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INVESTOR ¹	Western Balkan Six Chamber Investment Forum Piazza della Borsa nr. 14 34121 Trieste Italy
PROPERTY ²	Primary School "Danilo Kiš" Budva
LOCATION ³	Cadastral plot 1617/1 Cadastral municipality Budva <u>Municipality of Budva</u>
TYPE OF TECHNICAL DOCUMENTATION ⁴	PARTIAL BUILDING ADAPTATION
ARCHITECT ⁵	DECOM MONTENEGRO D.O.O. PODGORICA Br. licence UPI 107/7-705/8 od 26.07.2023. godine
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¹Investor's name

² Name of the proposed property

³ Construction site, planning document, urban plot, cadastral parcel

⁴Conceptual plan, preliminary design, final design, or as-built project (if it is the title page of the entire technical documentation).)

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Piazza della Borsa nr. 14 34121 Trieste Italy

PROPERTY² Primary School "Danilo Kiš" Budva

LOKACIJA³ Cadastral plot 1617/1 Cadastral municipality Budva
Municipality of Budva

PART OF THE TECHNICAL FIRE PROTECTION REPORT
DOCUMENTATION⁴ PARTIAL BUILDING ADAPTATION

ARCHITECT⁵ "DECOM MONTENEGRO" Ltd. Podgorica

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DATE: February 2024.

TECHNICAL DOCUMENT TD0920224
NO.

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ADAPTATION PROJECT
ADAPTATION PROJECT OF A PART OF THE FACILITY MIXED
SECONDARY SCHOOL "DANILO KIŠ"
cadastral parcel 1617/1 cadastral municipality Budva, Municipality of
Budva

C O N T E N T

BOOK 0: GENERAL DOCUMENTATION

BOOK 1: ARCHITECTURE

BOOK 2A: HIGH VOLTAGE ELECTRICAL INSTALLATIONS

BOOK 2B: LOW VOLTAGE ELECTRICAL INSTALLATIONS

BOOK 3: MECHANICAL INSTALLATIONS

BOOK 4: WATER PLUMBING AND SEWERAGE INSTALLATIONS

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PROJECT ASSIGNMENT FIRE SAFETY ASSESSMENT

INVESTOR: Western Balkan Six Chamber Investment Forum
Plazza della Borsa nr. 14 34121 Trieste Italy

PROPERTY: Primary School "Danilo Kiš" Budva

LOCATION: Cadastral plot 1617/1 Cadastral municipality Budva
Municipality of Budva

PROJECT TYPE: Fire safety report

For the needs of the Investor, it is necessary to prepare project documentation for: Adaptation of the Public Institution Secondary School 'Danilo Kiš' in Budva, Montenegro in accordance with:

- ➔ Contract with the Investor No. RCF/MNE/NC/2023/003 dated 30.11.2023
- ➔ Project assignment dated 08.02.2024.

Fire protection study to be done based on current laws, regulations, and standards

Special attention should be paid to the Law on Protection and Rescue ('Official Gazette of Montenegro' No. 13/07, 05/08, 86/09, 32/11, 54/16, 146/2021, and 3/2023) and the Law on Spatial Planning and Construction of Buildings ('Official Gazette of Montenegro' No. 064/17, 044/18, 063/18, 011/19, 082/20, and 04/23).

I N V E S T O R

LIST OF REGULATIONS AND DOCUMENTATION USED IN THE PREPARATION OF THE FIRE PROTECTION STUDY FOR THE SUBJECT FACILITY

1.1. LEGAL REGULATIONS

- ✓ Law on Protection and Rescue ("Official Gazette of Montenegro" No. 13/07, 05/08, 86/09, 32/11, 54/16, 146/2021, and 3/2023)
- ✓ Law on Spatial Planning and Construction of Buildings ("Official Gazette of Montenegro" No. 064/17, 044/18, 063/18, 011/19, 082/20, and 04/23);
- ✓ Testing of materials and constructions - Definitions of terms SRPS U.J1.010 ("Official Gazette of the SFRY" No. 29/73).
- ✓ Fire load SRPS U.J1.030 ("Official Gazette of the SFRY" No. 36/76).
- ✓ Response of building materials in fire SRPS U.J1.050 (from May 23, 1997)
- ✓ Response of building elements in fire SRPS U.J1.051 ("Official Gazette of the FRY" No. 53/97)
- ✓ Standard fire curve - time temperature SRPS U.J1.070 ("Official Gazette of the FRY" No. 20/94)
- ✓ Regulations on technical standards for access roads, turning circles, and arranged fire truck platforms near buildings at increased risk of fire ("Official Gazette of the SFRY", No. 8/95)
- ✓ Pravilniku o tehničkim normativima za hidrantsku mrežu za gašenje požara ("Sl. list SFRJ", br. 30/91). Regulations on technical standards for fire-fighting hydrant networks ("Official Gazette of the SFRY", No. 30/91).
- ✓ EN 13501-1:2015 Fire classification of construction products and building elements - Part 1: Classification based on fire reaction test results.
- ✓ Fire classification according to the type of combustible materials SRPS EN 2:2011.
- ✓ Classification of materials and goods according to behavior in fire SRPS Z.C0.005 ("Official Gazette of the SFRY" No. 68/80).
- ✓ Types of building constructions according to their internal fire resistance SRPS U.J1.240 ("Official Gazette of the SRJ" No. 83/94).
- ✓ Technical recommendations for building technical fire protection measures for residential, commercial, and public buildings SRPS TP 21 (since 2003).
- ✓ Manual and transportable fire extinguishers - General provisions SRPS Z.C2.020 ("Official Gazette of the SFRY" No. 68/80).
- ✓ R Manual and transportable fire extinguishers - Testing methods SRPS Z.C2.022 ("Official Gazette of the SFRY" No. 68/80).
- ✓ Hand powder fire extinguishers SRPS Z.C2.035 ("Official Gazette of the SFRY" No. 68/80).
- ✓ Symbols for technical schemes SRPS U.J1.220 ("Official Gazette of the SRJ" No. 56/81).

1.2. AVAILABLE DOCUMENTATION

Main projects:

- ➔ Architecture,
- ➔ High voltage electrical installations,
- ➔ Low voltage electrical installations,
- ➔ Mechanical installations
- ➔ Water and sewage systems.

Authorized engineer:

Slavko Palibrk, Engineer in Occupational Safety

Engineer associate:

Nikola Šoć, BSc of Civil Engineering

I TEXTUAL DOCUMENTATION

1. THE ROLE AND SIGNIFICANCE OF THE FIRE PROTECTION REPORT

According to Article 80 of the Law on Spatial Planning and Construction of Facilities ("Official Gazette of Montenegro", No. 064/17, 044/18, 063/18, 011/19, 082/20, and 04/23), as well as Article 89 of the Law on Protection and Rescue ("Official Gazette of Montenegro" No. 13/07, 05/08, 86/09, 32/11, 54/16, 146/2021, and 3/2023), before commencing the construction or reconstruction of an investment facility, the Investor is obliged to obtain the Approval of the Ministry of Internal Affairs and Public Administration - Directorate for Emergency Situations, regarding fire protection and explosion prevention measures on the revised technical documentation – Fire Protection Study.

Fires cannot be entirely eliminated, and the most cost-effective way to protect buildings and reduce material damage is to take appropriate fire protection measures during the design and construction of the facility itself. In order to take the most adequate fire protection measures, it is necessary to identify the causes of fires and fire hazards. By removing fire causes, reducing fire hazards to a minimum, ensuring an adequate supply of firefighting equipment and devices, and training personnel in the operation of such equipment and devices, the goal of fire protection is achieved.

Fire protection encompasses a set of normative, administrative, and organizational-technical measures and actions, organized and implemented in all places and facilities exposed to the danger of fire.

Fire protection is a multidisciplinary science that includes knowledge of:

- ➔ Object technologies,
- ➔ Architectural concept of the object,
- ➔ Building materials and structures of the object,
- ➔ Characteristics of roadways,
- ➔ Water supply installations,
- ➔ Strong and weak current installations,
- ➔ Mechanical installations, and

During the design and construction of the building with the application of fire protection measures, the fire protection goals of the building are met, which would be in order:

- ➔ Ensuring the safety of individuals within the facility with preventive measures to prevent fires, and enhancing their safety in the event of a fire occurrence.
- ➔ Providing structural integrity and functional performance of individual construction elements in case of fire, aiming to reduce risks for members of fire and rescue services - firefighters - during interventions,
- ➔ Safe and timely evacuation of individuals endangered by fire,
- ➔ Division of buildings into fire segments and sectors to limit the spread of fire,
- ➔ Proper selection of firefighting equipment and resources, leading to reduced fire damage.

2. LOCATION OF THE PROPERTY

The subject property is located at: cadastral parcel (k.p.) 1617/1 in Budva I, Municipality of Budva. The Fire Brigade of the Municipality of Budva is approximately 600 meters away from the subject property. Considering the developed system of road infrastructure and internal traffic routes around the property, it would enable the firefighters to effectively and promptly carry out their actions in case of an accidental situation - fire.

The commencement of firefighting, taking into account the parameters required for mathematical calculation:

- notification, alerting, and departure: 1.0 minute,
- preparation of the intervention team for the beginning of extinguishing: 2.0 minutes, and
- travel time from the unit's location to the object is calculated according to the following

formula:

$$\tau = \frac{L[\text{Km}]}{V_{\text{sr}} \left[\frac{\text{Km}}{\text{h}} \right]} = \frac{0,60}{30} = 0,02h = 1,2 \text{ min} \quad (1)$$

for the worst conditions, it would be expected in about 4.5 minutes.

Note: The predicted arrival time of the local Intervention Team of the Civil Protection and Rescue Service at the specified location is the time obtained by mathematical calculation under ideal conditions, which may vary in real conditions depending on the time needed to detect the fire and organize the fire notification to the Civil Protection and Rescue Service, weather conditions, road conditions, and other unforeseen factors.

2.1. ARCHITECTURAL AND CONSTRUCTION CHARACTERISTICS OF THE EXISTING BUILDING

Based on the Agreement with the Investor no. RCF/MNE/NC/2023/003 dated 30.11.2023. year and the Project Terms of Reference dated February 8, 2024, the adaptation project of the object in question was completed.

The subject of the adaptation addressed in this project is a part of the classrooms on the first floor and the restaurant area on the ground floor of the "Danilo Kiš" Mixed High School in Budva.

The building has a ground floor plus one upper floor (Pr+1). The clear height of the ground floor is 3.40 meters, and the upper floor is 3.00 meters. The total height of the building is 11.00 meters.

The location is accessed via urban roads from three sides. The building is constructed using a skeleton system with reinforced concrete beams and columns. The outer walls are made of brick blocks with a total thickness of 30 cm, while the partition walls are 10 and 20 cm thick, finished with plastering, smoothing, and painting. The facade is covered with sandstone facade panels. The thickness of the reinforced concrete slabs on the ground floor and the first floor is 20 cm. The roof covering consists of corrugated metal sheets with a slope of approximately 30% on the sloped sections, while the other part of the building has a flat roof.

The canopy above the restaurant terrace is constructed using reinforced concrete (RC) columns and RC beams on the outer side. The substructure is made of metal I-profiles, which are supported and connected to the RC structure at one end and anchored to the building wall at the other end.

On the ground floor and the first floor, there is one fire-fighting wall hydrant installed each.

The floors in the classrooms and cabinets are covered with parquet flooring, while the floors in other areas are covered with ceramic floor tiles. Ceramic tiles are used in wet areas such as bathrooms.

RECONSTRUCTED STATE

The designer has determined that no interventions are needed on the structure of the subject part of the school, as the newly designed works do not affect the stability of the building or increase the load. However, it is necessary to design and implement new mechanical, electrical, and plumbing installations, as well as to apply current fire protection measures. All installations are included and elaborated separately in each phase of the adaptation project.

The following tabular statement illustrates changes in floor treatment, by rooms:

GROUND FLOOR

Serial number	Room title	Flooring	Area (m ²)
1.	Restaurant hall	Ceramic tiles	177,15
2.	Bar	Ceramic tiles	14,57
3.	Entrance lobby	Ceramic tiles	23,30
4.	Kitchen block	Ceramic tiles	65,30
5.	Restroom	Ceramic tiles	8,43
6.	Cloakroom 1	Ceramic tiles	5,31
7.	Cloakroom 2	Ceramic tiles	5,27
8.	Covered terrace	Concrete substrate	81,04
9.	Terrace	Concrete substrate	38,32

GROUND FLOOR IN TOTAL P_N = 397,11 m²

I FLOOR

Serial number	Room title	Flooring	Area (m ²)
1.	Reception	Ceramic tiles	8,62
2.	Storage room	parquet	17,06
3.	Hall	Ceramic tiles	72,50
4.	Computer cabinet	parquet	85,25
5.	Rest room	Ceramic tiles	11,45
6.	Multifunctional hall	parquet	123,85
7.	Multifunctional cabinet	parquet	58,40
8.	Animation cabinet	parquet	56,10
9.	Apartment		65,38
	1. Entrance hall	ceramic tiles	4,96
	2. Bathroom	ceramic tiles	5,42
	3. Living room	ceramic tiles	31,50
	4. Bedroom	parquet	9,67
	5. Bedroom	parquet	13,83
I FLOOR TOTAL P_N = 498,61 m²			

The adaptation architectural project includes:

- All demolitions listed in the Bill of Quantities, installation of containers on the construction site, and disposal at the landfill,
- Demolition of partition walls in the sanitary facilities, replacement of sinks, toilet bowls in the sanitary facilities, as well as replacement of wall (Fig. 1) and floor tiles (Fig. 2),
- Replacement of sinks and wall and floor ceramic tiles in classrooms (Fig. 3),
- Replacement of floor tiles in the restaurant hall (Fig. 4),
- Replacement of sink in the bar area
- Replacement of existing parquet flooring in classrooms and storage room (Fig. 6),
- Replacement of glazed entrance doors in the restaurant hall, entrance walls on the upper floor, and all internal doors, with doors made of AL profile according to the Opening Scheme (internal doors), closing openings up to the height of the skylight on the ground floor, in the restaurant hall,

- Implementation of all necessary insulation and substrates for the mentioned floors,,
- Preparation of substrates and painting works on all walls (RAL 9018) and ceilings (RAL 9016) with dispersion paint.

