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1. OBJECTIVES

1.1 Scope of the report

This chapter deals with the general fire safety in the Llogar tunnel. The requirements of this report are implemented in other reports.

The fire safety report deals with single-tune tunnel Llogara with emergency tunnel and associated power stations in portal bulings

In accordance with the prepared documentation for the construction of Llogara tunnel adequate fire safety in the main tunnel tube is provided.

In the project documentation, the emergency tube of the tunnel is designed to meet the minimum conditions for ensuring safety, evacuation of tunnel users, access of ambulances and fire-fighting vehicles.

1.2 Scope / limitations

The fire safety report for tunnel in question mainly covers measures to ensure the safety of tunnel users (safety of passengers). The report does not specifically address the following emergencies or hazards:

- accidents resulting from unauthorized access to tunnel facilities or suicide,
- occupational accidents during maintenance,
- intentionally causing harm or terrorist acts.

Although the precautionary measures foreseen do not address these cases, they do limit the possible consequences of such actions due to similar disaster scenarios.

Environmental protection factors are considered in the context of environmental impact assessment.

2. REFERENCES

2.1 Codes and guidelines

- | | |
|------|--|
| [1] | Directive 2004/54/EC of the European parliament and of the council of 29 April 2004 on minimum safety requirements for tunnels in the Trans-European Road Network |
| [2] | RVS 03.01.11 Assessment of the traffic flow on roads |
| [3] | RVS 09.01.24 Structural equipment for operation and safety |
| [4] | RVS 09.02.22 Operations and maintenance |
| [5] | RVS 09.02.31 Road tunnel ventilation |
| [6] | RVS 09.03.11 Methodology of tunnel risk analysis |
| [7] | RVS 09.02.41 Tunnel Equipment – Lighting |
| [8] | RVS 09.01.45 Structural fire protection in road traffic structures |
| [9] | EN IC 62485-2 Safety requirements for secondary battery installations – Part 2: Stationary batteries |
| [10] | EN 13501-1 Fire classification of construction products and building elements - Classification using data from reaction to fire tests |
| [11] | EN 13501-2 Fire classification of construction products and building elements - Classification using data from fire resistance tests, excluding ventilation services |
| [12] | EN 13501-3 Fire classification of construction products and building elements - Classification using data from fire resistance tests on products and elements used in building service installations: fire resisting ducts and fire dampers |
| [13] | CFPA-E guideline Panic and emergency exit devices (2002/2004 European guideline) |
| [14] | EN IEC 61936-1 Power installations exceeding 1 kV a.c. - Part 1: Common rules |
| [15] | EN 3 Portable fire extinguishers |
| [16] | EN 54 Fire detection and fire alarm systems |
| [17] | VdS 2095 Guidelines for automatic fire detection and fire alarm systems - Planning and Installation |
| [18] | EN ISO 7010 Graphical symbols - Safety colours and safety signs - Registered safety signs |
| [19] | EN 60598-2-22 Luminaires - Part 2-22: Particular requirements - Luminaires for emergency lighting |
| [20] | EN 50171 Central power supply systems |
| [21] | EN 50172 Emergency escape lighting systems |
| [22] | EN 1838 Lighting applications - Emergency lighting |
| [23] | EN 179 Building hardware - Emergency exit devices operated by a lever handle or push pad, for use on escape routes - Requirements and test methods |
| [24] | EN 1125 Building hardware - Panic exit devices operated by a horizontal bar, for use on escape routes - Requirements and test methods |

[25] EN 13637 Building hardware - Electrically controlled exit systems for use on escape routes - Requirements and test methods

2.2 Annex

- a) SUMMARY OF FIRE SAFETY MEASURES: Llogara tunnel
- b) SUMMARY OF FIRE SAFETY MEASURES: North portal building
- c) SUMMARY OF FIRE SAFETY MEASURES: South portal building

3. DESCRIPTION OF THE FACILITIES

The fire safety study deals with fire safety for Llogara tunnel and the associated portal buildings. The Llogara tunnel comprises two tubes, the main tube for bi-directional traffic and service tube which serves also as emergency escape tunnel. These two tubes are mainly parallel with an axial distance of 40m which is reduced near the portals to reduce the size of the portal cuts.

The main tunnel tube has a length of approximately 5,99 km. Coming from North the vertical alignment of the tunnel has an ascending grade reaching the highest point of the tunnel approximately 160 m from the portal and descends from there with 0.6% continuously to the South portal.

The parallel emergency tunnel tube is approximately the same length. Both tubes are connected with 11 cross-sections intended for the evacuation of tunnel users and access for rescue services in case of an accident.

The regular cross section of the traffic tunnel is characterized by 2 x 3.5 m wide carriageway and 0.35 m wide side strips on each side of the carriageway. Also, each side has a 1.17m wide elevated walkway. Under the walkway there are two cable trenches.

The main clearance section is 7,70 m wide and 4,70 m high. The upper part of the section includes an exhaust air duct with a section of 11,54m².

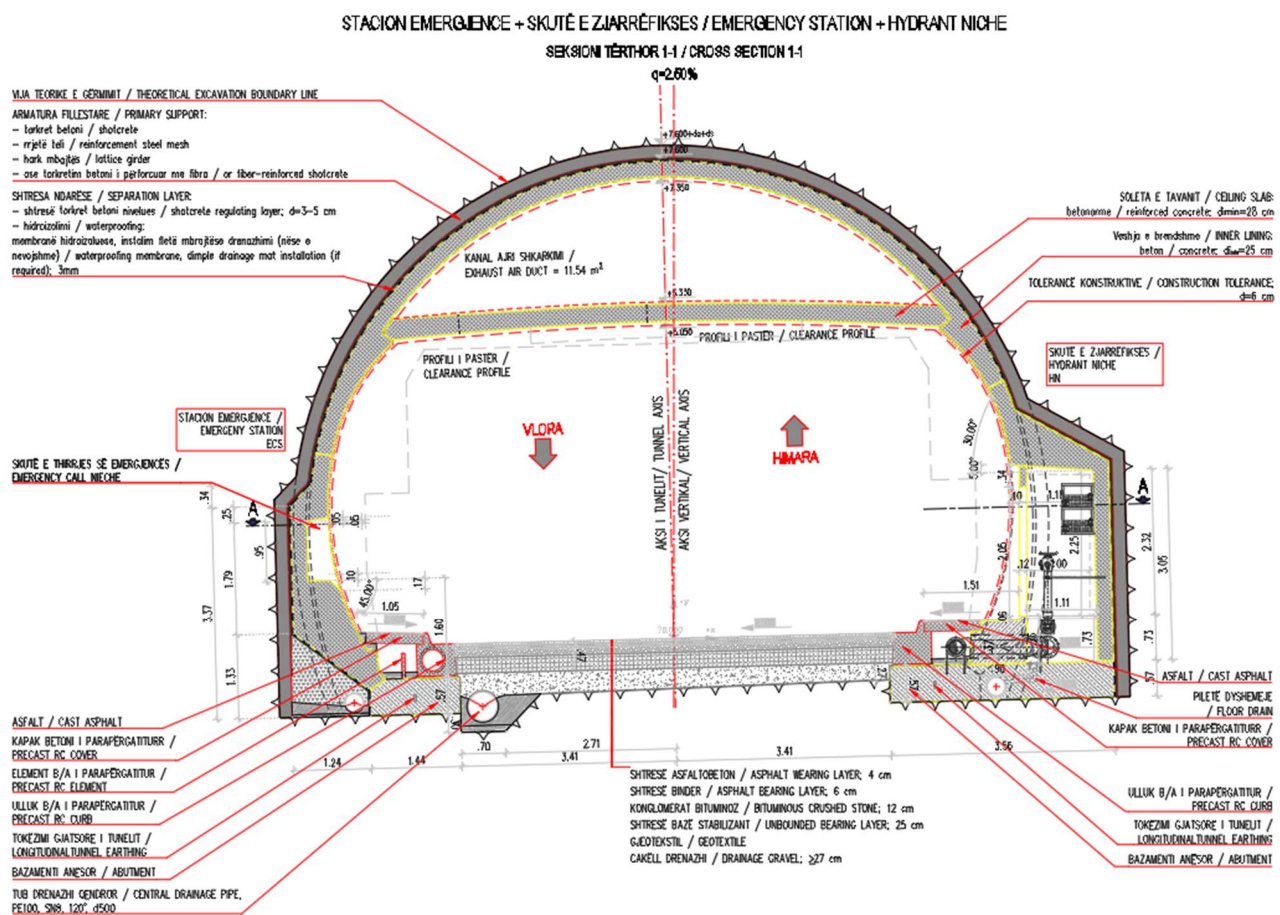


Figure 1: Cross section of the main tunnel at emergency station and hydrant niche

The tunnel section is built up by a primary lining mainly from sprayed concrete and rock bolts and a secondary lining of unreinforced cast concrete. Between the primary and secondary lining there is a waterproofing system which drains mountain water to a longitudinal drainage system which will mainly take ingress water to the South portal. The drainage system consists of two lateral drainage pipes and one central pipe which

collects the water from the lateral ducts.

The main tunnel has 11 lay-by niches, where 5 are on the east side of the carriageway for the northbound traffic and 6 are on the west side for the south-bound traffic. The cross section of the layby niche is a widened regular section by approximately 3,0 m to provide space for emergency parking.

Between the main tunnel and the emergency escape tunnel there are 11 cross-passages at a distance of 500 m between each of them. 5 of them (called EQ) are designed for the use by emergency vehicles, that means equipped with wider doors. The other 6 cross passages are designed for the passage of pedestrians (called GQ) with smaller doors. However, the GQ sections are identical as the EQ sections.

The emergency tunnel has main clearance section of 3,50 m wide and 4,00 m high. At the cross-passages the emergency tunnel is cross section is approximately 3,0 m wider to provide space for emergency vehicles parking and in the case of EQ cross-passages for turning emergency vehicles into the cross-passage.

4. NUMBER OF PEOPLE IN THE TUNNEL AND PORTAL BUILDINGS

4.1 Number of people in the tunnel

The tunnel in question is intended for road traffic for cars and trucks. The traffic in the tunnel will be bidirectional, which is less safe from traffic and fire safety point of view of than in the case of two-tube tunnels with unidirectional traffic.

The traffic data is an important parameter in estimating the numbers of people in the tunnel at the time of the accident with fire. The data is picked from the general report "Review of Feasibility Study and Drafting of the Detailed Engineering Project, Construction of Llogara Tunnel". The traffic forecast is based on Traffic survey includes the comprehensive transport pattern survey, road network survey, relevant road condition survey, and the relevant road section traffic volume observation.

