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Experience of Application of GOST R 59638-2021 for the Analysis of Statistics of False Alarms of the Fire Alarm System on the Example of a Multifunctional Shopping and Entertainment Complex

Dmitriy A. Siksimov ✉, **Vitaliy E. Merenyashev**
Don State Technical University, Russian Federation, Rostov-on-Don
✉ dasiksimov@list.ru

Abstract

Introduction. In 2021, new regulatory legal acts in the field of fire safety came into force. Special attention is paid to the control, classification and minimization of false alarms of fire protection systems and installations. In this regard, it makes sense to refer to the statistics of such triggers on specific objects in order to assess the sufficiency and validity of the criteria proposed in the new documents. The purpose of the work is to study the requirements for maintenance and operation of fire protection systems and installations. The objectives of this study are to study the main approaches to the regulation of false alarms of fire protection systems, analysis of the main quantitative indicators of the operation of systems of a particular object, assessment of the compliance of the protection object with new requirements.

Materials and Methods. The empirical basis of the study was the results of constant monitoring of the state of fire protection systems and installations in one of the largest shopping and entertainment complexes in the South of Russia. The reports of the fire prevention service, data from the automated workplace of the operator of the fire station, records in operational logs were used. The information is summarized in tables by types of false alarms and by chronology. Calculations were performed in MS Excel. To identify the links between different types of false positives, a correlation analysis was carried out.

Results. The connection between the number of false alarms and the intensity of work of tenants of the protection object is noted. The ratios of different types of false alarm and the significance of the triggering factors are determined. The correlation between false alarms and malfunctions of systems is revealed.

Discussion and Conclusion. The methodology developed by the authors makes it possible to monitor malfunctions of fire alarm systems on an ongoing basis. A number of problematic issues of applying the classification of false alarms of the fire alarm system in GOST R 59638-2021 have been identified. A connection has been established between the number of false alarms and the intensity of the work of the tenants of the shopping center. The conclusion is made about the compliance of the protection object with the newly introduced requirements. The identified problematic issues of the application of GOST R 59638-2021 for statistical analysis in future studies force us to develop a different classification of false alarms of fire alarm systems.

Keywords*:* fire alarm system, false alarms, shopping and entertainment complex, GOST.

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Introduction. Fire alarm systems (FAS) are the primary link in the functioning of fire protection systems. Its operation gives a start to actions to identify the source of fire and evacuation, informs the duty officer, turns on automatic fire extinguishing devices. Since 2021, new regulatory legal acts in the field of fire safety have been in force in Russia. Special attention is paid to the issues of control, classification and minimization of false alarms of fire protection systems and installations. In this regard, it makes sense to refer to the statistics of false alarms on specific objects. The data obtained in this way will allow us to assess the sufficiency and validity of the criteria proposed in the new regulatory documents.

The work objective is to study the requirements for maintenance and operation of fire protection systems and installations. The compliance with the standard for the number of false alarms was investigated at a specific object of protection. To achieve the goal, the following tasks have been completed:

– study of the main approaches to the rationing of false alarms of fire protection systems;

– analysis of the main quantitative indicators of the operation of fire protection systems of a particular object;

– assessment of compliance of the object of protection with the regulatory requirements in force since 2021.

It should be noted that the statistics of false alarms of fire protection systems were not the subject of scientific analysis. The reasons are listed below.

First. There is no access to this information. The relevant statistics are owned by the security services and management of economic entities.

Second. The large amount of information to be analyzed and the complexity, ambiguity of the criteria for attributing the alarm to false or justified present certain difficulties.

Third. Statistics on the alarms activation are considered secondary and insignificant. Only the information about fires and their consequences is centrally collected, systematized and published[1, 2, 3] [1]. The studies of the effectiveness and operability of fire alarm systems at various hazardous facilities have been published [2-4]. Turn-outs of fire and rescue units are recorded, but if the cause was a false alarm, then only the number of such cases are analyzed. The reasons are not considered. In addition, not every false alarm leads to the turn-out of firefighters [5].

Materials and Methods. The empirical basis of the study was the results of constant monitoring of the state of fire protection systems and installations of one of the largest shopping and entertainment complexes in the South of Russia. It is a four-storey building with a total area of 121,306 m^2. Premises and groups of premises of functional fire hazard classes: F2.1, F3.1, F3.2, F4.3, F5.1, F5.2. The facility is equipped with the following systems:

– addressable fire alarm;

– type 4 evacuation alerts and controls;

– smoke protection;

– gas, as well as sprinkler and drencher water fire extinguishing systems;

– announcement of fire notifications (FN).

