

ГАШЕЊЕ ПОЖАРА СТАМБЕНЕ ЗГРАДЕ

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Резиме: Све је више електричних инсталација и уређаја и остале опреме и инсталација у затвореном простору, па је заштита од пожара све важнија. Објашњена је дефиниција пожара и стамбеног објекта у складу са Законом о заштити од пожара и наведено која су права и обавезе сваког корисника стамбене зграде у којој живи или ради. Наведени су узроци пожара и тактике гашења пожара у стамбеним зградама. Узроци могу бити бројни, а један од главних узрока је непажња, док су тактике гашења од великог значаја за затворени простор. Приказано је каквим опасностима ватрогасци могу бити изложени током гашења пожара у стамбеним зградама.

Кључне речи: пожар, стамбена зграда, интервенција, узроци, опасности

FIRE EXTINGUISHING OF A RESIDENTIAL BUILDING

Abstract: There are more and more electrical installations and devices and other equipment and installations indoors, so fire protection is increasingly important. The definition of fire and residential building in accordance with the Law on Fire Protection is explained and it is stated what are the rights and obligations of each user of the residential building in which he lives or works. The causes of fires and firefighting tactics in residential buildings are listed. The causes can be numerous, and one of the main causes is carelessness, while extinguishing tactics are of great importance for an enclosed space. It is shown what dangers firefighters can be exposed to during firefighting in residential buildings.

Key words: fire, residential building, intervention, causes, dangers

1. INTRODUCTION

Fire protection includes planning, prescribing measures (organizational, technical, etc.), organization of the entity, implementation of measures, financing of fire protection and training of workers to perform fire protection activities for protecting people, animals, material goods and the environment.

According to the Fire Protection Act [1], a fire is an uncontrolled combustion that spreads in environment, while combustion is a chemical reaction of a combustible substance with an oxidant (oxygen) with an ignition source where heat, flame and light are released. The Ordinance on the classification of buildings into groups according to the complexity of fire protection measures describes a residential building as a building in which 50% or more of the construction (gross) area is intended for residential purposes, including corridors, woodsheds, waste disposal rooms, storage and other. [2]

It is the right and obligation of every person to be aware of the dangers of fire at the place where he works or resides in. Units of local and regional self-government make a decision in the plan, program and manner of acquaintance with fire dangers. Legal entities or units of local and regional self-government organize training of the population to implement preventive fire protection measures, rescue people and property endangered by fire and extinguish initial fires, and keep records on training. Figure 1 shows the fire protection training of the population.

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The training (Fig.1) is conducted along with firefighters, and in accordance with the Fire Act we distinguish between voluntary members of the fire brigade and a volunteer firefighter. A natural person who is a member of a voluntary fire brigade is called a member of the fire brigade, while a volunteer firefighter is a qualified adult member of the fire brigade of a voluntary fire brigade and performs activities in accordance with the Fire Act and regulations adopted on its basis. [3]

Figure 1 – Training of the population for the implementation of preventive fire protection measures at the Polytechnic of Karlovac



2. CAUSES OF FIRE

There are various causes of fires and we can divide them into five main groups, and these are natural causes, technical causes, human negligence, intentional planting and self-ignition. The main cause is human negligence, because inattention is a common characteristic for each of the causes.

2.1. Natural causes of fire

This group includes meteors and spacecraft, solar energy and atmospheric electricity. Meteors and spacecraft are rare causes of fire which by passing through the atmosphere at high speed heat up to glow due to friction and cause ignition by falling on combustible materials.

Solar energy stored under sheet metal roofs and roofing paper or if it passes through magnifying glass, optical glass, window glass, glass balls, etc. can lead to fuel ignition under certain criteria. The criteria for causing fire based on solar energy are as follows:

- ability to easily transmit heat from solar energy, materials such as rock salt, colorless glass, river and lime sand
- glass bodies which refract rays as convex lenses and focus them at one point can cause a fire if the lens focus is on combustible material such as straw, hay, fibrous materials, igniters, etc., some examples of bodies which act as convex lenses are glass vases, bottles, bowls and spheres, mirrors, etc.
- Ability to accumulate and retain the heat of the sun's rays because material like wool, hay, flax, wool, hair or cotton can absorb large amounts of solar energy in dry state and accumulate it in itself
- sprinklers, fireworks, nitrogen compounds with chlorine ignite directly due to the action of the sun's rays
- containers with ether, acetone, gasoline, kerosene lamps closed in an impermeable casing under the influence of strong sunlight can develop gases or vapors causing the casing to burst, and

containers containing lime under the influence of solar heat develop oxygen also causing the casing to explode

