# European Railway Agency

## Interoperability Unit

### Union Rail System

**Subsystems Infrastructure, Energy and Rolling Stock**

### TSI “Safety in Railway Tunnels”

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**Technical Specification for Interoperability**

**Status**

Preliminary draft

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1. INTRODUCTION

1.1. Technical scope
This TSI contains requirements for the following subsystems infrastructure (‘INF’), energy (‘ENE’), operation (‘OPE’) and rolling stock (‘RST’), as defined in Directive 2008/57/EC. Whereas this TSI contains no direct requirement for the subsystem control-command (‘CCS’), it contains requirements applicable to components of the subsystem and is interfaced with it.

Only specific measures, designed to reduce specific tunnel risks, are prescribed in the present TSI. General railway safety measures: Risks related to pure railway operation, such as derailment and collision with other trains, are addressed by general railway safety measures.

Tunnel-specific measures: The purpose of this TSI is to define a coherent set of measures for the infrastructure, energy, rolling stock and operation subsystems, thus delivering an optimal level of safety in tunnels in the most cost-efficient way.

It shall permit free movement of vehicles which are in compliance with this TSI to run under harmonised safety conditions in railway tunnels.

1.1.1. Scope related to tunnels
This TSI applies to new, renewed and upgraded tunnels which are located on the European rail network, and which are in accordance with the definition in section 2.4 of this TSI. Stations that are in tunnels shall be in conformity with the national rules on fire safety. When they are used as safe areas or rescue stations, they shall also comply to the specification of this TSI.

1.1.2. Scope related to rolling stock
This TSI applies to rolling stock which is in the scope of the LOC&PAS TSI.

1.1.3 Scope related to operational aspects
This TSI applies to the operation of all trains which are running in tunnels which are in the scope of this TSI.

1.1.4. Operation of freight trains
A freight train is a train composed of one or more locomotive(s) and one or more wagon(s). A freight train including at least one wagon carrying dangerous goods is a dangerous goods train.

When each vehicle of a freight train complies with the structural TSIs which apply to it (LOC&PAS, WAG, SRT, NOI) and when the dangerous goods wagon(s) complies with the
Annex II of Directive 2008/68/EC, the freight train operated according to the requirements of the OPE TSI shall be allowed to circulate in all tunnels.

1.1.5. Risk scope, risks that are not covered by this TSI

This TSI covers only specific risks to the safety of passengers and on-board staff in tunnels for the subsystems above. It also covers risks for the people in the neighbourhood of a tunnel where a collapse of the structure could have catastrophic consequences.

Risks not covered by this TSI are as follows:

- health and safety of staff involved in the maintenance of the fixed installations in tunnels.
- financial loss due to damage to structures and trains, and consequently the losses resulting from non-availability of the tunnel for repairs.
- trespass into the tunnel.
- terrorism, as a deliberate and premeditated act which is designed to cause wanton destruction, injury and loss of life.

1.2. Geographical scope

The geographical scope of this TSI is the Union rail system, composed of:

(a) The trans-European conventional rail system network (TEN) as described in Annex I section 1.1 “Network” of Directive 2008/57/EC.
(b) The trans-European high-speed rail system network (TEN) as described in Annex I section 1.2 “Network” of Directive 2008/57/EC.
(c) Other parts of the Union rail network, following the extension of scope as described in Annex I section 4 of Directive 2008/57/EC.

Networks referred to in Article 1(3) of Directive 2008/57/EC are excluded from the geographical scope of this TSI.

2. DEFINITION OF ASPECT/SCOPE

2.1. General

The TSI ‘Safety in Railway Tunnels’ extends to all parts of the railway system relevant for the safety of passengers and on-board staff in railway tunnels during operation.

Chapter 2.2 deals with the risk scenarios in tunnels.

The line of defence for the promotion of safety in tunnels comprises four successive layers: Prevention, mitigation, evacuation and rescue.

The largest contribution is in the area of prevention followed by mitigation and so on.
A major feature of railways is their inherent ability to prevent accidents through the traffic running on a guide-way and being controlled and regulated using a signalling system.

The layers of safety combine to produce a low level of residual risk.

2.2. The risk scenarios
This TSI looks at measures which could offset or mitigate the difficulty of evacuation or rescue operations following a railway accident.
Relevant measures have been identified, which will suppress or significantly reduce the risks arising from these scenarios.

They have been developed, in the categories prevention/mitigation-evacuation/rescue; however they do not appear under these headings in this TSI but under the headings of the concerned subsystems.

The measures prescribed can be considered as a response to the following three types of incidents

2.2.1. ‘Hot’ incidents: Fire, explosion followed by fire, emission of toxic smoke or gases.
The main danger is fire. Fire is understood as a combination of heat, flames and smoke.

It is assumed that the fire starts on a train.

The fire is detected, either by on-board fire detectors, or by persons on-board. The driver is notified of a problem, either that there is a fire by an automatic notification or that there is a problem in general by passengers using the passenger alarm.