The facility has implemented an algorithm C according to SP 484.1311500.2020[4]. FAS has about 12 thousand addressable devices, including about 9 thousand detectors.

Since 2019, constant monitoring has been conducted. The presented scientific work is based on data from 01.01.2019 to 30.06.2021. The information is obtained from the reports of the fire prevention service, system logs of the automated workplace of the fire station operator, operational logs. The information is summarized in tables by types of false alarms and by date [6, 7].

Since 2021, regulatory legal acts in the field of fire safety have been in force in Russia, which have fixed the need for control and corrective measures for false alarms of automatic fire protection systems and installations.

[1] Gordienko D. M. (Ed.) Pozhary i pozharnaya bezopasnost' v 2019 godu. Statisticheskii sbornik. Moscow: VNIIPO, 2020. 80 p. (In Russ.).
[2] Gordienko D. M. (Ed.) Pozhary i pozharnaya bezopasnost' v 2020 godu. Statisticheskii sbornik. Moscow: VNIIPO, 2021. 112 p. (In Russ.).
[3] Goncharenko V. S., Chechetina T. A., Sibirko V. I. et al. Pozhary i pozharnaya bezopasnost' v 2021 godu. Statisticheskii sbornik. Balashikha: FGBU VNIIPO MChS Rossii, 2022. 114 p. (In Russ.).
[4] SP 484.1311500.2020. Regulation. Fire alarm systems and automation of fire protection systems. Designing and regulations rules. Ministry of Emergency Situations of Russia. Available from: https://sudact.ru/law/prikaz-mchs-rossii-ot-31072020-n-582/sp-484.1311500.2020/ (accessed 14.03.2022). (In Russ.).

The first of them is SP 484.1311500.2020. "Regulation. Fire alarm systems and automation of fire protection systems. Designing and regulations rules". The document was approved and put into effect by the Order of the Ministry of Emergency Situations of Russia. It defines a false alarm as a fire notification generated in the absence of fire hazards[5]. FAS design should be aimed at the following tasks:

– timely detection of fire;

– reliable fire detection;

– collection, processing and presentation of information to the staff on duty;

– interaction with other fire protection systems (formation of the necessary initiating control signals) and engineering systems of the facility.

The reliability of detection in accordance with clause 6.1.3 is ensured by:

– selection of types of fire detectors;

– the choice of the algorithm for making a decision about a fire;

– protection against false alarms.

Protection against false alarms is based on the use of detectors that do not respond to factors similar, but not related to fire. To solve the problem, you should also use:

– multicriteria detectors;

– shielded cables;

– twisted pair cables;

– fiber-optic communication lines;

– algorithms for making a decision about B or C fire.

It is obvious that measures to ensure the reliability of detection correspond to the measures to protect against false alarms.

Let us consider another document —Order of the Ministry of Emergency Situations of Russia of June 7, 2021 No. 364 "On approval of the list of indicators of the risk of violation of mandatory requirements in the implementation of Federal state fire supervision" It is valid from 01.07.2021[6]. One of the indicators of the risk of violating mandatory requirements is three or more false alarms within thirty calendar days. Such a frequency of false alarm activation is the basis for unscheduled control and supervisory measures for the protected facility. The rule applies to objects where at the same time there can be 50 or more people (except residential buildings).

Finally, since September 15, 2021, the new GOST R 59638–2021 "Fire alarm systems. Guidance on the design, installation, maintenance and repair. Performance test methods" is valid[7]. It should be noted that the provisions of this GOST are not mandatory now, since it is not in the "List of documents in the field of standardization, as a result of the application on a voluntary basis of which the compliance with the requirements of Federal Law No. 123–FZ of July 22, 2008 "Technical Regulations on Fire Safety Requirements" is ensured[8]. Nevertheless, it is known that the control of false alarms of fire protection systems and installations is being tightened. Therefore, the inclusion of the GOST in question in the list is a matter of time[9]. Below are its main innovations.

First. A false alarm (fire) is defined as a notification of a fire in its absence.

Second. The classification of the causes of false alarms and their division into categories is introduced. The reasons for false alarms are described.

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[5] SP 484.1311500.2020.