The traffic volumes are very low. The road segment is mainly used in summer months. In winter season the traffic is significantly lower.

For estimating the maximum number of persons in the tunnel the following data from traffic forecast are used:

- Year: 2034
- Annual average daily traffic: AADT = 10.999 veh/day
- Peak hour traffic (30th hour): PHT₃₀ = 1.444 veh/h (both directions)
- Peak hour traffic (30th hour): PHT_{30,p} = 828 veh/h (in the predominant direction)
- Peak hour traffic (30th hour): PHT_{30,l} = 1.444 - 828 = 616 veh/h (in the direction with less traffic)
- The share of each type of vehicle is as follows:
 - o Passenger cars (with 1,8 persons per vehicle): 75%
 - o Vans (with 2,5 persons per vehicle): 8%
 - o Minibuses (with 10 persons per vehicle): 4%
 - o Buses (with 40 persons per vehicle): 7%
 - o Trucks (with 1,0 persons per vehicle): 6%

The number of vehicles stuck due to a traffic accident can be estimated based on chapter 3.11.1.10.2 Bestimmung der Anzahl der Fahrzeuge im Tunnel avstrijskih smernic Tunnel - Lüftung (TLü) Technische Richtlinie:

The total number of vehicles at a standstill: $N_v = N_{v1} + N_{v2}$

Number of vehicles in the tunnel at the time of the accident: $N_{v1} = (PHT_{30}/3.600) \times (L/v_{max})$

Number of vehicles entering the tunnel within 3 minutes after the accident: $N_{v2} = (PHT_{30}/3600) \times 180$

L ... length from the beginning of the tunnel to the site of the accident

v_{max} ... maximal velocity (80 km/h = 22,22 m/s)

A critical example is the accident just before exiting the tunnel in the direction of the prevailing traffic ($L_p = 5.800$ m). The number of persons left in the tunnel on the side of the predominant traffic in case of an accident:

$$N_{v1,p} = (828/3.600) \times (5.800/22,22) = 60,0$$

$$N_{v2,p} = 828/3600 \times 180 = 41,4$$

$N_{v,p} = 101,4$, this means that there will be about the following number of people in the tunnel during the summer rush hour in case of an accident on the side of the predominant traffic:

$$N_{p,p} = N_{v,p} \times (0,75 \times 1,8 + 0,08 \times 2,5 + 0,04 \times 10 + 0,07 \times 40 + 0,06 \times 1,0) = 488$$

The number of people who will remain on the side of the tunnel with less traffic:

$$L_l = L_{\text{tunnel}} - L_p = 5971,15 - 5.800 = 171,15 \text{ m}$$

$$N_{v1,l} = (616/3.600) \times (171,15 / 22,22) = 1,3$$

$$N_{v2,l} = 616/3600 \times 180 = 30,8$$

$N_{v,l} = 32,1$, it should be taken into account that the congestion on the side with less traffic will extend beyond the portal of the tunnel. The density of vehicles in congestion is: $D_0 = 150$ passenger cars / km (also applies to vans and minibuses).

$$L_{\text{car}} = 1.000 / 150 = 6,67 \text{ m}$$

For the length of trucks and buses we take: $L_{\text{truck}} = 2,5 \times L_{\text{car}} = 16,67 \text{ m}$.

Total share of passenger cars, vans and minibuses is: $75 + 8 + 4 = 87\%$

Total share of buses and trucks is: 13%

The length of the congestion is therefore: $32,1 \times (0,87 \times 6,67 + 0,13 \times 16,67) = 255,73 \text{ m}$

The tunnel the congestion will be 171.15 m long with: $N_{v,l,t} = 32,1 \times 171,15 / 255,73 = 21,5$ vehicles

This means that there will be about the following number of people in the tunnel during the summer rush hour in case of an accident on the side of the less traffic:

$$N_{p,l} = N_{v,l,t} \times (0,75 \times 1,8 + 0,08 \times 2,5 + 0,04 \times 10 + 0,07 \times 40 + 0,06 \times 1,0) = 103$$

The total estimated number of people in the tunnel in the event of a fire accident: $N_p = 488 + 103 = 591$

4.2 Number of people in the portal buildings

Up to 5 people will be present in the south portal building during occasional maintenance and overhauls (facility without permanent crew).

Up to 10 people are regularly present in the north portal building.

5. FIRE HAZARDS IN THE FACILITY

A fire in a tunnel is most often the result of traffic accidents. Truck fires can also be the result of brake overload, technical deficiencies of vehicles, spillage of dangerous liquids or self-ignition of loaded goods.

The fire in the road tunnel can spread quite quickly, as the removal of heat and flue gases is prevented, so there is relatively little time for evacuation. The escape of vehicles left in front of the crash site, which resulted in a fire, is impossible.

Large amounts of smoke are generated during a vehicle fire. Poor visibility can lead to panic, which makes evacuation even more difficult. Fatal fires in tunnels are usually associated with suffocation or poisoning by toxic gases. As a result, longer tunnels require ventilation during normal operation to reduce carbon monoxide concentrations, as well as flue gas and heat dissipation during fires. Due to the difficulty of heat dissipation in a tunnel fire, temperatures can be very high, which can lead to damage to the tunnel structure. In this case, in addition to human casualties, there is also greater material damage.

In the case of passenger car fires, we expect fires of up to 5 MW, while in the case of bus (20 - 30 MW) and truck (30 MW and more) accidents, the fire is significantly higher. In the tunnel, fires are also possible in technical rooms (electrical niches), which are the result of overloading devices or improper maintenance. The same is true for power station fires. Potential ignition sources in power plants are:

- Electrical protection failures, insulation breakdown due to conductor overload,
- Inadequate ventilation of the AKU space (possibility of cup gas formation),
- Transformer overloads, protection failure, insulation oil ignition.

Table 1: List and description of fire-hazardous areas, devices and operations

Nr.	Fire hazardous areas	Number of areas	Layout (lacion)	Equipment and devices	Dangerous operations
1.	Main tunnel tube	1	Traffic tunnel tube	Cars, buses, trucks	Driving too fast, overloading trucks or their equipment, self-ignition of loaded goods, spills of dangerous liquids
2.	Tunnel trenches	2	Levo in desno pod vzdrževalnim hodnikom	Cables, switches, insulation	Cable overloads, cable wear, short circuits
3.	Electrical rooms in the tunnel	18	In lay-by niches (5 transformer rooms, 5 middle voltage rooms, 5 low voltage rooms)	Cables, switches, power transformers	Cable overloads, short circuits
4.	Command room	2	Portal building north	Switches, cables, transformers	Cable overloads, short circuits
5.	Battery rooms	2	Portal buildings north (1) and south (1)	Batteries	Overloads, acid spills, incorrect filling or emptying procedures, explosion due to accumulation of hydrogen in the room
6.	Low voltage rooms	2	Portal buildings north (1) and south (1)	Cables, switches, transformers	Preobremenitve kablov, kratki stiki
7.	Transformer rooms	4	Portal buildings north (2) and south (2)	Power transformers	Cable overloads, short circuits, dry power transformers without oil
8.	Middle voltage rooms	2	Portal buildings north (1) and south (1)	Cables, switches, transformers	Cable overloads, short circuits
9.	System and telecommunication rooms	3	Portal buildings north (1) and south (2)	Cables, switches, transformers	Cable overloads, short circuits

6. FIRE SAFETY MEASURES

Fire protection in the tunnel and power plant relies on:

- Application of passive construction measures,
- Use active fire protection measures
- Application of systemic organizational measures of fire protection.

The concept of fire protection is based on the length of the tunnel, the number of tunnel pipes, the cross section of the tunnel pipe, the traffic density and the construction materials used.

6.1 Passive fire safety measures

Measures to ensure passive fire safety derive from the construction design of buildings and structures:

6.1.1 Location of facilities and necessary distances to other facilities

The tunnel is an underground civil engineering structure, so distances to neighboring buildings are not relevant from the point of view of fire safety.

The power stations (portal buildings) are built from reinforced concrete, which partly lean on the hill in front of the southern and northern portals. There are no other buildings in the immediate vicinity. The planned external walls of the portal buildings are made of materials with classification A1 / A2 according to EN 13501-1 and demonstrate fire resistance rating of at least EI60 (except for door openings to the outside that do not have fire resistance) or EI90 (toward the tunnel). There are no combustible coatings on the outer walls.

The distances of the portal buildings to neighbouring buildings are such that there is no possibility of fire transmission to neighboring facilities.

6.1.2 Fire resistance rating of the load-bearing structure

Facilities must be designed, built and maintained in such a way that their load-bearing structure retains the required load-bearing capacity in the event of a fire during the time period specified for each group of facilities by fire safety regulations for facilities.

The internal lining in the tunnel is not the load-bearing structure of the tunnel but a concrete arch, which represents the facade of the tunnel and has the purpose of protecting against water intrusion into the tunnel.

The load-bearing structure of the tunnel is the result of the interaction of the self-supporting rock and the primary substructure of the tunnel (outer cladding), which is formed by the cladding of injection-molded concrete, reinforcing mesh and anchors. When excavating the tunnel, a primary substructure (outer lining) is installed at the same time, which brings the tunnel to balance, which is also confirmed by observing the displacements of the lining until they are destroyed. Only after the balance is reached do we build a secondary (internal) lining.

In the fire-safety sense, the load-bearing structure of the tunnel (outer lining + self-supporting rock) is therefore protected by an inner lining. Rock is a highly fire-inert material and the probability of losing its mechanical properties in depth due to fire is negligible.

The inner lining of the tunnel is reinforced with polypropylene fibers that prevent explosive peeling of concrete.

In the area where the rock is not self-supporting (areas with a small overhang), it is necessary to ensure the fire resistance of the load-bearing structure R (EI) 90 (portal area).

A reinforced concrete load-bearing structure with a fire resistance of REI60/90 is provided for the portal buildings.

6.1.3 Materials used

A concrete carriageway is provided in the tunnel tube. For the walls and ceiling in the tunnel, non-combustible building materials and products of class A1 or A2-s2, d0 according to EN 13501-1 shall be used.

Classification of Bfl-s1 according to EN 13501-1 is required for pavement asphalt.

The load-bearing structure of the power plant is reinforced concrete. Transformers are installed in reinforced concrete transformer boxes (A1 or A2). For rooms with high-voltage installations, walls and ceilings of class A1 / A2 are required, and for floors at least C, B or A (Cfl, Bfl, Afl), which is met in our case.