The estimate, containing detailed descriptions of all tasks and types of materials utilized, is an essential component of this Adaptation Project.

RECONSTRUCTED STATE

The architect includes new mechanical, electrical, and plumbing installations, both low and high voltage, as well as hydraulic installations. All installations are covered and elaborated separately in each phase of the Adaptation Project.

U tabeli br. 1 prikazane su površine prostorija i promjene u obradi poda, po prostorijama:

GROUND FLOOR

Serial number	Room title	Area (m ²)
1.	Restaurant hall	173,24
2.	Bar	14,41
3.	Entrance hall	23,29
4.	Kitchen block	65,40
5.	Restroom	8,42
6.	Cloakroom 1	5,27
7.	Cloakroom 2	5,28
8.	Covered terrace	81,04
9.	Terrace	38,32
GROUND FLOOR TOTAL P_N = 414,67 m²		

I FLOOR

Serial number	Room title	Area (m ²)
1.	Reception	8,62
2.	Storage room	17,07
3.	Hall	72,50
4.	Computer cabinet	85,61

5.	Restoom	11,45
6.	Multifunctional hall	123,15
7.	Multifunctional cabinet	57,70
8.	Animation cabinet	58,00
9.	Apartman A	64,99
	1. Entrance hall	4,96
	2. Bathroom	5,25
	3. Living room	31,30
	4. Bedroom	9,65
	5. Bedroom	13,83
I FLOOR TOTAL P_N = 499,09 m²		

Serial number	Room title	Mark	Area (m ²)	Flooring
1.	Hall	H	49.63	stone slabs
2.	Hand washing toilet	T	3.80	ceramic tiles
3.	Hallway toilet	T1	3.22	ceramic tiles
4.	Men's toilet	TM	1.53	ceramic tiles
5.	Women's toilet	TŽ	1.53	ceramic tiles
6.	Multifunctional cabinet	M1	33.18	PVC electroconductive antistatic
7.	Multifunctional cabinet	M2	47.93	PVC electroconductive antistatic
8.	Multifunctional cabinet	M3	47.93	PVC electroconductive antistatic

9.	Multifunctional cabinet	M4	47.93	PVC electroconductive antistatic
10.	Multifunctional cabinet	M5	47.96	PVC electroconductive antistatic
11.	Multifunctional cabinet	M6	22.40	PVC electroconductive antistatic
12.	Multifunctional cabinet	MPS	66.22	dizajn ploče tipa LVT
13.	Multifunctional cabinet	K	10.00	ceramic tiles
TOTAL P_N = 383.25m²				

The adaptation architectural project includes:

- ➔ emolition of the brick washbasin in the anteroom toilets T and T1 and replacement with suitable sinks, replacement of toilet bowls in TM and TZ, as well as replacement of wall and floor tiles,,
- ➔ Replacement of sinks and wall ceramic tiles in classrooms M2, M3, M4, M5, and the MPS hall,
- ➔ Replacement of the sink in the tea kitchen K and installation of wall and floor tiles,
- ➔ Replacement of existing parquet flooring in:
 - ✓ Classrooms M1, M2, M3, M4, M5, M6 and installation of electroconductive antistatic vinyl floors,
 - ✓ MPS hall and installation of high-durability lamella parquet flooring, type LVT,
- ➔ Replacement of glazed entrance walls and all internal doors (with and without transoms), with doors made of AL profile according to the Opening Scheme (internal doors),
- ➔ Closure of door openings with gypsum plasterboard (on the substructure) between the MPS hall and the tea kitchen K,
- ➔ Implementation of all necessary insulation and substrates for the mentioned floors,
- ➔ Preparation of substrates and painting works on all walls (RAL 9018) and ceilings (RAL 9016) with dispersion paint.

For Persons with Disabilities, the Designer has planned an electric ramp within the staircase area, which is installed on the inner stair railing.

2.2.ACCESS ROADS

The access road enables timely and unobstructed arrival of firefighting and other emergency teams, including their vehicles, to the facility in the event of an accidental situation. When referring to the access road, it includes:

- ➔ the urban roadway around the facility,
- ➔ the entrance to the complex of the facility,

- ➔ internal roadways, and
- ➔ the fire extinguishing platform within the complex..

For this purpose, the characteristics of three-axle firefighting vehicles are used for calculation, as shown in Table number 1.

Inner radius of wheel track	7 m
Outer radius of wheel track	10,5 m
Axle load	13 t
Total vehicle weight with superstructure and load	36 t

Table 1. Characteristics of firefighting vehicles and road dimensions

The vehicular and pedestrian access to the building is provided from the contact street through an internal roadway connected to the main road. Roadway constructions around the building are designed to withstand a load of 100 kN per 0.1m², considering that the surface area of one foot of a firefighting vehicle is 0.1m² and the pressure force per one foot is 100 kN.

The roadway designated for firefighting vehicles must be accessible at all times.

2.3. CATEGORIZATION OF THE TECHNOLOGICAL PROCESS

In accordance with the Regulation on Technical Standards for Fire Hydrant Networks ("Official Gazette of the SFRY", No. 30/91), the category of the technological process is determined based on the type of materials used, their behavior in fire, and the maximum expected number of people in the facility. Applying the provisions for the subject facility, the category of the technological process according to the fire hazard is K4 - a facility where solid materials with a flash point above 300°C are handled, with a maximum expected occupancy of up to 300 people.

2.4. POSSIBILITY OF EVACUATION IN CASE OF EMERGENCY

The possibility of evacuation in case of emergency is determined in accordance with SRPS N.B2.730, based on Table 5.4. For the subject facility, it is BD3.

2.5. ELECTRICAL INSTALLATIONS FOR STRONG CURRENT

The project includes:

- ➔ general consumption installations,
- ➔ lighting installations, and
- ➔ potential equalization installation.

New electrical installations are planned in the rooms marked:

- ✓ corridor,
- ✓ multifunctional cabinets,
- ✓ multifunctional hall,
- ✓ toilets and
- ✓ tea kitchen.

LOW VOLTAGE CABLE CONNECTOR

In this section of the documentation, electrical installations are covered from the main distribution board (MDB) located in the technical room below the staircase, from which a supply cable type N2XH-J 4x25+1x16mm² needs to be brought to the subject distribution board, marked on the drawing as RO-1. RO-1 is positioned in the corridor, next to the toilets marked as T. The distribution board RT-2,

located in the tea kitchen, is also powered from RO-1. For the power supply of distribution board RT-2, a supply cable N2XH-J 5x16mm² is laid. The supply cable is to be installed along the wall and ceiling beneath the plaster. Conductors are laid in the wall with the creation of grooves and repair of damaged surfaces, as well as restoring damaged surfaces to their original condition.

Distribution boards and supply cables

The point of electrical energy delivery in the subject part of the building is the distribution board RO-1, which is supplied from the existing distribution board GRO with a supply cable type N2XH-J 4x25+1x16mm² located in the room below the staircase. The distribution board RT-2 in the tea kitchen is powered from RO-1 with a supply cable type N2XH-J 5x16mm². The distribution boards are installed at positions marked on the general consumption installation plan. The distribution board RO-1 and distribution board RT-2 are intended for installation, of appropriate dimensions, with IP40 protection rating, with cable entries from the bottom and top for the accommodation and interconnection of equipment. The part of consumers located in the rooms: toilets, part of the corridor, M6, M1, M3, and M2 are supplied from RO-1, while the consumers in the rooms: part of the corridor, MPS, M5, and M4 are supplied from RT-2. The distribution boards and cabinets of the building section consist of fields of automatic circuit breakers (fuses) of appropriate dimensions. Supply cables are laid partly along the wall and ceiling beneath the plaster (type C distribution), according to the drawing. In the front part of the project, the selection and verification of the cross-sections of the supply cables to the distribution board of the building are provided, as well as from the distribution board to the end users. In the rooms: M1, M2, M3, M4, M5, MPS, and the tea kitchen, there is a change of flooring, and cable distribution can be carried out through halogen-free installation conduits of appropriate diameter, beneath the concrete floor screed.

General consumption electrical installation

For the general consumption needs of the building, according to the purpose of this facility, the necessary number of single-phase connections is provided, as indicated in the electrical installation plans. The installation accessories are of modular type similar to manufacturers such as Legrand Mosaic, AVE, Tem čartez..., and an appropriate selection of other manufacturer's accessories can be made.

Lighting electrical installation

An appropriate lighting installation adapted to the purpose and installation conditions is provided in the subject part of the building, according to the legend on the installation plans. Lighting control within the subject part of the building is provided via switches, while in the corridor and toilets, it is controlled by motion sensors (detectors). Switches are mounted at a height of 1.2 meters from the finished floor. The installation inside the building is carried out using N2XH-J 3x1.5mm² conductors laid partly along the wall and ceiling beneath the plaster.

Emergency lighting installation

Considering the purpose of the subject part of the building, emergency lighting is also designed for the subject area (toilets and corridor).

Potential equalization installation

In accordance with the Technical Regulations for the execution of electrical installations, an installation for potential equalization in the building is also provided. All metal masses will be connected to protective busbars within the corresponding RT with 1x6 mm² conductors with halogen-free insulation.

Lightning protection and grounding installation

As this concerns the adaptation of a part of the building, the lightning protection installation and grounding are covered by the basic project and therefore not subject to this project.

2.6. ELECTRICAL INSTALLATIONS OF LOW CURRENT

The project includes:

- Installation of Structured Cabling System (SCS)
- Installation of Fire Alarm System
- Installation of IP Video Surveillance System

During the development of this project, relevant legal provisions, special regulations, technical standards, quality norms, standards, and professional recommendations have been adhered to.

Installation of structural cable system – SKS

In the building, one RACK cabinet is planned for the "Tea kitchen" room, and during the execution of works, consider whether it is better to relocate the RACK cabinet to the other side of the wall, i.e., to the "MPS - multifunctional hall" room. The project includes the direct installation of an optical SM cable to the RACK cabinet by the operator. Telecommunication outlets are shielded FTP RJ-45 cat.6, modular, and installed in junction boxes, in accordance with the estimate and cost estimate of strong and weak electrical installations. The outlets are positioned at a specified height from the finished floor level defined in the drawings of strong and weak electrical installations.

From the RACK cabinet to each outlet in the building, S/FTP cat.6 LSZH cables have been laid. The cables are routed partly along the wall beneath the plaster and partly through the concrete floor slab, in installation pipes with an internal diameter of Ø16mm. The computer S/FTP network is a universal installation according to the EIA/TIA T-568B standard. Such an installation can support all types of telephone and computer networks.

Fire alarm system installation

The facility will be equipped with a stable fire alarm system. The system includes one conventional control panel. The control panel is located in the "Tea kitchen" room, next to the RACK cabinet (if it is considered during the execution of works that it is better to place the control panel in the "MPS multifunctional hall" room, it can be installed on the same wall, just on the other side).

The signaling system consists of:

1. Alarm control panel;
2. Smoke, heat, and flame detection devices in protected areas;
3. Devices for activating/deactivating the fire protection system;
4. Executive elements of the system;
5. Transmission paths for signals and commands.

The fire alarm system is intended for early detection and signaling of smoke and/or elevated temperature of flames in protected areas, as well as sudden temperature rise, enabled by installed sensors (optical, thermal, and optical-thermal detectors, as well as manual fire alarm call points) throughout the protected areas. The system processes signals from the sensors to the control panel and transmits signals through the output of the fire alarm control panel to the executive elements of the system.

System's central unit

The central unit provides the following functions:

- Monitoring the system's operational status and signaling errors in case of deviations from the specified parameters.
- Receiving and registering information about fire incidents.
- Alarm and notification in case of fire.
- Control signals for fire doors, elevators, air conditioning, and power supply in accordance with the Fire Protection Report.

The fire alarm system is intended for early detection and signaling of smoke and/or elevated temperature - flames in protected areas, as well as sudden temperature rise, enabled by installed sensors (optical, thermal detectors, as well as manual fire alarm call points) throughout the protected areas. The system processes signals from the sensors to the control panel and transmits signals through the output of the fire alarm control panel to the executive elements of the system.

The control panel allows clear presentation of pre-alarm and alarm conditions, as well as other events, through LED indicators, and displays the location and time of the registered event on the screen. Additionally, the control panel processes and stores information collected in communication with all peripheral elements (primarily detectors) and provides executive control functions according to the specified program.

The primary power supply for the control panel comes from a separate power circuit of the building's general consumption installation. Backup power sources are provided by rechargeable batteries, which are continuously charged and maintained in a standby state. In the event of a power supply failure from the primary power source, the batteries automatically and seamlessly take over the system's power supply. The control panel periodically tests the capacity of the batteries and, if it detects their deterioration, provides an appropriate signal.

The fire control panel



- A CONVENTIONAL PANEL CAPABLE OF ACCEPTING 2 ZONES (NON-EXPANDABLE)
- 32 DETECTORS PER ZONE
- ONE PROGRAMMABLE OUTPUT/INPUT FOR EACH ZONE
- SUPERVISED OUTPUT FOR ACTIVATING SIRENS PROGRAMMABLE RELAY OUTPUT
- DEDICATED OUTPUT FOR SIGNALING AUTOMATIC DETECTION
- ILLUMINATED ALPHANUMERIC DISPLAY
- MEMORY OF THE LAST 100 EVENTS
- PROTECTION AGAINST DEEP DISCHARGE OF BATTERIES
- PROGRAMMING CAPABILITY VIA COMPUTER
- CERTIFIED ACCORDING TO EN54-2/EN54-4 AND EN12094-1 STANDARDS.