[6] Ob utverzhdenii perechnya indikatorov riska narusheniya obyazatel'nykh trebovanii pri osushchestvlenii federal'nogo gosudarstvennogo pozharnogo nadzora. Ministry of Emergency Situations of Russia. Available from: https://docs.cntd.ru/document/603896733 (accessed 14.03.2022). (In Russ.).

[7] GOST R 59638-2021. Fire alarm systems. Guidance on the design, installation, maintenance and repair. Performance test methods. Federal Agency for Technical Regulation and Metrology Available from: https://protect.gost.ru/default.aspx/document1.aspx?control=31&baseC=6&page=4&month=9&year=2021&search=&id=241176 (accessed 14.03.2022). (In Russ.).

[8] Perechen' dokumentov v oblasti standartizatsii, v rezul'tate primeneniya kotorykh na dobrovol'noi osnove obespechivaetsya soblyudenie trebovanii Federal'nogo zakona ot 22 iyulya 2008 g. No. 123-FZ "Tekhnicheskii reglament o trebovaniyakh pozharnoi bezopasnosti". Federal Agency for Technical Regulation and Metrology Available from: https://docs.cntd.ru/document/565314055 (accessed 14.03.2022). (In Russ.).

[9] Technical Regulations on Fire Safety Requirements: Federal Law No. 123-FZ. State Duma, Federation Council. Available from: https://docs.cntd.ru/document/902111644 (accessed 14.03.2022). (In Russ.).

1. Unwanted triggering. FAS was triggered as a result of exposure to factors similar to fire factors or unintentional impact on a fire manual detector.

2. Malfunction. FAS was triggered as a result of an equipment malfunction.

3. Hooliganism. FAS was triggered as a result of malicious actions.

4. Erroneous activation. FAS was triggered as a result of conscientious actions when a person activated FAS, suspecting that a fire had broken out.

5. Unknown reason.

GOST R 59638–2021 introduces an acceptable frequency of false alarms. This is an annual indicator. It takes into account one false alarm for every 500 m^2, rounded up. If the calculated value is less, the maximum allowable indicator is 12 false alarms. The frequency of false alarms in one fire alarm control zone or room should not exceed four alarms per year. If an object is provided for automatic transmission of fire notifications to a fire and rescue unit (fire notification system — FNS), then the unit may set higher requirements for the permissible number of false alarms. However, they should not exceed the following values:

– one false alarm for every 5 thousand m^2 of the object's area per year (rounded up);

– six false alarms per year per object as a whole.

At the same time, in the first year of operation of the facility, the number of false alarms may be higher. This is not considered a violation of the requirements if measures were taken to reduce the frequency of false alarms.

When compiling a statistical sample, it was taken into account that according to clause 6.5.9 of GOST R 59638-2021, the operation of a fire detector switched on according to the "And" scheme (algorithm C) may not be counted as false. However, in the daily practice of the protected facility, in our opinion, such triggers should be considered as false. This allows you to present in more detail the technical condition and performance of FAS. Accordingly, the sample included cases when the system:

– signals a fire and starts the fire automation algorithm;

– gives a "pre-alarm" signal without starting the algorithm.

Results. All actuations are classified in accordance with GOST R 59638-2021. The exception was the episodes when the alarm was turned on due to insects getting into the detector. GOST R 59638-2021 defines such cases as a malfunction. In our opinion, they should be attributed to unwanted triggers, because the optical pair of the detector reacts to dimming in the same way as in case of fire. "Erroneous activation of the "pre-alarm" signal was excluded, because such a situation is impossible: activation of a manual fire detector is in any case accompanied by a "fire" signal. Simultaneous operation of several detectors caused by a common cause for a maximum of 1.8 thous. s. was counted as one operation in accordance with GOST R 59638-2021.

Table 1 provides summary data on FAS false alarms in 2019.

Table 1

Summary data on FAS false alarms in 2019

Cause for FAS actuation according to GOST R 59638-2021	Month																							
	01		02		03		04		05		06		07		08		09		10		11		12	
	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%
"fire" signal																								
Unwanted actuation			1	5.0															1	5.0			1	5.0
Malfunction	1	5.0					1	5.0					1	5.0										
Hooliganism																								
Erroneous																								
Unknown cause																								
"pre-alarm" signal																								
Unwanted actuation	17	5.5	2	0.6	10	3.2	10	3.2	7	2.3	8	2.6	0		18	5.8	14	4.5	10	3.2	5	1.6	11	3.5
Malfunction	8	2.6	3	1.0	2	0.6	7	2.3	0		3	1.0	3	1,0	2	0,6	0		1	0,3	0		0	
Hooliganism																								

