

Development of the Unified National Power Network of Russia

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Abstract—Problems of functioning of the unified national power network (UNPN) of Russia are considered. Based on the analysis of the state and operation of power networks, the general principles of the development of the UNPN of Russia are determined.

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The operation problem of the unified national power network (UNPN) of Russia composes the basis of the transmission system of the Unified Energy System (UES) of Russia and involves power networks with a voltage of 220–330–500–750–1150 kV and some part of electric power lines (EPLs) with a voltage of 110 kV (not included in distribution networks).

At the beginning of 2010, the total extension of the UNPN EPLs was 122000 km. In addition, the UNPN contains about 800 electrical substations (SSs) with the total transformer power of 306000 MVA and other electrotechnical equipment (devices for compensation of reactive power, switches, breakers, and the automatic and computerized systems, including emergency automation systems).

The primary electrotechnical equipment mounted in installations of the UNPN, which operates in the continuous production cycle and determines the reliability and economy of the network operation, was made for the most part in the 1950s–1970s of the past century, yields to current developments in technical characteristics, dimensions and weight parameters, and reliability factors, and requires the periodic repair maintenance increasing in size as the lifetime rises.

The primary electric connecting circuits of operating SSs are oriented for equipment requiring constant technical maintenance, wherefore, they are meant for numerical ratios of switching apparatuses and connections which are in excess by modern criteria. This is the cause for the significant amount of serious technological violations through the fault of operation personnel.

Automation of technological processes at the end of 2010 was carried out for 79 SSs; and another 49 SSs are in the realization stage. Therefore, the basic scheme of the operation organization is oriented first of all to the 24-h residence of the operating personnel in them who control the installation state and fulfills operation switchings, which leads to a rise in the specific number of the personnel.

The UNPN installations for the most part use the base of the morally and materially outmoded apparatus of telemechanics and teleinformatics.

Electrical circuits of the majority of Russian power systems accept a voltage scale of 110–220–500–1150 kV. The Unified Power System (UPS) of the Northwest and, partially, the UPS of the Center use a scale of 110–330–750 kV. It should be noted that 330 and 750 kV networks in the UPS of the Center and the 330 kV network in the UPS of the South received an estimated expansion; and their further development is laid down, as a rule, in boundaries of regions of their substantial use.

The position of 110 kV lines amounts now to about 70% of the total extension for high-voltage lines (HVLs) with a voltage of 110 kV and more; and these lines gained the most expansion as the distribution network.

The 220 kV electrical networks operate in all regions of the Russian Federation except for single power systems of the UPS of the Northwest and the South for the power delivery of electric power stations and the power supply of loading centers of 35–110 kV networks and the power supply of large-scale consumers. For the most part, they are distribution networks, but fulfill system-forming functions in some power systems (Komi, Arkhangelskaya, Sakhalinskaya, etc.).

The 330 kV lines operate in the West and South of the UES of Russia. They realize power delivery of electric power stations, power supply of loading centers of 110 kV networks, and external power supply of large-scale production plants and connect the UES of Russia with the power systems of the Baltic States, Belarus, Ukraine, and Azerbaijan. The 330 kV electric networks in a number of power systems are system-forming.

The basic system-forming and intersystem EPLs in the UES of Russia are power networks with a voltage of 500 kV, which operate practically in all regions of Russia, providing the power delivery of the most large-scale electric power stations and the power supply of large-scale loading centers of 220 and 110 kV networks. The same EPLs serve for the connection of the