Appendix # 3
Minutes of the Board of Directors of Rosseti Centre, PJSC
Minutes dated 13.02.2025 # 04/25

# The Regulation of Rosseti Centre, PJSC
# "On the Unified Technical Policy"

## Content

## Introduction

The Regulation of Rosseti Centre, PJSC “On the Unified Technical Policy” (hereinafter referred to as the Regulation) is an internal document of Rosseti Centre, PJSC (hereinafter referred to as the Company), developed in accordance with the current legislation of the Russian Federation and is a fundamental document mandatory for application in the branches of Rosseti Centre, PJSC and its subsidiaries.

Compliance with the requirements of the Regulation is mandatory for the structural divisions of the Company.

The status of the Regulation in relation to third-party organizations that have joined the Regulation is determined by the accession agreement between the Company and the organization.

Based on the requirements of the Regulation, the Company must develop (revise) a set of regulatory documents (organization standards, regulations, norms, etc.) that define the priorities and rules for applying the technical solutions of the Regulation during the operation of electric grid facilities, the implementation of investment programs, as well as during innovative and prospective development.

The regulation complies with the requirements of the "Energy Strategy of the Russian Federation for the Period up to 2035", approved by order of the Government of the Russian Federation dated 09.06.2020 # 1523-r.

The application of the requirements of the Regulation must be based on the principles of technical feasibility and validity, economic efficiency, reasonable sufficiency and confirmed by the results of technical and economic comparisons of alternative technical solutions: equipment, structures, materials and systems.

To indicate the mandatory nature of compliance with technical requirements, the Regulation uses the concepts “must”, “should”, “necessary” and their derivatives.

The term “as a rule” means that the given technical requirement is predominant and any deviation from it must be justified.

The term “permitted” means that this technical requirement or solution is applied as an exception, as a forced one with appropriate justification (due to constrained conditions, limited resources, lack of necessary electrical equipment, products and materials, etc.).

The term “recommended” means that this technical solution is a priority, but not mandatory.

The adoption of a technical solution must be based on justification; the concept of “justification” means an analysis of options for various technical proposals, economic and environmental conditions, and life cycle stages in order to select the optimal technical solution.

The Regulation is approved by the decision of the Board of Directors - the collegial management body of Rosseti Centre, PJSC.

The Regulation shall be subject to revision as necessary, but not less than once every five years.

When using the Regulation, it is advisable to check the validity of the referenced regulatory legal acts and standards in the official public information systems of Rosseti Centre, PJSC. If the referenced document is replaced (changed), then when using this Regulation, one should be guided by the replacing (changed) document. If the referenced document is cancelled without replacement, then the provision in which the reference to it is given applies, in the part that does not affect this reference.

## 1 Goals and objectives of the Unified Technical Policy

1.1 The purpose of the Unified Technical Policy is to formulate requirements for the creation of a system of unified technologies, technical solutions and production equipment that ensure specified levels of reliability, safety and efficiency of the operation of electrical grids managed by the Rosseti group of companies.

1.2 The Regulation is based on the following basic principles:

- compliance with the strategic goals of the Rosseti group of companies;
- unity of approaches at all stages of the life cycle of production assets of the Rosseti group of companies (design, construction and reconstruction, operation, decommissioning of electric grid facilities);
- ensuring technological sovereignty;
- validity of management and technological decisions;
- synchronization of the implementation of industry technologies, equipment, information and telecommunication technologies, software, materials and systems;
- development of in-house competencies for conducting research and development work, conducting experimental design work, designing, constructing, operating, repairing and reconstructing electric grid facilities of the Rosseti group of companies, as well as for developing/developing in-house software;
- implementation of advanced technical solutions based on innovative technologies and materials in the electric grid industry;
- environmental safety.

1.3 The main objectives that the Regulation aims to address are:

- upgrading production assets through the use of modern equipment, technologies and materials during renovation (modernization, reconstruction, technical re-equipment) and construction of electrical grids;
- optimization of technical and technological solutions in the development of design documentation, taking into account the economic efficiency of the facility at all stages of the life cycle;
- the use of modern technologies and types of equipment, systems, devices, building structures and materials, subject to their economic efficiency, the possibility of unification and replication;
- improving the technological efficiency of construction processes;
- reduction of technological losses of electrical energy and increase in the capacity of electrical grids;
- development and improvement of the structure of operational, technological and situational management of electric grid facilities;
- development and improvement of the information infrastructure, technological communication network of the electric grid facilities, automated system of technological control, increasing the observability of the electric grid and the quality of information exchange with other subjects of the electric power industry, improving the quality of the information used through the mutual integration of information systems operated and implemented in the Rosseti group

of companies, using the principle of single data entry, unification of approaches to the integration of digital information models in the business processes of the Rosseti group of companies, as well as in interaction with other subjects of the electric power industry;

- development of automation of technological processes for managing the transmission and distribution of electrical energy, implementation and development of modern systems for monitoring the technical condition, diagnostics and monitoring of technological equipment, protection and automation systems, emergency automation, communication systems, engineering systems, commercial and technical metering of electricity, creation and development of highly automated substations and electrical grids;
- import substitution, creation of incentives for the development of production of modern types of equipment, components, building structures, materials, as well as the development of scientific, technical and design potential in the territory of the Russian Federation;
- ensuring the quality of purchased products and materials, preventing the supply of counterfeit products;
- minimizing the impact on the environment during new construction, reconstruction, operation, repair and maintenance of electrical grid facilities;
- ensuring facility and information security, preventing terrorist acts and neutralizing cyber threats during the operation of power grid facilities;
- ensuring, improving and developing professional training of personnel;
- improvement of the regulatory and technical framework and methodological support.

## 2 Instruments for the implementation of the Unified Technical Policy

2.1 Regulatory and technical support

2.1.1 The regulatory and technical support system of Rosseti Centre, PJSC is a system of local regulatory acts, including organizational and administrative documents, organizational standards, instructions, regulations, guidelines, and others.

2.1.2 Local regulatory acts are developed with the aim of ensuring the implementation of:

- requirements of the legislation of the Russian Federation;
- documents in the field of technical regulation, including regulations of the Eurasian Economic Union (technical regulations of the Customs Union);
- functions and objectives of the Company;
- the Unified Technical Policy of the Company.

2.1.3 The regulatory and technical support management system must ensure:

- timely development of local regulatory acts in accordance with the current and relevant requirements of regulatory authorities; timely revision and updating of current local regulatory acts in accordance with new and relevant requirements of regulatory authorities; timely development and updating of current local regulatory

acts in accordance with the functions and objectives of the Company for the implementation of the Regulation;

- availability and timely updating of the list of regulatory legal acts, documents in the field of technical regulation and local regulatory acts of the Company, regulating and ensuring compliance with the requirements of the Unified Technical Policy of the Company, with posting on the official website of the Company;
- the required level of unification and typification of local regulatory acts;
- compliance with the requirements and procedures established in the Company for the development, review of projects in accordance with the local regulatory acts and their approval;
- participation of the Company in the development of regulatory legal acts and documents in the field of technical regulation in accordance with the functions and objectives of the Company.

2.2 Quality control of equipment, materials and systems

2.2.1. The quality control system (certification) of equipment, materials and systems in PJSC Rosseti is an internal quality control system aimed at meeting the Company's needs for modern, reliable, safe and efficient equipment, materials and systems to ensure the Company's operational, repair and investment activities, and to ensure reliable and trouble-free operation of the Unified Energy System of Russia.

2.2.2. Conducting quality control (certification) of equipment, materials and systems is aimed at achieving the following goals:

- ensuring the reliability and safety of operation of equipment, materials and systems by preventing the supply to the Company’s facilities of equipment, materials and systems that do not meet their characteristics, established technical requirements, safety requirements, purposes and conditions of use;
- eliminating the possibility of deliveries to the Company’s facilities and subsidiaries of equipment, materials and systems that do not comply with the requirements of regulatory legal acts, as well as standards and technical documentation and local regulatory acts of PJSC Rosseti;
- ensuring compliance with the requirements of the Unified Technical Policy of the Company.

2.2.3. Quality control (certification) of equipment, materials and systems supplied to power grid facilities is carried out in accordance with the Local Regulations of the Company.

During the quality control procedure, the equipment, materials and systems are checked for compliance with the requirements of the standards of Rosseti Centre, PJSC developed to ensure the quality of products, performance of work and provision of services within the framework of Article 3 and Article 21 of Federal Law of 29.06.2015 # 162-FZ "On Standardization in the Russian Federation".

2.2.4. The result of the quality check (certification) is the conclusion of the certification commission of PJSC Rosseti, approved in accordance with the established procedure, the effect of which extends to equipment, materials and systems supplied and operated at the facilities of the Company and subsidiaries.

The results of a positive quality check are presented in the form of a list of equipment, materials and systems approved for use, with posting on the website of PJSC Rosseti:

-Section I. Primary equipment, materials and systems approved for use;

-Section II. Secondary equipment, materials and systems approved for use.

2.2.5. In the event of a decision to purchase equipment, materials and systems that are not included in the list of those approved for use at the facilities of Rosseti Centre, PJSC, a quality control procedure is carried out.

The responsibility for passing the quality check and obtaining a document confirming the possibility of using equipment, materials and systems at the Company's facilities and subsidiaries and defining the scope of application is assigned to the supplier/contractor.

The information base for conducting a quality check of the products offered for delivery is a package of technical documentation (test reports, certificates, etc.) for these products, provided by the supplier/contractor taking into account the requirements of industry regulatory and technical documentation, standards, and regulatory and technical documentation of the Company.

2.2.6. During the construction and reconstruction of electrical grid facilities, equipment, materials and systems must be used that have undergone a quality control procedure in accordance with the established procedure.

2.3 Design and construction

2.3.1 The strategy of the Unified Technical Policy of Rosseti Centre, PJSC is aimed at reducing the time and cost of construction of facilities, subject to compliance with the requirements established in the Company for the quality of capital construction processes and their results by reducing the time for developing design and organizational-technological documentation, and the use of modern methods, materials, technologies and optimization of organizational measures.

2.3.2 Technical policy in construction is aimed at the development and implementation of information modeling in the implementation of investment projects in the electric power industry in accordance with current regulatory legal acts.

2.3.3 Compliance with the quality of capital construction processes and their results must be systematized and subject to the following stages: resource planning, establishing requirements, monitoring the fulfillment of established requirements and improving the achieved indicators.

2.3.4 The technical and other solutions adopted in the design documentation must be compatible with each other, ensure the technological possibility of their joint implementation during construction, reconstruction, technical re-equipment, modernization, major repairs, as well as the possibility of operating the capital construction project taking into account the requirements established by the legislation of the Russian Federation.

2.3.5 To achieve the objectives of the Unified Technical Policy during design and construction, it is necessary to ensure:

- implementation of high-tech equipment and monitoring and automation systems;
- implementation of systematic market control and implementation of innovative construction technologies, equipment and materials;
- the formation of a modern regulatory and technological framework based, among other things, on the use of digital technologies and artificial intelligence;
- increasing the level of autonomy and energy efficiency of facilities through automation of engineering systems.
- compliance of solutions with the requirements of current regulatory documents.

2.4 Purchasing activities

2.4.1 Procurement activities are one of the processes that ensure the timely completion of construction of power grid facilities, maintenance and repair programs, and retrofitting and upgrading.

2.4.2 The main directions of the Unified Technical Policy in the management of procurement activities are:

- formation of the technical part of the procurement/tender documentation in accordance with standard technical requirements imposed on equipment, systems, structures and materials, and technical solutions adopted/approved in the design (working) documentation;
- control of compliance with technical proposals for the supply of equipment, systems, structures and materials with the requirements of the approved technical part of the procurement/tender documentation.

## 3 Planning for future development

General requirements for the development of schemes and programs for the development of electric power systems in Russia.

3.1 The electrical grid of the Unified Energy System of Russia, in accordance with the functions it performs, is divided into objects of the unified national (all-Russian) electrical grid (UNEG) and objects of the territorial distribution network.

The UNEG is a complex of electrical grids and other electrical grid facilities owned or otherwise provided for by federal laws by entities in the electric power industry and ensuring a stable supply of electrical energy to consumers, the functioning of the wholesale market, as well as the parallel operation of the Russian electric power system and the electric power systems of foreign states.

The territorial distribution network ensures the transmission of electric power from the UNEG substations, generation facilities and facilities of other owners to the central distribution substations (DS) with its delivery to end consumers, and also ensures the transmission and distribution of electric power from power plants connected to this type of network.

3.2 When developing electrical grids, it is necessary to be guided by the following main criteria:

− accessibility: the electric grid must provide all entities in the wholesale/retail electricity and capacity markets with conditions for the unimpeded supply of their products (electricity and capacity) to the market on a competitive basis if there is demand for them; provide all entities in the wholesale/retail markets with the opportunity to receive electricity and capacity in the required volume with the required reliability and quality that meets regulatory requirements;

− cost-effectiveness: network development should ensure maximum cost-effectiveness, provided that the required level of reliability is ensured, including during the implementation of new connection of applicants (minimization of the volume and cost of implemented measures) and contribute to the reduction of costs and losses for the transmission of electricity, as well as for the operation of equipment;

− controllability: the development of the electrical grid should be aimed at increasing its controllability and observability through the introduction of controlled elements and digitalization;

− efficiency: the development of the electrical grid should be carried out to achieve the best economic indicators for the companies of the Rosseti group and the energy system as a whole with maximum optimization of the use of existing production assets, regardless of the form of ownership of electric power facilities;

− innovativeness: the design of the development of the electrical grid must be carried out taking into account the latest achievements of science and technology;

− environmental friendliness: the development of the electrical grid must comply with environmental protection requirements, provide for the introduction of innovative solutions that help reduce the negative impact of electric power facilities on the environment, as well as eliminate cases of damage to the environment;

− unity of approaches: when developing electrical grids, the requirements of the methodological guidelines for the design of the development of energy systems approved by the federal executive body that carries out functions for the development and implementation of state policy and legal regulation in the fuel and energy complex (hereinafter referred to as the authorized body) must be observed;

− consistency of decisions: when developing electrical grids, decisions of documents for the long-term development of the electric power industry must be taken into account, namely the scheme and program for the development of electric power systems in Russia, approved by the authorized body, and the general scheme for the placement of electric power facilities, approved by the Government of the Russian Federation;

− security: the development of the electrical grid should be aimed at ensuring the energy security of the Unified Energy System of Russia.

3.3 Planning the development of energy systems includes the development of the following documents:

− in accordance with paragraph 2 of Article 6.1 of Federal Law of the Russian Federation of 26.03.2003 # 35 "On the Electric Power Industry" and the Rules for the Development and Approval of Documents for the Prospective Development of the Electric Power Industry, approved by Resolution of the

Government of the Russian Federation of 30.12.2022 # 2556, the following are being developed:

- the general scheme for the placement of electric power facilities is developed by the system operator for an 18-year period and approved by the Government of the Russian Federation every 6 years no later than 1 December of the calendar year preceding the long-term period for which the general scheme is developed;
- a scheme and program for the development of electric power systems of Russia, developed by the system operator for a 6-year perspective and approved by the Ministry of Energy of Russia annually, before 1 December of the calendar year preceding the medium-term period for which the scheme and program for the development of electric power systems of Russia are developed.

3.4 The scheme and program for the development of electric power systems of Russia in terms of measures for the development of electric networks are being developed with the aim of determining solutions for the placement of power transmission lines and substations of 110 kV and higher voltage class, as well as the reconstruction of power transmission lines and substations of 110 kV and higher voltage class, necessary to ensure the satisfaction of the forecast demand for electric energy and capacity, as well as ensuring the determination of the parameters of the electric power operating mode of the Unified Energy System of Russia, its individual parts and technologically isolated territorial electric power systems in the range of permissible values.

3.5 When developing power distribution schemes for electric power generation facilities, external power supply schemes for power receiving devices of electric power consumers, as well as the main technical solutions, design and working documentation for the construction/reconstruction of electric power facilities, development and approval of feasibility studies for the construction of new and renovation (reconstruction, technical re-equipment, modernization) of existing electric power facilities, including measures to ensure the decommissioning of electric power facilities, and the submission of proposals for the development of electric networks to the dispatch centres of the system operator, it is necessary to be guided by:

- Federal Law of the Russian Federation of 26.03.2003 # 35-FZ "On the Electric Power Industry";
- The rules for decommissioning electric power facilities for repairs and out of operation, approved by Resolution of the Government of the Russian Federation of 30.01.2021 # 86;
- The rules for development and approval of documents for the prospective development of the electric power industry, approved by Decree of the Government of the Russian Federation dated 30.12.2022 # 2556;
- The rules for technological functioning of electric power systems, approved by Resolution of the Government of the Russian Federation of 13.08.2018 # 937;

− Requirements for ensuring the reliability of electric power systems, reliability and safety of electric power facilities and power receiving installations "Methodological guidelines for the stability of energy systems", approved by order of the Ministry of Energy of Russia dated 03.08.2018 # 630;

− Guidelines for the design of energy systems development, approved by order of the Ministry of Energy of Russia dated 06.12.2022 # 1286;

− The rules for the development and approval of power distribution schemes for electric power generation facilities and external power supply schemes for power installations of electric power consumers, approved by order of the Ministry of Energy of Russia dated 28.12.2020 # 1195;

− The rules for providing information necessary for the implementation of operational dispatch control in the electric power industry approved by order of the Ministry of Energy of Russia dated 20.12.2022 # 1340,

− Guidelines for the technological design of power transmission lines with a voltage class of 35-750 kV, approved by order of the Ministry of Energy of Russia dated 31.08.2022 # 884;

− Guidelines for the technological design of AC substations with high voltage of 35-750 kV, approved by order of the Ministry of Energy of Russia dated 15.01.2024 # 6.

3.6 The technical policy in planning long-term development within the framework of the implementation of new connection of power installations of consumers of electric energy, facilities for production of electric energy, as well as electric grid facilities to electric networks is implemented through the development of technical specifications for new connection. The development of technical specifications for new connection is carried out using standard forms of technical specifications for new connection approved by JSC SO UES and Rosseti Centre, PJSC, in cases where, in accordance with the Rules for New Connection of Power Installations of Consumers of Electric Energy, Facilities for Production of Electric Energy, as well as Electric Grid Facilities Belonging to Grid Organizations and Other Persons to Electric Networks, approved by Decree of the Government of the Russian Federation dated 27.12.2004 # 861 (hereinafter referred to as the NC Rules), the technical specifications for new connection are subject to approval by JSC SO UES.

3.7 When carrying out new connection to electrical grids, the following basic principles should be followed:

− validity of the declared maximum capacity (perform a comparison in terms of maximum capacity for “analogous objects” and work with the applicant);

− developed options for a new connection should be aimed at increasing the load on existing power grid facilities of Rosseti Centre, PJSC while minimizing reconstruction and new grid construction;

− construction of electric grid facilities up to the boundaries of the applicant's site (except for the new connection of integrated territorial development facilities) must be provided with a priority option for connection at the lowest voltage level and the installation of commercial metering of electricity at the

boundary of the balance participation of power installations and the operational responsibility of the parties; during the new connection of integrated territorial development facilities, the new connection options must include measures for the construction by the grid organization of on-site electrical grids, taking into account the restrictions on the voltage class to the UNEG facilities;

- in the case of new connection of facilities for the production of electrical energy without the output of power to the grid, in the presence of previously connected to the electrical grid power installations and/or electrical grid facilities of the applicant, if the applicant plans to reduce the consumption of electrical energy and power from the electrical grid of a subsidiary, the new connection measures must ensure the corresponding changes to the existing new connection scheme (the parameters of the electrical grid facilities of the applicant must correspond to the reduced parameters of electrical energy (power) consumption after connection, etc.).

3.8 In the case of new connection of an electric power generation facility or power installations that meet the requirements of paragraph 10 of the NC Rules, a power distribution scheme or an external power supply scheme must be developed, the requirements for the development of which are determined by the Rules for the Development and Coordination of Power Distribution Schemes of Electric Power Generation Facilities and External Power Supply Schemes of Power-receiving Devices of Electric Power Consumers, approved by order of the Ministry of Energy of Russia dated 28.12.2020 # 1195.

3.9 When implementing the new connection of the applicant (power installations of consumers of electrical energy, facilities for the production of electrical energy, as well as electrical grid facilities) to electrical grids, the most optimal technical solutions should be selected that ensure the required level of reliability with a minimum amount of activities (costs).

## 4 Management of production assets. Maintenance, repair, renovation

4.1 Production asset management

4.1.1 General provisions

4.1.1.1 The management of the Company's production assets and subsidiaries is understood as systematic and coordinated activities to find an optimal balance between the costs of maintaining the technical condition of equipment in accordance with regulatory requirements, network development prospects and risks associated with failure to achieve the established level of reliability of services provided and the quality of electricity supply to consumers, as well as the requirements of regulatory authorities, in order to achieve the strategic goals of the Company.

4.1.1.2 The management system of production assets of the Company and subsidiaries must comply with the goals, principles and ensure the fulfillment of the tasks defined by order of the Government of the Russian Federation dated 03.04.2013 # 511r “On approval of the Strategy for the development of the electric grid complex of the Russian Federation”.

4.1.1.3 The main functional areas of the production asset management system:

- management of operational activities in terms of maintenance and repair of equipment, technological and engineering systems, buildings and structures;
- management of investment activities in terms of renovation (modernization, technical re-equipment and reconstruction) of power grid facilities;
- asset management at all stages of the life cycle, taking into account the current and predicted technical condition, risks, consequences of failures, cost of ownership and network development prospects;
- management of normative, methodological and regulatory support for production asset management processes;
- management of databases and reference data of automated production asset management systems.

4.1.2 The purpose of asset management

The goal of managing production assets is to increase the efficiency of operating and investment costs while ensuring the required level of reliability of electricity supply to consumers.

4.1.3 Principles of asset management

The main principles of managing the Company's production assets are:

- orientation towards achieving the strategic goals of the Russian Federation, the Company and subsidiaries;
- systematic decision-making, application of uniform criteria, principles, rules, and methods for the processes of planning, implementation, control, and evaluation of the effectiveness of work on operational and investment activities;
- focus on improving the efficiency of production asset management throughout the entire life cycle of assets by achieving positive effects in the short, medium and long term;
- ensuring the functioning of the production asset management system in all subsidiaries of the Company, which are an integral and integral part of the overall asset management system of the Company;
- reducing the share of equipment, power lines and structures that have high and medium levels of risk associated with their operation, taking into account the consequences of their failure.

4.1.4 Tasks of development of the production asset management system

The tasks of developing a production asset management system include:

- transition from a production asset management system based on a planned preventive maintenance organization to the organization of maintenance based on the actual technical condition, taking into account the probability and severity of the consequences of failure of the main technological equipment (risks);
- implementation and development of modern technologies and digitalization of business processes for managing production assets;

− development of a system of indicators for assessing production activities for the timely adoption of appropriate management decisions;

− development and unification of the organizational and regulatory framework for managing production assets;

− ensuring monitoring of the technical condition of substation equipment, power transmission lines and structures, the probability, consequences, failure of equipment and technical risk in accordance with the requirements of regulatory legal acts;

− effective distribution of financial resources for all types of impact, including repair and renovation of substation and power transmission line equipment, taking into account the technical condition of the equipment to ensure the required level of reliability and quality of electricity supply to consumers;

− synchronization of the development of the management system of the Company's production assets and subsidiaries with departmental programs of the relevant and related departments.

4.2 Maintenance, repair

4.2.1 In order to ensure reliable, safe and economical operation of electric grid facilities, technical maintenance and repair must be carried out with respect to equipment, power transmission lines, buildings, structures, technical and technological devices.

4.2.2 Timely and high-quality planning, maintenance and repair (technical impact) of equipment, power lines, buildings, structures, technical and technological devices is one of the most important factors ensuring the required level of reliability, safety and quality of electricity supply to consumers.

4.2.3 The organization of technical maintenance and repair must comply with the requirements of regulatory legal acts, technical documentation, which have the status of mandatory for application on the territory of the Russian Federation, organizational standards mandatory for application in the Rosseti group of companies, establishing requirements for ensuring the reliability of electric power systems, the reliability and safety of electric grid facilities.

4.2.4 The efficiency of maintenance and repair processes and procedures should be ensured through the implementation of uniform principles and approaches to planning, performing maintenance and repair work, monitoring and assessing compliance with established requirements.

4.2.5 The priority direction of organizing the repair of equipment of substations, power transmission lines of all voltage classes is recognized as the organization of repairs based on the actual technical condition, taking into account the reliability of the elements of the electrical grid and the economic feasibility of using this type of repair organization, taking into account the restrictions imposed by the requirements of the regulatory acts of the Russian Federation.

4.2.6 When planning maintenance and repair work on equipment and power transmission lines, the possibility of performing them using live work technology (without disconnecting) should be considered as a priority.

4.2.7 When planning maintenance and repairs, the results of technical diagnostics should be used, allowing for a reliable determination of the actual technical condition of substation and power transmission line equipment.

4.2.8 During maintenance and repair, high-tech and safe methods of performing work, modern tools, devices and equipment must be used.

4.2.9 The process of maintenance and repair must be accompanied by training of repair personnel in advanced methods and technologies for maintenance and repair of equipment, power lines, buildings, structures, technical and technological systems and monitoring of their technical condition.

4.2.10 When implementing technical maintenance and repair, it is necessary to ensure an optimal combination of outsourcing and business-like methods of performing work.

4.2.11 Maintenance and repair processes and procedures should be an integral part of the asset management system.

4.3 Renovation

4.3.1 In order to curb the rate of physical wear and tear and optimize the operation of equipment, the electrical grid is being renovated.

4.3.2 Timely planning and implementation of measures for the renovation of electrical grid facilities, the acquisition of special vehicles, backup power supplies, replenishment of emergency supplies, reconstruction of industrial buildings and structures helps to reduce the proportion of facilities in unsatisfactory condition and minimize technical risks.

4.3.3 The organization of renovation must comply with the requirements of regulatory legal acts and technical documents, as well as organizational and administrative documents and organizational standards that are mandatory for use in the Rosseti group of companies.

4.3.4 The formation of the Electric Grid Complex Renovation Program (approved by order of PJSC Rosseti dated 31.08.2023 # 430r) is aimed at increasing the efficiency of technical and economic decisions taken according to the following criteria:

- maintaining the level of reliability by performing actions on equipment that has deviations in technical characteristics from those established in regulatory, factory and/or design documentation, which do not allow the required functions to be performed in specified operating modes and conditions;
- reducing the level of physical wear and tear of equipment;
- reduction in the number of emergency outages;

− socio-economic significance - ensuring reliable power supply to consumers (depending on the category), safe working conditions for personnel operating the equipment;

− economic feasibility of the volume and timing of capital investments (economic efficiency).

4.3.5 In the renovation process, modern technologies, tools, devices and equipment must be used.

4.3.6 The formation of the Renovation Program is carried out using automated tools of the production asset management system.

## 5 Personnel training and labour protection

5.1 The personnel must be trained in the volume and within the timeframes in accordance with the Rules for working with personnel in organizations of the electric power industry of the Russian Federation, approved by order of the Ministry of Energy of Russia dated 22.09.2020 # 796, the Rules for training in labour protection and testing knowledge of labour protection requirements, approved by Government Resolution dated 24.12.2021 # 2464 on fire safety training programs or additional professional programs, other regulatory legal acts and organizational and administrative documents regulating the requirements for mandatory training of employees.

5.2 Work with personnel must be carried out in accordance with the Procedure for carrying out work with personnel in Rosseti Centre, PJSC, which provides for mandatory forms of work with personnel established by the Rules for working with personnel in organizations of the electric power industry of the Russian Federation, and take into account mandatory measures for training personnel provided for by other regulatory acts.

5.3 The maintenance and storage of documentation necessary for the implementation of operational and technological management, as well as documentation on the organization and conduct of training and confirmation of the readiness of employees of Rosseti Centre, PJSC, including their completion of mandatory forms of work with personnel, is carried out in accordance with the Requirements for the maintenance and storage of documentation necessary for the implementation of operational and dispatch control in the electric power industry and operational and technological management, approved by order of the Ministry of Energy of Russia dated 01.09.2022 # 894.

5.4 Corporate training centres should be the main sites for training production personnel and include:

5.4.1 Classrooms equipped for conducting in-person theoretical classes, including those using distance learning:

− workstations for students and teachers, including those equipped with personal computers;

− specialized software and hardware systems;

− distance learning tools (videoconferencing equipment, distance learning platform, etc.);

- interactive learning tools;
- educational and methodological materials, including those on electronic media.

5.4.2 Simulator classes for the purpose of practicing practical skills in performing work using computer simulators, equipped with specialized computer simulators, including simulators using virtual reality technology.

5.4.3 Training grounds, laboratories, workbenches designed for practicing skills in performing work on real equipment, equipped with the most common types, brands and brands of equipment, devices and instruments in the region where the training centre is present.

5.5 Main objectives in the field of labour protection

The main objectives in the field of labour protection should be reflected in the Labour Protection Policy of Rosseti Centre, PJSC and implemented through the creation, implementation and maintenance of the labour protection management system of Rosseti Centre, PJSC.

In order to ensure safety requirements in the field of labour protection, to eliminate injuries, to reduce the risks of accidents at work, the main goals in the field of labour protection have been formed, aimed at:

- elimination of cases of microdamage/microtrauma;
- elimination of cases of industrial injuries and occupational diseases;
- developing a culture of safe behavior at work and skills to prevent dangerous situations among workers;
- creation of conditions that ensure the activities of employees in accordance with labour legislation, collective agreements, and agreements;
- continuous improvement of working conditions and safety;
- ensuring priority for preserving the life and health of workers in production activities;
- timely informing of employees about the conditions and safety of work at their workplaces, about existing professional risks and their levels, as well as about measures to protect against the impact of harmful and (or) hazardous production factors present at the workplace;
- preventing the performance of work, as well as the operation of equipment, buildings or structures, the implementation of certain types of activities, the provision of services, if a threat to the life and health of workers arises until such a threat is eliminated;
- ensuring training of employees in occupational safety, with at least 50% of the training program for a new position and periodic training of production personnel allocated to practical training in safe work practices at training grounds, laboratories, and stands;
- providing training and admission to independent work for newly hired drivers after completing training at a specialized training centre;

− providing workers with certified, high-quality and ergonomic special clothing, special footwear and other personal and collective protective equipment, washing and (or) neutralizing agents, high-quality electrical protective equipment, serviceable tools, devices, and instructions;

− ensuring comprehensive thermal protection of the worker when selecting kits for protection against the thermal effects of an electric arc;

− equipping training grounds for training personnel in safe methods of performing work on power equipment;

− organization and implementation of internal control over compliance with labour protection requirements at power grid facilities and during the operation of vehicles;

− ensuring the implementation of a motivation system that encourages employees to unconditionally comply with occupational safety requirements;

− ensuring compliance with the requirements of legislative and other regulatory legal acts of the Russian Federation in the field of labour protection;

− ensuring the identification of hazards and professional risks, their regular analysis and assessment, and reduction of the risk of injury to personnel;

− ensuring the implementation and use of technologies that ensure safe working conditions in the workplace;

− ensuring the effective functioning and continuous improvement of the occupational safety management system;

− monitoring and implementation of advanced developments in the field of occupational safety;

− conducting a special assessment of working conditions in workplaces to ensure safe working conditions;

− ensuring access to the implementation of production activities of employees, based on the results of mandatory medical examinations (surveys), mandatory psychiatric examinations, as well as pre-shift medical examinations (surveys) and medical examinations of employees during the working day (shift) conducted at the request of employers;

− timely informing of employees about the conditions and safety of work at their workplaces, about existing professional risks and their levels, as well as about measures to protect against the impact of harmful and (or) hazardous production factors present at the workplace, about the results of the investigation of industrial accidents and microtraumas (microdamages), as well as measures developed in relation to them;

− conducting industrial control over compliance with sanitary rules and the implementation of sanitary and anti-epidemic (preventive) measures.

5.6 Technologies and activities aimed at ensuring occupational health and safety requirements for personnel

Main activities:

- adoption of technical solutions during the design of electrical grid facilities, buildings and structures that ensure the safety of their operation;
- reducing the share of manual labour, the severity of labour, and increasing labour productivity by increasing the level of mechanization and automation;
- reduction in the share of work related to lifting power transmission line supports without the use of special machines and mechanisms;
- exclusion of climbing using manholes and claws on supports that have been in operation for longer than the established standard period;
- equipping equipment with automatic safety systems, interlocks , and remote control systems in order to prevent a person from being in the immediate vicinity of the switching device during switching operations;
- equipping in the required volume with special mechanisms, automobile and special equipment (hydraulic lifts, telescopic towers, mobile laboratories, drilling and crane machines), as well as modern equipment, tools and devices to ensure the mechanization of maintenance and repair work, primarily the most hazardous and labour-intensive;
- use of shock-absorbing braking devices, blocking and locking devices, and safety systems using anchor devices when working at height;
- use of insulated busbars and busbars in places where people may pass;
- when commissioning new facilities, the use of voltage alarms built into the equipment (including 6-20 kV substations), with the possibility of integrating them into the telesignaling system and the safety interlock circuit;
- use of electrical equipment and technologies that are safe for life and harmless to the health of personnel;
- the use of safety devices that monitor the concentration of harmful substances in explosive and gas-hazardous air environments;
- purchase of vehicles for transporting personnel (buses, team vehicles, lifts (towers), etc.) equipped with seat belts and anti-lock braking systems;
- implementation of on-board vehicle monitoring systems on new vehicles, except for vehicles operating on the territory of the enterprise (loaders, self-propelled lifts, etc.);
- creation of modern sanitary and living conditions for staff;
- equipping line crews with motor transport equipment designed to create normal working and rest conditions for personnel during long-term stays in the field;
- use of modern devices for safe work (fiberglass ladders, devices for securing supports based on drilling and crane machines, lifting devices, safety systems);
- use of sets of protective equipment and devices for work on 0.4-20 kV overhead lines, which make it possible to install portable grounding and perform

certain types of work (pruning branches, removing overhead lines) without climbing onto overhead line supports;

- implementation of safe technology when performing maintenance and repair of equipment and power lines under voltage (without disconnection);
- use of modern specialized tools, devices, protective equipment, as well as special-purpose vehicles (automatic hydraulic lifts with an insulating link (insert, etc.) for performing work under voltage.
- limiting (where technologically possible) workers' contact with harmful substances such as asbestos, bitumen, acids and other substances that are harmful to health.