Cause for FAS actuation according to GOST R 59638-2021	Month																							
	01		02		03		04		05		06		07		08		09		10		11		12	
	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%
Unknown cause	0		2	0.6	1	0.3	0		3	1.0	6	1.9	1	0.3	4	1.3	2	0.6	0		0		2	0.6
Total	26		8		13		18		10		17		5		24		16		12		5		14	
Including "fire" signals	1		1		0		1		0		0		1		0		0		1		0		1	
Including "pre-alarm" signals	25		7		13		17		10		17		4		24		16		11		5		13	
Total within a year	**168**																							
Including "fire"	6																							
Including "pre-alarm" signals	162																							

The proportion of actuations for one reason or another was calculated from the total number of actuations from 01.01.2019 to 30.06.2021. The total number of false alarms for all this time was 330. Of these, a "fire" signal was activated in 20 cases, and a "pre-alarm" signal — in 310 cases. The final figures were rounded to tenths. In 2019, 6 false alarms "fire" were recorded. This corresponds to the maximum value that can be set by a fire and rescue unit in the presence of FNS (this is exactly the case at the object under study). Let us mention also that the number of unwanted actuations is equal to the number of malfunctions.

Table 2 provides summary data on FAS false alarms in 2020.

Table 2

Summary data on FAS false alarms in 2020

Cause for FAS actuation according to GOST R 59638-2021	Month																							
	01		02		03		04		05		06		07		08		09		10		11		12	
	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%
"fire" signal																								
Unwanted actuation			2	10.0					1	5.0													1	5.0
Malfunction							1	5.0							2	10.0			1	5.0				
Hooliganism																								
Erroneous activation																								
Unknown cause																								
"pre-alarm" signal																								
Unwanted actuation	8	2.6	6	1.9	9	2.9	1	0.3	1	0.3	4	1.3	4	1.3	11	3.5	4	1.3	2	0.6	4	1.3	7	2.3
Malfunction	1	0.3	1	0.3	1	0.3	1	0.3	0		0		1	0.3	0		0		0		0		1	0.3
Hooliganism																								
Unknown cause	0		1	0.3	0		1	0.3	2	0.6	5	1.6	3	1.0	0		4	1.3	4	1.3	1	0.3	1	0.3
Total	9		10		10		4		4		9		8		13		8		7		5		10	
Including "fire" signals	0		2		0		1		1		0		0		2		0		1		0		1	
Including "pre-alarm" signals	9		8		10		3		3		9		8		11		8		6		5		9	
Total within a year	**97**																							
Including "fire" signals	8																							
Including "pre-alarm" signals	89																							

In the conditions of the COVID-19 pandemic, shopping and entertainment complexes did not work. The object of protection in question was closed to visitors from 01.04.2020 to 30.06.2020. Nevertheless, false "fire" alarms were recorded more often than in 2019. There were 8 actuations in total. As noted above, this exceeds the maximum value set

by the fire and rescue unit for this shopping center. The number of unwanted actuations, as in 2019, corresponded to the number of malfunctions.

In 2020, there were 3 false "fire" alarms, which should be considered in more detail. In February 2020, twice with an interval of 6 days, signals of a drop in water pressure in the water extinguishing system were recorded. As a result, the FAS issued a "fire" signal and launched a fire-fighting algorithm. A similar event took place in May 2020. The examination showed the good condition of the pressure detector. It follows from this that the drop in water pressure in the system corresponded to the situation of a real fire (the thermal locks of the sprinklers are triggered, the pressure in the system drops, fire pumps start working). Nevertheless, the incidents are connected with a malfunction — leakiness of the distribution water pipe of the water extinguishing section. Accordingly, the malfunction created the conditions that arise in a real fire. GOST R 59638-2021 does not contain unambiguous criteria for attributing such a trigger to unwanted actuations or malfunctions. In this sample, they were attributed to unwanted actuations, since the FAS, in fact, worked normally, responding to the conditions arising from a fire.

Table 3 provides summary data on FAS false alarms in January — June 2021.