For battery rooms, the provisions of EN IEC 62485-2: 2018 on floor resistance to a groundable point when measured in accordance with IEC 61340-4-1 shall be between 50 kΩ and 10 MΩ, retention volume requirements for spilled liquids and resistance to acids must be observed.

6.1.4 Fire compartments

Fire compartments are determined as follows:

- Each tunnel tube (except electrical rooms, cable trenches and cross-passages) is one fire compartment,
- Electrical rooms form their own fire compartments,
- Cable trenches for installations in each main tunnel side are fire separated from carriageway with fire rated covers (EI90), trenches are not in the table of fire compartments,
- Each cross-passage is its own fire compartment,
- Technical rooms in portal building are separated into fire compartments.

Table 2: Separation of the tunnel and portal buildings into fire compartments:

Nr.	Fire compartment code	Fire compartment name	Area [m ²]	Type of combustible substances in area	Specific fire load [MJ/m ²]	Nevarnost za nastanek požara	Expected rate of fire development
Tunnel Llogara							
1.	FC-MT	Main tunnel tube (km 0+411,700 m to km 5+971,150 m)	60.000	Cars, buses and trucks with their load and fuel	<150 low, in the congestion > 3.000 high	Low	Slow in minor breakdowns and accidents, fast in fires of lorries and dangerous goods vehicles
2.	FC-ET	Emergency tunnel tube (km 0+140,000 m to km 6+156,090 m)	35.000	/	<150 low	Negligible	There is no possibility of fire development

Nr.	Fire compartment code	Fire compartment name	Area [m ²]	Type of combustible substances in area	Specific fire load [MJ/m ²]	Nevarnost za nastanek požara	Expected rate of fire development
3.	FC-GQ1, FC-GQ2, FC-GQ3, FC-GQ4, FC-GQ5, FC-GQ6	Cross-passages for pedestrians at: km 0+505,75 m, km 1+505,75 m, km 2+505,75 m, km 3+505,75 m, km 4+505,75 m, km 5+505,75 m	200	Low quantity of cables and switches	<150 low	Negligible	There is no possibility of fire development
4.	FC-EQ1, FC-EQ2, FC-EQ3, FC-EQ4, FC-EQ5	Cross-passages for emergency vehicles at: km 1+047,75 m, km 2+047,75 m, km 3+047,75 m, km 4+047,75 m, km 5+047,75 m	200	Low quantity of cables and switches	<150 low	Negligible	There is no possibility of fire development
5.	FC-EAREA1, FC-EAREA2, FC-EAREA3, FC-EAREA4, FC-EAREA5	Electrical niches at: km 1+047,75 m, km 2+047,75 m, km 3+047,75 m, km 4+047,75 m, km 5+047,75 m	46	Cables, switches, transformers	400 – 500 Medium	Normal	Slow to moderate
6.	FC-MVAREA1, FC-MVAREA2, FC-MVAREA3, FC-MVAREA4, FC-MVAREA5	Medium voltage rooms at: km 1+047,75 m, km 2+047,75 m, km 3+047,75 m, km 4+047,75 m, km 5+047,75 m	7	Cables, switches, transformers	400 – 500 Medium	Normal	Moderate to fast in case of short circuits

Nr.	Fire compartment code	Fire compartment name	Area [m ²]	Type of combustible substances in area	Specific fire load [MJ/m ²]	Nevarnost za nastanek požara	Expected rate of fire development
7.	FC-TRAN1, FC-TRAN2, FC-TRAN3, FC-TRAN4, FC-TRAN5	Medium voltage rooms at: km 1+047,75 m, km 2+047,75 m, km 3+047,75 m, km 4+047,75 m, km 5+047,75 m	7	Dry power transformers	400 – 500 Medium	Normal	Fast in case of short circuits
<i>North portal building</i>							
1.	FC-LVOL	Low voltage room	19	Cables, switches, transformers	400 – 500 Medium	Normal	Slow to moderate
2.	FC-MVOL	Medium voltage room	19	Cables, switches, transformers	400 – 500 Medium	Normal	Moderate to fast in case of short circuits
3.	FC-TR1	Transformer room 1	19	Dry power transformers	400 – 500 Medium	Normal	Fast in case of short circuits
4.	FC-TR2	Transformer room 2	19	Dry power transformers	400 – 500 Medium	Normal	Fast in case of short circuits
5.	FC-MT	Ventilation room with heat and smoke exhaust duct – actually part of main tunnel fire compartment	48	Heat and smoke exhaust fan with drive and equipment	400 – 500 Medium	Normal	Moderate to fast in case of short circuits
6.	FC-FD	Premises for firefighters	68	equipment for fire fighters, furniture, beds, wardrobe	150 – 500 Low to medium	Normal	Moderate
7.	FC-BATT	Battery room	12	Batteries, cables, switches	350 Low to medium	Normal	Fast in case of hydrogen explosions
8.	FC-KORR	Entrance with stairs and hallway in ground and 1 st floor	68	/	<150	Negligible	There is no possibility of fire development

Nr.	Fire compartment code	Fire compartment name	Area [m ²]	Type of combustible substances in area	Specific fire load [MJ/m ²]	Nevarnost za nastanek požara	Expected rate of fire development
9.	FC-COMM	Command room with system room	118	Electrical control cabinets for tunnel control	400 – 500 Medium	Normal	Slow to moderate
10.	FC-WARE	Warehouse	51	Stored material	800 Medium to high on the stored goods	Normal	Moderate
<i>South portal building</i>							
1.	FC-LVOL	Low voltage room	21	Cables, switches, transformers	400 – 500 Medium	Normal	Slow to moderate
2.	FC-MVOL	Medium voltage room	21	Cables, switches, transformers	400 – 500 Medium	Normal	Moderate to fast in case of short circuits
3.	FC-TR1	Transformer room 1	21	Dry power transformers	400 – 500 Medium	Normal	Fast in case of short circuits
4.	FC-TR2	Transformer room 2	21	Dry power transformers	400 – 500 Medium	Normal	Fast in case of short circuits
5.	FC-MT	Ventilation room with heat and smoke exhaust duct – actually part of main tunnel fire compartment	102	Heat and smoke exhaust fan with drive and equipment	400 – 500 Medium	Normal	Moderate to fast in case of short circuits
6.	FC-BATT	Battery room	12	Batteries, cables, switches	350 Low to medium	Normal	Fast in case of hydrogen explosions
7.	FC-KORR	Entrance with stairs and hallway in underground floor	60	/	<150	Negligible	There is no possibility of fire development
8.	FC-UPS	Uninterrupted power supply system room	20	Transformers, switches, cables	350 Low to Medium	Normal	Moderate
9.	FC-SYST	System room	31	Electrical control cabinets for tunnel control	400 - 500 Medium	Normal	Moderate

Nr.	Fire compartment code	Fire compartment name	Area [m ²]	Type of combustible substances in area	Specific fire load [MJ/m ²]	Nevarnost za nastanek požara	Expected rate of fire development
10.	FC-CKM	cable trench to the main tunnel	15	cables	800 Medium	Normal	Slow in case burning low voltage cables, fast in case of power cables
11.	FC-CKE	cable trench to the emergency tunnel	15	cables	800 Medium	Normal	Slow in case burning low voltage cables, fast in case of power cables

6.1.5 Fire resistance ratings at the boundaries of fire compartments

The walls at the boundaries of the fire sectors in the tunnel must demonstrate fire resistance rating of (R)EI 90. This applies to the walls between the electrical rooms and the tunnel carriageway and cable trenches manhole covers and tunnel carriageway. Penetrations of installations between the listed fire compartments are subject to the requirement of 90 minutes fire resistance (E90 according to RVS 09.02.22).

The fire resistance rating of the doors at the boundaries of the fire compartments in the tunnel (resistance of doors to electrical rooms) must be EI₂90-C3 (RVS 09.02.22 point 9.13) and for transformer rooms EI₂90 (without self closing mechanism).

In the case of closed cross-passages, the EI₂30-C3 door fire resistance rating requirement applies in accordance with RVS 09.02.22.

The walls separating the individual fire compartments in the portal building must show fire resistance rating EI60 (in accordance with SIST EN 61936-1). EI₂60-C3 is required for doors to the individual compartment in the building. There are no special requirements for doors to the outside (ventilation grilles can be installed in the door).

6.1.6 Tunnel elements important for fire safety

The following elements that affect the fire safety of users are provided in the tunnel:

6.1.6.1 CROSS-PASSAGES:

According to the RVS 09.01.24 guidelines, cross-passages for pedestrians must be provided in all tunnels longer than 500 m, and cross-passages for emergency vehicles in tunnels longer than 1000 m. The distance between the cross-passages should not exceed 500 m.

As the Llogara tunnel is longer than 1000 m, the following types of cross-passages are planned:

- 6 GQ cross-passages for pedestrians
- 5 EQ cross-passages for emergency vehicles

Distances between individual cross-passages are 500 m.

6.1.6.2 LAY-BY NICHES:

According to the RVS 09.01.24 guidelines, cross-passages for pedestrians must be provided in all tunnels longer than 1000 m. The distance between the lay-by niches should not exceed 1000 m. In the case of bi-directional traffic lay-by niches must be on both sides of the tunnel tube.

In our case, 11 lay-by niches are foreseen. 6 lay-by niches are provided on the right side of the tunnel (seen from north to south) along the GQ cross-passages, and 5 lay-by niches are provided on the left side of the tunnel (seen from north to south) opposite the EQ cross-passages.

6.1.6.3 FIRE FIGHTING NICHES:

According to the RVS 09.01.24 guidelines, fire fighting niches must be provided in all tunnels longer than 500 m. The distance between the fire fighting niches should not exceed 125 m. In our case 57 fire fighting niches is provided. They are located at a distance of less than 125 m from each other on the right side of the tunnel (seen from north to south). Additional niches are provided in the lay-by niches (on both sides of the tunnel). Hydrants that are installed in these niches, can also be used by tunnel users (TLA hydrants with foam and DN25 pipe).

6.1.6.4 EMERGENCY CALL NICHES / EMERGENCY CALL STATIONS

They are mandatory in tunnels longer than 500 m (requirement of RVS 09.01.24). Their mutual distance is usually 125 m, and they must not be more than 125 m away from the portals. As the tunnel is longer than 500 m, an emergency call system is provided in our case. There are 58 emergency call niches and emergency call stations in the tunnel. Niches and emergency call cabinets are located on the left side (opposite of the fire fighting niches) of the tunnel tube viewed in the direction south. Emergency call posts are also provided on both tunnel portals.

