and also organizational and administrative documents of the Company.

31.3.2.1.4. The lists of investment projects created by SDC ranged proceeding from target and quantitative indices of an investment program to the direction in the SDC investment block are approved by authorized body of management of SDC (Board, Order, Instruction) in coordination with the Deputy CEO of the Company supervising the direction.

31.3.3.1. Target and quantitative indices of an investment program.

31.3.3.1.1. The target and quantitative indices of an investment program including cost effect are approved by Board of the Company according to the proposal of profile Deputy CEOs of the Company by SDC and in general for the Company.

31.3.3.1.2. Selection of investment projects for inclusion in an investment program from lists is performed proceeding from achievement of the target and quantitative indices of an investment program established by Board of the Company, including the indicators of reliability and quality approved by regulating authorities, an index of technical condition, loading of capacities, losses of electric power, reduction in cost of the investment projects and quantitative indices of an investment program approved by Order of the Ministry of Energy of the Russian Federation of 14.03.2016 No. 177 and also organizational and administrative documents of the Company.

31.3.3.1.3. Inclusion in an investment program of projects is performed according to the Scenario conditions of forming of the investment programs approved by Boards of Directors of SDC

which define conditions, criteria and priorities of inclusion of investment projects in investment programs.

31.3.3.1.4. When forming an investment program exceeding of volume of the finished financing sources is not allowed.

32. Project implementation of new construction and reconstruction of the power grid complex

32.1. Design of objects of new construction, modernization and reconstruction

32.1.1. Development of the project documentation is carried out on the basis of the design assignment of construction and reconstruction of power grid facilities containing the main requirements to characteristics of a designed project, volume of engineering researches, terms and staging of development of the project documentation, allocation of stages of construction, need of receiving approvals and the conclusions of expert bodies approved and approved by the customer in accordance with the established procedure, and also on the basis of regulatory legal acts and the existing regulating documents accepted to use in the power grid company customer of the project documentation:

- technical regulations;
- national, industry and corporate standards, techniques, provisions, and also international standards of quality;
- instructions, orders, orders and other organizational and administrative documents obligatory at design of objects of the customer.

As a basis for development of the project documentation requirements to ensuring reliability of electrical power systems, reliability and safety of electric power facilities and the power installations, including requirements should be considered:

- to functioning of electrical power systems, including to ensuring stability and reliability of electrical power systems, the modes and parameters of work of electric power facilities and the power installations, relay protection and automatic equipment, including emergency and mode automatic equipment;
- to functioning of electric power facilities and the power installations;
- to development planning of electrical power systems;
- to safety of electric power facilities and the power installations;
- to training of employees in the field of power industry to work at electric power facilities and power installations.

32.1.2. A basis for development of a design assignment of power grid facilities of new construction, modernization and reconstruction is set of documents on the basis of which the decision on development of the project documentation is made:

- federal target program, program of development of the subject of the Russian Federation;
- investment program of the electric grid company;
- scheme and program of development of UES of Russia;
- schemes and programs of development of territorial subjects of the Russian Federation;
- specifications and the agreement on implementation of connection of new power installations to electric grids
- an order of the Government of the Russian Federation, etc.

32.1.3. When developing a design assignment the following should, including, be considered:

- recommendations of extra phasic works;

- technical solutions on the existing, constructed and designed projects adjacent to subject to design;
- requirements of specifications of implementation of connection of power stations of consumers (objects of generation);
- requirements of specifications to placement of designed power grid projects;
- technical requirements according to impact of designed network projects on the environment;
- threats of terrorist and cyber attacks to power grid facilities;
- requirements to power efficiency.

32.1.4. When developing the project documentation, along with reasonably the applied prototype solutions and solutions of repeated application, the individual, again developed technical solutions with their obligatory check by the corresponding calculations, and if necessary and special tests should be applied.

32.1.5. In the project documentation different options of technical solutions taking into account the main directions of the Regulation should be studied, be carried out necessary comparisons of options by criterion of a minimum of the discounted costs during all lifecycle of a facility (design, construction, reconstruction, operation, dismantle and utilization) with the choice preferable by criterion of technical and economic efficiency. The options chosen for comparison should consider the technical solutions described in programs of innovative development of SDC and Company, and also in program of energy saving.

32.1.6. Design of power grid facilities provides development of project and working documentation.

32.1.7. Check of compliance contained in the developed project documentation of technical solutions to requirements of the Regulation is performed:

- at a stage of consideration, approval and adoption of the main (pricing) technical solutions (in case of allocation of such stage);
- at approval of the developed project documentation in full before its transfer for consideration to bodies of examination;
- before issue of working documentation for «performance of works».

32.1.8. Examination of the project documentation and results of engineering researches is performed by the expert organizations authorized for it according to requirements of the operating regulatory legal acts of the Russian Federation.

32.2. Ensuring compliance to requirements for reliability, safety of the commissioned capital construction projects

32.2.1. Tasks of capital construction within the Regulation are:

- decrease in number of technology violations, and as a result undersupply of electric power, connected with low-quality construction;
- ensuring compliance of the constructed capital construction projects to required technical characteristics and the approved design estimates.

32.2.2. For accomplishment of these tasks during 2016 - 2019 in capital construction the following events demand implementation:

- development and establishment of quality requirements of the performed works (EAD, Construction and Installation) and their results influencing reliability, safety, providing required technical characteristics and compliance of the design and estimate documentation of the commissioned capital construction projects.
- creation of a monitoring system, analysis and quality evaluation of works (EAD, Construction and Installation) and their results influencing reliability, safety, providing required technical characteristics and compliance of the design and estimate documentation of the commissioned capital construction projects.

- development of competences of own personnel in quality control (EAD, Construction and Installation) and their results, assessments of conformity to requirements for reliability, safety, required technical characteristics and the design and estimate documentation of the commissioned capital construction projects.
- organization and control of quality (EAD, Construction and Installation) and their results influencing reliability, safety, providing required technical characteristics and compliance of the design and estimate documentation of the commissioned capital construction projects.
- involvement of the independent expert and inspection organizations, including within construction supervision, on quality control of performance of works and assessment of conformity to requirements for reliability, safety of the commissioned capital construction projects.

32.2.3. For the purpose of implementation of these actions in capital construction implementation and ensuring effective functioning of the Quality management system of processes (engineering researches, design, production of equipment, construction) of capital construction is supposed during 2016 - 2019.

32.3. Acceptance for operation of finished construction facilities.

32.3.1. Work on acceptance for operation of finished construction facilities is carried out according to "The standard order of acceptance for operation of finished construction facilities of SDCs of PJSC Rosseti approved by Order of 20.02.2015 No. 87r and approved by the Board of Directors of PJSC Rosseti (The protocol of 05.06.2015 No. 191).

32.3.2. Acceptance for operation of finished construction facilities can be made all title in general, stages of construction, a starting stage (complex), title temporary buildings and constructions, certain buildings and constructions, separate units or systems of the equipment (in the volume provided by the project documentation approved according to the current legislation).

32.3.3. Acceptance for operation of separate stages of construction or starting stages (complexes) which are not provided by the project documentation approved according to the current legislation is not allowed.

32.3.4. Acceptance of separate units of equipment at absence or malfunction of the auxiliary systems providing safe operation of the equipment is not allowed.

32.3.5. Before acceptance for operation of power grid facilities according to Rules of technical operation of power plants and networks of the Russian Federation individual tests of the equipment and complex approbation of the equipment should be carried out. Before carrying out complex approbation permissions of Rostekhnadzor to the admission in operation of the power station should be got.

32.3.6. According to Order of the Ministry of Energy of the Russian Federation of 19.06.2003 No. 229 "About the approval of Rules of technical operation of power plants and networks of the Russian Federation" (It is registered in the Ministry of Justice of the Russian Federation 20.06.2003 N 4799)" for acceptance of objects working and acceptance commissions should be formed.

32.3.7. Before appointment of inspection the preparation and training of the personnel operating a power grid facility aimed at providing its readiness for accomplishment of professional functions and maintenance of its qualification is organized. Necessary requirements to the operating personnel are regulated by CO 153-34.20.501-2003.

32.3.8. Acceptance for operation of power grid facilities without permissions to the admission in continuous operation of power stations issued by Rostekhnadzor and the conclusions about compliance constructed, the reconstructed, repaired capital construction project to requirements of technical regulations and the project documentation issued by the state construction supervision is not allowed if these documents are provided to registration on these objects according to the current legislation.

32.3.9. After acceptance for operation of finished construction facilities it is necessary to issue permission to commissioning according to the Town-planning code of the Russian Federation if this document is provided to registration on these objects according to the current legislation.

33. Organization of purchases of material resources and equipment, works and services

33.1. The main directions of the Regulation are:

- increase in a share of open competitive procedures of purchases of material and technical resources and equipment, works and services, for ensuring due level of the competition and attraction of a wide range of applicants;
- flexible approach to forming of requirements and selection criteria and assessment to purchased material and technical resources and equipment, to works and services for attraction of offers with the new technical solutions providing innovative components, offers which make or can make impact on decrease in consumption or rational use of FER; and also the containing advanced scientific and technical developments;
- expansion of selection criteria of winners of purchases for ensuring balance of reliability, cost, simplicity and profitability in operation of purchased material and technical resources and equipment;
- building of partnership with the leading producers of the power and electrotechnical equipment, for obtaining timely information on the latest technical solutions, with a possibility of influence on further improvement of purchased material and technical resources and equipment;
- determination of suppliers of the most effective and qualitative material and technical resources and equipment and services at the optimum cost;
- organization of acquisition of big batches of material and technical resources and equipment, the confirmed high quality for cost reduction on acquisition and operation of the unified equipment;
- holding open competitive procurement procedures on the right of the conclusion of long-term agreements (3-5 years) with obligations of participants of providing and further the implementation of long-term programs of development of production providing increase in a share of production and its component parts in the territory of the Russian Federation, improvement of quality of products, and also forming of single quotations for the entire period of validity;
- establishment (in case of availability of the relevant decision of the Government of the Russian Federation) the priority of goods of the Russian origin, works, services which are carried out, rendered by Russian persons in relation to the goods coming from the foreign state, to the works, services which are carried out, rendered by foreign persons taking into account the customs legislation of the Customs union and international treaties of the Russian Federation, and also features of participation in purchase of subjects of small and medium entrepreneurship.

34.Certification of equipment, materials and systems

34.1. The system of certification in the power grid complex is internal system of quality check of the purchased equipment, materials and systems, the effective instrument of the implementation of the Regulation directed to increase in reliability of UES of Russia.

34.2. The main objective of the system – exclusion of supply to electric grid facilities of the equipment, materials and systems which do not conform to technical requirements, the specifications and technical documentation, the purposes and conditions of application.