Table 3

Summary data on FAS false alarms in January — June 2021

Cause for FAS actuation according to GOST R 59638-2021	Month											
	01		02		03		04		05		06	
	n	%	n	%	n	%	n	%	n	%	n	%
"fire" signal												
Unwanted actuation			1	5.0					1	5.0	2	10.0
Malfunction							1	5.0	1	5.0		
Hooliganism												
Erroneous activation												
Unknown cause												
"pre-alarm" signal												
Unwanted actuation	5	1.6	5	1.6	7	2.3	9	2.9	3	1.0	8	2.6
Malfunction	1	0.3	0		0		2	0.6	2	0.6	1	0.3
Hooliganism												
Unknown cause	3	1.0	6	1.9	0		2	0.6	0		5	1.6
Total	9		12		7		14		7		16	
Including "fire" signals	0		1		0		1		2		2	
Including "pre-alarm" signals	9		11		7		13		5		14	
Total within a year	**65**											
Including "fire" signals	6											
Including "pre-alarm" signals»	59											

From 01.01.2021 to 30.06.2021 there were 6 false "fire" signals. At the same time, the number of unwanted actuations exceeded the number of malfunctions. However, this does not mean anything, given that the data were recorded for six months. In 2020, in the first half of the year, the indicator of unwanted actuations also exceeded the indicator of malfunctions, but by the end of the year the difference was leveled. We note two false alarms in particular:

– the fluid pressure alarm in the water extinguishing section was triggered due to a violation of the tightness of the pipeline (classified as an unwanted actuation on the grounds mentioned before);

– "fire" signal was activated and the fire–fighting algorithm was started during the programming of the system.

From the point of view of GOST R 59638-2021, such alarms are false, but the given classification criteria require clarification and raise new questions. We should note, in particular, that the alarm system may turn on during preventive or other work on FAS equipment. GOST does not provide for such an operation. It cannot be classified as

erroneous actuation, hooliganism and unknown cause. There remains a malfunction, which is also incorrect. In general, the fault criteria in GOST R 59638-2021 require clarification.

During the study, since 2019, 20 FAS false alarms with "fire" signal have been recorded at the protection facility. Of these, 11 (55%) were classified as unwanted actuations, 9 (45%) — as a malfunction. The number of false alarms per month did not exceed 2. FAS worked without false signals for no more than two months in a row. No actuations were detected due to hooliganism, erroneous actuation and for an unknown cause.

Let us consider false alarms with a "pre-alarm" signal. On average, for all analyzed periods, one false "fire" alarm accounted for 15.5 false "pre-alarms" (Table 4).

Table 4

Total number of false alarms with "fire" and "pre-alarm" signals

	n	%
"Fire"	**20**	**100.0**
Unwanted actuation	11	55.0
Malfunction	9	45.0
"Pre-alarm"	**310**	**100.0**
Unwanted actuation	210	67.7
Malfunction	41	13.2
Unknown cause	59	19.0

An unknown cause may trigger a false alarm signal (triggering of one detector switched on according to the logical scheme "And"). In the situation with the "fire" signal, such cases are not recorded.

Table 5 provides modal, median and average values for FAS triggering with the "pre-alarm" signal.

Table 5

Modal, median and average values for FAS triggering with the "pre-alarm" signal

Year 2019		**Year 2020**		**Year 2021**	
Mode		**Mode**		**Mode**	
Unwanted actuation	10.0	Unwanted actuation	4.0	Unwanted actuation	5.0
Malfunction	0.0	Malfunction	1.0	Malfunction	1.0
Unknown cause	0.0	Unknown cause	1.0	Unknown cause	0.0
Median		**Median**		**Median**	
Unwanted actuation	10.0	Unwanted actuation	4.0	Unwanted actuation	6.0
Malfunction	2.0	Malfunction	0.5	Malfunction	1.0
Unknown cause	1.5	Unknown cause	1.0	Unknown cause	2.5
Average		**Average**		**Average**	
Unwanted actuation	9.3	Unwanted actuation	5.1	Unwanted actuation	6.2
Malfunction	2.4	Malfunction	0.5	Malfunction	1.0
Unknown cause	1.75	Unknown cause	1.8	Unknown cause	2.7

Let us note that the most common cause of "pre-alarms" is unwanted actuation (210, or 67.7%). This is due to work at the facility. The examples include:

– disconnection and malfunction of the hood during cooking;

– oil and smoke emissions;

– ironing and steaming of clothes;

– fire-hazardous work;

– dust pollution of detectors during construction, installation and repair.

Obviously, the frequency of such actuations will be due to the intensity of work of tenants of a multifunctional shopping and entertainment complex. The total number of FAS malfunctions that generated the "pre-alarm" signal is 41, or 13.2 % of the total number of "pre-alarms". False alarms for unknown causes occurred 59 times (19.0 %).