## 6 Innovative development

6.1 One of the areas of the Regulation in terms of the application and development of new technical solutions is the Company's Innovative Development Program, approved in accordance with the established procedure by the decision of the Company's Board of Directors. The Innovative Development Program is mandatory for implementation by structural divisions of the Company's Executive Office, branches of Rosseti Centre, PJSC and its subsidiaries.

The Company's Innovative Development Program contains the most progressive technical solutions that should replace traditional technical solutions in the near future, and also defines general approaches, goals, objectives, priorities, indicators and control points for the implementation of innovative activities, indicators of the effectiveness and efficiency of innovative projects and events.

The development, implementation and replication of new technical solutions can be carried out in several stages:

- conducting scientific research work;
- conducting experimental design developments;
- conducting pilot implementations;
- conducting pilot industrial operation;
- implementation into industrial operation;
- development and adjustment of regulatory and technical documents;
- formation of requirements for the application of technology, equipment/products for which Rosseti Centre, PJSC and its subsidiaries have received patents, copyright certificates, trademarks and other industrial property objects;
- development of proposals for large-scale replication of innovative solutions.
- formation of a register of innovative products.

6.2 The organization of innovative activities within the framework of the Innovative Development Program of the Company is aimed at implementing the

algorithm for the development, testing and further wide application of innovative solutions, namely:

- identifying the need for certain solutions and technologies in accordance with the directions of innovative development defined by the Innovative Development Program;
- conducting benchmarking on domestic and foreign markets;
- if there are offers on the market – organizing a pilot implementation and conducting pilot industrial operation, if there are none – organizing R&D and also organizing a pilot implementation and conducting pilot industrial operation.

The most effective technologies or solutions may be included in the Unified Technical Policy of the Company as a basic technical solution for use in a new construction project or a comprehensive reconstruction after conducting a quality check at PJSC Rosseti.

6.3 The creation of a system for managing innovative development and the formation of an innovative infrastructure in the Rosseti group of companies is carried out within the framework of the implementation of organizational innovations.

## 7 Import substitution

7.1 Import substitution as a type of economic strategy and industrial policy of the Russian Federation is aimed at replacing the import of industrial goods that are in demand on the domestic market with goods of national production.

7.2 Import substitution promotes innovative development of energy and related industries, as well as the development of domestic power engineering, electrical engineering, industry and fundamental science to ensure the technological security of the Russian Federation.

7.3 As part of the implementation of import substitution, Resolution of the Government of the Russian Federation dated 17.07.2015 # 719 "On confirmation of the production of industrial products in the territory of the Russian Federation" defined the requirements for industrial products imposed for the purpose of classifying them as products manufactured in the Russian Federation, Resolution of the Government of the Russian Federation dated 16.09.2016 # 925 "On the priority of goods of Russian origin, works, services performed, rendered by Russian persons in relation to goods originating from a foreign state, works, services performed, rendered by foreign persons" established the priority of goods of Russian origin in relation to goods manufactured in the territory of a foreign state, Resolution of the Government of the Russian Federation dated 10.07.2019 # 878 "On measures to stimulate the production of radio-electronic products in the territory of the Russian Federation when purchasing goods, works, services to meet state and municipal needs, on amendments to Resolution of the Government of the Russian Federation dated 16.09. 2016 # 925 and the recognition of certain acts of the Government of the Russian Federation as invalid" established the priority of domestic radio-electronic

products in relation to radio-electronic products manufactured on the territory of a foreign state.

7.4 Resolution of the Government of the Russian Federation of 03.12.2020 # 2013 "On the minimum share of purchases of goods of Russian origin" established the minimum share of purchases of goods of Russian origin. Within the framework of this Resolution, goods of Russian origin are recognized as goods included:

- to the register of industrial products manufactured in the territory of the Russian Federation, or the register of industrial products manufactured in the territory of a member state of the Eurasian Economic Union, with the exception of the Russian Federation, provided for by Resolution of the Government of the Russian Federation of 30.04.2020 # 616 "On the establishment of a ban on the admission of industrial goods originating from foreign countries for the purposes of procurement for state and municipal needs, as well as industrial goods originating from foreign countries, works (services) performed (rendered) by foreign persons, for the purposes of procurement for the needs of the country's defense and state security";
- in the unified register of Russian radio-electronic products, as provided for by Resolution of the Government of the Russian Federation of 10.07.2019 # 878 "On measures to stimulate the production of radio-electronic products on the territory of the Russian Federation when purchasing goods, works, services to meet state and municipal needs, on amendments to Resolution of the Government of the Russian Federation of 16.09.2016 # 925 and recognizing as invalid certain acts of the Government of the Russian Federation".

7.5 The implementation of import substitution in the electric grid complex based on the development of competencies of domestic producers and technology transfer is carried out by:

- creating conditions for providing the electric grid complex with modern domestic equipment;
- identification of modern and innovative technologies necessary for the implementation of the Unified Technical Policy, their transfer while ensuring the required level of localization of production and the implementation of R&D.

7.6 The priority areas of the Unified Technical Policy in the field of import substitution are:

- minimization of the use of imported equipment and materials in the formation of design solutions, namely, the priority use in design, working documentation, assignments for the supply and purchase of products of equipment and components of domestic production (included in the Register of Industrial Products Manufactured in the Territory of the Russian Federation, the Register of Industrial Products Manufactured in the Territory of a Member State of the Eurasian Economic Union, with the exception of the Russian Federation, or the Unified Register of Russian Radio-Electronic Products), equipment and components, the

localization of which is carried out in whole or in part through subsidies provided from the federal budget in accordance with agreements concluded by manufacturers with the Ministry of Industry and Trade of Russia, as well as equipment and components that are considered to be manufactured in the territory of the Russian Federation in accordance with the requirements of the Decree of the Government of the Russian Federation of 17.07.2015 # 719 "On confirmation of the production of industrial products in the territory of the Russian Federation".

Equipment and components of imported manufacture may be used with the approval of the relevant structural divisions of PJSC Rosseti, which oversee issues of the Unified Technical Policy, import substitution and interaction with equipment manufacturers, if there is appropriate justification (in the absence of analogues manufactured in the territory of the Russian Federation that meet all technical requirements):

- typification of equipment used in the electric grid complex through the development and implementation of organizational standards for electrical products, with the aim of taking into account the production capabilities of domestic manufacturers and eliminating excessive requirements for equipment that lead to the need to purchase imported equipment;
- stimulation of the localization of production of high-tech equipment and components on the territory of the Russian Federation, including by establishing criteria for classifying products manufactured on the territory of the Russian Federation.

# 8 Electrical equipment and structural elements of networks

## 8.1 Electrical substations and distribution points

In new construction, open switchgear units (OSU) are usually used for voltage classes of 35 kV and higher.

The equipment used must meet the following general requirements:

- no need for major repairs during the service life;
- service life of at least 30 years;
- warranty period:
  - from the date of commissioning - not less than 60 months;
  - from the date of manufacture – not less than 66 months.
- regulatory level of explosion and fire safety;
- corrosion resistance of structures and equipment elements;
- standard level of noise and vibration.

### 8.1.1 Power autotransformers, transformers and reactors

8.1.1.1 The design of power transformers, autotransformers and reactors must ensure:

- no need to press the windings;
- energy efficiency level;

- electrodynamic resistance of windings to short-circuit currents;
- vibration resistance;
- use of mineral dielectric fluid;
- preventing the case from becoming depressurized due to internal damage;
- protecting the oil from contact with the surrounding air.

8.1.1.2 The design of power transformers in TS/DTS 6-20 kV must ensure:

- energy efficiency level;
- hermetically sealed design;
- In TS, DTS, DS built into buildings, as well as those constructed in dense urban areas or in cramped conditions, small-sized dry transformers with temperature control of windings and chambers should be used.

8.1.1.3 In oil-filled T/AT and reactors with an oil mass of more than 1000 kg, continuous regeneration must be ensured.

8.1.1.4 The design of newly installed high-voltage bushings for voltage classes 110-750 kV must have internal insulation made of paper or non-woven material impregnated with compound. It is allowed to use bushings for voltage class 750 kV with paper-oil insulation.

8.1.1.5 Power transformers 6-35 kV must be equipped with no-load voltage regulation devices (NLTC), the use of LTC is permissible upon justification.

8.1.1.6 Power transformers of 110 kV and above, as well as step-up transformers, must be equipped with an OLTC.

8.1.1.7 The LTC must provide the required voltage level on the buses in automatic and manual remote mode.

8.1.1.8 In 6-20 kV distribution transformer substations with uneven phase loads, it is recommended to consider the use of power transformers with a Y/Yn winding connection scheme, with a symmetrizing winding built into the transformer design.

8.1.1.9 In underground substations, power T/AT with SF6 insulation or with the use of synthetic dielectric liquids should be used.

8.1.1.10 Regulating transformers may be installed:

- at 330-750 kV substations in 330-750 kV AT circuits for regulating active power flows, if justified;
- at 35-220 kV substations, where voltage levels at the switching point do not meet standardized parameters when using control devices.

8.1.1.11 The use of voltage boosters for adapting 0.4-20 kV distribution electrical grids to changes (increases) in electrical loads and ensuring the required quality of electrical energy is permitted if there is appropriate justification and can be used as a temporary measure until the electrical grid reconstruction activities are completed.

### 8.1.2 Switching equipment

8.1.2.1 In electrical grids with a voltage of 110 kV and higher, the following should be used:

- SF6 circuit breakers, column and tank type, with spring drives;
- as technologies develop, the use of vacuum circuit breakers, as well as switch-disconnectors (combined modular devices) in 110-220 kV grids is permitted;
- for switching (controlled) shunt reactors and capacitor banks - special switches designed for switching the current of the reactor and capacitor banks, respectively, equipped with Universal Network Controller if necessary;
- When expanding the SS (switch towers), priority in choosing the design of switches should be given to a design similar to the installed switches.

8.1.2.2 When selecting switching devices, it is necessary to take into account the results of calculations of special (ad hoc) modes of operation of power transmission lines, performed in accordance with the methodology for calculating and selecting means that ensure disconnection of SF6 circuit breakers during switching of power transmission lines and busbars equipped with shunt reactors.

8.1.2.3 Disconnectors of 110 kV and higher of the pantograph, semi-pantograph and horizontal-rotary type, as a rule, must be equipped with electric motor drives of the main and earthing knives.

8.1.2.4 At 35/0.4 kV substations the following should be used:

- vacuum circuit breakers;
- SF6 circuit breakers - for connections with high rated currents, as well as when it is necessary to ensure an acceptable level of switching overvoltages.

8.1.2.5 In electrical grids with a voltage of 6-20 kV the following should be used:

- fuses - disconnectors;
- load switches.

8.1.2.6 The installation of a phase-by-phase drive on 220 kV switches must have operational justifications.

8.1.2.7 Promising directions for the development of switches:

- vacuum circuit breakers for voltage classes 110-220 kV;
- thyristor switches 0.4-10 kV.

### 8.1.3 Distribution devices

#### 8.1.3.1 Integrated switchgear units gas-insulated

8.1.3.1.1 Basic requirements for 110-500 kV switchgear:

- the design of the switchgear must provide for the removal of any gas volume for repair without completely disconnecting the switchgear, except for single-transformer substations installed according to schemes in accordance with GOST R 59279-2020;

− the design and gas circuit of the switchgear must ensure the possibility of its future expansion (if required) with minimization of disconnections of existing connections;

− the design of gas-insulated busbars must include compensating devices within the temperature difference boundaries and within the boundary separating the foundations of the switchgear building and the external supports of the busbars with expansion joints;

− the design of the switchgear must provide for the possibility of access by service personnel to each switchgear unit, to carry out repairs or replacement of switches with a minimum number of dismantled switchgear elements.

8.1.3.1.2 The switchgear rooms should have service platforms at different levels, and for the purpose of safe servicing of gas-insulated equipment, 110 kV switchgear should be equipped with factory-made mobile service platforms, and 220 kV and higher switchgear should be equipped with stationary service platforms.

8.1.3.1.3 In the switchgear room, cable rooms under the switchgear rooms, and rooms for storing SF6 gas cylinders, personnel protection and environmental safety must be ensured in the event of emergency emissions of SF6 gas.

8.1.3.1.4 Basic requirements for switchgear (SF6 gas) 6-35 kV:

− insulation of 6-35 kV switchgear must be air insulation, including combined insulation, with appropriate justification - with SF6 insulation, as well as switchgear of unilateral maintenance(SF6 gas) with vacuum circuit breakers or load switches, including in the "monoblock" design;

− metal protective cell curtains must be used;

− in switchgear it is necessary to use CT and VT with cast insulation;

− use cells with isolated compartments;

− it is recommended to use drives that provide the ability to remotely turn off and turn on the switch;

− it is recommended to provide for the equipping of disconnectors, roll-out trolleys and earthing knives with electric motor drives;

− must be equipped with operational interlocks to prevent erroneous operations;

− it is recommended to use contact joint heating control systems when justified.

8.1.3.1.5 In urban electrical grids with a voltage of 6-20 kV, it is recommended to use switchgear (SF6 gas) with modular cells in a metal housing (the cells should be low-maintenance or, if possible, not require maintenance during their service life).

8.1.3.1.6 The use of switchgear must be justified and comply with the requirements for switchgear.

8.1.3.1.7 Cable entries into switchgear/SF6 switchgear regulating equipment must prevent flooding of the cable room by groundwater.

8.1.3.1.8 The requirements for combined switchgear, which combine the functions of a switch, disconnectors, and earthing switches (multifunctional compact cells), must be similar to the requirements for integrated switchgear.

8.1.3.1.9 Promising areas of development:

− use of 110-330 kV switchgear in climatic version U1 (in the near future up to minus 25°C);

− use of compact modular switchgear 110 kV and higher with high factory readiness.

### 8.1.3.2 Open switchgear

8.1.3.2.1 Basic requirements for outdoor switchgear 35 kV and above:

− steel portal structures of switchgear must provide protection against nesting of birds;

− connections of busbar wires in spans must be made by crimping using connecting clamps, and connections in loops at supports, connection of branches in a span and connection to hardware clamps - by crimping or welding. Connection of branches in a span must be made without cutting the wires;

− branches from the main busbars of the switchgear, as a rule, should be located below the main busbars;

− The suspension of high-frequency barriers and loops should be carried out using technical solutions that eliminate their whipping, axial rotation and reduce the amplitude of the swing.

8.1.3.2.2 Steel supports, portals at 35-110 kV substations, frames for substation equipment, service platforms, as well as steel parts of reinforced concrete supports and structures, metal structures of foundations, fasteners, must be protected from corrosion at the manufacturing plants by hot-dip galvanizing.

8.1.3.2.3 The location and power of the outdoor lighting installations of the switchgear must ensure the standardized level of illumination during the dark hours of the day and in conditions of poor visibility in open areas of the switchgear territory, where there is movement of vehicles and people, and on the working surfaces of electrical equipment.

8.1.3.2.4 Lighting installations of the outdoor switchgear must be made using energy-saving lamps that do not contain mercury.

8.1.3.2.5 The layout of the equipment and the location of the switchgear of 330 kV and above must ensure the least impact of electromagnetic fields on the personnel servicing the substation equipment, taking into account the requirements of SanPiN 1.2.3685-21.

8.1.3.2.6 Suspension of busbars in one span over two or more T/AT cells is not permitted.

8.1.3.2.7 In order to reduce the occupied area and optimize the layout solutions, it is allowed to use rigid busbars at the outdoor switchgear. In places of the smallest interphase dimensions of open-type busbar bridges (inputs to switchgear

and switchgear units, at transformer inputs), it is allowed to use insulation for protection against birds/animals.

8.1.3.2.8 At 110-500 kV switchgear, the use of gas-insulated busbars with an insulating medium based on insulating gases is permitted with appropriate justification.

8.1.3.2.9 During new construction, reconstruction or expansion of existing electrical grid facilities, the use of hollow wires for busbar wiring is permitted.

8.1.3.2.10 When constructing outdoor switchgear in areas with an aggressive environment, busbars with an anti-corrosion coating must be used.

### 8.1.3.3 Mobile modular substations

8.1.3.3.1 A mobile modular SS must have basic parameters (weight, size) that do not exceed standard values (excluding oversized items), ensuring delivery of the SS as an assembly or its modules by all types of transport, as well as quick installation and commissioning of the SS at the facility.

8.1.3.3.2 The design of newly constructed modular substations must ensure:

- the possibility of increasing the number of SS cells using the block principle;
- remote monitoring and remote control in the OTU system;
- absence of exposed current-carrying parts;
- detachable cable connection inside the MSS (between the power transformer and the switchgear).

For connection to the high-voltage switchgear network, a detachable cable connection and/or high-voltage inputs for the possibility of overhead connection. In low-voltage switchgear, the possibility of connecting a KL end sleeve.

8.1.3.3.3 Modular substations with voltage of 6-220 kV are used:

- during repair, reconstruction and construction of a new substation until commissioning;
- for electricity consumers located in densely populated areas, remote areas, and aggressive external environments;
- for electricity consumers located in places where the construction of stationary substations is economically ineffective.
- to compensate for peak load values;
- if there is a need to promptly provide electricity supply to new facilities;
- when carrying out emergency restoration work in electrical grids.

8.1.3.3.4 To carry out emergency recovery and scheduled repair work in 0.4-6-20 kV electrical grids to organize temporary power supply to consumers and/or to organize the melting of ice and frost deposits, backup power supply sources can be used, including those with mobile step-up transformer substations (operating in reverse transformation mode).

### 8.1.3.4 Switch towers

8.1.3.4.1 In cities and populated areas (villages, towns, etc.), 35-500 kV switch towers should generally be of a closed type or placed on special multi-faceted supports with electrical equipment and security and fire alarm equipment installed in them.

8.1.3.4.2 Outside populated areas, it is permitted to construct open 35-500 kV switch towers, providing measures to prevent unauthorized persons from entering the territory, as well as implementing fire safety measures, including preventing ground fires.

8.1.3.4.3 Switch towers of 35-500 kV, located on the territory of the substation, should be of an open type, including in cities and populated areas.

8.1.3.4.4 When placing switch towers on special transition supports, 35-110 kV cable termination joints must be of a “dry” type.

8.1.3.4.5 For double-circuit cable lines, when using switch towers in a closed design, separate (non-connected) rooms should be provided for placing equipment and end couplings of each cable line.

8.1.3.4.6 When placing switch towers on special transition supports (portals), the following solutions must be provided:

- the design of the supports must take into account the additional load;
- cable joints, surge arresters or line arresters, support insulators and other equipment included in the transition point must be placed at a height of at least 10 m from the ground surface;
- measures must be taken to ensure year-round access to supports with switch towers;
- on supports with switch towers, platforms for technical maintenance must be provided;
- access by third parties must be excluded;
- the cable must be protected from mechanical damage at a height of at least 2 m above ground level and at a depth of 0.3 m in the ground;
- Along the cable line route, a reserve of cable must be provided in front of the end couplings for reinstallation of the end coupling.

8.1.3.4.7 Promising areas of development:

During new construction, reconstruction and technical re-equipment, it is necessary to use switching devices, grounding disconnectors and relay protection and automation devices with the ability to be controlled remotely from the automated workplace of the operator, the control centre and the grid control centre.

### 8.1.4 Busbars and busbars

8.1.4.1 At 6-35 kV substations, it is permitted to use rigid busbars, both non-insulated and protected. When using rigid busbars, it is necessary to use temperature deformation compensators, flexible branches from the busbars, as well as busbar holders and connections to devices using crimp-type units (preferably

cast). It is not permitted to use branches of flexible connections (including temperature compensators) from rigid busbars of switchgear of 35 kV and higher using pressed clamps.

8.1.4.2 In block-type transformer substations with a voltage of 6-20/0.4 kV with transformers with a capacity of up to 630 kVA, it is recommended to use isolated transformer busbars.

8.1.4.3 In distribution networks with transformer power of 1000 kVA or more on the 0.4 kV side, it is recommended to use insulated (three-phase and single-phase) busbars.

8.1.4.4 For overhead inputs on sections of lines from the feedthrough insulators of switchgear cells to the first supports of 6 (10) kV overhead lines, as a rule, it is necessary to use a protected (insulated) wire with insulation that does not spread combustion (type SIWn).

8.1.4.5 It is recommended that flexible busbars be connected to electrical equipment using hardware clamps without a welded connection between the contact plate and the clamp "leg", with a thermodynamic method of applying copper coating and drainage holes to prevent the pressed wire from being pushed out of the clamp body.

### 8.1.5 Instrument transformers

8.1.5.1 Basic requirements for measuring transformers:

− measuring transformers must be of the electromagnetic (CT, VT) or capacitive (VT) types;

− according to the types of insulation medium, gas (SF6, nitrogen, mixture), oil-filled sealed and with cast insulation should be used. Oil-filled CT and VT should have a reduced oil volume;

− digital (optoelectronic and other types) measuring transformers (DTT, DTN) can be used with appropriate justification;

− VT 6-35 kV must be anti-resonant;

− Capacitive dividers must have a reduced value of the temperature coefficient of capacitance;

− the use of combined current and voltage transformers for installation in 110-750 kV overhead transmission line cells for the purpose of compacting switchgear must be justified;

− Measuring transformers must have a separate winding for electricity metering purposes.

8.1.5.2 The selection of measuring current transformers must be carried out taking into account measures to eliminate incorrect operation of relay protection functions implemented in relay protection and automation devices in transient modes accompanied by CT saturation.

8.1.5.3 The accuracy classes of CT and VT windings must comply with the technical requirements of current regulatory legal acts and organization standards, depending on the functional characteristics of the connected equipment.

8.1.5.4 CTs should be used on 0.4 kV connections for the purposes of automated measuring and control systems for commercial power supply, automated process control systems and measurements in cases where the measured current exceeds 80 A and the connected power exceeds 50 kW.

8.1.5.5 The actual secondary loads of measuring CTs and VTs must comply with the requirements of regulatory documents and ensure the operation of CTs and VTs in the required accuracy class.

8.1.5.6 Measuring CTs and VTs used in 0.4-20 kV distribution electrical grids, as well as in 35 kV distribution electrical grids at closed-type substations, must have:

- cast insulation (the use of oil VTs is permitted with appropriate justification);
- at least two secondary windings.

### 8.1.6 Surge protection and grounding

8.1.6.1 Protection against lightning and switching overvoltages of switchgear and substations.

8.1.6.1.1 Protection against lightning overvoltage of switchgear and substations includes a set of technical measures to limit overvoltage during thunderstorms, switching and damage to a safe level for substation equipment.

8.1.6.1.2 Protection against direct lightning strikes is provided by rod and cable lightning rods.

8.1.6.1.3 Protection against incoming waves from overhead power lines must be carried out:

- lightning rods from direct lightning strikes along a certain length of these lines;
- protective devices;
- by connecting the overhead power line lightning protection cable to the grounded structures of the outdoor switchgear.

8.1.6.1.4 Switching overvoltages in switchgear must be limited by installing surge arresters.

8.1.6.1.5 To limit overvoltage during switching of the SR, in addition to the overvoltage limiter, it is recommended to use SF6 circuit breakers and a device for intentional non-simultaneous switching of poles on the switch.

8.1.6.2 Protection against internal overvoltage.

8.1.6.2.1 Electrical networks of 3-35 kV must operate with an isolated neutral, as well as with a neutral grounded through a resistor or arc-suppressing reactor.

8.1.6.2.2 When deciding on the advisability of using the neutral grounding mode of a 3-35 kV network through an arc-suppressing reactor, it is recommended to use smoothly adjustable DGRs (including those with compensation for the full short-circuit current to “ground”) with automatic adjustment regulators.

8.1.6.2.3 In 3-35 kV electrical grids, measures should be taken to prevent ferroresonance processes and spontaneous neutral displacements.

8.1.6.2.4 In 330, 500 and 750 kV networks, depending on the network layout, number of lines and transformers, measures should be taken to limit long-term voltage increases and internal overvoltages.

8.1.6.2.5 In 110-500 kV switchgear, technical solutions must be provided that eliminate the occurrence of ferroresonant overvoltages that occur when supplying idle buses with electromagnetic VTs through capacitive voltage dividers of switches. These solutions include, in particular:

- use of switches without capacitive voltage dividers;
- use of capacitive transformers instead of electromagnetic ones;
- use of antiresonant voltage transformers;
- increasing the capacity of the switchgear busbar by 1.5 - 2 times by installing additional capacitors on the busbars (with appropriate calculations/justifications).

8.1.6.3 When designing 110-500 kV switchgear, technical solutions must be provided that limit high-frequency switching overvoltages during operation of switchgear, including in “switchgear – aerial cable line” circuits of various configurations.

8.1.6.4 Grounding

8.1.6.4.1 Grounding devices of substations must comply with the requirements of regulatory and technical documentation in terms of requirements for the design and standardized parameters of the grounding device, and ensure the operational functions of electrical installations.

8.1.6.4.2 Grounding devices used for grounding electrical installations must meet the requirements for grounding electrical installations:

- protection of people from electric shock when insulation is damaged;
- conditions of network operating modes;
- protection of electrical equipment from overvoltage, etc.

8.1.6.4.3 The characteristics of the charger must meet the requirements of electromagnetic compatibility, ensuring the electrical safety of service personnel and reliable operation of the equipment under normal and emergency conditions throughout the entire service life of the electrical installation.

### 8.1.7 Reactive power compensation devices

8.1.7.1 The following types of reactive power compensation devices should be used:

- uncontrolled static means of longitudinal and transverse compensation:
  - shunt reactors 35-750 kV;
  - shunt batteries of static capacitors (BSC) and harmonic filters using dry capacitors or capacitors impregnated with environmentally friendly liquid synthetic dielectric;
- controlled means of longitudinal and transverse compensation, including:
  - controlled shunt reactor 110-500 kV;

- static reactive-power compensator and static var generator;
- vacuum-reactor and thyristor-reactor groups, switched by switches with increased switching life, equipped with a device for intentional non-simultaneous switching of poles.

8.1.7.2 The use of a capacitor unit is permitted provided that resonance phenomena are excluded in all operating modes of the electrical grid.

8.1.7.3 When designing the development of electrical grids of 110 kV and above, it is recommended to consider issues of reactive power compensation together with the issue of the possibility and feasibility of constructing self-compensating overhead lines, as well as compact overhead lines.

### 8.1.8 Own needs

8.1.8.1 General requirements for organizing own needs of the SS:

− power supply for auxiliary AC power consumers of the SS must be provided from two main independent mutually redundant power sources;

− as a rule, use cables with voltage above 1 kV with insulation:
  - made of cross-linked polyethylene;
  - heat-resistant with synthetic composition,

− cables up to 1 kV with fire-retardant insulation;

− ensure separate operation of 0.4 kV sections for own needs with an automatic throw-over circuit-breaker, provide for separate operation without an automatic throw-over circuit-breaker of circuits supplied from different 0.4 kV sections (supply of disconnector drives, winding of circuit breaker drive springs, etc.);

− use protective switches with the ability to create visible gaps;

− use selective circuit breakers as input and sectional protective devices on the 0.4 kV side;

− in TS, DS and DTS with alternating and rectified operational current, the auxiliary transformer should be connected through fuses, from the supply side, before the input switch, with the exception of auxiliary transformer with cast (dry) insulation, which should be connected through the switch from the busbars, while transformers with cast (dry) insulation must be equipped with thermal protection that acts to disconnect the switch, including when installed in switchgear, switchgear and control gear units, and indoor switchgear.

8.1.8.2 Power supply for the own needs of geographically remote objects, single-transformer substations, switch towers requiring the construction of separate 6-20 kV power transmission lines longer than 7 km, is preferably organized from high-power voltage transformers (HPVT).

8.1.8.3 The supply of operational alternating current from the auxiliary buses is carried out through stabilization devices with a voltage of 220 V at the output.

8.1.8.4 It is necessary to organize a centralized system with a distribution board and a control board for emergency and evacuation lighting of the main control board of the substation with the possibility of using standard lighting installations for emergency lighting and integration into the existing substation automated process control system, fire alarm systems, with autonomous testing of units and assemblies, both the system itself and the load connected to it (lighting networks), with the possibility of analyzing the control of the state of the lighting networks.

8.1.8.5 Power supply to third-party consumers from the SS own needs network is not permitted.

8.1.8.6 Metering of electrical energy for own needs should be organized on the high-voltage side of the auxiliary transformer.

### 8.1.9 Current limiting devices

8.1.9.1 In electrical grids of 6-35 kV, and if justified, in networks up to 330 kV inclusive, in order to limit short-circuit surge current at substations, dry current-limiting reactors with low electrical energy losses and sufficient electrodynamic resistance to short-circuit currents should be used.

8.1.9.2 Reactors should be used for installation in 6-20 kV circuits of power transformers or at connections of outgoing lines.

8.1.9.3 In the production of current-limiting dry reactors, high-quality wires, fiberglass strips, elements made of non-magnetic steels, without steel cores should be used.

8.1.9.4 Current-limiting reactors must be of dry construction.

### 8.1.10 Technical diagnostics and monitoring of main equipment

8.1.10.1 Technical diagnostics of substation equipment is carried out with frequency and volume in accordance with the current requirements for the volume and standards of testing electrical equipment, and the instructions of the manufacturers.

8.1.10.2 Determination of the technical condition of equipment based on the analysis of the required number of standardized parameters obtained from the measurement results:

- with equipment decommissioning;
- under operating voltage without disconnecting the equipment;
- data from continuous monitoring of the technical condition of equipment using an Automated monitoring and dispatching system.

8.1.10.3 Technical diagnostics should be developed by determining the technical condition of equipment using non-destructive testing methods under operating voltage and the use of an Automated monitoring and dispatching system.

8.1.10.4 The list of controlled and calculated parameters of substation equipment (AT, T, SR, integrated switchgear, switch) is determined by the company standards of PJSC Rosseti.

8.1.10.5 The assessment of the technical condition of the substation equipment can be carried out using additional diagnostic control methods in the presence of measurement methods and specified maximum permissible values of the measured parameters:

- infrared control and other heating control based on other physical principles for the entire range of equipment;
- optical control of porcelain and polymer support-rod insulation (UV diagnostics);
- sound and ultrasonic testing of microcracks in porcelain support-rod insulation and porcelain insulation of measuring transformers and switches;
- acoustic monitoring of closed overhead busbars and conductors;
- partial discharge monitoring in busbars and conductors with cast insulation;
- X-ray inspection of equipment – for the entire range of equipment, especially gas-insulated switching equipment.

### 8.1.11 Construction technologies and design solutions

8.1.11.1 The development of design solutions for the SS should be carried out taking into account the requirements for:

- construction site;
- electrical distribution diagrams;
- technical characteristics of the main electrical equipment;
- surge protection and grounding devices;
- own needs;
- cable industry;
- operational current systems and storage batteries;
- climatic conditions;
- protection of power grid facilities from emissions and pollution from industrial and infrastructure facilities.

8.1.11.2 When designing, constructing, reconstructing, modernizing and technically re-equipping substations, it is recommended to be guided by the following basic principles:

- the building structures of buildings and engineering structures of electrical substations, closed transformer substations, distribution substations and distribution substations must ensure the required reliability throughout the entire service life (at least 50 years), as defined by the regulatory documents and design documentation;
- standard solutions should, as a rule, be applied;
- availability of permission to place construction projects on land plots in accordance with current legislation;

− building structures on which electrical equipment is installed must be designed for electromagnetic, thermal and electrodynamic effects in normal and emergency modes of operation of the electrical grid, as well as natural impacts in the area of construction or placement;

− reduction of the occupied area by optimizing the layout and design solutions, the scheme of power transmission line approaches, while maintaining reliability, maintainability and safety of maintenance;

− When selecting equipment, buses and busbars according to rated current, normal, repair, emergency and post-emergency operating modes of the electrical grid, as well as the overload capacity of the equipment, must be taken into account.

8.1.11.3 For laying power cables of voltage class 110-500 kV (6-35 kV upon justification) across the territory of the substation, it is generally necessary to use overpasses, galleries, collectors, and surface cable channels.

8.1.11.4 During new construction and reconstruction of substations, provision must be made for the possibility of their expansion in the future due to:

− increasing the (auto)transformer capacity by replacing power T/AT with power T/AT of the next capacity (from a series of nominal capacities) or installing additional power T/AT (with appropriate justification);

− increasing the number of connections by reserving space.

8.1.11.5 For heating SS buildings in the absence of heat engineering communications, it is recommended to use fire-safe energy-saving electric heaters with thermostats.

8.1.11.6 When designing, constructing and reconstructing substations, provide for the installation of automatic control systems for heating substation equipment, substation control units, premises of service and production and administrative buildings.

8.1.11.7 At 110-750 kV substations it is possible to use heat removed from power transformers and reactors to heat production facilities.

8.1.11.8 When constructing a substation within the urban development limits, it is advisable to place ventilation, air conditioning, solar panels and heaters (in areas with sufficient solar activity) on flat roofs if they are used.

8.1.11.9 To maintain the climatic conditions for the operation of equipment in the premises of the substation buildings of the Central Substation and the substation 220 kV and higher, it is recommended to use centralized climate control units.

8.1.11.10 In conditions of development of populated areas, as well as on the territory of industrial enterprises (or near them), reconstruction of 110-750 kV substation switchgear should be carried out, as a rule, within the boundaries of the existing site or in close proximity to it.