34.3. The system of certification of the Company provides:

- interaction and exchange of information between the Company and SDC, and also other companies of the electrotechnical industry concerning quality and reliability of the delivered equipment;
- interaction with manufacturers (suppliers) of the equipment, for the purpose of ensuring the technical parameters demanded in operation;
- comprehensive study of a design and parameters of the electrotechnical equipment of different manufacturers (suppliers) offered in the market;
- presentation of the front lines corresponding to the Regulation, technical requirements to the equipment at the level of the international standards;
- monitoring and feedback of the manufacturer (supplier) with operation;
- technical and service support of the delivered equipment;
- interaction of the research, project, production organizations for the purpose of identification of the most effective application of the proposed technical solutions;
- exclusion of use of the equipment which does not conform to technical requirements, the equipment executed on outdated technologies, the equipment having the increased failure rate;
- adjustment and updating of the electric grid facilities normative and technical base;
- integration of innovative offers for the subsequent development and modernization of the released equipment, technologies and materials.

34.4. The system of certification of the Company is applied in addition to system of confirmation of conformity according to Federal law No. 184-FZ "About technical regulation".

34.5. Certification of equipment, materials and systems delivered to power grid facilities is carried out according to internal documents of the Company.

34.6. The conclusion of certifying commission approved by the Company in accordance with the established procedure which action extends to the equipment, materials and systems delivered and operated at facilities of the Company and all by SDC is result of certification.

34.7. Results of positive certification are made out in the form of "The list of the equipment recommended for application at facilities of the Company and all by SDC" with placement on the website of the Company.

34.8. Absence as a part of the commercial offer of the participant of a procurement procedure of the documents confirming compliance to products offered to delivery to technical requirements of the Company is the basis for recognition of the request of the participant of the tender documentation which does not conform to requirements. As the documents confirming compliance to requirements of the Company either the conclusion of certifying commission, or the package of technical documentation (test reports, certificates, etc.) represented as a part of the request of the participant of a procurement procedure can be considered. The decision on use of not certified products is made at a meeting of the commission on the admission of the equipment of SDCs of the Company on a result of consideration of a package of additional technical documentation regarding compliance to requirements of the Company.

34.9. For the purpose of:

- ensuring reliable and trouble-free operation of UES of Russia;
- development of a system of certification of equipment and materials;
- development of systems of national standartization and cross-industry interaction;

- formation of reliable mechanisms of certification and declaring of the electrotechnical equipment;
- stimulation of innovative development of domestic manufacturers of the electrotechnical equipment;
- ensuring program implementation of import substitution of SDCs of the Company;

creation of the uniform centre of competence in testing of the electrotechnical equipment and materials based on the test centre and the relevant associations is necessary.

35.Normative and technical provision

35.1. The system of normative and technical provision of the Company and its SDC is a set of the approaches applied when developing and metering the normative and technical documents (NTD) in the field of technical regulation of activity.

35.2. The purposes of development of system normative - the equipment are:

- development of the general and system requirements to development of a power supply system;
- distribution of the best experience of the organization of operation of power grid facilities;
- ensuring implementation of the Regulation;
- practical implementation of requirements of the legislation for objects, technical means and types of activity;
- harmonization of the specifications and technical documentation with technical regulations of the Eurasian Economic Union, national, interstate standards and international standards of IEC(IEC) and ISO(ISO), and also the industry specifications and technical documentation;
- unification and typification of the specifications and technical documentation;
- updating and updating of specifications and technical documentation base, taking into account trends of development and achievements of scientific and technical progress;
- development of voluntary certification of the equipment, materials and systems according to requirements of standards;
- forming of the regulatory legal base of the industry, including on development of offers and the corresponding justifications regarding change of requirements of reliability and safety in power industry, participation in work of the Working group on preparation of project proposals of regulatory legal acts in the field of ensuring reliability and safety of electric power facilities, ensuring reliability of functioning of electrical power systems and regular power supply of consumers (approved by Order No. 924 of the Ministry of Energy of 07.09.2016).

35.3. Specifications and technical documentation are developed concerning power grid facilities, the electrotechnical equipment and implementable types of activity. The list of subjects to technical regulation is defined by the Company and its SDC.

35.4. Specifications and technical documentation are divided by the following main subjects:

- rules of design and construction;
- requirements to the equipment, materials, systems, buildings and constructions;
- methods and regulations of testing and diagnostics;
- requirements for the organization of operation, maintenance and repair;
- work with personnel in the organizations of power industry;
- regulation in the power grid complex;
- operational and technology management;
- investigation and metering of technology violations;
- safety of power grid facilities, including information;
- metrology;
- quality of electric power;
- electromagnetic compatibility;
- industrial safety rule and industrial safety, fire safety,
- environmental protection, ecological safety;
- metering of electric power and development of services;
- production management, management.

35.5. Activities for development of a system of normative and technical provision of the Company and its SDC are controlled by a profile body on a permanent basis – the Coordination council on development of a system of normative and technical provision, created by Order No. 210r of 30.04.2015.

35.6. The realization of the Regulation via mechanisms of a system of normative and technical provision is enabled by forming and the updating of the register of the specifications and technical documentation in the field of technical regulation operating in the Company and its SDC, approved by Order No. 612r of 28.12.2015.

35.7. At reconstruction and new construction, and also at maintenance, repairs and at operation of power grid facilities the Company and its SDC should be guided by provisions of the documents included in the register according to their status and taking into account an organizational structure of the companies.

35.8. Work planning on development of standards of the Company and its SDC is performed with involvement of the Coordination council on development of a system of normative and technical provision.

36.Control of implementation of technical policy

36.1. The purpose of control of implementation of the Regulation is ensuring its execution in activity of the Company and its SDC.

36.2. Persons, responsible for implementation of the Regulation, should not allow application in activity of the Company and its SDCs of the technical solutions contradicting the Regulation.

36.3. Control of implementation of the Regulation includes the following stages:

- control of compliance of the scheme and program of development of power industry of regions to the Regulation;
- development of strategic documents: politicians, strategy, concepts in the technology directions described in the Regulation;
- development of the specifications and technical documentation in the field of technical regulation: standards, instructions, operational instructions, techniques, rules, regulations;
- control of compliance of production, repair, and target programs of reconstruction and construction of power grid facilities to strategic tasks of the Company and its SDC;
- control of compliance of the program of innovative development to strategic tasks of the Company and its SDC;
- control of compliance of design assignments, on accomplishment of EAD on reconstruction and construction of power grid facilities to requirements of the Regulation;
- control of compliance of the project documentation on objects of reconstruction and construction of power grid facilities to requirements of the Regulation;
- control of compliance of technical requirements and specifications on delivery and production of the equipment within reconstruction and construction of power grid facilities to requirements of the Regulation;
- control of compliance to technical and functional requirements of again purchased equipment and materials to requirements of the Regulation;
- control of execution of power service projects by consideration by Boards of Directors of SDCs of the Company of the quarterly report on the course and results of implementation of actions of the power service projects included in lists;
- control of observance of requirements of the Regulation at accomplishment of Construction and Installation, Commissioning at reconstruction and construction of power grid facilities;
- control of observance of requirements of the Regulation at implementation of productive activity, and also within operation, maintenance and repairs of power grid facilities and the equipment;
- control of compliance of the tender documentation on EAD, Construction and Installation and delivery of the electrotechnical equipment within reconstruction and construction of power grid facilities to requirements of the Regulation;
- confirmation of indicators of purpose of the equipment, materials and systems.

36.4. Control of implementation of the Regulation is exercised by operating structural units, and also branch of the Company - the Centre of technical supervision according to their functionality.

37.Perspective technologies

37.1. General provisions

37.1.1. Use of perspective technologies will allow to make transition to electric grid of new technology way with qualitatively new characteristics of reliability, efficiency, availability, controllability and customer focus of electric grid facilities of the Russian Federation in general.

37.1.2. Electric should provide with network of new technology way:

- automatic control of the modes of network on the principles of the distributed (multiagent) management;
- self-diagnostics in real time parameters and working hours of network, separate objects and units of equipment for the purpose of increase in system and consumer reliability, decrease in operating costs;
- flexible automatic reconfiguration of network in response to change of its parameters and topology (including prevention failures/self-recovery of network after failures);
- providing to different categories of consumers of specialized services and services (diversified on time, volumes, quality and the price of electrical supplies, regulation of demand and generation, charging of electric vehicles).

37.1.3. For implementation of the specified tasks widespread introduction of next technologies is necessary:

- microprocessor management systems and diagnostics, constructed on the basis of artificial intelligence;
- systems of exchange of the large volume of data in real time;
- systems of cyber security.

37.2. Creation of electric grids of new generation of new technology way (intellectual electric grids)

37.2.1. Forming of the concept of intellectual electrical power network, is caused by development of such technologies as:

- flexible power transmission lines of alternating current (FACTS);
- The power transmission line and inserts of direct current on the basis of modern converting devices with microprocessor management;
- high-speed means of communication;
- monitoring of the EES dynamic properties (WAMS - Wide Area Measurement Systems) on the basis of registration of vector parameters of the electric mode of network in real time with use of modern technical means of processing and information transfer (a monitoring system of the transitional modes of UES of Russia - wide-area measurement system);
- intellectual systems for information processing and control of the equipment, including system of metering of electric power and monitoring of a condition of the equipment.

37.2.2. The Intellectual Electrical Power Network (IEPN) is the network of new generation founded on the multiagent principle of management and development. The purpose of IES - ensuring effective use of all types of resources (natural, social and production and human) for reliable, high-quality and effective power supply of power consumers due to flexible interaction of her subjects (all types of generation, electric grids and consumers) on the basis of modern technology means and a uniform intellectual management system.