6.2 ACTIVE MEASURES TO ENSURE FIRE SAFETY

6.2.1 Ventilation with heat and smoke exhaust

When designing ventilation, it is necessary to take into account Directive 2004/54 / EC of the European Parliament and of the Council of 29.4.2004 on minimum safety requirements for tunnels in the trans-European road network and Austrian guidelines for tunnel equipment RVS 09.02.22 and ventilation RVS 09.02.31 and RVS 09.02 .32. In accordance with RVS 09.02.31, forced ventilation in tunnels with two-way traffic must be installed at a tunnel length over 500 m. As the Llogar tunnel is longer than 3.000 m, forced semi-transverse ventilation is provided. Ventilation is provided for normal operation (for dilution of pollutants by fresh air) and and in case of fire.

The Llogara tunnel will be designed with a semi-transverse ventilation system with an associated exhaust duct. The duct is connected to ventilation stations, one each portal. Where each an axial fan is located. Dampers in the false ceiling between the carriageway and the air duct have a standard distance of 100 m. In case of fire the smoke can be punctually extracted in a very efficient way. Air quality and air speed sensors are installed in carriageway. The jet fans are placed in bays outside clearance (like lay-by).

The main tunnel is divided into 59 fire zones at a distance of 100 m, 58 heat and smoke exhaust dampers will be installed. Two exhaust fans in the portal buildings for air flows of 165 m³/s (hot gases), with shaft power of 550 kW are foreseen. 2 x 5 jet fans in the main tunnel to achieve air flow 1,2 m/s towards the fire site, with the shaft power of 90 kW are foreseen. 2 x 3 jet fans in the emergency tunnel for fresh air supply, with shaft power of 30 kW are foreseen.

Smoke and heat extraction fans and jets fans in tunnel shall meet the requirements of EN 12101-3 (class F400): operating time 120 minutes at 400°C.

During fire procedures a semi-transverse ventilation system combined with jet fans in carriageway is used for nearly all fire zones. Only the two fire zones at portals are using a longitudinal ventilation (fire zone FZ01 and FZ59 with flow direction to the outside).

Several redundancy procedures are included in the ventilation system to ensure a safe evacuation during fire scenario even if parts of system are down. If a part of the systems fails another component can take over the function with no or a very little loss in safety.

- Dampers are multiple redundant – if one fails the next in flow direction will open
- Air speed sensors are multiple redundant – if one section fails the next priority will be used (2 times)
- Jet fans – if one fails the system can perform a fire ventilation but in some cases with few restrictions
- Axial fans – if one or both axial fans fail, a longitudinal ventilation system is performed for all fire zones. The performance of the ventilation is restricted.

The fire procedures will be done in automatic stages from PLC System (a manual intervention on request is always be possible from the tunnel operator) by one or more closed loop controllers.

In case of fire smoke will be extracted right at fire location through one damper. The nearest to the fire will open, all others will be closed. If the fire location is near the portal only one axial fan is used for extraction. At other locations both fans are used together. The volume flow will be split on both fans. The ratio is depending on exact extraction location. A balance between volume flow and pressure rise is needed.

All equipment in the exhaust air duct (including control and monitoring) must be resistant to a temperature of 400°C for a period of 120 min. The construction must not be mechanically destroyed up to a temperature of 750°C for 60 minutes. The flaps, the operating units and all associated equipment as well as the supply and control lines shall operate without restriction for at least 120 minutes at a temperature of 400°C.

During fire procedures the jet fans in the direct area of fire or in the possible smoke area must remain switched off to avoid destroying the smoke layer. This is be done automatically by the control system.

In order to achieve the correct results for fire procedures, it is necessary to detect the fire at the correct location.

According to RVS the smoke extraction must be designed for extraction during a fire event. The smoke in the carriageway must be extracted at any point of exhaust air duct via the dampers in a section of 150 m with a volume flow of at least 120 m³/s (related to the density corresponding to the sea level of the tunnel according to DIN ISO 2533). The air flow to the extraction point (damper) inside carriageway should be half each side and at minimum 1.2 m/s during bidirectional use. The Llogara tunnel is designed for a fire load of 30 MW.

The average air speed in the open damper must not exceed 25 m/s. The damper size is 4 x 3 m, with a minimum free area of 9.6 m². This results in an average air speed through the damper of 20 m/s.

The cross passages will be built as air locks separated by walls, one each side. Every air lock will be pressurized by a separate ventilation system. The fresh air needed will be drawn from service tube. In portal area of the service tubes are dampers to provide sufficient fresh air. With this system the escape routes can be kept smoke-free in all operating situations. Regulated overpressure between the main tube and the cross passage is in a range of 30 to 40 Pa. Smoke cannot enter through leakage. The cross passage keeps a safe area, also during fire. When the door to main tube is open fresh air flows through this door (design velocity is 1 m/s with direction to main tube) to prevent smoke from entering the cross passage. The cross passage remains as safe area. Fire dampers at the boundaries of cross-passages shall be fire rated (E30 according to EN 13501-3).

When an EQ gate is opened, it is impossible to prevent smoke from entering in this passage. In worst case smoke enters the cross passage. The area is not safe anymore. But the second gate prevents smoke from entering the service tube. This tube remains a safe area. Therefore, only one gate should be opened at once.

If the gate is closed again the cross-passage is flushed with fresh air at the same time.

6.2.2 Fire detection and alarm system

As required by RVS 09.02.22, an automatic fire alarm system must be installed in all tunnels that have built-in forced ventilation. As forced ventilation is provided in the tunnel, it is also necessary to provide an automatic fire alarm system.

Automatic fire detection system is provided along the entire length of the main tunnel, point smoke detectors are provided in electrical niches (also below raised floors), transformer rooms, medium voltage rooms and in

emergency call niches, at the emergency call cabinets, at the portals in the cross-passages. The system is designed on the principle of complete protection in accordance with the provisions and elements according to SIST EN54 and VdS 09.02.22.

Local control cabinet are in electrical rooms in the main tunnel and system rooms in the portal buildings, signal is transferred to the 24/7 occupied position in the the control center.

The cable trenches in the tunnel are not protected by detection system (no requirements in RVS 09.02.22).

The entire fire alarm supply system must have a fire resistance of E30-FE180. The fire alarm signal automatically triggers the fire program according to the location of fire. Control center activates fire fighting and rescue units, in accordance with the emergency and rescue plan.

A fire alarm signal is transmitted to the control centre via the fire control panels. The permanently occupied post is the control center in the northern portal building. A permanent crew of firefighters is also in the north portal building – direct communication. Tunnel users are alerted via variable traffic signs for warnings on the portals and in the tunnel. Through SCADA system following automatic measures are taken in case of fire alarm:

- traffic closure in front of the tunnel (a red traffic light) and in front of every lay-by niche with EQ (for traffic in to of the fire site),
- tunnel lighting at 100% power,
- flashing of LED turn signals in the tunnel
- surveillance of the fire site via cameras,
- start of ventilation according to the fire scenario according to the location of the fire,
- start of overpressure ventilation in cross-passages,
- start of the fresh air supply for the emergency tube,
- activation of fire brigade,
- start of playback of recorded voice messages via the control center

The automatic fire alarm system is also installed in portal buildings. The system is designed on the principle of complete protection in accordance with the provisions of VdS 2095, elements according to SIST EN54. Automatic fire detectors are provided throughout the building, manual call points are provided at exits. Smoke detectors are not required rooms where fire load is $P \leq 50 \text{ MJ} / \text{m}^2$. In raised floors, fire detection is not required if they are lower than 30 cm and when $P \leq 50 \text{ MJ} / \text{m}^2$ or per meter. Fire detection is the carrier of alarm and fire control (PH-30 cables). Local control cabinet is in system room, transfer to the 24/7 occupied position - the control center and fire fighters (next rooms) is provided.

6.2.3 Portable fire extinguishers

There are no requirements for automatic fire extinguishing systems in the tunnel.

Portable fire extinguishers are provided as follows:

- emergency call niches: 1 x ABC-9 kg (12 extinguishing units EU according to EN 3) and 1 x ABC- 6 kg (9 EU) - 59 niches in tunnel and portals
- north portal building: 13 x ABC-9 kg (12 EU) and 1 x CO₂-5 kg (5 EU),
- south portal building: 6 x ABC-9 kg (12 EU) and 1 x CO₂-5 kg (5 EU).

6.2.4 Hydrant network

In accordance with the requirements of RVS 09.01.24, the hydrant network must ensure a flow of 20 l / s of fire fighting water at a pressure between 6 and 12 bar at the most hydraulically unfavorable hydrant. The water supply must be sufficient for 90 minutes of extinguishing (RVS), which means that the fire water tank must have a volume of at least 108 m³.

Water supply for Llogara tunnel is provided from gravity tank with volume of 200 m³ of water. Pipeline DN200 through main and tunnel is provided. Hydrants (with 2 x C + B couplings) at 125 m (also hydrant type TLA with foam in lay-by niches) in the tunnel are foreseen, there is addition hydrant at each portal.

6.2.5 Full remote control of the tunnel

Monitoring of the situation and events in the tunnel from the control center via video cameras is planned. Cameras will be installed at the entrances to the cross-passages, in the cross-passages, and also on the side of the emergency tunnel.

6.2.6 Emergency call system SOS

The tunnel will be equipped with an emergency call system. There are 58 emergency call niches and emergency call stations in main tunnel pipe (alternately arranged niches and lockers). The distance between emergency call niches / stations is 125 m.

Emergency call points are located on the left side (driving form north to south) of the road opposite the hydrant niches. Additional emergency call points are in lay-by niches. Emergency call posts will be installed also in front of the portals.

Emergency call niches / stations are visibly marked (SOS). They must have a built-in blue LED that burns permanently and starts flashing when the alarm is triggered (IP65 installation protection).

An emergency call does not close the tunnel but triggers a warning alarm in the operator control center and triggers the speed limit in the tunnel and the flashing LED indicators.

6.2.7 Fire control of devices and systems

Fire alarm in the main tunnel tube, in the electrical rooms in the tunnel or emergency call niche is transferred to the control centre via the tunnel local fire control panel, which closes the tunnel. The same applies to the lifting of the fire extinguisher from its position in the tunnel.

Fire alarm portal buildings is also transferred to the control centre but does not close the tunnel. Similarly applies to the opening of the cross-passage door, opening of the door of cabinets with fire extinguishers and the detection of a standing vehicle in a tunnel. This must be made by operator manually if necessary.

6.2.8 Means of egress and emergency lighting

6.2.8.1 EMERGENCY LIGHTING IN THE TUNNEL:

Emergency lighting must cover the escape routes in the tunnel along their entire length (average illumination must be at least 3 lux; minimal illumination shall be at least 1 lux).