The driver is instructed to act appropriately depending on the local circumstances.
For rolling stock of category B, either the driver or on-board staff will shut-down ventilation to prevent smoke distribution.

The train continues running until it stops at a designated stopping point which may be located outside or inside the tunnel. In category B trains, the passengers in the affected area will move to a non-affected area of the train where they are protected from fire and fumes until the train reaches the designated stopping point.

Whenever possible the train leaves the tunnel.

If the train comes to a stop at a designated stopping point; passengers are evacuated, directed by the train crew, or by self-rescue, to a safe area.

On trains of category B without a defined running capability, the fire extinguishing system will extinguish the fire after which the incident will become a ‘cold’ incident.

2.2.2. ‘Cold’ incidents: collision, derailment
The tunnel specific measures concentrate on access/egress facilities to support evacuation and the intervention of rescue forces.

The difference with the hot scenarios is that there is no time constraint due to the presence of a hostile environment created by a fire.

2.2.3. Prolonged stop
Prolonged stop (an unplanned stop in a tunnel, without a fire on board, for longer than 10 minutes) is not by itself a threat to passengers and staff.

However it may lead to panic and to spontaneous, uncontrolled evacuation that exposes people to dangers present in a tunnel environment.

Measures shall be provided to keep such a situation under control.

2.2.4. Exclusions
The scenarios that have not been dealt with are listed in section 1.1.7.

2.3. The role of emergency response services
The definition of the role of the emergency response services is a matter for the Relevant National Authority.

The measures specified in this TSI for rescue are based on the assumption that emergency response services intervening in a tunnel accident shall protect lives as a first priority and not material values such as vehicles or structures.

It is assumed that they are expected to:
In a ‘hot’ incident type

- Rescue people unable to reach a safe area
- Provide initial medical support to evacuees
- Fight a fire insofar as required to protect themselves and people caught in the incident
- Conduct evacuation from safe areas inside the tunnel to open air

In a ‘cold’ incident type

- Provide initial help to people with critical injuries
- Free trapped people
- Evacuate people

No demands on time or performance requirements are included in this TSI.

Considering that accidents in railway tunnels involving multiple fatalities are rare, it is implicit that there might be events, with an extremely low probability, against which even well-equipped emergency response services would be powerless, such as a major fire involving a freight train.

Detailed scenarios adapted to local conditions shall be developed for the emergency plans.

If the expectations of the emergency response services expressed in those plans go beyond the assumptions described above, then additional appropriate measures or equipment can be provided.

2.4 Definitions

For the purpose of this TSI the following definitions are used:

- Railway tunnel: A railway tunnel is an excavation or a construction around the track provided to allow the railway to pass under, for example higher land, buildings or water. The length of a tunnel is defined as the length of the fully enclosed section, measured at rail level. A tunnel in the context of this TSI is 0.1km or longer.

- Safe area: a safe area is a survivable space, inside or outside the tunnel, for passengers and staff to find refuge after they have evacuated from a train. A passenger station (in a tunnel or at the surface) can be a safe area if it meets the requirements of paragraph 4.2.1.5.
• Designated stopping point: a designated stopping point is a defined location, inside or outside the tunnel, for the train to stop. There are two types of designated stopping points that are the fire fighting point and the rescue station.

  o Fire fighting point: a fire fighting point is a designated stopping point located outside the portals of a tunnel, where fire fighting equipment is available and where passengers can evacuate in the open air.

  o Rescue station: a rescue station is a designated stopping point located inside tunnels where fire fighting equipment is available. It is always paired with a safe area. A passenger station can be a combined rescue station and safe area if it meets the requirements of both paragraphs 4.2.1.5 and 4.2.1.7.2.

• All definitions related to rolling stock are defined in the LOC&PAS TSI.

3. ESSENTIAL REQUIREMENTS
The following table indicates basic parameters of this TSI and their correspondence to the essential requirements as set out and numbered in Annex III to Directive 2008/57/EC.

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4. CHARACTERISATION OF THE SUBSYSTEM

4.1. Introduction
The European Union rail system, to which Directive 2008/57/EC applies and of which the subsystems are parts, is developed to become an integrated system for which the consistency must be verified.

This consistency has been checked in relation to the development of the specifications within this TSI, its interfaces with respect to the systems in which it is integrated and also the operating rules for the railway.

Taking account of all the applicable essential requirements, the basic parameters related to safety in railway tunnels are set out for the subsystems infrastructure, energy and rolling stock in section 4.2 of this TSI. The operational requirements and responsibilities are set out in the OPE TSI and in section 4.4 of this TSI.

4.2. Functional and technical specifications of the subsystems
In the light of the essential requirements in Chapter 3, the functional and technical specifications of those aspects specific to tunnel safety in the above-mentioned subsystems are as follows:
4.2.1. Subsystem Infrastructure

4.2.1.1. Prevent unauthorised access to emergency exits and technical rooms
This specification applies to all tunnels.

(a) Unauthorised access to technical rooms shall be prevented.