37.2.3. IES should have new properties, are basic of which:

- the standardized hi-tech flexible interface "generator-network", "consumer-network";
- the new network topology providing regulation of exchanges of power with the corresponding management system of the IES active elements;

- adaptive reaction of the managed IES elements to change of the electrical power mode of a power supply system in real time, including in interaction with the centralized and local devices of mode and emergency control in normal, emergency and postemergency operation of work of a power supply system;
- basing on new information resources and technologies for assessment of situations, development and adoption of operational and long-term decisions;
- an opportunity to provide flexible response to change of solvent demand for the electric power with maintenance of balance in real time;
- effective use of the electric power by consumers for the realization account of algorithms situational (on the basis of market alerts) regulations of loading, considering the nature of use of the electric power by consumers;
- a possibility of collecting and processing of large volumes of information on a current status of a power supply system and its elements (ensuring observability) and about the external environment (illumination, rainfall, ice, wind loadings and other meteofactors), with its use in modern management systems of real time;
- a possibility of adaptive reaction to the current situation in a power supply system in real time, preventing emergence and development of emergencies due to use of automatic management systems and mutual rendering full range of services by subjects of the market of power industry and infrastructure, using market opportunities;
- a possibility of the maximum self-diagnostics of the IES elements with use of its results in algorithms of functioning of automatic systems of mode and emergency control;
- application of high-performance computing resources and control algorithms, both for development of automatic corrective actions, and for providing recommendations dispatching, operational technology and to repair personnel for implementation of management and carrying out necessary works;
- the organization of the standardized hi-tech flexible interface on all technology and information (including in integrated information and technology) sections: "generator - network", "consumer - network" with an exit to systems of technology management and commercial coordination;
- development of new information resources and technologies for assessment of situations, developments and adoptions of operational and long-term decisions;
- the solution of the tasks providing in real time approval on the market principles of economic interests of all participants of the market;
- ensuring reliable and high-quality power supply of consumers in the normal modes of functioning of a power supply system due to use of digital information systems, automated control systems and autonomous systems;
- removal of network restrictions on transmission capacity in nodes of network;
- ensuring system reliability of functioning of a power supply system in general and its parts in the normal modes;
- preserving of survivability of a power supply system, at emergence of emergencies, including cascade type, with a possibility of involvement of consumers to emergency control, a possibility of self-recovery of parts and a power supply system in general;
- providing the high level of information security, due to embedding of elements of security systems in all technology systems and transactions, protection of information space and private information of all structures of system, including consumers, in all modes of functioning of a power supply system;
- ensuring electromagnetic compatibility of secondary systems and their protection against external electromagnetic and other influences, including cyber attacks.

37.2.4. Creation of IES should stimulate development of basic and applied scientific research in the field of transfer and transformation of the electric power, automatic control, new materials, effective unconventional and renewable sources of the electric power.

37.2.5. Implementation of the IES model will provide:

- **for the State:** emergence of the new high-tech and competitive industry, ensuring non-volatility and infrastructure security of development of economy, the advancing modernization of the key infrastructure branch, control of growth of rates;
- **for the grid companies:** receiving savings in implementation of investment programs, increase in parameters of quality of power supply of consumers, a possibility of redistribution of the released power of SS without development of network. Ensuring readiness of infrastructure for development of the new markets, regulatory privileges at installation of the innovative equipment, increase in parameters of quality and reliability of power supply of consumers;
- **for consumers:** technical connection reduction in cost (due to decrease in necessary power thanks to own generation, stores, micronetworks), expense reduction on power supply (due to receiving money from rendering services to system, active regulation of consumption, sale of excess of energy in network), power supply improvement of quality (increase in stability of frequency, reservation in case of violation of work of external network).

37.3. Digital substations

37.3.1. DSS is the substation with the high level of management automation by technology processes equipped with the developed information and technology and managing systems and means (Information acquisition & transmission system, AMI, RP, EA, RASP, fault location devices, etc.) in which all processes of information exchange between the SS elements, information exchange with external systems, and also managements of work of SS are performed in a digital format. At the same time both primary power equipment of DSS, and components of information and technology and managing systems functionally and are structurally oriented to support of digital data exchange.

37.3.2. DSS is on implementation phase of pilot projects. The decision on mass implementation of separate elements or complex decisions of DSS should be considered following the results of obtaining results of trial operation of different options of technical solutions of creation of DSS taking into account the feasibility justification.

37.3.3. For obtaining the maximum effect of implementation of DSS technology it is necessary to develop, approve and implement the following events and technologies:

- specialized SW creating issue and interaction with files of the electronic project documentation of SCL, CID, CCD, accomplishment of configuring of the equipment of DSS reducing labour costs at design and a redesign of electric power facilities;
- technologies allowing to implement information transfer from one source to the necessary number of recipients on power facility or beyond its limits;
- technical requirements allowing to reduce time of approval of separate subsystems at the expense of high degree of compatibility of devices;
- SHC providing unity and high precision of measurements. All measuring components are included in measuring canals and form a single system with clocking synchronization;
- technologies allowing to reduce the most labour-consuming and non-technological types mounting and the balancing and commissioning connected with laying and testing of secondary circuits;
- work performance methods allowing to reduce time of carrying out balancing and commissioning at the expense of a possibility of the centralized setup and control of parameters of the equipment;
- technical solutions reducing the cost of cable system including due to multiplexing of signals that assumes bilateral transfer through one optical cable of a large number of signals from different devices;

- work performance methods at which the possibility of remote carrying out adjustment works is provided;
- systems of diagnostics covering not only intelligent devices, but also passive measuring converters and their secondary circuits, allowing to establish the place and a cause of failures in shorter terms, and also to reveal precritical condition;
- control systems of integrity of secondary circuits (continuous tracking of a condition of secondary connections: break, loss of data);
- work performance methods on maintenance and repair of devices directed to decrease in volumes and increase in intervals of service and repairs;
- standard technical requirements to the equipment of DSS allowing to reduce repair terms by use of the standardized equipment of the different producers compatible among themselves (the principle of interoperability);
- algorithms of work of the RPA functions: providing new opportunities, including absolute selectivity;

37.3.4. Requirements to DSS:

- DSS should be implemented on innovative technologies and methods of the measurements providing the set metrological characteristics of measuring channels, the complex and measuring components entering measuring system both at normal and under operating conditions of use. Stability of metrological characteristics of measuring channels, the complex and measuring components entering measuring system during all service life (not less than 20 years) with the increased interval (8-12 years) of periodic metrological control should be provided;
- all measuring components and measuring channels should be the approved type, are registered in the Federal information fund for ensuring unity of measurements and allowed to application in the Russian Federation;
- measurements of all range of parameters it has to be carried out using the measurement techniques certified in accordance with the established procedure developed according to requirements of GOST R 8.563;
- the measuring channels as a part of the DSS measuring systems used to measurements, the subsequent processing/transformation of results of measurements and display of results of the measurements expressed in the referred to as units of the measured size and their metrological support should conform to requirements of GOST R 8.596;
- SW IS should conform to requirements GOST R 8.654;
- The used devices and SHC should be industrial execution and are intended for work on electric power facilities in working conditions at the increased levels of electric and magnetic fields;
- SW and/or a program complex should be a component of the applied SHC;
- SW, the managing and infrastructure SW DSS providing automation of technology processes, in particular, should not contain any artificial limiters of functionality and functioning, electronic keys, etc. in the structure;
- at application of centralized systems duplication of RP, SA, RASP and TA (or separate functions of these devices) separate physically independent microprocessor devices, and also communications between devices, using traditional decisions is obligatory;
- combination of the RP and EA functions in one device, except for function of automatic equipment of frequency unloading is not allowed;
- the bus of process and the bus of data should be executed on the basis of protocols of data transmission of IEC 61850-8-1 and IEC 61850-9-2 respectively;
- the open server software (OSS) having available and evident tools for the detailed analysis and work on adjustment, checks, introduction in need of completions and changes should be provided. OSS should meet the requirements of ensuring necessary speed, have systems of internal self-diagnostics of the server and network hardware, contain intellectual algorithms of determination of refusals (failures) in system and forming of the alarm system, and in need of

anticipatory influences on liquidation of emergencies. OSS should fix all arriving input information and the created output influences with check of their execution on response signals from adjacent devices (systems). OSS should allow to keep automatically configurations and to have a possibility of quick recovery at physical damage of data carriers;

- for monitoring and diagnostics of secondary systems interface of SW of secondary systems and specialized test devices (complexes) should be provided;
- service life of the equipment of secondary systems should make not less than 20 years;
- creation of DSS should be implemented only using digitizers of current and voltage (without application of electromagnetic CT and VT);
- application of electromagnetic CT and VT together with converters of the measured analog sizes of current and voltage in a digital form (AMU devices (merging unit, RPA devices with the digital output interface under the IEC IEC 61850-9-2 protocols) performing broadcast of results of measurement in a digital form under the IEC 61850-9-2 protocol is allowed at a stage of pilot projects, by results of the feasibility justification and calculations confirming ensuring required reliability of operation of the equipment of DSS;
- the hardware platform and SW should conform to requirements imposed to the microprocessor devices and systems applied at facilities of SDCs of PJSC Rosseti;
- The hardware platform should have the built-in means of self-diagnostics and monitoring of a state, and also system of the alarm system of a state and operating modes of the equipment and SW;
- within the import substitution program use of the equipment of the Russian production, including SW is preferable;
- use of the DSS systems at the first stage should be carried out preferential with duplication of the RPA complexes executed on microprocessor element base;
- adjustment of the above-stated requirements will be performed on the basis of results of carrying out pilot projects.

37.4. Perspective technologies of intellectual electrical power network

№	Directions of development	List of perspective technologies	Basic technical requirements
1.	**Transition to digital active and adaptive networks with the distributed intellectual system of automation and management** Networks with qualitatively new indicators of availability (duration and cost of connection of consumers to grid), reliability of power supply, cost of ownership and efficiency of power grid infrastructure, adaptivity to different power sources and consumer requirements and openness, from the point of view of providing information to the authorized subjects of the market of electric energy and power.	- Intelligent switching devices (recloser) with the integrated controllers of connections and ability to integrate into a unified information system of management, as much as possible in Plug-n-Play ideology. - Managed loading switches with ability to integrate into a unified information system of management as much as possible in Plug-n-Play ideology. - Intellectual complete DD with the integrated controllers of connections and ability to integrate into a single system of management, as much as possible in Plug-n-Play ideology. - Intelligent metering devices, with ability to integrate into a single system of management, the providing functions of remote control, issue of information on network functioning parameters. - Intellectual monitoring systems and diagnostics of operation of the equipment of network (including means of remote diagnostics, and also the means integrated into structure of the equipment), with ability to integrate into a single system of management. - Fault location devices systems in network with ability to integrate into a single system of management. - Automatic management systems voltage and reactive power using means of FACTS (series capacitor bank, static VAR compensator, controlled shunt reactor, phase shifter, static compensator). - Systems of automatic control allowing to regulate voltage by several criteria of electricity quality. - Systems of balancing and compensation of harmonics of voltage (active filters).	- At implementation of intelligent switching devices (recloser) to give a priority to decisions on the distributed automation of the network assuming creation of ring feeders with single automatic reservation and automatic sectioning of the route. - At implementation of systems of intellectual metering the basic requirements is the possibility of their integration into unified information systems of management for the purpose of data acquisition about parameters of network, and also ensuring management functions with a power consumption for the subsequent use by all "clients" of an information system. Use of standard metering devices at obligatory availability of the controller performing the functions stated above is allowed. - All applied decisions should provide ability to integrate into a unified information system of management.