Detectors

The suitable type of automatic detector for each room is determined based on the expected early manifestations of fire, the room's purpose, fire load, and potential interfering influences. The required number of detectors in the monitored area and their placement are defined in accordance with the manufacturer's recommendations.

Conventional automatic smoke (optical) fire detectors possess opto-electronic chambers for detecting dark and light smoke particles with increased immunity to false alarms. They represent the basic type of detector in the system and are used in all administrative areas. They are intended as the primary type of fire detector and are mounted on the ceiling of the room. In the case of a suspended ceiling, optical detectors are also used to cover the space between the suspended ceiling and the ceiling. It is applied as a rule that one detector monitors an area of 60 m² for ceiling heights <6m, except in extinguishing zones where, as a rule, the area coverage of the smoke detector is reduced by 50%, i.e., the coverage area of the smoke detector is 30 m². Therefore, the maximum distance between two optical smoke detectors is $1.2 \times 60 = 9\text{m}$, and the maximum distance from the wall is 4.5m, or in extinguishing zones $1.2 \times 30 = 6.5\text{m}$, and the maximum distance from the wall is 3.2m. In passages and corridors narrower than 3m, the distances between detectors do not exceed 15m.

The thermal fire detector is equipped with a single thermal sensor, while the optical-thermal sensor has an opto-electronic chamber with two optical sensors for detecting dark and light smoke particles, as well as an additional thermal sensor that increases immunity to false alarms. They cover an area of 20m² and a height of up to 7.5 meters.

All detectors are resistant to standard interferences that may occur (dust, fibers, insects, humidity, condensation, EM influences, corrosive vapors, vibrations, impacts, etc.), have an alarm indicator visible within a 360° radius, and include built-in short-circuit and break line isolators. The detectors are mounted on bases made of impact-resistant synthetic material, with terminal contacts without screws. In places where detectors are installed in areas without suspended ceilings or on the roof structure, additional bases for surface mounting are provided, into which the cable is introduced from the side.

During the installation of the detectors, it is necessary for the placement to be coordinated with the position of other elements installed in the ceiling (lights, mechanical installation elements) and structural elements (beams, walls, etc.), whereby:

- the distance of the detector from the wall should be a minimum of 50cm,
- the distance of the detector from the beam (rib) should be a minimum of 50cm,
- the distance of the detector from the air inlet should be min. 50cm,
- the distance of the detector from the light fixture should be at least double the height of the fixture.

When laying cables, in areas where detector installation is foreseen, the cables should be left slightly longer to allow for the aforementioned coordination.

Smoke optical detector



- Intelligent Signal Processing (ISP) technology
- Reliable operation and high immunity to interference
- Mesh with openings of diameter 500µm, for protection against dust and insects

Heat optical detector



- Intelligent Signal Processing (ISP) technology
- Reliable operation and high immunity to interference
- Programmable operating modes: thermal-maximum 58°C/72°C; thermal-differential

Detector base



- Built-in short-circuit protection ensuring continuity in case of associated detector
- Material: polycarbonate
- Dimensions: Ø110mm x 24mm

Manual fire alarms

Provided at visible and accessible locations along evacuation routes. They are used to manually activate the alarm in case of a fire without time delay, thus playing a role in fire protection by directly triggering the alarm. Any alarm triggered by their activation is considered a safe sign of a fire without delay. The alarm consists of an electronic mechanism with direct activation by breaking the protective glass and a red-colored housing. An isolator line for short circuit protection is built into the alarm. The alarms are mounted at a height of 1.5 +0.2 m from the floor level.

Manual fire alarm



- LED status indicator: green - standby; yellow - fault; red - alarm
- Two integrated isolators
- Automatic and manual adjustment

Executive functions of the system

The functions that the system in question needs to perform in case of fire are defined by the Fire Protection Elaborate.

For the purpose of managing the operation of other systems that function as part of the fire protection of the facility, as well as receiving signals from them, appropriate interface modules have been selected. These modules are installed in special housings designed for surface mounting or in the suspended ceiling where available or on the wall.

In the event of a fire in the facility, various technical systems are commanded to perform certain functions: audible alarms, activation of sirens, and playback of recorded messages in the public address system, lowering elevators to evacuation level and disabling them, acting on the elevator control panel, unlocking doors in the access control system that are obstructing evacuation routes, smoke extraction in the atrium and lobby bar on the ground floor, and additional module for opening doors in case of fire, disabling air conditioning and closing fire dampers, acting on the power panels, activating smoke extraction and garage ventilation system, activating elevator overpressure, activating ventilation,

activating overpressure in stairwells, in evacuation elevators and/or windows in stairwells on the top floor of the building, flow indicators as executive function for fire, while signals (valve and residual) indicate system errors, which are connected to the central via I/O modules.

Alarm activation

Fire alarm activation is provided as follows:

- by activating electronic sirens with the required sound levels;

Sirens are mounted on the wall, according to the graphic documentation at a height of 2.2m, adjustments are possible on-site (MEP synchronous plan or interior design project). One of 24 different warning tones can be software-configured on the siren.

Internal siren



- Automatic addressing by the control panel
- Sound pressure: 101dB(A) @ 1m
- 14 available melody types

Alarm Notification

The project includes the installation of an automated system with recorded voice messages, intended for telephone alarm and error notification.

Alarm Plan

With this alarm concept, in the event of a fire, staff can make decisions within an automatic sequence of operations. This way, false alarms are not relayed to the fire department. The impact of any human error is reduced by the technology applied in the solutions.

The fire alarm system supports two operating modes, "day" and "night," in accordance with the Regulation on Technical Standards for Stable Fire Alarm Installations ("Official Gazette of the SFRY", No. 87/93).

Upon the activation of automatic fire detectors in the "day" operating mode, an internal light and sound alarm is triggered at the fire alarm control panel. This serves as the first warning sign for the on-duty personnel. If the on-duty personnel is not present, after the predefined time period (from 20 - 60 seconds), also known as the "presence time," a general alarm is activated throughout the facility.

In a normal situation, the on-duty personnel, who is continuously present, confirms the receipt of the information from the system by pressing a button. This confirms their presence and initiates another programmable time period, the "scouting time."

The scouting time depends on the size and geometry of the monitored facility and is defined separately for each facility during the functional testing of the system. This time typically lasts from 3 to 5 minutes. Upon confirming their presence, the on-duty personnel at the operational console reads the exact location of the alarm detector, proceeds to the location, and in the event of a fire, activates the nearest manual detector (as confirmation of the alarm in the system) and proceeds with fire extinguishing according to the predefined operational plan for fire incidents.

If the automatic detector has reacted to some interfering influences (such as heavy dust, steam, etc.), and the on-duty personnel, upon inspection, determines that it is a false alarm, they return to the operational console, cancel the "internal" alarm, and the system continues to operate in regular mode. Alarms from manual detectors do not have a delay and immediately trigger a general alarm status in the facility, as they are considered a reliable indication that a fire has indeed occurred.

The control panel has the capability to switch between "day" and "night" modes. This switching must be performed semi-automatically, i.e., automatically (via a timer for switching) from day to night mode, and manually from night to day mode.

In the "night" mode, all alarms in the system are considered relevant and are automatically forwarded to the on-duty personnel and/or fire brigade without the previously described scouting time and confirmation.

The evacuation plan is defined by the Main Fire Protection Project and ensures the following:

- Alerting individuals in danger for timely evacuation,
- Activation of the on-duty personnel and firefighter, or the local fire brigade,
- Alerting the nearest fire brigade,
- Alerting staff members with specific duties in case of fire,
- Taking all measures in case of malfunction or disconnection of individual zones.

Installation of the video surveillance system

The video surveillance system in the facility is based on IP technology. The main purpose and objective of the security surveillance system are as follows:

- Ensure the protection of critical infrastructure from unauthorized access and actions.
- Enable monitoring of corridors and multifunctional areas.
- Act preventively against intrusions and property damage and provide assistance in identifying perpetrators.
- Allow for subsequent analysis of archived video material.

In line with security considerations, the solution involves the installation of high-quality color and day/night cameras.

Dome camera



- DVC
- 5Mpx/20fps, turret
- Fixed lens 2.8mm
- Onvif, 12VDC/POE

The central NVR device is located in the RACK cabinet and enables the connection of all cameras in the facility. The NVR device has the capability to power cameras up to a distance of 100 meters.

NVR device



- Supports 4 channels for DVC IP cameras with 1x HDD
- Supports resolutions of 8Mpx/5Mpx/4Mpx/3Mpx/1080p
- Video material archiving should be performed using an efficient compression algorithm (recording only changes between video frames) and should allow archiving of a minimum of 15 days of recorded material.

Activation of video material should be done using an efficient compression algorithm (recording only changes between video frames) to enable archiving of a minimum of 15 days of recorded material. The installation of the system will be conducted following the routes and methods used for the installation of other telecommunication systems, partly in cable racks and partly in halogen-free installation pipes of appropriate diameter.

2.7. FIRE HAZARDS DUE TO ELECTRICAL ENERGY

In general, the most common cause of fires in buildings is attributed to electrical energy, resulting from damage or malfunctions in electrical devices. These causes may include:

- ➔ Heating of electrical conductors due to overload,
- ➔ Short circuit currents,
- ➔ Unauthorized voltage drop,
- ➔ Accidental contact with live parts,
- ➔ Appearance of high-voltage contact,
- ➔ Influence of moisture, water, and dust on electrical equipment,
- ➔ Influence of electromagnetic and electric fields,
- ➔ Unauthorized light levels,
- ➔ Atmospheric discharge,
- ➔ Static electricity, and
- ➔ Fire induction.

PROTECTIVE MEASURES, With the main project of electrical installations, the following protective measures are envisaged to prevent the mentioned occurrences:

- ✓ The entire installation is protected from overload by using correctly selected fuses at the beginning of each circuit, as well as by properly dimensioning adequately selected electrical equipment,
- ✓ Protection of cables from short circuit currents is achieved by using appropriate and properly selected fusible or automatic fuses, with a suitable insert at the beginning of each circuit when changing the cross-section. It is also foreseen to properly select suitable elements in all circuits.

The selectivity of the fuses guarantees that a short circuit due to a fault will not be transmitted further, thus ensuring the protection of expensive devices,

- ✓ The entire installation is dimensioned so that voltage drops, under normal conditions, do not exceed the permitted values. In an emergency situation, the protection will disconnect the corresponding circuit,
- ✓ Protection against accidental contact with live parts is ensured by choosing appropriate electrical equipment and applying appropriate measures, devices, and elements in distribution cabinets,
- ✓ To protect against the occurrence of excessively high contact voltage in the installation, a protective grounding system with a separate protective conductor is applied, the TN-S system. All metal masses that are not normally live but can come into contact in the event of an error must be visibly connected (with a yellow-green conductor of the appropriate cross-section) to the protective conductor busbar (grounding).

Upon completion of the installation and before energizing the installation, the following measurements must be performed:

- ➔ Loop resistance,
- ➔ Potential equalization efficiency, and
- ➔ Grounding resistance.

By correctly selecting the distances between power, signal, and telecommunication cables, as well as choosing electrostatic and electromagnetic protection both inside and outside the cables, the risk of electromagnetic and electrical field influence is eliminated. Fire protection is ensured by the proper selection of fire protection equipment, which, when properly installed and maintained according to regulations during operation, cannot cause fires.

During operation, loop resistance, potential equalization efficiency, and grounding resistance must be checked periodically, at least every other year.

- ✓ Electrical installations, including distribution cabinets and switches, are protected from moisture and dust by selecting appropriate cables and equipment according to the conditions prevailing at the installation site. Care has been taken to protect the mechanical structure of distribution cabinets from the risk of contact, ingress of solid objects and dust, as well as from the penetration of water and moisture based on IEC criteria and recommendations.
- ✓ The risk of excessive lighting levels is avoided by choosing the appropriate type and power of light sources for individual spaces in and around the building.
- ✓ The risk of atmospheric discharge is minimized by the provided lightning protection installation
- ✓ The risk of static electricity is also minimized by the provided potential equalization installation.

Note:

When passing cables of electrical installations from one fire sector to another, it is necessary to seal the openings in the wall between the two fire sectors through which the cables pass, using certified fireproofing material with the same fire resistance rating as the fire wall through which the passage is made. When passing cables from one fire sector to another, the cables must be coated with fireproof coatings. The cables in the penetration zone, 250 mm in front and behind the penetration, are coated with a minimum thickness of 1 mm of fireproof coating, as well as the outer surface of the penetration. Gaps between cables in the bundle are filled with fireproof foam or fireproof pillows. The final coat should be applied at least 80 mm over the surrounding wall surfaces from the penetration point, with a thickness of 1 mm. Preventing the spread of fire through and from the vertical riser to other parts of the building is done by sealing all openings with fire-resistant material after passing the cables. For the material used as fire protection, it is necessary to obtain a certificate demonstrating its resistance to

combustion according to the applicable standard at the time of installation in Montenegro, which is currently the standard MEST EN 13501-1:2020, MEST EN 13501-2:2019, MEST EN 13501-3:2011, MEST EN 13501-4:2019, MEST EN 13501-5:2019, MEST EN 13501-6:2020.