Uninterrupted power supply (UPS) with power for 60 minutes shall be provided. Cables for emergency lighting shall be E30-FE180 according to DIN VDE 0266 and ÖNORM DIN 4102-12.

Self-illuminated signs on both sides of the tunnel at distances of 50 m shall be provided. In between them photo luminescent signs shall be provided (both according to Tabelle 2 RVS 09.02.22).

Lamp housings must be resistant to atmospheric influences inside the tunnel and have at least a degree of protection of IP 65.

6.2.8.2 EMERGENCY LIGHTING IN THE PORTAL BUILDINGS:

Emergency lighting is required in rooms without daylight with an area of more than 50 m² and in rooms with daylight with an area of more than 100 m². Nevertheless, emergency lighting is provided throughout the portal buildings.

Emergency lighting must be designed and implemented in accordance with the standards EN 1838, EN 50171 and EN 50172. The luminaires must comply with EN 60598-2-22. Luminaires with their own battery are provided (autonomy for 60 minutes).

Exit signs and evacuation route signs must be directly or indirectly illuminated by emergency lighting. Means of egress, changes of direction and exits must be marked in accordance with EN ISO 7010.

6.2.8.3 EMERGENCY EXITS IN LLOGARA TUNNEL:

The tunnel has 11 cross-passages, which in the case of emergency from the central part of the tunnel significantly shorten the length of the means of egress. Maximal length of escape route in the tunnel is therefore less than 500 m.

In case of emergency from the initial part of the tunnel, exits are available on the portals.

Dimensions of exits: Minimum door dimension at the entrance to cross-passages and exits to the emergency tunnel is 2,2 x 1,0 m. The door must open in the direction of evacuation. The door must be equipped with an anti-panic mechanism according to EN 1125. Maximal opening force of the door is 100 N. The minimum door dimension at the entrance to cross-passages and exits to the emergency tunnel for emergency vehicles is 3,5 x 4,0 m. There are no special requirements for opening the door at the exits from the emergency tunnel to the open space.

6.2.8.4 WALKWAYS IN THE TUNNEL:

On each side of the carriageway, the walkway must be at least 85 cm wide (a wider walkway is provided, because of the dimensions of cable trench). The free height above the walkway must be at least 225 cm.

The maximum permissible longitudinal slope of the cross passage is 6% (10% with anti-slip coating in accordance with ÖNORM Z 1261).

Minimal dimensions for GQ cross-passages are 225 x 225 cm (the foreseen cross-passages are much wider). Minimal dimensions of EQ cross-passages and for emergency tunnel are 350 x 400 cm with a footpath on both sides 70 x 225 cm.

6.2.8.5 MEANS OF EGRESS IN THE PORTAL BUILDINGS:

Maximum length of unprotected escape route is up to 35 m. Minimum width of the escape route (corridor, stairs) is 120 cm. Minimum door width on escape route is 90 cm. For doors of technical rooms without permanently occupied posts, the minimum width shall be 80 cm.

Exits from transformer rooms are directly to the open area. From other rooms, the evacuation route leads first to the corridors and on towards the exits. The door in the corridors must open in the direction of evacuation. Doors with access control shall be designed in accordance with EN 13637. Door mechanisms on escape routes shall be in accordance with EN 179. Maximal opening force of the door is 100 N.

6.3 DESIGN AND IMPLEMENTATION REQUIREMENTS

6.3.1 Requirements for installations penetrations

The penetrations of installations through walls that represent the boundaries of individual fire compartments must be sealed with certified fire rated seals (EN 1366-3), so that the same fire resistance will be provided as shown by a fire-rated wall or other building element (requirement EI90 applies to cable penetrations from trenches to carriageway, cable penetrations from the portal buildings to the tunnel, the EI60 requirement applies to cable penetrations between individual fire compartments in the portal buildings).

6.3.2 Power supply in the event of fire

A two-way power supply at 20 kV level from two independent networks (new substation with voltage level of 110/20 kV in Palasa village for south portal, 20 kV line from the substation that is on Vlora side for north portal) is provided. Uninterruptible power supply (UPS) for 60 min for fire safety system is provided (RVS 09.02.22).

UPS is provided for the following systems:

- Devices for controlling and monitoring the energy supply system
- Measuring devices for monitoring the air conditions in tunnel
- Traffic control and monitoring (traffic lights, traffic and information signs, traffic recording, video, height control,
- Emergency call facilities (SOS system),
- Information systems (tunnel radio systems),
- Systems for fire detection
- tunnel lighting
- Emergency lighting,
- Transmission and control systems,
- Auxiliary drives for gates, provided they are power operated (EQ),
- Devices for controlling and monitoring the operation center.

Cable corridors (trenches) must have fire rated coverings (EI90), inside the carriageway cables must be E30-FE180 according to DIN VDE 0266 and ÖNORM DIN 4102-12.

The cables in the EI90 fire separated cable trench do not need to be fire resistant (the same applies to cameras).

6.3.3 Requirements for ventilation of battery rooms

The portal buildings of the tunnel have rooms with systems of rechargeable batteries. Rechargeable batteries are in a separate fire compartment.

Premises where batteries are charged are not explosive (although oxygen and hydrogen are formed when batteries are charged), if reliable ventilation (dilution and discharge of released gases) ensures that dangerous concentrations in the room cannot occur. Adequate ventilation of the battery room with stationary batteries is calculated according to the chapter 7.2 of EN IEC 62485-2: 2018. Natural ventilation of these rooms is provided with openings for air supply and exhaust of size $A_{ef} = 270.2 \text{ cm}^2$.

As explosive mixtures cannot be reliably excluded in the immediate vicinity of the battery cell openings (point 7.7 of EN IEC 62485-2: 2018, there must be no switches, sockets and lights that can cause ignition up to a distance of 0,6 m. This also applies to heat sources with a temperature above 300 °C.

For lamps in a room with batteries, we suggest that they drop below the lower level of the air exhaust grilles.

The luminaires should have IP54 protection.

The resistance of the floor to a groundable point when measured in accordance with IEC 61340-4-1 shall be between 50 kΩ and 10 MΩ.

each side of the carriageway, the walkway must be at least 85 cm wide (a wider walkway is provided,

7. ORGANISATIONAL SAFETY MEASURES

7.1 Accident prevention measures

The tunnel must be regularly maintained so that its functions, usability and operation are in constant accordance with the requirements of regulations and standards and the needs dictated by their purpose.

The Llogara tunnel will be operated from the control center in north portal where also fire fighters are located as part of a joint system.

Maintenance work, system checks and inspections must be carried out at regular intervals. The emphasis should be on checking and maintaining the following systems:

- operation of the fire alarm system and related systems,
- operation of the ventilation system,
- operation of the traffic signaling system and warning devices,
- operation of the power supply system and tunnel lighting, guidance and control devices,
- checking the condition of the inner concrete lining of the tunnel (it is also necessary to check for possible deformations in the lining of the tunnel).

For the needs of maintenance work in tunnel, the operator must keep appropriate documentation, which should contain all the findings of inspections and records of performed maintenance work.

In the case of hot maintenance work in a tunnel or portal buildings (welding, cutting, grinding metals), it is necessary to provide a fire brigade, which must take appropriate safety measures.

Means of egress and accesses for fire fighters must always be free.

Emergency exercises in the tunnel should be performed regularly.

The fire signal will be transmitted to the control center in north portal building, where a permanent personnel will be available, which will take appropriate action.

When extinguishing a possible fire, the main burden will fall on the portal fire fighters. They must be properly equipped.

7.2 Operating restriction

Due to the single-tube bidirectional traffic, where two vehicles can collide in the tunnel, there is the probability of an event where the passenger car or bus collides with truck loaded with dangerous goods. The transport of dangerous goods must therefore be planned at a time when traffic in the tunnel is low.

Otherwise no other operating restrictions are currently foreseen.

7.3 Emergency and rescue plan

Emergency and rescue plan for the event of an accident should be prepared in cooperation with ministries and other state bodies and relevant professional organizations.

The emergency and rescue plan shall specify:

- accident for which the plan is drawn up,
- scope of planning,

- the concept of protection, rescue and disaster relief for which a plan has been drawn up,
- the necessary forces and resources and available resources,
- organization and implementation of observation, information and alerting,
- activation of forces and means,
- management and leadership,
- protection, rescue and assistance measures and tasks,
- personal and mutual protection,
- interpretation of terms and abbreviations.

The appendices and appendices to the plan are:

- activity plans of the providers of the protection and rescue plan,
- databases needed to implement the plan,
- training, exercises, and exercises program,
- instructions for the maintenance and distribution of the protection and rescue plan.

When devising a plan, it is necessary to start from:

- the volume of traffic on the new route,
- characteristics of the road accident,
- safety of transport dangerous goods

The analysed fire scenarios must be considered (fire of a truck with the dangerous goods in the tunnel and limited possibilities for evacuation of people, transport of dangerous substances and their possible spillage).

7.4 Exercise

Before the opening of the tunnel, a comprehensive fire drill covering evacuation and rescue operations shall be carried out, involving all categories of personnel specified in the emergency and rescue plan.

The addendum to the plan, which defines the program of training and exercises, shall specify the types of fire drills, frequency of fire drills and the method of checking the qualifications of personnel, keeping records of fire drills and qualifications of personnel.

Fire drills to verify the emergency and rescue plan in the event of accidents involving dangerous goods shall be carried out at least every three years.

