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Management of site security and reliability of the control of fire

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ABSTRACT. Ensuring the safety of human life is one of the main tasks of scientific and technological progress. Priority, in terms of the significance of the impact on human life, is reasonably given to the tasks of ensuring fire safety. All infrastructure objects of urban development, industrial, cultural and entertainment sectors, in accordance with the standards, are equipped with security and fire alarm systems, with various target execution and possibilities for their implementation.

According to statistics, in 50-60% of fires that have occurred, there is usually no fire signal. This explains the continuing, high level and significance of material and human losses in fires. Despite the fact that the security and fire alarm system has undergone major changes over the past ten years, in particular, the variety and quality of system components has significantly increased, the algorithm of functioning and interaction of communication channels have become more complex. The more complex the system, the less reliable it is. Indicators of reliability of the type of security and fire alarm systems, as practice shows, do not correspond to the declared values, and naturally require further study.

Analysis of the reliability of the security and fire alarm system is defined as a step-by-step, rather voluminous process. One of the features of determining the reliability of automated systems is a serious difference between the reliability indicators of the main elements of the system and the automation system as a whole. In this regard, the problem of improving the used models for evaluating and ensuring the reliability of the security and fire alarm system remains urgent.

As a model of reliability assessment of the system of fire alarm was invited to take the approach of improving the metrological part of its circuitry, carried out by maintaining the specified accuracy parameter, separate technical means within the system of fire alarm.

Considering the various combinations and combinations of parameters of technical means-element system, fire alarm systems, approved the conditions of increasing metrological reliability of security and fire alarm, at reservation of technical means and usage of its promising modifications.

The proposed research has a methodological orientation that allows implementing various options for its practical use.

KEY WORDS: fire safety, control, security and fire alarm system, metrological reliability, technical means, accuracy of parameter measurement.

I. INTRODUCTION

Currently, there is a change in priorities in the field of security. The leading direction, along with the protection of life and property, is to ensure the stable stability of the operation of facilities based on the protection of tangible and intangible assets, risk management, and investment rationalization. This fully applies to the priority segment of the security sphere – fire safety of objects.

The adoption of market conditions, the development of a new economic structure and strategies for innovative development of industries, and the associated changes in the social status and economic formats of life of citizens cannot occur without the transformation of the fire safety system. Fire safety of an object is clearly connected with the reliable functioning of its life support subsystems, including metrological support of a complex of technical means (TM) and monitoring devices: fire hazard, the level of input parameters of the object; network voltage, indicators of environmental aggressiveness, resource and quality of line installation – the primary sources of fire and explosion situations.

The paper considers the improvement of metrological reliability of information and technical support of the fire safety system of the object. The choice of the latter is not accidental. The security format of an object and the success of its tasks are largely determined by the rational solution of technical support tasks and their metrological support. Analysis of the fire and rescue service (FRS) highlights reasonable requirements for improving the safety resource, determined, among other things, by the reliability of fire control systems for the object [1].

This is relevant and directly applies to the entire element base of the vehicle security and fire alarm systems (FAS) of a separate object. In view of the diversity of this segment of the security system, it is advisable to consider the problem on a typical example of the FAS system, as a system that includes a variety of vehicles with a complex relationship.

The degree of satisfaction with the requirements assigned to the object's security system, evaluated and confirmed by practice, is provided, as indicated above, by the reliability of the functioning of the set of technical means included in the FAS system. In the proposed study, from the set of reliability indicators, its metrological component is selected for the entire complex of vehicles included in the FAS of a fire-hazardous object.
Thus, the paper highlights the results of a study devoted to improving the metrological reliability of fire hazard control of production (implemented by technical means of early fire detection), an important segment of information and technical support for the security system of the object as a whole.

II. RELATED WORKS

The following studies should be considered similar in substance to the issues being solved and the approaches used. In the work of Pakhomov V. P. "Security and fire alarm systems at explosive objects" [2], as well as in the work of Omelyanchuk A. "Security and fire alarm systems at industrial enterprises" [3], it is stated that one of the important factors that increase the overall level of security is a well-designed FAS. This type of alarm system provides not only timely transmission of information about a fire or violation of the protected perimeter, but also guarantees that it will not cause a fire or explosion.

The latter circumstance is considered in more detail in the work of A. A. Akhmedov, T. G. Shevtsov, and R. V. Kotlyarov "assessment of the reliability of the fire notification system" [4].

III. METHODOLOGY

Let's consider the task of improving the metrological reliability of fire hazard control of production, using the example of the FAS system, which includes a variety of vehicles with a complex relationship.

The reliability of the system FAS is determined to maintain the specified accuracy parameters (smoke, heat, flame) individual TM, which justifies the terminology of the theory of reliability of measurement systems [5].

