# FACTORS AFFECTING THE INSULATION OF POWER SUPPLY CABLES OF NON-PULLING CONSUMERS

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**Abstract:** In the article, almost all methods of factors affecting the insulation of power supply cables of non-pulling consumers are considered. Also, the detection of damaged areas of cables is also provided.

**Key words:** power supply, insulation, electromagnetic field theory, corrosion, magnetic field modeling, vibration energy.

# ФАКТОРЫ, ВЛИЯЮЩИЕ НА ИЗОЛЯЦИЮ КАБЕЛЕЙ ЭЛЕКТРОПИТАНИЯ НЕТЯНУЩИХ ПОТРЕБИТЕЛЕЙ

**Аннотация:** В статье рассмотрены практически все способы воздействия факторов, влияющих на изоляцию кабелей электропитания нетянущих потребителей. Также предусмотрено обнаружение поврежденных участков кабелей.

**Ключевые слова:** источник питания, изоляция, теория электромагнитного поля, коррозия, моделирование магнитного поля, энергия вибрации.

## INTRODUCTION

One of the main causes of damage to power supply cables of non-tractor railway consumers is the damage of the insulation shell and the erosion of the metal protective element under the conditions of use. As a result, the resistance of the cable insulation decreases and the normal operation of the cable line is disturbed. The serviceability of the cable is determined by the nature of the insulating sheath and the dependence on the protective metal elements of the cable.

Cables of the MP-1, MP-3 and MP-5 brands up to 35 kV are produced with oil-soaked paper insulation. Today, these cables are being replaced by polymer insulated cables. Polyethylene sheath is used for underground cables.

Below are the advantages of polyethylene insulated cables compared to paper-oil insulated cables:

a) when the ground burial heights of the cables with paper-oil insulation are different, drying of the insulation is observed at the highest point. Cables with polyethylene insulation do not have this drawback;

b) special materials and devices are not required for the installation of cables with polyethylene insulation. For example, it is not necessary to wrap a paper tape dipped in oil at the connection point;

c) the coefficient of dielectric dissipation angle, relative dielectric absorbance values are small in cables with polyethylene insulation;

g) additional heating is not necessary when burying polyethylene cables in the ground (but it is possible to bury voltages of 30 kV at a temperature of minus 200C);

d) polyethylene shell is less sensitive to environmental changes;

e) cables with polyethylene cable insulation are resistant to vibration.

Polyethylene insulated cables have several advantages as well as disadvantages. The process of electrical wear and the appearance of a training channel depends on the purity of the insulation material and the hermeticity along the length of the cable. Losses in the transmission of electrical energy occur mainly due to dielectric loss.

**Figure 1. Damage to the insulating sheath and aluminum sheath of the power supply cable.**

**MATERIALS AND METHODS**

The service life of the cables is evaluated by the flatness of the surface of the part between the screen and the insulation shell. In some parts of the cable, micro-heights are formed during production, and as a result, the value of the electric field strength increases. In order to maintain the performance of polyethylene-insulated cables, it is necessary to prevent the ingress of moisture through the insulating material to the current-carrying parts of the cable. Currently, lead, aluminum and polymer materials are used as cable sheath material. Lead is the least absorbent of these materials. It has a serious drawback: it is an expensive and rare material, it corrodes quickly under the influence of currents and has a large weight.

The plastic sheath is cheap, but it has a great moisture absorption property compared to the lead sheath, and the electrical parameters are also relatively low. Aluminum material is the most convenient to use. But this material is prone to corrosion. Therefore, rubber hoses are used as its shell, and the resistance of the insulating material should not be less than 5×106 Ohm·km.

**RESULTS AND DISCUSSION**

The risk of corrosion of the aluminum sheath occurs as a result of damage to the insulating sleeve when moving cables from one place to another, during use or during installation.