Annex A

SUMMARY OF FIRE SAFETY MEASURES				
Name of the structure:	Llogara Tunnel: single tube (length of 5.971,15 m) with service tube (length of 6.156,090 m, bidirectional traffic)			
Type of structure:	Road Tunnels, Underpasses, Covered Trenches and Galleries			
Location of the structure:	Located approximately 20km southwards of Vlora and approximately 500m northwestwards of S. Elisa Bridge in Dukat- Llogara road section.			
Fire safety measures				
Fire safety measures:	Planned measures (DD)	Measures taken (AB)		
		Measure	Date and signature	Notes (a summary of the changes and evidence of the adequacy of the implementation)
Spread of fire to neighboring buildings and structures				
Requirements for separation from adjacent facilities and boundaries of land of a neighboring owner:	There are no requirements for separation for the building (providing the external walls at the portals to the portal building show fire resistance REI90 according to EN 13501-2).			
Requirements for external walls, facades, ceilings and roofs or others fire separations between buildings and structures:	Reinforced concrete exterior walls at the portals with non-combustible clading A1 / A2 according to SIST EN 13501-1.			
Load-bearing capacity of the structure to withstand fire and spreading fire throughout the building				
Load-bearing capacity of the structure to withstand fire	Underground structure with high cover: self-supporting stone + primary support (concrete + anchors + reinforcing mesh) - fire inert material, R(EI)90 for portal walls to the adjacent portal building.			
Requirements for division in fire compartments with fire loads in fire compartments and areas of compartments:	FC-MT, main tube 5.971,15 m, < 150 MJ/m² (up to 3.000 MJ/m² at place of an accident with traffic jam), 60.000 m², FC-ET, emergency escape tunnel, <150 MJ/m², 35.500 m², FC-GQ1 (at 505,75 m), FC-GQ2 (at 1.505,75 m), FC-GQ3 (at 2.505,75 m), FC-GQ4 (at 3.505,75 m), FC-GQ5 (at			

	<p>4.505,75 m), FC-GQ6 (at 5.505,75 m), cross passages for pedestrians, <150 MJ/m², 200 m², FC-EQ1 (at 1.005,75 m), FC-EQ2 (at 2.005,75 m), FC-EQ3 (at 3.005,75 m), FC-EQ4 (at 4.005,75 m), FC-EQ5 (at 5.005,75 m), cross passages for emergency vehicles, <150 MJ/m², 200 m², FC-EAREA1 (at 1.047,75 m), FC-EAREA2 (at 2.047,75 m), FC-EAREA3 (at 3.047,75 m), FC-EAREA4 (at 4.047,75 m), FC-EAREA5 (at 5.047,75 m), electrical niches, 400 – 500 MJ/m², 46 m², FC-MVAREA1 (at 1.047,75 m), FC-MVAREA2 (at 2.047,75 m), FC-MVAREA3 (at 3.047,75 m), FC-MVAREA4 (at 4.047,75 m), FC-MVAREA5 (at 5.047,75 m), middle voltage rooms, 400 – 500 MJ/m², 7 m², FC-TRAN1 (at 1.047,75 m), FC-TRAN2 (at 2.047,75 m), FC-TRAN3 (at 3.047,75 m), FC-TRAN4 (at 4.047,75 m), FC-TRAN5 (at 5.047,75 m), transformer rooms, 400 – 500 MJ/m², 7 m². Cable trenches under the sidewalk should also be separated.</p>			
<p>Fire rating requirements at the boundaries of the fire compartments (walls, ceilings, openings, penetrations for installations, parapets, facades, protections for external fire stairs, etc.)</p>	<p>(R)EI90 according to EN 13501-2 for walls at the compartment boundaries between tunnel tubes, walls of the electrical rooms, transformer room, midlevoltage rooms, EI90 for manhole covers and covers of cable trenches, E90 for installation penetrations. There are no external staircases. EI290-C3 according to EN 13501-2 for doors of electrical rooms and middle voltage rooms. For transformer rooms EI290 (without self closing mechanism). For cross passage doors EI230-C3. There are no fire rating requirements for outside doors at the entrance of the evacuation tunnel.</p>			
<p>Fire safety requirements for building materials, such as floor, wall and ceiling coverings</p>	<p>Tunnel building material for structural elements shall fulfil the requirements of</p>			

	classification A1 / A2 according to EN 13501-1. Cast asphalt on sidewalk shall fulfill the requirements of classification Bfl-s1 according to EN 13501-1. Cables of class B2ca, s1a, a1 according to EN 50399 and EN 60332-1-2.			
Spread of smoke throughout the building and ventilation requirements				
Requirements for division in the smoke compartments with list of compartments, areas of smoke compartments and description smoke curtains:	The division into smoke compartments is the same as the division into fire compartments. There are no requirements for smoke curtains.			
Smoke and heat control systems requirements and surfaces for natural smoke extraction:	Semi-transverse ventilation system with smoke extraction designed for 30 MW of fire load with volume flow of at least 120 m ³ /s (related to the density corresponding to the sea level of the tunnel according to DIN ISO 2533). Minimal air flow to the extraction point (damper) inside carriageway should be at minimum 1.2 m/s from each side. The maximum speed through damper is 25 m/s. Smoke and heat extraction fans and jets fans in tunnel shall meet the requirements of EN 12101-3 (class F400): operating time 120 minutes at 400°C.			
Smoke control requirements (for example, control devices smoke in exit enclosures)	In case of fire in the crosspassages provide overpressure 30 - 40 Pa, air velocity towards the main tunnel 1.0 m/s through an open door.			
Requirements for ventilation systems (fire resistance, smoke tightness, installation of fire dampers, steering of ventilation in case of fire)	The entire length of the main tunnel is divided into 59 fire zones, at a distance of 100 m, 58 smoke and heat exhaust dampers will be installed. Two exhaust fans in the portal buildings for air flows of 165 m ³ /s (hot gases), 550 kW. 2 x 5 jet fans in the tunnel to achieve air flow 1,2 m/s towards the fire site, 90 kW. 2 x 3 jet fans in the emergency tunnel for fresh air supply, 30 kW. E30 according to EN 13501-			

	3 for fire dampers at the boundaries of cross-passages. All equipment in the exhaust air duct (including control and monitoring) must be resistant to a temperature of 400°C for a period of 120 min. The construction must not be mechanically destroyed up to a temperature of 750°C for 60 minutes. The flaps, the operating units and all associated equipment as well as the supply and control lines shall operate without restriction for at least 120 minutes at a temperature of 400°C. Activation in case of fire alarm in the main tunnel (automatic). Target air volume and speed values for ventilation system must be reached 5 minutes after activation.			
Means of egress				
Estimated maximum number of persons in the facility and individual rooms	The total estimated number of people in the tunnel in the event of a fire accident is 591.			
Emergency assembly point (requirements for location):	North portal of the tunnel. It is necessary to provide a flat paved surface of at least 500 m².			
Means of egress requirements (list of exits with locations and dimensions, special features regarding door opening):	Exits from the main tube to the cross passages and further to the emergency tube every 500 m (11 all together: at 505,75 m, 1.005,75 m, 1.505,75 m, 2.005,75 m, 2.505,75 m, 3.005,75 m, 3.505,75 m, 4.005,75 m, 4.505,75 m, 5.005,75 m, 5.505,75 m) and 2 at the portals of the main tunnel (at 0,00 and 5.971,15). The minimum door dimension at the entrance to cross-passages and exits to the emergency tunnel is 2,2 x 1,0 m. The door must open in the direction of evacuation. The door must be equipped with an anti-panic mechanism according to EN 1125. Maximal opening force of the door is 100 N. The minimum door dimension at the entrance to cross-passages and exits			

	to the emergency tunnel for emergency vehicles is 3,5 x 4,0 m. There are no special requirements for opening the door at the exits from the emergency tunnel to the open space.			
Requirements for unprotected length of means of egress (maximum permitted lengths and widths):	Maximum length of unprotected escape route: up to 500 m. Minimum width of the escape route in the main tube is 85 cm. Minimum height of the escape route in the tunnel is 225 cm.			
Requirements for protected parts evacuation routes (location, required width and maximum permitted lengths):	The protected parts of the evacuation route are the tunnel cross-passages and the emergency tunnel. The maximum permissible longitudinal slope of the cross passage is 6% (10% with anti-slip coating in accordance with ÖNORM Z 1261). Minimal dimensions for GQ cross-passages are 225 x 225 cm /the foreseen cross- passages are much wider). Minimal dimensions of EQ cross-passages and for emergency tunnel are 350 x 400 cm with a footpath on both sides 70 x 225 cm.			
Emergency lighting and fire escape signs requirements:	Emergency lighting throughout length of the main tunnel (average illumination 3 lux, min. 1 lux), UPS 60 minutes, cables E30-FE180 according to DIN VDE 0266 and ÖNORM DIN 4102-12. Self-illuminated signs on both sides of the tunnel at 50 m, in between photo luminescent signs (both according to Tabelle 2 RVS 09.0222).			
Requirements related to evacuation lifts:	No requirements.			
Fire detection and alarm				
Fire detection (permanent presence of personnel - organizational measures / systems for automatic fire detection):	Automatic fire detection system along the entire length of the main tunnel, point smoke detectors in electrical niches (also raised floor), transformer rooms, medium voltage rooms, emergency call niches. The system is designed on the principle of complete protection in accordance with the provisions and			

	elements according to SIST EN54 and VdS 09.02.22. Local control cabinet are in electrical rooms in the main tunnel and system rooms in the portal buildings, signal control system SCADA transfer to the 24/7 occupied position in the the control center is provided.			
Alarm (permanent presence - organizational measures / automatic alarm with sound, speech or light communication, alarm transmission to permanently occupied position):	A fire alarm signal is transmitted to the control centre via the fire control panels. The permanently occupied post is the control center in the northern portal building. A permanent crew of firefighters is also in the north portal building – direct communication. Tunnel users are alerted via variable traffic signs for warnings on the portals and in the tunnel. Through SCADA system following automatic measures are taken in case of fire alarm: - traffic closure in front of the tunnel (a red traffic light) and in front of every lay-by niche with EQ (for traffic in to of the fire site), - tunnel lighting at 100% power, - flashing of LED turn signals in the tunnel - surveillance of the fire site via cameras, - start of ventilation according to the fire scenario according to the location of the fire, - start of overpressure ventilation in cross-passages, - start of the fresh air supply for the emergency tube, - activation of fire brigade, - start of playback of recorded voice messages via the control center			
Power supply for fire protection systems and control of fire protection systems				
Requirements for power supply for fire systems and devices (time of power supply, fire protection, fire ratings for cables or cable corridors):	A two-way power supply at 20 kV level from two independent networks (new substation with voltage level of 110/20 kV in Palasa village for south portal, 20 kV line from the			

	<p>substation that is on Vlora side for north portal). Uninterruptible power supply (UPS) for 60 min. for:</p> <ul style="list-style-type: none"> - Devices for controlling and monitoring the energy supply system - Measuring devices for monitoring the air conditions in tunnel - Traffic control and monitoring (traffic lights, traffic and information signs, traffic recording, video, height control, - Emergency call facilities (SOS system), - Information systems (tunnel radio systems), - Systems for fire detection - tunnel lighting - Evacuation lighting, - Transmission and control systems, - Auxiliary drives for gates, provided they are power operated (EQ), - Devices for controlling and monitoring the operation center. <p>Cable corridors (trenches) EI90, inside the carriageway E30-FE180 according to DIN VDE 0266 and ÖNORM DIN 4102-12.</p>			
Requirements for activation and deactivation of systems and devices (manually or automatically via fire control cabinet, the possibility of manual reactivation and other requirements for firefighters):	<p>Fire alarm (line detectors, manual call points in the tunnel, cross-passages or on the portals, smoke detectors in electrical rooms, transformer rooms, middle voltage rooms in the tunnel):</p> <ul style="list-style-type: none"> - automatic activation of fire ventilation according to the matrix regarding the location of the fire (also overpressure system in cross-passages and fresh air supply to the emergency tunnel), - traffic closure in front of the tunnel and in the tunnel (red traffic signs), - switching traffic signals to fire operation, - lighting at 100% power, - surveillance of the fire site via cameras <p>Control centre can deactivate or switch again all systems.</p>			