8.1.11.11 Outside urban agglomerations, when designing closed substations, oil-filled equipment with blast cooling (T/AT, SR) with a rated voltage

of 110 kV and higher should be installed in open areas, if necessary with noise barriers. Installation of transformers (AT, SR) in buildings is permitted with justification and development of comprehensive fire safety measures.

8.1.11.12 Lightweight pre-stressed reinforced concrete pillars, solid blocks of heavy concrete, reinforced concrete piles, monolithic and screw piles should be used as foundations for equipment.

8.1.11.13 Monolithic and prefabricated foundations, including surface and pile reinforced concrete (bored, including with and without widening) foundations, should be used as foundations for portals.

8.1.11.14 During new construction, reconstruction of transformers/ATs at substations that have stationary devices for repairing transformers (towers) and rolling tracks, at substations with their placement in closed spaces, they should be installed on carriages (rollers).

8.1.11.15 Earthquake-resistant transformers must be installed directly on the foundation with their fastening to the embedded elements of the foundation to prevent their displacement in the horizontal and vertical directions. The transformer foundations must have places for installing jacks. In other cases, it is possible to use a trackless (carriageless) installation using special supports to ensure access to the bottom of the T/AT tank.

8.1.11.16 In order to minimize the production of earthworks, it is recommended to use various types of precast reinforced concrete and pile foundations (prismatic reinforced concrete piles, screw piles, open-profile piles, shell piles, bored and driven piles), shallow and surface foundations, thermal piles and screw piles in permafrost soils, rod embedments in rocky soils, as well as highly efficient working drilling bodies for drilling holes in hard rocks and rocky soils.

8.1.11.17 When selecting the design and materials used in the construction of industrial buildings (switchgear, warehouses, fire-extinguishing reservoir buildings, etc.), combined industrial buildings and general substation control points of the substation, it is necessary to conduct a technical and economic comparison of the design options taking into account local capabilities (the availability of manufacturing plants or suppliers of building materials, ready-mixed concrete, prefabricated steel structures and reinforced concrete products in relative proximity to the construction site), the shoulders of delivery of building materials to the place of work.

8.1.11.18 During the construction of fire-fighting system or substation control buildings, along with the use of brick, foam concrete and cinder concrete blocks with external finishing of buildings made of facing brick, porcelain stoneware or ventilated facade, curtain wall panels with corporate colors, it is possible to use frame or modular building structures with sandwich panel cladding, in particular in permafrost areas upon justification.

8.1.11.19 It is recommended to use new highly effective materials for protection against corrosion of building structures, corrosion-resistant steels of increased strength for the manufacture of metal structures of portals and support structures for equipment.

8.1.11.20 For the distribution of cables of secondary systems in the premises of the main control unit and distribution board, it is preferable to use cable shafts and raised floors; cable floors are permitted upon justification.

8.1.11.21 Treatment facilities can be located outdoors or in buildings. Accumulative tanks for collecting wastewater must be made in the form of tanks made of steel, composite or polymer materials of high factory readiness.

8.1.11.22 In areas with absolute minimum temperatures below minus 45 ºC, outdoor treatment facilities and drainage pipes in the freezing zone are recommended to be insulated with an automatic electric heating system.

8.1.11.23 Fire-fighting water storage tanks must be made in the form of tanks made of steel, composite or polymeric materials of high factory readiness, depending on climatic conditions, have thermal insulation and/or an automatic electric heating system, and be located openly or in buildings.

8.1.11.24 When fire reservoirs are placed outdoors in areas with absolute minimum temperatures below minus 45 ºC, it is recommended to use a double circuit (main and backup) of the built-in electric heating system of fire water supply reservoirs with monitoring of the water level and temperature, as well as transmission of information to the control panel of the fire fighting personnel.

8.1.11.25 At substations of 110 kV and above, as a rule, a water supply and sewerage system must be provided.

8.1.11.26 Connection of the SS to the centralized water supply system should be considered as a priority. In the absence of technical possibility and/or economic feasibility of connection to the centralized system, technical water supply is recommended to be carried out from artesian wells. Supply of SS with imported technical water is allowed if there is justification.

8.1.11.27 SS buildings must be equipped with heating, air conditioning, ventilation, and fire alarms in accordance with established requirements. The entrance external doors of all SS premises must be made of metal with internal locks. Glazing of buildings on the SS territory must be reduced to a minimum. If natural lighting is required, the windows of the first floor must be equipped with gratings that must be easily removed or opened from inside the premises without the use of tools.

8.1.11.28 Outdoor networks of low-pressure domestic and drinking water supply should be provided from socket pressure pipes made of polyvinyl chloride (PVC) type "T" complete with rubber rings. For regions with a cold climate, it is recommended to use a system of flexible polyethylene pipelines with PU foam with a built-in electric heating system.

8.1.11.29 External household sewerage networks should be provided from non-pressure PVC pipes complete with sealing rings. For regions with a cold climate, external household sewerage networks are recommended to be made from pipes made of low-pressure polyethylene, with a built-in electric heating system.

8.1.11.30 When constructing oil-receiving devices for oil-filled equipment, the method of poured reinforced concrete with polymer additives should be used to improve the characteristics of concrete. Oil drains should be closed. Construction of open oil drains is allowed in highly heaving soils, at high groundwater levels, upon justification.

8.1.11.31 The internal surfaces, oil receiver guard and oil collector should be painted with oil-resistant paint (new effective materials) to protect the surface from transformer oil.

8.1.11.32 It is recommended to consider the use of new efficient materials for enclosing and roofing structures, floors and finishing of building premises.

8.1.11.33 The choice of floor design solution must be made taking into account the provision of:

- reliability and durability of the adopted design;
- economical use of building materials;
- the most complete use of the physical and mechanical properties of the materials used;
- optimal sanitary and hygienic conditions;
- fire and explosion safety.

8.1.11.34 In utility and production areas, depending on the functional purpose, it is necessary to use floor coverings such as commercial linoleum, ceramic tiles, porcelain tiles, and for areas with special requirements for dust formation (switchgear, rooms for converter and microprocessor technology, protection and automation, etc.) - self-leveling floors based on polyurethane or epoxy resins as the most durable and wear-resistant.

8.1.11.35 Self-leveling floors must meet the following requirements:

- low abrasion;
- dust-free;
- chemical resistance;
- high speed of installation work (floors can be laid at positive and negative temperatures);
- ease of upgrading and repair.

The base for the self-leveling floor should be a concrete floor, there should be no cracks or chips on the surface, the humidity of the base should not exceed 4-5%.

8.1.11.36 When repairing or reconstructing the facades of SS buildings, in addition to the traditional use of facade paints, the use of "ventilated facade" technology is allowed. Work may only be carried out after a comprehensive

inspection of the technical condition of the building structures of buildings and structures by a specialized organization.

8.1.11.37 When designing a substation, it is necessary to carry out environmental measures in accordance with environmental legislation.

8.1.11.38 When designing a SS, it is necessary to apply the unification of design solutions into a single architectural and industrial complex, to apply a single corporate style for the design of the facades of buildings, structures, architectural solutions (color schemes, emblems, etc.).

8.1.11.39 The general plan and layout solutions of the SS, as well as the space-planning solutions of the buildings and structures located on its territory, must ensure:

- ease of use;
- the ability to carry out routine and repair work, including those related to the replacement of large-sized equipment;
- conditions for the prompt elimination of accidents and emergency situations.

8.1.11.40 In order to promptly identify faults in the building structures of switchgear, switchgear, and transformer substation buildings, facades may be repaired or reconstructed without covering the walls with frame facade materials.

8.1.11.41 In order to create favorable conditions for the operation of buildings and structures of the SS, it is necessary to ensure that during the construction of new and reconstruction of old buildings, the planning and improvement of the territory, the systems for the drainage of atmospheric precipitation and groundwater are carried out in accordance with the design documentation.

8.1.11.42 The façade parts of buildings and structures closed by SS, TS, DS and DTS, located in a residential area, must fit into the surrounding architectural landscape.

8.1.11.43 When designing substations, buildings and structures, it is necessary to provide technical solutions that ensure the safety of their operation, including the safe performance of work at height by installing fixed ladders using crawler-type safety equipment as a safety system when climbing onto equipment, fixed anchor points (anchor posts), or with pre-installation of an anchor line and the use of retractable safety equipment, or using telescopic anchor posts for work on substations of 35 kV and above, where there is a risk of falling from a height of more than 1.8 m.

8.1.11.44 When designing closed substations, it is recommended to use technologies of three-dimensional models of equipment and laid engineering systems to eliminate unacceptable proximity and intersections of substation technological equipment and laid cables with engineering systems in closed substations (ventilation, water supply, fire extinguishing, sewerage, and others).

8.1.11.45 When constructing buildings and structures of the SS, the roof structure must be pitched. When constructing SS within the urban development limits, a flat roof is allowed.

8.1.11.46 When constructing new feeding centres, it is necessary to use standard equipment.

8.1.11.47 Layout solutions for the placement of relay protection and automation devices, the control system for automatic control of electrical equipment and automated process control systems must exclude their damage in the event of a fire or explosion of the T (AT), shunt reactor (controlled shunt reactor). It is not allowed to lay power and control cables, communication cables above the T (AT), shunt reactor (controlled shunt reactor) chambers, along the walls and ceiling of the distribution device rooms. It is recommended to place power and control cables, communication cables in the mezzanines.

## 8.2 Operational current systems and storage batteries

8.2.1 Direct operating current

8.2.1.1 At substations of 35 kV and above (except for branch and dead-end substations):

− stationary batteries must be used that are capable of providing maximum calculated inrush currents after a guaranteed discharge of at least two hours by the load current in autonomous mode (upon loss of the substation's own needs) throughout the entire service life; the service life must comply with the requirements of regulatory and technical documentation;

− electromagnetic compatibility must be ensured;

− automatic detection of a decrease in insulation of each pole and simultaneous decrease in insulation on both poles of the operating DC voltage system should be applied;

− The SS operating DC voltage system must have a three- or two-level protection system:

- lower level: protection of power supply circuits of direct consumers (protection and automation devices, circuit breaker control circuits, etc.);
- medium level: protection of distribution cabinet circuits of operational direct current and other consumers of the power grid;
- upper level: protection of the busbars of the substation at the input of the battery.

− the implementation of protection of the direct current network at the upper and middle levels must be carried out using selective circuit breakers or switching and protective devices with electrically safe fuses; at the lower level, the use of circuit breakers is recommended;

− the design of protective devices must ensure their safe maintenance;

– preferential use of standard solutions for the organization and distribution of the operating DC voltage system.

8.2.1.2 At substations of 330 kV and above, an automated search for “ground” in the direct current network must be used without disconnecting the connections extending from the switchboard.

8.2.1.3 The design of operational current systems must be carried out taking into account the possibility of the substation operating without the constant presence of operational personnel.

The choice of the type and kind of batteries is made during design.

8.2.1.4 In justified cases, with the exception of cases specified in paragraph 8.1.8.1 of the Regulation, when organizing operational power supply, provision must be made for the installation of a diesel generator of the required capacity.

8.2.1.5 The operating DC voltage system is designed to supply power to communication equipment, automated process control systems, fire alarm systems, fire protection systems, automatic fire protection systems, and the information and computing infrastructure of the substation, and to provide power for at least 2 hours when the substation power supply is disconnected.

8.2.1.6 At distribution substations with a voltage of 35 kV and higher, it is recommended to use 220 V operating DC voltage system.

8.2.1.7 At 35-110 (150) kV substations, the use of a direct operating current system is justified by the need for guaranteed power supply of relay protection and automation devices, automated process control systems, automated control systems and communication equipment.

8.2.1.8 During the reconstruction of 35-220 kV distribution substations associated with the installation of microprocessor protection, it is permissible to install a new microprocessor protection system in addition to the existing one to supply power only to the reconstructed part of the substation.

8.2.1.9 The connection of the batteries to the first level protective devices and between elements must be carried out using copper flexible (multi-wire) cables with acid-resistant insulation.

8.2.1.10 It is also recommended when organizing direct operational current:

– the presence of a device for monitoring the current parameters of the power supply system with the issuance of individual signals to the automated process control system or telemetry about malfunctions (increase/decrease in voltage, presence of pulsations, deviation in capacity, temperature, tripping of circuit breakers on the DC switchboard and the power supply unit, etc.);

– the presence of a device for monitoring the isolation of the network poles relative to the ground;

− measuring the insulation of network poles relative to the ground without disconnecting connections (searching for “ground”);

− the presence of a device for recording emergency processes and events in the operating DC voltage system with the organization of data transmission to the APCS or telemetry (if justified);

− the presence of a means for issuing a generalized fault signal of the operating DC voltage system in the automated process control system and telemetry;

− availability of a means for issuing an emergency signal from the operating DC voltage system to the APCS or telemetry system.

8.2.1.11 Current decisions on the organization of the operating DC voltage system should be focused on:

− development of standard schemes for organizing operational power supply (operating DC voltage system, auxiliary transformer, UPS, DGU) and standard design solutions taking into account solutions from various manufacturers;

− use of modern methods for calculating short-circuit currents and selecting types of protective devices and their response parameters;

− development of issues of using new alternative sources of direct current to replace batteries.

8.2.1.12 The DC operational current system must be divided into at least two independent parts, with each of them supplied from a separate input protective device of the storage battery. The power supply of the DC operational current load must be distributed between the two independent parts in such a way that mutually redundant devices receive power from different parts of the DC operational current.

8.2.1.13 To organize rectified operational current, stabilized voltage units connected to the VT on the HV side of the substation and current power units connected to the CT on the HV side of the substation must be used.

8.2.1.14 To detect ground faults without disconnecting connections in rectified operational current systems, automatic devices or manual search tools must be provided.

8.2.1.15 Operational blocking circuits must be powered from the SS operating DC voltage system with galvanic isolation.

8.2.2 Alternating current

8.2.2.1 Alternating operating current and rectified alternating operating current are generally recommended for use at TS, DS and DTS 6-20 kV and are permitted at 35 kV substations upon justification.

8.2.2.2 The use of alternating operational current at substations with 110 kV HV is permitted only if justified.

8.2.2.3 Schematic solutions for organizing the AC power supply system must provide for:

− insulation monitoring devices must be installed on the AC busbars.

− separate CTs, to which power supplies and pre-charged capacitors are connected, should be used as sources of alternating operational current for powering protection and control circuits;

− to power the protection and control circuits, individual combined power supplies can be used, connected to the CT of the protected connection and the auxiliary transformer.

8.2.3 Chargers

8.2.3.1 The storage devices must ensure:

− the possibility of an automatic three-stage charging mode (stage of limiting the initial charging current, stage of limiting the voltage, stage of temperature-compensated voltage stabilization);

− in the maintenance charge mode, the voltage quality (level, pulsation, stability and temperature compensation) meets the technical specifications for batteries of a specific type;

− the quality of the voltage meets the technical conditions of direct current power consumers (for example, protection and automation devices) in both maintenance charge and equalizing charge modes;

− power supply for devices that are constantly under voltage (in particular, protection and automation devices), corresponding to their technical conditions in the event of a communication failure with the battery for any reason;

− automatic full charge of the battery in the shortest possible time, taking into account the limitations defined by the technical conditions of the battery;

− power supply for direct current electrical receivers, including when the battery is disconnected for any reason;

− recharging the battery at a constant stabilized voltage of the supporting charge recommended by the battery manufacturer.

8.2.3.2 The power of two chargers operating in parallel on one battery must provide power to all electrical receivers of the substation connected to the set of the operating DC voltage system, taking into account the simultaneous accelerated charging of the battery to 90% of the nominal capacity for no more than 8 hours.

8.2.3.3 The power supply of the chargers must be carried out from the 0.4 kV auxiliary needs sections. The power supply of mutually redundant chargers must be carried out from different sections of the 0.4 kV switchboard.

8.2.3.4 The charger must ensure the accuracy of output voltage stabilization in the maintenance charge mode of no worse than ±1% and thermal compensation of the maintenance charge voltage.

8.2.3.5 The level of current pulsation in the battery during maintenance charging should not exceed 5 A per 100 Ah of its capacity, and the voltage pulsation when the charger is operating at full load of the operating DC voltage system set with the battery disconnected should not exceed ±5% Unom.

8.2.3.6 The charger must have a lock to enable the equalizing and accelerated charging mode of the battery when the supply and exhaust ventilation of the battery room is not working.

8.2.3.7 The chargers must automatically turn on after interruptions in AC power supply and operate in a charging mode corresponding to the state of the battery.

8.2.3.8 It must be possible to simultaneously operate two chargers in parallel on the rectified voltage side with symmetrical division of the total load current between them, or to operate one of the chargers in the "hot" reserve mode (when using three chargers for two batteries).

8.2.3.9 The chargers should not be placed in one cabinet or in adjacent cabinets.

## 8.3 Overhead power lines

### General provisions

The main directions of the Unified Technical Policy in the design, construction, reconstruction, modernization, technical re-equipment and operation of overhead power transmission lines (OPL) are:

- ensuring reliability and efficiency of work;
- reduction of construction and operating costs;
- reducing the impact on the environment, including by minimizing the width of forest clearings, using high-rise supports and supports with vertically suspended wires (if the need to use these solutions is justified);
- reduction of energy losses;
- the use of structures and materials that ensure resistance to vandalism, theft and damage by third parties;
- use of advanced, safe methods of construction, operation and repair;
- as technologies for diagnosing overhead lines develop, systems for diagnosing the technical condition of overhead lines under operating voltage without taking them out of service are used;
- the use of unmanned aerial vehicles and robotic systems to assess the technical condition of elements of 35 kV and higher overhead power lines and routes within security zones;
- ensuring the possibility of installing or replacing control panels with connection under operating voltage without taking them out of service for 0.4 kV overhead power lines (VLI);
- provision of emergency stock, its optimal placement taking into account its delivery routes, as well as rotation;
- use of computer-aided design systems;
- implementation of information modeling technologies to support the design, construction and operation of overhead lines;
- application of geographic information systems;

– implementation of satellite positioning systems (GLONASS);

– application of automated systems for monitoring meteorological parameters, technical condition of overhead power lines, early detection of ice and frost deposits and load control.

### 8.3.1 Supports

8.3.1.1 On overhead power lines of 35 kV and above, the following must be used in accordance with the current regulatory documents: single-circuit, double-circuit and multi-circuit steel supports of polyhedral and lattice structures, composite supports, as well as reinforced concrete supports based on vibrated and centrifuged, including sectioned, pillars. When choosing supports, it is recommended to give preference to supports of the new unification.

8.3.1.2 During new construction and reconstruction of overhead power lines, it is advisable to use individually designed supports in cases where the use of standardized designs and their modifications is not technologically feasible or economical.

8.3.1.3 The choice of material and type of supports should be made based on the technical and economic feasibility of using design solutions in specific construction conditions, taking into account the reliability and optimality of technical maintenance of the overhead power line during operation.

8.3.1.4 Steel supports, as well as steel parts of reinforced concrete supports and structures, metal structures of foundations, U-bolts, fasteners, with the exception of those made of corrosion-resistant steel, must be protected from corrosion at the manufacturing plants by coating the surface with zinc. When carrying out construction and installation, repair and restoration work, technologically associated with the possibility of damaging the zinc coating, it is permissible to protect the damaged area by cold galvanizing.

8.3.1.5 In reinforced concrete support structures, in accordance with SP 28.13330.2017 "Protection of building structures from corrosion. Updated version of SNiP 2.03.11-85", concretes must be used whose water resistance, frost resistance and other characteristics will ensure reliable operation throughout the entire service life, but not less than 50 years, without the use of surface waterproofing.

8.3.1.6 Anchor and anchor-angle supports of overhead power lines must be steel, free-standing, and of rigid construction. The use of reinforced concrete anchor-angle supports on guy wires, including those made of sectioned posts, is permitted provided that the efficiency of using such supports is confirmed by calculations of the structural elements of the overhead power line.

8.3.1.7 During repair, construction, reconstruction and modernization of existing 110-750 kV overhead power line supports with guy ropes, it is recommended to use plastically deformed ropes as guy ropes for overhead power line supports.

8.3.1.8 The structures of supports for 220 kV and higher overhead power lines must ensure the possibility of technical maintenance and repair of overhead power lines under voltage.

8.3.1.9 The support structures must ensure the efficient installation of wires and cables, and the absence of the need to obtain special permission for transportation on roads.

8.3.1.10 On overhead power lines passing through populated areas, tourist and recreational zones, near recreation areas, in national parks and reserves, at intersections with major transport highways in the vicinity of cities, it is permitted to carry out decorative painting of supports with paint and varnish coatings with a long service life, as well as to use individually designed supports developed taking into account increased aesthetic requirements.

For overhead power lines of 35 kV and higher, running in cities and areas with a high risk of vandalism, it is recommended to use free-standing supports made of steel polyhedral profile and reinforced concrete supports based on vibrated and centrifuged, including sectioned, pillars as intermediate supports.

8.3.1.11 On overhead power lines of 35 kV and above, as protection against vandalism on metal lattice supports, it is necessary to provide for the use of vandal-proof corner fasteners up to a height of 5-6 meters from the bottom of the support.

8.3.1.12 When placing fiber-optic communication lines on overhead power lines under construction (reconstructed), the load from the suspended optical cable must be taken into account.

When designing the suspension of fiber-optic communication lines on existing overhead lines, the calculation of the mechanical strength of the overhead line elements (supports, foundations), the sag of the optical cable must be carried out for loads from the effects of wind and ice under climatic conditions in accordance with regional maps of climatic zoning approved regulatory documents in force at the time of designing the overhead line. If mechanical loads on individual elements of the overhead line increase, measures must be taken to strengthen them.

8.3.1.13 Vibrated reinforced concrete supports based on vibrated posts, multi-faceted supports, steel supports made of bent profile, composite supports, and wooden supports treated with antiseptics are used on 0.4-20 kV overhead lines. The choice of the type of support should be made taking into account the technical and economic justification, and when the overhead line passes through populated areas - taking into account compliance with aesthetic requirements.

For 0.4 kV overhead lines, the possibility of replacing the three-column anchor-angle reinforced concrete support with a single-column steel multi-faceted support should also be considered.

8.3.1.14 In areas where ground fires are possible, the use of wooden supports without additional fire safety measures is not permitted.

8.3.1.15 In order to ensure the safety of aircraft flights, power transmission line supports must have day and night markings in accordance with the current Federal Aviation Regulations.

8.3.1.16 The structures of supports for 220 kV and higher overhead transmission lines, installed in cramped conditions on approaches to substations, as a rule, must provide the ability to suspend two or more circuits; the structures of supports for 110 kV and lower overhead transmission lines - up to four circuits.

8.3.1.17 The service life of metal, reinforced concrete and composite transmission line supports must be at least 50 years. The service life of wooden supports must be at least 40 years.

8.3.1.18 In order to carry out emergency recovery work on overhead lines up to and including 500 kV, it is necessary to provide for the use of special quickly erected supports, including reusable ones, a mobile set of quickly erected supports complete with a foundation and an insulating suspension, including multi-faceted and composite supports that do not require lengthy assembly and are easy to install, with a high mobilization readiness factor, in order to minimize the time for eliminating an emergency.

### 8.3.2 Foundations

8.3.2.1 The conditions for using foundations on overhead power lines are determined taking into account the requirements of current regulatory documents, depending on the results of soil studies (engineering-geological, hydrogeological and other surveys) at the places of their installation.

8.3.2.2 When choosing a support fastening, one should be guided by the economic and technological efficiency of using a particular type of foundation in specific geological and hydrological construction conditions, taking into account ensuring the reliability of the overhead power line during operation.

8.3.2.3 When designing new construction and reconstruction of overhead power lines, the following must be used:

- unified precast reinforced concrete foundations (deep, shallow, surface) of high factory readiness, with the exception of foundations that are composite footings assembled from separately manufactured vibrated reinforced concrete posts and slabs;
- monolithic reinforced concrete foundations;
- pile foundations with metal grillages (made of reinforced concrete piles, tubular piles, open-profile piles, screw piles);
- shell piles (reinforced concrete centrifuged and metal) and other types of foundations.

8.3.2.4 The feasibility of implementing on overhead lines should be considered:

- industrial methods of performing work in field conditions;
- modern corrosion-resistant materials, weather-resistant steels and coatings to protect reinforced concrete and metal structures from corrosion;
- foundation structures that do not destroy soil structures in particularly difficult geocryological conditions.

8.3.2.5 To secure supports in permafrost soils, it is generally necessary to use foundations that ensure the preservation of the frozen state of the soil during construction and throughout the entire period of operation of the transmission line.

8.3.2.6 To secure transmission line supports in rocky soils, it is necessary to consider the possibility of using anchor embedment, foundations made of bored piles, and foundation designs that ensure reliable support fastening in such soils.

8.3.2.7 When power lines pass through dune sands, supports must be installed between the dunes with sand stabilization measures taken.

8.3.2.8 When power lines pass through mountains with a risk of landslides, measures must be taken to drain water and strengthen the foundations of supports with the construction of anti-landslide structures (retaining walls and other structures) to ensure the stability of the support.

8.3.2.9 In reinforced concrete foundation structures, in accordance with SP 28.13330.2016 "Protection of building structures from corrosion. Updated version of SNiP 2.03.11-85" concretes should be used whose water resistance, frost resistance and other characteristics will ensure reliable operation throughout the entire service life, but not less than 50 years, without the use of surface waterproofing.

8.3.2.10 In aggressive environments, foundations made of sulfate-resistant cement, coated with specialized protective compounds, should be used.

8.3.2.11 Concrete foundations must have waterproofing to prevent the destruction of reinforced concrete from the effects of aggressive water and soil, durable surface waterproofing that is not destroyed by ultraviolet radiation, temperature changes and environmental influences.

8.3.2.12 Metal heads of reinforced concrete foundations and metal grillages must be protected from corrosion in accordance with current regulatory documents.

8.3.2.13 Mechanical testing is carried out on prototypes of newly developed types of foundation structures.

### 8.3.3 Wires and lightning protection cables

8.3.3.1 For overhead power lines with a voltage class of 35 kV and higher, depending on the operating conditions and construction/reconstruction purposes, it is recommended to use the following types of wire:

- steel core wire with profiled upper strand cores;
- carbon fiber composite core wire;
- wire with increased corrosion resistance of steel cores;
- aluminum alloy wire;
- steel-aluminum wire.

The choice of the type of wires used must be justified during the design of the overhead power line.

8.3.3.2 On overhead power lines with a voltage class of 35 kV and higher, steel cables, steel-aluminum wires, steel cables with increased corrosion resistance (galvanized, for particularly harsh operating conditions), and steel-aluminum cables can be used as lightning protection cables. The lightning protection function of overhead power lines can also be performed by a fiber-optic cable built

into the cable (OCGT). The choice of the type of lightning protection cables used must be justified when designing the overhead power line.

8.3.3.3 The use of wire grades and cross-sections, lightning protection cables, and phase designs that differ from those used in other sections of the overhead power line (large crossings over water bodies, mountains, floodplains, swamps, difficult climatic conditions) must be confirmed by calculations of the overhead power line structural elements and a feasibility study.

8.3.3.4 On overhead power lines, protection of phase wires, lightning protection cables and optical cables from vibration and oscillations must be provided.

8.3.3.5 The service life of steel-aluminum non-insulated wires of the AC brand on overhead power lines must be at least 50 years. For wires of other brands, the service life is established by the relevant manufacturing requirements (GOST, TU).

8.3.3.6 The service life of a lightning protection cable on a power line with a voltage of 35 kV and higher must be at least 40 years.

8.3.3.7 On 6-20 kV overhead power lines, steel-aluminum bare wire or protected wire with a cross-section of at least 70 $mm^2$ should be used. It is permissible to use a wire with a cross-section of 50 $mm^2$ during the reconstruction of existing 6-20 kV overhead power lines, subject to justification. On linear branches (taps) from main lines, it is recommended to use steel-aluminum wires or protected wires with a cross-section of at least 35 $mm^2$.

8.3.3.8 Protected wires are recommended apply on 6-110 kV overhead lines first of all:

- when the power line route passes through populated areas;
- when power lines pass through forest areas;
- when crossing water barriers;
- if it is impossible to maintain the required clearances when passing overhead power lines in confined spaces;
- when suspended together with 0.4 kV overhead transmission lines.

If justified, the use of self-supporting cable is permitted on 6-35 kV overhead lines.

8.3.3.9 During new construction and reconstruction of 0.4 kV overhead power lines on main sections, it is preferable to use SIW-2 type SIW with an insulated neutral load-bearing conductor. The use of SIW-4 type SIW on main sections is permitted only during emergency recovery or repair work on sections of overhead power lines where SIW-4 was previously installed. Upon justification, the use of self-supporting insulated wires with built-in optical fiber for organizing information exchange of technological data is permitted.

8.3.3.10 During new construction and reconstruction of 0.4 kV overhead power lines, the use of non-insulated aluminum wire is permitted upon justification.

8.3.3.11 Installation of 0.4 kV overhead line wires with an insulated neutral conductor can be carried out both on supports and on the walls of buildings and structures.

8.3.3.12 0.4 kV overhead power lines with distributed load along the line length must be implemented using self-supporting insulated wire with a cross-section of at least 50 $mm^2$. The length of the 0.4 kV overhead power line must ensure stable voltage at the consumer at the end of the line in accordance with the requirements of the regulatory documents. To connect individual consumers, as well as to perform a branch from the line, self-supporting insulated wire of a smaller cross-section, but not less than 16 $mm^2$, can be used.

8.3.3.13 For overhead inputs on line sections from the bushing insulators of switchgear cells to the first supports of 6(10) kV overhead lines, as a rule, it is necessary to use a protected wire with insulation that does not spread combustion. The fire hazard class of the wire is not lower than O1.8.2.5.4 according to GOST 31565-2012 "Cable products. Fire safety requirements".

### 8.3.4 Insulators, line fittings

8.3.4.1 The quantity and type of insulators in garlands for different purposes, as well as coupling, supporting, tensioning, protective, connecting and contact fittings on overhead power lines must be selected in accordance with current standards, as well as taking into account local conditions and operating experience.

8.3.4.2 The choice of the type and material of insulators installed on overhead power lines must be made taking into account climatic conditions and the presence of sources of environmental pollution. When the route of the designed overhead power line passes through an area with sources of pollution, it is permissible to use glass insulators with an organosilicon protective shell.

8.3.4.3 During new construction and reconstruction of overhead power lines:

- Glass insulators should be used on:
  - overhead power lines 330 kV and higher;
  - large transitions;
  - power lines passing through difficult operating conditions (mountains, swamps, regions of the Far North);
  - overhead power lines supplying traction substations of electrified railways.
- on 35-220 kV overhead lines, it is permitted to use solid polymer insulators with an organosilicon protective shell in places accessible for maintenance all year round, located in areas with SZ I-III (with the exception of overhead lines located in areas III and higher downwind/ice), and equipped with devices for fixing the overlap;

− the use of polymer insulation without flashover indicators is permitted if the overhead power line is equipped with technical means that ensure the location of damage on the overhead power line is determined with an accuracy of up to a span;

− on 35-220 kV overhead lines it is permissible to use cantilever insulating crossarms;

− on overhead power lines of 220 kV and higher, insulator garlands equipped with protective fittings should be used;

− it is permissible to use long-rod porcelain insulators on overhead power lines of 110-220 kV and higher, if there is justification;

− it is necessary to use coupling, supporting, tensioning, protective and connecting fittings that do not require maintenance, repair or replacement during the service life of the supports and wires;

− for wires, it is necessary to use fittings (tensioning, connecting, supporting, contact, protective) certified for use with a given type of wire;

− vibration dampers must be used;

− multi-chain insulating suspensions must be used on transitional intermediate supports of large crossings with separate fastening to crossbars (at least at two points);

− on 330-750 kV overhead lines, it is recommended to use damping distance intra-phase spacers in areas with frequent and intensive wire dancing, as well as together with compacted wires characterized by increased rigidity;

− - for 220 kV and higher overhead power lines, use insulators and line fittings with a reduced level of radio interference together with protective screens that reduce the electromagnetic field strength in the area of insulators and garland fittings, as well as increase the arc resistance of insulating suspensions;

− for overhead power lines of 35 kV and higher, as a measure to strengthen the welded connection of loops in the loops of anchor-angle supports, it is recommended to use a spiral loop clamp (protector);

− it is necessary to use anchor and branch fittings for connecting the SIW branch to the building input (subscriber connection) made of materials that do not spread combustion.

8.3.4.4 On overhead power lines of 220 kV and higher, participating in power distribution schemes of stations, crimped clamps should be used as connecting clamps of wires, and crimped or wedge-jointed clamps should be used as tension clamps for fastening wires.

8.3.4.5 To reduce bending stresses and to increase the service life of the wire and lightning protection cable, it is recommended to use supporting clamps equipped with spiral protectors, using multi-frequency or broadband vibration dampers.

8.3.4.6 During new construction and reconstruction in areas with an ice wall thickness of 25 mm or more (Ice Zone IV) characterized by intensive ice

formation, snow accumulation, possible strong winds, frequent and intensive dancing of wires, it is necessary to provide for the use of interphase insulating spacers of non-rigid construction.

8.3.4.7 To reduce the costs of losses during the flow of transport current, the contact part of the supporting, connecting and tensioning fittings installed on the overhead power line wires must be made of non-magnetic materials and comply with the requirements of GOST R 51177 - 2017 for losses due to magnetization reversal. In addition, the absence of corrosive pairs of materials used in the composition of wires and linear fittings must be ensured.

8.3.4.8 When constructing new 6-20 kV power lines, the following should be used:

- suspended polymer, glass insulators;
- polymer cantilever (cantilever with guying) insulating crossbars;
- support-rod porcelain and polymer insulators, including those with an eye for protected wires;
- support-rod polymer insulators-arresters;
- pin polymer insulators;
- pin porcelain insulators with eye;
- tempered glass pin insulators;
- interphase polymer insulating spacers;
- polymer insulating crossbars.