(b) Where emergency exits are locked for security purposes, it shall always be possible to open them from inside.

4.2.1.2. Fire resistance of tunnel structures
This specification applies to all tunnels.

(a) In the event of fire, the integrity of the tunnel lining shall be maintained for a period of time sufficiently long to permit self-rescue, evacuation of passengers and staff and intervention of emergency response services. This objective is attained when it is demonstrated that the integrity of the tunnel lining is maintained under a temperature of 450°C at ceiling level during the same period of time, which shall be in accordance to the evacuation scenario and reported in the Emergency Plan.

(b) In the cases of immersed tunnels and tunnels which can cause the collapse of important neighbouring structures, the tunnel main structure shall withstand the temperature of the fire for a period of time allowing evacuation of the endangered tunnel zones and neighbouring structures. This period of time shall be agreed in the emergency plan. The specified ‘temperature-time curve’ (EUREKA curve) for the evaluation of the resistance of the tunnel is given in the following figure. This verification is not needed for rock tunnels without additional support.
4.2.1.3. Fire reaction of building material
This specification applies to all tunnels.

(a) Building material and installations inside tunnels shall have low flammability, be non-flammable or be shielded against the effects of fire.

(b) Tunnel building material shall fulfil the requirements of classification A2 of EN 13501-1:2002. Non-structural panels and other equipment shall fulfil the requirements of classification B of EN 13501-1:2002.

4.2.1.4. Fire detection in technical rooms
This specification applies to all tunnels of more than 1 km in length.

(a) Technical rooms are enclosed spaces with doors for access/egress inside or outside the tunnel with safety installations which are necessary for at least one of the following functions: self-rescue, evacuation, emergency communication, rescue and fire fighting, signalling and communication equipment, and traction power supply.

(b) Technical rooms shall be equipped with detectors which alert the infrastructure manager in case of fire.

4.2.1.5. Evacuation facilities

4.2.1.5.1 Safe area
This specification applies to all tunnels of more than 1 km in length.
(a) A safe area shall allow for the evacuation of trains that use the tunnel and may be located adjacent to the tunnel. It shall have a capacity corresponding to the maximum capacity of the trains planned to be operated on the line where the tunnel is located.

(b) The safe area shall maintain survivable conditions for unprotected persons during the time needed for the complete evacuation from the safe area (away from the accident scene, e.g. to the surface).

(c) In case of underground/undersea safe areas, the provisions shall allow people to move from the safe area to the surface without having to re-enter the affected tunnel tube.

4.2.1.5.2 Access to the safe area
This specification applies to all tunnels of more than 1 km in length.

(a) Safe areas shall be accessible for people who commence self-evacuation from the train as well as for emergency response services.

(b) One of the following solutions shall be selected for access points from a train to the safe areas:

   (1) Lateral and/or vertical emergency exits to the surface, where the surface is a safe area.

   (2) Cross-passages to an adjacent independent tunnel or to another dedicated safe area.

(c) An access point to a safe area shall be available at least every 1000m in a multiple track tunnel. In a single track tunnel, an access point shall be available at least every 500m.

(d)For points (b) and (c) above, alternative measures with an equivalent level of safety are allowed; the equivalent level of safety to passengers and staff shall be demonstrated using the Common Safety Methods on risk assessment.

(e) Doors giving access from the escape walkway to the safe area shall have a minimum clear opening of 1,4m wide and 2,0m high, alternatively it is permitted to use multiple doors next to each other which are less wide as long as the flow capacity of people is demonstrated to be equivalent or higher.

(f) After passing the doors, the clear width shall continue to be at least 1,5m wide and 2,3m high.

(g). The way the emergency response services access the safe area shall be described in the emergency plan.
4.2.1.5.3 Communication means in safe areas
This specification applies to all tunnels of more than 1 km in length.

(a) Communication shall be possible, either by mobile phone or by fixed connection from underground safe areas to the control centre of the IM.

4.2.1.5.4 Emergency lighting on escape routes
This specification applies to all tunnels of more than 0.5 km in length.

(a) Emergency lighting shall be provided to guide passengers and staff to a safe area in the event of an emergency.

(b) Illumination shall comply with the following requirements:

   (1) Single-track tube: at least on the side of the walkway

   (2) Double-track tube: on both sides.

   (3) Position of lights: above the walkway, as low as possible, so as not to interfere with the free space for the passage of persons, or built into the handrails.

   (4) The maintained illuminance shall be at least 1 lux at a horizontal plane at walkway level.

(c) Autonomy and reliability: an alternative power supply shall be available for an appropriate period of time after failure of the main power supply. The time required shall be consistent with the evacuation scenarios defined in the Emergency Plan.