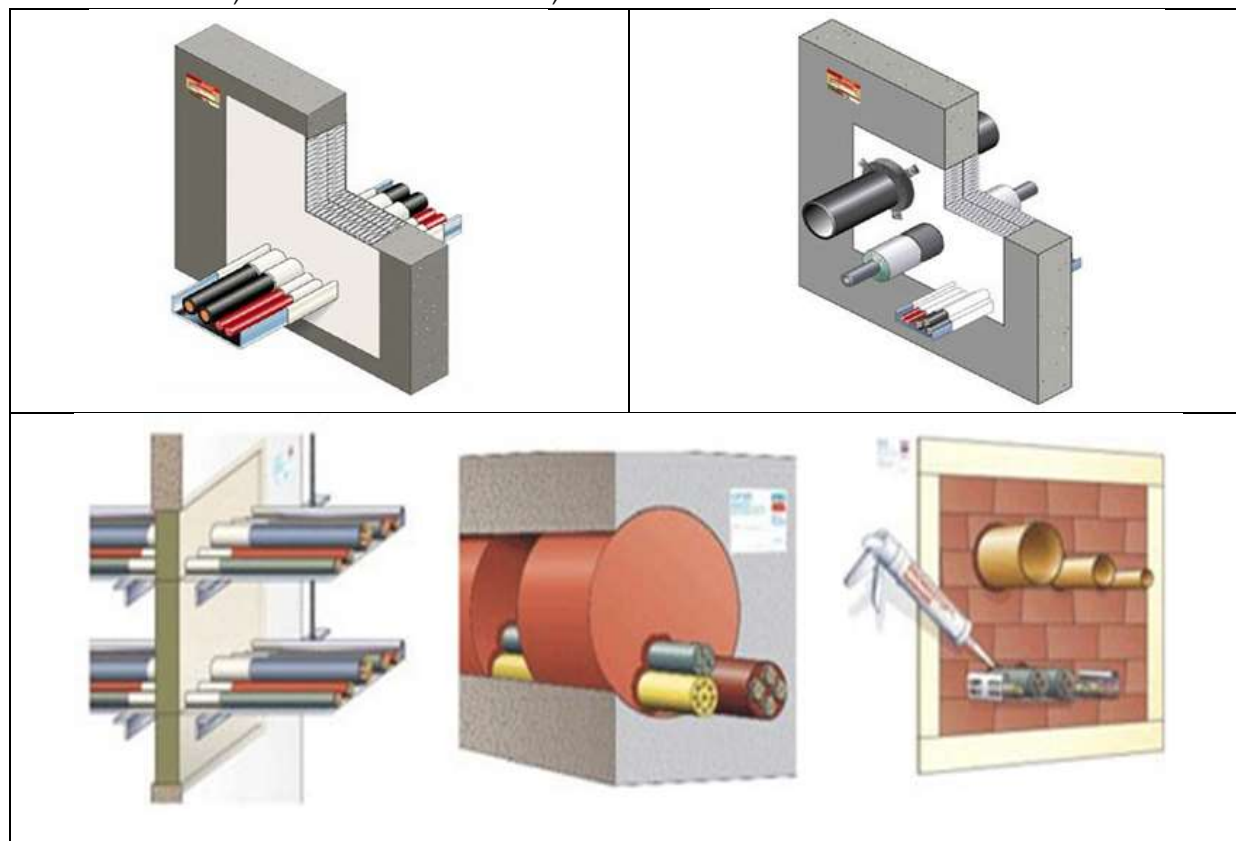


Fig. 1. Ways of protecting electrical cables between fire sectors.

2.8. MECHANICAL INSTALLATIONS

General concept of HVAC installations

When designing and selecting installations for the subject building, consideration is given to the architectural design to choose the best solution in terms of investment and operational conditions, ensuring a high level of comfort. The school building consists of classrooms and corridors.

There are both heating and cooling systems in place.

Currently, there are three heating systems in the building:

- ➔ Radiator heating system for the entire facility supplied by the central boiler room
- ➔ Electric radiators in rooms
- ➔ Wall-mounted split air conditioning units.

The existing electric radiators are being dismantled due to their low energy efficiency, and existing air conditioning units are being utilized for climate control.

Air conditioning system with split wall units

For heating and cooling the classrooms, the installation of a split system is envisaged, with an outdoor unit and its corresponding indoor wall unit.

Description of the system: The split air conditioning system with a wall unit consists of an indoor wall unit and an outdoor unit. This system is very popular due to its efficiency and ease of use.

Indoor wall unit: The indoor wall unit is mounted on the wall inside the room you want to air-condition. It usually has an attractive appearance and blends with the room's interior. This unit is responsible for

regulating the temperature in the room and distributing cold or hot air. The indoor unit has a fan that circulates air strongly through the room and expels it through the grille. It also has a compressor that regulates the air temperature.

Outdoor unit: The outdoor unit is located on the exterior side of the building. This unit usually contains a condenser, compressor, fan, and other components responsible for generating cold or hot air. The compressor in the outdoor unit compresses the refrigerant, causing its temperature to increase. Then, this heat is transferred to the condenser where it is expelled from the system. The fan of the outdoor unit helps to dissipate heat and ensures efficient cooling of the system. **Functioning:** The split air conditioning system with a wall unit operates through the circulation of refrigerant passing through the outdoor and indoor units. When cooling is activated, the outdoor unit extracts heat from the interior of the room and expels it outside the system. During heating, the system operates in reverse - the outdoor unit absorbs heat from the external environment and transfers it inside, thus heating the room.

Advantages: The split air conditioning system with a wall unit has many advantages. Firstly, it allows precise temperature control and provides comfort in the room. Additionally, this system is relatively quiet and aesthetically pleasing since the indoor unit is mounted on the wall. The split system is also energy-efficient, resulting in lower electricity bills. Moreover, the split system also allows heating during winter months, providing multiple functionalities.

2.9. WATER SUPPLY AND SANITATION

A. WATER SUPPLY

During the inspection of the facility, it was not possible to determine the position from which the current supply of sanitary fixtures in the facility is being provided. For this reason, it is planned to connect near the existing fire hydrant positions in the facility.

Note: After the start of construction works and the dismantling of existing sanitary facilities, it is necessary to determine the factual situation (position of supply pipes, etc.), and adapt the water installation layout to the actual conditions on-site.

The distribution network for sanitary elements, which will be laid in floors and walls, will be made of polypropylene pipes (PPR) and fittings for 20 bars, which are welded together (materials supplied with proper certifications as per the project). The diameters of the pipes, determined by hydraulic calculations, are provided in the graphic attachments as outer diameters. The table shows the outer diameters of PPR pipes and their corresponding inner diameters:

Outer diameter	Inner diameter
DN 20	1/2"
DN 25	3/4"
DN 32	1"

On the branches for sanitary blocks and some water supply points, gate valves with nickel-plated plug and flange are provided for cold water supply. Install the valves in visible and easily accessible locations, as proposed in the graphic attachments. All newly designed water pipes are insulated with a thickness of 4mm.

In the bathroom, the installation of a 50-liter capacity water heater is planned.

The internal water distribution network will be partially installed in the wall, in special grooves, with the necessary insulation, above which tiles or plaster are applied, and partially in the floor with the same

prescribed thermal protection. At points where water supply and sewage pipes overlap, water pipes are installed above sewage pipes.

The testing of the internal water distribution network will be conducted according to the regulations applicable to such works. The network will be pressurized to a minimum of 12 bars, and any deviation or pressure drop will be observed after 24 hours. Any deviation exceeding 10% indicates that the network has not been properly installed. The testing is performed before the sanitary fixtures are installed. After the installation of sanitary fixtures, flushing will be carried out, followed by disinfection of the network and subsequent flushing. An appropriate authorized institution should provide the Investor with a certificate of water quality to be used in the facility after all the described procedures. For all tests, including pressure testing, disinfection, and flushing, the Contractor and the Supervisory Authority are required to prepare reports.

B. FEKALNA KANALIZACIJA

DRAINAGE OF SEWAGE FROM WET ROOMS IN THE BUILDING

When inspecting the building, it was not possible to determine the position of the existing sewage verticals in the facility.

Note: After the start of construction works and dismantling of existing sanitary facilities, it is necessary to determine the factual situation (positions of sewage verticals), and adjust the sewage installation layout according to the actual conditions on the ground.

The wastewater from various sources is collected by horizontal distribution pipes, which are then connected to existing vertical pipes.

When connecting horizontal pipes to vertical ones, the rules outlined in the "European Standard EN12056, Appendix 2000, 2002" have been followed. According to these standards, the horizontal pipe is connected to the vertical one at an angle of 87°-88.5°.

The technical solutions for routing installations through the building are in line with the architectural and construction project. When designing the horizontal sewage network, care was taken to provide an optimal solution with the shortest possible branches, ensuring efficient drainage of wastewater to the connections. All pipes in the building should be installed with a minimum slope of 1.0%.

Horizontal and vertical internal sewage distribution is designed using PP sewage pipes ranging from D50 to D110mm in diameter, laid in the floor, ceiling, or walls. All pipes are designed using low-noise PP pipes.

Verticals and branches should be secured with steel clamps with rubber inserts to reduce noise. Penetrations of sewage pipes through slabs should be insulated with sound isolators or specially designed components, all according to the manufacturer's instructions.

C. SANITARY FIXTURES AND ACCESSORIES

The project includes the dismantling of all existing sanitary fixtures (toilets and sinks). The selection of sanitary equipment and accessories will be made according to the proposal of the Architect and the Investor.

D. DISTRIBUTION OF HYDRANTS PER FLOOR

The water supply to the subject building is provided from the municipal water supply network. According to the Main project of water supply and sanitation, water verticals will be made of galvanized and PVC water pipes, of appropriate diameters obtained based on hydraulic calculations. Within the building, water will be used for drinking and sanitary purposes. The pressure in the network is 3 bars. A fire hydrant network has been installed in the building. There is 1 hydrant box on each floor. The

layout of hydrants and the pipeline route is shown in the graphic documentation. For fire extinguishing purposes, the number of internal hydrant locations is shown in Table 2.

Rb.	Etaža	Broj hidranata
1.	Ground floor	1
2.	I Floor	1
THE TOTAL NUMBER OF INTERNAL		2

Table 2. Distribution of hydrants per floors of the building

According to the Regulation on Technical Norms for the Design of External and Internal Fire Hydrant Networks for Fire Extinguishing ("Official Gazette of the SFRY" No. 30/91), for buildings up to 22 m in height, the water pressure on the top floor must be a minimum of 2.5 bars, with a flow rate of 5 l/s. The internal fire hydrant network must be equipped with a metal hydrant cabinet containing: one hose with a diameter of \varnothing 52 mm, length 15 m, a universal nozzle (for full and spray jet), a wrench for tightening hose couplings with the nozzle, and a valve for opening and closing the water supply. Hydrant cabinets with the hydrant set are marked with the Latin letter "H" and are installed or recessed in the wall at a height of 1.50 m from the floor level to allow for immediate activation in case of need. They are distributed so as not to obstruct evacuation, and the water jet from the hose and nozzle covers a total of 20 m, covering every point in the building.

Hydrants are placed in corridors, stairwells, and along evacuation routes, in close proximity to the entrance doors of rooms that may be at risk of fire, without obstructing evacuation.

Wastewater evacuation is provided through a collective drainage channel outside the building.

3. BUILDING MATERIALS

3.1. BEHAVIOR OF BUILDING MATERIALS AT HIGH TEMPERATURES

The stability of the construction of a building largely depends on the physical and chemical properties of the construction materials from which the structure is built. In order for the building construction or its part to be resistant to high heat exposure for a certain period of time in fire conditions, it is necessary to understand their behavior in high temperature conditions.

To determine this, it is particularly important to know the temperature values that may occur during a fire.

Experimental testing has determined that the temperature at the fire focal point increases over time according to the values in Table 3.

Table 3. Increase in Temperature Over Time During a Fire

Time from the beginning of the fire	10 min	30 min	60 min	120 min	240 min
Temperature [°C]	600	800	900	1000	1100

In specific cases, depending on the conditions under which the fire develops, temperatures may vary to a greater or lesser extent from those mentioned.

According to the nomenclature of the SRPS standard U.J1.050 (from May 23, 1997), the behavior of building materials in fire is defined into the following classes: non-combustible - class A1 and combustible, further divided into difficult to ignite - class B1 and normally combustible - class B2.

- **Non-combustible building materials - class A1:** These are materials that cannot ignite, smolder, or carbonize under high temperatures. This group includes natural and artificial mineral construction materials such as sand, gravel, clay, all types of stone, cement, gypsum, lime, all types of mortar, all types of concrete, bricks, asbestos, mineral fibers, as well as metals and their alloys used in construction.
- **Difficult to ignite building materials - class B1:** These are materials that, under the influence of flame or high temperatures, are difficult to carbonize. They can only burn when exposed to an external heat source, such as flame, and stop burning when the external source is removed. This group includes lightweight panels based on mineral wool, pipes and fittings made of rigid PVC, vinyl-asbestos floor coverings glued to a mineral base, and oak parquet varnished with synthetic resin lacquer.
- **Combustible building materials - class B2:** These are materials that ignite and burn when exposed to an external heat source, and continue to burn even after the removal of the external source. This group includes wood, linoleum, rubber sheets, paper, and other synthetic materials. Table 4 shows the construction and craft materials found in the subject building, as well as their behavior during a fire.