8.3.4.9 On 0.4 kV overhead lines and 6-20 kV overhead lines, it is necessary to use line fittings of the corresponding design. Connections and branches on 0.4 kV overhead lines and 6-20 kV overhead lines should be made only using special clamps corresponding to the type of self-supporting insulated wire or protected conductor. Branch connections to overhead lines with internal wiring should be made using single-use, piercing, sealed branch clamps with a shear head; reuse of clamps with a shear head is not allowed.

8.3.4.10 For 0.4 kV overhead power lines and 6-35 kV overhead power lines, fittings must be used that allow installation at temperatures down to minus 20 °C. The use of reinforcement with an extended lower limit is permitted upon justification.

8.3.4.11 For 0.4 kV overhead lines and 6-35 kV overhead lines, when organizing a branch from the main line, as well as when connecting uninsulated wires to insulated ones, fittings with color differentiation according to voltage classes must be used.

8.3.4.12 0.4 kV overhead power lines with distributed load along the line length must be implemented using self-supporting insulated wire with a cross-section of at least 50 $mm^2$. The length of the 0.4 kV overhead power line must ensure stable voltage at the consumer at the end of the line in accordance with the requirements of the regulatory documents. On a linear branch from the overhead

power line with a cross-section of less than 25 $mm^2$ for connecting individual consumers, self-supporting insulated wire of a smaller cross-section, but not less than 16 $mm^2$, can be used.

8.3.4.13 For 0.4 kV overhead lines, fittings made of flammable and non-flammable materials must have color differentiation.

8.3.4.14 Linear fittings for overhead power lines must be maintenance-free and correspond to the service life of the wires and cables for which they are intended.

8.3.4.15 The service life of porcelain, glass and polymer insulators must be at least 40 years.

8.3.4.16 When carrying out emergency recovery work on overhead power lines up to 220 kV, universal clamps designed for several wire cross-sections and mounted using hand tools without the use of a press or other mechanization tools, selected taking into account the climatic design, can be used to connect wires in order to minimize the time required to eliminate the emergency mode.

8.3.4.17 In order to ensure safety requirements during maintenance and repair of 0.4 kV overhead lines, at the beginning and end of the overhead line main line, as well as at the beginning and end of linear branches, it is recommended to install stationary devices for short-circuiting and grounding the overhead lines, equipped with a separate grounding lead.

8.3.4.18 In order to increase the reliability of distribution networks and reduce the costs of repair and restoration work related to tree falls on overhead lines, it is recommended to use self-healing overhead lines (SOL) during reconstruction, repair and new construction of 6-20 kV overhead lines with both protected and non-insulated wires running in forest areas. The design of the suspension clamps should exclude blind fastening of the wire, which facilitates the slippage of the wire through the clamp in the event of a tree falling on the overhead line and allows for automatic restoration of the standard sag of the wire due to longitudinal tension in the anchor span after the fallen tree has been removed from the overhead line. SOL is intended for use on intermediate supports.

### 8.3.5 Linear switching equipment

8.3.5.1 In order to optimize operating modes, increase the reliability of power supply to consumers, reduce operating and repair costs, it is necessary to automate 6-35 kV networks during design by means of:

- application of automatic reserve input;
- the use of outdoor vacuum and SF6 circuit breakers (reclosers) with microprocessor control units that allow programming the operation of circuit breakers for the required operating modes for sectioning overhead power lines;
- organization of the automatic reclosing system both on the line switches of the central control unit and on the sectioning points of the overhead power line;

− use of the switch to disconnect branches of overhead power lines;

− equipping with devices for detecting the location of overhead power line faults.

8.3.5.2 Sectioning points with vacuum circuit breakers and automatic reserve switching points must be installed on 6-35 kV main lines, as well as on extended branches of overhead lines, if justified.

8.3.5.3 Automatic transfer switch points and sectioning points must be equipped with vacuum switches and microprocessor-based protection and automation devices.

8.3.5.4 To disconnect branches of 6-35 kV overhead power lines, the length of which is more than 1.5 km, it is recommended to install the switch at the beginning of these branches.

8.3.5.5 In order to improve the controllability and monitorability of the electrical grid, all automation systems must operate with the ability to transmit information to the control centre about the current state of the equipment, and also provide the ability to remotely control this equipment.

### 8.3.6 Construction technologies and design solutions

8.3.6.1 The development of design solutions for overhead power lines must be carried out taking into account the requirements for:

− a route;

− supports and foundations;

− wires and lightning protection cables;

− insulation, reinforcement, surge protection;

− communication organizations;

− ensuring safe operation and anti-terrorist protection;

− environmental protection.

8.3.6.2 When designing, constructing, reconstructing, modernizing and technically re-equipping overhead power lines, it is recommended to consider the following technical solutions:

− the decision to increase the transmission capacity of overhead power lines must be made on the basis of schemes and programs for the development of electric power systems in Russia approved in accordance with the established procedure;

− use of a wire with a protective insulating sheath for 6-110 kV overhead power lines when the line passes through cramped conditions, through populated areas, through forests;

− taking into account additional conductors to enable the connection of street lighting in the event of its predicted development;

− implementation of overhead power lines in dimensions of a higher voltage class upon justification;

− application of technical solutions that ensure increased reliability and minimize operating costs for 35 kV and higher overhead power lines that do not have year-round access for maintenance and repair.

8.3.6.3 When designing overhead power lines up to and including 35 kV, as a rule, it is necessary to use standard units presented in the agreed standard solutions.

8.3.6.4 The design documentation for overhead power lines must contain the results of verification calculations of the structures of overhead power line supports and foundations, calculations of wires and lightning protection cables, including mechanical calculations confirming and justifying the adopted technological and design solutions.

8.3.6.5 For overhead power lines of 110 kV and higher, the route of which passes through areas subject to ground or peat fires, elevated supports must be used or an increased clearance must be provided between the wire and the ground, determined during the design of the overhead power line, taking into account the need to maintain the operability of the overhead power line in conditions of a ground or peat fire.

8.3.6.6 When selecting the route of the designed overhead power line, the degree of pollution of the surrounding atmosphere must be taken into account. When the route of the designed overhead power line passes through an area with sources of pollution (highways, industrial enterprises, agricultural facilities where chemical fertilizers and chemical treatment of crops are used) that affect the state of the insulation and other elements of the overhead power line not specified in this paragraph, or when the route of the overhead power line crosses such an area, as well as when designing overhead power lines in coastal areas of the seas, technical measures must be implemented taking into account the wind rose to ensure reliable and safe operation of the overhead power line.

In order to eliminate the above factors, it is necessary to ensure increased overall distances from overhead power line wires to the ground and intersected objects, not less than the following values:

- 7 metres (12 metres - within the boundaries of populated areas) - with a design nominal voltage class of 35-110 kV;
- 7.5 metres (14 metres - within the boundaries of populated areas) - with a design nominal voltage class of 150 kV;
- 8 metres (14 metres - within the boundaries of populated areas) - with a design nominal voltage class of 220 kV;
- 8.5 metres (14 metres - within the boundaries of populated areas) - with a design nominal voltage class of 330 - 400 kV;
- 9.5 metres (14 metres - within the boundaries of populated areas) - with a design nominal voltage class of 500 kV;
- 16 metres – with a design nominal voltage class of 750 kV.

The specific value of the overall distance must be determined by carrying out calculations taking into account the selected route and influencing factors.

8.3.6.7 When designing, constructing new structures, reconstructing and operating overhead power lines, the requirements of regulatory legal acts and technical documentation must be taken into account:

- for the organization of ice melting on wires and lightning protection cables;
- for the use of no more than two brands and cross-sections of wires when passing overhead power lines in flat terrain. The use of brands and cross-sections of wires and lightning protection cables, and phase designs, different from those used in other sections of the line in certain sections of the overhead power line (large crossings over water bodies, mountains, floodplains, swamps, difficult climatic conditions), must be justified.

8.3.6.8 When designing, constructing new structures, reconstructing and operating overhead power lines, technical solutions for lightning protection of overhead power lines must be adopted, taking into account:

- when passing overhead power lines in areas with high soil resistivity, in order to increase the lightning resistance of the overhead power line, it is recommended to consider strengthening the grounding circuits of supports with extended and deep ground electrodes, including electrolytic ground electrodes, and if this measure is insufficient, use the combined use of lightning protection cables and surge protection devices, including linear overvoltage arresters, surge arresters and multi-chamber arresters;
- in the case of using surge arresters as devices for protection against overvoltage on 6-35 kV overhead lines in electrical grids with isolated (compensated) neutral, preference should be given to surge arresters with an external spark gap, and on 110 kV and higher overhead lines, surge arresters without an external spark gap;
- in electrical grids with a voltage of 110 kV and higher, it is necessary to provide for the installation of protective devices with trip counters, and for surge arresters - with a trip pulse current sensor and the ability to measure leakage currents under operating voltage;
- On double-circuit overhead power lines of 110 kV and higher, in order to reduce the number of double-circuit lightning flashovers, it is necessary to differentiate the insulation by circuits with the determination of the required degree of differentiation.

8.3.6.9 During design, new construction and reconstruction, a scheme for hanging the lightning protection cable on the overhead power line supports must be determined, taking into account the need to use insulators, grounding leads, discharge horns, etc.

8.3.6.10 For overhead power lines running in particularly difficult operating conditions (mountains, swamps, regions of the Far North, etc.), the design documentation must include a technology for organizing the repair and maintenance of overhead power lines, taking into account the use of mechanisms and vehicles that correspond to the conditions of future operation.

8.3.6.11 In order to reduce the timeframe and optimize costs during construction, reconstruction and emergency recovery work on overhead power lines, the following should be considered:

- on main lines of 6-20 kV electrical grids with branches, pin insulation is usually used, without branches - suspension insulation;
- use of 6-20 kV transmission line supports for joint suspension of self-supporting insulated wires with overhead power lines for voltages up to 1000 V;
- use of quick-assembly fittings;
- industrial construction methods, the use of high-precision structures in order to minimize the time and complexity of performing technological operations in the conditions of the overhead power line route, and to minimize the volume of excavation work;
- construction and clearing of clearings using modern technical means (high-performance felling complexes, mulchers, etc.);
- the availability of a permit for the placement of construction projects on land plots in accordance with current legislation, which must be a mandatory condition;
- use of environmentally friendly technologies for clearing clearings and technologies that prevent and reduce the growth rate of trees and shrubs
- the use of technologies for the construction of support foundations that reduce the time spent on installation and minimize the volume of excavation work (vibration driving, pressing in shell piles, screwing in screw piles, rod embedments in rocky soils, the use of highly efficient drilling rigs for drilling holes in hard rocks and rocky soils);
- as a rule, the use of truck cranes that ensure the installation of supports without the use of a falling boom;
- use of helicopter technology or installation of supports using the extension method in difficult-to-reach areas or in confined spaces;
- replacement of steel-aluminum wires with wires with increased throughput, including high-temperature wires if it is necessary to increase throughput without constructing a new overhead power line. The choice of phase design, cross-section and wire brand, including the suspension of new wires of a larger cross-section, additional wires in the phase or wires with an increased current load must be carried out taking into account the mechanical strength of the supports and be confirmed by calculations of the structural elements of the overhead power line.

8.3.6.12 To fasten guy ropes in soils with a high degree of corrosion aggressiveness in accordance with Table 1 of GOST 9.602-2016 "Unified system of protection against corrosion and aging. Underground structures. General requirements for protection against corrosion" with high specific resistance, as well as when organizing ice melting using the earth as a conductor, foundations with a guy rope fastening unit extended above the ground surface should be used.

8.3.6.13 When designing 35-750 kV overhead power lines, the results of mathematical modeling of power system operating modes must be taken into account. For the purposes of forming the specified calculation models, the design organization forms an information model of the power system in the volume necessary for the design of power transmission lines, in compliance with the requirements for the formation, updating of information models of the electric power industry and information exchange profiles approved by the Ministry of Energy of Russia in accordance with Resolution of the Government of the Russian Federation of 02.03.2017 # 244 "On improving the requirements for ensuring the reliability and safety of electric power systems and electric power facilities and amending certain acts of the Government of the Russian Federation". Based on the results of the development of design solutions, changes must be made to the information model of the power system related to the commissioning (decommissioning) of the power transmission lines taken into account during the design.

8.3.6.14 To prevent birds from landing and nesting on 35 kV and higher overhead power line supports in places where birds are present and congregate, the supports must be equipped with non-traumatic anti-perching bird protection devices that prevent birds from landing and nesting, as well as barrier devices that protect insulator strings from contamination by bird waste. The use of such devices for 6-20 kV overhead power lines is permitted upon justification.

8.3.6.15 In order to ensure the safety of aircraft flights, overhead lines must be marked in accordance with the Federal Aviation Rules “Placement of marking signs and devices on buildings, structures, communication lines, power lines, radio equipment and other objects installed to ensure the safety of aircraft flights” in the current version.

### 8.4 Cable power lines

The section applies to cable lines, cable entries into the overhead power line at the substation, cable sections (if the overhead power line has a section along the route made of cable) and cable jumpers laid between the substation equipment.

#### 8.4.1 Cables

8.4.1.1 When constructing cable lines, it is necessary to use cables that meet the following requirements:

− in distribution networks up to 1 kV, cables with a neutral conductor must be used;

− for 6-35 kV cable lines, cables with cross-linked polyethylene insulation, heat-resistant insulation made of synthetic compound, and impregnated paper insulation should be used;

− For 110 kV and higher cable lines, cables with cross-linked polyethylene insulation with longitudinal sealing of the cable core, transverse and longitudinal sealing of the screen and built-in optical fiber for monitoring the cable temperature must be used.

For underwater and underground cable lines, cables with built-in optical fiber can be used.

8.4.1.2 When constructing cable lines, it is necessary to use standard or standard designs of cable wells, cable structures, and other elements and units assembled and equipped in factory conditions.

8.4.1.3 When laying cable lines in the ground, it is necessary to use cables with a reinforced outer polyethylene sheath.

8.4.1.4 When laying cable lines in mountainous areas, in seismic activity zones, and in soils subject to displacement, it is necessary to use armoured cables placed in cable structures.

8.4.1.5 When laying cable lines in cable structures, depending on the requirements, it is necessary to use cables that do not spread combustion, with low smoke and gas emission, with low toxicity of combustion products, that do not emit corrosive gaseous combustion products, with an outer conductive layer.

8.4.1.6 For fastening cables in cable structures, metal structures with bolted connections of structural elements with an anti-corrosion coating made in factory conditions using the hot-dip or thermodiffusion galvanizing method must be used.

8.4.1.7 To protect cables at intersections with roads, engineering structures and natural obstacles, specialized multilayer heat-resistant pipes made of non-magnetic materials should be used.

8.4.1.8 Laying in pipes made of magnetic material is permitted only for three-phase cables or for three single-phase cables connected in a triangle.

8.4.1.9 The service life of the cable must be at least 30 years.

### 8.4.2 Cable fittings

8.4.2.1 Cable fittings must have a high degree of factory readiness and ensure a minimal risk of damage to the structural elements of the couplings during installation.

8.4.2.2 It is necessary to use cable fittings 1-35 kV, manufactured using heat-shrinkable, tension, pre-stretched, cast or gel technology.

8.4.2.3 Basic requirements for cable fittings for 110 kV and higher lines:

− end joints and cable entries (for connecting cable lines to gas-insulated switchgear and power transformers) must have a detachable design that allows for inspection of the technical condition and reassembly (if necessary) during operation.

− connecting couplings must have reliable sealing against moisture penetration and provide protection against mechanical impacts;

− the design of cable fittings must ensure reliable sealing, protection from mechanical damage and atmospheric pollution;

− Metal structures for installation and fastening of end couplings must have an anti-corrosion coating, made in factory conditions by hot-dip or thermodiffusion galvanizing.

8.4.2.4 The service life of cable fittings must be at least 30 years.

### 8.4.3 Requirements for the arrangement of cable screens

8.4.3.1 Specialized transposition wells (grounding) for cable lines must be sealed, serviced and protected from access by unauthorized persons.

Wells can be made of monolithic reinforced concrete or polymeric materials with an internal non-combustible layer.

Design measures must be provided to reduce the risk of harm to the life and health of the population due to the possibility of the manhole covers of the transposition wells flying out of their fastenings.

8.4.3.2 Cable screen transposition (grounding) boxes must be reliably sealed against moisture penetration.

8.4.3.3 To place the transposition (grounding) boxes of cable screens, it is necessary to use cable structures and specialized cable wells.

### 8.4.4 Technical diagnostics and monitoring of cable lines

8.4.4.1 Technical diagnostics and assessment of the technical condition of cable lines must, in terms of composition, volume and frequency, comply with the current requirements of regulatory legal acts, local regulatory acts of the Company, and instructions of the manufacturers.

8.4.4.2 The main principle in technical diagnostics and monitoring of cable lines is the use of systems for diagnosing the technical condition under operating voltage without taking the cable line out for repair.

8.4.4.3 For cable lines of 110 kV and above, continuous monitoring must be carried out using an Automated monitoring and dispatching system.

8.4.4.4 Technical requirements for cable line monitoring systems must meet the requirements of company standards PJSC Rosseti.

### 8.4.5 Construction technologies and design solutions

8.4.5.1 Design solutions for cable line construction should be based on the use of construction technologies aimed at optimizing time, saving materials and complying with the technological process of cable line installation.

8.4.5.2 A mandatory condition for the design of the cable line must be the availability of a permit for the placement of construction projects on land plots in accordance with the legislation of the Russian Federation, as well as the availability of an agreement with the owner of utility lines for the intersection, proximity to the designed cable line, and when the cable line crosses shipping rivers and other water bodies - with the owners of engineering structures and organizations engaged in the economic use of the water body.

8.4.5.3 Apply technologies aimed at reducing the production of earthworks, including through the use of trenchless methods for laying cable lines (horizontal directional drilling) or collectors in order to protect nature conservation areas and landscaped areas of cities and places saturated with utility lines and infrastructure facilities.

8.4.5.4 When laying cable lines at intersections with roads, engineering structures and natural obstacles, construction technologies can be used that allow localizing the location of damage to the power cable in the pipe.

8.4.5.5 Use standardized or typical designs of cable wells, cable structures and other elements.

8.4.5.6 The design of cable lines should be carried out according to the principle of minimizing the number of connecting sleeves and unifying the equipment used.

8.4.5.7 For underwater cable laying it is necessary to provide:

− laying an armoured cable of a single construction length, ensuring operation under hydrostatic pressure, and when laying at great depths from 40 to 60 m, in the presence of strong sea surf and in sections of rivers with strong currents and eroded banks - a cable with double metal armour;

− construction of coastal cable chambers for organizing the connection of underwater and underground cables;

− reserve for underwater laying of single-phase cables of 110 kV and higher: for one cable line circuit - one phase, for two cable line circuits - two phases, for three or more cable line circuits the number of reserve phases is determined by the design documentation, but not less than two. The scheme for including the reserve phase in operation must be designed in such a way that it can be used instead of any working phase of any circuit.

8.4.5.8 In cities, cable lines should, as a rule, be laid in the ground (in trenches) along non-traffic parts of streets, under sidewalks, in courtyards and technical strips in the form of lawns.

8.4.5.9 Technical solutions during the construction (laying) of cable lines (overhead power lines) must exclude the possibility of damage to adjacent phases of the cable if damage occurs in one of the phases.

8.4.5.10 It is recommended to lay 10 or more cable lines in a flow in collectors, cable pipe ducts and cable tunnels. When crossing streets and squares

with improved surfaces and with intensive traffic, cable lines should be laid in specialized pipes to protect power cables.

8.4.5.11 In cramped or underground utility sections of the route, at the intersection of highways, railways, rivers, canals and other bodies of water, wide streets and streets with heavy traffic, etc., it is recommended to lay the cable line using a closed method. Control and executive survey of these sections of HDD and pipe laying should be performed using inertial hardware and software measuring systems that allow determining high-precision spatial coordinates of the axis (top, tray) of the pipeline section, casing (with an error of only 0.05% of the length of the measured section).

8.4.5.12 At intersections, it is recommended to provide backup cables (subject to justification) or backup pipes.

8.4.5.13 Cable entries into buildings, cable structures and other premises must be made in chrysotile, concrete, ceramic or polymer pipes.

8.4.5.14 When justifying, the need for laying reserve pipes is determined, and for 110 kV cable lines and above, with a pipe section length of more than 100 m, as well as in cases for the fastest possible repair work, reserve pipes with a laid reserve cable should be provided (for cable lines made of single-phase cables - one cable for each circuit). When using pipe sections longer than 500 metres, as a rule, a reserve should be provided - at least two pipes for each circuit.

8.4.5.15 If it is necessary to lay cable lines in aggressive soils, measures must be taken to replace the soil, and the need to lay cable lines in sealed pipes must be additionally considered.

8.4.5.16 Cable lines, including those on overhead power lines, must be protected from overvoltages (lightning and switching) by installing overvoltage limiters. In this case, lightning overvoltage protection is not required for cable inserts of 35-220 kV with a length of 1.5 km or more on overhead power lines protected by cables.

8.4.5.17 For cable lines of 35 kV and above, after preliminary selection of the cable cross-section and design, a clarifying thermal calculation of the cable line must be performed in accordance with GOST R IEC 60287-1-1-2022, taking into account all factors that determine the temperature regime of the cable.

8.4.5.18 Cable entries into the substation building and other cable structures (chambers, collectors, microtunnels, etc.), branch locations, passages through each floor and building structures must be sealed with modern non-combustible materials (products) with a fire resistance rating of at least EI 45, reusable, providing reliable waterproofing from groundwater ingress.

8.4.5.19 The design of cable sealing units in switchgear ceilings must be detachable and reusable.

8.4.5.20 In areas with absolute minimum temperatures below minus 45 ºC, during new construction and reconstruction, open placement of transition cable joints of 35 kV and above is not permitted.

**8.5 Network equipment for urban agglomerations**

8.5.1 Basic requirements

8.5.1.1 In power supply systems of megacities, it is necessary to implement measures aimed at limiting the growth of short-circuit currents and exceeding their level beyond the permissible capabilities of switching devices.

8.5.1.2 To accommodate the electric grid facilities, it is necessary to use the underground space of megacities, ensure the construction of deep high-voltage cable entries located as close as possible to the load centre, provide for the reservation of territories for the construction of cable structures associated with territorial development projects, reconstruction and new construction of infrastructure facilities. When designing, constructing, reconstructing, modernizing and technically re-equipping substations, it is recommended to be guided by the following basic principles:

- the number of floors of a closed substation building must not exceed three, including the cable mezzanine;

- in cities with high building density, with appropriate justification, the construction of modular buried or underground substations is permitted.

8.5.1.3 During new construction and reconstruction of 6-220 kV substations, closed, including modular underground and recessed type designs must be implemented using:

− Switchgear 6-35 kV with air insulation or (if justified) combined, gas-insulated;

− 110-220 kV gas-insulated switchgear;

− oil-free switches (vacuum for voltage of 10-35 kV, gas-insulated for voltage of 110-220 kV);

− oil-free instrument transformers 6-20 kV with cast resin;

− 35-220 kV measuring transformers with SF6 insulation (the use of oil measuring transformers is permitted (subject to justification);

− digital transformers (DTT, DTN) for voltage of 110-220 kV (subject to justification).

SS must have minimum dimensions, while ensuring an appropriate level of safety, including environmental safety, and ease of use, and also fit into the architectural appearance of the metropolis landscape.

8.5.1.4 When constructing underground substations and those built into or adjacent to administrative buildings, use equipment, including power transformers with non-flammable insulation and without mineral transformer oil.

8.5.1.5 During new construction of 110-220 kV substations and reconstruction of 35-220 kV substations, 35-220 kV power transformers/ATs must be placed in closed chambers of substation buildings.

8.5.1.6 During new construction of 20 kV distribution networks and reconstruction of existing 6-10 kV distribution networks, power transformers must be placed in closed chambers.

8.5.1.7 In megacities, cable lines of various voltage classes should be predominantly used, and overhead power lines running through residential areas of megacities should be gradually replaced with cable lines.

8.5.1.8 Overhead power lines intended for outdoor street lighting must be constructed using insulated or self-supporting insulated wires.

8.5.1.9 6-20 kV power supply networks should be designed taking into account automatic line redundancy in the distribution point. A scheme should be used using distribution points (Distribution Transformer Substations) connected to two independent territorially distributed 110 kV and higher power supply centres. Design of 6-20 kV power supply networks in areas of new development is performed using two-section distribution points with an automatic throw-over circuit-breaker on the 6-20 kV section switch and power supply via two independent (mutually redundant) cable lines (usually from two independent power sources). A distribution point with one sectioned busbar system with power supply via mutually redundant lines connected to different sections of different substations should be used; there should be an automatic throw-over circuit-breaker on the section switch.

For large consumers (industrial and commercial enterprises) with a load current of more than 200 A and consumers located in the city of Moscow, it is necessary to allocate a separate distribution point, which is fed from two independent power supply centres.

The redundancy of the DTS sections of residential microdistricts and municipal-industrial zones in the post-emergency mode must be carried out using cable communication lines of the same cross-section as the PCL.

It is recommended to design and construct a 20 kV support network using both the SP (GSP) according to the trunk principle and the DS (DTS) according to the radial-ring principle.

8.5.2 Promising areas of development

8.5.2.1 When reconstructing the distribution electrical grids of a metropolis, it is necessary to consider the transition of electrical grids to a voltage of 20 kV, and when designing, the use of resistive grounding of the neutral with automatic disconnection of ground faults or the use of systems for compensating for complete ground faults.

8.5.2.2 During the reconstruction of existing 110 kV facilities, it is permissible to consider a justified transition to a higher voltage class.

8.5.2.3 During new construction and reconstruction of 110 kV and higher substations, it is necessary to consider the feasibility of using dielectric liquids with improved fire safety characteristics and corresponding to the requirements of IEC 61099 "Electrical insulating liquids. Unused synthetic organic esters for electrical engineering. Specifications" as the main insulation in power substations/automatic transformers.

8.5.2.4 The power supply scheme in megacities must ensure the minimum time for restoring power supply to consumers in the event of emergency conditions, taking into account the implementation of the following technical solutions:

- network redundancy, network sectioning;
- the use of high-speed switches together with automatic power supply devices with the function of reverse restoration of the normal power supply circuit;
- application of automatic rewinding, including on cable lines;
- organization of an automated control system and remote control of switches.

8.5.2.5 In the post-emergency mode, the restoration of electricity supply to consumers should be carried out in a sequence depending on the responsibility and social importance of the facility in the system of functioning and life support of the metropolis (medical, children's institutions, subway, train stations, railways, road control systems, communications, television, radio, high-rise buildings, heating and water supply systems, sewerage, etc.).

8.5.2.6 In the 6-35 kV distribution electrical grid of special categories of consumers for whom short-term interruption of power supply is not permitted, it is necessary to consider power supply from three independent mutually redundant power sources.

Local power plants, power system power plants (in particular, generator voltage buses), uninterruptible power supply units intended for these purposes, storage batteries, storage devices, etc. can be used as a third independent power source.

8.5.2.7 In power supply systems of megacities, it is advisable to consider the introduction and use of a current limiting device, and in the future, BBT, as promising solutions when developing measures aimed at limiting the growth of short-circuit currents and exceeding their level beyond the permissible capabilities of the SC.

### 8.6 Relay protection and automation. Automated process control systems

As of 2024, of the total number of relay protection and automation devices operated by subsidiaries and branches of PJSC Rosseti, about 70% of relay protection and automation devices are made on an electromechanical and microelectronic element base with a service life that is two or more times longer than their service life. Such devices require more frequent maintenance and more

time to perform periodic types of technical maintenance, due to the need to replace components (relays, units, etc.) that do not meet regulatory requirements.

In order to reduce the level of wear and tear and increase the reliability of the devices, it is necessary to:

ensure the replacement of relay protection and automation devices that have reached their established (standard) service life, for which a decision has been made on the impossibility of extending the service life, drawn up in accordance with the current standards and technical documentation and regulations;

ensure replacement/modernization of relay protection and automation devices with a high rate of accidents (malfunctions) and malfunctions, taking into account the cessation of production of devices and the lack of spare parts for repairs;

during reconstruction with replacement of the main equipment of the substation, provide for measures to replace relay protection and automation devices that have reached the established (standard) service life;

ensure the replacement of relay protection and automation devices and automated process control systems from foreign manufacturers due to the termination of technical support and the lack of spare parts.

8.6.1 Operation and maintenance

The priority task in the field of technical maintenance of relay protection and automation devices and automated process control systems is:

– transition to condition-based maintenance;

– use of devices with minimal maintenance requirements and built-in diagnostic tools;

– application of automation tools for control processes and monitoring the serviceability of microprocessor devices;

– staffing structural divisions with highly qualified specialists who have undergone specialized training and have the right to independently carry out technical maintenance;

– increasing the share of work performed in a businesslike manner, including adjustment and maintenance, including the first preventive inspection.

Condition-based maintenance may be used for microprocessor-based relay protection and automation devices, for which the conditions and requirements of Chapter IV of the Rules for the Maintenance of Relay Protection and Automation Devices and Complexes, approved by order # 555 of the Ministry of Energy of Russia of 13.07.2020, are met. For other relay protection and automation devices and automated process control systems, scheduled preventive maintenance is used.

The introduction of condition-based maintenance along with increasing the reliability of relay protection and automation devices and automated process control systems will ensure the redistribution of released resources primarily for maintaining the standard technical condition of devices based on electromechanical and microelectronic components, with a service life exceeding the service life.

To ensure the organization of technical maintenance based on the condition, depending on the level of technological equipment of the substation, the following

types of monitoring and analysis of the functioning of microprocessor devices must be implemented:

– continuous monitoring –for the purpose of tracking the occurrence of malfunction signals of devices and their external circuits, and device operation (start) signals;

– periodic monitoring – for the purpose of analyzing the measured values of current, voltage and power received from various devices and monitoring the analog-digital path, checking the position of the switching device and the state of the functions, the state of the communication channels used, ensuring the operability and functioning of the devices;

– situational monitoring – when technological disturbances occur and performing an analysis of the functioning of devices based on the correct operation and embedded algorithms, as well as an analysis of switching operations during which switching devices were controlled and, as a result, the integrity of the control circuit of switching devices was checked.

Systems for monitoring and analyzing the operation of relay protection and automation devices and automated process control systems (hereinafter referred to as ACS), including the organization of information exchange between electric power industry entities and relevant dispatch centres, must comply with the requirements of current company standards, national standards and regulatory legal acts.

Data transfer to software packages for supporting the life cycle of relay protection and automation systems and automated process control systems of the substations and branches of PJSC Rosseti at newly constructed and reconstructed substations with replacement of automated process control systems, as well as at substations with automated process control systems that support the data transfer protocol according to IEC 61850 90-2, should be organized using IEC 61850 90-2. At substations where there is no technical possibility to transfer data according to IEC 61850 90-2, it is necessary to install means for collecting and transferring data to the software package for supporting the life cycle of relay protection and automation systems and automated process control systems.

Automatic transmission of oscillogram files to the control centres of JSC SO UES is organized in accordance with the requirements of GOST R 59550-2021 "Unified Energy System and Isolated Energy Systems. Relay Protection and Automation. Collection, Storage and Automatic Transmission to Control Centres of Files with Emergency Event Registration Data. Standards and Requirements" by installing and configuring specialized software for the non-operational process information collection system, if technically feasible.

In the future, it is necessary to provide algorithms in monitoring and analysis systems that take into account the probability of changes in the parameters of the electronic component base during the service life, based on mathematical models that allow identifying the most vulnerable components of the device (block), as well as methods for diagnosing and predicting faults.

The quality of calculations and selection of response parameters for protection and automation devices must be ensured:

– application of guidelines for calculating and selecting the response parameters of relay protection and automation devices, taking into account the recommendations of equipment manufacturers;

– using a software package for supporting the life cycle of relay protection and automation systems and automated process control systems, including the ability to model existing and prospective network elements, intelligent elements of active-adaptive action;

– maintaining a high level of personnel qualifications.

### 8.6.2 Directions for the development of relay protection and automation systems and automated process control systems

The main directions of development of relay protection and automation systems and automated process control systems are:

– typification of technical solutions;

– improvement of operating algorithms;

– development and scaling of the technology for implementing secondary systems of highly automated substations;

– automation of life cycle support processes;

– implementation technologies such as clustering, virtualization, containerization, etc.;

– development and implementation of secure remote access technology to ensure the possibility of remote administration and maintenance of automated process control systems.

In order to determine the requirements for equipment of substations with new type architectures, to develop new technologies, to confirm or identify new technical and economic effects, it is advisable to further conduct research and development work.

During new construction, reconstruction and modernization it is necessary to use standard cabinets, relay protection and automation devices, automated process control systems, materials and systems :

having passed the quality control procedure in accordance with the established procedure;

providing the ability to remotely control technological operating modes and the operational state of facilities;

with built-in diagnostic tools to ensure automation of control processes and monitoring of serviceability.

Depending on the volume of implementation of digital data transmission technologies at the substation, three architectures for constructing the secondary systems of highly automated substations are distinguished, characterized by the following types of implementation of information interaction:

architecture type I:

between the automated process control system IEDs – via the IEC 61850-8-1 GOOSE protocol;

between the relay protection and automation equipment – discrete and analog electrical signals transmitted via a control cable;

IEU RPA and APCS with the station level (SCADA) – according to the IEC 61850-8-1 MMS protocol;

current and voltage measurements are transmitted as electrical analogue signals using control cables.

architecture type II:

between the relay protection and automation equipment, automated process control systems – via the IEC 61850-8-1 GOOSE protocol;

IEU RPA and APCS with the station level (SCADA) – according to the IEC 61850-8-1 MMS protocol;

current and voltage measurements are transmitted as electrical analogue signals using control cables.

architecture type III:

between the relay protection and automation equipment, automated process control systems – via the IEC 61850-8-1 GOOSE protocol;

IEU RPA and APCS with the station level (SCADA) – according to the IEC 61850-8-1 protocol;

Instantaneous values of current and voltage from measuring devices are transmitted to the substation LAN via the IEC 61850-9-2 protocol, and information exchange between measuring devices and the station level (SCADA) is carried out via the MMS digital protocol.