Atmospheric electricity is created by the existence of an electric field in the Earth's atmosphere, the creation of positively and negatively charged water particles within the clouds and the spatial separation of water within the clouds. The best example are thunder and lightning strikes where the electric charge of thunder clouds is discharged by a spark in the Earth's atmosphere with a light form (lightning) and a sound form (thunder). The discharge that takes place between the clouds is called lightning, and the thunder when it happens between the clouds and the ground. Lightning acts as a high-power electric spark which can create an electric arc with a temperature of up to 5,000 degrees Celsius in the thunder conduction channel. If the lightning arc comes in contact with fuel such as wood, hay and straw inflammation may occur. Short-term passage of lightning through combustible material will not cause ignition. [4]

2.2. Technical causes of fire

The technical causes of fires include thermal, electrical(Fig.2), mechanical and chemical energy. Fires of this type occur due to faulty electrical appliances in the household, electrical installations, chimneys, energy conversion plants which cause numerous fires every day. Figure 2 shows the aftermath of fires due to faulty installations.

Thermal energy is the most common cause of fire, by the action of open flames on combustible materials such as fire, matches, candles, but also solar energy. This type of energy is most often recorded as the cause of a fire.

The second most common cause of fire is electricity, which includes electricity, static and atmospheric electricity, short circuit, current overload, sparking and electric arc. The movement of electric charges is called electric current, and without it life is unthinkable. Electric current creates heat which heats the material in the immediate vicinity, a certain temperature of the material is created after which the material ignites, and an example of the material is the insulation of electrical conductors or some parts of a device or machine. Some of the causes are overload of electrical conductors, short circuit, high transient resistance, electric lighting fixtures, sparking and electric arcs.

When mechanical work such as friction, impact or pressure are converted into thermal energy it can lead to a fire caused by mechanical energy. By rubbing two surfaces heat is released which can lead to ignition and fire. The occurrence of sparks is caused by the impact of metal from metal and falling on combustible material can also cause a fire.

The causes of chemical energy fires include exothermic reactions, ignition of dust, self-ignition of various plant substances, fats and oils, chemicals and coal. Exothermic chemical reactions are chemical or biological processes in which thermal energy is generated and released into the environment, as well as heating and ignition of combustible material. [4]

Figure 2 - Aftermath of fire in a residential building due to faulty electrical appliances



2.3. Carelessness of people

People's negligence is an unintentional and common cause of fires due to improper handling of electrical and gas appliances (iron on the ironing board left on), improper lighting of fires, lighting of candles and lamps during the holidays, throwing cigarette butts and matches in flammable places.

Deliberate arson with gasoline and oil out of revenge, envy, jealousy, vandalism, drunkenness and many other reasons is a criminal offense and it is important to determine who started the fire. [5]

2.4. Self-ignition

Self-ignition is the heating, ignition and burning of a material without an external energy source of ignition with thermal energy in the mass of the substance itself, and can be a slow (measured in days) or fast process (measured in seconds) of oxidation. The process of self-heating of a substance that warns of the danger of self-ignition occurs first.

Self-ignition can occur in some solids and it is very important to follow the instructions during transport and storage of such materials. Examples of solids are materials of plant origin, coal, various chemicals and dry or semi-dry fats and oils. [4]

3. BASIC SETTINGS IN FIRE EXTINGUISHING OF A RESIDENTIAL BUILDING

Firefighting activity consists of operational and preventive actions. In order to prevent the occurrence of fire, preventive actions are taken, while operational actions are taken when there is a fire, accident, earthquake, flood. Operational activities in most cases are performed by the fire brigade, voluntary fire brigades and fire brigades as professional and humanitarian organizations, all of which perform firefighting activities. They are one of the settings for successful firefighting because unorganized firefighting can result in an even greater accident.

The course of the fire intervention: fire alarm, alerting, intervention, leading the gas train to the place of the fire (Fig.3), deployment of the vehicle and the choice of firefighting tactics.

Fire alarm with telephones, radio connections, GPS, one-way call pagers and various others means are very important because the success of extinguishing and the speed of extinguishing depends on it. The person reporting the fire is obliged to remain at the scene of the fire until the arrival of the fire brigade to provide basic information.

After a fire is reported, alerts and alarms are sounded and light signaled in the fire brigade. As a sign of alert by the shortest and fastest route, each member is obliged to reach the fire station and obey the orders of the commander or leader of the firefighting operation.

Preparation for responding to the intervention should run in silence and without nervousness, and each firefighter should know in advance his place in the vehicle and his role in the intervention. The time from the alarm to the exit of the vehicle in well-organized services can be less than 60 seconds. All vehicles must be equipped with all necessary fire extinguishers, and an example of one such vehicle is shown in Figure 3.

Movement of the gas train to the place of intervention through a single column consisting of all vehicles needed to extinguish the fire. The first vehicle in the column is the command vehicle and other vehicles are further organised on the priority and the type of intervention.

