
PROBLEMS AND PROSPECTS OF FIRE PREVENTION AND EXTINGUISHING

Scientific article

UDC 614.841.334; DOI: 10.61260/2304-0130-2025-2-78-82

PECULIARITIES OF FIRE PROTECTION LEVEL ANALYSIS OF WAREHOUSE TRANSSHIPMENT LOGISTICS COMPLEXES

Vagin Alexander Vladimirovich;

✉ Ragimov Anton Olegovich;

Maer Oleg Mikhailovich.

Saint Petersburg University of State Fire Service of EMERCOM of Russia, Saint Petersburg, Russia

✉ antonragimov96@mail.ru

Abstract. Modern warehouse transshipment logistics complexes are complex engineering and technical facilities with a high degree of functional workload. The intensive movement of goods, the use of various technological equipment, and the availability of combustible materials, combined with the large area and height of storage facilities, create significant risks of fire occurrence and rapid spread. In these conditions, it is especially important to conduct a systematic analysis of the level of fire protection, which makes it possible to identify vulnerabilities and develop effective measures to ensure fire safety.

The article discusses the main approaches to the analysis of fire protection of logistics complexes of transshipment type, taking into account both the technical parameters of buildings and organizational aspects of operation. Key indicators for assessing the level of protection are proposed and recommendations are given for improving analysis methods, taking into account the specifics of logistics operations. The results of the study can be used in the design of new facilities and modernization of existing warehouse complexes.

Key words: fire safety, warehouse transshipment logistics complexes, fire protection analysis

For citation: Vagin A.V., Ragimov A.O., Mayer O.M. Peculiarities of fire protection level analysis of warehouse transshipment logistics complexes // Supervisory activities and forensic examination in the security system. 2025. № 2. C. 78–82. DOI: 10.61260/2304-0130-2025-2-78-82.

Introduction

In modern conditions of active development of logistics infrastructure, the issues of ensuring fire safety of warehouse facilities are of particular importance. According to the definition given in GOST 59282-2020, a warehouse complex is a set of infrastructure elements designed for the storage, processing and distribution of material resources, including both physical storage areas and areas managed by the warehouse logistics system. The complex includes work areas, warehouse sections, open and closed sites, silos, reservoirs, as well as other facilities used for the placement of inventory and logistics operations [1].

Warehouse transshipment logistics complexes (WTLC) are an integral part of the modern transport and logistics infrastructure. They serve as an intermediate link in the supply chain, ensuring the redistribution of commodity flows between different modes of transport and delivery routes. The peculiarity of their operation is the high intensity of operations, the use of various types of lifting and transport equipment, as well as the availability of a large volume of stored products, including flammable materials [2].

Federal Law №. 123-FL of July 22, 2008 «Technical Regulations on Fire Safety Requirements» (FL №. 123-FL) establishes general requirements for ensuring fire safety of facilities, including WTLCs. The table shows the key provisions of the law related to such objects [3]:

Table

Main requirements for WTLCs

№	Requirements	Statute	Article/paragraph
1	Classification by functional fire hazard	Warehouse buildings and premises belong to the functional fire hazard class F5.2. This class includes buildings and structures intended for storing material assets, archives, book storages and parking lots for cars without maintenance and repair	n/a «b» clause 5 of art. 32 of Federal Law №. 123-FL [3]
2	Fire and explosion hazard category definition	Industrial and warehouse premises are classified according to fire and explosion hazard categories: Category A – increased explosion and fire hazard; Category B – explosion and fire hazard; Category B – fire hazard (subcategories B1–B4); Category G – moderate fire hazard; Category D is the minimum fire hazard. The category is determined based on the characteristics of the stored substances and materials, as well as their storage conditions.	Article 27 of Federal Law №. 123-FL [3]
3	Escape routes and exits requirements	For Class F5 premises of categories A and B, in which more than five people work in the most numerous shift, at least two evacuation exits are required. For category B premises with an area of more than 1,000 sq. m. m or with more than 25 employees, it is also necessary to provide at least two evacuation exits.	clauses 8.1.1, 8.1.2 of SP 1.13130.2020 [4]
4	Fire-fighting distances and passages between shelving units	In warehouse buildings (with the exception of category D), cross passages must be provided every 40 m between shelving units with a height of at least 2 m and a width of at least 1.5 m. They must be separated by fire barriers of at least type 2 and floors of at least type 4. There should be doorways in the outer walls where the cross passages are installed in the shelving units.	Clause 8.3.3 of SP 1.13130.2020 [4]
5	Additional requirements for specialized warehouses	Fire safety regulations establish additional requirements for warehouses intended for storage of: – flammable and combustible liquids; – grains; – coal and peat; – gas; – forest materials. These requirements relate, in particular, to the placement of escape exits, the construction of walkways and escape ladders, as well as the materials from which they are made.	Decree of the Government of the Russian Federation №. 1479 dated September 16, 2020 «On Approval of Fire Safety Regulations in the Russian Federation» [5]

A fire at such an object can lead not only to significant material losses, but also to a halt in logistics processes at the regional and interregional levels. This requires special attention to fire protection issues, including constant assessment of its level. However, typical fire safety analysis methods often do not take into account the specifics of transshipment logistics complexes, which reduces their effectiveness. This article is aimed at identifying the features of such an analysis and making recommendations for its improvement [6].