Type I architecture should be used, as a rule, at sites of non-comprehensive reconstruction with partial replacement (modernization) of relay protection and automation devices and process control systems.

Type II architecture should be used for new construction and complex reconstruction of substations.

Type III architecture should be applied after the technology for transmitting instantaneous values of current and voltage via the IEC 61850-9-2 protocol has been developed and subject to the availability of a technical and economic justification based on a combination of the following main criteria: reliability, efficiency, and cost assessment over the entire life cycle.

### 8.7 Automated systems for monitoring and metering of electrical energy and power

8.7.1 The purpose of the Unified Technical Policy in the field of electrical energy (capacity) metering is to develop unified approaches to the creation of automated electrical energy metering systems (AEMS), including in the performance of legislatively imposed obligations on grid companies.

8.7.2 The tasks of the Metering Systems are:

– determination of the reliable volume of services provided by the Company;

– determination and monitoring of the amount of electrical energy losses in electrical grids;

– provision of information on the accounting indicators of electrical energy (capacity) at the Company's electric grid facilities to the Company's structural divisions, electric power industry entities and consumers in the established manner.

8.7.3 Accounting systems should be created as geographically distributed multi-level information systems with centralized management and a single centre for collecting, processing, storing and transmitting measurement data.

8.7.4 Accounting systems must cover all points of commercial and technical accounting of active, reactive electrical energy and power in order to obtain a complete balance of electrical energy at the facility, including balances of electrical energy by bus sections, bus systems of different nominal voltages, including the allocation of electrical energy consumption for the energy facility's own needs.

8.7.5 The metering system must include electrical energy measuring complexes consisting of electrical energy meters, current and voltage measuring transformers, as well as secondary measuring circuits and data transmission facilities to the centralized data processing centre.

8.7.6 When creating a Metering System:

– at substations of 35 kV and higher, network facilities must cover all connections and also provide for data transmission and reception devices or controllers, technical means for receiving and transmitting data (channel-forming equipment) in accordance with the requirements of the standards of PJSC Rosseti;

– at work sites (including directly in the 0.4 kV distribution network) TS, PTS, DS and DTS 6-20 kV, it is permitted to use intermediate data collection devices (IDD) subject to the availability of a feasibility study that takes into account the condition of existing metering devices with remote data collection, the prospects for increasing their number at work sites and also ensuring a positive economic effect throughout the entire service life of the equipment (at least ten years).

8.7.7 Collection and processing of information must be carried out in a hardware and software complex equipped with a unified time system.

8.7.8 Metering systems must comply with the requirements of regulatory legal acts, including at connections that are part of the supply sections to the WECM - the requirements imposed by the regulations of the wholesale electricity and capacity market, and in the RSC (on the retail electricity market) - the requirements of the Basic Provisions for the Functioning of Retail Electricity Markets, approved by Resolution of the Government of the Russian Federation of 04.05.2012 # 442 (hereinafter referred to as the Basic Provisions for the Functioning of Retail Electricity Markets), and the requirements of the Rules for Providing Access to the Minimum Set of Functions of Intelligent Electricity (Capacity) Metering Systems, approved by Resolution of the Government of the Russian Federation of 19.06.2020 # 890 (hereinafter referred to as the Rules for Providing Access to the Minimum Set of Functions of Intelligent Electricity (Capacity) Metering Systems).

8.7.9 Metrological support of measuring instruments included in electric energy metering systems must comply with the provisions of Section 8.8 "Metrological Support" of the Regulation and be carried out in accordance with the requirements of the legislation of the Russian Federation.

8.7.10 Depending on the network topology, in order to balance the sections of the distribution network, it is recommended to organize metering at network facilities along the boundaries of the Company's balance sheet affiliation.

8.7.11 Substations of 35 kV and above must be equipped with measuring complexes and a data acquisition and transmission device (if justified) using data transmission facilities to the Centralized Communications Information System (CCIIS), while metering devices must be installed at all connections.

8.7.12 To protect metering devices, measuring transformers and (or) measuring complexes for commercial and technical (if justified) metering of electric energy from unauthorized access, the following must be used:

– at the hardware level:

• sealing or marking of terminal covers of metering devices, CT, VT, test boxes, switching devices and equipment for protecting metering devices from short-circuit currents, test and intermediate terminal blocks of current and voltage circuits;

• devices and structures that protect metering devices (measuring complex) from unauthorized interference in their operation (for example, for split-type metering devices with exposed current-carrying parts, the use of sealed transparent protective covers).

– At the software level, identification and authentication of access subjects and objects is required.

8.7.13 When connecting metering devices and (or) measuring complexes for commercial and technical metering of electric energy to wireless communication networks of cellular operators, protection of information from unauthorized access must be ensured by using a dedicated APN (VPN) of the data transmission network operator and the “Star” (Hub and Spoke) network topology.

8.7.14 At the connections of substations of 35 kV and above, if there is technical and economic feasibility, it is allowed to install metering devices that perform the functions of an oscillographic recorder of parameters of normal and emergency modes, transient processes and non-conformities of the power quality control system with the standards of GOST 32144 -2013 and the Requirements for the quality of electrical energy, including the distribution of responsibilities for its provision between entities of the electric power industry and consumers of electrical energy approved by order of the Ministry of Energy of Russia dated 08/28/2023 # 690.

8.7.15 TS, DS, DTS 6-20 kV must be equipped with 0.4-20 kV measuring complexes using data transmission means.

8.7.16 Providing information interaction between the Accounting and Telemetry System in terms of transmitting process information to the Grid Control Centre for the purposes of operational and process control (currents, voltages, powers, etc.).

8.7.16.1 For the efficient use of resources when designing new construction and/or reconstruction of 0.4-20 kV distribution network facilities, it is recommended to provide for the use of unified devices that support the ability to

collect and transmit telemetry signals and metering system data (with appropriate economic and/or technical justification).
Design common communication channels for the Accounting and Telemechanics System.

8.7.16.2 Provide the ability to use telemetric information received and transmitted via the Metering System to organize remote monitoring and control of 0.4-20 kV distribution network facilities:

a) at the level of measuring complexes:

– network controllability through switch control (if the switch has the appropriate technical capability);

b) at the level of the data acquisition and transmission device (controller, metering device (external module) with remote control functions):

– volume of teleinformation:

- collection of information on the volume of electricity consumption and the values of current, power and voltage;
- collection of information on individual parameters of power supply quality;
- phase-by-phase monitoring of the presence of voltage at the inputs of LV sections 0.4 kV;
- access control to the facility (motion detectors, photo recording, if necessary - video surveillance, protection during switching) with a signal from the door closing control sensor;
- monitoring for flooding in cable pits (if there are pits);
- control of the operation of fire alarm detectors - generalized signal section by section (if available);
- control of automatic throw-over circuit-breaker operation (if available);
- monitoring the excess temperature of the power transformer housing (if necessary);

- volume of telemetric information of internal self-diagnostics:

- diagnostics of the presence of communication with modules (nodes) of collection and control;
- diagnostics of malfunctions or critical operating modes of the system's computing module;
- monitoring the serviceability of the system's own backup power source.

8.7.16.3 Use unified primary converting devices (current and voltage sensors/transformers) to connect measuring instruments of the Metering and Telemetry Systems.

8.7.16.4 It is possible to implement the Metering and Telemetry System separately if there is appropriate justification (based on criteria of economic feasibility or ensuring the required level of reliability of power supply to consumers in the designed section of the network).

8.7.17 Organization of electricity metering in distribution electrical grids.

8.7.17.1 To organize the metering of electric energy, including in the case of crossing the boundary of operational responsibility for the consumer's grid

facilities, the metering of electric energy must be organized using remote (including high-voltage) commercial metering points, in accordance with the requirements of the standards of PJSC Rosseti.

8.7.17.2 Electricity metering points must be equipped with measuring systems using data transmission equipment.

The priority of choosing communication channels is given in Table 2.

Table 2. Communication channel selection priorities from the IIC

| Metering facility | Transmission protocols | | Communication channels IIK-IVKE (IVK) | | | | |
|---|---|---|---|---|---|---|---|
| | Ethernet | RS-485 | Technological communication network | RLC | RF* | GSM/ GPRS | Other third-party communication channels |
| SS 35 kV and above | 1** | 2 | 1 | 4 | 2 | 3 | 5 |
| TS 6.10 kV | 1 | 2 | 1 | 2 | 3 | 5 | 4 |
| Non-residential premises of an apartment building, the electricity supply of which is carried out without the use of common property | 1 | 2 | - | 1 | 2 | 4 | 3 |
| Houses (residential buildings and terraced houses) | - | - | - | 1 | 2 | 3 | 4 |

* the concept of “RF” includes channels implemented in various radio frequency ranges, including those using ZigBee, LPWAN, BlueTooth, etc. technologies.

** 1 is the highest priority, 5 is the lowest priority.

8.7.17.3 To protect meters with a universal housing design from mechanical impacts and unauthorized access, they must be placed in lockable cabinets with a window at the display level.

8.7.17.4 In the event that it is not technically possible and/or economically feasible to install measuring instruments directly at the balance sheet boundary, their installation at other points in the network is permitted, provided that they are located the least distance from the balance sheet boundary.

8.7.18 Organization of electricity metering at 0.4 (0.23) kV switchgear of consumers of private households and legal entities

8.7.18.1 Metering points for legal entities and private households connected to the 0.4 (0.23) kV network must be equipped with measuring complexes using data transmission means (via mobile networks, radio channels, PLC technologies, as well as interfaces for access to remote reading of information). It is allowed to use metering devices equipped with a remote (remote) display for displaying information.

8.7.18.2 For citizens - consumers of electric energy living in private homes, measuring instruments must be installed at the boundary of balance sheet ownership outside the territory of the residential premises at the entrance to the house (on the overhead power line support, the wall of the house) or on the overhead

power line support using metering devices with a split architecture or remote commercial metering points.

8.7.18.3 For legal entities - consumers of electric energy, measuring instruments must be installed at the boundary of balance sheet ownership using metering devices with a split architecture or remote commercial metering points.

8.7.19 Requirements for components of accounting systems

8.7.19.1. Requirements for measuring CT and VT for the purposes of accounting for electrical energy:

– in new construction and reconstruction of central substations of 110 kV and higher, preference should be given to installing digital measuring CTs and VTs;

– measuring CT and VT must comply with the technical requirements of the organization's standards;

– The technical characteristics of measuring current transformers must not limit the permissible current loads of any power transmission lines, autotransformers (transformers) and other equipment connected to the distribution device, taking into account their overload capacity.

8.7.19.2. Requirements for electricity meters installed at connections of grid facilities and in distribution networks:

– metering devices must ensure the accumulation of statistics on random events (voltage dips and interruptions, overvoltage);

– newly installed electricity meters at 35 kV and higher substations must have at least two digital interfaces or a multi-access interface for operation in the Company's Metering System.

– the accuracy classes of electricity meters for various metering objects must be as follows:

• for connections with a voltage of 110 kV and higher - not less than 0.2S;

• for connections with a voltage of 0.4-35 kV (for transformer-connected meters) – not less than 0.5S;

• for connections with a voltage of 0.4 kV and below (for direct connection meters) – not lower than 1.0.

The accuracy class of reactive electric energy meters may be selected one level lower than the corresponding accuracy class of active electric energy meters.

– metering devices must be included in the List of equipment, materials and systems approved for use at the facilities of the Company's subsidiaries in accordance with the Methodology for conducting certification of equipment, materials and systems in the electric grid complex, approved by the Management Board of PJSC Rosseti, or approved for use by the commission of Rosseti Centre, PJSC for the approval of equipment, materials and systems for use at the facilities of the electric grid complex of Rosseti Centre, PJSC and its subsidiaries;

– digital metering devices must comply with the requirements of GOST 22261-94, GOST 31819.22-2012, GOST 31819.23-2012, GOST R 56750-2015, IEC 61850-8.1, IEC 61850-9.2 SV or have the technical capability of promptly switching to information interaction according to IEC 61850 with the corresponding readiness of the higher control level (NCS) without additional costs and without the

need to replace (dismantle) the metering device, data acquisition and transmission device.

8.7.20 Requirements for communication channels.

8.7.21 When determining the types of communication channels in each specific case, one should proceed from the territorial location of the metering objects and the maximum use of one's own telecommunications connections.

8.7.22 Communication channels intended for transmitting information must ensure stable connections between devices of different levels of the Electricity Metering System. The use of cellular communication is permitted as the main communication channel (for example, for the data acquisition and transmission device (IVKE) - IVK VU channel) only in cases where there are no other communication channels that ensure a stable connection.

8.7.23 When using cellular communications, it is necessary to ensure the integrity of the transmitted information, use a dedicated APN (VPN) of the data transmission network operator and the "Star" network topology (Hub and Spoke). The types of communication channels should be determined by economic feasibility.

**8.8 Metrological support**

8.8.1 General provisions

8.8.1.1 The main task of metrological support is to ensure the unity and required accuracy of measurements in all technological processes during the implementation of activities for the reception, conversion, transmission and distribution of electrical energy.

8.8.1.2 Metrological support is carried out at all stages of the life cycle of electric grid facilities (design, commissioning, continuous operation of facilities and equipment), as well as during the development of new measuring instruments and types of equipment equipped with measuring instruments (research and design work).

8.8.1.3 The nomenclature of the measured parameters, the requirements for the accuracy standards of their measurements, the purpose and scope of application of the measured parameters are determined by the divisions operating the measuring instruments and/or being the functional customers of the measurements, on the basis of current regulatory legal acts and/or regulatory and technical documents governing the performance of measurements of these parameters.

8.8.1.4 Depending on the purpose and scope of application, measurements (measured parameters) in accordance with the legislation of the Russian Federation on ensuring the uniformity of measurements either fall within the scope of State regulation of ensuring the uniformity of measurements or do not fall within it.

8.8.1.5 Metrological support of measurements related to the field of State regulation of ensuring the uniformity of measurements and measuring instruments used for these measurements is regulated by the legislation of the Russian Federation in the field of ensuring the uniformity of measurements.

8.8.1.6 Metrological support for measurements not related to the scope of State regulation of ensuring the uniformity of measurements and measuring instruments used for these measurements is regulated by the local regulatory acts and standards and technical documentation of the Company.

8.8.1.7 The type of periodic control of metrological characteristics (verification, calibration, serviceability control) of measuring instruments used for measuring parameters not related to the scope of State regulation of ensuring the uniformity of measurements is determined by the divisions operating the measuring instruments and/or being the functional customers of the measurements.

8.8.2 Priority areas in the field of metrological support:

– compliance with the requirements of the current legislation of the Russian Federation on ensuring the uniformity of measurements for measurements related to the field of State regulation of ensuring the uniformity of measurements;

– formation and compliance with the requirements of the Company (regulations, company standards) in the area of ensuring the uniformity of measurements and metrological support for measurements not related to the sphere of State regulation of ensuring the uniformity of measurements;

– ensuring measurement efficiency;

– use of measuring instruments with an extended interval of periodic monitoring of metrological characteristics;

– application of uniform measurement methods (techniques) to perform identical measurements at different sites and in different branches and subsidiaries of the Company;

– use of CAD in developing design solutions for organizing measurements;

– implementation of automated systems for accounting of measuring instruments, planning and control of their metrological maintenance, transition to electronic forms of measuring instruments;

– transition to maintenance of measuring equipment (SI, measuring channels and measuring system complexes) based on the condition of the subsystems and methods of monitoring measurements during continuous operation (applicable for measurements of parameters not related to the scope of State regulation of ensuring the uniformity of measurements).

– ensuring the quality of calibration work performed by metrological laboratories of the branches and subsidiaries of the Company by:

1) confirmation of technical competence in the Company’s calibration system;

2) equipping metrology laboratories with modern (compact, mobile) installations for calibration/verification of measuring instruments and standard means, the necessary computing equipment, and vehicles.

8.8.3 Requirements for measurements, measurement methods (techniques)

8.8.3.1 Measurements must be performed in accordance with the required measurement accuracy standards for the specific parameter being measured.

8.8.3.2 Measurements (except for direct measurements) must be performed using measurement methods (methods) (MI) certified in the established manner.

8.8.3.3 Measurements related to the field of State regulation of ensuring the uniformity of measurements must be performed using measuring instruments certified in accordance with the procedure established by the legislation of the Russian Federation in the field of ensuring the uniformity of measurements and registered with the FIF.

8.8.3.4 Measurements not related to the scope of the State regulation of ensuring the uniformity of measurements must be performed either according to the MI registered in the FIF, or according to the MI put into effect by the regulations of the Company or the regulations of the branch/subsidiary of the Company.

8.8.4 Requirements for units of measurement

Units of measurement must be used in accordance with GOST 8.417 and the Regulation on units of measurement permitted for use in the Russian Federation, approved by Decree of the Government of the Russian Federation dated 31.10.2009 # 879.

8.8.5 Requirements for measuring instruments

8.8.5.1 SI used for measurements in the field of State regulation of ensuring the uniformity of measurements and for measurements for which requirements for measurement accuracy standards are established must be approved as a type of SI and registered with the FIF.

8.8.5.2 The metrological characteristics of measuring instruments (measuring channels/complexes) must ensure that measurements are performed with the required measurement accuracy standards.

8.8.5.3 The actual operating conditions of the measuring instrument must correspond to the operating conditions specified in the operating documentation for the measuring instrument.

8.8.5.4 All newly purchased and delivered measuring instruments to the facilities of the Company’s branches and subsidiaries, regardless of their area of application, must be verified.

8.8.5.5 The design of measuring instruments must ensure the possibility of their verification/calibration during operation (including at the place of operation).

8.8.5.6 SI used for measurements in the field of State regulation of ensuring the uniformity of measurements are subject to periodic verification.

8.8.5.7 The verification procedure for multifunctional measuring instruments (intended for measuring several quantities) or having several measurement sub-ranges must contain indications of the possibility of conducting verification in a reduced scope.

8.8.5.8 Verification of measuring instruments is carried out in the manner established by the legislation of the Russian Federation on ensuring the uniformity of measurements. The verification results are certified by official information included in the FIF, and can also be additionally confirmed (upon

request) by a verification mark, and/or a verification certificate, and/or an entry in the operating documents for the measuring instrument, or a notice of unsuitability (in case of negative verification results).

8.8.5.9 Periodic calibration of measuring instruments is carried out in accordance with the requirements of the Company's standards and technical documentation for ensuring the uniformity of measurements.

8.8.5.10 The calibration results are certified by a calibration protocol and may additionally be certified by a certificate and/or calibration mark.

8.8.5.11 SI used for monitoring and control of parameters, the accuracy requirements for measurements of which are not imposed, are subject to serviceability control in accordance with the requirements of the standards and technical documentation of the Company for ensuring the uniformity of measurements.

8.8.6 Requirements for information and measuring systems

8.8.6.1 Information and measuring systems (including their components) must be metrologically supported at all stages of the life cycle in accordance with the requirements of the current standards and technical documentation of the Company in the area of ensuring the uniformity of measurements.

8.8.6.2 Standard software and hardware complexes used to create information and measuring systems applied in the field of State regulation of ensuring the uniformity of measurements must be approved as a type of measuring instrument and registered with the FIF.

8.8.7 Requirements for standard samples

Standard samples used in measurements must:

- have a certificate of approval of the standard sample type;
- be fit for use (have an unexpired shelf life);
- be used in accordance with the requirements of the measurement methodology and regulatory documents on the conditions of its operation.

## 8.9 Operational and technological management and situational management

8.9.1 In accordance with the Federal Law of 26.03.2003 # 35-FZ "On the Electric Power Industry", the OTU is an integral part of the service for the transmission of electrical energy, namely: a set of organizationally and technologically related actions that ensure the transmission of electrical energy through technical devices of electrical grids in accordance with mandatory requirements.

8.9.2 The OTU of the electric grid facilities is understood to mean a set of measures for managing the technological modes of operation of electric power facilities and (or) power-receiving installations of consumers of electric energy, carried out by the owners or other legal holders of such facilities and (or) installations in accordance with dispatch commands and orders of the subject of operational dispatch control in the electric power industry and (or) in agreement with

such a subject in relation to power transmission lines, equipment and devices of electric power facilities and power-receiving installations, the technological mode of operation and operational condition of which affect the electric power mode of operation of the electric power system, or independently or in coordination with other subjects of the electric power industry and consumers of electric energy in relation to other power transmission lines, equipment and devices of electric power facilities and (or) power-receiving installations.

8.9.3 Management control means activities aimed at preventing the occurrence and eliminating the consequences of accidents and other emergency situations at electric grid facilities, through the analysis, adoption and implementation of relevant management decisions taking into account the current operational situation, available resources and forecasts of the consequences of management decisions taken.

8.9.4 The structure, objectives, principles of construction and operation, and the main functions of the OTU and SU system in the electric grid facilities are determined taking into account the provisions of the Concept for the development of the operational-technological management system and situational management in the electric grid complex of PJSC Rosseti, approved by the Management Board of PJSC Rosseti (minutes dated 24.08.2018 # 755pr).

8.9.5 In order to implement the functions of the OTU and SU, the structural divisions of the OTU and SU system in the electric grid complex must be equipped at all management levels with information technology systems to perform the corresponding functions of the OTU and SU, including information collection and transmission systems, redundant communication channels for operational negotiations and transmission of technological information to the ASTU PTC.

8.9.6 Taking into account the level of development of automated control systems, when implementing OTU in the electric grid facilities, preference is given to remote control of technological operating modes and the operational state of electric power facilities and (or) power-receiving installations of consumers of electric energy from remote control centres (dispatch centres and control centres).

At the same time, during the construction and reconstruction of electrical grid facilities, a form of organizing their round-the-clock operational maintenance should be considered that does not require the constant presence of operational personnel at the facility.

### 8.10 Automated process control system

8.10.1 Basic requirements

ASTU is a complex of automation tools for operational and technological management of electric grid facilities, providing solutions to problems of process automation based on modern software and hardware automation tools, computing equipment and information technologies.

The ASTU is designed to ensure and improve the efficiency of the electric grid complex through comprehensive automation of processes.

In accordance with the Rules for the technical operation of electric power plants and networks of the Russian Federation, approved by order of the Ministry of Energy of Russia dated 04.10.2022 # 1070, and the Rules for the technological functioning of electric power systems, approved by the Decree of the Government of the Russian Federation dated 13.08.2018 # 937, to ensure the OTU, the Grid Control Centre and electric power facilities must be equipped with the necessary information technology infrastructure, including a set of equipment and software and hardware, including communication channels, for the construction of an automated control system in the Grid Control Centre and an automated process control system at substations.

The ASTU includes levels of control and management objects (CMO) equipped with the ACS TS/SSPI/TM CMO PTC and levels of the CCM equipped with the corresponding CCM ASTU CCM PTC.

Requirements for the composition of the functions of the PTC ASTU, types of support, information security and criteria for classifying the automated system of technological control of grid control centres as intelligent control systems for electric grid facilities when creating new and technically re-equipping the existing PTC ASTU of distribution and trunk electric networks are defined in GOST R 70450-2022 "Operational and technological control. Automated systems of technological control of grid control centres of grid organizations. Conditions of creation. Standards and requirements."

8.10.2 Promising directions

The PTC ASTU must be created in all the network organization's control centres in a volume sufficient to perform the functions of the OTU.

The architecture of the PTC ASTU must ensure the reliability of the entire complex as a whole (including taking into account the redundancy of the PTC itself and information exchange with control objects and between control centres) without failures and interruptions in operation. Distributed, centralized or hybrid (distributed-centralized) architecture is allowed. The choice of architectures should be made at the design stage based on a feasibility study.

When creating the PTC ASTU, the current national standards GOST R should be taken as a basis.

When constructing and developing the PTC ASTU, the most important tool is the unity of information models of electrical grids. National standards of the GOST R 58651 series should be used as a basis for creating these models.

In the future, the PTC ASTU should provide for integration tools (including those implemented on platform principles) of electrical grid models - descriptions of adjacent energy systems in order to ensure transparent exchange of information

on energy system models, guided by the GOST R 58651 series (if necessary, supplementing it with missing provisions of the IEC 61970-30x series of standards).

Prospective technical solutions for the creation of the PTC ASTU should provide for the construction of complexes using the following principles:

– modular principle, ensuring system flexibility - the ability to change functionality by adjusting the composition of modules;

– the principle of clustering and segmentation, ensuring the distribution of load and tasks between software and hardware, increasing the reliability of the functioning of the complex as a whole, as well as the level of information security;

– the principle of replication, ensuring fault tolerance of the hardware and software complex;

– seamless integration of technological information systems and control systems, built on uniform, unified principles of interaction.

8.10.3 Basic requirements for the organization of technical operation

The organization of technical operation of the PTC ASTU is aimed at ensuring the implementation of the ASTU with the specified reliability of the provided functions, its integrity, operability and functional safety throughout the entire service life with minimal operating costs.

The operation of the PTC ASTU must be carried out in accordance with the requirements of Sections 2 and 7 of the Rules for the Technical Operation of Electric Power Plants and Networks of the Russian Federation, approved by order of the Ministry of Energy of Russia dated 04.10.2022 # 1070.

Operational and technical maintenance of the PTC ASTU must be organized.

Operational maintenance of the PTC ASTU should include:

– - round-the-clock monitoring, including control of telemetry data receipt and remote control commands. Monitoring of the current state of the PTC components should be performed, as a rule, using self-diagnostic tools and centralized monitoring systems;

– operational management;

– restoration of working capacity after disruptions in work;

– maintaining operational documentation on operation.

Technical maintenance of the PTC ASTU should include:

– conducting scheduled operational checks of technical and software equipment;

– performance of routine maintenance on the technical equipment of the complex;

– maintaining software and the reference database, operational documentation up to date;

– keeping records and analyzing the causes of disruptions in work;

– analysis and generalization of operating experience, development and implementation of measures aimed at eliminating the causes and prerequisites for the occurrence of violations.

The frequency and volume of operational checks and routine maintenance should be established in accordance with the recommendations of equipment manufacturers. If self-diagnostic and monitoring systems are available, routine maintenance can be initiated based on the information received from them.

Technical maintenance of the PTC ASTU can be performed either by the network organization itself or by engaging specialized organizations on the basis of contracts.

8.10.4 Restrictions on the use of equipment, technologies and materials

In order to ensure technological independence and security of the critical information infrastructure of the Russian Federation, when creating the PTC ASTU, the software used (including application and system software) and electronic electronic products (electronic products) must be included, respectively, in the unified register of Russian programs for electronic computers and databases in order to ensure technological independence and security of the critical information infrastructure (Presidential Decree of 30.03.2022 # 166 "On measures to ensure technological independence and security of the critical information infrastructure of the Russian Federation").

## 8.11 Communication network of the electric grid complex

8.11.1 Main tasks

8.11.1.1 The ESC communication network is a complex of interacting communication networks of electric grid companies.

The communication network of an electric grid company is a complex of means, nodes and communication lines united by a common structure, common technical, technological and organizational principles.

The above-mentioned communication networks are intended to ensure the management of technological processes in the transmission and distribution of electric power, operational dispatch control in the electric power industry and OTU facilities, including information exchange for the operation of devices and relay protection and automation systems, administrative and economic activities of electric grid companies and the entire electric grid complex and, in accordance with the Federal Law "On Communications" dated 07.07.2003 # 126-FZ "On Communications", are classified as technological communication networks.

8.11.1.2 The main tasks that the Technical Policy of the Company in the area of development and operation of the communication network of the electric grid complex is aimed at solving are:

- development of the ESC system, improving the quality of information exchange;
- optimization of technical and technological solutions, application of modern technologies and types of equipment, systems, devices and materials, subject to their economic efficiency,
- decommissioning of physically worn-out and obsolete communication facilities and lines;

- interaction and integration of communication networks of power grid companies;
- bringing the ESC SS to the specified requirements for availability, throughput, reliability and information security;
- priority use of Russian-made electronic products;
- improvement of the operating system – use of modern means of diagnostics, monitoring and management of telecommunication resources taking into account information security;
- improvement of regulatory and technical documentation.

8.11.2 Basic principles of development of the EGC CN

8.11.2.1 The EGC CN must meet the needs of users and systems in the exchange of information of various types and purposes with specified indicators of service quality at optimal costs for the development and operation of the communication network to achieve the required level of reliability and rate of development of the EGC.

8.11.2.2 When developing and modernizing communication networks, it is necessary to be guided by the basic principles and provisions that determine the architecture and direction of development of the EGC CN, in accordance with the requirements of the standards and technical documentation.

8.11.2.3 The main directions and activities for the development of communication networks must be defined in the “Schemes (Programs) for the Development of Communication Networks of Electric Grid Companies” (hereinafter referred to as the Schemes for the Development of Communication Networks) taking into account the provisions of the standards and technical documentation of PJSC Rosseti.

8.11.2.4 The development of communication networks should include:
- own construction of communication facilities and lines,
- use of telecommunication resources of telecom operators, as well as related power grid companies;
- integration with the technological communication network of JSC SO UES in terms of exchanging technological information with the dispatch centres of JSC SO UES.

8.11.2.5 In order to increase the fault tolerance of communication networks, increase the reliability of operational dispatch control in the electric power industry and operational technological control of objects that determine the system reliability of the electric grid complex, it is recommended that when developing communication networks, at least one of the two communication channels be provided for the transmission of technological information from the specified electric power facilities to the dispatch centres of JSC SO UES and the Grid Control Centre in the technological communication networks of the Rosseti group of companies by creating their own communication lines or using the resources of the technological communication networks of other grid organizations and generating companies.

The criteria for classifying power grid facilities as objects that determine the system reliability of the power grid complex are:

- nodal substations connected to a 110 kV or higher network by at least three supply power transmission lines;
- transit substations connected to power transmission lines extending from nodal substations, from substations of a higher voltage class, and also from power plants.

8.11.2.6 The materials and equipment used in the communication networks of electric grid companies, including optical cables, fittings and couplings for placement on overhead power lines, information transmission systems, network equipment must comply with the established requirements of the regulatory legal acts of the Ministry of Digital Development of the Russian Federation, the local regulatory legal acts of PJSC Rosseti and have a Certificate or declaration of conformity issued by the federal executive authority in the field of communications.

8.11.3 Basic requirements for information exchange

8.11.3.1 Communication networks at all management levels must ensure the exchange of all types of information with guaranteed quality in accordance with the requirements and standards of the regulatory legal acts of the Russian Federation, local regulatory legal acts of the Company and international ITU-T recommendations.

8.11.3.2 To implement the requirements of application architecture and ensure information security in terms of isolation and elimination of the influence of different types of traffic on each other, communication networks must support division into segments.

8.11.3.3 The exchange of technological information for operational dispatch control tasks between electric power facilities, the equipment and devices of which are classified as dispatch objects, and the DC must comply with the requirements of the current agreements on technological interaction between JSC SO UES and grid organizations.

8.11.3.4 The exchange of technological information for operational and technological control tasks between electric grid facilities, the equipment and devices of which are not classified as dispatching facilities, and the Grid Control Centre must be carried out using communication channels with sufficient capacity to transmit the required types and volumes of information and meet the requirements:

| # | Voltage class of power grid facilities, kV | Requirements for the organization of information exchange |
|---|---|---|
| 1 | 110 and above | Two independent communication channels are organized for the transmission of TM data and operational negotiations to the Grid Control Centre.<br>Wired and wireless communication technologies are used.<br>It is not permitted to organize two communication channels using only cellular or only satellite communications.<br>It is permissible to use cellular communication technologies for one communication channel and satellite communication for the other. |
| 2 | 35 | One communication channel/channel is organized for transmitting TM data to the Grid Control Centre and, if necessary, for conducting operational negotiations using wired or wireless communication technology.<br>If necessary, it is permissible to organize a second independent communication channel for transmitting TM data and conducting operational negotiations using any open telecommunications technology. |
| 3 | 0.4 – 20 | One communication channel is organized for transmitting TM data to the Grid Control Centre using any open telecommunication technology. |
| 4 | For power grid facilities without permanent duty of operational personnel, telephone communication for operational negotiations can be organized using the regular communication means of the OVB, equipped in accordance with the order of PJSC Rosseti dated 16.03.2023 # 113. | |
| 5 | The quality characteristics of communication channels must meet the requirements for ensuring the functioning of production and administrative-economic management systems. | |

8.11.3.5 When the Grid Control Centre performs operational functions for electric grid facilities whose equipment and devices are classified as dispatching facilities, the exchange of technological information must be organized in accordance with the “Technical requirements for organizing communication

channels for operational negotiations and transmission of telemetric information when the Grid Control Centre performs operational functions in relation to dispatching facilities" (technical requirements of JSC SO UES and PJSC Rosseti dated 29.12.2017 in the current version).

8.11.3.6 To ensure the operation of relay protection and automation devices in accordance with the Requirements for communication channels for the functioning of relay protection and automation, approved by order of the Ministry of Energy of Russia dated 13.02.2019 # 97), information exchange must be organized both between the relevant power facilities and between the power facilities and the DC. The above Requirements for communication channels for the functioning of relay protection and automation, approved by order of the Ministry of Energy of Russia dated 13.02.2019 # 97, apply to:

- communication channels for transmitting signals and commands for relay protection, network and emergency automation, organized between the corresponding devices and relay protection and automation systems;
- communication channels for transmitting telemetric information and/or data from the transient mode monitoring system for the purposes of operating emergency response and control automation.