Deployment of the vehicle at the intervention site is determined by the intervention commander, and depends on the position of the fire site, the length of the pipe and the distance of the water source. Extinguishing and rescue vehicles are parked as close as possible to the residential building affected by the fire, but they must not be exposed to heat and collapse.

The choice of firefighting tactics for each intervention is different due to different fuels, facility construction, microclimatic conditions, approaches and accesses. However, there are basic rules of extinguishing tactics: the fire should be attacked strongly, extinguishing starts from the edge towards

the middle of the fire from the most favorable position, the fire of the residential building is extinguished from the inside with internal rush, prevent the fire from spreading to neighboring buildings side, strong forces should attack the main hotspots, etc. [5]

Figure 3 - View of the vehicle with all the necessary fire extinguishers



To apply successful extinguishing tactics, the following should be considered:

- the type and amount of combustible substances affected by the fire
- the place and facility where combustion takes place
- imminent dangers to the environment and to the firefighters who will take part in the extinguishing action
- available forces
- water supply conditions
- weather conditions

When extinguishing, the methods of fire attack, type of jet and type of pipe are determined. The choice of jet depends on the ventilation opening. A diffuse jet is used when the vent is above and heat, smoke and fire are escaping outside while a full jet is used directly to the focus when the vents are not large enough for successful ventilation. The choice of pipes depends on the type of combustible materials, mobility, tactics, the number of people on the nozzles, the amount of water needed for extinguishing and more. The rush method can be internal, external and combined. An internal rush on a focus with full or diffuse jet fire is most effective. If firefighters cannot enter the area affected by the fire, an external rush through doors or spaces is used. However, an external rush cannot be used for extinguishing if people are trapped in the facility or if the fire threatens to spread to surrounding buildings. The action of an internal and external rush creates a combined rush by directing a jet of water towards the ceiling and combustible materials in the shape of the letters O, T and Z. [6]

The choice of extinguishing tactics also depends on the following principles: increase of ventilation, water flow or both if the internal rush has no effect or change the tactics, switch to an external rush if an internal rush is not possible or effective within twenty minutes. When using external rush it is possible for the fire to spread throughout the entire building.

The intervention leader carries a huge responsibility and monitors the course of action in order to determine the effectiveness of the action taken. Decisions should be made quickly and with quality, and depend on the knowledge and experience of the commander. Upon arrival at the intervention, the commander collects information on whether people are at risk, whether the property is of special value, the location of the object affected by the fire, speed and manner of combustion, danger of expansion, material and construction affected by fire, rescue routes and attacks, special dangers.

Based on the information gathered, the commander issues an order. Addition of the order is not recommended, but during the intervention it is possible to regroup forces, partly or completely due to the need for urgent evacuation of people, sudden outbreak and spread of fire and to achieve a better result in a shorter time. Partial regrouping can be ordered by the sector commander while full regrouping can only be ordered by the fire intervention intervention commander.

3.1. Methods of extinguishing a fire in a residential building

The fire can be extinguished by removing the basic factors of the combustion process. We distinguish four methods of extinguishing fires. The first method is to lower the temperature of the fuel with water. It is considered to be one of the most well-known methods of extinguishing fires for solid and liquid fuels, but it is not effective in extinguishing flammable liquids and gases due to the low flash point temperature, a cooling effect cannot be achieved. The next method is to remove the source of combustible material by interrupting the inflow of flammable liquid, gas or solids. This is followed by the method of removing oxygen by releasing carbon dioxide (CO₂) into the area affected by the fire or by covering the combustible material with foam. The last method is to stop the chain chemical reactions in the process of combustion (inhibition) with a chemical powder in order to interrupt the free flow of the chain chemical reactions and thus the removal of the flame.

Extinguishing media are substances that interrupt the combustion process, ie extinguish a fire. Fire extinguishing results in the removal of fuel, cooling, suffocation or inhibition. Which agent to choose depends on the type of fuel, the strength of the unit, access point to the fire, the place of use of extinguishing agents and others. The most commonly used are water, powder, foam, carbon dioxide, hand tools, and all these tools are expected to have a quenching effect, not harmful to the health of those present, to be cheap and economical, not to conduct electricity, to be easily transported and stored, so as not to release flammable and toxic products when exposed to heat. [5]

3.2. Proper movement during the intervention

When extinguishing a fire in a residential building, firefighters must be deployed in a group with a minimum of two members. The positioning of fire brigades when extinguishing by an external rush should be as far away from the danger zone as possible, while the internal rush has priority as a coordinated attack for the purpose of rapid search and extinguishing of the fire focus. If there is a fire below ground level, it is necessary to provide at least two exits on opposite sides of the building.

In case of fire, special attention should be paid to movement:

- above the focus,
- when extinguishing a roof fire,
- in case of combined extinguishing,
- in case of fire below ground level,
- if there are dangerous substances in the fire,
- in case of poor fire control.

