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The state of fire alarm systems at protection facilities from 2016 to 2020

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Introduction. The article presents the results of studies on assessing the performance of fire alarm systems in buildings (structures) for various purposes in the period from 2016 to 2020. The analysis of the regulatory framework and the results of previous studies in the field of assessing the effectiveness of fire automatics, including at industrial and residential facilities, is presented. This article explores other types of protected objects.

Problem Statement. The objective of the research is to study the efficiency of functioning of fire alarm systems.

Theoretical Part. Based on the statistical data for the period from 2016 to 2020 about fires and their consequences, the operability of fire alarms in buildings (structures) for various purposes has been investigated. The social (the number of dead and injured people) and economic (direct material damage) consequences of fires when the fire alarm systems are triggered are analyzed.

Conclusion. The results of the study of the operability of the fire alarm in general indicate an increase in the efficiency of its operation compared to the period up to 2016. At the same time, the number of protected objects is characterized by rather low values (less than 50 %) of response efficiency indicators and significant socio-economic consequences of fires.

Keywords: fire, object of protection, automatic firefighting equipment, fire alarm, operability, efficiency, statistical data, fire accounting card.

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Introduction. In 2020, about 439.31 thousand fires occurred in the Russian Federation, which killed 8310 people, injured 8419 people, and direct material damage amounted to more than 20.8 billion rubles [1].

The largest number of dead and injured people falls on the initial stage of the fire development. At the same time, fires that are not detected in a short time can lead to significant material consequences. In this regard, one of the solutions to prevent significant socio-economic consequences of fires is to reduce the time of fire detection and increase the efficiency of the fire alarm system (hereinafter referred to as FAS), which are the primary elements in the fire protection system of buildings (structures).

Foreign approaches to FAS design at various protection facilities are included in the European regional standards of the EN 54 series and in the international standards ISO7240. Also, the requirements for the design standards and test methods of FAS are included in the standards EN 14604 and ISO 12239. In the Russian Federation, the issues of designing and applying of FAS are determined by the provisions of the codes of rules — SP 484.1311500.2020 "Fire protection systems. Fire alarm systems and automation of fire protection systems. Norms and rules of design" and SP 486.1311500.2020 "Fire protection systems. The list of buildings, structures, premises and equipment subject to protection by automatic fire extinguishing installations and fire alarm systems. Fire safety requirements". In GOST R 53325-2012 "Fire equipment. Technical means of fire automation. General technical requirements and test methods" FAS elements test methods are regulated.

A significant number of publications have been devoted to the research on the effectiveness of triggering and evaluating FAS efficiency at various hazardous locations. Thus, in work [2], the methods for assessing the reliability of fire automation systems are proposed. The approaches to the safety of technological processes with the use of diagnostics of fire detectors are reflected in publications [3–4]. Article [5] discusses the issues of trouble-free operation of FAS at energy facilities based on the reliability function. In work [6], the effectiveness of fire automation operation at production facilities from 2005 to 2014 was studied. According to its results, it was found that only in 77% of cases FAS worked and completed the task; in other cases (23%) the task was not completed.

Articles [7–9] are devoted to evaluating the effectiveness of FAS operation in the residential sector. The data on FAS efficiency from 2005 to 2012 were studied. It was found that FAS installed on residential facilities only fulfilled their task in 36.2% of cases. Accordingly, in the remaining cases (63.8%), FAS did not fulfill their task. In works [9-10], the measures are proposed for the installation of smoke fire detectors in residential buildings, including built-in sound alarms for reducing the social consequences of fires in the housing stock.

The analysis of publications [5–9] shows that studies of the effectiveness of fire alarm activation at residential and industrial facilities were conducted on the basis of statistical data generated before 2014.

The results of research on FAS efficiency from 2016 to 2020 at residential and industrial facilities are given in publications [11–12]. Thus, in article [11] it is noted that the efficiency of FAS operation in residential buildings has increased significantly and from 2016 to 2020, on average, it was 83.1% for single-family residential buildings, and for multi-apartment buildings — 75.7%. A similar situation with an increase in the efficiency of fire alarm operation is observed at industrial facilities [12].