8.11.3.7 Information exchange for the purposes of production and administrative and economic management must be ensured taking into account the necessary bandwidth for transmitting the required types and volumes of information and dividing into segments for different types of information.

8.11.3.8 When organizing the interaction of communication networks of various electric grid companies included in the EGC CN, it is necessary to provide for the installation of equipment at the points of connection to external networks, procedures for mutual coordination of the configuration and operation of joints, taking into account information security. It is necessary to develop and sign agreements on information exchange with a specification of detailed characteristics of services, rights and obligations of the parties, as well as the level of availability of the target service.

8.11.4 Composition of communication networks of electric grid companies

8.11.4.1 The communication networks of electric grid companies include:

- transport networks consisting of a set of universal or special elements:
  - fiber-optic communication lines (FOCL);
  - cable communication lines with metal cores (CLC);
  - radio relay communication lines;
  - wireless access systems;
  - mobile radio communication systems;
  - high frequency communication systems;
  - information transmission systems over communication lines;
  - telecommunications resources of third-party organizations.
- data transmission network;
- telephone network;

- network clock synchronization network.

8.11.4.2 For the placement of communication facilities and lines, the following structures (accommodation facilities) must be used:

- premises/areas for equipment placement;
- linear cable structures;
- electric grid infrastructure facilities of electric grid companies;
- antenna mast structures.

8.11.4.3 For the operation of communication facilities and lines, systems of accommodation facilities may be used, including:

- power supply systems;
- climate control systems;
- fire extinguishing systems;
- access control systems.

It is permissible to create separate systems for communication facilities and lines.

8.11.4.4 The boundaries of communication networks are determined by their composition in accordance with clause 8.11.4.1. Local area networks of objects (LAN) are not part of communication networks, but use them to organize information interaction between objects.

8.11.5 Fiber optic communication lines

8.11.5.1 Fiber-optic communication lines (FOCL) include:

- The system "fiber-optic cable (FOC) - fittings - coupling". Function - transmission medium for optical telecommunication signals. It is implemented using a FOC containing one or more optical fibers, combined into a single structure that ensures their operability under specified operating conditions, placed on overhead power lines, in the ground, cable ducts and buildings, special fittings, optical couplings (connecting, branching, etc.)
- Linear cable structures are engineering infrastructure facilities created or adapted for the placement of communication cables.
- Optical fiber monitoring system - is designed for remote and continuous automatic monitoring of the physical condition of optical fibers, early detection of changes in signal attenuation in optical fibers and minimization of the time of detection of damage to monitored optical fibers (OF).
- The distributed optical fiber temperature monitoring system is designed to measure the distributed temperature of the optical fiber along the entire length of the optical cable built into the OPGW, in order to prevent the heating of the optical fiber above the permissible temperature of the OPGW (usually $+80\ ^{0}$C) when melting ice on the lightning protection cables of the overhead power line.

8.11.5.2 The design, construction and operation of fiber-optic communication lines must be carried out in accordance with the requirements of company standards PJSC Rosseti.

8.11.5.3 For use at power grid facilities, the fiber-optic cable (FOC) – fittings – coupling system placed on overhead power lines must undergo a quality control (certification) procedure at PJSC Rosseti.

8.11.5.4 Priority should be given to using optical cable built into the ground wire (GWB) on 35 kV and higher overhead power lines. GWB is a communication cable, mainly placed on overhead power lines in standard places of cable attachment, located in this case under the operating conditions of the cable and performing an additional function of protecting overhead power line wires from lightning strikes with the resulting requirements for its characteristics.

8.11.5.5 For the organization of fiber-optic communication lines, it is permissible to use high-voltage underground and underwater cables with built-in optical fibers.

8.11.5.6 Overhead power lines for the placement of fiber-optic communication lines must comply with the Requirements for associated infrastructure facilities in order to ensure the placement of telecommunication networks (their individual elements) on overhead power lines, approved by order of the Ministry of Energy of Russia dated 15.04.2022 # 327.

8.11.6 Cable communication lines with metal cores

The cable communication lines include:

- Communication cables with metal cores (symmetrical high-frequency, coaxial, symmetrical for use in structured cable systems, telephone). Function - transmission medium for analog and digital telecommunication signals in a certain frequency range.
- Special fittings, couplings.
- Linear cable structures are engineering infrastructure objects created or adapted for the placement of cables and couplings using special fittings (for example, cable ducts).

The target task is the gradual withdrawal of symmetrical high-frequency and coaxial cable communication lines from operation with their replacement by fiber-optic communication lines. In economically justified cases - digitalization of cable communication lines, if the technical condition and electrical parameters of the cable communication lines allow their use for organizing digital communication channels.

8.11.7 RRL, broadband and mobile radio communication systems

8.11.7.1 The composition of the RRL, the broadband system and mobile radio communications includes:

- Antenna-feeder devices. Function – organization of the transmission medium of analog and digital telecommunication signals in a certain frequency range.
- Transmitting and receiving equipment. Function – formation of radio signal for transmission and detection of input radio signal.
- Channel-forming equipment. Functions – aggregation, switching and transmission of traffic.
- Subscriber devices. Function – user access to network resources.
- Base stations/switches. Functions – control and switching of traffic between subscriber devices.

- Control and monitoring system. Implemented by external PTC (equipment/network configuration management, monitoring of accidents, quality and performance) and diagnostic and control tools built into the equipment.

RRL is designed to organize wireless channels of fixed radio access over long distances using the point-to-point scheme.

Broadband wireless access is designed to organize fixed radio access networks using point-to-point and point-to-multipoint topologies.

Mobile radio communication systems are designed to ensure the transmission of voice information during the work of emergency response and repair teams.

8.11.7.2 RRL, broadband and mobile radio communication systems must comply with the requirements of the regulatory legal acts of the Ministry of Digital Development of the Russian Federation, company standards PJSC Rosseti.

8.11.7.3 Transmitting and receiving equipment, base stations and repeaters must be used in radio frequency bands permitted for use by the State Commission on Radio Frequencies.

8.11.7.4 Obtaining permits for the allocation and assignment (designation) of radio frequencies for wireless communication lines is carried out in accordance with the Decisions of the State Commission on Radio Frequencies:

- Decision of the State Commission on Radio Frequencies under the Ministry of Communications of the Russian Federation dated 20.12.2011 # 11-13-01 “On approval of the Procedure for reviewing materials and making decisions on the allocation of radio frequency bands, reissuing decisions and making changes to them”;
- Decision of the State Commission on Radio Frequencies under the Ministry of Communications of the Russian Federation dated 07.11.2016 # 16-39-01 "On approval of the Procedure for conducting an examination of the possibility of using declared radio-electronic means and their electromagnetic compatibility with existing and planned radio-electronic means, reviewing materials and making decisions on assigning (designating) radio frequencies or radio frequency channels within the allocated radio frequency bands".

8.11.8 HF communication systems

8.11.8.1 The high-frequency communication systems include:

- HF communication equipment. Function – traffic aggregation, switching and transmission, traffic segmentation/isolation, connection management, amplification/regeneration.
- HF path. Function – organization of the transmission medium for transmission of analog and digital telecommunication signals in a certain frequency range. It is implemented using waveguides, HF processing and connection devices (HF traps, connection filters, separating filters, coupling capacitors, radio frequency cables). Wires and cables of the overhead power line are used as a waveguide in HF communication systems.
- Control and monitoring system. Implemented by external PTC (equipment/network configuration management, monitoring of accidents, quality and performance) and diagnostic and control tools built into the equipment.

Considering the high reliability and optimal costs of creating high-frequency communication systems in comparison with other wired communication technologies, it is advisable to use them in the conditions of the modern threat model in order to ensure minimal dependence on the services of communication operators' networks by creating our own communication lines.

It is permitted to use broadband HF communication systems (BPLC technology) in sections between objects with a voltage class below 35 kV, including with consumer metering devices. Requirements for broadband HF communication equipment are standardized by company standards PJSC Rosseti .

A necessary element in organizing HF communication systems is determining the transmission frequencies of the equipment and fulfilling the conditions for ensuring electromagnetic compatibility with existing and previously designed systems. Optimization of the frequency selection process should be implemented through the creation of a Unified Information System for Selecting HF Communication Channel Frequencies (UIS HF).

8.11.9 Systems of information transmission via communication lines

The systems for transmitting information via communication lines include:

- Multiplexing system. Function – aggregation, switching and transmission of traffic, traffic segmentation/isolation, connection management, amplification/regeneration. Implemented on DWDM/OTN/SDH/PDH/Ethernet/DSL equipment (multiplexers, modems). Requirements for SDH/PDH equipment are standardized by company standards of PJSC Rosseti.
- Control and monitoring system. Implemented by external PTC (equipment/network configuration management, monitoring of accidents, quality and performance) and diagnostic and control tools built into the equipment.

The choice of information transmission system technologies depends on the type of connected objects, the distances between communication nodes, and the requirements for the information being transmitted (volume, delay, reliability).

When organizing independent communication lines for energy facilities, information transmission must be carried out through independent sets of information transmission system equipment.

8.11.10 Data transmission network

The SPD consists of:

- Data transmission module. Function - transmission of packet traffic, in addition: traffic segmentation/isolation, signaling management, data transmission quality management, connection management. Implemented on active network equipment (routers, switches) and logical trunk channels of the SPD, connecting the SPD communication nodes.
- System for managing and monitoring the SPD. It is implemented by means of management, monitoring, diagnostics, as well as systems for managing the configuration of equipment/network, monitoring accidents, incidents, quality and performance.

- Information security system of the SPD. Functions – identification and authorization of operating personnel, account management, logging of administrator actions, traffic separation and filtering, protection of service protocols. Implemented by built-in active network equipment or external complex information security tools.

8.11.11 Telephone network

The telephone network must provide telephone communications of two types/classes – industrial and technological communications (ITC, equivalent to Corporate Telephone Communications) and telephone communications for operational negotiations.

Telephone networks must use VoIP technology to transmit voice information over IP - based packet -switched networks.

Both classes of telephone communication (PTS and PSTN) can be implemented on one set of equipment if it meets the requirements of both classes.

Automatic registration (recording) of negotiations on the PSTN must be provided in the Grid Control Centre and at the electric grid facilities. At the electric grid facilities, the use of software and hardware for recording negotiations without redundancy is permitted.

8.11.12 Network Clock Synchronization Network.

The Clock Network Synchronization (CNSS) network consists of:

- Sources of the reference synchronization signal. Function – generation and restoration of the reference synchronization signal. Implemented on generator equipment: primary reference generators (PRG), secondary master generators (SMG), network element generators (NEG).
- Control and monitoring system. Implemented by external PTC (equipment configuration management, condition and quality monitoring) and diagnostic and control tools built into the equipment.

The organization of TSS systems in the communication networks of electric grid companies must be ensured using their own generating equipment, as well as receiving clock network synchronization services from communication operators.

8.11.13 Power supply systems for communication equipment.

Communication equipment, in terms of power supply reliability requirements, belongs to category I and requires uninterruptible power supply.

Power supply for communication equipment must be provided from the power supply system.

8.11.13.1 The SBE consists of the following elements:

- rectifier system (has a modular design, the number of rectifier modules depends on the connected load). Function – conversion of input voltage 220/380 V of single/three-phase AC network into output voltage 48 V DC. If it is necessary to supply power to communication equipment with an input voltage different from 48 V, it is permissible to change the nominal value of the output DC voltage of the rectifier system.
- inverter system (has a modular design, the number of inverter modules depends on the connected load). Function – inverting the input voltage of 48 V DC into an output voltage of 220 V of a single-phase AC network.

- voltage converters (have a modular design, the number of voltage conversion modules depends on the connected load). Function – converting the input voltage of 220 V DC to the output voltage of 48 V DC.
- input, protection and switching devices (automatic throw-over circuit-breaker, input and distribution panels, etc.). Function – protection of communication facilities from the effects of the electrical grid and distribution of electrical energy.
- control and management systems. Function – monitoring of power supply systems, circuit breakers, automatic throw-over circuit-breaker, etc.
- autonomous sources of alternating current electrical energy (diesel generators, etc.). Function – independent power supply for communications equipment.
- rechargeable batteries. Function – independent power source for communication equipment.

8.11.13.2 The power supply of the power supply system is carried out from two independent sources.

Any of the independent sources can be used:

- Switchboard for single/three-phase AC network with rated voltage of 220/380 V.
- Autonomous source of alternating current electric energy via a single/three-phase alternating current network with a nominal voltage of 220/380 V.
- An operating DC voltage system over a 220 V DC network

8.11.13.3 The autonomous operation time of the power supply system is determined based on the power supply scheme of the substation and the composition of the power supply system, taking into account the time of restoration of power supply from external sources, which must be at least 2 hours.

8.11.13.4 The set and number of elements of the power supply system must provide power supply for communication equipment via two independent circuits, excluding common elements, while:

- Communication equipment that can be powered via two inputs must be provided with two independent power supply circuits;
- Communication equipment capable of being powered via one input must be provided with two independent power supply circuits through static voltage switches and diode isolation;
- redundancy of modules (rectifiers, inverters, voltage conversion) must be provided. The withdrawal of one module from operation for any reason must allow the power supply of communication equipment to be provided in full.
- failure of one or more modules supplying AC loads shall not result in degradation of the installed capacity for supplying DC loads.
- failure of one or more modules supplying DC loads shall not result in degradation of the installed capacity for supplying AC loads.
- The power supply system must have the ability to disconnect low-priority loads when the battery is discharged.

8.11.13.5 The design of the power supply system must allow for an increase in output power by installing additional rectifier and inverter modules and be built on a block-modular principle.

8.11.13.6 The service life of the battery in buffer mode with the retention of at least 80% of the initial capacity should be 12 years or more. It is permissible to use a battery with a capacity of up to 10 Ah with a service life of at least 10 years.

8.11.14 Third party telecommunications resources

When creating communication networks, power grid companies can use telecommunication resources of communication networks of third-party organizations:

- resources of technological communication networks of related electric grid companies;
- resources of public communication networks of communication operators, taking into account the requirements of clause 8.11.2.5.

The telecommunications resources of third-party communication networks used include:

- physical circuits (primarily optical) for transmitting telecommunication signals;
- communication equipment;
- services provided by electric grid companies to each other;
- communication services provided by communication operators.

At the same time, responsibility for compliance with the required quality indicators of information exchange organized using telecommunication resources of third-party organizations, the norms and requirements of the regulatory legal acts of the Russian Federation and the local regulatory acts of PJSC Rosseti, is assigned to the electric grid companies using such resources.

Technical parameters and requirements for the provision of telecommunications resources by third-party organizations must be defined in Service Level Agreements (service provision) between third-party organizations and electric grid companies.

When using public communication network resources to organize information exchange of significant objects of critical information infrastructure, it is necessary to be guided by Resolution of the Government of the Russian Federation of 08.06.2019 # 743 "On approval of the Rules for the preparation and use of resources of the unified telecommunication network of the Russian Federation to ensure the functioning of significant objects of critical information infrastructure" and order of the Federal Service for Technical and Export Control of 28.05.2020 # 75.

8.11.15 Protection of communication networks from unauthorized access

8.11.15.1 In order to protect against unauthorized access to communication networks, organizational and technical measures must be taken to prevent access to software and hardware systems, means, lines and communication structures located both inside and outside the facilities.

8.11.15.2 Organizational and technical measures determine:

- organization of access control to the protected area within which communication facilities are located (protected area) and the procedure for protecting this area;
- procedures for the use of technical means of protection, detection and signaling in a protected area;
- a list and samples of documents granting the right to be in the protected area, as well as in communication facilities and individual premises located within the protected area;
- the procedure for obtaining permission to carry out work on communication facilities and lines, as well as work related to the technological possibility of access to information transmitted via a communication network, establishing a list of persons entitled to carry out such work;
- the procedure for registering events related to the implementation of access to communication facilities, lines and structures.
- equipping communication facilities and structures with access control means;
- the presence of locking devices for premises and linear cable structures in which communication facilities and lines are located.

8.11.15.3 The minimum set of measures to protect against unauthorized access to elements of nodes and communication networks should include:

- measures that prevent persons who do not have the right to access means of communication;
- control of connection to communication facilities of technical and software tools used during operation;
- registration and subsequent control of the actions of service personnel during the operation of communication facilities and structures;
- using role-based access;
- use of personal authentication for remote access to systems;
- registration and subsequent control of facts of access of individuals, including service personnel, to communication facilities and structures during operation and construction.

8.11.15.4 To protect against unauthorized access to communication facilities not located in protected areas, the following must be performed:

- equipping premises and buildings in which communication equipment is located with locking devices, alarm and security alarms;
- installation of communication equipment in places that exclude or significantly impede unauthorized access to them;
- equipping cabinets with communication equipment with locking devices and sensors to alert against unauthorized access;
- inspections and walk-throughs of cable-line structures, including telephone sewer manholes, cable terminal devices, and keeping an inspection log.

8.11.15.5 Events related to unauthorized access to networks and communication facilities and information transmitted through them are recorded in writing and certified by the signature of the official who registered the event.

8.11.16 Organization of the technical operation system of the EGC CN

8.11.16.1 The technical operation system of the ESC SS is organized in accordance with the Rules for the technical operation of electric power plants and networks of the Russian Federation, approved by order of the Ministry of Energy of Russia dated 04.10.2022 # 1070, the Rules for the organization of technical maintenance and repair of electric power facilities, approved by order of the Ministry of Energy of Russia dated 25.10.2017 # 1013, and other current regulatory legal acts and technical documents.

8.11.16.2 The purpose of the STE is to maintain continuous operational readiness of the communication networks of electric grid companies for their intended use to ensure information exchange with specified quality parameters.

8.11.16.3 STE EGC CN is a set of methods and algorithms for operating a complex of means, nodes and communication lines, technical personnel of electric grid companies, ensuring the functioning of the communication network with the required quality indicators, the necessary material and technical support.

8.11.16.4 OTE are elements of communication networks, systems that ensure their functioning, and communication facilities.

8.11.16.5 The STE of a communication network must be built on a territorial-hierarchical principle with the number of hierarchical levels determined by the specific conditions of technical operation and the scale of the communication networks being serviced.

8.11.16.6 STE EGC CN is provided with:

- in the Executive Office of PJSC Rosseti (federal level) by organizational structures that ensure the implementation of the Unified Technical Policy in terms of technical operation of the EGC CN and technical operation of networks and communication systems that require centralized distribution of resources taking into account all the needs of the communication networks of electric grid companies;
- in Rosseti Centre, PJSC (territorial level), as well as in branches of Rosseti Centre, PJSC (regional level) by organizational structures that ensure the technical operation of communication networks in their area of operational responsibility.

8.11.16.7 Technical operation includes:

- commissioning, as a set of organizational and technical measures aimed at checking the functional and technical characteristics of equipment, systems and communication networks (hereinafter referred to as communication networks) for compliance with the requirements of the design documentation, in accordance with the regulatory, technical and organizational and administrative documentation in effect at the time of acceptance;
- management of communication networks, as a set of organizational and technical measures aimed at ensuring the functioning of communication networks, which are reduced to the processes of monitoring and controlling the state of nodes, lines and interactions of nodes.
- technical maintenance and repair (TMR) as a set of organizational and technical measures aimed at maintaining the operability and repair of equipment and communication lines.

8.11.16.8 The main tasks of communication network management are:

− Failure management. In terms of failure management, the following is ensured:

- 24-hour monitoring of the state of communication networks using control and monitoring systems;
- coordination and control of scheduled, unscheduled and emergency recovery work on communications networks, including those of interacting communications operators;
- preparation of operational reports and maintenance of operational and technical documentation on the status of the OTE EGC CN;
- generation of network reports;
- informing and escalating management on the progress of work to eliminate malfunctions of equipment and communication lines of the EGC CN.

Failure management is carried out by specialized round-the-clock duty services formed at the territorial level; it is advisable to form such services for several subsidiaries of PJSC Rosseti. The presence of duty shifts at the regional level is allowed with the appropriate justification.

Failures should be recorded in an incident registration system that ensures incident classification, integration with monitoring and technical accounting systems, and data export in the required forms.

− Configuration management. In terms of configuration management, the following is provided:

- analysis of the technical feasibility of implementing requests for changes, development and approval of technical solutions and work plans;
- making changes to the operating configuration of equipment in accordance with approved technical solutions and work plans;
- backup of the current active hardware configuration.

Technical accounting of resources.

Technical accounting of resources ensures the availability of reliable information on the state of the ESC SS, timely updating and maintenance of the functional completeness of data in accordance with the adopted model and forms of accounting, including equipment and communication lines. Technical accounting should be organized using specialized software - a telecommunications resource accounting system (TRAS), based on a logically interconnected resource-service model of the state of communication networks and the formed network/application services.

Management . Performance management includes:

- monitoring the implementation of service level agreements;
- control of traffic intensity of communication directions or virtual connections;
- determination of readiness factors;
- analysis of communication network performance for planning and

operational management purposes;

- analysis of the causes of equipment and communication line failures, planning and implementation of measures to eliminate them.

8.11.16.9 The main tasks of maintenance and repair are:

- Organization and implementation of work on scheduled maintenance of equipment and communication lines;
- Organization and implementation of emergency recovery operations on equipment and communication lines;
- Technical support for maintenance and repair, including the formation of spare parts and emergency reserves (ER) for equipment in operation and communication lines, which must be carried out taking into account failure statistics based on the principle of minimum sufficiency to achieve the established readiness parameters;
- Organization of service maintenance, including post-warranty maintenance, providing for the quota supply of spare parts on demand from the warehouses of manufacturers and system integrators.
- Maintenance and repair of fiber-optic communication lines located on overhead power lines is usually carried out with the involvement of overhead power line service personnel.

8.11.16.10 The STE organization must ensure the implementation of organizational and technical measures to protect the communication networks of electric grid companies from unauthorized access.

## 9 Territory, industrial buildings and structures

9.1 Territory, site and internal driveways

9.1.1 When designing a substation, the requirement for the location of structures and equipment on the territory must be taken into account, taking into account:

- the use of machines, mechanisms and mobile laboratories during repairs, maintenance and testing of equipment;
- delivery of heavy equipment to the installation site (foundation) using motor vehicles or rail vehicles;
- industrial safety requirements when using lifting structures and equipment operating under excess pressure.

9.1.2 The following must be provided on the territory of the SS:

- roads, approaches to (on) the territory of the substation (access road for connecting the substation with the general network of motor roads; backup access road to the substation if the area of the substation is more than 5 hectares; internal motor roads; access railway tracks to the substation with the highest voltage class of 220 kV and higher - in case of technical impossibility of delivery of heavy loads by road transport);

- water supply, heating, water disposal, sewerage, drainage facilities;
- oil receivers, oil drains and oil collectors to prevent oil spills in case of damage to oil-filled equipment, treatment facilities.

9.1.3 On the territory of the switchgear, pedestrian paths must be provided to ensure inspection of the equipment by personnel.

9.1.4 The territory, buildings and structures, utility networks, highways, railways, engineering and technical security equipment must be in proper operational and sanitary condition.

9.2 Architectural and construction appearance, layout, designs and materials of industrial and administrative buildings.

9.2.1 The designed buildings and structures of the SS must be united into a single architectural and industrial complex, executed in the approved corporate style for the design of the facades of the Company's buildings and structures (color schemes, emblems, etc.).

9.2.2 The façade parts of buildings and structures located in residential areas must fit into the surrounding architectural landscape.

9.2.3 During new construction and reconstruction in megacities, the designed substations must have minimum dimensions, while ensuring an appropriate level of safety, including environmental safety, and ease of operation.

9.2.4 The external appearance of the designed buildings and structures must comply with the current regulatory requirements for the architectural and urban planning appearance of a capital construction project and the rules for its approval by local government bodies.

9.2.5 Space-planning solutions should ensure the most efficient use of internal areas, facilitate the optimal placement of power communications, ease of maintenance, as well as the possibility of expanding the substation in accordance with the basic electrical circuit of the substation.

9.2.6 Foundations are selected based on the properties of the base soils, the results of engineering surveys and seismic conditions of the area, based on a technical and economic comparison of options and technical calculations.

9.2.7 The design and materials used in construction are selected on the basis of a technical and economic comparison, taking into account the territorial, climatic, transport and other features of the facility.

9.3 Ensuring the operational and sanitary-technical condition of industrial buildings, structures and sanitary-technical devices

9.3.1 When operating industrial buildings and structures, sanitary and technical devices, sanitary and preventive measures must be taken and safe working, living and rest conditions for personnel must be ensured in accordance with the current sanitary rules in accordance with Article 24 of Federal Law of 30.03.1999 # 52-FZ "On the Sanitary and Epidemiological Welfare of the Population".

9.3.2 Industrial buildings, structures, facilities that have premises for the permanent presence of personnel (continuously, for more than two hours during the working day or shift in accordance with Article 2 of Federal Law of 30.12.2009 # 384-FZ "Technical Regulations on the Safety of Buildings and Structures") (hereinafter referred to as ZIS) must be equipped with cold and hot water supply systems, water disposal, sewerage, heating, power supply, as well as ventilation and fire alarm systems.

9.3.3 Ensuring the safe operation of the facility, conducting periodic inspections and control checks, monitoring the condition of the foundation, building structures and engineering and technical support systems are carried out in the form of operational control by the person responsible for the operation of the ZIS, in accordance with the legislation of the Russian Federation.

9.3.4 The parameters of the microclimate, air exchange, levels of natural and artificial lighting, insolation, noise, vibration, electromagnetic fields in the premises of the ZIS must comply with the hygienic standards approved in accordance with paragraph 2 of Article 38 of Federal Law of 30.03.1999 # 52-FZ "On the Sanitary and Epidemiological Welfare of the Population".

The building materials and structures used during the operation of ZIS must comply with sanitary-epidemiological and fire safety requirements.

9.3.5 Sanitary and utility rooms, including dressing rooms, showers, washrooms, dining rooms, heating or cooling, rest, drying and storing special clothing, toilet rooms, places for placing drinking water supply devices and smoking are prohibited to be used for other purposes. The walls, ceilings and equipment of dressing rooms, washrooms, showers, toilets, drying and storing special clothing must have coatings made of moisture-resistant materials with smooth surfaces, and floors with anti-slip surfaces resistant to the effects of detergents and disinfectants. Sanitary and utility rooms must be regularly subjected to wet cleaning and disinfection using cleaning, washing and disinfecting agents.

9.3.6 For sites, areas and other isolated facilities with up to 15 workers at the facility, combined dressing rooms, toilets, showers and washrooms are permitted, while the number of places in the dressing rooms for special clothing, regardless of the storage method, must correspond to the number of workers engaged in the work.

9.3.7 The arrangement of rooms for drying special clothing and footwear, their capacity and the drying methods used must ensure complete drying of special clothing and footwear by the start of the next work shift.

9.3.8 The area adjacent to the ZIS must be covered with materials (concrete, asphalt, crushed stone, etc.) that prevent the formation of dust and dirt during rainy periods and snow melting.

9.3.9 The area must be cleared of garbage daily or as it becomes dirty.

9.3.10 The container site for collecting solid municipal waste must have a hard surface (asphalt, concrete) and a slope for the drainage of melt and rainwater,

have a fence on three sides at least 1 m high, and the dimensions of the site must exceed the area of the base of the containers by 1 m in all directions.

## 10 Energy saving and increasing energy efficiency

10.1. Energy saving in an electric grid company is a set of organizational, legal, technical, technological, economic and other measures aimed at reducing the volume of energy resources used while maintaining the corresponding beneficial effect from their use (including the volume of manufactured products, completed work, rendered services).

Energy conservation should be ensured by implementing a set of the specified measures that have a synergistic effect.

Increasing energy efficiency is the improvement of the energy and technological characteristics of the existing electric grid and engineering equipment of electric grid facilities, reflecting the ratio of the useful effect from the use of energy resources to the costs of energy resources incurred in order to obtain such an effect, as applied to products, technological processes, energy-intensive technical operations as a whole in the main or distribution electric grid complex.

Electric grid companies must ensure the achievement of economically justified efficiency in the use of energy resources at the existing level of development of technology and technology, while observing environmental protection requirements.

In the context of energy conservation and maintaining high energy efficiency indicators for all types of production and business activities related to the transmission and distribution of electrical energy, it is necessary to create conditions for the rational use of renewable natural and existing secondary fuel and energy resources available to the Company’s facilities.

10.2. The technical policy in the field of energy conservation and energy efficiency improvement should be aimed at implementing the requirements of the legislation of the Russian Federation in the field of energy conservation and energy efficiency improvement, comprehensive technical support for achieving the strategic goals and objectives of the Company in the field of energy conservation and energy efficiency improvement, rational use of natural and fuel and energy resources in the implementation of production and economic activities.

10.3. The objectives of the Unified Technical Policy of the Company in the field of energy conservation and increasing energy efficiency are:

- reduction of electrical energy losses during its transmission;
- reduction of consumption of all types of fuel and energy resources and water;
- achieving planned target indicators of energy efficiency in the use of fuel and energy resources and water.

10.4. The achievement of the Company's goals in the field of energy conservation and increased energy efficiency is ensured by the development of measures aimed at solving the following tasks:

- reduction of electricity losses during its transmission through trunk and distribution networks;
- reduction of energy resource consumption in industrial and administrative buildings, structures and facilities, including through equipping with automated systems for monitoring and managing energy resource consumption;
- reduction of consumption of fuels and lubricants by motor vehicles and special equipment used in the production and economic activities of the Company;
- equipping facilities with energy metering devices, organizing the process of collecting information based on data from energy metering devices;
- creation and implementation of innovative demonstration projects that ensure increased energy efficiency of power grid facilities and industrial and business facilities and their replication;
- conducting energy surveys with the development of measures aimed at the efficient use of energy resources;
- development and improvement of the Company's local regulatory acts for the implementation of activities in the field of energy conservation and increasing energy efficiency;
- formation of an energy saving management system in an electric grid company based on the implementation (development) of an energy management system in accordance with GOST R ISO 50001-2023 "Energy management systems. Requirements and guidance for use" and best world practices;
- formation and development of a corporate system for comparative analysis and evaluation of the results of the work of existing Energy Management Systems of subsidiaries, as well as branches;
- continuous training of personnel of electric grid companies in energy conservation and improving energy efficiency;
- formation of a culture of energy consumption among consumers and development of proposals for optimizing costs of energy consumption;
- analysis and implementation of best practices and best available technologies;
- use of modern energy-efficient electrical equipment with standardized energy efficiency indicators;
- development and adjustment of specific energy consumption rates for industrial and business facilities (buildings) taking into account the achieved energy efficiency class of the building;
- implementation and development of systems for monitoring and control of the use of motor vehicles and specialized equipment based on GLONASS/GPS positioning systems during production and business activities;
- equipping facilities with energy consumption meters, organizing the process of collecting information based on data from commercial and technical energy consumption meters, including on the use of electric energy for heating and

hot water supply of industrial and business facilities (buildings), as well as separate monitoring and accounting of electric energy consumption to ensure the operation of the Data Processing Centre, as separate functional production facilities of the electric grid complex;

- collection, analysis and phased implementation of best practices and best available technologies using ITS 48-2017 "Information and technical reference book on best available technologies. Improving energy efficiency in the implementation of economic and (or) other activities" (approved by order of Rosstandart dated 29.09.2017 # 2060) developed in accordance with GOST R 56828.24 2017;
- accounting for the use, in the implementation of production and economic activities, of modern energy-efficient energy equipment and engineering systems of operated facilities, with proven (implemented) energy efficiency indicators from the generated and updated Register of Energy Efficient Equipment and Technologies (approved by order of PJSC Rosseti dated 30.03.2023 # 162r);
- restriction of the use, when carrying out production and economic activities of the subsidiary at certain facilities of the electric grid complex, of morally and technologically obsolete equipment, technologies with low energy efficiency, low efficiency, as well as certain types of energy resources that can be replaced with more energy-efficient ones (use is prohibited without providing a detailed (extensive) technical and economic justification and reasons for the impossibility of using more efficient solutions).

10.5. In the context of energy conservation and maintaining high energy efficiency indicators, it is necessary to create conditions for saving not only electrical energy, but also thermal energy, motor fuel, and water resources.

10.6. In order to improve the efficiency of energy cost management, the energy management system should be implemented and continuously developed.

10.7. Energy management in electric grid companies must be continuous, constantly declared in quarterly and annual reports and a mandatory production element.

10.8. As part of energy management, power grid companies should:

- form a team (working group) on energy management from among experienced specialists and managers;
- establish the scope and boundaries of the energy management system;
- develop and approve the energy policy of the electric grid company, aimed at continuous compliance with the principles of energy conservation and increased energy efficiency for reliable and high-quality energy supply to consumers;
- develop energy goals, objectives and action plans in accordance with the development strategy of the electric grid company;
- create a register of technological and energy-consuming equipment;

- form basic values of target performance indicators (energy characteristics) based on the target indicators of the energy saving and energy efficiency improvement program of the electric grid company;
- compare the actual technical parameters of power equipment with the passport values of the manufacturers and the requirements of the technological regime;
- update and expand the register of energy-consuming equipment (to include smaller, previously unaccounted items) every 1-2 years;
- tighten requirements for the energy efficiency of electrical equipment every 2-3 years.

10.9. Electric grid companies must constantly increase the share of smart metering systems, in accordance with the requirements of the Russian Government Resolution of 19.06.2020 # 890 "Rules for providing access to the minimum set of functions of smart electric energy (capacity) metering systems" with electronic data collection and data processing, by replacing existing metering devices and other equipment in cases stipulated by the Basic Provisions for the Functioning of Retail Electricity Markets. It is necessary to ensure the use of digital data analysis capabilities with smart metering systems, and constantly increase the share of work performed by software using artificial intelligence technology.