Standard deviations and sample variances give the following picture. The largest spread of data relative to the average value is demonstrated by unwanted actuations ($D(x) = 19.9$). Accordingly, the maximum standard deviation ($\sigma = 4.5$) is noted for this indicator, which is not surprising, given the high randomness of the parameter. The spread of data on false alarms due to malfunctions and unknown causes gives similar values: $D(x) = 3.8$ and $\sigma = 1.9$; $D(x) = 3.7$ and $\sigma = 1.9$, respectively.

The "pre-alarms" analysis gives the following results. In 2019, with intense activity of tenants, the modal value is 10 false alarms per month. The indicator corresponds to the median, i.e. the entire sample for this parameter splits into two equal parts. The most frequent value of false alarms due to malfunctions is 0, but in this case the mode does not correspond to the median and average indicators — 2 and 2.4 alarms, respectively. The situation is similar with the results of actuations for unknown causes — 0, 1.5 and 1.75, respectively.

In 2020, the highest frequency of unwanted FAS actuations is 4 per month. The indicator, as in 2019, is equal to the median. The modal value for false alarms due to malfunctions is 1 per month. The indicator is close to median and average values. Triggering for an unknown reason was recorded no more than 1 time per month, which is equal to the median indicator with an average of 1.8.

In 2021, with the growth of tenants' activity, the indicators of unwanted actuations increased. The maximum frequency reached 5 per month, which is close to the median one — 6 and the average one — 6.2. In 2021, 1 actuation due to malfunctions was recorded every month. FAS false alarms for unknown causes give a spread: 0, 2.5 and 2.7. Most likely, this is due to the fact that the sample included data for only six months.

Table 6 provides the structural averages for the entire monitoring period.

Table 6

Structural averages for "pre-alarms" for the entire monitoring period

Mode	
Unwanted actuation	4.0
Malfunction	0.0
Unknown cause	0.0
Median	
Unwanted actuation	7.0
Malfunction	1.0
Unknown cause	1.5
Average	
Unwanted actuation	7.0
Malfunction	1.4
Unknown cause	2.0

The indicators of structural averages for the entire period of the study differ significantly from the annual ones. This also proves the connection of FAS false alarms in the shopping center with the tenants' activity. In 2019, high rates were recorded with the most intense activity of tenants. The shutdown during the pandemic was accompanied by a decrease in the number of FAS false alarms.

To identify the links between different types of FAS false alarms, we conducted a correlation analysis for all monitoring periods. The following correlations were revealed in the sample under study:

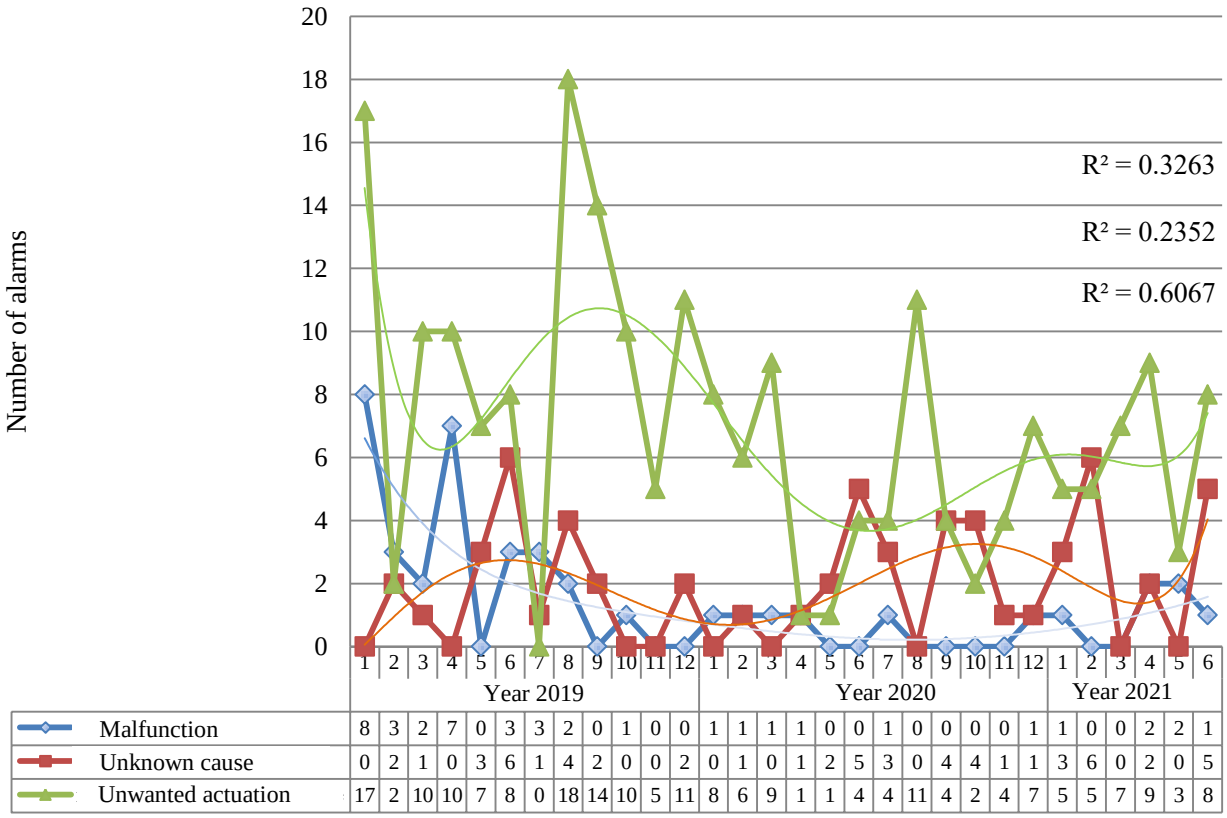
– unwanted actuation and malfunction — moderate positive correlation ($Rxy = 0.35$);