Systems and devices for firefighting and requirements for firefighters				
Water supply required (fire water sources, capacity and duration, number of required external and internal fire hydrants)	A hydrant network with a flow rate of 20 l / s at a pressure of 6 to 12 bar is required at the most unfavorable hydrant. Water supply from gravity tanks with minimum volume of 108 m ³ (200 m ³ of water is foreseen). Pipeline DN200 through main and tunnel. Hydrants (57 with 2 x C + B couplings) at 125 m (also hydrant 11 type TLA with foam in lay-by niches) in the tunnel, one hydrant at each portal.			
Requirements for fire extinguishing systems (location, fire extinguisher type, manner of activation, special extinguishing requirements)	There are no requirements for automatic fire extinguishing systems. Portable fire extinguishers: - emergency call niches: 1 x ABC-9 kg (12 extinguishing units EU according to EN 3) and 1 x ABC- 6 kg (9 EU) - 59 niches in tunnel and portals.			
Requirements for access routes and areas for fire fighters	Access through the emergency tunnel to the cross-passage which is nearest to the fire. Through the cross-passages for emergency vehicles (EQ), can firefighters enter the main tunnel with their vehicles. Lay-by niches in the emergency tunnel represent free areas for firefighters. They allow vehicle avoidance.			
Requirements related to elevators for fire fighters (place of entry for firefighters, elevator dimensions, overpressure requirement control, etc.):	No requirements.			
Installations affecting fire safety				
Installation requirements flammable gases and liquids:	No special requirements.			
Requirements for heating installations, flue systems and fuel storage:	No special requirements.			
Requirements regarding explosion protection:	No special requirements.			
Lightning protection requirements:	Provide adequate lightning protection.			

Annex B

SUMMARY OF FIRE SAFETY MEASURES				
Name of the structure:		North Portal Building		
Type of structure:		Ancillary facility for safety in the tunnel		
Location of the structure:		Located at the north portal of the Llogara tunnel.		
Fire safety measures				
Fire safety measures:	Planned measures (DD)	Measures taken (AB)		
		Measure	Date and signature	Notes (a summary of the changes and evidence of the adequacy of the implementation)
Spread of fire to neighboring buildings and structures				
Requirements for separation from adjacent facilities and boundaries of land of a neighboring owner:	There are no requirements for separation. There are no buildings nearby to which the fire could be transmitted. Partially underground building leaning on a hill. The exterior walls show fire resistance at least REI90 according to EN 13501-2. In the event of a fire in the building, the fire could be transmitted at distance of 3,0 m in the direction of fire-unprotected openings (transformer room doors).			
Requirements for external walls, facades, ceilings and roofs or others fire separations between buildings and structures:	Reinforced concrete exterior walls at the portals with non-combustible clading A1 / A2 according to SIST EN 13501-1.			
Load-bearing capacity of the structure to withstand fire and spreading fire throughout the building				
Load-bearing capacity of the structure to withstand fire	R(EI)60 for load bearing colums and walls. Given the predicted thickness of the concrete walls, this is easily achieved.			
Requirements for division in fire compartments with fire loads in fire compartments and areas of compartments:	Fire compartment division according to individual technical units important for safety in the tunnel: FC-TR1, transformer room 1, 400 - 500 MJ/m² (dry transformers). 19 m², FC-			

	TR2, transformer room 2, 400 - 500 MJ/m ² (dry transformers), 19 m ² , FC-MT, ventilation room with heat and smoke exhaust duct – actually part of main tunnel fire compartment, 400 - 500 MJ/m ² , 48 m ² , FC-BAT, battery room, 350 MJ/m ² , 12 m ² , FC-KORR, entrance with stairs and hallway in ground and 1 st floor, <150 MJ/m ² , 68 m ² , FC-FD, premises for firefighters, from <150 MJ/m ² up to 500 MJ/m ² , 340 m ² , FC-COMM, command room with system room, 400 – 500 MJ/m ² , 118 m ² , FC-LVOL, low voltage room, 400 – 500 MJ/m ² , 19 m ² , FC-LVOL, middle voltage room, 400 – 500 MJ/m ² , 19 m ² , FC-WARE, warehouse, 800 MJ/m ² , 51 m ² .			
Fire rating requirements at the boundaries of the fire compartments (walls, ceilings, openings, penetrations for installations, parapets, facades, protections for external fire stairs, etc.)	(R)EI60 according to EN 13501-2 for walls at the compartment boundaries between the fire compartments within the building, EI90 for walls to heat and smoke exhaust duct from the tunnel, EI60 for installation penetrations between the rooms, EI90 for installation penetrations to the exhaust duct from the tunnel. There are no external staircases. EI290-C3 according to EN 13501-2 for doors to the exhaust duct, EI260-C3 for door between the fire compartments. There are no fire rating requirements for outside doors.			
Fire safety requirements for building materials, such as floor, wall and ceiling coverings	Building material for structural elements shall fulfil the requirements of classification A1 / A2 according to EN 13501-1. Ventilation ducts for building must be made of non-combustible materials. The thermal insulation of the ducts must be non-combustible or hardly flammable (classes A1, A2, B or C according to EN 13501-1). For transformer room floor and walls made			

	of non-combustible materials, for other rooms there are no special requirements. The walls and ceilings are actually A1 / A2.			
Spread of smoke throughout the building and ventilation requirements				
Requirements for division in the smoke compartments with list of compartments, areas of smoke compartments and description smoke curtains:	The division into smoke compartments is the same as the division into fire compartments. There are no requirements for smoke curtains.			
Smoke and heat control systems requirements and and surfaces for natural smoke extraction:	No special requirements for heat and smoke exhaust from the building. The building consists of small fire / smoke compartments. In the event of a fire, the rooms are ventilated outdoors through windows and doors.			
Smoke control requirements (for example, control devices smoke in exit enclosures)	No requirements. No exit enclosures.			
Requirements for ventilation systems (fire resistance, smoke tightness, installation of fire dampers, steering of ventilation in case of fire)	There are no requirements for fire dampers (each room is ventilated with its own ventilation system), fire resistance EI60 for duct for battery room air supply is required (ducts crossing through other fire compartment).			
Means of egress				
Estimated maximum number of persons in the facility and individual rooms	The building will accommodate up to 10 people.			
Emergency assembly point (requirements for location):	Directly in front of the building on the tunnel portal (flat paved surface of at least 500 m ² is provided).			
Means of egress requirements (list of exits with locations and dimensions, special features regarding door opening):	Exits from transformer rooms directly to the open area, from other rooms, the evacuation route leads first to the corridors and on towards the exits. The door in the corridors must open in the direction of evacuation. Doors with access control designed in accordance with EN 13637. Door mechanisms on escape routes in accordance with EN 179. Maximal opening force of the door is 100 N.			

Requirements for unprotected length of means of egress (maximum permitted lengths and widths):	Maximum length of unprotected escape route: up to 35 m. Minimum width of the escape route (corridor, stairs) is 120 cm. Minimum door width on escape route is 90 cm. For doors of technical rooms without permanently occupied posts, the minimum width shall be 80 cm.			
Requirements for protected parts evacuation routes (location, required width and maximum permitted lengths):	No requirements, no protected parts of the evacuation route.			
Emergency lighting and fire escape signs requirements:	Emergency lighting is required in rooms without daylight > 50 m ² and in rooms with daylight > 100 m ² . Nevertheless, emergency lighting is provided throughout the building. Emergency lighting must be designed and implemented in accordance with the standards EN 1838, EN 50171 and EN 50172. The luminaires must comply with EN 60598-2-22. Provided lamps with their own battery (autonomy 60 minutes). Exit signs and evacuation route signs must be directly or indirectly illuminated by emergency lighting. Means of egress, changes of direction and exits must be marked in accordance with EN ISO 7010.			
Requirements related to evacuation lifts:	No requirements.			
Fire detection and alarm				
Fire detection (permanent presence of personnel - organizational measures / systems for automatic fire detection):	The system is designed on the principle of complete protection in accordance with the provisions of VdS 2095, elements according to SIST EN54. Automatic fire detectors throughout the building, manual call points at exits. Smoke detectors are not required rooms where fire load is $P \leq 50 \text{ MJ} / \text{m}^2$. In raised floors, fire detection is not required if they are lower than 30 cm and when $P \leq 50 \text{ MJ} / \text{m}^2$ or per meter. Fire detection is the carrier of alarm and fire control (PH-30 cables).			

	Local control cabinet is in system room, transfer to the 24/7 occupied position - the control center and fire fighters (next rooms) is provided.			
Alarm (permanent presence - organizational measures / automatic alarm with sound, speech or light communication, alarm transmission to permanently occupied position):	Provided sound alarm on the facade of the building. For installation fire resistance of cables PH-30. The signal is transmitted to the permanently occupied position - the control center and on to the fire brigade. Sound signal of 65 dB (A) or 5 dB (A) above ambient noise.			
Power supply for fire protection systems and control of fire protection systems				
Requirements for power supply for fire systems and devices (time of power supply, fire protection, fire ratings for cables or cable corridors):	Safety power supply for safety lighting: 60 minutes - lamps with own battery, fire detection system: 30 minutes alarm + 48 hours standby. The emergency lighting is powered from own batteries, so no fire-rated installation is required.			
Requirements for activation and deactivation of systems and devices (manually or automatically via fire control cabinet, the possibility of manual reactivation and other requirements for firefighters):	Activation of the alarm and transmission of the signal to the control center of the operator via the fire alarm control panel. Signal transmission to firefighters. In case of fire on devices that are important for safety in the tunnel, the tunnel is closed from the control center - there is no automatic closure of the tunnel.			
Systems and devices for firefighting and requirements for firefighters				
Water supply required (fire water sources, capacity and duration, number of required external and internal fire hydrants)	Protection provided from the hydrant network of the tunnel, hydrant on the portal in front of the building 20 l / s at a pressure of 6 to 12 bars. An internal hydrant network is neither required nor provided. Water supply from gravity tank with minimum volume of 108 m ³ (200 m ³ of water is foreseen).			
Requirements for fire extinguishing systems (location, fire extinguisher type, manner of activation, special extinguishing	There are no requirements for automatic fire extinguishing systems. Portable fire extinguishers:			

requirements)	13 x ABC-9 kg (12 extinguishing units EU according to EN 3) and 1 x CO ₂ -5 kg (5 EU).			
Requirements for access routes and areas for fire fighters	The constant presence of firefighters in the building itself. No additional requirements.			
Requirements related to elevators for fire fighters (place of entry for firefighters, elevator dimensions, overpressure requirement control, etc.):	No requirements.			
Installations affecting fire safety				
Installation requirements flammable gases and liquids:	No special requirements.			
Requirements for heating installations, flue systems and fuel storage:	No special requirements.			
Requirements regarding explosion protection:	In accordance with EN IEC 62485-2, it is necessary to provide natural ventilation of the room with openings for air supply and exhaust of size $A_{ef} = 270.2 \text{ cm}^2$.			
Lightning protection requirements:	Provide adequate lightning protection.			