(d) If the emergency light is switched off under normal operating conditions, it shall be possible to switch it on by both of the following means:

   (1) manually from inside the tunnel at intervals of 250 m

   (2) by the tunnel operator using remote control

4.2.1.5.5 Escape signage
This specification applies to all tunnels.

(a) The escape signage indicates the emergency exits, the distance and the direction to a safe area.

(b) All signs shall be designed according to the requirements of Directive 92/58/EC of 24 June 1992 concerning the provision of health and/or safety signs at work and to ISO 3864-1.

(c) Escape signs shall be installed on sidewalls along escape walkways.
(d) The maximum distance between escape signs shall be 50 m.

(e) Signs shall be provided in the tunnel to indicate the position of emergency equipment, where such equipment is present.

(f) All door leaves leading to emergency exits or cross-passage shall be marked.

4.2.1.6. Escape walkways
This specification applies to all tunnels of more than 0.5 km in length.

(a) Walkways shall be constructed in a single track tunnel on at least one side of the track and in a multiple track tunnel on both sides of the tunnel. In tunnels with more than two tracks, access to a walkway shall be possible from each track.

   (1) The width of the walkway shall be at least 0.8 m.
   (2) The minimum vertical clearance above the walkway shall be 2.3 m.
   (3) The height of the walkway shall be at top-of-rail level or higher.
   (4) Local constrictions caused by obstacles in the escape area shall be avoided. The presence of obstacles shall not reduce the minimum width to less than 0.7 m, and the length of the obstacle shall not exceed 2 m.

(b) Handrails shall be installed between 0.8m and 1.1m above walkway providing a route to a safe area.

   (1) Handrails shall be placed outside the required minimum clearance of the walkway.
   (2) Handrails shall be angled at 30° to 40° to the longitudinal axis of the tunnel at the entrance to and exit from an obstacle.

4.2.1.7 Designated stopping points
The following paragraphs 4.2.1.7.1 and 4.2.1.7.2 apply to tunnels considered individually. Where lines are fitted with several tunnels, it is required that a designated stopping point is available at a maximum distance of 5 km (resp: 20 km) from the portal of any tunnel.

The distribution of designated stopping points on a line shall be justified in the Emergency Plan.

4.2.1.7.1 Fire fighting points
This specification applies to all tunnels of more than 1 km in length.

(a) Fire fighting points shall be created outside both portals of every tunnel of >1km.
(b) The fire fighting points shall be equipped with water supply (minimum 800l/min during 2 hours) close to the intended stopping point of the train. The method of supplying the water to a stopped train shall be described in the emergency plan.

(c) The open air area around a fire fighting point shall be sufficiently large to allow passengers to move to a safe location.

(d) The fire fighting points shall be accessible to emergency response services. The way the emergency response services access the fire fighting point shall be described in the emergency plan.

4.2.1.7.2 Rescue station
This specification applies to all tunnels of more than 5 km in length.

(a) A rescue station shall be available at a maximum distance of 5 km or 20 km from the entry portal of the tunnel and from any other rescue station, according to the category of rolling stock that is planned to be operated.

(b) This is summarized in the table below:

<table>
<thead>
<tr>
<th>Maximum distance from the portals to a rescue station and between rescue stations</th>
<th>Rolling stock category according to paragraph 4.2.3.3.1</th>
</tr>
</thead>
<tbody>
<tr>
<td>5 km</td>
<td>Category A</td>
</tr>
<tr>
<td>20 km</td>
<td>Category B</td>
</tr>
</tbody>
</table>

(c) The intended stopping position of the affected train shall be indicated to the train driver. This shall not require specific on-board equipment (all TSI compliant trains must be able to use the tunnel).

(d) A safe area shall be accessible from the stopping position of the train. Dimensions of the evacuation route to the safe area shall take into consideration the evacuation time (as specified in § 4.2.3.4.1 (b) (2)) and the planned capacity of the trains (referred to in § 4.2.1.5.1 (b)) intended to be operated in the tunnel. The adequacy of the sizing of the evacuation route shall be demonstrated in the Emergency Plan.

(e) The safe area that is paired with the rescue station shall offer a standing surface of at least 0.5 m² per person.
(f) The rescue station shall be equipped with water supply (minimum 800l/min during 2 hours) close to the intended stopping point of the train. The method of supplying the water to a stopped train shall be described in the emergency plan.

(g) It shall be possible to switch off the traction energy supply and earth the electrical installation of rescue stations.

(h) The rescue station shall be equipped with access for emergency response services as defined in the emergency plan. (road access or rescue train for example)

(i) There shall be an access to the affected train for emergency response services without going through the safe area.

(j) The lay-out of an underground rescue station and its equipment shall take into account the control of smoke, in particular to protect people who use the self-evacuation facilities to access the safe area.

4.2.1.8 Emergency communication
This specification applies to all tunnels of more than 1 km in length.

(a) Radio communication between the train and the control centre shall be provided in each tunnel with GSM-R.