№	Directions of development	List of perspective technologies	Basic technical requirements
		- Application of all types of storage of electric power, together with management systems. - Creation of new power grid services for consumers: charging infrastructure for the electric transport, engineering services, provision of services of network "on reservation".	
2.	**Transition to digital SS of 35-110 (220) kV** The minimum dimensions and implementation cost (including a possibility of pole-mounting execution of SS), availability of the built-in measuring and intellectual opportunities (the integrated functions of protection and automatic equipment, monitoring, metering and data transmission) which in the long term are not demanding individual settings for work in the networks communicating on digital channels of communication, as much as possible in Plug-n-Play ideologies (demanding the minimum design costs and implementation, including possibilities of digital design).	- Controllers of connections integrating the RPA functions, metering and monitoring supporting a digital format of data exchange. - At a transitional stage, the RPA digital devices supporting digital data exchange. - At a transitional stage, the digital metering devices supporting digital data exchange. - Digital measuring instruments of current and voltage (including transformers, and also different types of sensors) supporting digital data exchange. - The intellectual DD supporting digital data exchange. - Intelligent switching devices with the integrated controllers of connections supporting digital data exchange. - Monitors and diagnostics supporting digital data exchange integrated into structure of the equipment; - Devices of synchronized measurements (PMU).	- In priority for projects of new construction. The basic requirements is reduction of aggregate value of ownership of the solution not less than for 20% in comparison with traditional analogs. - In projects of reconstruction and new construction it is necessary to be guided by the decisions supporting digital exchange to data between devices with ability to integrate into a unified information system of management under standard protocols of exchange.
3.	**Transition to complex efficiency of business-processes and automation of management systems**	- Systems of creation of a grid model according to the uniform standard of data. - Systems of collecting and display of information (SCADA). - Distribution Management System (DMS). - Outage Management System (OMS).	- One and all implemented systems should provide a possibility of support of a uniform information model of the network relying on requirements of the IEC 61970/IEC61968 standard.

№	Directions of development	List of perspective technologies	Basic technical requirements
	The unified information system of operational and technology and situational management providing: - creation of uniform model of the network relying on requirements of the CIM IEC61970/IEC61968 standard; - the automated collecting of all operational information at all levels of operational and technological management and SU; - increase in justification and timeliness of adoption of management decisions; - reduction of time of carrying out emergency recovery operations; - replacement of paper operational logs and the automated forming of reporting and analytical information; - decrease in operating costs at operation of the power grid equipment; - improvement of quality of informing the management due to reduction of time of collecting and the analysis of operational information.	- Management systems (EMS). - Systems of display of information on the base map (GIS). - Asset management systems (AMS). - Systems of digital design of networks (PLM, BIM, CAD). - Personnel training systems - Client services and customer relationship management systems (CRM). - Systems of integration with external systems, "public" information space. - Electronic catalogs and databases of prototype technical solutions. - Systems of modeling of working hours of networks (SSS, SSCAD/EMTDC, RTDS). - Management systems of Information acquisition & transmission system, SSPTI. - Digital monitoring systems and diagnostics. - SHC and SW for ensuring protection against cyber attacks. - Creation of adaptive management systems and ensuring parallel network functioning with renewable sources e/e. - Implementation of the EAM, EDS, CAFM systems based on system of standards 55000. - Systems of intellectual monitoring and diagnostics. - Risk management system. - Systems of modeling of effects of technology violations and failures.	

№	Directions of development	List of perspective technologies	Basic technical requirements
4.	**Use of new technologies and materials in power industry**	In the field of system-wide questions: - Application of direct current at connection to network (small generation and Distribution Zone), management (inserts of direct current, restriction of short circuit), power transmission on all voltage classes. - Technologies providing increase in transmission capacity of electric grids without change of a configuration of network of all voltage classes.	
		For SS: - Use of power transformers, energy efficient, reliable and safe for environment.	For power transformers: - winding wires: with gluing together of elementary conductors or from the strengthened copper; - high-voltage inputs with solid insulation; - with insulation from nonflammable, environmentally friendly dielectrics; - gas-insulated (110-220 kV for megalopolises); - "dry" (without oil) executions it is preferential for internal installation; - With the loss rate of idling and short circuit - with the cooling system allowing to utilize heat for heating of premises of SS - For distribution transformers: - the loss rate of idling and short circuit; - "dry" execution; - with solid (cast or fiber glass) insulation.
		- Use of switching devices with the minimum impact on the environment.	- vacuum (up to 220 kV), - gas, with minimization of application of SF6 (mixed or nitric); - semiconductor.
		- Use of active lightning protection	

№	Directions of development	List of perspective technologies	Basic technical requirements
		- For arc-extinguishing devices of compensation of single-phase earth short circuits	- plunger type – variable-frequency drive of plungers; - static arc suppression coils with high-speed management systems of compensation of single-phase earth short circuits, including with thyristor-switched capacitors.
		- Application of the means of compensation of reactive power (SVC) with smooth automatic adjustment in all range of work. For networks of 330 kV and above – with automatic equipment of management allowing to work in cycles of single-phase autoreclosing	

38.Indicators of progressiveness of technical solutions

38.1. General provisions

38.1.1 Progressiveness indicators - a system of indicators characterizing qualitative properties of a product and their compliance to the best world samples; technical and other benefits of new electrotechnical products in comparison with the known equipment; the expected economic or other effect.

38.1.2. During 3-5 years transfer of a number of indicators from indicative to obligatory through development new and updating of the existing standards of the organization of the company is supposed.

38.2. Indicators of progressiveness of primary and secondary equipment

№	Technology system	Progressiveness indicators		
		Functional and technology	**Economic**	**Ecological, safety**
1	**SS**	- construction of SS without permanent service personnel - ensuring observability for SS of 10-35 kV - for SS of 110 kV and above: ensuring automation of production processes (monitoring and management)	- use of the equipment and the technologies providing the minimum costs during lifecycle	- use of the explosion-proof and explosion-proof equipment - decrease in influence of electromagnetic fields and acoustic noise

<table>
<tr>
<td>2</td>
<td>Distribution transformers

6-35 kV</td>
<td>
Loss rates of Idling (XX)
<table>
<tr><th rowspan="2">Rated power, kVA</th><th colspan="2">Losses of XX, W</th></tr>
<tr><th>A_0</th><th>B_0</th></tr>
<tr><td>100</td><td>145</td><td>180</td></tr>
<tr><td>160</td><td>210</td><td>260</td></tr>
<tr><td>250</td><td>300</td><td>360</td></tr>
<tr><td>400</td><td>430</td><td>520</td></tr>
<tr><td>630</td><td>560</td><td>680</td></tr>
<tr><td>1000</td><td>770</td><td>940</td></tr>
<tr><td>1250</td><td>950</td><td>1150</td></tr>
<tr><td>1600</td><td>1200</td><td>1450</td></tr>
<tr><td>2500</td><td>1750</td><td>2150</td></tr>
</table>
Loss rates of Short Circuit (SC)
<table>
<tr><th rowspan="2">Rated power, kVA</th><th colspan="3">Losses of short circuit, W</th></tr>
<tr><th>A_k</th><th>B_k</th><th>C_k</th></tr>
<tr><td>100</td><td>1250</td><td>1474</td><td>1750</td></tr>
<tr><td>160</td><td>1700</td><td>2000</td><td>2350</td></tr>
<tr><td>250</td><td>2350</td><td>2750</td><td>3250</td></tr>
<tr><td>400</td><td>3250</td><td>3850</td><td>4600</td></tr>
<tr><td>630</td><td>4800</td><td>5600</td><td>6750</td></tr>
<tr><td>1000</td><td>7600</td><td>9000</td><td>10500</td></tr>
</table>
</td>
<td>- efficiency evaluation of use of transformers with reduced losses of idling and short circuit (in relation to requirements according to GOST 11920-85 and GOST 27360-87) taking into account the cost of losses in each specific region of the Russian Federation
- dry transformers (with a possibility of installation of forced ventilation)</td>
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<table>
<tr><th>№</th><th>Technology system</th><th colspan="3">Progressiveness indicators</th></tr>
<tr><th></th><th></th><th colspan="2">Functional and technology</th><th>Economic</th><th>Ecological, safety</th></tr>
<tr><td></td><td></td><td colspan="2"><table>
<tr><th rowspan="2">Rated power, kVA</th><th colspan="2">Losses of short circuit, W</th></tr>
<tr><th>A_k</th><th>B_k</th></tr>
<tr><td>1250</td><td>9500</td><td>11000</td></tr>
<tr><td>1600</td><td>12000</td><td>14000</td></tr>
<tr><td>2500</td><td>18500</td><td>22000</td></tr>
</table></td><td></td><td></td></tr>
<tr><td>3</td><td>Power transformers, AT and shunting reactors</td><td colspan="2">- availability of LTC for transformers with the highest voltage of 35 kV and below
- LTC the number of switchings before the first audit not less than 140 000 with automatic control of coefficients of transformation, a mechanical resource of the contactor, the number of switchings, not less than 700 000
- wear resistance of contacts at (0,7-1,0) ×Inom, the number of switchings, not less than 400 000
- natural circulation of oil for transformers with power less than 80 MVA·
- automated system of monitoring and diagnostics.
- application for demountable compounds of the sealing materials designed for all service life of the equipment
- use of non-shrinkable materials allowing not to carry out repressing of windings of the transformer during all service life
- automatic management system of LTC of transformer/ group of transformers</td><td>- -the losses of idling reduced on 25% in relation to requirements in accordance with GOST 17544-85, GOST 12965-85
- -specific losses of transformer steel of P1,7/50 - 0,85 W/kg at induction of 1,7 T</td><td>- equipment by systems of prevention of depressurization of the body at internal damages and
- explosion-proof inputs
- inputs of 110-500 kV tight, without excessive pressure, without broad tank with solid insulation with an exception of the oil used as the cooling environment</td></tr>
</table>

№	Technology system	Progressiveness indicators		
		Functional and technology	**Economic**	**Ecological, safety**
4	**SVC:** - Static thyristor compensators and dry-type reactors (static VAR compensator and Dry-type reactors), - Static capacitor banks and compensation filter devices	- work with rated power in the mode of generation and consumption - for static capacitor banks and compensation filter devices based on dry power capacitors with service life of 30 years and with a temperature range of-50 +40 ºC.	- relative losses in the nominal mode, %, no more: Static thyristor compensators – 0,6 Dry-type reactors – 0,3	- explosion-proof - equipment with ecologically safe materials - installation of dry-type reactors on ODD should exclude dangerous influence of magnetic field on personnel
5	**Arc suppression coils providing compensation of capacity current**	- for plunger reactors: the drive providing compensation setup less than 1% and excluding self-oscillations - -total compensation of current of short circuit (including an active component of current and currents of the highest harmonious components with an accuracy of 1%) - availability of function of determination of the damaged connections - ability to integrate into industrial control system of SS; - a possibility of a conclusion to the monitor of the operator of a condition of the reactor and the compensated network in real time (settings and the current operating mode of the reactor, voltage on the neutral, oscillograms of voltage and current of the reactor at single-phase short circuit on the earth and so forth) - a possibility of storage of oscillograms of single-phase short circuit on the earth in memory		- compensation of an active component of current of short circuit