The above analysis of literary sources shows that specialists in the field of fire automation in their research focused on the study of a certain group of hazardous facilities. Mainly industrial objects and residential buildings were considered. Other types of buildings (structures) were not considered and fell out of the field of view of researchers. In this regard, it is advisable to analyze FAS performance at other hazardous facilities. This study will allow us to assess FAS performance on a wider range of hazardous objects with different functional purposes.

Problem Statement. The task of the study is to analyze the state of FAS operability at various hazardous facilities from 2016 to 2020. As hazardous facilities, industrial buildings, warehouse buildings (structures), buildings (structures) for storing cars and other wheeled vehicles, places for storing substances (materials), farmland and other open areas, residential buildings, agricultural buildings (structures), buildings (structures) under construction (reconstruction), industrial buildings (installations), vehicles, buildings (structures) of trade enterprises, educational buildings, buildings of health care and social services, buildings of service maintenance, administrative buildings, buildings (structures) for cultural and leisure activities and religious rites, buildings for temporary stay (residence) of people, other buildings (structures).

Theoretical part and the results of the research. To solve this problem, two calculation methods are proposed for evaluating the effectiveness of FAS operation. The first method is based on the analysis of various modes of FAS operation ("it worked and completed the task", "it did not work and did not complete the task", "it was disabled"). The second method is based on determining the social and material consequences of fires, taking into account the operation of the fire alarm system.

The description of the proposed methods and the corresponding calculated dependencies are given in publications [11–12]. The initial information for the calculations was the data of the federal state information system "Federal Data Bank "Fires" [13].

The following results of the assessments of the performance of FAS on various hazardous facilities were obtained.

Figure 1 shows data on changes in the performance of FAS for all hazardous objects from 2016 to 2020. The average value of the efficiency of FAS for all hazardous objects for the period under review was 85.9%. The highest value (86.9%) was observed in 2020, the lowest (85.1%) — in 2017.

Fig. 1. Change in FAS effectiveness from 2016 to 2020

Figure 2 shows the data on FAS efficiency for different types of buildings (structures) from 2016 to 2020. The highest efficiency of FAS operation was registered at industrial facilities (installations) — 91.4%, as well as at buildings (structures) for storing cars and other wheeled vehicles — 90.3%. The lowest efficiency of FAS operation is characteristic of places of open storage of substances (materials), agricultural land and other open areas — 41.9%.

