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Assessment of the fire hazard level of buildings (structures) in operation, taking into account the functional fire hazard class for 2017-2020

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Introduction. The article analyzes the methods of assessing the fire hazard level of operated buildings (structures). The indicator "the proportion of people injured in fires from the total number of people injured in fires" is proposed to assess the fire hazard level of operated buildings (structures).
Problem Statement. To assess the fire hazard level of operated buildings (structures), various indicators are used that do not take into account the number of people present at the facility during the fire, but are dependent on this value. The calculation of the indicator "the proportion of people injured in fires from the total number of people injured in fires" as an additional one allows us to estimate the magnitude of fire hazard factors at facilities without taking into account the number of people who were at the protection facility during the fire.
Theoretical Part. As the basic information in the study, the statistics of fires and their consequences for 2017-2020 at operated facilities grouped by functional fire hazard classes were used. The indicators used in the calculation are the number of fires, the number of people killed and the number of injured people.
Conclusions. The indicator "the proportion of people injured in fires from the total number of people injured in fires" evaluates the probability of survival of people caught in the zone of exposure to fire hazards that lead to injury or death of a person, and characterizes the magnitude of fire hazard factors. Large values of this indicator may indicate a low level of fire hazard — the damage to health does not lead to the death of victims. The calculations of this and other indicators for objects of protection by functional fire hazard classes based on statistical data on fires and their social consequences are given. The high level of fire hazard in single-family residential buildings, agricultural buildings and cultural and leisure institutions is shown.

***Keywords*:** fire, object of protection, functional fire hazard class, death, injury.

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Introduction. Many scientific studies have been devoted to the problem of fire hazard assessment of operated buildings (structures) [1–4]. At the same time, approaches to such an assessment often differ. It is proposed to use the following indicators: "the risk for a person to die in a fire" [1, 2]; "the proportion of dead and injured people for a group of hazardous objects similar in types of economic activity", calculated as the average number of injured people per object per year [3]; an indicator based on the Dow-Jones approach [4] et al. However, it is not always possible to accurately estimate the number of people who are at the hazardous object during a fire. In addition, biased estimates are calculations of the average number of people killed per 1 object per a year or per 1 fire, because they do not take into

account the total number of people who are at the hazardous object during the fire, at the same time, the estimates under consideration depend on the total number of people.

In 2020, the number of planned and unscheduled fire safety inspections of hazardous facilities decreased by 66% [5]. This is due to several factors: firstly, changes in control and supervisory activities, enshrined in Federal Law No. 248-FZ of 31.07.2020 "On State Control (Supervision) and Municipal Control in the Russian Federation", which establishes a new procedure for the organization and implementation of state and municipal control. Secondly, the adoption by the Government of the Russian Federation of a number of resolutions related to the pandemic, including the extension of the moratorium on scheduled inspections of small and medium-sized businesses and the restriction of unscheduled inspections in the conditions of the spread of COVID-19. The purpose of these studies is to identify the hazardous objects that have the maximum level of fire danger.

Problem Statement. Based on the statistics of fires and their consequences for 2017-2020 [6-9, 10], the research provides the fire hazard assessment of operated buildings (structures) grouped by the level of such hazard in accordance with Article 32 of Federal Law No. 123-FZ of 22.07.2008 "Technical Regulations on fire safety requirements". Data on the statistics of fires and their consequences are given in Table 1.

Table 1

Statistical data on the number of fires and injured and dead people for 2017-2020

Functional fire hazard class	Number of fires	Number of people	
		dead	injured
Ф1.1	889	32	62
Ф1.2	1446	56	140
Ф1.3	119665	9713	14478
Ф1.4	173086	17555	10031
Ф2.1	528	65	86
Ф3.1	10961	44	165
Ф3.2	2563	14	84
Ф 3.4	488	11	21
Ф3.5	1136	10	38
Ф3.6	9627	86	158
Ф4.1	776	2	21
Ф4.3	3552	40	102
Ф5.1	13059	244	527
Ф5.2	30616	521	792
Ф5.3	8091	185	154

The following indicators were calculated for each group of hazardous objects differing in the class of functional fire hazard:

— the number of people killed in fires per 1 fire;

— the number of victims (dead and injured) in fires per 1 fire;

— the proportion of injured people from the amount of people affected by fires.

Theoretical Part. Figure 1 shows the distribution of fires by groups of hazardous objects corresponding to functional fire hazard classes. Most of the fires in 2017-2020 occurred in single-family residential buildings (46%), multi-apartment residential buildings (32%) and objects of functional fire hazard class Ф5.2 (warehouse buildings, etc.). Figures 2, 3 reflect the consequences of fires at various facilities.