The term "resource-required reliability" refers to the duration (τ) of the vehicle's operation in a given mode in the FAS system until one of its elements fails. In this case, τ = min (τ', τ''), where (τ' is the duration of the system's operation until failure; τ'' is the time starting from which the accuracy of measuring the vehicle in the FAS system is insufficient. If $\Delta_j(t) -$ the measurement error of the i-th characteristic, i=1, n at t [0, t_0], depending on time t, and [a_j, b_j] $\Delta_j(t) -$, is the tolerance on, then t''is the time of the first exit from the tolerance $a_j, \le \Delta_j(t) - \le b_j$, when considering such conditions in the interval [0, t_0]. The value τ = min (τ', τ'') is considered random and is called the metrological reliability of the FAS system, since it takes into account not only the failure of the FAS system, but also the loss of metrological quality

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of the measurement process at a given interval [0, t_0]. If we assume that the values τ' and τ'' are independent on the interval [0, t_0], the function F distribution value t and the functions F_1 and F_2 the distribution of values τ' and τ''are associated the obvious correlation

$$P(\tau x)=F(x)=1[1-F_1(x)][1-F_2(x)], \qquad (1)$$

where $P(\tau \leq x)$ is the probability that the random variable τ will not exceed x; x is a fixed number. The FAS system usually includes a number of vehicles: a fire detector (FD); a fire alarm station (FAS); a control device (CD); a signal-starting device (SSD); sounders (S). These may be vehicles that are sometimes of the same type and are connected by the logic of their functioning in such a way that the failure of one of them leads to the failure of the entire (m) set of vehicles. Then it is said that m separate vehicles in the FAS system are connected in series. Let j be the vehicle number in the FAS system, and TM be its metrological reliability, i.e. τ_j =min (τ_j' τ_j''). Then t=min τ_j, and in the case of independence of the values τ_j, j=1, m, the expression (1) for the function F of the distribution of the value τ changes the form. Expressions are obtained that allow for the known functions F_1 and F_2 of the distribution of values τ_j' and τ_j'' to find the function F of the distribution of metrological reliability τ of the FAS system. We consider the average value tj of metrological reliability τ_j for j-ro vehicles, provided that all m vehicles in the FAS system are of the same type and have to=tj, then t=t_0/m. Thus, for these assumptions (the independence of the value τ_j, the exponential distribution of these values), the average reliability t in the FAS system, consisting of m similar vehicles, each of which has the same average reliability t_0, decreases by m times compared to t_0. This sharp decrease is primarily due to the assumption of independence of the values of τ_j. An interesting case is the estimation of the average value t of the metrological reliability of the FAS system, taking into account the dependence of the values. So the average reliability t in the FAS system, consisting of m similar vehicles, each of which has the same average reliability t_0, decreases by m times compared to t_0.

An interesting case is the estimation of the average value t of the metrological reliability of the FAS system, taking into account the dependence on the values τ_j. Note that such accounting is a problematic task and can be implemented only approximately at the present time. Considering various variants of the distribution of τ_j, the ratio

$$l-F(x) =l-F_1(X), \qquad (2)$$

which corresponds to the case τ_1>x=>τ_j> x, j=m, m, i.e., the case when it turns out that a vehicle with a fixed number j=m has less reliability among m all TM, and this fact is known. In this case, the average metrological reliability coincides with the average reliability of one "weakest" TM with the number j=l, which has a lower reliability τ_1 among m of all TM included in the FAS system. To increase the metrological reliability of the FAS system, it is proposed to reserve the vehicle. for the case under consideration, this is the use of a dual-technology vehicle, i.e. independent channels for detection and signal generation [6]. In this situation, it is said that the FAS system consists of m blocks connected in series. We assume that in the j-th block, the vehicles are of the same type and independent. Then, if the system blocks, in turn, are also independent, the condition

$$1-F(x)=\Pi\{l-[F_J(x)]^{v/j}\} \qquad (3)$$

If, for the above reasons, the blocks are dependent, the formula proposed earlier is used in the following interpretation:

$$l-F(x)= \{l-[F_I(x)]^{v/l}\}\ \Pi\ \{l-[F_J(x))^{v/l}\}^{1/z} \qquad (4)$$

The z coefficient is determined using the least squares method based on experimental data. Omitting mathematical transformations, it can be concluded that the introduction of backup elements and taking into account the dependence of τ_j metrological reliability of τ_j TM included in the FAS system significantly increases the average value of its metrological reliability.

IV. CONCLUSION AND FUTURE WORK

The proposed method for improving the metrological reliability of monitoring the parameters of a fire-hazardous object has been studied for practical application in several formats. Let's look at the most common options.

The first. The FAS system uses m different vehicles that function in such a way that the failure of one of them leads to the failure of the FAS system as a whole, and T1 are independent at j=l, m, a typical example with a security and fire alarm. To improve the reliability of the FAS system, the following steps were taken::

a) instead of m different vehicles (for example, PI, SPS, PU, SPP), a single universal technical device (TC);

b) the TCB is reserved. The latter almost should be interpreted as follows: prior to the implementation of our proposals reservation of the vehicle is not carried out, values of T1 are independent and their mean value corresponds to MT1= l/ j = l/ =t; thus t=t'/m (where t'is the mean value of the metrological reliability of one vehicle system FAS). We assume, according to our example, that m=4, and the failure rate 1 of the TC exceeds the failure rate of the original TC in such a ratio that 1=3/2 . The reliability of the FAS system t=t/m=t'/4 after the introduction of TC is determined by t= t', i.e. due to the correlation of TJ values and the use of a universal redundant vehicle, the metrological reliability of the FAS system will increase by m=4 times.

Second. In the case of using a number of design options for fire detection vehicles (with different reliability indicators) in the considered fire-hazardous area, replacing them with a design that has a "total" overlap of this area (from the position of fire protection), it might be possible to consider as a case of replacing several vehicles with one, with a more acceptable indicator of the reliability of fire control of this area. So, for example, the safety indicator [6] proposed by us has such a design, which has the so-called multi-functionality and performs the functions of PI, SPP, and O.

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