№	Technology system	Progressiveness indicators		
		Functional and technology	**Economic**	**Ecological, safety**
6	**Switches**	- gas - 220 kV and above, vacuum - to 110 kV - mechanical resource (not less than 10 000 cycles ON-OFF) switching resource 20-25 I - automated system of monitoring and diagnostics; - digital management systems - own time of shutdown no more than 0,02 with - preserving of nominal parameters at an air temperature –60ºC with influence of wind loading - leakage of SF6, no more than 0,1%; - switches to 500 kV with the single-break arc suppression enclosure - equipment by a management system the moment of switching of each pole for switches of 110 kV and above, switching reactive loadings	- do not demand scheduled works or repair before exhaustion of a switching or mechanical resource	- are fire and explosion safe - availability of the safety valve for dumping of pressure; - replacement of SF6 with alternative gas with the best properties regarding liquefaction and utilization
7	**GIS**	- three-phase execution to 220 kV inclusive - single-break switches to 500 kV inclusive - leakage of SF6 - no more than 0,1% - block and modular execution in dimensions acceptable for transportation (the Russian Railway, a transportation car) - use of optoelectronic measuring transformers - climatic modification and category of placement U1 - digital management systems	- does not demand repair before exhaustion of mechanical or switching resources of disconnectors and gas-insulated switches - does not demand scheduled verification works of measuring CT and VT. - not serviced - small metal consumption	- explosion-proof execution
8	**Disconnectors**	- automation of drives of disconnectors of 6-110 kV - mechanical resource (not less than 10 000 cycles ON-OFF) - digital management systems and blocking	- do not demand repair before exhaustion of a mechanical resource	- impossibility of removal of blocking by personnel at manual transactions without a complete conclusion of the equipment from work

№	Technology system	Progressiveness indicators		
		Functional and technology	**Economic**	**Ecological, safety**
9	**Measuring transformers**	- a CT winding accuracy class for the purposes of AMI – 0,2S - a class of accuracy of a winding of VT for the purposes of AMI – 0,2 - coefficient of safety of devices of a winding for measurements no more than 5 - extreme frequency rate of windings for protection not less than 30 - designs of the body of measuring transformers with gas insulation with control of pressure, leakage of SF6 – no more than 0,1% a year - application of the combined CT and VT - use of optoelectronic measuring transformers (including with the combined functions of measurement of current and voltage) with a class of accuracy is not worse than 0,1	- do not demand repair during all service life	- explosion safety due to use of bellow valves and membranes - fire safety due to application of designs with gas insulation - decrease in influence on the environment due to use of nitrogen as the insulating environment
10	**Limiters**	- level of restriction of overvoltage corresponding to the level of insulation of the installed equipment - use of nondegradable varistors	- do not demand repair during service life	- explosion-proof
11	**Maintenance and repairs**	- implementation of methods and diagnostic aids of the equipment without a removal from work	- transition to maintenance and repairs on the basis of assessment of technical condition	- use of ecologically safe technologies of clearing of Conductor ROWs and territories of SS

№	Technology system	Progressiveness indicators		
		Functional and technology	**Economic**	**Ecological, safety**

12	**RPA**	- more perfect algorithms of processing of parameters (currents and voltage) of emergency operation
		- adaptive change of settings and volumes of influences
		- speed
		- reaction time of measuring bodies - less than 30 ms.
		- informational content, interaction with industrial control system, application of the protocol of data exchange of IEC 61850-9-2LE
		- self-diagnostics
		- the average time of recovery – no more than 3 h (replacement of the module)
		- an average time between failures – 125 000 hours
		- at new construction or modernization of SS:
		  - remote (tele) control of functions of RPA devices
		  - remote monitoring of RPA devices
		  - creation of an automated system of metering and job evaluation of RPA devices at all levels operational-technology and supervisory control
		  - updating of the fleet of RPA devices – annually not less than 5% of total quantity of RPA devices
		  - application uniform the specifications and technical documentation in the field of RPA
		  - the annual indicator of assessment of correctness of work of the RPA functions implemented in RPA K1 devices (percent of the correct work) should be not less than 99,7%
			- typification of cases of RPA	- use of devices with the built-in means of information protection

№	Technology system	Progressiveness indicators		
		Functional and technology	**Economic**	**Ecological, safety**

13	**INDUSTRIAL CONTROL SYSTEM**	- the availability quotient – is not lower than 99,95% (class of readiness A3 of table 2 in GOST IEC 60870-4-2011)
		- an average time between failures (on the channel of input-output) – not less than 100 000 hours
		- average maintenance of system on any of the carried-out functions – no more than 60 min. (when using a set of spares on an object) and no more than 36 h according to a class of maintainability M1 in accordance with GOST IEC 60870-4-2011 (with departure of the specialist to a facility)
		- frequency of a stop of system (without shutdown of systems providing operability of SS) – is not more often than once a year and no more than 8 hours
		- service life:
		  - for SHC of the bottom level – not less than 20 years
		  - for SHC of the average level – not less than 15 years
		  - for SHC of the top level – not less than 10-12 years
		- processing speed:
		  - discrete signals – 200 - 40 000 events/sec.
		  - analog signals – 200 - 15 000 changes/sec.,
		  - signals of management – the guaranteed time
		- passing of control command from Operator's automated workplace to final control elements for 150 ms
			- reduction of number of the servicing and operation personnel, owing to the organization of remote control from remote points
			- cost reduction on maintenance and repair due to accomplishment of problems of planning of repairs taking into account monitoring and diagnostics
			- prolongation of service life of the equipment due to decrease in errors of management and metering of results of monitoring and diagnosing of the equipment
				- increase in level of safety of performance of works, decrease in injury rate on the automated SS
				- use of systems with the built-in means of information protection

№	Technology system	Progressiveness indicators		
		Functional and technology	**Economic**	**Ecological, safety**
14	**Communication networks**	- transition to perspective means of communication with technology of switching of packages for the organization of communication channels of operational and dispatching and technology management - application in digital systems of information transfer of the opened and standardized protocols and interfaces of communication - use of communication lines with range of information transfer on superlong distances from 300 to 500 km without use of intermediate intensifying points for the organization of communication channels on high-class Conductor of voltage - effective use of frequency range of channels of HF-communication, use of the combined HF-communication equipment for voice transfer and data; - implementation of automated systems of a digital mobile radio communication - increase in energy efficiency of means of communication due to transition to more hi-tech and less power-intensive equipment - ensuring transmission capacity of a communication network taking into account forecasts of potential needs for telecommunication and information services for 10-year perspective	- cost reduction on construction and operational maintenance - the unified prototype solutions and automation of processes of diagnostics and management - attraction in construction of FOCL of extra tariff investments of telecom operators and other third parties - mutual exchange of telecommunication resources with the third-party companies on a contractual basis	- control and management systems for means of communication with providing actions for information security

40.3. Progressiveness indicators for the equipment and elements

№	Power lines (power transmission line)	Functional and technology	Economic	Ecological, safety
1	**Conductor in general**	- specific failure rate for one-circuit Conductor (the number of faults on 100 km a year): - 110 kV – 1,1; - 220 kV – 0,6; - 330 kV – 0,5; - 500 kV – 0,4; - 750 kV – 0,3; irrespective of material of support - designs of Conductor providing the minimum width of a ROW - service life: - on the steel concrete centrifugated and vibrated support - not less than 50 years; - on steel trellised support – not less than 60 years; - on steel many-sided support – not less than 70 years; - on composite support – not less than 70 years. - application of monitoring systems and diagnostics of a condition of Conductor of 110 kV and above	- cost reduction on carrying out bypasses and surveys of Conductor	- electric field strength (no more) - the inhabited area: - 0,5 sq.m - in buildings; - 1 sq.m - in the territory of the housing estate; - 5 sq.m – out of a zone of the housing estate. - not inhabited area: - 15-20 sq.m. - level of radio interferences at a frequency of 0,5 MHz no more than 37 dB at distance from Conductor: - 110-220 kV 50 m; - 330 kV and is higher than 100 m - acoustic noise no more than 53 DB at the same distances at a wet wire. - the technology of construction and repair excluding harmful effects on the environment.
2	**Support,** **bases**	- anti-vandal execution - brands of the steel increased durability and corrosion resistance should be applied to support - protection of metal parts of support against corrosion by method of hot galvanizing	- the number of repairs of support and the bases for service life of Conductor, no more than two times	- in regions of urban development - many-sided metal support of the closed profile, the Conductor composite support up to 220 kV
		- the minimum bending moment of racks of the Conductor support of 0.4-20 kV should make: - on routes of 6-20 kV without branches – not less than 70 kNm - on branches of 6-20 kV – not less than 50 kNm - on Conductor of 0.4 kV – not less than 30 kNm		

№	Power lines (power transmission line)	Functional and technology	Economic	Ecological, safety
3	**Wires and lightning-protective cables**	- application of the ground wire bearing lightning stroke with a charge not less than 125 C - application of wires with the characteristics improved in comparison with a wire like AS. - application of MIW which are flame-retardent on ConductorInsulated to 1 kV laid on outside walls of buildings and constructions on branches to inputs to buildings - on Conductor of 110 kV and above – equipment of ground wire and/ or phase wires heat-resistant optical fiber	- economic current density: - Conductor of 220 kV and above - 0,8 A/mm2 - Conductor of 110 kV and below - 1-0,8 A/mm2 - use of the equipment, the technologies and materials providing the minimum costs during all lifecycle of Conductor	- application of the self-bearing insulated wires providing burning non-proliferation (category of resistance to burning of PV-0 in accordance with GOST 28157, the specific heat of combustion – less than 20 MJ/kg, ignition temperature – more than 350 °C)
4	**Insulation**	- specific damageability (the number of damaged insulators on 100 km a year), no more: - glass plate type - 10-4 - polymeric - 10-4-10-5 - porcelain long-rod - 10-6 - indicators of breakdown of polymeric insulators of 220 kV and above		
5	**Line fittings**	- lack of a visible crown, losses on magnetic reversal - the design of fittings should not lead to damage of wires and cables - application in the voltage and supporting fittings of non-magnetic materials - application for designs of wires (high-temperature, compacted, etc.), other than wires in accordance with GOST 839, specially developed fittings		- bird protecting devices which are not injuring anti-additive protective from pollution of garlands of insulators
6	**Protective equipment**	- application on Conductor of the protective devices providing protection of insulation against storm overvoltage and prevention of a burning-out of wires (including, limiters, limiters with a discharge gap and lightning protection surge arresters)	- cost reduction on carrying out bypasses and surveys of Conductor connected with emergency shutdown and carrying out emergency recovery operations; - increase in a service life of SS	