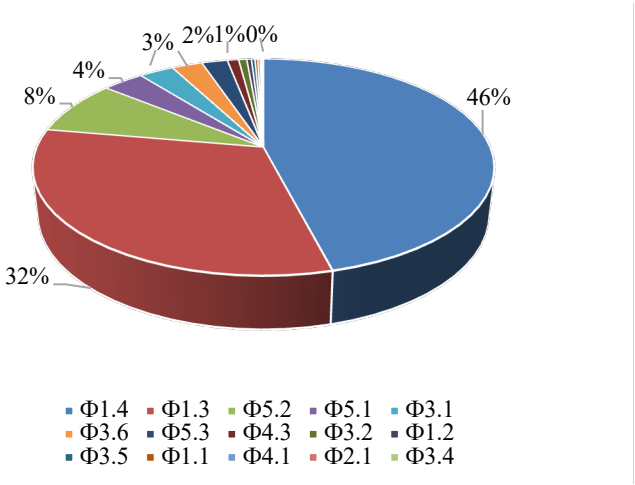

Fig. 1. Distribution of fires by functional hazard classes

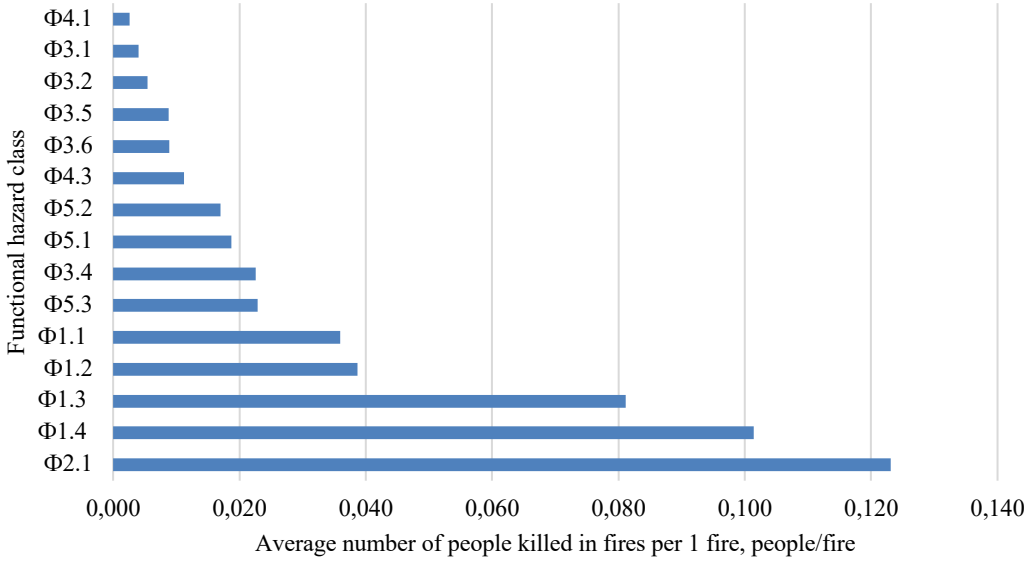

Fig. 2. Distribution of the number of people killed in fires per 1 fire by groups of hazardous objects

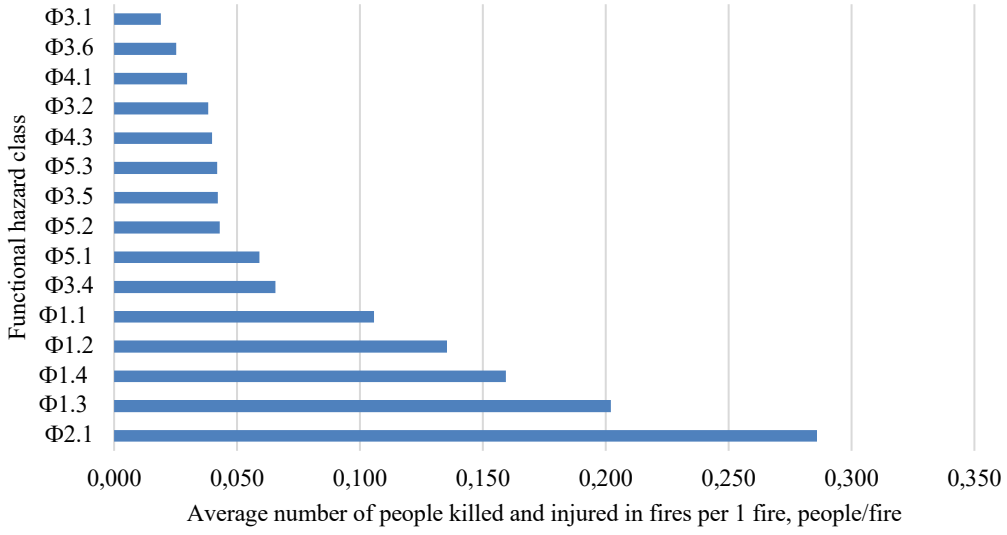

Fig. 3. Distribution of the number of victims (dead and injured) in fires of people per 1 fire by groups of hazardous objects

The maximum negative effect from fires was recorded at objects of functional hazard class Ф2.1 (cultural and leisure institutions, etc.). This indicator is also high in single-family and multi-apartment residential buildings and at objects of class Ф1.2 (hotels, dormitories, etc.). However, such values of the considered indicators can be associated with both a high level of fire danger of hazardous facilities and a large number of people who are at the facilities during a fire.

