Ensuring fire safety in the technosphere: important aspects

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Abstract. This article discusses the factors that lead to fires, how to prevent and avoid them and the different types of primary fire extinguishing equipment used in production. It also describes the algorithm of actions to be followed by personnel and the public in case of fire, according to the fire safety instructions.

Despite the fact that the fire safety rules and fire pyramid conditions (source of fire, temperature, combustible substance and oxygen access) are widely known, the number of technogenic fires in Russia is still high. In connection with this, the article examines the fires that have occurred with loss of life and material damage. These cases are analyzed with the aim of developing and modernizing rules of behavior aimed at preventing fires, as well as developing an algorithm of action in extreme situations and forecasting possible fires.

The article presents statistical data on fires in the Russian Federation. Measures are also suggested to evaluate the risk taking into account the layout and design of buildings, prevent fires and determine fire hazards. After analyzing the situations, preventive measures and fire safety propaganda are recommended, as well as regular training and education of personnel, workers and rescuers in order to reduce the number of fires and thus minimize material and human losses.

1 Introduction

Fires are a serious disaster for people. According to statistics, in 2012 more than 160 thousand fires were registered on the territory of the Russian Federation, because of which more than 23 thousand people were affected, including more than 11 thousand deaths. The total material damage from man-made fires in 2012 alone amounted to about 14 billion rubles, not including forest fires. Statistics of the Ministry of Emergency Situations of Russia show that fires in urban and rural settlements occupy the first place in terms of damage, casualties and deaths.
2 The main causes of fires

Despite the adoption of a number of laws and regulations, technogenic fires occur with regular frequency in the Russian Federation.

Fires are caused by non-compliance with the rules of technical and technological use of electrical systems, such as overloading of cables and wires of electrical networks and occurrence of short circuits, high electrical resistance at installation sites, connection of conductive contacts, occurrence of arcing, operation of electrical appliances that do not meet the requirements of fire protection regulations. The most common causes of fires are equipment faults, violations of technological processes, namely early detection of faults and subsequent repairs of equipment, violations of correct technological instructions, introducing materials into production technology without regard to their fire hazard and formation of significant electrostatic charges which are left unattended, as well as careless handling of fire, in particular burning near combustible materials and buildings, heating of frozen pipelines.

Open Sources of ignition may also include stains of nitro lacquers and nitro enamels, paints, washing and degreasing agents and flammable liquids.

For example, the fire at the Lame Horse Club in Perm on 5 December 2009, which killed 156 people, and the tragedy at the Winter Cherry Shopping Centre in Kemerovo, where 64 people, including 41 children, were killed and 79 injured on Sunday 25 March 2018 (Fig. 1).

In the process of combustion, a maximum concentration of fire hazards develops by the ninth minute after ignition. At a height of 1.7 m (head level of the average person) the temperature of the burning room is +343°C. Toxic smog is produced, so that a person falls down after two or three breaths. Instead of oxygen, the person inhales carbon monoxide and cyanides. After a person has lost consciousness, their body can live for another ten minutes. Then carbon dioxide completely replaces oxygen. Those saved from the fire due to severe toxic brain damage become infantile, and as of today, there is no effective treatment for this in Russia.

To avoid material and human losses, it is necessary to inform the population and conduct preventive measures, which are possible with scientific analysis of the causes, conditions and mechanisms of formation and spread of man-made fires, to develop effective methods of avoiding fires and other mechanisms that reduce property and human losses, which determines the importance and relevance of this topic.

Fig. 1. The aftermath of the Winter Cherry Shopping Centre fire
3 Fire prevention

The most effective measure against fires is prevention. Fire protection currently includes the following measures:

- Expertise and approval of construction projects;
- Control of compliance with fire safety rules and regulations;
- Arson control;
- Collecting information and data;
- Training, education of personnel, the public and the public in fire protection measures and the promotion of fire protection.

Fire protection has three main objectives, which are closely linked to the implementation of a number of activities:

- Training and dissemination of knowledge on fire protection behavior;
- Supervising the development and enforcement of national building and fire safety standards;
- Supply of special equipment and technical development.