№	Power lines (power transmission line)	Functional and technology	Economic	Ecological, safety
7	**Cables of 6 kV and above**	- cables of 6-35 kV with insulation from polyvinylchloride plastic compound and cross-linked polyethylene - cables of 110 kV and above with solid insulation from cross-linked polyethylene, diagnostics equipped with systems - universal cables for air and underground and underwater laying without use of transitional cable fittings, or with fittings on the basis of heat-shrinking elements - armored cables for underwater laying with insulation from cross-linked polyethylene or different modifications of the paper insulation impregnated with non-draining compounds and fittings of a tight configuration - at operation in a zone with a frigid climate: - the lower value of working ambient temperature to minus 60 °C - the lower value of ambient temperature when laying without warming up of all length of a cable – to minus 40 °C - application of monitoring systems and diagnostics of a condition of CL of 110 kV and above		- ensuring normative sizes of magnetic field from cable lines ROW of passing and in the territory of electric power facilities; - application of cables providing burning non-proliferation when laying in buildings and constructions

39.Restrictions on use of equipment, technologies and materials

39.1. The section contains restrictions (prohibition) on use of technologies and equipment, materials and systems at new construction and reconstruction of objects of Conductor, CL and substations of all voltage classes.

On Conductor it is forbidden to apply:

39.2. Anchor plates with an underground node of fastening of stay-guys in moderately aggressive and highly aggressive soil.

39.3. The polymeric insulators assembled by consecutive assembly of a protective cover.

39.4. Polymeric insulators of the LP and LPIS series with a cover from polyolefin composition.

39.5. Vibration dampers single-frequency GVN type.

39.6. A lightning-protective steel cable without anticorrosive covering, and also a lightning-protective cable of TK brand (in accordance with GOST 3062, GOST 3063, GOST 3064).

39.7. SKT type fittings (clevis-tenon) for Conductor passing in areas with the increased dancing of wires and vibration.

39.8. The supporting releasing clips of the PV-4 type in settlements.

39.9. Wooden support in places of the possible local fires.

39.10. The clips providing current carrying connection (connecting, repair, stub, branch), the having connecting elements or protectors-fixers from the steel zinced or aluminized wire.

39.11. The insulating protectors on wires of Conductor made from zinced or aluminized steel.

39.12. The supporting and voltage clips made of magnetic materials (steel and cast iron) established on wires of Conductor.

39.13. A steel rod iron as conductors of repeated grounding on ConductorInsulated of 0.4 kV for connection of a zero wire to the grounding descent of a support.

39.14. Tubular surge arresters, valve surge arresters on the basis of silicon carbide, discharge gaps (except for discharge gaps as a part of lightning protection surge arresters and linear limiters) and arc suppression horns on Conductor of 6-35 kV the protection against storm overvoltage used as devices.

39.15. The open transitional points "air cable" in intended for building zones.

39.16. Uninsulated wires of brand A (aluminum) on Conductor of 0.4-20 kV.

39.17. Suspended plate type insulators of the PF6-A and PF6-B types.

On CL it is forbidden to apply:

39.18. The power cables which are not meeting the existing requirements for fire safety and evolving big concentration of toxic products when burning.

39.19. Cables with paper-oil insulation and oil-filled.

39.20. The cables made on technology of silane cross-linking.

On SS, DS and TS it is forbidden to apply:

39.21. Concrete current-limiting reactors;

39.22. Rotating electrical machines for compensation of reactive power, except asynchronized compensators in the presence of special justifications;

39.23. Air, oil switches of 110-750 kV;

39.24. Autogas switches of 6-10 kV;

39.25. Low-oil switches of 6-220 kV;

39.26. Switches of 110 kV and above with pneumatic and electromagnetic drives;

39.27. Disconnectors of the vertically cutting type of 110-750 kV;

39.28. Disconnectors of 35 kV and above without a motor drive operating mechanism;

39.29. Filling by gravel of oil receivers of (auto) transformers and shunting reactors;

39.30. Oil-filled boxes for connection of (auto) transformers to GIS;

39.31. Cable oil-filled boxes for connection of cables of 110-500 kV to power (auto) transformers;

39.32. Valve surge arresters;

39.33. Schemes of power supply without the automatic input of a reserve (changeover switch);

39.34. AB with gel electrolyte;

39.35. AB of open execution;

39.36. The equipment (including static capacitor banks) which uses trichlorodiphenyl.

39.37. Capacitors with danger class dielectric I-II in accordance with GOST 12.1.007-76;

39.38. Apply under the equipment of SS steel concrete racks like USO.

39.39. Schemes of the SS primary connections of 35-220 kV with breaker-isolating switches and short-circuiting switches;

39.40. Schemes of the SS primary connections of 35-220 kV with line splicing of Conductor;

39.41. The flexible insulated conductors for connection of automatic switches of departing lines to buses of 0.4 kV on SS boards;

39.42. Open cases of own needs in which protection of personnel against electric current is not provided.

39.43. High-voltage gas-insulated switches, gas measuring transformers if at pressure decrease of gas in the body of the equipment their automatic shutdown (removal of voltage) is required.

39.44. On TS 6-20/0.4 kV, DS of 6-20 kV:

- Package Transformer Substation 6-20/0.4 kV of cabinet type with a vertical arrangement of equipment;
- untight power transformers of the TM brand;
- DS executed from separate bays of Package outdoor switchgear;

39.45. At the organization of operation and carrying out repair work it is forbidden to equip with:

- electric protective means executed using a paper bakelite insulation;
- indicators of high voltage which operability requires grounding of a working part of the index;
- indicators of voltage using gas-discharge lamps;
- indicators of high voltage without a sound alarm system;
- posters and signs of safety made of hydroscopic materials.

39.46. In power supply systems of alternating operational current:

- AB of open execution (GOST 26881-86);
- fault locators on the earth with the injected current more than 2,5 мА;
- charging and subcharging units with stabilization of voltage more than 1%, pulsation of current and voltage at the disconnected AB more than 5%.

40.Appendices

40.1. Standard requirements to educational and training centres of zones and production departments under construction

40.1.1. General requirements.

40.1.1.1. Educational and training centres (hereinafter - centres) will be organized for the purpose of skills training, practicing and maintenance of practical skills of safe performance of works by personnel of Distribution Zone, PD, forming of psychology of safe behavior in electric installations.

40.1.1.2. All employees of PD, Distribution Zone who are directly performing works in the operating electric installations should be trained on a regular basis on educational and training centres in the form of the trainings and trainings on safety providing practicing of skills of technology of safe works.

40.1.1.3. The quantity of centres in production department, branch should provide annual holding educational and training actions with all employees, in volume, conforming to requirements of Rules of work with personnel in the organizations of power industry of the Russian Federation (special preparation) taking into account seasonality of accomplishment of repair work and the schedule of use of the equipment which is available at a centre and infrastructure.

40.1.1.4. The location of centres and remoteness from Distribution Zone should be optimized taking into account the maximum time for moving of employees - no more than two hours, and also centre charges in readiness for training.

40.1.1.5. The person responsible for the maintenance of a centre and the organization of educational and training process should be designated by the order of the head of PD, branch from among leading employees.

40.1.1.6. In Distribution Zone, if necessary, for a regular practical training with employees of Distribution Zone it is recommended to organize pass educational and training centres.

40.1.1.7. It is recommended to protect the territory of a centre. Gates, doors and fence doors should be (in the presence) equipped with locks and be locked with storage of keys at the nominated persons responsible for serviceable condition of the equipment, the devices mounted at a centre.

40.1.1.8. For the purpose of ensuring safety of the equipment and constructions of training grounds it is recommended to have them in the protected territories of PD, Distribution Zone, and in the absence of such opportunity – near the protected territories of Distribution Zone, SS of 35 kV and above, etc., with a possibility of ensuring the round-the-clock supervision of a centre from protection and (or) personnel of the enterprise, including by means of video surveillance.

40.1.1.9. People in the territory of a centre are allowed with the permission of the persons responsible for serviceable condition of the equipment, according to the approved educational and training programs, schedules of equipment maintenance, and also for urgent works or organized tours (excursions).

40.1.1.10. The centre is equipped with the power transmission line elements, constructions and the equipment similar to the operative equipment in a zone of service of the trained personnel. Elements of the power transmission line are carried out as full-scale, and in the lowered execution for practicing of safe rise on height, skills of accomplishment of repair and operational work. Elements of the equipment of small dimensions can be placed not at a centre, but in a technical office.

40.1.1.11. The equipment of the training ground is not operating, has no working voltage, at the same time it is necessary to provide a possibility of connection of devices and other equipment, and also stands on demonstration of factors of danger of electric current and electric arch. For the purpose of protection of personnel against unintentional emergence of voltage, harmful factors placement of the training ground in security and sanitary protection zones, in spans of crossing with the operating Conductor, in an area of coverage of induced voltage is forbidden, and also 30 meters closer from current carrying parts of operating electric installations.

40.1.1.12. It is recommended for high-quality practicing of skills of service of electric installations and their elements, to mount circuits of secondary switching (drives of switching devices), alarm systems, blocking, protection and control. At the same time requirements to frequency and amount of service, including carrying out tests of such electric installations (stands) should conform to normative requirements for the operating electric installations.

40.1.1.13. The mounted equipment, buildings and constructions should conform to requirements of Construction Norms and Regulations, to Electrical Installation Code and other mandatory requirements for forming at personnel of a concept of a proper condition of the equipment, skills of detection of defects and so forth.

40.1.1.14. Dispatching names of the equipment installed at centres, a text, posters, signs of safety are carried out according to the existing normative and technical and organizational and administrative documents of Societies. Coincidence of dispatching names of the equipment to the real dispatching names which are available in a zone of service of Distribution Zone, PD is not allowed.

40.1.1.15. The centre is recommended to be equipped with loud-speaking communication for coordination of training processes on different sites, warnings of approach of people to dangerous zones, outside LED lighting, video surveillance.

40.1.1.16. At a centre the fleeting for the motor transport of the trained crews should be equipped.

40.1.1.17. The equipment of canopies for the shelter of personnel in case of bad weather, and also racks for the remedies, tools and devices intended including for their check, assessment, training in application is recommended.