To assess the fire hazard of operated buildings (structures), it is proposed to use the indicator "the proportion of people injured in fires from the total number of people injured in fires" as an additional indicator. This indicator evaluates the probability of survival of people exposed to fire hazards that lead to injury or death of a person, and characterizes the magnitude of fire hazard factors. Large values of this indicator may indicate a low level of fire danger, when damage to health does not lead to the death of victims. Figure 4 shows the ratio of the proportion of people injured in fires from the total number of victims of fires by groups of hazardous objects corresponding to functional hazard classes.

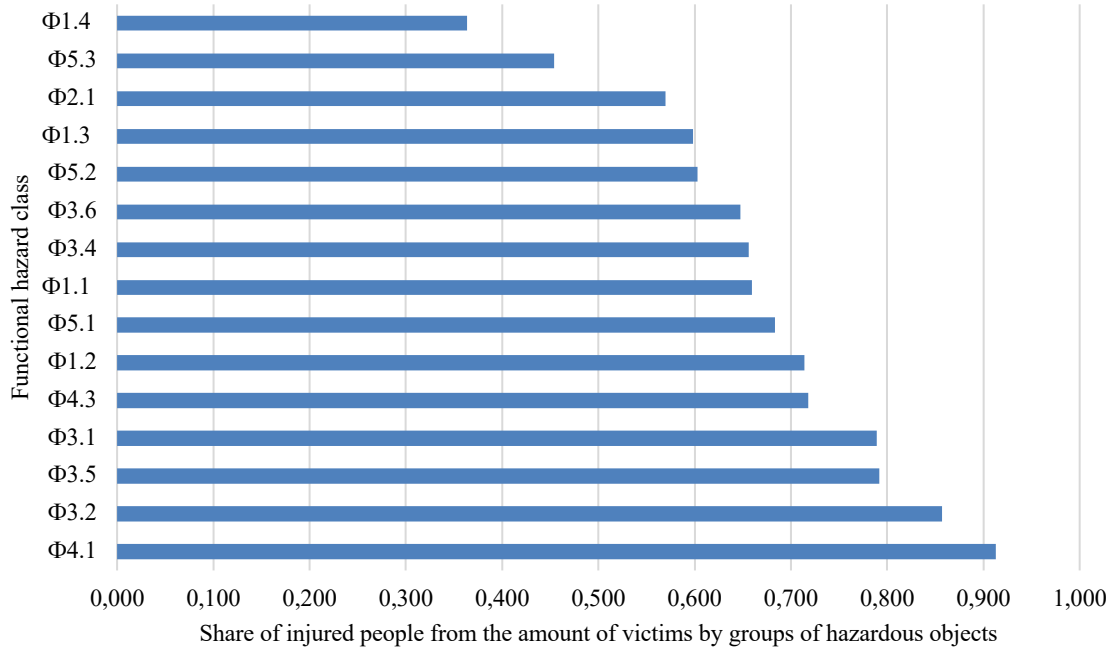

Fig. 4. The proportion of injured people from the amount of victims by groups of hazardous objects

As it can be seen from Figure 4, the highest level of fire hazard is recorded in single-family residential buildings. It should be noted that the biggest amount of fires occurred at these facilities (Fig. 1). However, if the indicator "average number of deaths per 1 object per year" is used, we get an estimate of 2.4·10-5 people/object /year, whereas for apartment buildings a similar estimate is 9.0·10-5 people /object/year. The calculated data obtained confirm the conclusion that it is incorrect to use this indicator to assess the level of fire danger of operated buildings (structures) without taking into account the number of people who are at the hazardous object during the fire. The proposed indicator "the proportion of people injured in fires from the total number of people injured in fires" does not depend on taking into account the number of people who are at the hazardous object during a fire, and seems to be more optimal for assessing the magnitude of the fire hazard of buildings (structures) in operation. It should be noted that low values of this indicator were obtained for agricultural buildings (Ф5.3), as well as cultural and leisure institutions (Ф2.1). Let us mention that other methods of assessing the fire hazard of operated buildings (structures) do not record a high level of fire hazard of agricultural buildings.

Conclusions. The indicators of fire hazard assessment of operated buildings (structures) classified according to the level of fire hazard in accordance with Article 32 of Federal Law No. 123-FZ dated 22.07.2008 "Technical Regulations on Fire Safety Requirements" are analyzed. A new indicator for such an assessment is proposed. The high level of fire hazard in single-family residential buildings, agricultural buildings and cultural and leisure institutions is

shown. It is necessary to develop new forms of organization and implementation of state and municipal control, taking into account the high risks of fire hazard of hazardous objects of the selected categories.

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V. V. Kharin — scientific supervision, analysis of the research results, correction of the conclusions, revision of the text; E. V. Bobrinev — formulation of the main idea and concept of the study, review of publications on the topic of the article, participation in the collection and processing of material, analysis of the research results, participation in writing the text of the manuscript; A. A. Kondashov — development of the purpose and objectives of the study, calculations, analysis and interpretation of data, formulation of the conclusions, participation in writing the text of the manuscript; E. Yu. Udavtsova — development of the research design, preparation of literature, participation in the collection and processing of material, participation in writing the text of the manuscript; T. A. Shavyrina — participation in writing the text of the manuscript, editing the text, making the final version of the article.