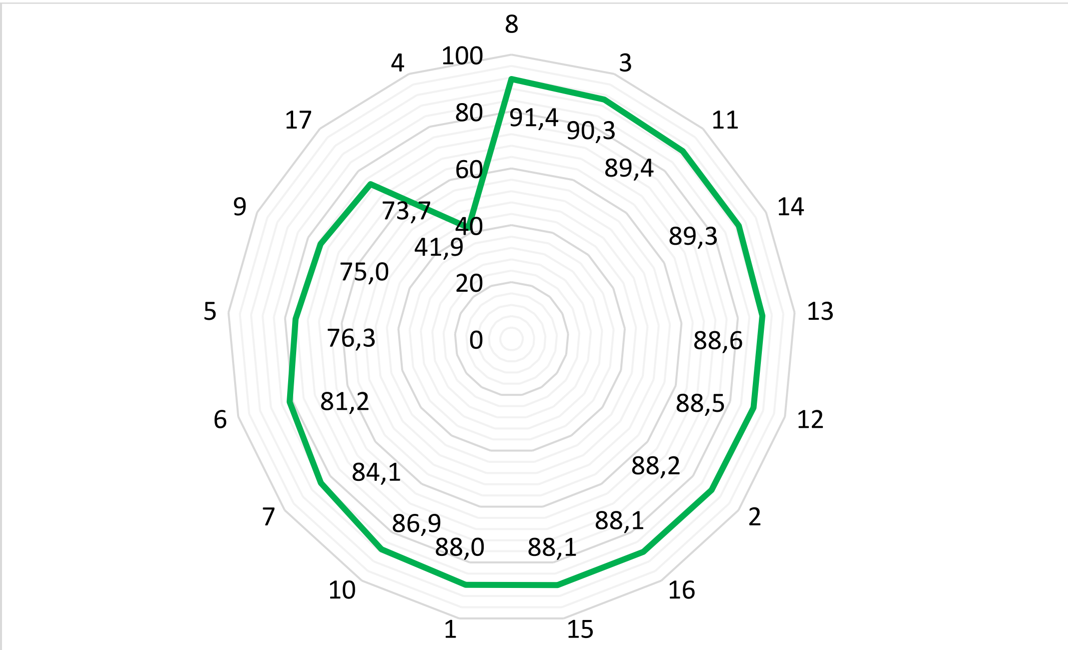

Fig. 2. FAS efficiency by type of hazardous objects

The number on the diagram corresponds to the following types of hazardous objects: 1 — industrial buildings, 2 — warehouse buildings (structures), 3 — buildings (structures) for storing cars and other wheeled vehicles, 4 — places for storing substances (materials), agricultural land and other open areas, 5 — residential buildings, 6 — agricultural buildings (structures) , 7 — constructed (reconstructed) buildings (structures), 8 — constructions (installations) for industrial use, 9 — vehicles, 10 — trade buildings (constructions), 11 — educational purpose buildings, 12 — healthcare and social services buildings, 13 — service buildings, 14 — administrative buildings, 15 — buildings (structures) for cultural and leisure activities and religious rites, 16 — buildings and premises for temporary stay (residence) of the people, and 17 — other buildings (structures)

The calculated data for the indicator "the number of victims (dead and injured) per fire" for those cases when FAS worked and gave a fire alarm are shown in Fig. 3. The smallest number of victims when fire automation devices are triggered is observed at industrial facilities (installations) — 0.016 people per one fire, or one victim per 64 fires, as well as for buildings (structures) of trade enterprises — 0.023 people per one fire, or one victim per 44 fires. Most of the victims are observed in fires in residential buildings — 0.218 people per one fire, or one victim per 5 fires.

The calculated data for the indicator "direct material damage per fire" for those cases when FAS triggered and gave a fire alarm are shown in Fig. 3. The greatest direct damage from fires was registered for warehouse buildings (structures) — 13.7 million rubles per fire, as well as for agricultural buildings (structures) — 11.4 million rubles per fire. The least direct damage from fires was registered for buildings (structures) under construction (under reconstruction) — 58.7 thousand rubles per fire, as well as for buildings, structures for storing cars and other wheeled vehicles — 84.0 thousand rubles per fire.

