

EVACUATION OF RESIDENTS FROM AN APARTMENT BUILDING AND EXTINGUISHING A CAR FIRE - PUBLIC DEMONSTRATION EXERCISE

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Abstract: A public demonstration exercise of firefighters and rescuers was held in an apartment building and underground garage in August 2024. The aim of the exercise was to partially evacuate residents from the apartment building (evacuation of the basement, ground floor, first and second floors), extinguish a car in the underground garage, and test the training and proficiency (as well as advanced training) of workers of the fire and rescue units of the Ministry of Internal Affairs of the Republic of Serbia in performing fire extinguishing and evacuation interventions.

Key words: evacuation, rescue, public demonstration exercise, fire extinguishing

1. INTRODUCTION

The etymology of the word *evacuation* is not complicated. In the word *evacuation*, its connection

to the noun *vacuum* can be recognized, a scientific term for empty space without any elements or compounds in a container or area. The origin of both words, *vacuum* and *evacuation*, comes from the Latin adjective *vacuus* (empty), in the neuter form *vacuum*. This Europeanism is used in almost all languages in Europe.

The Fire Protection Act [1], among other things, defines the basic terms related to evacuation: the evacuation route from a building is the path leading from any point in the building to the outside area or to a safe and secure area within the building; the evacuation corridor is formed by the building's structural components that enclose communication areas (hallways, buffer rooms, staircases, vestibules, entrances, and so on.) and thereby prevent the penetration of flames and smoke from living spaces and other areas endangered by fire. These structures have specific characteristics (fire resistance, fire reaction, width, height, etc.) which allow individuals caught in a fire to safely leave the building (either independently or with the assistance of rescuers); rescue refers to the intervention of fire and rescue units and firefighting teams to protect human lives, physical integrity, and material assets during fires, accidents, and other emergency events, in accordance with a specific law.

During the design and construction of a building, which is carried out in accordance with the law governing the field of planning and construction [2], basic fire protection requirements must be ensured so that in the event of a fire: the load-bearing capacity of the structure is maintained for a certain period of time; the spread of fire and smoke within the building is prevented; the spread of fire to neighboring buildings is prevented; and the safe and secure evacuation of people or their rescue is enabled.

The Law on Disaster Risk Reduction and Emergency Management [3] classifies evacuation as a civil protection measure undertaken to save people, material, and cultural assets from dangers caused by disasters. Article 58 of the Law defines evacuation as "the planned and organized movement of people, animals, and material assets from endangered to non-endangered areas. Depending on the level of danger and potential consequences, evacuation may be partial or complete."

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The primary goal of evacuation during a fire is the safe rescue of people from the endangered area. Evacuation involves an organized method of leaving a space before more serious consequences occur, primarily the endangerment of life. Evacuation can be either complete or partial. In high and complex buildings, this is practically impossible, which is why the concept of partial evacuation has been introduced. Partial evacuation means that a part of the building or a portion of the people from the endangered area is evacuated step by step.

2. DESCRIPTION OF THE EVENT AND PLACE OF THE FIRE

A residential building located in Šid was determined as the place of occurrence. It is assumed that the car caught fire due to faulty electrical installations on the car. The tenant of the residential building where the fire started informed the fire and rescue unit (hereinafter: FRU) Šid and the president of the tenant of the residential building about the incident and returned to try to put out the fire on the car.

The first task of the exercise is to prepare the workers of FRU Šid for action in case of fire in underground garages. The second task of the exercise is the preparation of employees for action in the event of a fire with a special emphasis on the preparation and method of conducting a safe evacuation. The third task is the demonstration and popularization of the call of firefighters - rescuers among the residents of the apartment building.

2.1. Procedures and course of intervention

Having received the notification that there was a car fire in the underground garage of a residential building in Šid, the on-duty FRU from Šid alerts the shift and informs the fire-rescue battalion of Sremski Mitorovica and the head of the shift. Arriving at the scene in a vehicle with four rescue firefighters (picture 1) in 2 minutes, they find the president of the tenant who informs the manager of the action (hereinafter: MA) that there is a person in the garage who is trying to put out the car fire.

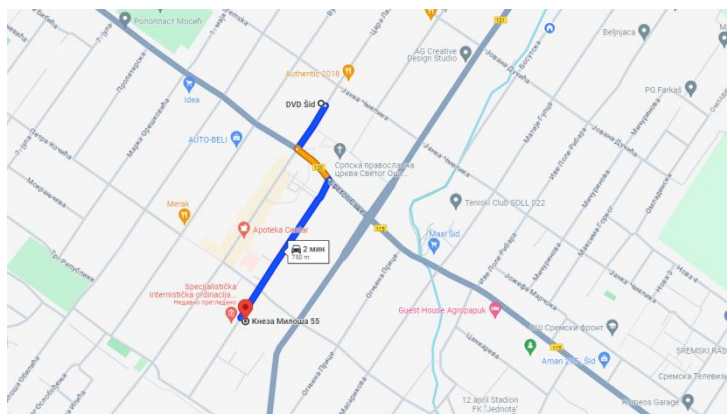


Figure 1. Primary route of movement

After the reconnaissance, the MA orders that the members of FRU Šid be equipped with devices for the protection of respiratory organs, the driver (hereinafter: M) to lay one pusher "B" hose and a distributor, the storm team N1 and N2 to lay a pusher line from the distributor with 3 "C" hose and universal nozzle $\varnothing 52$ and informs the Red Cross about the resulting event.