In order to fully implement fire protection in the area, organizations and businesses must apply and observe the prevention of forest fires: quality electric wiring, appropriate thermal insulation, insulation of electric sockets, switches and damp-proof boxes, installation of automatic circuit breakers, electric thermal insulation, electric cookers and other heaters of wooden furniture and many others. According to SP 1.13130.2009 "fire protection systems", (second paragraph 17) buildings, production and storage facilities belonging to category A are equipped with early warning and evacuation systems in case of fire (EMS), which must be interlocked with technological fuses or fires. According to SP 1.13130.2009 "Fire protection systems", (article A4 paragraph 1) rooms containing flammable and combustible liquids shall be provided with automatic fire extinguishing system with water supply of 30l/s and water supply duration of 60 minutes. On the basis of RD 009.01-96. "Standard regulations of maintenance of fire alarm systems" periodicity of maintenance tests of all elements of the system: detectors, alarm systems, main controllers, connecting cables of devices is one month, which passes through the authorized service organization, which has concluded the corresponding contract. Compliance with these requirements is monitored by representatives of the State Fire Inspectorate who have the right to issue a warning regarding the inadmissibility of violations of the mandatory requirements. The professional standards state that only graduates of higher education institutions with a degree in fire protection and persons who have been retrained in the respective field should be employed as specialist firefighters and supervisors.
these substances in the environment. Environment, in all regimes. Fire protection measures are governed by GOST.

According to the fire safety system, a short-term fire safety permit must be obtained from the person responsible for the fire safety of the facility in question. The chief engineer of the company is authorized to issue a permit for fire-fighting operations in flammable premises.

If there are explosive and flammable rooms on the territory of the enterprise, it is necessary to organize a fire safety point with which the conditions for carrying out hazardous firefighting operations have been agreed. Qualified personnel who have passed a fire safety regime examination and are issued with a special fire safety passport attached to their qualification certificate are allowed to carry out welding and other fire work. Fire areas and installation sites for welding machines and gas cylinders must be kept free of inflammable materials and equipped with first aid fire extinguishers. Care must be taken so that sparks do not spread and fall on burnt structures, lower production facilities and floors. Work involving the use of open flames (welding, etc.) may be started at least 15 m from openings of colored cells (bottom suction grid edges) and outlets of local ventilation and pumping systems, and at least 5 m when front grilles of non-combustible connections are installed, isolating sparks and heat radiation in these grilles (grilles), and shutting off the exhaust system. To avoid fire, avoid the source of fire coming into contact with combustible materials. However, in some areas, equipment is installed in such a way that both sources are located. Such a room must therefore be protected as much as possible by installing various fire alarm systems and automatically switching off the appliances. Smoking is only permitted in certain areas with suitable waste bins, water tanks and other fire-fighting devices. Safety signs must always be posted in these areas.

In the event of a fire and when extinguishing fires, immediate evacuation must be compulsory. In case of fire or evacuation, the use of a lift is prohibited. Work and emergency lighting on escape routes must be in good condition. Exit panels must also be placed in a prominent position. Room doors must be kept open on the way to escape routes so that they do not interfere with traffic flow. It is strictly prohibited to block emergency exits, install different thresholds, close doors, etc. escape routes must also be illuminated at all times. An emergency exit must accommodate up to 50 people in a building. Free use of and access to the main fire exits in buildings and structures on the organization’s premises must still be ensured. Non-combustible safes are recommended for the protection of valuables and documents, as they cannot be collected in the event of fire. Persons responsible for these facilities are responsible for the timely and proper equipping of organizations and enterprises with primary fire-fighting devices, their proper maintenance and training of workers in the use of these devices. Persons responsible for the availability and accessibility of fire extinguishers shall check the main fire extinguishers at least once every six months, and the results of the check shall be recorded in the log of the status of these devices. Used and defective fire extinguishers (defective seal, insufficient or no fire extinguishers, insufficient or no working gas in the starting cylinder, damaged safety valve, etc.) shall be immediately taken out of service and replaced with serviceable fire extinguishers. Fire extinguishers, fire hoses and other fire extinguishers that fail the test and are taken out of service shall be taken out of service and removed from service by a commission appointed by the head of the enterprise or organization where the activity takes place.

Basic fire-fighting equipment must be easily accessible and must not obstruct the evacuation of people from the premises. Fire-fighting equipment must be readily accessible at all times. The use of fire extinguishers and other fire extinguishers for domestic, industrial and other purposes other than training a volunteer fire brigade, extinguishing fires and dealing with natural disasters is strictly prohibited.
The measures to be taken by the personnel in case of fire are to immediately report the fire to the fire brigade and to the management of the company. Then the automatic fire extinguishing device shall be checked by the personnel or their assistants (if any) and all operations at the technological equipment shall be carried out (electric power supply shall be interrupted etc). In the event of a life-threatening situation, immediately organize rescue operations (evacuation). Name a person who knows the location of the access roads and waterways to meet the fire station. Provide a safe environment for personnel and firefighters when extinguishing fires. Proceed to extinguish the fire with the resources of the production plant.