Table 4. Fire Performance of Building Materials and Interior Finishes

Material	Purpose	Performace	Approximate temperatures (°C)
Polyester	Foam for thin-wall constructions, curtain rod holders, radio, TV, cassettes	collapse, softens, melts and flows	120 120-140 150-180
Polyethylene	bags, sheets, bottles, baskets, pipes	wrinkled, softens and melts	120 120-140
Polymethyl, methacrylate	Holders, covers, windows, doors	softens, blisters	130-200 250
PVC	cables, pipes, pipe channels, profiles, holders, household items, toys, bottles	dilutes, smokes and darkens, carbonizes	100 150-200 400-500
Cellulose	wood, paper, cotton	darkens	200-300
Tin	sewage and water installations, connectors	melts	250
Lead	water and sanitary installations	melts, rounding sharp edges softens,	300-500
Aluminium and alloys	fixed objects, doors, windows	melts and deforms softens,	400 500
Glass	windows, glazed surfaces	rounding edges, viscous flow melts, deformation	500-600 800
Silver	jewelry, cutlery	topi se, deformacija	950
Brass	locks, handles, faucets	melts at edges and deforms	900-100

Copper	wires, cables	melts	1000 – 1100
Cast iron	radiators, pipes	melts and deforms deformation,	1100 – 1200
Zinc	pipes, drainage pipes	melts and deforms deformation,	400 420
Bronze	windows, doorbells, ornaments	rounding edges, deformation	900 900-1000
Paints	-	decay, destruction	100 250
Wood	-	ignition	240

3.2. FIRE LOAD

Under thermal fire load (q_n), it is understood as the total value of thermal energy released during the combustion of all combustible materials present in the room and those materials incorporated into its building structures, and the calculation is performed using the following expression:

$$q_n = \frac{\sum (M_i \times H_{ul} \times m_i \times \psi_i)}{A} [MJ/m^2] (2)$$

Where:

M_i - mass of individual combustible material (kg)

H_{ul} - energy value of individual combustible material (MJ/m^2),

m_i - faktor sagorijevanja pojedinih gorivih materijala, (na osnovu SRPS U.J1.054),

ψ_i - Combined supplementary value ($\psi_i=1$ for unprotected materials) and

A - Calculated area of the fire sector, (m^2).

The fire load, hazard class, smoke generation, and corrosive vapors according to the purpose of the subject building are adopted based on the Collection of Regulations in the Field of Fire and Explosion Protection, Book II, Group V, Appendix 2, which is as follows:

- ▶ Substation: 586 MJ/m^2 , Hazard Class III, with smoke generation and corrosion. Administration offices: 754 MJ/m^2 , Hazard Class II, without smoke generation and without corrosion.

The classification of the fire hazard of the building or its parts according to the standard SRPS U.J1.030 ("Official Gazette of the SFRY" no. 36/76) based on the fire load is divided into three groups, namely:

- The fire hazard level of a building with a fire load of 1 GJ/m^2 is classified as low
- The fire hazard level of a building with a fire load of 2 GJ/m^2 is classified as moderate
- The fire hazard level of a building with a fire load exceeding 2 GJ/m^2 is classified as high

According to this standard, **the subject commercial building falls into the low fire hazard category, with a fire load of up to 1 GJ/m^2 .**

3.3. FIRE SECTORS AND SEGMENTS

One of the most effective methods of fire protection for buildings is the formation of fire sectors. This measure is considered mandatory in design, considering that it addresses many issues related to fire protection not only of the building but also of the individuals within it. A fire sector is defined as a spatial unit within a building that can be independently treated regarding the application of technical and organizational fire protection measures, separated from other parts of the building by structural components of the building construction, with the required degree of fire resistance. Considering the

layout of rooms and communication pathways in the subject building, it represents a single fire sector.

3.4. EVACUATION OF ENDANGERED INDIVIDUALS

Evacuation of endangered individuals refers to the forced exit from a building where an accidental situation has occurred—such as a fire—by all individuals present at that moment, until reaching a safe area outside the building. Unlike everyday exits from a building during normal use, in the event of a fire, evacuation occurs suddenly, without the possibility of prior notice or preparation. In such cases, panic is always present among the individuals due to the dangerous factors of the fire, which further complicates and hinders evacuation.

The dangerous factors of the fire include:

- air temperature above 70°C,,
- heat flux exceeding 1,5 kW/m²,
- carbon dioxide concentration above 6.0 volume %,
- carbon monoxide concentration above 0.5 volume %,
- concentration of any toxic gases that may occur during combustion above the Maximum Allowable Concentration (MAC),
- oxygen concentration below 17%,
- visibility less than 5.0 m in the evacuation direction, and
- ignition of a vessel containing flammable liquids, gases, or other hazardous substances.

Basic concepts and definitions related to evacuation are:

Hazardous Fire Factors (except the last two) indicate the ambient conditions that a healthy endangered person can endure without permanent consequences for a certain period (up to 5 minutes at most, but a significant percentage would survive even with exposure up to 10 minutes).

Basic terms and definitions related to evacuation are:

- **Starting Point (SP)** is the location where a person can be found at the moment they become aware that evacuation is necessary due to a fire emergency..
- **Safe Place (SP)** is a location outside the building where harmful effects of fire such as flames, smoke, or falling debris are not expected. For buildings of this type, a safe place is at least 5 meters away from the building exit, on the street or in a spacious courtyard.
- **Evacuation Corridor (EC)** consists of building structures within the building that limit communication spaces (hallways, buffer spaces, staircases, vestibules, entrances, etc.) and prevent the penetration of flames and smoke from living spaces..
- **First Exit (FE)** is the exit from a room or group of rooms towards a corridor. It is typically the exit from an apartment, hotel suite, classroom, office, workshop, etc. If there are multiple similar FE passages, they can be alternative exits (AFE) only if they are sufficiently separated to prevent simultaneous smoke filling (exits from cinemas, theaters, sports halls, etc.)
- **Direct Path of the First Stage Evacuation** is the distance from the starting point to the first exit..
- **Floor Exit (FE)** consists of fire-resistant doors or barriers at the exit from the hallway or those that prevent the penetration of fire and smoke at the entrance to the staircase or lobby.
- **Final Exit (FE)** is the exit from the building.
- **Primary Evacuation Corridor (PEC)** is the corridor used for normal movement of people in the building
- **Alternative Evacuation Corridor (AEC)** is a corridor that has the same or similar conditions for evacuation as the primary one
- **Reserve Evacuation Corridor (REC)** is a short corridor used by a maximum of two people from technical rooms.
- **Evacuation Speed (Ve)** is the design value of the speed at which people move through the

evacuation corridor.

- ➔ **Evacuation Time (T_e)** is the time for preparation for evacuation and the time it takes to move from the starting point to the safe place.
- ➔ **Evacuation Preparation Time (T_{pe})** is the projected time during which individuals prepare for evacuation, i.e., assess the need for evacuation.
- ➔ **Evacuation Evacuation Time (T_k)** is the time it takes for a person to move from the starting point to the safe place.
- ➔ **Evacuation Path** is the projected path that a person takes during evacuation.

According to the norm "Technical recommendations for construction technical fire protection measures for residential, commercial, and public buildings" SRPS TP 21 (from 2003), the evacuation process is defined by the following parameters:

The preparation time for evacuation is the time from when an endangered person becomes aware of the fire (and that it poses a threat to their life) until the moment of leaving the room. During this period, individuals experience a highly stressful situation, assess the justification for evacuation, search for family members and pets, gather valuables, and other items they intend to take with them. Depending on the purpose of the building, the following times are adopted during the evacuation preparation phase:

- ➔ At least 10 minutes for residential buildings,
- ➔ At least 5 minutes for commercial buildings, and

At least 3 minutes for public buildings (except for stadiums and sports halls, for which at least 2 minutes are envisaged).

The evacuation movement speed, for unimpeded movement of endangered persons along a straight path, is projected at $V_o = 1.5$ m/second. This speed decreases due to grouping before narrowing of corridors (doors), corridor turns, staircases, etc. The projected speed of restricted movement represents the product of unimpeded movement speed and deceleration factor in:

$$V_{om} = u \cdot V_o \quad (3)$$

The deceleration factor (u) adopts the following values::

- 0,8 for movement downstairs, and
- $0,8 - 0,05 \cdot d$ for movement upstairs, where d represents the number of fictitious floors of 3 meters each,

When encountering a narrowing of the corridor or doors narrower than 1.0 m for 10 to 40 people, or door openings smaller than 1.6 m for 40 to 200 people, the projected retention time is 3.0 s for every 10 people.

When making a turn at an angle greater than 30 degrees but less than 60 degrees, or encountering stairs or a ramp, the retention time is 2 s for every 10 people.

For making a turn at an angle greater than 60 degrees, an additional 5 s is required for every 10 people.

The evacuation stages represent the path that an endangered person travels from the moment they leave the room where the fire occurred to the final exit from the building, i.e., to a safe area. These stages consist of:

- **Stage I:** It involves leaving the room where the fire occurred (PM) and reaching the first exit (PI). For rooms with a direct exit outside, this is also the first exit.,
- **Stage II:** It involves the movement of endangered persons from the first exit (PI) to the floor exit (EI). For ground-level buildings, the floor exit is also the final exit,
- **Stage III:** It includes the movement of endangered persons from the floor exit (EI) to the final

exit (KI)

- **Stage IV:** It covers the movement of endangered persons from the final exit (KI) to a safe place (BM).

The movement of endangered persons in Stage I of evacuation for residential, commercial, and public buildings is projected to take 0.5 minutes. Longer times for Stage I are required for buildings with a larger number of people (cinemas, theaters, sports halls, etc.).

The movement of endangered persons in Stage II of evacuation should be completed in less than 1.0 minute, and in Stage III in less than 3.0 minutes

Evacuation corridors should ideally be clear, without unnecessary turns, without a change in direction of less than 90 degrees (except for staircases), and without obstacles (thresholds and suspended loads). The width of the corridor should not be less than 1.2 m, and staircases should be 1.0 m wide (or 1.2 m if it is the only staircase for a fire segment).

Evacuation routes to the first exit should be as short as possible. To avoid the possibility of the first exit being blocked, a certain number of alternative first exits are planned for larger rooms:

- ➔ For more than 50 but less than 300 people, two additional alternative exits.
- ➔ For more than 300 but less than 600 people, three additional alternative exits.
- ➔ For more than 600 but less than 2,000 people, four additional alternative exits.
- ➔ For every 2,000 people (if more), one additional alternative exit is required.

The distance from the first exit to the floor exit should not exceed 30 m in above-ground floors and 25 m in underground floors. For buildings without floor exits, the distance from the first exit to the staircase should be no more than 10 m.

The minimum width of the door opening for apartments or offices where more than 10 people reside is 0.92 m, and for more than 10 but less than 50 people, it is 1.0 m.

Staircases in buildings should have straight flights to allow overtaking and passing.

The calculation of evacuation time (t_{uk}) for endangered persons is based on the following criteria: the total number of people to be evacuated, their density per unit area, the shape of the evacuation route (level, up and down stairs), the length and width of the evacuation route, and the number and size of exit openings.

Evacuation time consists of preparation time for evacuation and the time taken to move from the starting point to the safe exit point on the street.

The evacuation time is calculated using the following formula:

$$t_{evak} = \frac{P}{B_1 \times F_p} + \frac{L_h}{V} [sec] \quad (4)$$

where:

- ➔ t_{ev} - Evacuation time in seconds
- ➔ P - Total number of people to be evacuated (dimensionless),
- ➔ B_1 - Total width of exit doors - vrata [m],
- ➔ F_p - Coefficient of people passage through exits [m/s],
- ➔ L_h - Maximum length of evacuation route [m] i
- ➔ V - Speed of people exiting [m/s].

The relevant time for the calculation of evacuation is from the farthest place in the building to the exit to the free one space. The length of the straight path is 26 m, the path down the stairs is 7.5 m, and the width of the exit is 3.40 m.

The evacuation calculation was made according to the data that 100 people are staying in the building in case of an accidental situation - fire.

Driving time on a flat road:

$$t_{evo} = \frac{P}{B \times F_p} + \frac{L_h}{V} [sec] = 30,40sec \quad (5)$$

Walking time down stairs:

$$t_{evc} = \frac{P}{B \times F_p} + \frac{L_{\square}}{V} [sec] = 25,50sec \quad (6)$$

Total evacuation time:

tuk = tevo + tevc = 30,40 sek + 25,50 sek = 55,90 sek.

Total evacuation time is 3,95 min.

NOTE:

Evacuation time of approximately 1 minute, obtained by mathematical calculation for the predicted number of people, while in real cases, evacuation time can be longer.

Evacuation time is conditioned by proper design of internal space organization, optimal layout of rooms and disposition of openings, horizontal and vertical communications in the building, which allows access to multiple alternative exits, ensuring safe and timely evacuation of endangered persons in case of an accident situation.

The evacuation route from the building to a safe space must be continuous, flat, and always clear and unobstructed. The doors in the building located on evacuation routes are of proper dimensions and appropriate capacity, allowing evacuation from the building to proceed continuously and without interruption. Evacuation routes should be visibly marked with evacuation direction signs and equipped with panic lighting fixtures labeled "EXIT".

4. FIRE RESISTANCE OF BUILDING CONSTRUCTIONS

When determining the fire resistance time of the entire building construction or part of the construction, it is necessary to know the minimum fire resistance required for the materials. These values are typically found within building regulations or standards, and they can be calculated through mathematical or experimental methods using various techniques.

The fire resistance of building elements or constructions is conditioned by a series of factors, among which the most important ones are:

- Spatial position of the building (influence of geographical-morphological conditions, impact of winds, traffic, safety distances from neighboring buildings),
- Mutual relationship and position of the building and its dimensions within the project,
- Fire resistance of the construction and other building elements,
- Choice of materials for the construction of the building,

- Definition and calculation of evacuation routes,
- Fire zones and sectors,
- Total fire load of the building,
- Definition of external and internal traffic routes and access to the building.

Based on the previous architectural analysis and the mentioned influential parameters, the most favorable spatial position of the building has been chosen, as well as the mutual relationship between the position and dimensions of the building within the project.

The fire resistance of a building construction is its ability to maintain its load-bearing capacity, prevent the penetration of fire, and preserve thermal insulation when exposed to fire, according to the Serbian standard SRPS U.J1.070 ("Official Gazette of SRJ" No. 20/94). Accordingly, the fire resistance time of the construction as a whole represents the time in minutes for which it ensures compliance with the above requirements.