10.10. Typical energy saving measures:

- identification of unaccounted consumption of electrical energy and analysis of electrical energy balances;
- ensuring the formation of correct useful supply of electrical energy;
- regulation of the power factor of electric energy;
- use of LED lamps with a luminous efficiency of 90-120 lm/W;
- application of local lighting systems;
- installation of automatic control for switching on/off lighting of the substation control unit, the substation territory, premises of service and production and administrative buildings;
- installation of devices for automatic switching on/off of heating systems for substation equipment, substation control units, premises of service and production and administrative buildings;
- use of windows and enclosing structures with high thermal resistance (insulation of walls, replacement of gates, doors and windows);
- ensuring control over the geolocation of vehicles and special equipment, integration of GIS data and optimization of transport routes and loading of vehicles and special equipment;
- use of natural light;
- use of infrared heaters at SS;
- use of sensors to control electrical appliances;
- use of cables and wires of the cross-section specified in the design documentation;

- uniform distribution of loads across phases;
- minimization of connections;
- use of self-supporting insulated wires and protected wires;
- use of modern means of protecting lines from short circuits;
- implementation of periodic monitoring of network insulation resistance, checking of electrical grid contacts;
- use of variable frequency drives, intelligent control systems for transformer and reactor cooling that take into account the thermal parameters of the equipment and the environment, equipment load and other methods for optimizing the operation of transformer and reactor cooling systems, including systems for utilizing heat from transformer equipment for heating the control unit;
- use of new generation current-limiting reactors;
- application of automatic heating systems for substation switchgear cabinets.

10.11. When designing new construction and reconstruction of existing facilities, it is necessary to develop a list of energy saving measures in the sections of design documentation in accordance with the requirements of the Decree of the Government of the Russian Federation of 16.02.2008 # 87 "On the composition of sections of design documentation and requirements for their content", while ensuring compliance with energy efficiency requirements, as well as consideration of the following measures with an assessment of their technical and economic feasibility:

- equipping with technical metering devices for consumed energy resources and water with automated collection of readings and storage of measurement archives;
- use of LED lamps with a luminous efficiency of at least 90 lm/W;
- application of lighting control systems, including lighting zoning, presence and light sensors, astronomical timers in outdoor lighting systems;
- priority application of architectural and design solutions approved in the “Album of standard solutions for buildings of substations 220-750 kV”;
- the use of electric heating devices controlled by the ambient air temperature;
- automated air conditioning control systems, including joint control of heating devices, control of window opening, and schedules of personnel presence at the workplace;
- the use of heat pumps and solar collectors in building heating systems.

10.12. When designing, reconstructing, overhauling and operating heated buildings (not related to electrical grid facilities), requirements for energy efficiency (specific characteristics of thermal energy consumption for heating and ventilation) should be established as part of sections of design documentation.

10.13. When designing new construction and reconstructing existing facilities, limit the use of the following types of equipment and technologies, unless

otherwise justified (lack of possibility of using energy-efficient equipment or introduction of energy-efficient equipment is economically impractical):

- unregulated electric heating systems for electrical equipment or buildings and structures;
- halogen incandescent lamps with a luminous efficiency of 17–25 lm/W (without appropriate justification);
- incandescent lamps with a luminous efficiency of 10–15 lm/W (without appropriate justification).

## 11 Electromagnetic compatibility

11.1. The substation must provide an electromagnetic environment in which the levels of electromagnetic impacts of all types do not exceed the permissible values for each specific device. At the same time, any electromagnetic impacts must not lead to damage or disruption of the operation of protection and automation devices, automated process control systems, TM, automated control systems, automated control systems, information collection and transmission systems, communication systems, operational current systems, fire-fighting systems, video surveillance systems, security alarms.

11.2. The electromagnetic environment at the substation is ensured by implementing a set of organizational and technical measures in accordance with current regulatory and technical documents:

- implementation of grounding devices that ensure potential equalization on the territory of the substation and grounded equipment;
- the use, as a rule, of corrosion-resistant materials with reduced specific resistance for the charger;
- implementation of lightning protection that prevents insulation flashover and penetration of overvoltages into secondary switching circuits;
- selection of the layout of the substation taking into account the electromagnetic influence of the primary circuits and equipment on the secondary switching circuits and individual devices;
- carrying out electromagnetic compatibility surveys for newly constructed and reconstructed substations by specialized organizations;
- selection of the method and routes for laying power cables and secondary switching cables that guarantee levels of interference, noise and other influences acceptable for the substation devices used;
- prohibition of laying direct current and alternating current circuits in the same cable;
- adoption, if necessary, of additional measures to ensure EMC (use of shielded cables, installation of filters in power supply circuits, SPDs, etc.);
- taking measures to protect electrical installations from high-frequency switching overvoltages;

- taking measures to protect against static electricity;
- taking measures to protect against radio radiation;
- the use of fully dielectric fiber-optic cables at substations that are protected from mechanical damage and rodents;
- placement of cable trays, usually below the ground surface, with the organization of drainage of groundwater and melt water, including at intersections with communications and at entrances to buildings.

## 12 Power quality monitoring and management

12.1 The purpose of quality control management, as one of the processes of the Company's quality management system according to the international standard ISO 9001:2015, is to maintain quality control indicators in electrical grids in accordance with the requirements of GOST 32144-2013, as well as compliance with the Requirements for the quality of electrical energy, including the distribution of responsibilities for its provision between entities in the electric power industry and consumers of electrical energy, approved by order of the Ministry of Energy of Russia dated 28.08.2023 # 690.

12.2 Control of the electricity quality in electrical grids includes solving the following technological problems:

- electricity quality monitoring;
- development and implementation of measures to maintain standard values of voltage deviations and to prevent voltage dips and overvoltages;
- development and implementation of measures to maintain standard values of electricity quality indicators characterizing non-sinusoidality, asymmetry and voltage fluctuations.

12.3 Monitoring of electricity quality

12.3.1 The objectives of monitoring the electricity quality are to assess the compliance of the electricity quality indicators with the requirements of GOST 32144-2013 and, if necessary, to monitor additional electricity quality characteristics (current, power) necessary to identify the causes of violations of regulatory requirements for the electricity quality, as well as compliance with the Requirements for the quality of electrical energy, including the distribution of responsibilities for its provision between entities in the electric power industry and consumers of electrical energy, approved by order of the Ministry of Energy of Russia dated 28.08.2023 # 690.

12.3.2 As intelligent systems for metering electrical energy (power) develop, these systems should become the main source of information on individual parameters of power supply quality in accordance with the company standards of PJSC Rosseti when interacting with consumers.

12.3.3 Currently, monitoring of the EQ in distribution electric networks and the UNEG is mainly carried out on the basis of periodic short-term measurements of EQ indicators performed by portable measuring instruments.

12.3.4 In order to improve the efficiency of the electricity quality management in the UNEG, as a basis for ensuring standardized electricity quality in electric networks of all voltage classes in general, stationary means of measuring electricity quality indicators and additional electricity quality characteristics (by current, power) are installed at newly designed and reconstructed UNEG substations and consumer substations. The readings of the specified measuring devices must be transmitted to a single automated electricity quality monitoring system, which is a multi-level, spatially distributed information technology system with access from the levels of branches and the executive apparatus of the Company.

12.3.5 To improve the efficiency of using the results of electricity quality monitoring performed by portable and stationary measuring instruments, automated systems are being created and developed that provide functions for processing, storing, presenting and initially analyzing the results of monitoring.

12.4 Measures to maintain standard values of voltage deviations and to prevent voltage drops and overvoltages.

12.4.1 When designing and reconstructing the Company's electrical grids, as well as when implementing new connections to the Company's electrical grids, the following measures aimed at maintaining standardized voltage deviations and preventing voltage dips and overvoltages must be considered:

- in UNES:
  - the use of switched reactive power compensation devices: SR, BSC (taking into account their possible influence on the values of harmonic components of voltages);
  - use of adjustable reactive power compensation devices: controlled shunt reactor, static reactive-power compensator, static var generator, SK/ASK (subject to technical and economic justification);
  - the use of highly reliable OLTC (auto-) transformers capable of providing automatic voltage regulation;
  - use of voltage boosters on the low (6-20 kV) voltage side of (auto-) transformers with automatic voltage regulation (in the presence of third-party consumers connected to these buses and the impossibility of ensuring standard values of voltage deviations without the use of voltage boosters);
- in distribution electrical grids also:
  - rational construction of power supply schemes for electricity consumers (transition to the use of higher voltage; increase in the cross-section of current-carrying conductors of power transmission lines; replacement of transformers with more powerful ones; replacement of transformers with a Z (zigzag) connection scheme for secondary windings; construction of additional power transmission lines, distribution substations, 6-20 kV transformer substations; uniform distribution of

loads across the three phases of the electrical grid);

- application of tapped transformers;
- use of stabilizers, boosters at a voltage of 0.4 kV;
- the use of energy storage devices, UPS with batteries or supercapacitors (as a side effect in the implementation of measures to improve the reliability of power supply to consumers and the availability of a technical and economic justification).

12.4.2 The use of additional reactive power compensators and voltage regulation means in the UNEG should be considered under the condition of complete exhaustion of the regulation range in 110 kV and higher networks and insufficient response speed of the reactive power compensation and voltage regulation means installed in the power system, which are dispatching objects (including at generation facilities and other owners). The developed measures for voltage regulation on 35 kV buses and below the UNEG substations should not lead to the impossibility of ensuring the required ranges and response speed of voltage regulation in 110 kV and higher electrical grids.

12.4.3 The automation of the voltage control system and voltage regulation equipment with a nominal voltage of 6 kV and higher installed at the UNEG substations must ensure the possibility of remote control of the technological operating modes and operational status of the said equipment from remote control centres (dispatch centres (in terms of equipment with a nominal voltage of 110 kV and higher, related to dispatching facilities) and the Grid Control Centre.

12.4.4 The use of additional reactive power compensators and means of voltage regulation in the distribution electrical grid should be considered in the following cases:

− complete exhaustion of the voltage regulation range on the power supply centre buses, taking into account the capabilities of the reactive power compensation and voltage regulation devices installed in this section of the network (including in the power supply centre, as well as at generation facilities and other owners participating in voltage regulation in the distribution electrical grid);

− power supply to an area with a low level of electricity consumption (including with a pronounced seasonal load) and no prospects for growth in electricity consumption;

− the lack of possibility of reconstructing the power supply centre/power transmission line, constructing additional power transmission lines, distribution substations, 6-20 kV transformer substations, or when the option of reconstructing/constructing the power transmission line/distribution substation/transformer substation is less economically efficient compared to the option of installing reactive power compensation devices and voltage regulation devices;

– the need for independent voltage regulation at individual connections of the 6–20 kV distribution network to the power supply centre in cases where the load schedules of the connections differ significantly and there is no possibility of ensuring the required voltage levels in the entire area under consideration by centralised regulation at the power supply centre.

12.4.5 The automation of reactive power compensation devices and voltage regulation devices installed in distribution electrical grids must ensure the possibility of remote control of technological operating modes and the operational state of the said devices from remote control centres:

– rated voltage of 110 kV and higher from control centres (in terms of control facilities);

– rated voltage of 35 kV and higher from the Grid Control Centre;

– nominal voltage of 0.4 – 20 kV from the Grid Control Centre (subject to technical and economic justification).

12.5 Measures to maintain standard values of electricity quality indicators characterizing non-sinusoidality, asymmetry and voltage fluctuations.

12.5.1 When implementing new connection to the Company's electrical grids of consumers with powerful non-linear/asymmetrical/abruptly variable loads, as well as facilities for the production of electrical energy, the output of which is carried out using inverter equipment, priority measures for compensating for distortions of currents and voltages must be implemented specifically at the specified consumer/generation facilities at the stage of new connection.

12.5.2 During the construction and reconstruction of the Company's electrical grids in areas where violations of regulatory requirements for indicators characterizing asymmetry/non-sinusoidality/voltage fluctuations are regularly recorded, the following measures must be considered:

– in UNES:

- application of adjustable reactive power compensation devices with phase-by-phase control: static reactive-power compensator, static var generator, controlled shunt reactor;
- the use of automated active filters based on modular multi-level voltage converters that provide voltage stabilization, harmonic filtering and voltage balancing in real time;

– in electrical distribution networks:

- rational construction of power supply schemes for electricity consumers (uniform distribution across the three phases of the electrical grid);
- use of phase current balancers (devices for equalizing asymmetric phase loads in 0.4 kV networks based on a symmetrizing transformer);
- use of transformers with a Z (zigzag) secondary winding connection scheme;
- use of unregulated harmonic filters and balun filters;

- application of adjustable reactive power compensation devices with phase-by-phase control: static reactive-power compensator, static var generator, controlled shunt reactor;
- application of active filters.

12.5.3 When selecting the optimal types, parameters and installation locations of means for compensating for asymmetry/non-sinusoidality/voltage fluctuations, the following must be taken into account:

− the actual composition of the electricity quality indicators, according to which, based on the electricity quality monitoring, violations of regulatory requirements are recorded during normal and repair schemes of the electrical grid;

− possible reasons for reduced electricity quality (connection points to the network and operating modes of dominant sources of current and voltage distortion, presence of current and voltage resonances, etc.);

− existing and prospective modes of operation of the electrical grid under normal and repair network schemes, including taking into account the possibility of power gain by consumers with distorting loads within the framework of current contracts.

12.5.4 In the event that violations of regulatory requirements are recorded for several indicators of the electricity quality (in terms of asymmetry/non-sinusoidality/voltage fluctuations), priority should be given to the use of multifunctional compensation tools that ensure the normalization of the electricity quality for all indicators that do not comply with the standards.

12.5.5 When selecting reactive power compensation means containing a capacitor bank in its composition, in network sections where regular above-standard levels of indicators characterizing the non-sinusoidality of voltage are observed, a check of this device, and in particular the capacitor bank, should be carried out for possible overload by currents of higher harmonics, as well as an assessment of the change in the levels of voltage harmonics in the adjacent network after connecting the compensation devices in question with the development of measures to prevent possible resonances of currents and voltages (if necessary).

12.5.6 The installation locations of the voltage asymmetry/non-sinusoidality/fluctuation compensation devices must be selected taking into account the following criteria:

− in the presence of a dominant source of distortion that determines the level of distortion in the entire adjacent network – as close as possible to the given object;

− in the presence of multiple sources of distortion and the need for priority provision of standardized EQ indicators in individual sections of the network - as close as possible to powerful load nodes, the use of the compensation tool in question near which will increase EQ for the greatest number of loads.

12.5.7 The operating modes of compensation devices installed on the low/medium voltage buses of the substation, but intended for priority compensation

of distortions on the medium/high voltage buses of the given substation, should not lead to deterioration of the electricity quality in the installation unit in the presence of a connection to the low/medium voltage buses of consumers.

## 13 Security and anti-terrorist protection of power grid facilities

13.1 Objectives and tasks of ensuring security and anti-terrorist protection of electric grid facilities (hereinafter referred to as Facilities).

Objectives: ensuring the stable and safe functioning of the Company's electric grid facilities, protecting the interests of individuals, the Company and the Russian Federation in the event of the commission/threat of committing acts of illegal interference.

Objectives: creation of a system for ensuring anti-terrorist security and ensuring its functioning, in particular:

- identifying threats of acts of illegal interference and preventing such threats;
- increasing the level of anti-terrorist protection by categorizing and equipping facilities of engineering and technical means of protection that meet the functional characteristics of the requirements of regulatory legal acts, organizational and administrative documents of the Company and the conditions of use;
- within the framework of the creation, modernization, and operation of systems of engineering and technical means of protection - conducting a regular assessment of the scale of possible consequences for the Facilities, social, political, economic, and environmental consequences, as well as consequences for ensuring the defense of the country, the security of the Russian Federation, and law and order in the event of an act of illegal interference;
- ensuring technological security and independence from imported equipment, services (works) of foreign companies and the use of foreign software through the replacement of software, as well as the priority use of only such software, information about which is included in the unified register of Russian programs for electronic computers and databases;
- development of corporate standards in the field of ensuring anti-terrorist security of Facilities;
- prevention of unauthorized access to information processed by systems of engineering and technical means of protection, destruction of such information, its modification, blocking, copying, provision and distribution, as well as other illegal actions in relation to such information;
- preventing any impact on engineering and technical means of protection that may result in their functioning being disrupted and/or terminated;
- conducting internal control in the area of ensuring security and anti-terrorist protection of Facilities by carrying out scheduled or unscheduled inspections;

- increasing the level of knowledge of employees on issues of ensuring security and anti-terrorist protection of Facilities, organizing (re)training of specialists on these issues.

Ensuring the security and anti-terrorist protection of the Facilities is carried out in accordance with the requirements of Federal Law of 21.07.2011 # 256-FZ "On the security of fuel and energy complex facilities", by-laws and organizational and administrative documents of the Company.

Requirements for ensuring the security and anti-terrorist protection of Facilities that have been assigned a hazard category are determined by the Government of the Russian Federation; in relation to facilities that have not been assigned a hazard category or that are not subject to categorization, they are determined by the Company.

13.2 Composition of engineering and technical means of protection:

1) engineering and technical means of protection:
   - engineering barriers;
   - engineering facilities and structures;
2) technical security means:
   - information collection and processing system;
   - security alarm system;
   - security television system;
   - security lighting system;
   - access control and management system;
   - alarm system;
   - power supply system of engineering and technical means of protection.

13.3 Engineering and technical means of protection

Engineering and technical means of protection, by their design and physical properties, ensure the creation of physical barriers to unauthorized entry into the Facility and (or) into the protected area (part of the territory, building, structure, facility, premises), the difficulty (delay) of an intruder's advance to vulnerable areas and critical elements of the Facility, passage into protected areas only in designated places, the protection of employees and visitors to the Facility, and also designate the boundaries of protected objects and areas (sites) within them.

13.3.1Engineering barriers are physical barriers of a special design that must not have elements that make it easier for an intruder to overcome them, made using materials that are capable of maintaining physical and mechanical characteristics no lower than the levels established during the design (construction) period of their design.

According to their functional purpose, engineering barriers are divided into:

a) main fence;
b) additional fencing;

c) warning fence.

The main fence is a permanent structure erected around the entire perimeter of the Facility.

The height of the main fence must be at least 2 m, it must not have any holes, breaches or other damage, unlocked or uncontrolled gates or wickets, or structures that facilitate unauthorized entry.

By type, the main fence can be visible or solid, taking into account the fire and explosion hazard category of the facility.

The use of visible primary fencing based on twisted mesh is prohibited.

An additional fence is installed above (must be visible) and below the main fence at facilities of any hazard category.

At sites located in permafrost zones, on rocky ground, as well as on sites where the area is covered with crushed stone at least 0.5 m thick, or has a hard surface (concrete, asphalt, etc.), the lower additional fence is not installed.

A warning fence marks the boundaries of the protected area of the facility and forms the restricted area of the facility together with the main fence. Warning fences are installed on individual sections of the facility's territory, critical elements of high and medium hazard facilities, as well as checkpoint areas (hereinafter referred to as checkpoints) of automobile or rail transport intended for its inspection.

13.3.2 Engineering means and structures include:

1) restricted area;
2) dividing and warning signs;
3) engineering equipment of security posts;
4) protective structures;
5) Checkpoint.

The restricted area is a specially designated strip of terrain running along the perimeter of the protected territory of the Facility and intended for the performance of official tasks by employees of security units in order to protect the Facility.

The engineering equipment of security posts includes guard booths, as well as partitions in buildings where security personnel serve in the form of barriers.

Protective structures include:

1) means of protecting window openings:
a) protective glazing;
b) protective metal window structures;
c) protective films;
2) doorway protection means:
a) metal door structures;
b) metal structures with protective glass inserts.

Protective structures are installed in window openings and door openings on the first floor that extend beyond the territory of the facility, as well as in external window and door openings of the checkpoint.

The installation of window and door openings with protective structures is carried out taking into account the requirements of the Russian Federation legislation on fire safety.

Checkpoints are installed at the main entrances (exits) and entry (exit) directions of facilities of any hazard category. Checkpoints for the passage of people can be combined with checkpoints for the passage of motor vehicles.

13.4 Technical security equipment

The perimeter of the facility, checkpoints, the perimeter of critical elements of high and medium hazard category facilities, as well as other sites, buildings and premises determined by the Customer during design are equipped with TSO.

When placing the TSO outdoors, as well as in unheated rooms, equipment of the appropriate climatic design must be used and all-weather lockable cabinets with a security alarm that monitors the opening or breaking of the door of such a cabinet must be used.

In explosion and fire hazardous areas of the facility, explosion-proof TSO must be used.

13.5 The SSOI must ensure:

1) receiving alarm notifications about intrusion into the Facility;

2) control of taking (removing) the Facility ( facility zone) from security;

3) display of received information;

4) video verification of information received from the areas where video cameras are installed;

5) mutual integration of the security alarm system with the security television system;

6) the ability to access archived data of technical security equipment for their analysis.

When integrating a security alarm system with a security television system, the following must be ensured:

1) automatic output to a dedicated alarm monitor or automated workstation of images received from cameras monitoring the area where the security alarm was triggered, to confirm the fact of illegal actions, determine the nature of the violation, assess the situation, and take the necessary measures;

2) automatic positioning of the rotating video camera (if it has such a capability) to the area where the security alarm is triggered;

3) automatic switching on of lamps and additional security lighting in the area where the security alarm system is triggered;

4) automatic activation of alarm notification devices based on signals received from the TSO in accordance with algorithms defined by the Customer.

13.6 Security alarm system

The security alarm system is designed to detect and notify of unauthorized entry (attempted entry) or other unauthorized actions at the Facility and includes the following technical means:

1) security detectors designed to generate an alarm notification automatically or manually;

2) devices for collecting and processing information (receiving and control devices, end devices, controllers and security panels, interface modules, etc.);

3) light and sound (speech) notification devices (local notification devices);

4) control and indication devices (control panels, mnemonic diagrams, indicator panels, etc.);

5) auxiliary devices (backup power supplies, switching devices, etc.).

Security detectors must be placed in such a way as to prevent the possibility of bypassing or overcoming their detection zone without generating an alarm notification.

Information about events generated by the security alarm system must be stored for at least 30 days.

13.7 Security television system

The security television system provides visual monitoring of the situation on the perimeter of the Facility and the adjacent territory, critical elements of the facility and individual sections of its internal territory (for facilities of high and medium hazard categories), as well as the transmission of visual information.

The Facilities may use a security television system with video detection functions (moving object detection function) and video analytics.

Video cameras are installed on separate supports, brackets fixed to the main fence, security lighting supports, Facility structures, walls of buildings and structures, or inside premises.

The subject of the fuel and energy complex determines the location and height of installation of video cameras, the type of lens and the angle of inclination of its optical axis, based on the condition of forming the required observation zone, including the zone for continuous observation of the closed perimeter of the Facility, while the location of the video cameras must exclude their illumination and the presence of “dead (blind) zones” on the perimeter of the Facility.

At Facilities of any hazard category, video cameras must provide visual monitoring of:

1) the perimeter of the object with an observation zone covering the internal restricted area and the territory adjacent to the object;

2) actions of security personnel in checkpoint areas;

3) behind emergency passages (driveways) to the Facility;

4) other elements (zones) of the facility, by decision of the fuel and energy complex entity.

Video cameras intended for outdoor installation must be placed in housings that ensure their operability when exposed to natural factors in accordance with the climate zone.

Information about events generated by the security television system must be stored for at least 30 days, and the search through the video archive must be carried out by specifying the time, date and video camera ID.

13.8 Security lighting system

The security lighting system must provide stable and uninterrupted lighting during the dark hours of the day of the perimeter of the facility, security zones established in accordance with the legislation of the Russian Federation.

The facility's security lighting system can be integrated with the security alarm system so that when an alarm notification is generated, additional lighting is automatically switched on in the relevant area at night, and also manually during the day when visibility is poor.

The security lighting system of the Facility must ensure:

1) uniform illumination at ground level of continuous strips at least 3 m wide around the perimeter of the facility;

2) control of lighting devices of the security lighting system, including additional lighting, from the security post of the facility;

3) compatibility with technical means of the security alarm system and security television system.

Lighting devices of the security lighting system must be installed on the main fence or on separate supports, facades (roofs) of buildings and structures in such a way as to exclude illumination of television cameras.

During the design, the customer determines the number of lighting fixtures in the security lighting system, their installation height and lamp power based on the required illumination level in accordance with lighting calculations.

Lighting devices of the security lighting system must be protected from mechanical damage (if necessary) and have an operating temperature range corresponding to the climatic zone of the facility’s location.

The security lighting system must ensure the functioning of the security television system.

13.8.1 Access control and management system

The ACS provides authorized access to the Facility and to restricted access areas at the Facility by identifying a person using one feature or a combination of different identification features:

1) real code (access cards, touch-memory keys and other devices);

2) memorized code (keyboards, code-setting panels and other devices);

3) biometric features (fingerprints, retina and other features);

4) photo verification.

The ACS ensures the opening of devices that block controlled:

1) when reading the identification feature, access to which is permitted to a given restricted access zone at the Facility during a specified time interval;

2) upon receipt of a signal from the fire safety system or manually from a security officer in accordance with the rules of the access control and internal facility regimes.

Doors of individual rooms, entrances to buildings, as well as doors of airlock cabins equipped with ACS, must be equipped with mechanical closers.

When the power supply is disconnected, the access control system must ensure that its settings are saved, including the settings of the identification feature database and the event archive, and also ensure that the controlled barrier devices operate in autonomous mode when the connection with the server is lost.

Information about events generated by the access control system must be stored for at least 30 days.

Checkpoints of medium and low hazard category facilities must be equipped with an access control system that operates on the basis of at least one identification feature.

The fuel and energy complex entity can integrate the access control system with the security television system in terms of using the video analytics module "recognition of faces of people entering the facility" as an additional identifier.

13.8.2 Alarm system

The facility is equipped with the following alarm system devices:

1) panic buttons;

2) wearable devices (for high and medium hazard facilities) that provide remote transmission of alarm signals via wireless communication channels at any location of a security unit employee while performing his official duties at the Facility (radio buttons, radio key fobs, GPS trackers, etc.) (hereinafter referred to as wearable devices).

Panic buttons are installed in the cabins of security personnel performing tasks at checkpoints, as well as in the service rooms of security posts in places that are inconspicuous and inaccessible to unauthorized persons.

13.8.3 ITSO power supply system

The power supply of the ITSO must be uninterruptible and carried out either from two independent AC sources, or from one AC source with automatic switching to backup power (in emergency mode) and notification of physical protection personnel about the transition to power supply from the backup source.

To maintain power supply when switching between two independent power sources, rechargeable batteries are provided.

13.9 Technical means for detecting weapons, ammunition, explosive devices, items and substances restricted in circulation.

At facilities of any hazard category, when people pass through or vehicles enter, technical means for detecting weapons, ammunition, explosive devices, items and substances restricted in circulation (hereinafter referred to as technical inspection means) must be used, which include metal detectors (stationary, portable, hand-held), introscopes, endoscopes, probes and mirrors, and explosive detectors.

The decision on the advisability of using certain technical inspection means at the facility is determined by the Customer.

13.10 Technical requirements for ITSO elements are determined by:

− in relation to objects that have been assigned a hazard category – by the Government of the Russian Federation;

− in relation to objects that have not been assigned a hazard category or that are not subject to categorization – by an organizational and administrative document of the Company.

13.11 Features of providing additional security measures and anti-terrorist protection of facilities

Based on the decisions of the highest official (executive authority) of the constituent entity of the Russian Federation in whose territory the Facility is located, and also taking into account the current situation and emerging risks in the territory of this constituent entity of the Russian Federation, the fuel and energy complex entity implements measures to ensure additional security measures and anti-terrorist protection of the Facility.

If necessary, the Facility is equipped with:

− shelters that allow personnel and employees of the security unit to take cover during shelling of the Facility or an attack by unmanned vehicles (unmanned aerial, underwater and surface vessels and devices, unmanned vehicles and other automated unmanned systems), as well as in the event of a threat of such acts of illegal interference;

− protective structures that ensure the protection of critical elements (protective nets, concrete blocks, gabions, etc.);

− special technical means by which the detection and suppression of the operation of unmanned aerial vehicles is carried out, including by suppressing or converting remote control signals of unmanned aerial vehicles, influencing their control panels, as well as damaging or destroying unmanned aerial vehicles.

## 14 Information security

14.1 Goals and objectives of information security.

Objectives: ensuring the stable functioning of the critical information infrastructure of the subjects of the electric grid complex of the Rosseti group of companies (hereinafter referred to as the Subjects) during computer attacks against it, preventing unauthorized access to processed information, destruction of such information, its modification, blocking and distribution, as well as other illegal actions in relation to such information.

Objectives: creation of a security system for critical information infrastructure facilities and ensuring its functioning, in particular:

- increasing the reliability and security of the OKII of the electric grid complex through the supply of digital equipment, systems and technical means of information protection that have a reasonably sufficient set of built-in security functions and that correspond in their functional characteristics to the requirements of regulatory and technical documentation in the field of information security and the conditions of use;
- within the framework of the creation, modernization, operation of the OKII - conducting a regular assessment of the scale of possible consequences for the Subjects, social, political, economic, environmental consequences, as well as consequences for ensuring the defense of the country, the security of the Russian Federation and law and order in the event of computer incidents at the OKII of the Rosseti group of companies, assigning the OKII one of the categories of significance, the required level of protection of personal data;
- ensuring technological security and independence from imported equipment, services (works) of foreign companies and the use of foreign software in significant OKII through the replacement of software, as well as the priority use of only such software, information about which is included in the unified register of Russian programs for electronic computers and databases;
- development of corporate standards in the field of information security;
- ensuring the security of the OKII during operation:
- prevention of unauthorized access to information processed by the OKII, destruction of such information, its modification, blocking, copying, provision and distribution, as well as other illegal actions in relation to such information;
- preventing any impact on technical means of information processing that may result in disruption and/or termination of the functioning of the OKII and the processes that support (are managed, controlled) it;
- automation of processes for detecting and preventing computer attacks on OKII using machine learning algorithms and heuristic analysis;
- ensuring the continuous functioning of technical means of ensuring information security;
- conducting regular instrumental assessment of the effectiveness of the OKII security subsystem;
- ensuring the fastest possible recovery (self-recovery) of the OKII;
- interaction with the state system for detection, prevention and elimination of the consequences of computer attacks on information resources of the Russian Federation;
- application of risk-oriented management of critical information infrastructure assets, organization of verification and installation of critical software updates within the framework of the operation process;

- ensuring the safety of the OKII during decommissioning;
- conducting internal control in the area of ensuring the security of the OKII by carrying out scheduled or unscheduled inspections;
- increasing the level of knowledge of employees on information security issues, organizing (re)training of engineers, technicians, administrators and operators on information security issues.

14.2 Basic principles of development

The security system of the critical information infrastructure of the Russian Federation must be created in accordance with the requirements and provisions of Federal Law of 26.07.2017 # 187-FZ "On the Security of the Critical Information Infrastructure of the Russian Federation" and the Federal Law of 27.07.2006 # 152-FZ "On Personal Data", as well as the relevant by-laws.

The OKII security system should be created as a standard territorially distributed security system, including forces and means designed to detect, prevent computer attacks and eliminate the consequences of computer incidents.

The measures taken to ensure the security of the OKII should not have a negative impact on the functioning of the ASTU, the exchange of technological information, the functions of remote control of equipment and relay protection and automation devices from the Grid Control Centre and from the control centres of JSC SO UES.

The result of ensuring the security of critical information infrastructure should be the preservation of the achieved effects in terms of ensuring the reliability, technological and economic efficiency of power supply and other strategic goals of the digital transformation of the Russian electric power industry.

14.3 Basic requirements

14.3.1 The objects of protection in the context of ensuring the security of critical information infrastructure and processed information are:

- corporate information systems (including machine-readable information carriers, automated workstations, servers, means of processing alphanumeric, graphic, video and speech information, firmware, general system, application software) that ensure the sustainability of financial and economic activities;
- automated control systems (including automated workstations, industrial servers), programmable logic controllers, production and technological equipment (executive devices) with both local and remote control functions, or with functioning network interaction interfaces, firmware, general system, application software, ensuring a reliable supply of electricity to consumers;
- corporate and technological information and telecommunications networks (including telecommunications equipment, software, control system) that form a single information space and digital interaction environment;
- telecommunication networks used to organize interaction between objects;

- architecture and configuration of information systems, information and telecommunication networks, automated control systems, information (data) on the parameters (state) of a controlled (monitored) object or process (including input (output) information, control (command) information, control and measurement information, personal data, other critically important (technological) information, including that which is of commercial value due to being unknown to third parties.

14.3.2 Ensuring the security of significant critical information infrastructure is carried out depending on the established category of significance in accordance with the requirements established by the federal executive body authorized in the field of ensuring the security of the critical information infrastructure of the Russian Federation.

14.3.3 Ensuring the security of OKII without an established category of significance is carried out in accordance with the organizational and administrative documents of the Rosseti group of companies and the requirements of this Regulation.

14.3.4 In order to ensure the security of OKII, which are personal data information systems, these requirements are applied taking into account the requirements for the protection of personal data when they are processed in personal data information systems, approved by Decree of the Government of the Russian Federation dated 01.11.2012 # 1119.

14.3.5 If the object of protection is information when making money transfers, then in accordance with the Bank of Russia Regulation # 719-P dated 04.06.2020 "On the requirements for ensuring the protection of information when making money transfers and on the procedure for the Bank of Russia to monitor compliance with the requirements for ensuring the protection of information when making money transfers", it is necessary to be guided by the requirements for ensuring the protection of information when making money transfers, determined in the internal documents of the money transfer operator, bank payment agent (subagent), payment system operator, payment infrastructure services operator.

14.3.6 The implementation of these requirements is carried out by the Subjects independently or with the involvement of organizations that comply with the requirements of the legislation of the Russian Federation on licensing activities in the field of information security.