(b) Radio continuity shall be provided for permitting the emergency response services to communicate with their on-site command facilities. The system shall allow the emergency response services to use their own communication equipment.

4.2.2. Subsystem Energy
This section applies to the infrastructure part of the subsystem Energy.

4.2.2.1. Segmentation of overhead line or conductor rails
This specification applies to tunnels of more than 5 km in length.

(a) The traction energy supply system in tunnels shall be divided up into sections, each not exceeding 5 km. This specification applies only if the signalling system permits the presence of more than one train in the tunnel on each track simultaneously.

(b) The location of the switches shall be arranged so that the number of switches in the tunnel is minimised.

(c) Remote control and switching of each ‘switching section’ shall be provided.

(d) A means of communication and lighting shall be provided at the switching location to enable safe manual operation and maintenance of the switching equipment.
4.2.2.2. **Overhead line or conductor rail earthing**
This specification applies to all tunnels of more than 1 km length.

(a) Earthing devices shall be provided at tunnel access points and, if the earthing procedures allow the earthing of the single section, close to the separation points between sections. These shall be either fitted manually or remotely controlled fixed installations.

(b) Communication and lighting means necessary for earthing operations shall be provided.

(c) Procedures and responsibilities for earthing shall be defined between the infrastructure manager (IM) and the emergency response services, based on the emergency scenarios considered within the emergency plan.

4.2.2.3. **Electricity supply**
This specification applies to all tunnels of more than 1 km length.

(a) The electricity power distribution system in the tunnel shall be suitable for emergency response services equipment in accordance with the emergency plan for the tunnel. (Some national emergency response services groups may be self-sufficient in relation to power supply. In this case, the option of not providing power supply facilities for the use of such groups may be appropriate. Such a decision, however, must be described in the emergency plan.)

4.2.2.4. **Requirements for electrical cables in tunnels**
This specification applies to all tunnels of more than 1 km length.

(a) In case of fire, exposed cables shall have the characteristics of low flammability, low fire spread, low toxicity and low smoke density. These requirements are fulfilled by compatibility of the cables with EN 50267-2-1 (1998), EN 50267-2-2 (1998) and EN 61034-2:2005

4.2.2.5. **Reliability of electrical installations**
This specification applies to all tunnels of more than 1 km length.

(a) Electrical installations relevant for safety (Fire detection, emergency lighting, emergency communication and any other system identified by the Infrastructure Manager or contracting entity as vital to the safety of passengers in the tunnel) shall be protected against damage arising from mechanical impact, heat or fire.

(b) The distribution system shall be designed to enable the system to tolerate unavoidable damage by (for example) energizing alternative links.

(c) Autonomy and reliability: an alternative power supply shall be available for an appropriate period of time after failure of the main power supply. The time required shall be consistent with the evacuation scenarios defined in the Emergency Plan.
4.2.3. Subsystem rolling stock
(a) In the context of this TSI the subsystem rolling stock is subdivided into the following categories.

(1) Category A passenger rolling stock (including passenger locomotive) for operation on lines within the scope of this TSI, where the distance between designated stopping points or the length of tunnels does not exceed 5km.

(2) Category B passenger rolling stock (including passenger locomotive) for operation in all tunnels on the lines within the scope of this TSI, irrespective of the length of the tunnels.

(3) Freight locomotives for operation in all tunnels on the lines within the scope of this TSI, irrespective of the length of the tunnels. Locomotives designed to haul freight trains as well as passenger trains falls under both categories and shall respect requirements of both categories.

(4) Self-powered OTMs when in transport mode for operation in all tunnels on the lines within the scope of this TSI, irrespective of the length of the tunnels.

4.2.3.1 Measures to prevent fire
This section is applicable to all categories of rolling stock.

4.2.3.1.1 Material requirements
(a) The selection of materials and components shall take into account their fire behaviour properties.

(b) Materials used to construct rolling stock shall comply with EN 45545-2, where:

(1) Category A passenger rolling stock corresponds to operation category 2, and

(2) Category B passenger rolling stock corresponds to operation category 3, and

(3) Freight locomotives correspond to operation category 2

(4) OTMs correspond to operation category 1 and the requirements are only applicable to areas which are accessible to staff when the unit is in running mode.

(c) The certificate to prove compliance of a material with the standard, which shall be issued immediately after testing of this material, shall be not older than 5 years.
4.2.3.1.2 **Specific measures for flammable liquids**  
(a) Railway vehicles shall be provided with measures preventing a fire from occurring and spreading due to leakage of flammable liquids or gases.

4.2.3.1.3 **Hot axle box detection**  
Requirements are set out in the LOC&PAS TSI.

4.2.3.1.4 **Electric Freight locomotives**  
(a) Flammable liquids used as cooling medium in high voltage equipment of freight locomotives shall be compliant to the requirement R13 of table 7 of EN 45545-2:2009.