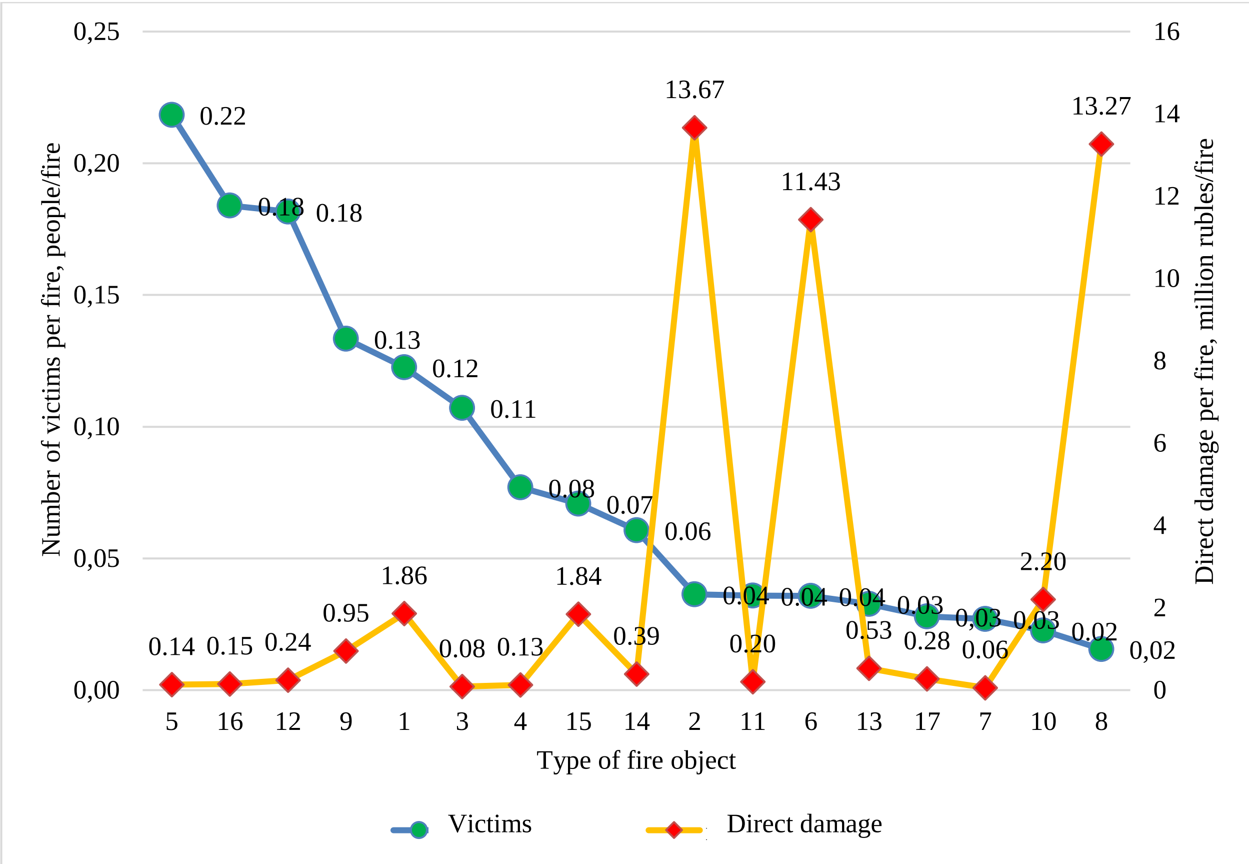

Fig. 3. Number of victims and direct material damage per fire by type of hazardous objects. The number on the abscissa axis corresponds to the type of hazardous facilities shown in Fig. 2.

Conclusion. The study of FAS efficiency at various hazardous facilities from 2016 to 2020 showed the following. Compared to the previous period (until 2016), the effectiveness of FAS operation at many hazardous facilities has significantly increased. The average value of FAS efficiency for all hazardous objects is now 85.9%. The highest efficiency of FAS operation was noted in industrial structures (installations) (91.4%) and in buildings (structures) intended for storing cars and other wheeled vehicles (90.3%). The lowest efficiency of FAS operation is observed in places of open storage of substances (materials), on agricultural land and other open territories (41.9%). The largest number of victims was noted in fires in residential buildings (on average, one victim per 5 fires), despite the fact that FAS worked and gave a fire alarm. The greatest direct damage from fires was caused to warehouse buildings (structures) — 13.7 million rubles per fire, as well as buildings (structures) for agricultural purposes — 11.4 million rubles per fire).

References

1. Statistika pozharov za 2016–2020 gody [Fire statistics for 2016-2020]. Available from: https://sites.google.com/site/statistikapozaro/home/rezultaty-rascetov/operativnye-dannye-po-pozaram (Accessed 29.03.2021) (In Russ.)

2. Lomaev E. N., Fedorov A. V., Gaplaev A. A.-B. Obosnovanie primeneniya funktsional'no-parametricheskogo podkhoda k otsenke nadezhnosti sistem pozharnoy avtomatiki v protsesse ekspluatatsii. Eurasian Union of Scientists. 2015;10–2(19):84–86. (In Russ.)

3. Putilin I. P. Problemy obespecheniya i kontrolya rabotosposobnosti pozharnyi avtomatiki [Problems of ensuring and monitoring the operability of fire automation]. Algoritm bezopasnosti. 2018;6:30–33. (In Russ.)

4. Topolskiy N. G., Samarin I. V., Strogonov A. Yu. Model of evaluation of comprehensive safety in the APCS with the use of diagnostic fire detectors for the construction of automated systems of support of management of fire and explosion safety. Fire and Explosion Safety. 2018;27(11):15–22. (In Russ.)