– unwanted actuation and unknown cause — weak negative correlation ($Rxy = –0.12$);

– malfunction and unknown cause — weak negative correlation (*Rxy* = –0.24).

The assessment of the significance of the identified correlations by the Student's t-criterion allows us to consider only a moderate positive relationship as significant. Apparently, it is explained by some dependence between the tenants' activity (unwanted actuations) and the intensity of construction, installation, repair and fire-hazardous work (unwanted actuations and malfunctions caused by interference with the FAS).

Figure 1 provides the dynamics of FAS false alarms for various causes.



	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6
Malfunction	8	3	2	7	0	3	3	2	0	1	0	0	1	1	1	1	0	0	1	0	0	0	0	1	1	0	0	2	2	1
Unknown cause	0	2	1	0	3	6	1	4	2	0	0	2	0	1	0	1	2	5	3	0	4	4	1	1	3	6	0	2	0	5
Unwanted actuation	17	2	10	10	7	8	0	18	14	10	5	11	8	6	9	1	1	4	4	11	4	2	4	7	5	5	7	9	3	8

Fig. 1. FAS false alarms

Peak values of unwanted actuations most often coincide with periods of high consumer activity. This is the time of the most intensive activity of the shopping center tenants. This situation is recorded in December, January, March, April and August. In June, the most frequent entry of insects into the detectors was noted. The dynamics are also illustrated by polynomial trend lines. The highest approximation coefficient was obtained when constructing the fault dynamics trend line (R^2 = 0.6067), the lowest is associated with actuations for an unknown cause (R^2 = 0.2352). There is a clear trend of a decrease in false alarms due to unwanted actuations and malfunctions in the first half of 2020. Then, in 2021, these indicators are growing, which, as noted above, is most likely due to the lifting of the pandemic restrictions.

The total dynamics of all false alarms for the analyzed periods is shown in Fig. 2.