The main consequences of fires are material damage caused by destruction of property, buildings and structures due to high temperatures and loss of life due to carbon monoxide poisoning and other toxic gases emitted when burning modern plastics, paints, rubber and other materials.

4 Results and discuss

Fig. 2. Number of registered fires in the Russian Federation, thousand units.
Fig. 3.

Subsequently, money is needed for restoration work and compensation for workers or their families. Therefore, fire prevention is more important and cost-effective than extinguishing fires. Preventing emergencies requires a scientific approach with risk assessment and management. Risk management includes a number of activities: hazard zoning of the area; regular monitoring of hazardous areas; construction of protective equipment; installation of indicators and automatic fire extinguishing equipment; adequate education, training, publicity, instruction and information for personnel and population. The planned solutions of the building are analysed for a preliminary risk calculation. After that one can start to learn about fire protection. Then the frequency of fire situations has to be determined. The next step is the analysis of escape routes and emergency exits, after which the evacuation times have to be specified and technological solutions have to be calculated. Only then can fire risks begin to be assessed. The last steps in the calculation are the preparation of recommendations and the drawing of conclusions. In order to calculate the overall risk, fire hazards (FHF) should be considered. The DfE includes all the elements that can cause harm to a person or his property. In other words, TFPs are flames, smoke, high temperatures (which can range from 800 to 1,300 degrees, depending on the fire), toxic products of combustion and chemical decomposition, and low oxygen content.

It should be noted that there is a second wave of damage. It is represented by radioactive substances, electric shocks, various toxins, falling pieces of equipment, buildings which may cause damage to health or property when falling, and a fire may cause an explosion. Thus, the maximum pressure, temperature, explosive properties, rapid pressure rise and explosion front must be considered when calculating risks. The main hazardous factors of an explosion are:

1. An airburst wave whose main parameter is the overpressure at its front;
2. Shrapnel fields produced by flying fragments of exploding objects, the effects of which are governed by the number of flying fragments, their kinetic energy and their expansion radius.

5 Conclusion

Thus, fire is a dangerous process of burning various materials and releasing poisonous gases. Ensuring fire safety is one of the main tasks for the facility manager and everyone. It is better to prevent an emergency than to eliminate its consequences. This is a universal rule.
been tested in practice in all countries and at all times. It is necessary no
t only to preserve
material and technical assets, but also to ensure the safety of people who work or live in a
particular location. In other words, fire safety is a priority that the state must control by
developing a specific legal framework. This positi
on includes a wide range of activities such
as regular inspections by regulatory authorities, providing training to staff on fire safety
standards and regulations, developing and upgrading technical inspections, etc. All these
measures ensure optimal and e
fficient development of the country's economic sphere.

At the same time, everyone should be aware of the main causes of fires and take
precautions both inside and outside. Only by working together can we cope with the fire
element, which kills thousands of
people every year and causes billions of dollars of damage
to our economy. Many people are often negligent about safety rules. We should not forget
that fire safety violations increase the likelihood of fatal consequences.

In the event of a fire, a large part of the rescue operations for these fires must be carried
out in areas and atmosphere contaminated by radioactive, chemical and biohazardous
substances. Searching for people in an emergency area characterised by fire haz
ards often
results in their death. In these circumstances, the task of reducing the risk to the lives of
rescuers and increasing the efficiency of rescue, firefighting, rescue and other special
operations through the development and use of more modern robo
tic firefighting devices is
becoming increasingly urgent. The extensive development of the industry requires the
development of intelligent solutions in the field of fire generating robots of various designs,
autonomous or controlled, with infra-
r
reflection sensors, with efficient fire
fighting
equipment, suspended, tracked, stationary with trolley barrels, etc., operating under high


temperature, pressure, gas and radioactivity and other environmental hazards.

Regular training, retraining, prevention, educ
ation, promotion and education of personnel
and the public with appropriate modern and innovative fire extinguishing devices for
buildings and structures by security and fire safety services are crucial to prevent fires and
hence prevent significant loss
of life and property.

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