4.2.3.2 **Measures to detect and control fire**

4.2.3.2.1 **Portable fire extinguishers**  
This section is applicable to all categories of rolling stock designed to carry passengers.

(a) The unit shall be equipped with adequate and sufficient portable fire extinguishers.

(b) Water plus additive type fire extinguishers are deemed to be adequate for on-board rolling stock purposes.

4.2.3.2.2 **Fire detection systems**  
This section is applicable to all categories of rolling stock designed to carry passengers.

(a) The equipment and the areas on rolling stock that intrinsically impose a fire risk shall be equipped with a system that will detect fire at an early stage.

(b) Upon fire detection the driver shall be notified and appropriate automatic actions shall be initiated to minimize the subsequent risk to passengers and train staff.

(c) For sleeping compartments, the detection of a fire shall activate an acoustic and optical local alarm in the affected area that is sufficient to wake up the passengers.

4.2.3.2.3 **Automatic fire extinguishing system for freight locomotives**  
This section is applicable to diesel powered freight locomotives.

(a) Diesel powered freight locomotives shall be equipped with an automatic system capable of detecting and extinguishing a diesel fire.

4.2.3.2.4 **Fire spreading protection measures for passenger rolling stock**  
This section is applicable to category B passenger rolling stock.

(a) The rolling stock shall be equipped with adequate measures to control the spread of heat and fire effluents through the train.
(b) The conformity with this requirement shall be deemed to be satisfied by the verification of conformity to the following requirements:

(1) The rolling stock shall be equipped with full cross section partitions within passenger/staff areas of each vehicle, with a maximum separation of 30m which shall satisfy requirements for integrity for a minimum of 15 minutes. (Assuming the fire can start from either side of the partition), or with other Fire Spreading Prevention Measures (FSPM).

(2) The rolling stock shall be equipped with fire barriers that shall satisfy requirements for integrity and heat insulation for a minimum of 15 minutes.

i. Between the drivers cab and the compartment to the rear of it (assuming the fire starts in the rear compartment).

ii. Between combustion engine and adjacent passenger/staff areas. (Assuming the fire starts in the combustion engine)

iii. Between compartments with electrical supply line and/or traction circuit equipment and passenger/staff area. (Assuming the fire starts in the electrical supply line and/or the traction circuit equipment)

(3) The test shall be carried out in accordance with the requirements of EN 1363-1:1999 partition test.

(c) If FSPM are used instead of full cross section partitions, it shall be demonstrated that:

(1) They ensure that fire and smoke will not extend in dangerous concentrations over a length of more than 30m within the passenger/staff areas inside a unit, for at least 15 minutes after the start of a fire. The assessment of this parameter is an open point.

(2) They are installed in each vehicle of the unit, which is intended to carry passengers and/or staff,

(d) If the FSPM relies on reliability and availability of systems, components, or functions, their safety level shall be taken into account in the demonstration; in that case the global safety level to be met is an open point.

4.2.3.2.5 Fire spreading protection measures for freight locomotives
This section is applicable to locomotives designed to haul freight trains.

(a) Freight locomotives shall have a fire barrier to protect the driver's cab. These fire barriers shall satisfy requirements for integrity and heat insulation for a minimum of 15 minutes.
4.2.3.2.6. Fire protection for trains with passengers and freight or road vehicles
This section is applicable to units intended to be operated in trains transporting passengers and freight or road vehicles.

(a) The passenger coaches shall fulfil the relevant prescriptions for category B passenger rolling stock.

4.2.3.3 Requirements related to emergencies

4.2.3.3.1 Running capability
This section is applicable to category A and category B passenger rolling stock.

(a) The unit shall be designed so that, in the event of fire on-board, the running capability of the train will enable it to run to a designated stopping point.

(b) Compliance shall be demonstrated by application of EN 50553, in which the system functions impacted by a type 2 fire shall be:

1. braking for rolling stock in fire safety category A: this function shall not be impacted by a type 2 fire for a duration of 4 minutes.
2. braking and traction for rolling stock in fire safety category B: these functions shall not be impacted by a type 2 fire to an extend that prevents the rolling stock running at a minimum speed of 80 km/h for 15 minutes.

4.2.3.3.2 Smoke control
This section is applicable to category B passenger rolling stock.

(a) In case of fire, the distribution of fumes shall be minimised.

1. To prevent outside smoke from entering the unit, it shall be possible to switch-off or close all means of external ventilation at train level. This requirement is verified on the rolling stock subsystem at unit level. An operational rule shall ensure the operational functionality at train level.

2. To prevent smoke that could be inside a vehicle from spreading, is shall be possible to switch-off the ventilation and recirculation at vehicle level, this may be achieved by switching off the ventilation at unit level.