With prolonged extinguishing it is necessary to take into account the collapse of the building, and some of the indicators are cracks in the outer walls, sounds of moving structure, smoke or water passing through the wall, movement of floor structures and load-bearing walls. Withdrawal from the facility is necessary in the event that some of the above indicators are present.

When entering a building affected by fire, it is necessary to take precautions: ensure a strong enough jet of water, check the door temperature by hand, check the way the smoke comes out of the room, take the correct opening position, open the door only a few centimeters, extinguish in a kneeling position and after firefighting ventilate the facility.

In the fire-affected building, it is necessary to take precautionary measures because the load of equipment reduces the sense of touch, and thick smoke reduces the eyesight of firefighters. When moving, it is important to touch the wall with the outside of the palm, and always feel the part of the

floor in front of the firefighters with your foot. Climbing the stairs is done as on a flat floor while descending is done backwards with checking each step with a blow. The water jet serves as a landmark during the retreat.

The search of smoky spaces is done by tapping the group first quickly and then thoroughly by releasing the rope as a search landmark. If people are found in the building, it is necessary to perform rescue in parallel with the extinguishing action, if it is not possible, rescue has priority. Using thermal cameras makes searching and rescuing faster and easier. [5]

3.3.Dangers of housing shutdown intervention

In accordance with the Occupational Safety and Health Act [7], the work of firefighters is classified as work with special working conditions, and the ability of workers to perform such work is determined on the basis of health and mental ability. During the rescue, the firefighter is exposed to many dangers, and the overview of the dangers is in Table 1. The dangers listed in the table are also encountered by persons who are in a residential building affected by the fire.

Table 1 – Overview of the hazards to which firefighters are exposed during the intervention

HAZARDS DURING INTERVENTION	
danger of suffocation and poisoning	danger of heat
danger of explosion	danger of extinguishing media
danger of electric shock	danger of stress, fear, panic
risk of mechanical injury	danger of infection
danger of burns	danger of flames

Combustion can create toxic products such as carbon dioxide, carbon monoxide, nitrogen oxides, hydrogen chloride and many others, which reduces oxygen and creates a risk of suffocation and poisoning. Explosion hazards include explosions of gases, liquids and pressure vessels, and an increase in temperature and pressure can cause serious injuries. While moving through the building, firefighters touch the wall with their palms, and by touching live devices and conductors, there is a risk of electric shock.

Cuts, crushes, sprains, fractures are considered mechanical injuries. This type of danger occurs when residential buildings collapse, objects fall from heights and fall into depths due to reduced visibility. One of the major dangers when extinguishing a residential fire is the danger of heat and burns. We distinguish three degrees of burns, at a temperature of 48 ° C first degree burns occur, when the skin temperature reaches 55 ° C second degree burns occur and above that temperature third degree burns occur. Burns can be caused by steam when a jet of water is directed directly at hot surfaces, which leads to the danger of extinguishing agents. To protect themselves, firefighters wear fire-fighting equipment.

The danger of fear, panic and shock can occur in crisis situations, and this type of danger will be easier to deal with for a firefighter who is well aware of the dangers present in a fire. Coming to the intervention firefighters the heart pressure, pulse and temperature increase, they decrease with daily training and constant schooling to improve knowledge.

Dangers of infection occur due to contact with human or animal secretions and blood. It is very dangerous if firefighters have open wounds or scratches on their hands. This danger comes to the fore during the Covid-19 pandemic. The risk of flames can be created during a fire in explosive combustion

conditions with preconditions such as good and poor ventilation, the amount of fuel and the time from the beginning of the fire. [8]

4. CONCLUSION

It is necessary to plan, analyze and take the necessary measures for fire protection in order to prevent adverse events, and to keep records of all actions taken and past events. It is of great importance to train the public for fire protection because the initial fires can be extinguished with a glass of water, and in the later stages the professional help of firefighters and much more extinguishing agents is needed. Rules for interventions such as entering a building, moving around a building, searching of a smoky area, climbing and descending stairs are very important and must be followed. During the intervention, the commander issues orders in accordance with the state of the fire.

The most important task in a residential fire is to rescue people, and if rescue and extinguishing cannot be done at the same time, rescue has priority. If a fire occurs, it is very important to stay calm, close doors and windows, notify neighbors, leave the apartment, not use the elevator and wait for firefighters to arrive. Firefighters are exposed to various types of hazards and are therefore classified as working with special working conditions. The dangers are many, and it is very important to point out that a larger number of people die due to lack of oxygen in the building affected by the fire than from the effects of heat during firefighting.

Just one second of inattention is enough to make a disaster happen, so be aware of the moment to protect yourself and other people and property and the environment.

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