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EMERGENCY OPERATION MODES OF ELECTRICAL INSTALLATIONS - IGNITION SOURCES IN OLD BUILDINGS

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Abstract. *An analysis of the emergency operation of electrical networks in old buildings was carried out, in which the saturation of the premises with technical life support systems increased greatly, as a result of which the load of electrical networks increased, which exceeds the calculated values and causes frequent emergency disconnection of the electrical network by previously installed automatic switches. In addition, operation of automatic circuit breakers in aggressive conditions may violate the permissible level of current values set for disconnecting consumers. In this case, it is necessary to replace the outdated electrical network with a new one, replace faulty automatic switches with new ones. Such work requires material costs, so some electricians use the dangerous method of connecting an additional group of contacts to the main group of contacts of the circuit breaker in parallel. In order to avoid this, it is necessary to establish regulatory terms for the maintenance of circuit breakers, to prohibit the connection of contact terminals of circuit breakers with external and internal conductors to change the value of the maximum opening current of the electrical network.*

Keywords: *Fire, fire safety, automatic switches, input and output contact groups, current overloads*

Introduction. Nowadays, electricity has become so common that we forget about safety rules to avoid the danger of electric shock and fire. According to official data, among fires in the residential sector, 43.4% occur due to violations of the rules for the installation and operation of the electrical network. As a result of fires, 3-4 thousand people die, 90% of them in the residential sector. Statistics confirm that the number of fires, especially in the residential sector, continues to increase. According to the "Operational Information on Man-made, Natural and Other Emergency Situations" on the territory of Ukraine as of April 4, 2023, there were (per day/since the beginning of the year): 95/14086 fires, of which: - 62/6751 in the residential sector, - production 2/455, - transport 6/584, - other 25/6296, 4/555 people died, 8/437 people were injured. [1]. The vast majority of such fires occur during the operation of cables, wires and other electrical products.

According to statistics, in 20-25% of cases, the causes of fires are violations of the rules of installation and operation of electrical equipment and household electrical appliances. That is, every fifth fire occurs as a result of emergency modes in the electrical networks of buildings, electrical conductors, ignition of electrical products and electrical installations [2].

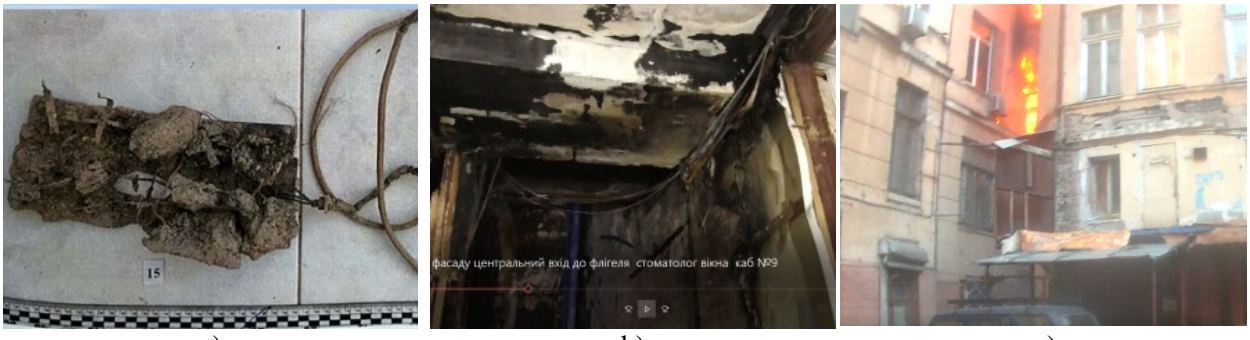
Combustible substances in electrical installations are insulation of wires, combustible parts of apparatus housings, combustible and explosive environment around electrical installations. Air oxygen is the oxidizing agent. The sources of ignition are the emergency modes of operation of electrical installations, namely short circuits, current overloads, the formation of large transient resistances and eddy currents, potential drift, sparking and electric arcs. [3].

Main text.

Determining the fire safety of the power grid is performed by various methods and means, namely: measuring the insulation resistance of the conductors relative to the neutral; measurement of the total resistance of the entire electrical network and comparison with the reference resistance calculated mathematically and others.

Each technique has certain advantages and disadvantages. However, none of the methods allows you to calculate the probability of a fire.

The main reason for the occurrence of fires is a high degree of wear and tear of buildings, their structural elements and engineering networks, especially in buildings of historical construction, and violations of fire safety rules during the operation of electrical installations due to network overload, short circuits and large transient resistances, which is associated with the presence of a large number of old electrical networks , not designed for a significant amount of electrical equipment with a large power consumption. Until the mid-1990s, aluminum conductors were used in public and residential buildings, and the power of electrical equipment was insignificant. The main cause of fires in the residential sector is fire safety violations during the operation of electrical installations. In modern premises, much more consumers with increased capacity are used (Fig. 1) [4].



a) b) c)

Fig. 1. Consequences of the emergency mode of operation of the electric extension cord:

a) *the ignition source is an emergency extension cord with traces of electrical network overload;* ***b)*** *conductors of the emergency electrical network are observed under the ceiling;* ***c)*** *intensive burning is observed on the stairwell from the thermal action of the electrical energy of the overloaded electrical network of conductors*

Automatic switches and fuses are used to protect the electrical network from overloads and short circuits. In the process of long-term operation of the power grid, especially in old buildings, due to the increase in power and the number of switched-on electrical consumers, the use of electrical energy for heating the premises and the load on a separate power grid may exceed the calculated values and cause frequent emergency shutdown of the power grid by previously installed automatic switches. In addition, operation of automatic circuit breakers in aggressive conditions may violate the permissible level of current values set for disconnecting consumers. In order to ensure trouble-free functioning of the electrical network in this case, it is necessary to replace the outdated electrical network with a new one designed for increased load, replace faulty automatic switches with new ones.