According to the norm "Technical recommendations for construction technical fire protection measures for residential, commercial, and public buildings" SRPS TP 21 (from 2003), according to the Classification of Buildings by Purpose, Isolation, and Height (point 4), it falls under a detached commercial building, up to 9 m in height (IP 1). Furthermore, based on the number of people in the fire sector, the size of fire sectors, and the required degree of resistance of elements/constructions to fire, they are presented in tables 6 and 7:

Number of People	Less than 20	21 - 50	51 - 100	101 - 300	301 - 700	701 -1500	More than 1500
Class P	P1	P2	P3	P4	P5	P6	P7
A	< 400	< 800	< 1200	< 1600	< 2000	< 2500	> 3000

Table 6: Impact of the Number of People in the Fire Sector and the Size of Fire Sectors A (m^2)

Building	IS1	NS1	IS2	NS2	IS3	NS3	IP1	NP1 IJ1	IP2 NJ1	NP2 IJ2	IP3 NJ2	NP3 IJ3	NJ 3
P1	II	II	III	III	III	IV	II	II	II	III	III	IV	IV
P2	II	III	III	III	IV	IV	II	II	III	III	IV	IV	IV
P3	III	III	III	IV	IV	IV	II	II	IV	IV	IV	IV	IV
P4	III	III	IV	IV	IV	IV	III	III	IV	IV	IV	IV	IV
P5	IV	IV	IV	IV	IV	IV	III	III	IV	IV	IV	IV	V
P6	IV	IV	IV	IV	IV	IV	IV	IV	IV	IV	IV	V	V
P7	IV	IV	IV	IV	IV	IV	IV	IV	IV	IV	V	V	V

Table 8: Determination of the Required Degree of Fire Resistance of Elements/Constructions

The fire resistance class of the building, based on the previous items, places the subject building in the II fire resistance class. For buildings with a II fire resistance class, according to the provisions of the standard SRPS U.J1.240 ("Official Gazette of SRJ" No. 83/94), the specified fire resistance of basic elements/constructions is indicated (bulleted) in Table 8.

Fire Resistance Rating of Building Elements/Constructions [h]

Type of Construction	Testing methods SRPS	Position	Fire resistance rating of building elements/constructions (h)				
			I [NO] Slight	II [MO] small	III [SO] medium	IV [VO] bigger	V [WO] large
Load-bearing wall	U.J1.090		1/4	1/2	1,0	1,5	2,0
column	U.J1.100		1/4	1/2	1,0	1,5	2,0
beam	U.J1.114		-	1/4	1/2	1,0	1,5

Intermediate construction	U.J1.110		-	1/4	1/2	1,0	1,5
Partition wall	U.J1.090		-	1/4	1/2	1/2	1,0
Roof construction			-	1/4	1/2	1/2	1,0
wall	U.J1.110		1/4	1,0	1,5	2,0	3,0
Intermediate construction	U.J1.110		1/4	1/2	1,0	1,5	2,0
door 3,5m ²	U.J1.160		1/4	1/4	1/2	1,0	1,5
door >3,5m ²	U.J1.160		1/4	1/2	1,0	1,5	2,0
Evacuation route			negor. mat.	1/2	1/2	1,0	1,5
Facade wall	U.J1.092		-	1/2	1/2	1,0	1,0
Roof covering	U.J1.140		-	1/4	1/2	3/4	1,0



Table 9. Standard Fire Resistance Rating of Different Types of Constructions

However, based on real indicators, the subject building, according to the standard SRPS U.J1.240, falls into the IV (VO) fire resistance class, which is significantly more favorable from a fire protection standpoint.

5. POSSIBLE FIRE CLASSES

The choice of fire extinguishing agent is of crucial importance depending on which type and quantity of material is burning, or which agent is most effective in extinguishing the fire and preventing its further spread. When the material is known, and if it is not mixed with others, there is no dilemma about which fire extinguishing agent to use. However, in practice, it is most common that the fire has affected multiple flammable materials of different types and properties. In such cases, if possible, the extinguishing agent should be chosen that is effective for multiple flammable materials involved in the fire.

According to the standard JUS ISO 3941 ("Official Gazette of SRJ", No. 5/94), and in accordance with the nature of the material's persistence during combustion, they are classified into the following five fire classes, and the following agents are used for their extinguishment:

	<p>Class A: fires involving solid flammable materials (with the formation of flames and embers - wood, paper, textiles, coal, etc.). Extinguishing agents for these fires may include:</p> <ul style="list-style-type: none"> • water, with or without antifreeze additives, • foam (chemical-foam and light foam), and • special powder extinguishing agents for ember fires.
	<p>Class B: fires involving flammable liquids (without embers - gasoline, kerosene, oils, fats, adhesives, resins, etc.). Extinguishing agents for these fires may include:</p> <ul style="list-style-type: none"> • foam (chemical-foam and light foam), • powder without sodium bicarbonate and based on potassium hydrocarbonate, • special powder and carbon dioxide.




	<p>Class C: fires involving flammable gases (natural gas, methane, acetylene, propane, butane, etc.). Extinguishing agents for these fires may include:</p> <ul style="list-style-type: none"> • powder based on sodium bicarbonate and potassium hydrocarbonate, • special powder, and • carbon dioxide gas
	<p>Class D: fires involving flammable metals (aluminum, magnesium and their alloys, sodium, potassium, etc.). Extinguishing agents for these fires may include:</p> <ul style="list-style-type: none"> • special powder, with special approval, • specific extinguishing powder, • non-extinguishing substances (dry sand, gray cast iron shavings).
	<p>CLASS F - encompasses fires involving flammable oils and fats [burning with flames]. Extinguishing agents for these fires may include:</p> <ul style="list-style-type: none"> • soap foam, • fire blanket or wet blankets.

Image 2. Fire resistance rating

According to the standard, fires originating from electrical installations and appliances are not classified as a separate fire class; instead, they belong to either Class A or Class B fires. In such cases, the usual extinguishing procedure involves cutting off the power supply to the entire building or room where the fire occurred, along with the application of standard extinguishing methods. Only in cases where this procedure cannot be safely executed are special extinguishing agents used that do not conduct electricity and do not damage materials, such as: vaporizing liquids and carbon dioxide (CO₂).

Taking into account that it is a cable duct buried underground, in the event of a fire, a fire on the subject building and substation can be expected, but they are not the subject of this Report.

5.1. FIRE EXTINGUISHING AGENTS

- Fire extinguishing agents are substances (liquid, solid, and gaseous) that are deployed onto a fire, interrupting the combustion process. There is no universal extinguishing agent suitable for all types of fires. Different agents are used depending on the material that is burning.
- Water as a fire extinguishing agent holds the greatest significance and role among all fire extinguishing agents. Water has a significant capability to extinguish fires due to its cooling effect, which lowers the temperature and the rate of combustion. Another extinguishing effect of water is through smothering, which occurs due to the formation of water vapor from the evaporation of water.

For fire extinguishing, both solid stream and water mist are utilized. Water mist is applied in special cases of fire extinguishing, as it requires high working pressure to generate.

Since there is no distinct boundary between a solid stream and a dispersed one, and ideally, a fully compact solid stream does not exist, during fire extinguishing, it is evaluated which droplet size would be the most optimal to achieve maximum reach.

Water is used to extinguish Class A fires (involving solid materials) such as wood, coal, textiles, and tobacco. Extinguishing these fires requires the cooling effect of the extinguishing agent to destroy the embers characteristic of solid material fires. Additionally, water should be utilized in fires where it is necessary to lower the temperature below the material's ignition temperature. Although flames can often be successfully eliminated using other extinguishing agents such as powder, effective extinguishing requires cooling below the ignition temperature and the destruction of

embers to prevent re-ignition.

Water should not be used to extinguish fires on electrical devices and installations (as water is an excellent conductor of electricity), or on some flammable chemical compounds, as it may pose a significant danger to the extinguisher.

- Powder as a fire extinguishing agent is successfully used to extinguish Class A, B, C, and D fires due to its high extinguishing power and nearly instantaneous flame elimination. However, this does not mean that powder extinguishing has universal capabilities. There are two types of fire extinguishing powders:

1. Powder based on sodium bicarbonate.
2. Powder based on other substances.

Powders based on other substances were introduced in response to the need for extinguishing fires where embers are present, namely for Class A fires. These are powders based on potassium hydrogen carbonate, but they have not yet been widely used in extinguishing. Powder can only extinguish a fire in the form of a cloud, as it has no special effect in other forms.

The extinguishing action of powder, besides extinguishing the flame, also involves covering the fire's focus by forming a layer similar to glass crust or solid foam at high temperatures.

Powder extinguishers are manufactured according to the SRPS Z.C2.035 standards in two versions: with a cartridge and under constant pressure. The standard unit extinguisher is the S type, weighing 9 kg, which has the following characteristics:

Table 10. Characteristics of mobile and transport devices, type S - 9 kg

Technical characteristics		
mark/type	S ² - 9	S ³ - 9
fire class	B, C	A, B, C
action time (s)	23,00	30,00
jet range (m)	7,00	8,00

² The apparatus with a bottle releases dry chemical powder using CO₂ gas and is not harmful to the human body.

³ The apparatus under constant pressure (inert gas - usually N₂).

Quantity of extinguishing agent (kg)	9,00	9,00
Mass of the full extinguisher (kg)	15,30	50,00
Area of application (°C)	-20 do +60	-20 do+60
Operating pressure (bar)	12	12
Application	It extinguishes electrical appliances under voltage up to 1000 V	It extinguishes electrical appliances under voltage up to 1000 V.

To use mobile fire extinguishers (those not under constant pressure), type S - 9, the following steps need to be performed in the following sequence:

- Quickly transport the device to the fire location.
- Pull the fuse of the movable handle on the device's valve.
- Strike the movable handle on the device's valve firmly with the palm of your hand.
- Wait for 5 seconds.

- Direct the nozzle towards the fire and press the movable handle fully.

To use the same type of device (under constant pressure), the following steps need to be taken:

- Transport the device to the fire location as quickly as possible.
- Pull the fuse of the movable handle on the device's valve.
- Direct the nozzle towards the fire and press the movable handle fully.

The working principle of all handheld powder extinguishers is to eject the powder from the container in a sufficient quantity and at a sufficient distance over a unit of time. This requires the use of a propellant gas, typically CO₂ or another inert gas, to perform this function.

Carbon Dioxide as a Fire Extinguishing Agent -Carbon dioxide is successfully used to extinguish Class A, B, and C fires. As carbon dioxide is an inert gas, it covers the fuel surface, reducing the supply of oxygen from the air to the fire, thereby interrupting combustion.

However, this gas also has some negative characteristics, including its low specific heat, inability to cover the entire ignited surface, limited range, and susceptibility to being carried away by wind outside the fire zone, reducing its effectiveness. This is particularly true for outdoor fires.

Extinguishing fires with carbon dioxide does not leave residues on the material being extinguished. This allows its use on electrical devices, even when they are under electrical current, as well as in the extinguishing of precision mechanical equipment, motor vehicles, and similar items. The best results in extinguishing with this gas are achieved under high pressure and with rapid action. Its use should be avoided in outdoor environments and at high temperatures, especially on heated metal elements, where sudden temperature changes may cause damage.

Carbon dioxide in fire extinguishers is stored in a liquid state under high pressure. Upon activation, it exits the bottle in a compressed state, and upon entering the expansion nozzle, it turns into a gaseous state, forming a wide jet that suffocates the fire. These types of devices should not be stored at temperatures above 40°C. When extinguishing fires on expensive and sensitive electrical equipment, it can cause temperature shocks, resulting in significant material damage. Additionally, caution must be exercised regarding its hazardous effects on the human body, especially with prolonged exposure in enclosed spaces. For this reason, respiratory protection equipment must be used in such cases. They are manufactured according to SRPS Z.C2.040 standards for handheld devices.

Technical specification	
mark/type	CO ₂ – 5
Fire Classes	B, C
Duration of Action (s)	12,00
Range of Jet (m)	3 - 4
Quantity of Extinguishing Agent	5,00
Weight of Full Apparatus (kg)	19,30
Safety Valve Pressure (bar)	170 ±5
Operating Temperature Range	-20 do 43 (+60)
Operating Pressure (bar)	56
Application	Extinguishes electrical equipment under voltage up to 1000 V.

Table 11. Characteristics of the device, type CO₂ 5kg

To use the CO₂ - 5 fire extinguisher, follow these steps in sequence:

- Quickly transport the extinguisher to the fire location.
- Pull the safety pin from the valve handle of the extinguisher.
- Aim the nozzle of the extinguisher towards the fire.

Open the valve on the cylinder fully (turning it counterclockwise or pressing the extinguisher handle) and cover the area on fire with the CO2 gas jet.

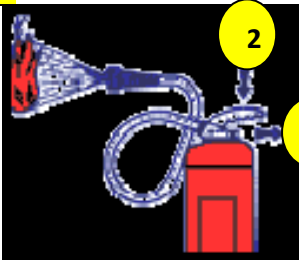
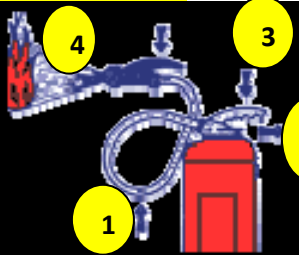
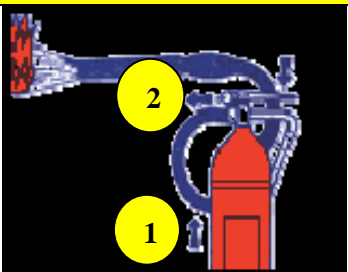
FIRE EXTINGUISHER WITH POWDER "S", without constant pressure, type S - 9 kg	
	<ol style="list-style-type: none"> 1. Pull out the safety pin (1). 2. Press the trigger handle (2) and release it abruptly. 3. Wait for 5 seconds. 4. Press the trigger handle again. 5. Aim the nozzle towards the fire.
Fire extinguisher with constant pressure, type S - 9 kg	
	<ol style="list-style-type: none"> 1. Release the nozzle (1), 2. Pull the safety pin (2), 3. Press and hold the nozzle handle all the way down (3), and 4. Aim the nozzle at the fire.
Fire extinguisher with carbon dioxide "CO2", type CO2-5 kg	
	<ol style="list-style-type: none"> 3. Release the nozzle (1), 4. Pull out the safety pin (2), 5. Depress the lever fully and hold it (3), and 6. Direct the nozzle towards the fire.