4.2.3.3.3. Communication means on trains
Requirements are set out in the LOC&PAS TSI.

4.2.3.3.4. Passenger alarm
Requirements are set out in the LOC&PAS TSI.
4.2.3.3.5. Emergency lighting system in the train
Requirements are set out in the LOC&PAS TSI.

4.2.3.4 Requirements related to evacuation

4.2.3.4.1 Passenger emergency exits
This section is applicable to units designed to carry passengers.

(a) Definitions and clarifications

(1) Emergency exit: train borne provision to allow people inside the train to get out of the
train in case of an emergency. An external passenger door is a specific type of emergency
exit.

(2) Through route: route through the train which can be entered and exited from different
ends and which permits the movement of passengers and staff, along the longitudinal axis
of the train without obstruction. Interior doors on the through route which are intended to
be used by passengers in normal service and which can also be opened in case of power
failure are considered not to obstruct the movement of passengers and staff.

(3) Passenger area: Area to which passengers have access without particular
authorisation.

(4) Compartment: Passenger area or staff area, which cannot be used as a through route
for passengers or staff respectively.

(b) Requirements

(1) Emergency exits shall be provided in sufficient quantity on both sides of each vehicle.
They shall be accessible and sufficient in size to allow the release of persons.

(2) The number of the doors and their dimensions shall allow the complete evacuation
within three minutes by passengers without their baggage. It is permitted to consider that
passengers with reduced mobility are to be assisted by other passengers or staff, and that
wheelchair users are evacuated without their wheelchair. Verification of this requirement
shall be made by a physical test considering an occupation level of 100% of the seats,
under normal operating conditions.

4.2.3.4.2 Driver’s cab emergency exits
This section is applicable to units fitted with a cab.

(a) In an emergency situation, evacuation of the train crew from the driver’s cab and access to
the interior of the cab by the emergency response services shall be possible on both sides of the
cab by using one of the following emergency exit means: external doors, or side windows, or emergency hatches.

(b) In all cases, the emergency exit means shall provide a minimum clearance (free area) of 2 000 cm\(^2\) with a minimum inner dimension of 400 mm to allow the release of trapped persons.

(c) Front position driver’s cabs shall have at least an interior exit; this exit shall give access to an area of a minimum length of 2 metres, of a minimum clearance of height 1 700 mm x width 430 mm, and its floor shall be free of any obstruction; the above area shall be located on-board the unit, and can be an interior area or an area opened to the outside.

4.3. Functional and technical specifications of the interfaces

4.3.1. Interfaces with the Infrastructure subsystem

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<th>INF TSI</th>
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<tbody>
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<td>Parameter</td>
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4.3.2. Interfaces with the Energy subsystem

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4.3.3. Interfaces with the Control-Command-Signalling subsystem

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<td>SRT TSI</td>
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4.3.4. Interfaces with the Traffic Management and Operation subsystem

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4.3.5. Interfaces with the Rolling Stock subsystem

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</thead>
<tbody>
<tr>
<td>SRT TSI</td>
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<tr>
<td>Parameter</td>
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</table>
### Interface with the rolling stock subsystem

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<th>SRT TSI</th>
<th>LOC&amp;PAS TSI</th>
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<tbody>
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### 4.3.6. Interfaces with the PRM TSI

<table>
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<tr>
<th>SRT TSI</th>
<th>PRM TSI</th>
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<tbody>
<tr>
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<td>Clause</td>
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</table>

### 4.4. Operating rules

The following operating rules do not form any part of the assessment of the structural subsystems.

#### 4.4.1 Emergency rule

These rules apply to all tunnels.

In light of the essential requirements in Chapter 3, the operating rules specific to tunnel safety are:

(a) The operational rule is to monitor the train condition before entering a tunnel in order to prevent a defective train from entering a tunnel. This can be done through line side hot axle box detection or other predictive equipment or through on-board equipment.

(b) In case of an incident outside the tunnel, the operational rule is to stop the train before entering a tunnel.

(c) In case of an incident the operational rule is to drive the train out of a tunnel, or to the next rescue station.

#### 4.4.2 Tunnel emergency plan

These rules apply to tunnels of > 1km.
(a) An emergency plan shall be developed under the direction of the Infrastructure Manager(s), in co-operation with the railway undertakings, the emergency response services and the relevant authorities for each tunnel.

(b) The emergency plan shall be consistent with the self-rescue, evacuation, fire-fighting and rescue facilities provided.

4.4.3 Exercises
These rules apply to tunnels of > 1km.

(a) Prior to opening of a single tunnel or a series of tunnels, a full-scale exercise comprising evacuation and rescue procedures, involving all categories of personnel defined within the emergency plan, shall take place.

(b) The emergency plan shall define how all organisations involved can be familiarised with the infrastructure and how often visits to the tunnel and table top or other exercises have to take place.

4.4.4. Isolation and Earthing procedures
These rules apply to all tunnels.

(a) If the emergency response services require disconnection of the traction power supply, they shall receive a guarantee that the relevant sections of catenaries or conductor rails have been disconnected before entering the tunnel or a section of the tunnel.

