Classification of Devices of Protection of Linear Objects of Power Supply Against Dangerous Electromagnetic Influences on the Basis of Grounding with Distributed Parameters

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Abstract. In article it is offered results of the analysis of statistics of failures of devices and the systems of railway automatic equipment because of storm influences. Systematization of the main types used on railway transport of the grounding devices is given.

1. Introduction
As a result of long-term experience of service and the carried-out tests of separate elements and in general electric power supply systems of devices of railway automatic equipment and telemechanics it (AET) it is visible that isolation of constructive parts of this electric equipment resides under the influence of external factors which lead to internal overvoltage. The low levels of operating voltages under certain conditions can exceed all admissible normative values which lead to insulation breakdown in places of the underestimated resistance. These facts are fixed at numerous researches of manifestations of failures of attention devices, centralization and blocking (DCB). On network of the railroads of the Russian Federation during the storm period (from April 1 to October 31), more than five thousand cases of storm activity (according to Management of a way and constructions of Central Directorate of Infrastructure JSC "Russian Railways") which in turn bring to more than seven hundred cases of accretion of normal operation of AET devices are annually fixed.

2. Analysis
In the analysis of static data, it is visible that more than 60 % of total number of all facts of the registered refusals at a storm retension, are the share of automatic lock-out devices with the decentralized placement of the equipment. The provided data confirm need of further research and development of technical actions and means of protection of DCB devices and the AET systems from retension arising at lightning discharges.

The important role at protection of DCB devices and the AET systems against dangerous electromagnetic influences is played by grounding devices. When determining efficiency of use of various types and types applied in use objects it is AET the grounding devices and identification of the general and specific features and also the analysis allowing to systematize all grounding devices on a number of signs is made for definition of the direction of a research when developing technical solutions and recommendations about their design. When determining basic qualifiers of the grounding devices the analysis of the available references on the basis of which the following distinctive signs are chosen was made: the used material of grounding conductors, their configuration and a profile of section, design features and the carried-out functions. Not an unimportant role at
systematization of grounding plays types (systems) of grounding, a condition of a neutral of the power supply, device of the zero worker and zero protective conductor, a condition of the open carrying-out parts of electroinstallation concerning the earth etc. (Fig. 1).

Figure 1. Systematization of the grounding devices on a number of classification signs.

3. Systematization
On the carried-out functions distinguish working, protective and linearly - protective grounding. The grounding intended for connection with the earth of devices of protection (lightning rods, rated sportsmen) and also metal parts of the power equipment belong to protective. Linearly - protective grounding provide connection with the earth of metal covers and screens of various cables.

The profile of section of the grounding conductor defines the picture of spreading of current and the area of contact with soil which is directly influencing the size of resistance of the grounding device. At production of the grounding devices usually use such types of a profile as: pipe, core, strip, leaf and wire.

The design of grounding conductors is chosen taking into account specific resistance of soil and the required size of resistance to spreading of current. If the top layers of earth have the smaller resistance to spreading, than lower is considerable, then the superficial design of a contour of grounding and vice
versa is chosen. The main types of the used designs are the vertical, rod, horizontal, extended, ring, lamellar and deep grounding devices.

Material of the grounding conductor is chosen taking into account ensuring corrosion and mechanical resistance with grounding conductors. As material black or galvanized steel is usually used. In some cases copper and other materials can be used.

On a configuration distinguish the grounding executed in the form of slightly short, connected to a strip on a facade of the building, electrodes, a deep electrode and also in the form of modular and electrolytic grounding. The grounding conductor configuration usually is chosen taking into account a possibility of its application on a concrete object and results which is previously executed taking into account the corresponding configuration, calculation of parameters of the grounding devices.

On a condition of a neutral of the power supply distinguish devices with deafly - the grounded and isolated neutral. Deafly - grounded call the neutral which is directly attached to the grounding device or attached to it via the devices having small resistance, for example, current transformers, etc. The isolated neutral or does not join the grounding device at all or joins it via devices having big resistance, such as compensators of a capacitive component of current, etc. Unlike the considered earlier protective grounding, grounding of a neutral of the generator or transformer is called working grounding. Big short circuit current and also the considerable complication and rise in price of the grounding devices caused by need of significant increase in quantity of the grounding electrodes for the purpose of ensuring the required size of resistance of the grounding contour belongs to the main shortcomings of deaf grounding of a neutral.

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The design of grounding conductors is chosen taking into account specific On a condition of the open carrying-out parts of electroinstallation concerning the earth distinguish: protective grounding and protective zeroing. Understand as protective zeroing carried out for electrical safety, connection of the open carrying-out parts with deafly - the grounded neutral of the generator or transformer in three-phase electroinstallations or connection with deafly - the grounded conclusion of a source of single-phase current.

On the device of zero working (N) and the zero protective conductor (PE) distinguish earthing systems with association of the zero worker and zero protective conductor throughout network and an earthing system with association of zero working and protective conductors on a part of a system. Also distinguish systems with completely separate working and protective conductors. At modern construction according to Regulations for electrical installation, the role of protective and working grounding is carried out by separate contours, and connection to objects is carried out with respect for electric independence of N and RE of conductors.

On types of a system of grounding distinguish TN, TN-S, TN-S, TN-C-S, IT and a TT of a system. In a TN system the neutral of the power supply is deafly grounded, and the open carrying-out parts of electroinstallation are attached to a neutral by means of zero protective conductors. In TN-S to a system the zero protective and zero worker conductors are combined on all its extent of a system. In TN-S to a system the zero protective and zero worker conductors are divided on all its extent of a system. In TN-C-S to the system of function of the zero protective and zero worker of conductors are combined in some part of a system, beginning from the power supply. In an IT system the neutral of the power supply is isolated from the earth or grounded via the devices or devices having big resistance, and the open carrying-out parts of electroinstallation are grounded. In a TT to a system the neutral of the power supply is deafly grounded, and the open carrying-out parts of electroinstallation
are grounded by means of the grounding device, electrically independent from deafly - the grounded source neutral.

4. Conclusion
Objects of railway transport which are subject to obligatory grounding are: support of the feeding and sucking away lines; support with dischargers and section disconnectors of contact network; support of contact network; DCB and AET floor devices; wave guides and communication lines; high-voltage lines of power supply; lines of lighting; traction substations; the integral transformer substations fed on the system of the Two-Wires-Rail (TWR), tunnels; bridges and overpasses; separate objects near the electrified ways (posts of electric or microprocessor centralization). A main type of grounding devices of houses of communication, telephone exchanges, posts of electric and microprocessor centralization is the circuit from several probes (corners, pipes) made of black steel and grounding conductors connected among themselves with burying from 1.8 to 2.5 meters.

Derogations from design codes and mounting of grounding are inadmissible as in use it will lead to change of its parameters that will cause increase in probability of manifestation of failures not only the separate equipment, but also the systems of safety of train service on railway transport in general. These failures have an adverse effect on effective work of the transport system of the country as they can lead to faults or accidents, the followed loss of human life, extensive material damage and other negative effects. The choice and calculation at design, mounting and operation of the grounding equipment of objects of railway transport is very important task which execution should be tightly regulated normative and technical documentation, following to which should be obligatory.

The offered systematization of the grounding on the offered classification signs and characteristics revealed by results of the carried-out analyses allows to track the main technical solutions when developing of the specified devices. At the further researches conducted for the purpose of improvement existing and design of new types of the grounding devices not only for objects of railway transport, this systematization can be useful.

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