Annex C

SUMMARY OF FIRE SAFETY MEASURES				
Name of the structure:		South Portal Building		
Type of structure:		Ancillary facility for safety in the tunnel		
Location of the structure:		Located at the south portal of the Llogara tunnel.		
Fire safety measures				
Fire safety measures:	Planned measures (DD)	Measures taken (AB)		
		Measure	Date and signature	Notes (a summary of the changes and evidence of the adequacy of the implementation)
Spread of fire to neighboring buildings and structures				
Requirements for separation from adjacent facilities and boundaries of land of a neighboring owner:	There are no requirements for separation. There are no buildings nearby to which the fire could be transmitted. Partially underground building leaning on a hill. The exterior walls show fire resistance at least REI90 according to EN 13501-2. In the event of a fire in the building, the fire could be transmitted at distance of 3,0 m in the direction of fire-unprotected openings (transformer room doors).			
Requirements for external walls, facades, ceilings and roofs or others fire separations between buildings and structures:	Reinforced concrete exterior walls at the portals with non-combustible clading A1 / A2 according to SIST EN 13501-1.			
Load-bearing capacity of the structure to withstand fire and spreading fire throughout the building				
Load-bearing capacity of the structure to withstand fire	R(EI)60 for load bearing colums and walls. REI90 for walls toward the tunnel tubes. Given the predicted thickness of the concrete walls, this is easily achieved.			
Requirements for division in fire compartments with fire loads in fire compartments and areas of compartments:	Fire compartment division according to individual technical units important for safety in the tunnel: FC-TR1. transformer room 1.			

	400 - 500 MJ/m ² (dry transformers), 21 m ² , FC-TR2, transformer room 2, 400 - 500 MJ/m ² (dry transformers), 21 m ² , FC-MT, ventilation room in two levels with heat and smoke exhaust duct – actualy part of main tunnel fire comartment, 400 - 500 MJ/m ² , 102 m ² , FC-UPS, UPS room, 350 MJ/m ² , 22 m ² , FC-BATT, battery room, 350 MJ/m ² , 20 m ² , FC-KORR, entrance with stairs and hallway in underground floor, <150 MJ/m ² , 60 m ² , FC-TELE, TC room, 400 – 500 MJ/m ² , 54 m ² , FC-SYST, system room, 400 – 500 MJ/m ² , 31 m ² , FC-LVOL, low voltage room, 400 – 500 MJ/m ² , 21 m ² , FC-LVOL, middle voltage room, 400 – 500 MJ/m ² , 21 m ² , FC-CKM, cable trench to the main tunnel, 800 MJ/m ² , 15 m ² , FC-CKEM, cable trench to the emergeny tunnel, 800 MJ/m ² , 15 m ² .			
Fire rating requirements at the boundaries of the fire compartments (walls, ceilings, openings, penetrations for installations, parapets, facades, protections for external fire stairs, etc.)	(R)EI60 accordind to EN 13501-2 for walls at the compartment boundaries between the fire comparments within the buildin, EI90 for walls to heat and smoke exhaust duct from the tunnel, EI60 for installation penetrations between the rooms, EI90 for installation penetrations to the exhaust duct from the tunnel. There are no external staircases. EI ₂ 60-C3 for door between the fire compartments. There are no fire rating requirements for outside doors.			
Fire safety requirements for building materials, such as floor, wall and ceiling coverings	Building material for structural elements shall fulfil the requirements of classification A1 / A2 according to EN 13501-1. Ventilation ducts for building must be made of non-combustible materials. The thermal insulation of the ducts must be non-combustible or hardly flammable (classes A1, A2, B or C according to EN 13501-1). For transformer			

	room floor and walls made of non-combustible materials, for other rooms there are no special requirements. The walls and ceilings are actually A1 / A2.			
Spread of smoke throughout the building and ventilation requirements				
Requirements for division in the smoke compartments with list of compartments, areas of smoke compartments and description smoke curtains:	The division into smoke compartments is the same as the division into fire compartments. There are no requirements for smoke curtains.			
Smoke and heat control systems requirements and surfaces for natural smoke extraction:	No special requirements for heat and smoke exhaust from the building. The building consists of small fire / smoke compartments. In the event of a fire, the rooms are ventilated outdoors through windows and doors.			
Smoke control requirements (for example, control devices smoke in exit enclosures)	No requirements. No exit enclosures.			
Requirements for ventilation systems (fire resistance, smoke tightness, installation of fire dampers, steering of ventilation in case of fire)	There are no requirements for fire dampers (each room is ventilated with its own ventilation system).			
Means of egress				
Estimated maximum number of persons in the facility and individual rooms	Building without a permanent crew, occasionally up to 5 people during maintenance.			
Emergency assembly point (requirements for location):	Directly in front of the building on the tunnel portal (flat paved surface of at least 200 m ² is provided).			
Means of egress requirements (list of exits with locations and dimensions, special features regarding door opening):	Exits from transformer rooms directly to the open area, from other rooms, the evacuation route leads first to the corridors and on towards the exits. The door in the corridors must open in the direction of evacuation. Doors with access control designed in accordance with EN 13637. Door mechanisms on escape routes in accordance with EN 179. Maximal opening force of the door is 100 N.			
Requirements for unprotected length of means of egress (maximum permitted lengths and	Maximum length of unprotected escape route: up to 35 m. Minimum width			

widths):	of the escape route (corridor, stairs) is 120 cm. Minimum door width on escape route is 90 cm. For doors of technical rooms without permanently occupied posts, the minimum width shall be 80 cm.			
Requirements for protected parts evacuation routes (location, required width and maximum permitted lengths):	No requirements, no protected parts of the evacuation route.			
Emergency lighting and fire escape signs requirements:	Emergency lighting is required in rooms without daylight > 50 m ² and in rooms with daylight > 100 m ² . Nevertheless, emergency lighting is provided throughout the building. Emergency lighting must be designed and implemented in accordance with the standards EN 1838, EN 50171 and EN 50172. The luminaires must comply with EN 60598-2-22. Provided lamps with their own battery (autonomy 60 minutes). Exit signs and evacuation route signs must be directly or indirectly illuminated by emergency lighting. Means of egress, changes of direction and exits must be marked in accordance with EN ISO 7010.			
Requirements related to evacuation lifts:	No requirements.			
Fire detection and alarm				
Fire detection (permanent presence of personnel - organizational measures / systems for automatic fire detection):	The system is designed on the principle of complete protection in accordance with the provisions of VdS 2095, elements according to SIST EN54. Automatic fire detectors throughout the building, manual call points at exits. Smoke detectors are not required rooms where fire load is $P \leq 50 \text{ MJ} / \text{m}^2$. In raised floors, fire detection is not required if they are lower than 30 cm and when $P \leq 50 \text{ MJ} / \text{m}^2$ or per meter. Fire detection is the carrier of alarm and fire control (PH-30 cables). Local control cabinet is in system room, transfer to the 24/7 occupied position			

	- the control center and fire fighters (next rooms) is provided.			
Alarm (permanent presence - organizational measures / automatic alarm with sound, speech or light communication, alarm transmission to permanently occupied position):	Provided sound alarm on the facade of the building. For installation fire resistance of cables PH-30. The signal is transmitted to the permanently occupied position - the control center and on to the fire brigade. Sound signal of 65 dB (A) or 5 dB (A) above ambient noise.			
Power supply for fire protection systems and control of fire protection systems				
Requirements for power supply for fire systems and devices (time of power supply, fire protection, fire ratings for cables or cable corridors):	Safety power supply for safety lighting: 60 minutes - lamps with own battery, fire detection system: 30 minutes alarm + 48 hours standby. The emergency lighting is powered from own batteries, so no fire-rated installation is required.			
Requirements for activation and deactivation of systems and devices (manually or automatically via fire control cabinet, the possibility of manual reactivation and other requirements for firefighters):	Activation of the alarm and transmission of the signal to the control center of the operator via the fire alarm control panel. Signal transmission to firefighters. In case of fire on devices that are important for safety in the tunnel, the tunnel is closed from the control center - there is no automatic closure of the tunnel.			
Systems and devices for firefighting and requirements for firefighters				
Water supply required (fire water sources, capacity and duration, number of required external and internal fire hydrants)	Protection provided from the hydrant network of the tunnel, hydrant on the portal in front of the building 20 l / s at a pressure of 6 to 12 bars. An internal hydrant network is neither required nor provided. Water supply from gravity tank with minimum volume of 108 m ³ (200 m ³ of water is foreseen).			
Requirements for fire extinguishing systems (location, fire extinguisher type, manner of activation, special extinguishing requirements)	There are no requirements for automatic fire extinguishing systems. Portable fire extinguishers: 6 x ABC-9 kg (12 extinguishing units EU according to EN 3) and 1 x			

	CO ₂ -5 kg (5 EU).			
Requirements for access routes and areas for fire fighters	The access road is a service tunnel. Firefighters stationed in the north portal building. No additional requirements.			
Requirements related to elevators for fire fighters (place of entry for firefighters, elevator dimensions, overpressure requirement control, etc.):	No requirements.			
Installations affecting fire safety				
Installation requirements flammable gases and liquids:	No special requirements.			
Requirements for heating installations, flue systems and fuel storage:	No special requirements.			
Requirements regarding explosion protection:	In accordance with EN IEC 62485-2, it is necessary to provide natural ventilation of the room with openings for air supply and exhaust of size A _{ef} = 270.2 cm ² .			
Lightning protection requirements:	Provide adequate lightning protection			