14.3.7 Depending on the category of significance, the required level of protection of personal data and current threats to information security, the following organizational and technical measures must be implemented in the OKII security system:

- identification and authentication;
- access control;
- software environment limitation;
- protection of machine storage media;

- security audit;
- antivirus protection;
- preventing intrusions (computer attacks);
- ensuring integrity;
- ensuring accessibility;
- protection of technical equipment and systems;
- protection of the information (automated) system and its components;
- planning of security measures;
- configuration management;
- software update management;
- response to information security incidents;
- ensuring actions in emergency situations;
- informing and training staff.

14.3.8 The following organizational measures are used to ensure the security of the OKII:

- organization of control over physical access to software and hardware components of the OKII and its communication lines;
- implementation of access control rules regulating the rights of access of access subjects to access objects, and the introduction of restrictions on user actions, as well as on changes in operating conditions, composition and configuration of software and hardware;
- description in organizational and administrative documents of the actions of users and administrators of the OKII components for the implementation of organizational measures;
- definition of the OKII security administrator;
- practicing the actions of users and administrators of the OKII to implement measures to ensure the security of the OKII and restore the information infrastructure and processed information;
- improving the qualifications of information security specialists, increasing user awareness.

14.3.9Technical measures to ensure information security are implemented through the use of operating systems from the Russian Software Register, and the following classes of software and hardware-software – information security tools (including those built into general system, application software):

- means of protection against unauthorized access to information;
- means of registration and management of security events;
- network level firewalls, logical network boundary level firewalls;
- industrial network level firewalls;
- means of filtering negative content;
- means of protecting online payment services and remote banking services;

- anti-virus protection tools for automated workstations of administrative and management personnel;
- anti-virus protection tools for automated workplaces of production personnel, industrial servers;
- anti-virus protection tools for network level, steam and web servers, file storage, anti-spam tools;
- means of detecting and preventing targeted attacks;
- means of guaranteed data destruction;
- means of detecting and preventing information leaks;
- means of cryptographic protection of information and electronic signature;
- means of protecting data transmission channels, including cryptographic methods;
- means of access control to information resources;
- backup tools;
- intrusion (attack) detection and/or prevention tools;
- threat detection and network incident investigation tools;
- means of automation of information security processes;
- means of protecting virtual environments.

The means of protection against unauthorized access to information include the following protection mechanisms (including those built into the general system, application software and/or hardware):

- trusted boot tools;
- identification and authentication of users;
- discretionary user access control; mandatory user and process access control;
- marking of documents and control of their printing;
- protection of input and output of information to an alienable physical medium;
- control of the integrity of critical files and data;
- control of access to peripheral devices and input/output ports;
- guaranteed deletion of data on disks and selective erasure of files, etc.

14.3.10 The basic set of technical means for ensuring information security includes:

- means of protection against unauthorized access to information (including built-in security functions in general system, application software and/or hardware);
- network level firewalls, industrial network level firewalls;
- intrusion (attack) detection and/or prevention tools;
- anti-virus protection tools for automated workstations, mail and web servers, file storage;
- means of access control to information resources;

- means of cryptographic protection of information and electronic signature;
- means of protecting communication channels, including cryptographic methods;
- backup tools.

The basic set of technical means is subject to adaptation in accordance with current threats to information security, the information technologies used, and the specific features of the functioning of the OKII. At the same time, measures directly related to information technologies not used in the OKII or with non-specific characteristics may be excluded from the basic set.

14.3.11 As means of ensuring information security, priority should be given to the use of means built into software and/or hardware and software (if available).

14.3.12 If it is impossible to implement the stated goals using built-in information security tools, the corresponding functionality must be provided by imposed information security tools.

14.3.13 To ensure the security of information and telecommunication networks, these Requirements shall be applied along with the regulatory legal acts of the federal executive body responsible for the development and implementation of state policy and legal regulation in the field of communications, as well as GOST R 62443 "Industrial communication networks. Security (cybersecurity) of networks and systems", GOST R 56498-2015 IEC 62443-3:2008 Industrial communication networks. Security (cybersecurity) of networks and systems. Part 3. Security (cybersecurity) of industrial measurement and control processes.

14.3.14 Routers certified for compliance with information security requirements (in terms of the security functions implemented in them) are selected as boundary routers that have access to the Internet information and telecommunications network.

14.3.15 The procedure for creating information systems, automated control systems, information and telecommunication network control systems, the stages of work, as well as the development of technical and working documentation must comply with GOST R 51583-2014 "Information protection. Procedure for creating automated systems in a secure design. General provisions", the provisions of Federal Law # 187-FZ of 26.07.2017 "On the security of the critical information infrastructure of the Russian Federation" and subordinate regulatory legal acts, as well as organizational and administrative documents of the Subject.

At the stages (phases) of the life cycle during the creation (modernization) of the OKII, the following is carried out:

- analysis of information security threats and development of a security threat model or its clarification (if any), determination of the category of significance of the OKII, the required level of protection of personal data;

− design of organizational and technical measures to ensure the information security of the OKII, development of working (operational) documentation for the OKII (in terms of ensuring its security);

− implementation of organizational and technical measures to ensure information security of the OKII, preliminary testing, vulnerability analysis, trial operation, acceptance testing and commissioning of the OKII and its security subsystem;

− regulation of processes for ensuring information security of the OKII during operation.

The design of solutions to ensure information security of new construction, expansion, reconstruction, technical re-equipment or modernization of electric grid facilities must be carried out in accordance with standard technical solutions approved by the organizational and administrative documents of the Company.

14.3.16 The results of the design of the OKII information security system are reflected in the design documentation (sketch (technical) design and (or) in the working documentation), developed taking into account GOST 34.201-2020 “Information technology. Set of standards for automated systems. Types, completeness and designation of documents when creating automated systems” (hereinafter - GOST 34.201-2020) and the organization's standards, in accordance with the established category of significance, the required level of protection of personal data.

14.3.17 Protection of processed information when using virtualization technologies is carried out in accordance with GOST R 56938-2016 "Protection of information when using virtualization technology. General provisions".

14.4 Assessment of compliance with information security requirements of the implemented organizational and technical measures to ensure security

14.4.1 Commissioning of the OKII is permitted if there is a protocol (act) of acceptance tests with a positive conclusion on the compliance and effectiveness of the adopted organizational and technical measures of information security with the established requirements for ensuring security.

14.4.2 To ensure the security of the OKII, technical means of ensuring information security must be used that have been assessed for compliance with information security requirements in the form of mandatory certification, testing or acceptance.

Confirmation of compliance of technical means of ensuring information security with requirements in the form of tests, including requirements for compatibility with automated process control systems, is carried out in accordance with the regulation approved by the organizational and administrative document of the Subject.

14.4.3 The assessment of the compliance and effectiveness of the adopted organizational and technical measures for the security of the OKII with the

established requirements for ensuring information security is carried out by the Subjects independently or with the involvement of organizations that have, in accordance with the legislation of the Russian Federation, a license for the relevant activity in the field of information protection before the commissioning of the OKII. The assessment of compliance should include an analysis of the vulnerabilities of the object in order to identify shortcomings (weaknesses) in the security subsystem and assess the possibility of their use to implement information security threats.

14.4.4 Certification of OKII interacting with state information systems is mandatory with the involvement of organizations that have, in accordance with the legislation of the Russian Federation, a license for the relevant activity in the field of information protection.

14.5 Restrictions on the use of technologies and equipment

14.5.1 The software and hardware and software that are part of the OKII and that store and process information must be located on the territory of the Russian Federation (except for cases when the placement of the said tools is carried out in foreign separate divisions of the Subject (branches, representative offices), as well as cases established by the legislation of the Russian Federation and (or) international treaties of the Russian Federation).

14.5.2 The software and DBMS used must not have publicly known vulnerabilities published on the Internet, provided that they can be used to implement information security threats.

14.5.3 The software and DBMS should not contain functions that allow:

- remotely connect directly to the software or DBMS for updating or management by persons who are not employees of the Rosseti group of companies, however, connection to the substation automated process control system for the implementation of remote control functions from the control centres of JSC SO UES is not a remote connection directly to the software or DBMS;
- automatically, without control on the part of the Subject, transfer information, including technological information, to the copyright holder (developer) of the software or DBMS, as well as to third parties.

14.5.4 All transferred software and DBMS must not have restrictions from the Copyright Holder (developers) or other persons on their use throughout the territory of the Russian Federation.

14.5.5 Technical maintenance and support of software, including DBMS, must be provided by the Copyright Holder (developer) or a representative of the Copyright Holder registered in the territory of the Russian Federation, and from the territory of the Russian Federation.

14.5.6 The development of software, including software for information security, must be carried out in accordance with secure software development standards.

14.5.7 Technical means of ensuring information security must be operated in accordance with the operating instructions (rules) developed by the developers (manufacturers) of these means, and other operating documentation for the technical means. When installing and configuring technical means of information security, compliance with restrictions on the operation of these means must be ensured, if they are included in the operating documentation.

14.5.8 The technical means used to ensure information security must be provided with warranty and technical support.

14.5.9 In the event of a technical need to organize remote access to software and hardware, including information security tools, organizational and technical measures are taken to ensure the security of such access, providing for:

- determining the persons and devices that are allowed remote access to the software and hardware of the facility, granting them minimal powers when accessing these resources;
- control of access to software and hardware of the facility;
- protection of information and data during their transmission via communication channels during remote access to the software and hardware of the facility;
- monitoring and recording the actions of persons who are allowed remote access to the software and hardware of the facility, as well as the processes initiated by them, and analyzing these actions in order to identify instances of illegal actions;
- ensuring that it is impossible for persons to refuse actions performed when implementing remote access to the software and hardware of the facility;
- providing two-factor authentication for remote access.

14.5.10 When using the OKII specified in paragraph 14.3.4., in the event that it is necessary to create test copies, it is necessary to use technologies for depersonalizing personal data.

14.6 Quality control (conformity assessment) of digital equipment, systems and technical means of ensuring information security.

14.6.1 Software and hardware and software that provide search, collection, storage, processing, presentation, and distribution of information at the facilities of the electric grid complex of the Rosseti group of companies, including technical means of ensuring information security, are subject to quality control (conformity assessment).

14.6.2 Quality control (conformity assessment) of software and hardware and technical means of ensuring information security is an internal testing system and is aimed at confirming:

- the absence of vulnerabilities and deficiencies in the software that could lead to violations of the design values of the parameters for performing target functions and (or) lead to technological disruptions;

− implementation by built-in information security tools of a reasonably sufficient set of security functions that correspond in their functional characteristics to the requirements of regulatory and technical documentation in the field of information security and the conditions of use at the facilities of the Company's electric grid complex and subsidiaries;

− the presence in the operating documentation of a description of the conditions for safe operation;

− compatibility of technical means of ensuring information security with automated process control systems;

− implementation by the manufacturer and developer of measures to develop secure software at all stages of the life cycle in accordance with GOST R 56939-2016;

− implementation by the manufacturer and developer of procedures for eliminating deficiencies, vulnerabilities and upgrading software;

− absence of copyright infringements on the transfer and use of software at the facilities of the Company's electric grid complex and subsidiaries.

14.6.3 Quality control (conformity assessment) is carried out for compliance with the information security requirements established by the regulatory legal acts of the Russian Federation, the regulations of PJSC Rosseti and the regulations of Rosseti Centre, PJSC, as well as for compliance with the technical conditions agreed upon by the manufacturer, developer with PJSC Rosseti, Rosseti Centre, PJSC.

14.6.4 Quality control (conformity assessment) for compliance with information security requirements is organized by PJSC Rosseti in accordance with the regulation approved by the organizational and administrative document of the Subject. The results of the quality control (conformity assessment) are formalized by the commission's conclusion and approved by PJSC Rosseti taking into account the conclusions on the possibility of using software and software-hardware and technical means of ensuring information security at the facilities of the electric grid complex of the Rosseti group of companies.

## 15 Fire, industrial and ecological safety and environmental protection

### 15.1 General provisions

15.1.1 In order to ensure reliable, safe and economical functioning of the facilities in operation, to preserve the life and health of workers involved in the design, construction, reconstruction, operation and liquidation of facilities , as well as to reduce the risks of harm to the life, health and property of third parties and the environment, measures must be organized in the field of industrial, fire and environmental safety.

15.1.2 One of the most important tasks in achieving the stated goals is effective planning, timely and high-quality maintenance and repairs (technical impacts) of equipment, buildings, structures, including technical devices at

hazardous production facilities, technical and technological systems. The scope and frequency of implementation of measures in the field of industrial, fire and environmental safety must comply with the requirements of the legislation of the Russian Federation and international obligations in the field of environmental protection.

15.1.3 The criteria for achieving the stated goals are the formation of unified principles and approaches to the processes of organizing and implementing organizational and technical measures in the field of industrial, fire and environmental safety.

15.2 Fire safety

15.2.1 Ensuring fire safety requirements at the operated and designed facilities of the Rosseti group of companies is based on creating the necessary level of protection of workers and property from fires and fulfilling the conditions for compliance of protected facilities with the requirements of Federal Law of 22.07.2008 # 123-FZ "Technical regulations on fire safety requirements".

15.2.2 The main factor in ensuring fire safety requirements is the formation of uniform principles and approaches to the procedure for organizing and implementing the requirements of legislation in the field of fire safety.

15.2.3 In order to implement fire safety requirements at operating and designed facilities, the following key activities are planned and implemented:

- establishment of a fire safety regime at the Company’s facilities, determining the rules of conduct for people, the procedure for the operation and maintenance of territories, buildings, structures, premises and other protected objects;
- development of systematic approaches to the implementation of fire safety measures, development of a fire safety management system for the Company;
- definition and assessment of a set of tasks to reduce and prevent the risk of fires at the Company’s facilities;
- improving the database of local regulatory acts of the Company in the field of fire safety;
- ensuring reliable operation of fire protection equipment;
- implementation of modern means and technologies for ensuring fire safety at the Company’s facilities;
- implementation of advanced and innovative scientific developments, technologies and methods of fire safety management at the Company’s facilities;
- ensuring work on the preparation and training of the Company's employees in fire safety measures.

15.3 Industrial safety

15.3.1 Ensuring industrial safety requirements at the facilities in operation is based on the priority of preserving the life and health of employees of Rosseti Centre, PJSC involved in the operation of hazardous industrial facilities (hereinafter referred to as HIFs) and third parties, including ensuring the level of protection against accidents and incidents at HIFs, as well as the consequences of such

accidents and incidents in accordance with the requirements of Federal Law of the Russian Federation of 21.07.1997 # 116-FZ "On Industrial Safety of Hazardous Industrial Facilities".

15.3.2 The main factor in ensuring industrial safety requirements at operating facilities is the timely and complete identification of hazardous production facilities in accordance with the requirements of Federal Law of the Russian Federation of 21.07.1997 # 116-FZ "On Industrial Safety of Hazardous Production Facilities".

15.3.3 In order to implement industrial safety requirements at the facilities in operation, the following key activities are planned and implemented:

- organization and implementation of industrial control at hazardous production facilities to ensure compliance with industrial safety requirements;
- ensuring the receipt of licenses for the operation of explosive, fire and chemically hazardous industrial facilities of hazard classes I, II and III in accordance with the requirements of Federal Law # 99-FZ of 04.05.2011 “On Licensing of Certain Types of Activities”;
- ensuring the implementation of industrial safety examinations of buildings, structures and technical devices used at a hazardous production facility, as well as the implementation of diagnostics, testing, inspections of structures and technical devices used at a hazardous production facility, within the established timeframes and in the required volume;
- ensuring receipt of a positive conclusion from the industrial safety expert review of design documentation for technical re-equipment, conservation and liquidation of a hazardous production facility;
- implementation of registration of hazardous industrial facilities in the state register of hazardous industrial facilities;
- planning and implementation of measures to localize and eliminate the consequences of accidents at hazardous industrial facilities of hazard class III, as provided for in paragraph 1 of Appendix 1 to the Federal Law of the Russian Federation of 21.07.1997 # 116-FZ "On Industrial Safety of Hazardous Industrial Facilities";
- ensuring the conclusion of civil liability insurance contracts for damage caused as a result of an accident at a hazardous facility;
- ensuring the training and certification of employees in the field of industrial safety, training and testing of knowledge of personnel employed at hazardous production facilities;
- timely and high-quality investigation of accidents and incidents at hazardous production facilities, development and implementation of measures to reduce the risks of similar accidents at other hazardous production facilities operated by Rosseti Centre, PJSC and its subsidiaries;
- implementation of interaction on industrial safety issues with state control (supervision) bodies.

15.4 Environmental protection and ensuring environmental safety.

15.4.1 The main principles of environmental protection and ensuring environmental safety are:

- compliance with the requirements and standards established by the environmental legislation of the Russian Federation and international legal acts in the field of environmental protection;
- priority of taking measures to prevent negative impacts on the environment over the implementation of measures to eliminate the negative environmental consequences of such impacts;
- protection and rational use of natural resources during the design, construction, reconstruction, operation and liquidation of power grid facilities.

15.4.2 In order to comply with environmental protection requirements and ensure environmental safety at power grid facilities, the following basic technical measures should be carried out:

- restoration and reclamation of lands disturbed during the construction, reconstruction, technical re-equipment and operation of electrical grid facilities;
- decommissioning of PCB-containing equipment by 2025, followed by its transfer for destruction;
- construction and reconstruction of water drainage systems, including ensuring the proper technical condition of local treatment facilities designed to treat wastewater;
- ensuring standard values of physical impact (construction of noise protection screens, etc.);
- the use of protected wires, which make it possible to significantly reduce the width of the clearing in forest areas;
- equipping overhead power line supports with special devices that prevent birds from nesting on the structural elements of the supports, using repelling and bird-protecting devices;
- arrangement of places for accumulation of production and consumption waste in accordance with the requirements of environmental and sanitary legislation.

15.4.3 Carrying out activities in the field of ornithological safety of electric grid facilities using special bird protection devices of anti-nesting, barrier, insulating, marker, combined and other types, including devices that prevent the construction of nests in places where birds and their waste products can come into contact with current-carrying wires and equipment contacts.

## 16 Electricity storage and charging infrastructure for electric vehicles

### 16.1 Electrical energy storage systems

16.1.1 The SNEE is an electrical installation, which is an actively adaptive device consisting of the main and auxiliary equipment, a set of computer programs, which together ensure the implementation of the SNEE technological cycle. The SNEE technological cycle is a working cycle of direct conversion of electrical energy from the electrical grid into a form or type that can be accumulated in an

energy storage device, accumulation of the converted energy and storage of the accumulated energy in the energy storage device, subsequent release of the stored energy from the energy storage device, reverse conversion of energy into electrical energy with its release to the electrical grid. The SNEE charge/discharge cycle is a SNEE technological cycle without the stage of storing the accumulated energy in the energy storage device. An active-adaptive device is an electrical device capable of changing its operating mode (parameters) according to a certain law both automatically and in accordance with the control actions of the ACS.

16.1.2 In the electric grid complex, the SNEE is recommended to be used to ensure the reliability of power supply to consumers, indicators of the quality of electric energy, the organization of power supply to remote hard-to-reach areas, the development of electric transport with justified economic feasibility of use, taking into account the current legislation of the Russian Federation.

16.2 Charging infrastructure for electric vehicles

16.2.1 Electric charging stations designed to charge electric vehicles from alternating current electrical grids must comply with the technical requirements of regulatory and technical documentation.

Electric charging stations can be used with alternating current (standard charging station) and direct current (fast charging station) depending on the goals of the development of the charging infrastructure.

16.2.2 The design of a DC charging station with a rated power of 40 kW or more must be modular with multiple converters to enable charging of electric vehicles when one or more converters fail.

16.2.3 The charging station must be equipped with a video surveillance system, which is installed behind the front panel of the charging station. The video surveillance system must ensure:

- the ability to store video data;
- the ability to remotely access the video surveillance system and video recording archive.

The charging station must be equipped with a system of protection against emergency situations.

16.2.4 The charging station shall supply charging current or charging voltage to the battery of the electric vehicle in accordance with the request from the charging control function of the charging station.

16.2.5 Nominal input voltages and input voltage frequencies of the charging station are selected according to GOST 29322-2014.

16.2.6 When operating an electric charging station, the quality of electricity in the network must be ensured in accordance with the Requirements for the quality of electrical energy, including the distribution of responsibilities for its provision between subjects of the electric power industry and consumers of electrical energy,

approved by order of the Ministry of Energy of Russia dated 28.08.2023 # 690, as well as in accordance with the requirements of GOST 32144-2013.

16.2.7 Electric charging stations can be equipped with an Internet access system, a system for remote monitoring and control of the station, as well as a power distribution system in case of network load.

## 17 Industrial and technical supervision and control.

17.1 All energy facilities and production structural divisions of the branches and subsidiaries of the Company are subject to technical supervision. Technical supervision includes multi-level continuous and periodic production and technical control of the state of energy installations (equipment, buildings and structures), other inspection procedures (hereinafter referred to as inspections) implemented in Rosseti Centre, PJSC and its subsidiaries. During inspections, an assessment of the reliability indicators of power transmission lines and equipment of energy facilities must be carried out taking into account the design and operating conditions.

17.2 Industrial and technical control includes centralized quality control of the fulfillment of mandatory requirements for the technical condition, organization of equipment operation, industrial safety and other areas of industrial activity in the branches and subsidiaries of the Company, with subsequent assessment of the effectiveness of decisions taken in these areas.

17.3 Inspections may include examination of materials, products, installations, plants, processes, work procedures or services, determining their compliance with requirements and then reporting the results to customers. Inspection parameters may include quantity, quality, safety, fitness for purpose, and continued fulfilment of safety requirements of installations or systems in operation.

17.4 Technical supervision is aimed at implementing the Unified Technical Policy of the Company, as well as preventing accidents, technological violations and incidents at electric grid and hazardous production facilities operated by branches and subsidiaries of the Company, fires and industrial accidents, and is an integral part of the processes of commissioning and operation of electric grid facilities.

The main tasks of technical supervision:

- increasing the level of equipment operation and the reliability of the electric grid complex;
- increasing the level of production safety, preventing accidents and industrial injuries due to failure to comply with established requirements;
- rounds and inspections of workplaces to ensure the readiness of personnel to work at electric grid facilities in accordance with the Rules for Working with Personnel in Electric Power Organizations of the Russian Federation;
- supervision and control over compliance with the requirements established by the legislation of the Russian Federation, by-laws, standards of the organization and regulations of Rosseti Centre, PJSC, regulatory technical

documents on the operation, maintenance and repair of electric grid facilities of branches and subsidiaries of Rosseti Centre, PJSC in accordance with the requirements of the Rules for the technical operation of electric power plants and networks of the Russian Federation, approved by order of the Ministry of Energy of Russia dated 04.10.2022 # 1070;

- organization of an internal control system for repair activities, including selective supervision and quality control of production processes, performance of maintenance and repair, activities to maintain equipment, buildings and structures of electric power facilities in good technical condition, in which they meet all the requirements established in the repair documentation for them in order to clarify the list of works and volumes of maintenance and repair and the timing of their implementation in accordance with the requirements of paragraph 4 of the Rules for the Organization of Technical Maintenance and Repair of Electric Power Facilities, approved by order of the Ministry of Energy of Russia dated 25.10.2017 # 1013);
- monitoring the technical condition of power transmission lines, equipment, devices, buildings and structures to determine the optimal forms and methods of technical impact in accordance with the requirements of paragraph 7 of the Rules for the technical operation of power plants and networks of the Russian Federation, approved by order of the Ministry of Energy of Russia dated 04.10.2022 # 1070;
- control over the organization of technical inspection of equipment, power lines, buildings and structures in accordance with the requirements of the current regulatory legal acts and local regulations of the Company;
- identification of negative trends and forecasting of possible consequences, reduction of reliability and level of industrial safety based on the analysis of technical supervision results and analytical data on technological violations and injuries.

17.5 Continuous monitoring of the technical condition of the equipment is carried out by operational and operational-repair personnel of the power facilities of the branches and subsidiaries of the Company. The scope of monitoring is established in accordance with the provisions of regulatory documents. The monitoring procedure is established by local production and job instructions.

17.6 Periodic inspections of equipment, buildings and structures are carried out by persons supervising their safe operation. The frequency of inspections is established by the technical manager of the separate structural division of the Company, but not less frequently than the frequency established by the Rules for the technical operation of electrical power plants and networks of the Russian Federation, approved by order of the Ministry of Energy of Russia dated 04.10.2022 # 1070. The results of inspections must be recorded in a special journal.

17.7 Persons, monitoring the condition and safe operation of equipment, buildings and structures, ensure compliance with technical conditions during the

operation of energy facilities, accounting for their condition, investigating and recording failures in the operation of power plants and their elements, and maintaining operational and repair documentation.

17.8 Employees exercising production and technical control over the operation of equipment, buildings and structures of the power facility must: organize the investigation of violations in the operation of equipment and structures; keep records of technological violations in the operation of equipment; monitor the condition and maintenance of technical documentation; keep records of the implementation of preventive emergency and fire safety measures; participate in the organization of work with personnel.

## 18 Terms and definitions

| | |
|---|---|
| Automated monitoring and technical diagnostics system | a system that provides for the collection, storage, processing of information and technical diagnostics in the mode of continuous monitoring of the parameters of an object using automated real-time systems and human participation |
| Transmission electrical grids | an electrical grid designed to transmit electrical energy from the producer to the connection points of the distribution electrical grids |
| Production assets | a set of material assets directly involved in the transmission and distribution of electric power, as well as those in emergency reserves used as an exchange fund. Production assets include electric grid facilities - power transmission lines, transformer and other substations, distribution substations and other equipment intended to ensure electrical connections and implement the transmission of electric power, buildings, structures, technological control systems |
| Electrical distribution networks | an electrical grid that ensures the distribution of electrical energy between consumption points |
| Repair | a set of technological operations and organizational actions to restore the operability, serviceability and resource of an object and/or its components. |

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| Information collection and transmission system | in accordance with GOST R "Unified energy system and isolated energy systems. Operational dispatch control. Remote control. Systems for collecting and transmitting information from electric power facilities to dispatch centres of the subject of operational dispatch control in the electric power industry." |
| Telemechanics | telemetry devices installed at power grid facilities. |
| Technical diagnostics | the process of determining the technical condition of an object. |
| Maintenance | a set of technological operations and organizational actions to maintain the operability or serviceability of an object during its intended use, waiting, storage and transportation. |
| Production staff | employees of Rosseti Centre, PJSC and its subsidiaries related to administrative and technical, operational, operational and repair and repair personnel |
| Data centre | a specialized building or premises within such a building for housing the main server and telecommunications equipment of the Company and connecting it to communication channels |

## 19 Abbreviations

| | |
|---|---|
| AB | battery |
| AVR | automatic input of reserve (backup power supply) |
| ASUE | autonomous hybrid electric power plant |
| AISCGGN | automated information system for monitoring ice load |
| APV | automatic re-enable |
| APS | automatic fire alarm |
| ARM | automated workstation |
| ASK | asynchronous synchronous compensator |
| ASMD | automated monitoring and dispatching system |
| ASTU | automated process control systems |
| ACS TP | automated process control system |

| | |
|---|---|
| ASUE | automated electricity metering system (the term also refers to automated information and measuring system for commercial electricity metering – AIMS KUE for the Wholesale Electricity Market) |
| ASEMPC | asynchronous electromechanical frequency converter |
| AFSU | an active filter-compensating and balun device based on modular multi-level voltage converters that provide voltage stabilization, harmonic filtering and voltage baluning in real time |
| BSC | static capacitor bank |
| BSHPD | wireless broadband access system |
| secondary systems of highly automated substations | highly automated substation |
| VDT | booster transformer |
| RES | renewable energy source |
| VZG | secondary master oscillators |
| VL | overhead power line |
| VLZ | overhead power line with protected wires |
| VLI | overhead power line with self-supporting insulated wires |
| VN | high voltage |
| VOLS | fiber optic communication line |
| BBT | back-to-back-tie |
| VRU | input distribution devices |
| HF | high frequency |
| GT | lightning protection cable |
| State Commission on Radio Frequencies | State Commission on Radio Frequencies |

| | |
|---|---|
| GROYE | the sphere of state regulation of ensuring the uniformity of measurements; |
| DGR | arc suppression reactor |
| DGU | diesel generator set |
| TO | a subsidiary and dependent company, shares of which are owned by Rosseti Centre, PJSC and its subsidiaries |
| UNES | unified national (all-Russian) electrical grid |
| EEC | Unified energy system |
| ZRU | closed switchgear |
| ZTP | closed transformer substation |
| ZU | chargers |
| UPS | uninterruptible power supply |
| IVK (IVK VU) | upper-level information and computing complex |
| IVKE | information and computing complex of electrical installation |
| IIC | measuring and information complex of measurement point |
| ITSO | engineering and technical security means |
| IEU | intelligent electronic device |
| KA | switching device |
| KVL | cable-overhead line |
| KZ | short circuit |
| CL | cable power line |
| KLS | cable communication line with metal cores |
| KP | connection controller |
| KRU | integrated switchgear |
| KRUV | integrated air-insulated switchgear (from a mixture of nitrogen ($N_2$) and oxygen ($O_2$)) |
| integrated switchgear | integrated switchgear with SF6 insulation |

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| switchgear of unilateral maintenance | complete stationary switchgear units for single-sided service |
| KTP | package transformer substation |
| KE | quality of electricity |
| LAN | local area network |
| local regulatory acts | local regulations of Rosseti Centre, PJSC |
| Power transmission line | power line |
| MI | measurement technique |
| MO | metrological support |
| IEC | International Electrotechnical Commission |
| R&D | research and development work |
| NN | low voltage |
| regulations | normative legal act |
| standards and technical documentation | normative and technical documentation |
| OZZ | single phase ground fault |
| OKGT | optical cable embedded in lightning protection cable |
| OKII | critical information infrastructure facility |
| overvoltage limiter | non-linear surge arrester |
| OPO | hazardous industrial facility |
| OPS | fire alarm system |
| OPU | general substation control point |
| ORD | organizational and administrative document of PJSC Rosseti |
| ORU | open switchgear |

| | |
|---|---|
| OREM | wholesale market of electricity and power |
| OTU | operational and technological management |
| OTE | technical exploitation object |
| PA | emergency automatics |
| PBB | tap changeover without excitation |
| PVC | polyvinyl chloride |
| PKE | power quality indicators |
| PP | transition point |
| PU foam | polyurethane foam |
| P.S. | substation |
| PTC | software and hardware complex |
| PTE | rules for the technical operation of electrical stations and networks |
| RD | guiding document |
| RPA | relay protection and automation |
| RMZ | lightning arrester |
| DS | distribution point, substation |
| LTC | voltage regulation under load |
| RRL | radio relay line |
| RISE | backup power supply |
| RSC | distribution grid company |
| DTS | distribution transformer substation |
| RU | switchgear |
| RSH | relay board |
| RES | electrical grid area |
| CAD | computer-aided design system |
| SBE | uninterruptible power supply system |
| SZ | degree of air pollution |

| | |
|---|---|
| SZAU | protection, automation and control system |
| SI | measuring instrument |
| SIW | self-supporting insulated wire |
| SK | synchronous compensator |
| SKRM | reactive power compensation means |
| ACS | access control and management system |
| SN | medium voltage |
| SNEE | electrical energy storage system |
| SOY | unified time system |
| SOPT | operating DC voltage system |
| SPD | data transmission network |
| SPZ | fire-fighting system |
| SPE | cross-linked polyethylene |
| SRN | voltage regulator |
| SSOI | information collection and processing system |
| SSPI | system for collecting and transmitting information from an electric power facility |
| EGC CN | power grid communication network |
| SSS | satellite communications network |
| static var generator | static reactive power compensator based on voltage converters; |
| static reactive-power compensator | static thyristor compensator |
| STO | organization standard |
| STE | technical operation system |
| DBMS | database management system |
| SUOT | occupational health and safety management system |
| SOUP | asset management system |

| | |
|---|---|
| SU | situational management |
| T/AT | transformer/autotransformer |
| TM | telemechanics |
| TN | voltage transformer |
| Maintenance and repair | maintenance and repair |
| TOW | current limiting device |
| TP | transformer substation |
| TPiR | technical re-equipment and reconstruction |
| auxiliary transformer | auxiliary transformer |
| TSO | technical security means |
| PSTN | telephone communication for operational negotiations |
| TT | current transformer |
| TER | fuel and energy resources |
| SPD | surge protection device |
| UPNKP | device for intentional non-simultaneous switching of poles |
| USD | data collection device (including a data acquisition and transmission device (data collection and transmission device) |
| controlled shunt reactor | controlled shunt reactor |
| FIF | Federal Information Fund for Ensuring the Uniformity of Measurements |
| FKU | filter compensating device |
| FSU | filter balun |
| CPU | feeding centre |
| TsSOI | information collection and processing centre |
| TSPI | digital information transmission system |

| | |
|---|---|
| CTN | digital voltage transformer |
| CTT | digital current transformer |
| CUS | grid control centre |
| SPAS | analog signal converter cabinet |
| ShPDS | discrete signal converter cabinet |
| SR | shunt reactor |
| SchPT | DC panel |
| SchSN | cabinet of own needs |
| EKB | electronic component base |
| EMS | electromagnetic compatibility |
| ESC | power grid complex |
| Electric charging station | electric charging station |
| APN | Access Point Name |
| CID | Configured IED Description |
| GOOSE | Generic Object Oriented Substation Event |
| GPRS | General Packet Radio Service |
| ICD | IED Capability Description |
| LPWAN | Low-power Wide Area Network |
| MMS | Manufacturing Message Specification |
| PLC | Power Line Communication |
| SCD | Substation Configuration Description |
| SSD | System Specification Description |
| SV | Sampled Values |
| VLAN | Virtual Local Area Network |
| VPN | Virtual Private Network |