Emergency group N1 and N2 inform MA that there is a person in the garage who needs to be evacuated due to heavy smoke. The RA informs the members of the Red Cross to prepare to take over one person. The emergency group N1 and N2 carry out the evacuation of the person with the help of an evacuation hood and hand it over to the Red Cross (picture 3). The MA informs the head of the shift about the evacuated person. The emergency group N1 and N2 return and start extinguishing the fire on the car (picture 3). MA goes out inside the building and due to the presence of smoke, informs the shift chief that a partial evacuation of the building (basement, ground floor, first and second floors)

is being carried out. MA and M begin the partial evacuation of the residential building (MA puts on a mask to protect the respiratory organs and evacuates the basement and ground floor, while M evacuates the first and second floors). The MA orders the installation of smoke exhaust fans in the ground floor of the residential building. M lays the pressure "C" hose and connects it to the hydrant network, which is located in front of the entrance to the underground garage. The emergency group N1 and N2 inform the MA that the fire is extinguished. After that, the MA orders the completion of the exercise, the collection of equipment and analyzes the public demonstration exercise.



Figure 3. The ground floor of the building and the evacuation of a person

2.2. Exercise participants and equipment

The following persons participated in the exercise: the commander and coordinator of the exercise is a firefighter-rescuer driver; the emergency group N1 and N2; the driver. The following equipment was used for the exercise: naval vehicle with equipment; 3 handheld radio stations; 3 devices for the protection of respiratory organs; 1 rescue mask; 2 pressure "B" hoses; 5 pressure "C" hoses; 1 hydrant key; 1 universal nozzle; 1 three-pronged splitter; 1 overpressure exhaust fan.

In preparing the exercise, the person responsible for the exercise had information on the evacuation time from the building - a calculation made based on the Rulebook on technical norms for fire protection of residential and commercial buildings and public buildings [4] and the program package - computer software Pathfinder [5]. The following table 1 shows the results of all three methods, and in this case you can see the approximate real state of readiness of the residents and firemen-rescuers in case of evacuation.

Table 1. The second scenario comparison results

	Evacuation calculation based on regulations	Computer software	Evacuation exercise
Evacuation of a person from an underground garage	43,368 s	23 s	15 s
Evacuation of people from the second floor	85,023 s	81 s	70

3. TACTICAL TASK

Before going to the exercise, a tactical task was done (table 2).

Table 2: Form for developing a tactical task

The name of the tactical task	Shift	Date	Objective of the tactical task	Teaching tasks
Fire simulation in the underground garage of a residential building and partial evacuation of the residential building	II	22.08	Elaboration of the procedure and sequence of actions in the event of a car fire in an underground garage and the evacuation of residents of a residential building	Overview of general hazards. Demonstrate team protection. Installation of equipment for water supply from hydrants and evacuation of residents.
Teaching topic	Practical work with protective equipment, devices and equipment for extinguishing fires with water, evacuation		Teaching unit	Equipping with protective equipment, laying the pressure rail, evacuation.
Total number of hours	2	The number of hours for working out the tactical task-teaching unit		1

General information about the text part of the tactical task setting:

Type of lesson	Practical training
Place of performance	Residential building, Šid
Performance time	09:00-10:00
Number of participants	4
Engagement (IFD, VFD, Army, others)	In cooperation with the Red Cross Šid
Necessary means and equipment of engaged firefighting units	Surge vehicle, manifold, 2 "B" pressure hoses, 5 "C" pressure hoses, 3 isolation devices, rescue mask, universal nozzle ø52, hydrant wrench, 3 hand-held radios and positive pressure exhaust fan
Assumed danger situation	There was a car fire in the underground garage of a residential building. Danger of dangerous combustion products and smoke in the entire residential building

Elements of the tactical task flow:

Time (min)	Task executor	Tactical situation	Anticipated actions to resolve the situation
00:00	On-duty FRU Šid	Notification of the event by the tenant of the building	Alarming the unit about the incident
01:00	MA	Determination of forces and equipment	Departure of the naval vehicle and 4 crew members
03:00	Driver FRU (M)	Period of free fire development	Movement of vehicles to the scene of the fire
04:00	MA	Arrival of the VFD Šid team. It examines the situation around the facility and the involvement of the Red Cross	Reconnaissance of events and informing the head of the shift about the situation and engaging the Red Cross
05:00	The team of FRU Šid	Orders the formation of a line for firefighting	Equipping the naval crew and action leader with protective equipment
06:00	Driver FRU (M)	Formation of the first part of the railway	Laying 1 "B" pressure hose and manifold
07:00	N1 and N2	Formation of the second part of the railway	Laying 3 "C" pressure hoses and universal nozzles ø52
09:00	N1 and N2	Evacuation of persons required	They inform the action leader that they have found a person in a conscious state who needs to be evacuated
09:30	MA	Engagement of the Red Cross	Informs members of the Red Cross about the evacuation of persons
10:00	N1 and N2	Beginning of evacuation	Putting an evacuation mask on a person who is conscious and starting the evacuation