42.1.1.18. Rooms of a bathroom (in case of lack of a system of the sewerage, installation of dry closets should be provided), and also water supply sources should be provided.

40.1.1.19. Polygons should be provided with drinking water for holding educational and training occupations.

40.1.1.20. It is recommended to have at a centre the reserve site (place) for installation of the equipment maintenance which is again entered and earlier not applied in a zone for its high-quality studying by personnel before installation and implementation.

42.1.1.21. The equipment installed at a centre can be in the use before (except for the Conductor support which the personnel by means of climbers and access holes will climb). The oil-filled equipment (power transformers, tank switches, etc.) should not contain oils.

40.1.1.22. It is recommended to equip with floorings for carrying out a complex of the emergency resuscitation help.

40.1.1.23. It is recommended for working out of practical skills of fire extinguishing and application of emergency firefighting equipment at a centre of a branch to organize the site with a necessary set of the equipment and devices.

40.1.2. Work performance order at a centre.

40.1.2.1. Educational and training process at centres should be carried out according to annually approved scheduled plans. Scheduled plans should beforehand, but no later than 2 months before date of training, be brought to the attention of heads of structural divisions of the trained personnel and the corresponding higher administrative personnel.

40.1.2.2. Training with a long separation from places of permanent basing is recommended to plan prior to carrying out mass repair work.

40.1.2.3. Works on planned maintenance, construction installation works should be planned without violation of terms of accomplishment of the approved scheduled plan of training.

40.1.2.4. Works at a centre are performed according to requirements of the existing rules for labour protection (with briefings, execution of work permits, orders, accomplishment of records in "A register of works on orders and instructions", conducting operational talks and records, application of remedies, etc.) and taking into account requirements of sanitary and hygienic regulations and rules (the time spent in the open air in different seasons).

40.1.2.5. Entries in logs during the work at a centre begin with a mark "Training!", the same mark is put on fields of the work permit, form of switchings and other blanks documents.

40.1.2.6. The dispatcher who is in change with whom operational talks are conducted participates in occupations from the workplace.

40.1.2.7. Training on the training ground is made out in the log of any form or in the log of inservice training with the obligatory indication of date, a subject of occupations, surnames and initials of the training and trained persons, their signatures.

40.1.3. Minimum requirements to equipment of a basic centre of a branch or PD.

40.1.3.1. The site of Conductor of 35-110 kV on the intermediate and anchor support made of different materials (no more than 2-3 spans are recommended). It is allowed to equip with the site of Conductor of 35-110 kV one of training grounds of the branch.

40.1.3.2. The arrangement of the site should allow to place when carrying out educational and training works machines and mechanisms for practicing of standard work types or their imitation: replacement of the supporting and voltage isolating suspension brackets, replacement of a wire, ground wire, linear fittings, support (imitation with a real arrangement of the used machines and mechanisms).

40.1.3.3. The site of Conductor of 10 kV with a joint suspension bracket of wires of Conductor of 0.4 kV, including networks of outside lighting (in the presence in operation).

40.1.3.4. The arrangement of the site of Conductor should allow to place when carrying out educational and training works machines and mechanisms for practicing of standard work types: replacement of insulators, replacement of wires of Conductor of 0.4 kV and Conductor of 10 kV, replacement a traverse and support (imitation with a real arrangement of the used machines and mechanisms). Conditions on practicing of skills of short-circuiting of lines with method of a temporary ground and removal of the victim from a support should provide an arrangement of separate zones of the site of Conductor.

42.1.3.5. The site of Conductor of 0.4 kV which is crossed with Conductor of 10 kV (on 2-3 spans of each Conductor).

40.1.3.6. The arrangement of the site should allow to place when carrying out educational and training works machines and mechanisms for practicing of standard work types: replacement of insulators, replacement of a wire both by Conductor of 0.4 kV, and by Conductor of 10 kV, a traverse, support (imitation with a real arrangement of the used machines and mechanisms). Separate zones of the site of Conductor of 0.4 kV and Conductor of 10 kV should provide conditions on practicing of skills of short-circuiting of the line with method of a temporary ground of the grounding conductor and removal of the victim from a support.

40.1.3.7. The site of Conductor of 0.4 kV with a joint suspension bracket of wires of street lighting and radio on wooden and steel concrete support.

40.1.3.8. The arrangement of the site should allow to fulfill when carrying out educational and training works skills of climbing a pole, transition through traverses or hooks of lines of a joint suspension at accomplishment of standard work types, to install detaching devices.

40.1.3.9. The site of ConductorInsulated-0.4 kV on wooden and steel concrete support. The arrangement of the site should allow to fulfill when carrying out educational and training works skills of climbing a pole, accomplishment of standard work types on ConductorInsulated - 0.4 kV, performance of works on elimination of damages on ConductorInsulated - 0.4 kV.

40.1.4. Branches from Conductor of 0.4 kV to input to the building.

40.1.4.1. The arrangement of the site should allow to fulfill skills of replacement of wires, insulators, installation of metering devices and their connection (including remote-position control), measurements of resistance of a loop "phase zero", measurements of dimensions, resistance of stationary grounding devices.

40.1.4.2. It is recommended to provide IDD-0.4 kV with the metering station of the electric power and switching devices located on the imitated building facade.

40.1.4.3. Set of transformer SS of 10/0.4 kV.

40.1.4.4. Package Transformer Substation 10/0.4 kV of rural type on can prefixes connected to site Conductor-10 kV of a centre with safety locks on the party of 10 kV and automatic switches of 0.4 kV, with the transformer of any permitted power.

40.1.4.5. Package Transformer Substation 10/0.4 kV of any type of execution connected in transit of site Conductor-10 kV one-transformer with linear internal switches of load of 10 kV, the transformer disconnector of 10 kV of internal installation.

40.1.4.6. MTS 10/0.4 kV connected in transit of site Conductor-10 kV. Proceeding from structure of the installed equipment and an arrangement of the site, practicing of the following skills should be provided:

- productions of operational switchings, preparation of a workplace and the admission to works;
- installation, replacement of separate elements, adjustment of the disconnector, switch of load of 10 kV;

- replacement of through passage and basic insulators, PK-10 kV, switching devices of 0.4 kV;
- measurement of contours of grounding, dimensions.

40.1.4.7. On one of transformer SS 10/0.4 kV it is recommended to provide the organization of metering stations of 0.4 kV and 10 kV with a CT.

40.1.4.8. The site of practicing of technology of accomplishment of installation works without rise on height:

- the site of can of the shortened Conductor support of 10 kV (height over the soil's surface of 2 m) with a traverse and insulators performed by suspended and pin insulation at the level of a breast of the person (1,4 m);
- the site of the wooden shortened Conductor one-rack support of 0.4 kV (height over the soil's surface of 2 m) with insulators (on hooks) at the level of a breast of the person (1,4 m);
- the site shortened wooden and can of support for practicing of skills of determination of their technical condition (extent of rotting of wooden support, disclosure of cracks of concrete support, digging out on depth of 0,6 m with state assessment) and possibilities of climbing a pole (it is recommended to combine a set of defective support with normal).

40.1.5. Platform of the substation equipment.

40.1.5.1. It is allowed to have one on branch training ground having the platform of the substation equipment.

40.1.5.2. Equipment by a set of bays of switchgear(Outdoor) of 10 kV of a zone of service with switches and working drives, drawout elements, disconnectors, grounding switches.

40.1.5.3. Equipment by a bay of the switch and disconnector of 35 kV (the block scheme "the disconnector-the switch-the disconnector" on one metal construction is recommended) and 110 kV with the operating drives, disconnectors, the grounding switches, if necessary, with two systems of buses and bypass system of buses of 110 kV.

40.1.5.4. It is recommended to organize substation control building with a control panel and the room of communication, with placement on a control panel of cables of secondary switching, in communication - the communication equipment.

40.1.5.5. Structure of the equipment and an arrangement of the site should provide practicing of the following skills:

- operating by switching devices;
- studying of configuration of the equipment;
- preparation of a workplace for different types of works;
- replacements of through passage and basic insulators;
- adjustments of disconnectors and drives;
- estimates of a condition of support and pin insulator of 110 kV;
- removals of characteristics of drives of disconnectors and switches;
- accomplishment of standard work types on maintenance of switches;
- accomplishment of standard work types on maintenance and repair of the equipment of industrial control system (TM) and supervisory control system;
- teaching maintenance of metering stations of 10-110 kV, replacement of counters of the electric power, tool verification of the scheme of the meter connection.

40.1.5.6. It is recommended to provide the organization of stands for demonstration of factors of danger of electric current and an electric arch, imitation of action of electric current on the person.

40.1.5.7. The site of a centre for working out of practical skills of application of emergency firefighting equipment, including on the equipment of electric installations.

40.1.5.8. The structure of the equipment and an arrangement on the allocated site should provide it:

- exception of smoke formation of the neighboring sites during simultaneous practicing;
- working out of practical skills of localization of ignition using fire extinguishers of the conditional centre with use of a drip culvert and localizations of combustible liquids with sand use;

- whenever possible, availability of systems of fire-water supply with use, tanks, motor-pumps, fire hoses and fire trunks;
- practicing of actions according to the admission on fire extinguishing, the admission of divisions of fire protection with grounding of fire trucks and fire trunks.

40.1.5.9. The site is recommended to equip not less, than two bays of switchgear(Outdoor) of 6-10 kV the KPH-III-10 (KPH-IV-10) type with a possibility of installation in a bay of a drip culvert and Package Transformer Substation 10/0.4 kV of kiosk or block type for practicing of liquidation of internal ignitions.

40.1.5.10. The drip culvert is recommended to choose as the size not less: 1200 mm x 1000 mm x 200 mm (LxWxH). For imitation of burning of combustible substance it is recommended to provide the following proportion of gas mixture: water + diesel fuel + gasoline in a proportion 3:1:1.

40.1.6. Site of the cable communication line.

40.3.6.1. It is recommended to equip the site on repair of CL of different voltage classes.

40.1.7. The minimum requirements to pass to educational and training centres of Distribution Zone.

40.1.7.1. Package Transformer Substation 10/0.4 kV of rural type on can prefixes connected to site Conductor-10 kV of a centre with safety locks on the party of 10 kV and automatic switches of 0.4 kV, with the transformer of any permitted power.

40.1.7.2. The site of Conductor of 10 kV on wooden and steel concrete support – one span with the disconnector of 10 kV on a trailer support before TS.

40.1.7.3. Structure of the equipment and an arrangement of the site should provide practicing of the following skills:

- production of operational switchings, preparation of a workplace and the admission to works;
- installation, replacement of separate elements, adjustments of the disconnector;
- replacement of through passage and basic insulators, PK-10 kV, switching devices of 0.4 kV;
- measurement of contours of grounding, dimensions.