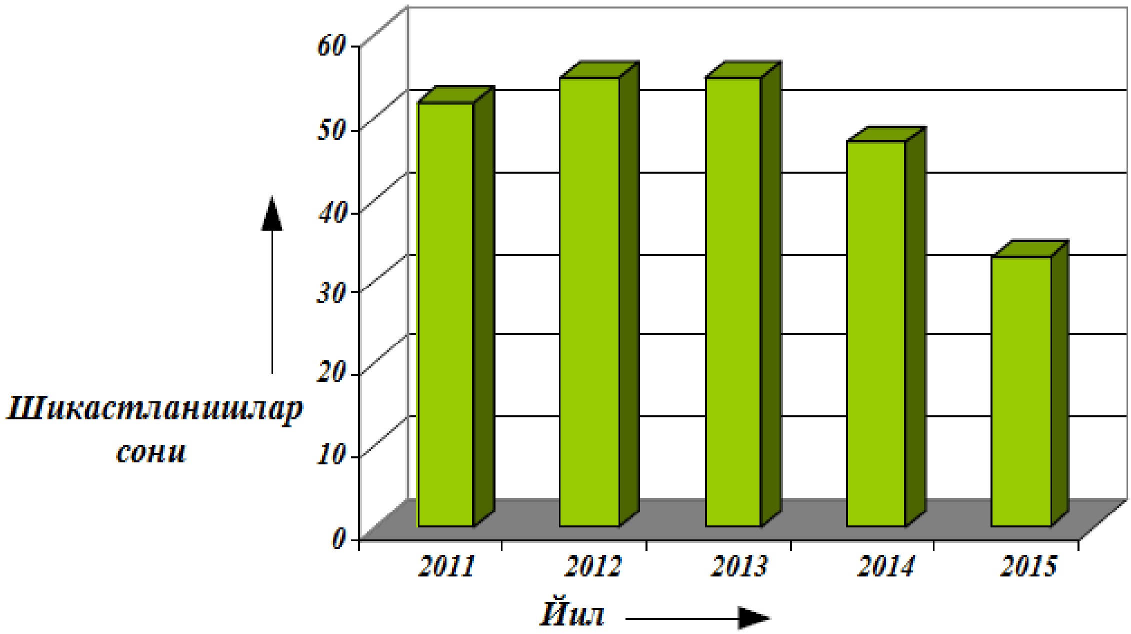


**Figure 2. The number of damage to the power supply cables of non-pulling consumers by year.**

Signaling, centralization and blocking devices, stations and administrative buildings are cut off from power supply when power supply cables of non-traction consumers of railways are damaged. For example, the picture below shows damage to the power supply system. In it, we can see that the number of injuries can be reduced by supplying electricity to non-pulling consumers by using modern cables.

Consumers of non-tractor railways are supplied with electricity through the longitudinal power supply line or through feeders with a voltage of 6, 10, 35 kV of special traction substations.