12:00	MA	Evacuation completed	Informs the head of the shift about the completed evacuation and handing over the person to the Red Cross for further action
13:00	N1 and N2	The beginning of the fire extinguishing operation	Return to the scene of the fire and the beginning of the extinguishing action
14:00	MA	Observing the condition inside the object	Reconnaissance of the situation inside the residential building
16:00	MA	The need to partially evacuate the residential building	Informs the head of the shift about the need to partially evacuate the residential building
17:00	MA and driver FRU (M)	Beginning of evacuation	Evacuation of the basement, ground floor, first and second floors of the residential building
22:00	PA	Evacuation completed	Informs the head of the shift about the successfully completed evacuation of the residents of the residential building
23:00 24:00	MA and driver FRU (M) N1 and N2	Smoke removal of a residential building Localization of the fire	Installation of exhaust fans in a residential building. They inform MA that the fire is localized and proceed with the liquidation with the same forces
29:00	Driver FRU (M)	The need to top up the water	Connection to the hydrant network
35:00	N1 and N2	Fire suppression	They inform the MA about the liquidation of the fire
45:00	The team of FRU Šid	End of action	Purchase of equipment, control of the area and notification of the head of the shift about the completion of the action
60:00	The team of FRU Šid	Return to the unit	

3.1. Assessment of the quality of the performed exercise

The person in charge according to the evacuation and rescue drill execution plan also gives a grade for the practically performed drill (eg for the performed drill, given the established deficiencies - if there are any, the given grade is excellent). It is also necessary to give a proposal on how to improve the quality of evacuation and rescue exercises in the future (e.g. education of exercise managers, individuals providing first aid, fire extinguishing experts, environmental remediation personnel, old endangered buildings, motor vehicle owners, other experts which in some way participate in the exercise).

4. CONCLUSION

The paper deals with evacuation, a program for calculating the evacuation time, the evacuation calculation for one residential building is shown, and most importantly, a demonstrative exercise that showed the real situation during the evacuation. The results of the evacuation time according to the computer software [5], the evacuation calculation according to the Rulebook [4] and on the exercise are shown, which are compared with each other. The residential building for which the calculation was made has extremely good preventive protection, it is a new construction, there are no evacuation plans and they are not hung in the corridors (the building is not fully occupied). It has pictograms for evacuation, equipped and unlocked hydrant cabinets and fire extinguishers, it has a fire alarm system.

By carrying out the exercise in which the extinguishing of the car in the garage and the partial evacuation of the residents were shown, a lot of shortcomings were noticed, namely:

Access roads: the high speed of construction of residential buildings and other facilities creates the problem of lack of access roads, but also of congested access roads.

External and internal hydrant network: the problems of many residential buildings of old construction is the absence of an external hydrant network outside the building, while the problems of all residential buildings are locked hydrant cabinets and fire extinguishers, lack of equipment in hydrant cabinets.

Training the population: probably one of the biggest problems today is the untrained population when it comes to emergency situations. The solution to this problem lies in the education of the

population, holding drills, posting instructions in case of an emergency, teaching children in schools and kindergartens how to behave in the event of an emergency, familiarizing residents and workers with meeting places.

Evacuation plan: Evacuation plans should be on all floors in residential buildings, workplaces, schools, etc. In the event that an evacuation plan does not exist, it should be created, and inspections should be conducted more often.

Evacuation signs: Just as there should be evacuation plans, there should be evacuation signs in all places (evacuation routes, hydrant closets, hazards, etc.), leading to the nearest exit.

Lighting: Buildings that have their own power supply should preferably install lighting, which would be of great importance in case of an emergency.

Introduction of alarm systems: Although this is one of the more expensive investments of prevention, and we know that every dinar invested is returned 10 times better, it is desirable to do it in all residential buildings so that the residents are informed in a timely manner about an emergency situation that occurs in the residential building.

Creation of alternative exits: we have witnessed that in the vast majority of older residential buildings there is only one exit, which may not be sufficient in an emergency situation, or may be blocked. It is desirable to create at least one more exit in all buildings that would be used only in case of emergency.

5. LITERATURE:

- [1] Law on fire protection ("Official Gazette of RS", no. 111/2009, 20/2015, 87/2018 and 87/2018 - other laws),
- [2] Law on Planning and Construction ('Official Gazette of RS', no. 24/2011, 121/2012, 42/2013, 50/2013, 98/2013, 132/2014, 145/2014, 83/2018, 31/2019, 37/2019, 9/2020, 52/2021 u 62/2023)
- [3] Law on Disaster Risk Reduction and Emergency Management ("Official Gazette of RS", No. 87/2018)
- [4] Rulebook on technical norms for fire protection of residential and commercial buildings and public buildings ("Official Gazette of RS", No. 22/2019)
- [5] Computer program "PATHFINDER"