Such work requires material costs, so some electricians use the dangerous method of connecting an additional group of contacts to the main group of contacts of the circuit breaker in parallel. At the same time, in three-phase circuit breakers, the input and output contact groups of the existing circuit breaker are connected in parallel in pairs (by shunting), for example, the input contacts of phases "A" and "C" and the output contacts of phases "A" and "C" are connected to each other ". At the same time, they do not take into account that such shunting of the input and output contact terminals (for example, phases "A" and "C") does not protect the core cable of the electric network from overloading, because the automatic switch is turned off in this case only at the strength of the shock, which in is two times higher than permissible for the conductor of this network. In this case of network overload, the circuit breaker does not operate, excess thermal energy is released, which with a high probability can cause ignition and fire.

Examples of using this "method" of losing circuit breakers are not unique. Thus, during the inspection of the site of the fire in the architectural monument of the city of Odessa, Asvadurov's profitable house, two automatic switches with such changes in the load connection were found in the kitchen of the electrical panel and vegetable shop.

Fig. 2. Photo of an automatic switch with shunt jumpers of input and output contact groups for phases "A" and "C".

Fig. 3. Photo of an automatic switch with shunt jumpers of input and output contact groups for phases "A" and "B".

In the photo Fig. 2, 3, performed by experts during the inspection of the city of the fire that occurred on December 4, 2019 in the building of the historical development of the city of Odessa, in order to "disable" the frequent tripping of switches with increased load on the electrical network, a typical paired shunting of the input and output contacts of three-phase automatic switches is observed for the purpose of using them as automatic switches in a single-phase power network.

It should be noted that according to Ohm's law for a segment of an electric circuit in this case, the amount of current at the input contacts of the switch is divided into two, and through both protection elements of the corresponding switch, the current is twice as small, and therefore the switch will turn off the contacts only when the current, in two times higher than the normative permissible value established during the arrangement of this electrical network:

$$I_{in.} = I_{in1} + I_{in2} = I_{out.},$$

where I_{in} is the value of the current flowing through the input core of the cable; I_{in1} - the value of the current flowing through the input contact pair of the automatic switch; I_{in2} - the amount of current flowing through the second contact group of the automatic switch; $I_{out.}$ - the value of the current flowing through the output contact pair of the circuit breaker and the consumer's network.

Unfortunately, this situation is observed in many premises of historical buildings, because the authorities of the State Fire Supervision (SFP), as a rule, do not pay special attention to such "rationalization" of the service personnel of the enterprise, and do not conduct, as a control of the reliability of the operation of automatic switches, so and correct connection of power grid conductors with their contacts.

Conclusions

In order to prevent the occurrence of fire as a result of the thermal effect of electrical energy, namely overloading and short circuits of the electrical network, we consider it expedient to implement periodic monitoring of the quality of low-voltage electrical networks during operation, first of all, to prevent shunting of the input and output contact terminals of automatic electrical network protection devices power supply to consumers, which will reduce the risk of fires in historical buildings and architectural monuments of Ukraine.

Thus, to prevent heating from large transient resistances and to prevent fire, special attention should be paid to the connection of current-carrying parts to each other, as well as to their connection to the conductors of the electrical network. We consider defining and establishing regulatory terms for maintenance of automatic circuit breakers. It is forbidden to connect the contact terminals of automatic switches with external and internal conductors to change the value of the maximum opening current of the electrical network, and to observe safety measures during their operation.

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Анотація. *Проведений аналіз аварійної роботи електромереж в старих будівлях, в яких дуже збільшилась насиченість приміщень технічними системами життєзабезпечення, в результаті чого збільшилось навантаження електричних мереж, яке перевищує розрахункові значення та викликає часте аварійне відключення електромережі установленими раніше автоматичними вимикачами. Крім того, експлуатація автоматичних вимикачів в агресивних умовах може порушити допустимий рівень величин сили струму встановлених для відключення споживачів. В даному випадку необхідно замінювати застарілу електричну мережу на нову, замінювати несправні автоматичні вимикачі на нові. Така робота потребує матеріальних затрат, тому деякі електрики використовують небезпечний метод паралельного підключення до основної групи контактів автоматичного вимикача додаткову групу контактів. Щоб цього уникнути необхідно встановити нормативні терміни технічного обслуговування автоматичних вимикачів, ззаборонити з'єднування контактних клем автоматичних вимикачів зовнішніми та внутрішніми провідниками для зміни величини максимального струму розмикання електромережі.*

Ключові слова. *Пожежа, пожежна безпека, автоматичні вимикачі, вхідні та вихідні контактні групи, струмові перевантаження.*