5. Gushchin Ya. S. Kolichestvennye otsenki nadezhnosti signalizatsii na proizvodstvennykh ob"ektakh [Quantitative assessments of the reliability of alarm system at production facilities]. Sistemy bezopasnosti-2017: materialy 26 Mezhdunar. nauch.-prakt. konferentsii [Safety Systems-2017: proc. of the 26th International Scientific and Practical Conference]. Moscow, 2017. p. 364–367. (In Russ.)

6. Fedorov A. V., Lomaev E. N., Gaplaev A. A.-B., Toktarkhan E. O. Rabotosposobnost' sistem pozharnoy avtomatiki na promyshlennykh ob"ektakh v 2005–2014 godakh [Efficiency of fire automation systems at industrial facilities in 2005-2014]. Pozhary i chrezvychaynye situatsii: predotvrashchenie, likvidatsiya. 2016;2:73–76. (In Russ.).

7. Sokolov S. V., Kostyuchenko D. V. Effectiveness of fire automation on fires in homes. Fire and Explosion Safety. 2014;23(6):70–75. (In Russ.)

8. Kostyuchenko D. V. Aktual'nost' primeneniya sredstv pozharnoy avtomatiki v zhilykh domakh [The relevance of the use of fire automation tools in residential buildings]. Pozharotushenie: problemy, tekhnologii, innovatsii: materialy mezhdunar. nauch.-prakt. konf. [Firefighting: problems, technologies, innovations: proc. of the international scientific and practical conference]. Moscow, 2014. p. 16–18. (In Russ.)

9. Sokolov S. V., Fedorov A. V., Kostyuchenko D. V. Obespechenie pozharnoybezopasnosti s pomoshch'yu sredstv pozharnoy avtomatiki v mnogokvartirnykh zhilykh domakh pri realizatsii regional'nykh programm po ikh kapital'nomu remontu [Ensuring fire safety with the help of fire automation equipment in multi-apartment residential

buildings during the implementation of regional programs for total buildings renovation]. Pozhary i chrezvychainye situatsii: predotvrashchenie, likvidatsiya. 2015;1:41–47. (In Russ.)

10. Goryachenkov M. S. Pozhary v mnogokvartirnykh domakh: kak perelomit' situatsiyu? [Fires in apartment buildings: how to turn the tide?]. Sistemy bezopasnosti. 2019;1:106–108. Available from: http://lib.secuteck.ru/articles2/bypub/ss-1-2019). (In Russ.)

11. Poroshin A. A., Kondashov A. A., Sibirko V. I. Otsenka rabotosposobnosti sistem pozharnoy signalizatsii na ob"ektakh zhilogo fonda za period s 2016 po 2020 god [Assessment of the operability of fire alarm systems at residential facilities for the period from 2016 to 2020]. Tekhnologii tekhnosfernoy bezopasnosti. 2021;1(91):19–32. (In Russ.)

12. Poroshin A. A., Kondashov A. A., Sibirko V. I. Efficiency Assessment of Fire Alarm Systems Actuation at the Production Facilities for the Period 2016–2020. Industrial Safety. 2021;4:32–37. (In Russ.)

13. O formirovanii elektronnykh baz dannykh ucheta pozharov i ikh posledstviy: prikaz MChS Rossii ot 24.12.2018 no. 625 [On the formation of electronic databases for accounting for fires and their consequences: Order of the Ministry of Emergency Situations of Russia No. 625 of 24.12.2018]. Elektronnyy fond pravovykh i normativno-tekhnicheskikh dokumentov. Available from: http://docs.cntd.ru/document/552366056 (Accessed 29.03.2021). (In Russ.)

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Contribution of the authors:

A. A. Poroshin — formulation of the concept of the article, the goals and objectives of the study, preparation and analytical review of the literature, calculations, preparation of the text, formulation of the conclusions; A. A. Kondashov — calculations, analysis of the results, preparation of the figures; V. I. Sibirko — preparation of the initial data for the calculation, formulation of the conclusions; V. S. Goncharenko — preparation of the initial data for the calculation.