Image 3 - User Manual for Portable Fire Extinguishers

5.2. MOBILE EQUIPMENT AND SELECTION OF FIRE EXTINGUISHERS

Mobile equipment represents the basic preventive measure for fire protection and is used for extinguishing fires in the initial stage. Under the standard JUS Z.C2.020, it includes handheld and transportable extinguishers. An extinguisher whose mass when filled is not greater than 20 kg represents handheld equipment. In order to ensure adequate preventive fire protection, it is necessary to select the appropriate fire extinguishing agent, type, capacity, number of extinguishers, and strategically distribute them in the facility based on specific criteria.

Criteria for assessing the vulnerability of the facility to fire are as follows:

- Size and layout of the facility,
- Purpose of individual rooms,
- Presence of flammable and hazardous materials, their storage, transportation, and handling,
- Fire load of individual rooms and the entire facility,
- Possible fire classes,
- Training of individuals present in handling fire extinguishing equipment, and
- Other conditions that affect the possibility of fire occurrence and spread.

Na osnovu sagledavanja navedenih kriterijuma, za predmetni objekt najoptimalnije rješenje je orijentacija na ručne prenosne aparate za gašenje požara i to:

1. Dry powder fire extinguisher, labeled with S.

Type of fire extinguisher: Dry powder	S-9
Weight of fully charged extinguisher (kg):	13,3
Filling capacity (kg):	9
Operating pressure (bar):	12-14
Continuous discharge time (seconds):	20
Jet range (m):	4-6
Container diameter (mm):	175
Total height (mm):	540

Table 12 - Characteristics of fire extinguisher, type S-9 k

2. Fire extinguisher, labeled CO₂.

Tehničke karakteristike	
Fire extinguisher type	CO₂ - 5
Container diameter (mm)	137
Total height (mm)	665
Capacity (l)	7,5
Weight of the full extinguisher (kg)	17,7
Test pressure (bar)	250
Operating pressure at 20°C (bar)	174
Material	34CrMo4
Dimensions (mm)	215x155x770

Table 13 - Characteristics of fire extinguisher, type CO₂ - 5 kg

To ensure adequate preventive fire protection for the subject facility, during operation, the following instructions should be followed:

- It is not permitted to store goods or deposit empty packaging on handling routes, as well as near entrances and exits.
- Regularly inspect the functionality of all electrical devices and fire protection equipment.

To ensure adequate preventive fire protection for the subject building, the following instructions should be followed during operation:

- It is not permitted to store goods or deposit empty packaging on handling routes, as well as near entrances and exits.
- Regularly inspect the functionality of all electrical devices and fire protection equipment.

Instructions for setting up fire extinguishers: Fire extinguishers are distributed and placed near potential fire outbreak areas, always in a visible and accessible location. All hand-held "S" extinguishers are mounted on the wall, at a height of 1 to 1.5 meters from the bottom of the extinguisher.

Maintenance of the appliances in use is classified and carried out in three categories of work: inspection of functionality, servicing, and control testing.

Inspection of the functionality of the fire extinguishers in use is performed periodically every six months after the expiration of the warranty period.

Servicing includes actions such as refilling after use or replacing worn or damaged parts identified during the functionality inspection.

Control testing is carried out in accordance with the provisions of standard JUS Z.C2. 022 point 2.2 and standards for individual types of fire extinguishers.

The time interval between two control tests must not exceed 5 years for all types of extinguishers. Carbon dioxide fire extinguishers are tested according to the Regulation on technical norms for movable closed vessels for compressed, liquid, and pressure-dissolved gases ("Official Gazette of the SFRY" No. 25/80).

The completed inspection of functionality and servicing is recorded in the control sheet.

A positive result of the control test should be visually marked on the extinguisher with a sticker containing the following information:

- Control tested, and
- Quarter and year of the performed test

5.3. CHOICE OF APPARATUS TYPE AND CAPACITY

Based on the consideration of the mentioned criteria, the most optimal solution for the subject object is to focus on handheld portable fire extinguishers, specifically:

- Dry powder fire extinguishers, marked as "S."
- Carbon dioxide (CO₂) fire extinguishers.

From this group, handheld extinguishers with capacities of S-9 and CO₂-5 are selected, which are compliant with standard SRPS Z.C2.035.

No.	Level	Type	
		S-9	CO ₂ -5
1.	Ground floor	3	1
2.	First floor	3	/
TOTAL		6	1

Table 14. Distribution and Type of Appliances in the Facility

To ensure adequate preventive fire protection for the subject object, the following instructions should be undertaken and adhered to during operation:

- On handling routes, as well as near entrances and exits, storage of goods and empty packaging is not permitted.
- Regularly check the functionality of all electrical devices and fire protection equipment.
- Instruction for the installation of appliances: Fire extinguishers are distributed and placed near potential fire outbreak areas, always in a visible and accessible location. All handheld "S" extinguishers are mounted on the wall, at a height of 1 to 1.5 meters from the ground, while CO₂ extinguishers are placed on the floor surface.
- Maintenance of appliances in use is categorized into three types of work: functionality inspection, servicing, and control testing.

Functionality inspection of fire extinguishers in use is carried out periodically every six months after the expiration of the warranty period.

Servicing includes actions such as refilling, after use, or replacement of worn or damaged parts identified during the functionality inspection.

Control testing is conducted in accordance with the provisions of standard SRPS Z.C2.022 point 2.2 and standards for individual types of fire extinguishers.

The time interval between two control tests must not exceed 5 years for all types of extinguishers. Carbon dioxide fire extinguishers are tested according to the Regulation on technical norms for movable closed vessels for compressed, liquid, and pressure-dissolved gases ("Official Gazette of the SFRY" No. 25/80).

Completed functionality inspection and servicing are recorded in the control sheet.

A positive result of the control test should be visually marked on the extinguisher with a sticker containing the following information:

- Control tested, and
- Quarter and year of the performed test.

6. FIRE PROCEDURE

Fire, as a natural phenomenon, can occur accidentally, practically in any part of the subject building, and its extent, duration, and consequences cannot be predetermined or predicted. As a primary preventive measure, it is necessary to implement rational design solutions that provide a higher level of safety for people and property. The basic concept of every designer includes the belief that in the event of a fire in the subject building, the most important thing is to ensure timely and safe evacuation of affected individuals, with the building itself being considered secondary, as it can be rebuilt. Fires along the power line route can occur due to:

- Use of open flames (smoking, etc.),
- Malfunction or overload of electrical devices and installations,
- Failure to adhere to necessary preventive measures when using welding, soldering, and cutting devices,
- Storage of materials prone to spontaneous combustion, and
- Intentional arson and similar acts.

From the perspective of fire protection, the following facts are primarily considered:

- Prevention of fire occurrence by implementing "active" or "primary" measures,
- Extinguishing fires in the early stages,
- Conducting the evacuation of affected individuals and valuable equipment,
- Suppressing and localizing fires, and
- Preserving the integrity and stability of the building.

✓ Prevention of fire occurrence in a building is most effectively achieved by using non-combustible building materials in structural elements during construction wherever possible. In this regard, it is desirable to replace easily ignitable materials with less combustible ones in terms of lower heat capacity. Another active measure includes reducing the total amount of combustible load in the building, which would decrease the temperature in the fire's core in the event of a fire. Care should also be taken to ensure that the source of heat is not near combustible objects.

✓ Extinguishing small pilot flames is possible with improvised means, sometimes even by stomping on the area where the flame originated. For extinguishing fires in the initial stage and their early elimination, it is best to use portable firefighting equipment that can be used by all individuals (including children, elderly, and disabled individuals).

✓ In the event that the fire could not be extinguished with one mobile device, but got out of control, it is necessary to carry out a larger intervention - a larger number of people with more equipment (apparatus for initial extinguishing and water from the internal hydrant network) should approach the extinguishing.

Also, in that case, by phone, it is necessary to notify:

- Rescue Service - fire department, at telephone number 123.
- Ministry of Internal Affairs, at telephone number 122, and if necessary, emergency medical services, at telephone number 124.

When reporting a fire, the following information should be provided to the Rescue and Protection Service - fire department or the Ministry of Internal Affairs:

- Precise location of the fire's origin,
- Brief description of what is burning and the size of the area affected by the fire,
- Exact information on whether there are any endangered individuals in the fire zone and the possibility of their endangerment,
- Name and surname of the person reporting the fire, and
- Telephone number from which the report is being made.

These details must be entirely accurate since based on the received information, the duty officer of the Rescue and Protection Service dispatches vehicles and equipment for the intervention, and depending on the intensity and size of the fire, notifies other emergency services: the Ministry of Internal Affairs and emergency medical services.

Firefighting should still offer prospects of success even when the fire covers a large area, several tens of square meters. At this stage, members of the professional fire department participate in firefighting, and the procedure is carried out in the following phases:

Phase I: If possible, disconnect electrical power and begin extinguishing the fire using handheld extinguishers or water from the hydrant network, if the burning material allows.

Phase II: Occurs when the fire cannot be extinguished by the methods used in the first phase. Upon the arrival of fire department personnel, they take over the management of the firefighting operation, carrying out necessary preparations and actions. All present are subordinate to the firefighting action commander, follow their instructions, and must not take independent actions.

Phase III: This phase occurs in the case of more intense fires when previous actions have not led to its extinction. The firefighting commander informs the fire department and their superiors via radio communication, requesting reinforcements in personnel and equipment. Until reinforcements arrive, and if necessary, other rescue teams, efforts are made to prevent further spread of the fire, utilizing all available firefighting means and equipment. Upon the arrival of the commander or their deputy, the firefighting action commander briefs their superiors on the current situation, and they then take command and lead the firefighting operation. All operatives are under their command, must not take independent actions, and are responsible for all actions until the fire is finally extinguished.

7. MEASUREMENT AND CALCULATION OF MANUAL APPARATUS FOR STARTING FIRE EXTINGUISHING

No.	Type of device	Pcs	Price(€)	Ukupno (€)
1.	Manual fire extinguishers type S-9	6		
2.	Manual apparatus for initial fire extinguishing CO2-5	1		
		CIJENA BEZ PDV-a:		
		PDV 21%:		
		UKUPNO:		

Note:

The estimate and calculation of the PP door is given in the Architecture Project.

The estimate of external overhead and internal wall hydrants is defined by the Main Project water supply and sewerage.

Authorized engineer:

Slavko Palibrk, Dipl. Eng. Occupational Safety

Associate Engineer:










Nikola šoć, BSc of Civil Engineering


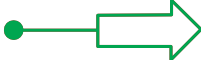
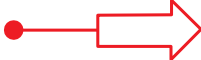
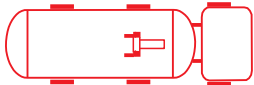
III GRAPHIC DOCUMENTATION

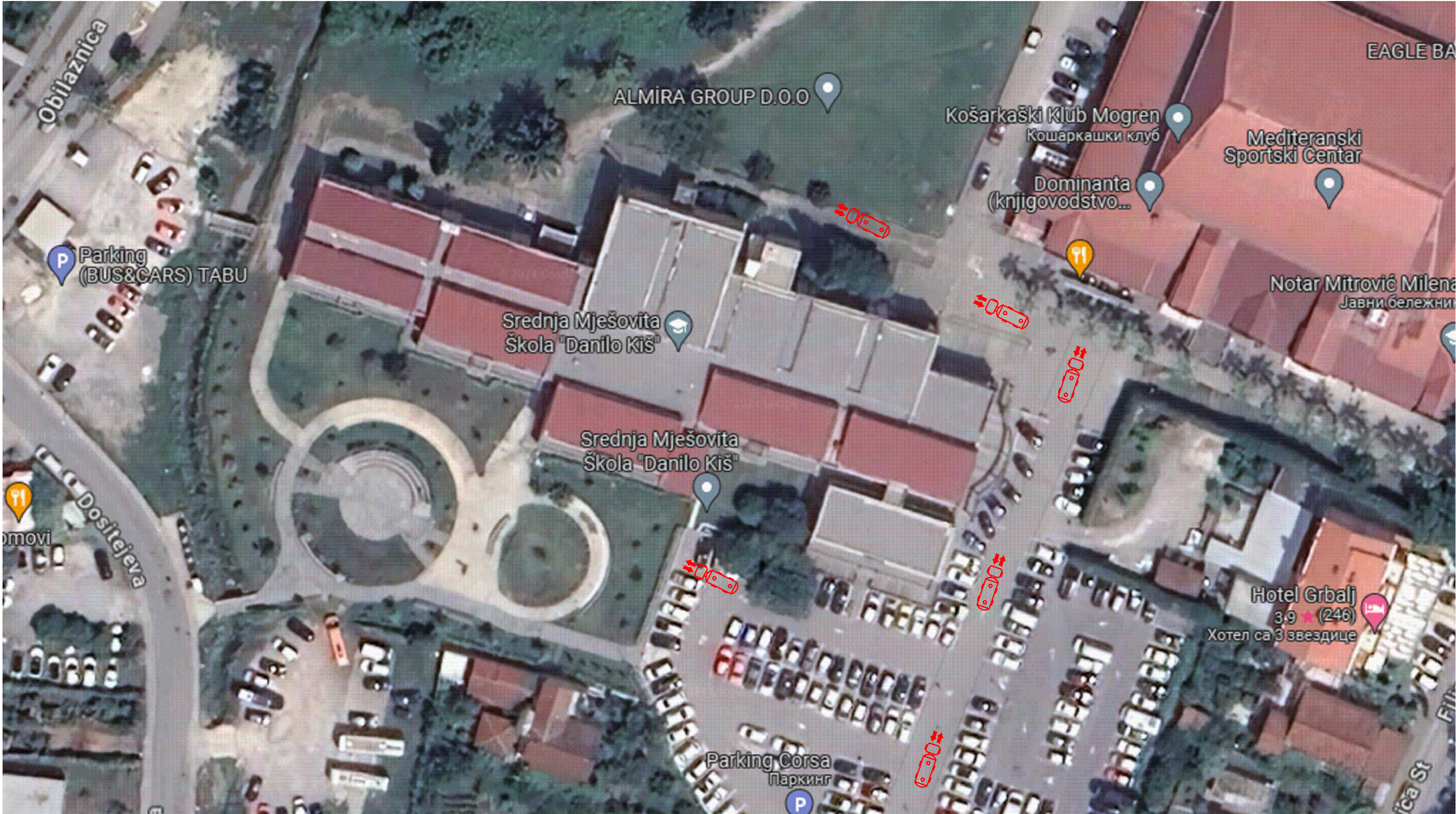
- Attachment I: SYMBOL EXCERPT FOR TECHNICAL SCHEME
- Attachment II: GROUND FLOOR PLAN OF THE SUBJECT BUILDING
- Attachment VII: FIRST FLOOR PLAN
- Attachment XII: CROSS SECTION