Peculiarities of fire protection level analysis

The analysis of the level of fire protection of WTLC should be carried out taking into account their spatial planning and functional characteristics. As a rule, such facilities have a large area, high ceilings, a significant number of gates and loading ramps, which creates both favorable and problematic conditions in terms of fire safety.

According to Federal Law №. 123-FL, the fire safety of the WTLC must be ensured by fire prevention and fire protection systems, including organizational and technical measures. These systems must:

- prevent the occurrence of fire;
- ensure fire safety of people;
- ensure fire safety of material assets;
- to ensure fire safety of people and property at the same time [7].

SP 12.13130.2009 «Definition of categories of premises, buildings and outdoor installations for explosion and fire hazards» provides the classification necessary to determine the relevant fire safety requirements aimed at preventing fire and protecting people and property in the event of its occurrence (Fig.) [8]:

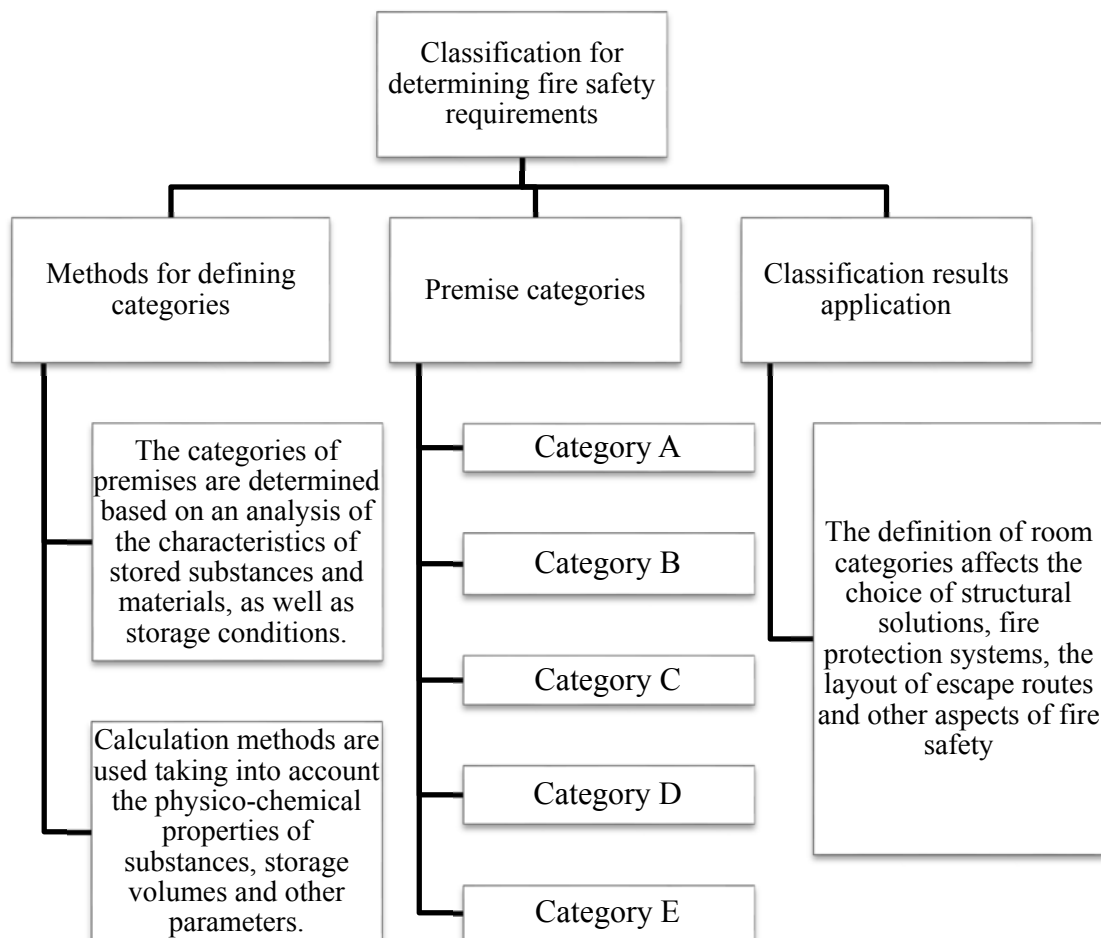


Fig. Classification for determining fire safety requirements

According to the Rules of the fire protection regime in the Russian Federation, the key areas of analysis are:

1. Assessment of the compliance of design solutions with fire safety requirements, including the presence of fire barriers, escape routes, smoke extraction systems and automatic fire extinguishing.

2. Analysis of organizational and operational factors, such as the regularity of equipment maintenance, staff training, and the availability of instructions and regulations for actions in case of fire.

3. The use of digital technologies and automated monitoring systems, integration with building management systems.

4. Assessment of the fire load and scenarios of possible fires, taking into account the placement of goods, their packaging, as well as the characteristics of the equipment used [5].