40.3.7.4. The site of Conductor of 0.4 kV departing from TS (one span with descents).

40.1.8. Branches from the site of Conductor of 0.4 kV to input to the building.

40.1.8.1. The arrangement of the site should allow to fulfill skills of replacement of wires, insulators, installation of metering devices and their connection (including remote-position control), measurements of resistance of a loop "phase zero", measurements of dimensions, resistance of the stationary grounding devices.

40.1.8.2. The arrangement of sites of Conductor should allow to place when carrying out educational and training works machines and mechanisms for practicing of standard work types: replacement of insulators, replacement of wires of Conductor of 0.4 kV and Conductor of 10 kV, replacement a traverse and support (imitation with a real arrangement of the used machines and mechanisms). Conditions on practicing of skills of short-circuiting of lines should provide with method of a temporary ground and removal of the victim from a support an arrangement of separate zones of the site of Conductor.

40.2. The list of internal documents of the company providing implementation of the technical policy

№	Name	Information on the document		
		Body which approved the document	Type of the organizational and administrative document	Date, number
1.	Long-term program of development of PJSC Rosseti	Board of Directors	Minutes	dated 19.12.2014 No. 174
2.	Concept of development of a management system of production assets of the group of companies of JSC Rosseti	Management Board	Minutes	dated 22.04.2015 No. 340pr
3.	The standard development plan for a management system of production assets of SDC of PJSC Rosseti for 2016-2018	Management Board	Minutes	dated 12.02.2016 No. 439pr/5
4.	About implementation of the standard development plan for a management system of production assets of JSC Rosseti and SDC of JSC Rosseti for 2015-2017	First Deputy CEO	Order	dated 16.06.2015 No. 290r
5.	About ensuring unity of normative reference information in a management system of production assets in JSC Rosseti and SDC of JSC Rosseti	First Deputy CEO	Order	dated 28.11.2014 No. 530r
6.	About input in trial operation of a procedure of organization and evaluation of efficiency and a maturity level of a management system of production assets of Rosseti Group of Companies	First Deputy CEO	Order	dated 26.01.2016 No. 28r

7.	About input in trial operation of a standard technique of assessment of effects of equipment failure	First Deputy CEO	Order	dated 29.01.2016 No. 39r
8.	Policy of innovative development, energy saving and increase in power efficiency of JSC Rosseti	Board of Directors	Minutes	dated 23.04.2014 No. 150
9.	Provision on forming of Programs of energy saving and increase in power efficiency of affiliated and dependent companies of JSC Rosseti	Board of Directors	Minutes	dated 29.05.2014 No. 156
10.	About the organization of work on development of power service activity in affiliated and dependent companies of JSC Rosseti	First Deputy CEO	Order	dated 02.09.2013 No. 545
11.	About the approval of the register of normative and technical documents in the field of technical regulation of PJSC Rosseti and SDCs of PJSC Rosseti	First Deputy CEO	Order	dated 28.12.2015 No. 612r
12.	About the approval of the plan of development of normative and technical documents in the field of technical regulation of PJSC Rosseti and SDCs of PJSC Rosseti for 2015-2017	First Deputy CEO	Order	dated 03.03.2016 No. 90r
13.	About the approval of Regulations on implementation of uniform technical policy of PJSC Rosseti and SDCs of PJSC Rosseti in the power grid complex	First Deputy CEO	Order	dated 16.11.2015 No. 542r

14.	HR and social policy of PJSC Rosseti	Board of Directors	Minutes	dated 20.06.2014 No. 158
15.	Strategy of the Company and SDC in the field of information technologies, automation and telecommunications for the period till 2016	Board of Directors	Minutes	dated 02.07.2012 No. 86
16.	Concept of development of relay protection and automatic equipment of the power grid complex	Management Board	Minutes	dated 22.06.2015 No. 356pr/1

40.3. Used abbreviations

№	Abbreviation	Description of abbreviation
1.	ASEMPCH	Asynchronized control converter of frequency
2.	AB	Rechargeable batteries
3.	High power electric battery	Batteries of high power
4.	ACR	Automatic transfer switch
5.	AMI	Automated information and measuring system of commercial metering of electric power
6.	ACR	Automatic reclosing
7.	AUTOMATED WORKPLACE	Automated workplace
8.	ASTA	Automated systems of technology management
9.	ACS	Automated control system
10.	Automated power consumption measurement system	Automated system of metering of electric power
11.	INDUSTRIAL CONTROL SYSTEM	Automated process control system
12.	AT	Autotransformer
13.	AT/T	Autotransformer/transformer
14.	AUTOMATIC TELEPHONE EXCHANGE	Automatic telephone exchange
15.	NPP	Nuclear power plant
16.	BSHPD	Wireless broadband access
17.	VDT	Voltage booster
18.	SRC	Secondary master frequency generators
19.	BKC	System of a video conferencing
20.	Conductor	Overhead-line
21.	HV	High voltage
22.	VOLP	Fiber-optical transmission line
23.	FOCL	Fiber-optic communication link

24.	High voltage direct current link	HVDC link
25.	VTSP	High-temperature superconductivity
26.	VCH	High-frequency
27.	PSPP	Pumped storage power plant
28.	GIL	Gas-insulated power line
29.	GIS	Geographic information system
30.	SDC	Affiliated and dependent company
31.	DP	Control office
32.	DTS	Dispatching centre
33.	ENES	Unified national power grid
34.	UES of Russia	Unified energy system of Russia
35.	IDD	Indoor switchgear
36.	ITS	Indoor transformer substation
37.	Battery charging set	Charger
38.	Data processing system of upper level	Information complex of top level
39.	Data processing system of a power facility	Information complex of an electric installation
40.	IMC	Information and measuring complex
41.	IIS	Information and measuring system
42.	IS	Information system
43.	IT	Information technologies
44.	Technical security equipment	Technical means of protection
45.	C	Cable line
46.	CLS	Cable communication line
47.	KPI	Key performance indicator
48.	Switchgear	Switchgear and control gear
49.	GIS	Gas-insulated switchgear
50.	GISO	Outdoor gas-insulated switchgear

51.	KCO	Switchgear of unilateral maintenance
52.	Electricity quality	Quality of electric power
53.	LAN	Local computer network
54.	PL	Power line
55.	ONAN/ONAF	System of natural oil cooling/ oil cooling with blasting and natural circulation of oil
56.	ONAN/ONAF/DTS	System of natural oil cooling/ oil cooling with blasting and natural circulation of oil / oil cooling with blasting and forced circulation of oil through air coolers
57.	MT	Measurement technique
58.	R&D	Research and development
59.	LV	Low voltage
60.	SPECIFICATIONS AND TECHNICAL DOCUMENTATION	Specifications and technical documentation
61.	OPGW	Optical cable which is built in a lightning-protective cable
62.	OKLV	Optical cable nonmetallic spirally twisted, cast over a lightning-protective cable or a phase wire
63.	OKFP	Optical cable which is built in a phase wire
64.	OKCH	Optical cable self-bearing nonmetallic
65.	OIUK	Operational and information managing complex
66.	ARCPS	All-Russian Classifier of Political Subdivisions
67.	OKCM	All-Russian Classifier of Countries of the World
68.	Fault location device	Fault location
69.	Limiters	Limiters of overvoltage
70.	NTD	Organizational and administrative documents
71.	OSW	Outdoor switchgear
72.	Wholesale electricity market	Wholesale market of electric energy and power
73.	OSI	Support and rod insulators
74.	Operational and technological management of electric grid facilities	Operational and technology management of the power grid complex

75.	EAE	Antiemergency automatic equipment
76.	LTC	NLTC
77.	EAD	Design and exploration work
78.	Electricity quality indicators	Indicators of quality of electric power
79.	SW	Software
80.	PD (Distribution Zone)	Production department (district of electric grids)
81.	DCC	Converters of direct current
82.	SS	Substation
83.	DESIGN AND ESTIMATE DOCUMENTATION	Design estimates
84.	SHC	Software and hardware complex
85.	Electrical Installation Code	Regulations for electrical installation
86.	PRC	Primary reference clock
87.	SAIDI	System average interruption duration index
88.	SAIFI	System average interruption frequency index
89.	Detector of emergency events	Recorder of emergency events
90.	RPA	Relay protection and automatic equipment
91.	DS	Distribution point
92.	LTC	Regulation of voltage under loading
93.	RRL	Radio relay communication lines
94.	DTS	Distribution transformer substation
95.	DD	Distributing device
96.	RSHCH	Switchboard
97.	CBTK	System of internal technical control
98.	MI	Gages
99.	SIW	Self-bearing insulated wire
100	SIWFR	Self-bearing insulated wire flame-retardent
101	SVC	System of compensation of reactive power

102	Access control system	Access control
103	Electricity monitoring and quality control system	Electric power monitoring and quality control system
104	Wide-area measurement system	Monitoring system of transitional modes
105	CIW	Installation and construction works
106	MV	Middle voltage
107	Construction Norms and Regulations	Construction regulations and rules
108	Operating DC voltage system	System of operating direct current
109	Office and technical buildings	Multipurpose production building
110	SSPD	System of collecting and data transmission
111	Information acquisition & transmission system	System of collecting and information transfer
112	SVR	Static compensator of reactive power
113	SVC	Static thyristor compensator
114	STS	Pole-mounted transformer substations
115	OHSAS	System management of labour protection
116	Short circuit	Short circuit current
117	TM	Telemechanics
118	VT	Voltage transformer
119	Maintenance and repair	Maintenance and repair, PM
120	TOU	Current-limiting device
121	TS	Transformer substation
122	Retrofitting and reconstruction	Program of modernization and reconstruction
123	CNS	Clock network synchronization
124	CT	Current transformer

125	PSTN	Public telephone network
126	TPP	Thermal power plant
127	VHF	Very high frequency
128	UPASK	Device for transmission of emergency and control signals
129	UPNKP	Device of deliberate non-simultaneous switching of poles
130	URPA	System of relay protection of power plants and electrical substations
131	Data Acquisition and Transmission Devices	Device of collecting and data transmission
132	UF	Ultra-violet (radiation)
133	USHR	Controlled shunting reactor
134	FTUU	Phase shifters
135	PCA	physical and chemical analysis
136	TSATS	Central module of a system of automatic telephone exchange
137	TSSPA	Centralized system of emergency control
138	TSUS	Grid Control Centre
139	SHOT	Cabinet for operative current
140	SHR	Shunting reactor
141	SHCHPT	DC board
142	SHCHMV	Auxiliaries board
143	EMI	Electromagnetic interference
144	Electric grid facilities	Power grid complex
145	ETL	Electrotechnical laboratory