SYMBOLS FOR TECHNICAL SCHEME

JUS U.J1.220 ("Official Gazette of the SFRY", No. 56/81)

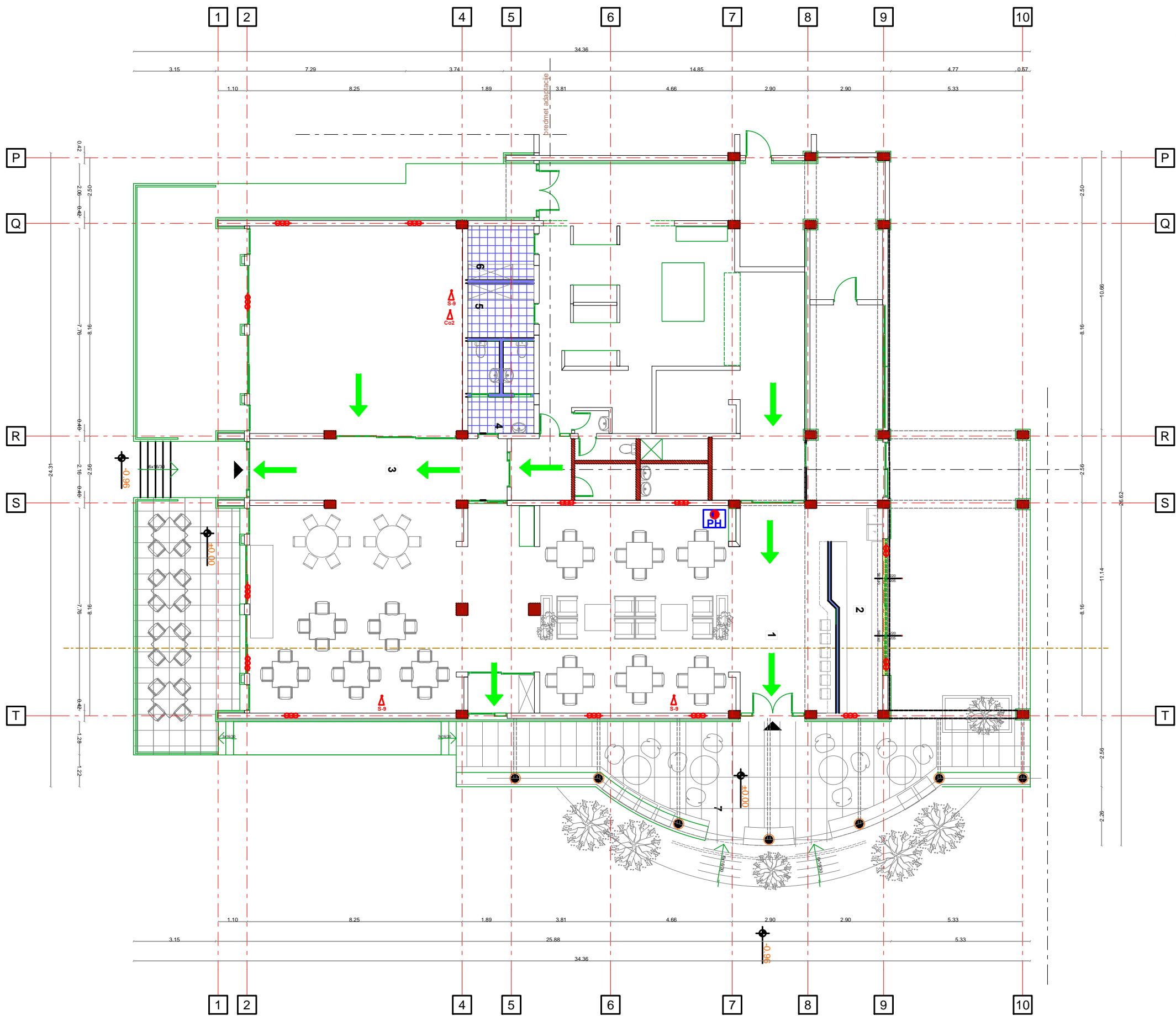
MEANING	SIMBOL-MARK
Walls and intermediate structures with a fire resistance of 1 hour	
Walls and intermediate structures with a fire resistance of 2 hours	
Walls and intermediate structures with a fire resistance of 3 hours	
Fire sector boundary	
Powder extinguisher S – 9 kg	
CO2 extinguisher-5	
Internal hydrant with pressure equipment	
Fire-resistant doors with a resistance of 1 hour	
Fire-resistant doors with a resistance of 1 and 1/2 hours	

Fire-resistant doors with a resistance of 1 hour	
Path and direction of normal evacuation	
Path and direction of fire vehicle	
Fire truck	



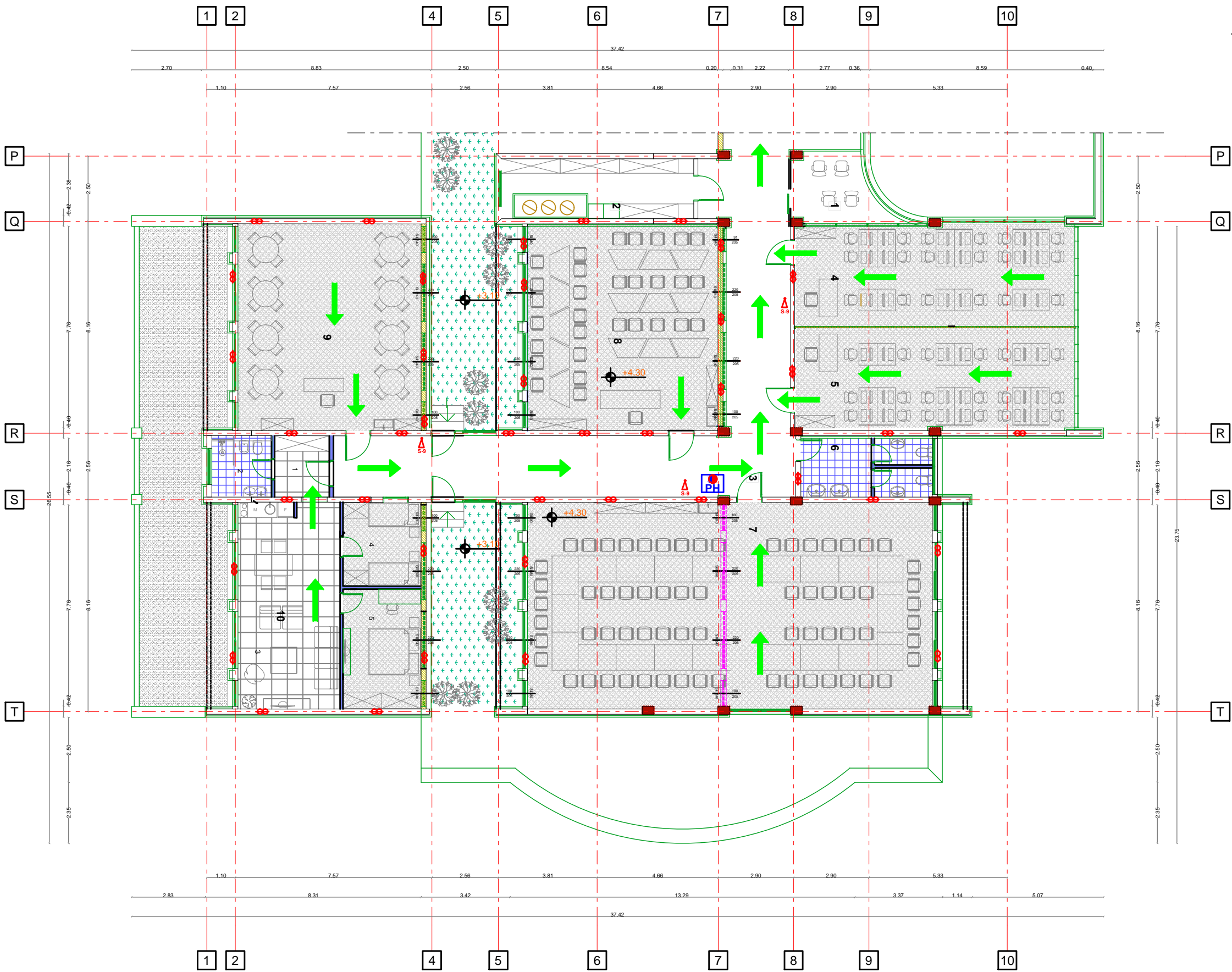
 Protivpožarno vozilo

PROJEKTANT: "DECOM MONTENEGRO" d.o.o. Ankarski bulevar br 16 81000 Podgorica		 INVESTITOR: Western Balkan Six Chamber Investment Forum Piazza della Borsa nr. 14 34121 Trieste, Italy	
Objekat: JU SMŠ "Danilo Kiš"		Lokacija: K.p. 1617/1 K.O. Budva, Budva	
Glavni inženjer: Zagorka Bozovic Pejanovic		Vrsta tehničke dokumentacije: Projekat adaptacije	
Odgovorni inženjer: Slavko Palibrk, dipl.inž.znr.		Dio tehničke dokumentacije: Elaborat zaštite od požara	
Saradnik/ci: Nikola Šoć Bsc.građ		Prilog: Situacija	Br.priloga 1
Datum izrade i M.P		Datum revizije i M.P	
Februar, 2024. godine			



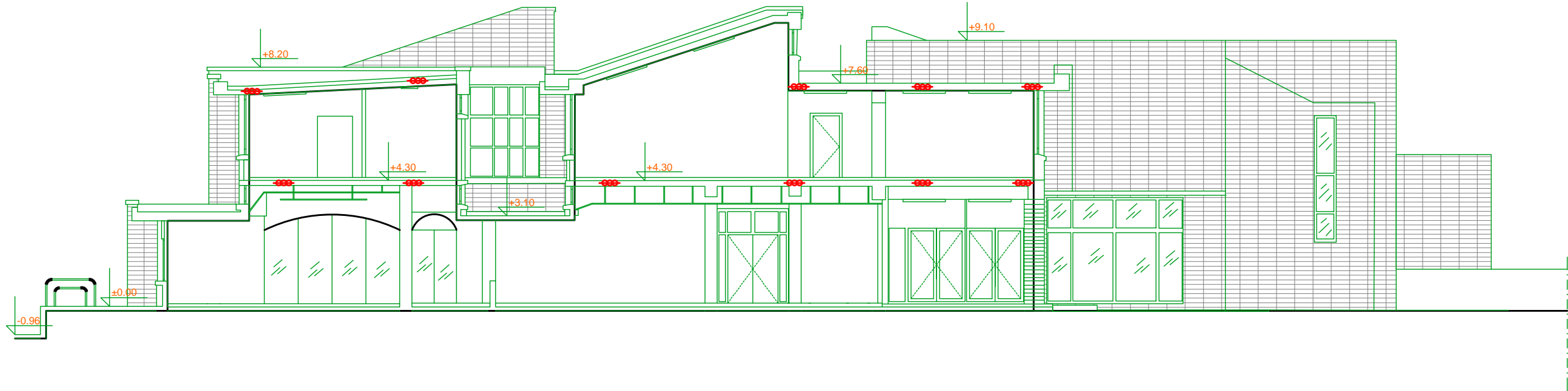
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Odgovorni inženjer: Slavko Palibrk, dipl.inž.znr.		Dio tehničke dokumentacije: Elaborat zaštite od požara	RAZMJERA:
Saradnik/ci: Nikola Šoć Bsc.građ		Prilog: Osnova prizemlja	Br.priloga 2 Br.strane
Datum izrade i M.P		Datum revizije i M.P	
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- osnova sprata -

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Odgovorni inženjer: Slavko Palibrk, dipl.inž.znr.		Dio tehničke dokumentacije: Elaborat zaštite od požara	RAZMJERA:
Saradnik/ci: Nikola Šoć Bsc.građ		Prilog: Osnova sprata	Br.priloga 3 Br.strane
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Saradnik/ci: Nikola Šoć Bsc.građ		Prilog: Presjek	Br.priloga 4 Br.strane
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