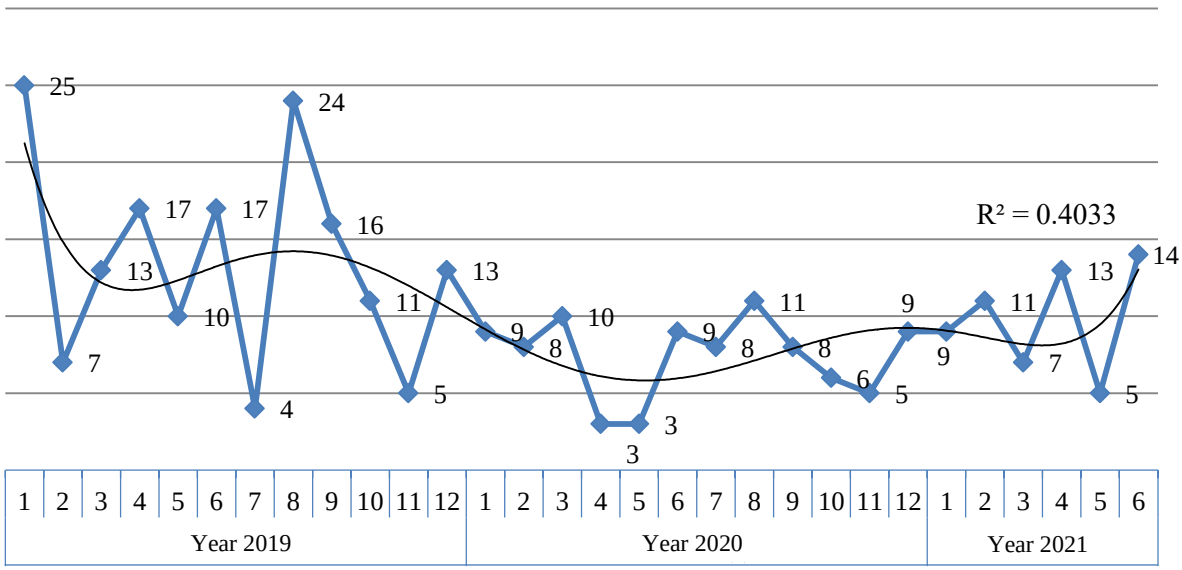


Fig. 2. Total dynamics of FAS false alarms

Let us note that the false triggering of the "pre-alarm" signal was recorded in each month. The frequency of false alarms is related to the tenants' activity. A polynomial trend line with an approximation coefficient of 0.4033 confirms the trends identified earlier when considering individual periods.

Discussion and Conclusion. The conducted research allows us to draw a conclusion regarding the applicability of GOST R 59638-2021 for the classification and analysis of statistics of FAS false alarms on a specific object.

Firstly, we note that the accepted classification is based on enlarged criteria; therefore it does not give an idea of the specific cause of actuation. More promising for future research is an analysis based on specific types of triggering (for example, violations during fire-hazardous work, non-compliance with the rules of operation of technological equipment, unauthorized interference in the system, improper operation of the system, etc.).

Secondly, there are difficulties in correlating specific actuations with GOST classification. Let us identify three main issues.

1. Attribution to malfunctions of insects entering the detector. From a technical point of view, in our opinion, this is an unwanted actuation. The detector reacts to changes in the light environment, and this is a factor similar to the effect of smoke in a fire.

2. The ambiguity of attribution to malfunction and unwanted actuation of cases when FAS is switched on normally. This happens if a faulty related fire automation system operates in conditions similar to a fire. The paper considers the situation with a pressure drop in an automatic fire extinguishing system.

3. The proposed classification excludes cases of actuation during preventive and other work related to the maintenance of the system (work on its programming is considered).

Thirdly, GOST R 59638-2021 does not contain a direct indication of the need to analyze FAS false signals when a fire detector is activated, switched on according to the logical scheme "And" (algorithm C). The wording "may not be taken into account as a false alarm" seems incorrect. The analysis of such situations (in the case of "pre–alarm") makes it possible to:

– predict the number of false alarms;

– evaluate the performance of the system;

– identify the factors of false alarms and prevent them.

A connection has been established between the number of false alarms and the intensity of the work of the shopping center tenants. In addition, the analysis allowed us:

– to determine the proportion of different types of false alarms in general statistics and the significance of factors affecting FAS false actuation;

– to identify the correlation between unwanted actuations and malfunctions.

The statistics allow us to conclude that FAS of the considered object of protection meets the requirements of GOST R 59638-2021 and Order of the Ministry of Emergency Situations of Russia of June 7, 2021 No. 364 "On approval of the list of indicators of the risk of violation of mandatory requirements in the implementation of Federal state fire supervision".

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About the Authors:

Siksimov, Dmitriy A., Master's degree student, Department of Life Safety and Environmental Protection, Don State Technical University (1, Gagarina sq., Rostov-on-Don, RF, 344003), ORCID, dasiksimov@list.ru

Merenyashev, Vitaliy E., Associate professor, Department of Life Safety and Environmental Protection, Don State Technical University (1, Gagarina sq., Rostov-on-Don, RF, 344003), Cand. Sci. (Mil.), associate professor, ORCID, papa@xorelse.com

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D. A. Siksimov — calculations, text preparation, analysis of the research results, formulation of the conclusions. V. E. Merenyashev — formulation of the basic concept, goals and objectives of the study, revision of the text, correction of the conclusions.

Conflict of interest statement

The authors do not have any conflict of interest.

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