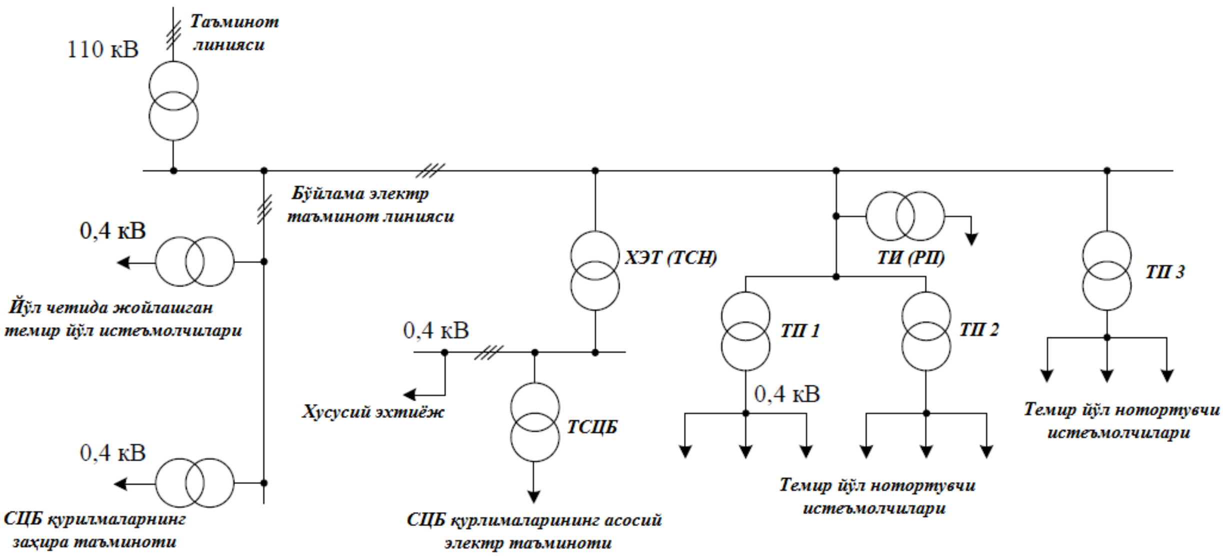


***Figure 3. Scheme of electricity supply of non-traction consumers of electrified railways.***

***Electrified railways form a system consisting of a number of loads and sources of electricity connected to a single supply line with non-traction consumers. Non-tractive***

*consumers include signaling, centralization and interlocking devices, intermediate station power and lighting loads, service and farm buildings, locomotive and wagon depots.*

*Meteorological and climatic effects on the normal operation of cable power transmission lines, electrified railway traction networks are observed in areas where lightning occurs a lot. Wind and humidity (ice, cold wet air) are the most important meteorological factors affecting the cable line.*

*Ice (gololed) is a type of ice with a density of about 900 kg/m3, which occurs as a result of the accumulation of raindrops on the surfaces of wire and support bodies of cable lines.*

*In the winter-spring season (February-March) and autumn-winter season (November-January), the formation of frost is observed when the atmosphere is unstable, that is, when the air level is close to zero. In most cases, the preservation of frostbite is two to three days, but in some conditions it can last up to several weeks.*

*Cable lines are divided into three types depending on the intensity of the frost formed on the wires of cable lines: N (normal), U (reinforced) and OU (extremely reinforced). The cable line is selected depending on the level of frost in the design. In conclusion, it can be said that the distance between the supports should be chosen less in the areas where freezing occurs with a high speed, and at the same time, the diameter of the supports should be large and the mechanical strength of the cable lines should be increased.*

*Cold moist air is a fine needle-shaped particle with a density of 50 to 700 kg/m3 formed on tree branches and cable lines on cold, foggy days. Usually their thickness on the wires is not more than 2.5 cm, but in special cases it can be 5 cm or even more. Cold moist air has a much smaller density than freezing and does not create a large mechanical load on the support and wires.*

*In changing weather, mixed particles from mixed precipitation, ice sheets and sleet can form on the wires of cable lines.*

*Freezing increases the mechanical load on the supports and wires of cable lines. This load is exceeded when freezing occurs together with strong winds. In such conditions, breaks of supports and disconnection of wires can be observed.*

*The rate of formation of ice is determined by the equivalent thickness of ice on the wires. As the equivalent ice thickness, the cylindrical section of ice that can form on the surface of the wire is taken.*

*In order to increase the operational reliability of cable lines in freezing conditions, elements of the cable line are calculated according to mechanical strength.*

*The effect of wind on cable lines is not limited to mechanical impact on supports and wires. In open flat areas, wind speed up to 5 m/s can cause vibrations in wires. Such a situation causes vibrations in the vertical plane with a frequency of 10-100 Hz and an amplitude of several millimeters. This vibrational energy is transmitted through the wires to the insulators to which the wires are attached. A rapidly changing direction of vibration causes the wires to loosen and cause the wires to break. In order to prevent damage caused by vibrations, a special (spring-loaded) method is used to fasten wires to insulators.*

*CONCLUSIONS*

*Open distribution facilities and cable lines can be affected by lightning (atmospheric overvoltage). A direct lightning strike to electrical equipment can damage insulators, electrical equipment, supports, wires, and other equipment. To protect against the*

***mentioned cases, lightning arresters, dischargers and overvoltage limiting devices are installed in distribution devices. Electrical overvoltages can occur in the cables of the cable line based on the electro-magnetic phenomenon of lightning that occurred near the cable line.***

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