Additionally, as part of a comprehensive analysis of the level of fire protection of the WTLC, it is advisable to use methods of mathematical modeling of fire dynamics and evacuation. Specialized software tools such as Fire Dynamics Simulator (FDS) and Pathfinder are used for these purposes.

FDS is a computational fluid dynamics tool designed to simulate the spread of fire, temperature, smoke, and other physical parameters in enclosed or open volumes. Using this system, it is possible to simulate the development of a fire in various scenarios: if the fire extinguishing systems fail, if there is a fire source in a certain storage area, taking into account specific materials, rack configuration, ceiling height, ventilation, etc. This allows you to determine the time limits of the spread of fire and the appearance of critical conditions [9].

Pathfinder, in turn, is designed to simulate the behavior of people during evacuation. It allows you to take into account many parameters: the width and number of evacuation exits, the density of staff accommodation, the logistics of movement of employees and visitors, as well as the impact of fire factors on the speed and direction of movement. This makes it possible to assess whether the evacuation is within the regulatory time frame and where «bottlenecks» may occur that make it difficult for people to safely exit.

Together, these tools make it possible to:

- identify constructive and organizational vulnerabilities in the fire protection of the WTLC;
- adjust architectural and planning solutions before the project implementation stage;
- to justify the need for additional equipment with means of active protection (for example, fire extinguishing installations, smoke extraction systems, automatic control of evacuation lighting);
- to increase the overall efficiency of the fire safety system based on objective calculated data [10].

Thus, modeling fire and evacuation scenarios is an important element of expert assessment and design of fire protection, especially for high-risk facilities such as warehouse logistics complexes.

Conclusion

WTLC are facilities with high requirements for fire protection. Standard approaches to fire safety assessment need to be adapted to the specifics of such facilities, given their planning complexity, high density of logistical operations and the presence of many potential sources of ignition.

The analysis shows that complex methods combining technical and organizational aspects, as well as the use of digital technologies for early detection of threats, are the most effective. The development of specialized fire protection analysis methods, taking into account the specifics of warehouse logistics, is an urgent task, the solution of which will increase the resilience of facilities to emergency situations and minimize the consequences of possible incidents.

List of sources

1. GOST R 59282-2020. Warehouse management systems. Functional requirements // ELECTRONIC FUND of legal and regulatory-technical documentation. URL: <http://www.docs.cntd.ru> (date of reference: 21.04.2025).
2. Ponomarev A.V. Technical aspects of ensuring fire safety of logistics complexes // Safety in the technosphere. 2021. № 4. P. 45–50.
3. Technical regulations on fire safety requirements: Feder. Law №. 123-FL of July 22, 2008. Access from the legal reference system «ConsultantPlus».
4. SP 1.13130.2020. Fire protection systems. Evacuation routes and exits // ELECTRONIC FUND of legal and regulatory-technical documentation. URL: <http://www.docs.cntd.ru> (date of reference: 21.04.2025).
5. On the approval of Fire Safety Regulations in the Russian Federation: Decree of the Government of the Russian Federation. Of the Russian Federation dated September 16, 2020, № 1479. Access from the legal reference system «ConsultantPlus».
6. Zhuravlev D.A. Modeling of fire propagation in logistics buildings // Modern technologies. System analysis. Modeling. 2020. №. 2. P. 35-41.
7. GOST 12.1.004–91 Fire safety. General requirements // ELECTRONIC FUND of legal and regulatory-technical documentation URL: <http://www.docs.cntd.ru> (date of reference: 21.04.2025).
8. SP 12.13130.2009 Definition of categories of premises and buildings for explosion and fire hazards // ELECTRONIC FUND of legal and regulatory technical documentation. URL: <http://www.docs.cntd.ru> (date of reference: 21.04.2025).
9. Sharapov V.M. Fire safety of industrial buildings and structures. Moscow: Akademiya, 2018. 328 p.
10. Tarasov K.V. Fire protection of logistics facilities: challenges and solutions // Transport and logistics. 2023. № 5. P. 57–62.

Information about the article: submitted for editing: 02.05.2025; accepted for publishing: 03.06.2025

Information about authors:

Vagin Alexander Vladimirovich, Associate Professor of the Department of Fire Safety of Buildings and Automated Fire Extinguishing Systems at the St. Petersburg University of State Fire Service of EMERCOM of Russia (149 Moskovsky Ave., Saint Petersburg, 196105), Candidate of Technical Sciences, Associate Professor, e-mail: vagin@igps.ru, SPIN code: 3296-1936

Ragimov Anton Olegovich, Master's student at St. Petersburg University of State Fire Service of EMERCOM of Russia (196105, St. Petersburg, Moskovsky ave., 149), e-mail: antonragimov96@mail.ru

Maer Oleg Mikhailovich, Associate Professor of the Department of Supervision at the St. Petersburg University of State Fire Service of EMERCOM of Russia (196105, Saint Petersburg, Moskovsky ave., 149), Candidate of Economic Sciences, e-mail: oleg.maer.84@mail.ru, SPIN-code: 6979-7289