(b) It is the responsibility of the infrastructure manager to disconnect the traction power supply.

(c) The responsibility and procedure for earthing shall be defined in the emergency plan. Provision shall be made for isolation of the section in which the incident has taken place.

4.4.5. Provision of on-train safety and emergency information to passengers
(a) Railway undertaking shall inform passengers of on board emergency and safety procedures related to tunnels.

(b) When such information is in written or spoken form, it shall be presented in the language of the country the train is running in as a minimum, plus English.

4.4.6. Operational rules related to trains running in tunnels
(a) TSI-conform vehicles shall be permitted to operate in tunnels in accordance with the following principles:
(1) Category A passenger rolling stock shall be deemed to comply with the tunnel safety requirements for rolling stock on lines where the distance between rescue stations, or the length of tunnels does not exceed 5km.

(2) Category B passenger rolling stock shall be deemed to comply with the tunnel safety requirements for rolling stock on all lines.

(3) Freight locomotives shall be deemed to comply with the tunnel safety requirements for rolling stock on all lines.

(4) OTMs shall be deemed to comply with the tunnel safety requirements for rolling stock all lines.

(5) Freight trains shall be admitted in all tunnels according to the conditions specified in § 1.1.5. Operational rules may manage the safe operation of freight and passenger traffic, e.g. by separating these types of traffic.

(b) Member States may permit operation of Category A rolling stock on lines where the distance between rescue stations, or the length of tunnels exceeds 5km, in case there are no passengers on board.

4.5. Maintenance rules

4.5.1. Infrastructure
(a) Before placing a tunnel in service a maintenance file shall be prepared setting out at least:

(1) Identification of elements which are subject to wear, failure, ageing or other forms of deterioration or degradation,

(2) Specification of the limits of use of the elements under (1) and a description of the measures to be taken to prevent that these limits are exceeded,

(3) Identification of those elements which are relevant to emergency situations and management,

(4) Necessary periodic checks and servicing activities to ensure the proper functioning of the parts and systems under (3) to ensure permanent compliance with the present TSI.

(b) At the moment of placing a line in service the infrastructure manager shall have a maintenance plan containing the elements listed under (a) together with at least the following:

(a) A set of values for intervention limits and alert limits,
(b) A statement about the methods, professional competences of staff and personal protective safety equipment necessary to be used,

(c) The rules to be applied for the protection of people working on or near the track,

(d) The means used to check that the compliance with this TSI is permanently maintained.

4.5.2. Maintenance of rolling stock
The maintenance requirements for rolling stock are set out in the LOC&PAS TSI. Maintenance activities shall ensure that compliance with the present TSI is permanently maintained.

4.6. Professional qualifications
The professional qualifications of staff required for the operation specific to tunnel safety in the subsystems concerned by this TSI and in accordance with the operating rules in clause 4.4. of this TSI are as follows:

4.6.1. Tunnel specific competence of the train crew and other staff
All professional staff driving and accompanying a train, as well as staff that authorise train movements, shall have the knowledge and the ability to apply that knowledge to manage degraded situations in the event of an incident.

For staff undertaking the tasks of accompanying trains, the general requirements are specified in the OPE TSI.

All train crew shall have knowledge of the appropriate safety behaviour in tunnels and in particular be able to evacuate the people on board a train, when the train is stopped in a tunnel.

This involves instructing the passengers, e.g. to go to the next coach or to exit the train, and to lead them outside the train to a safe place.

Auxiliary train staff (e.g. catering, cleaning), who do not form part of the train crew as defined above shall, in addition to their basic instruction, be trained to support the actions of the train crew (1).

Professional training of engineers and managers responsible for maintaining and operating the subsystems shall include the subject of safety in railway tunnels.

1) Train crew is defined in the OPE TSI
4.7. Health and safety conditions
The health and safety conditions of staff required for operation specific to tunnel safety in the subsystems concerned by this TSI and for the implementation of the TSI are as follows:

4.7.1. Self-rescue device
Manned traction units of freight trains shall be equipped with a self-rescue device for the driver and other persons on board, satisfying the specifications of one of the two standards EN 402:2003 or 403:2004.

The RU has to choose one out of the two different solutions defined in these standards

4.8. Infrastructure and Rolling stock registers

4.8.1. Register of infrastructure
See annex A of this TSI

4.8.2. Rolling Stock Register
See annex B of this TSI

5. INTEROPERABILITY CONSTITUENTS
There are no interoperability constituent defined in the SRT TSI. However, the area of use of some of the Interoperability Constituents defined in other TSIs (LOC&PAS, PRM) is affected by the category of rolling stock in which the IC will be installed.

6. ASSESSMENT OF CONFORMITY AND/OR SUITABILITY FOR USE OF THE CONSTITUENTS AND VERIFICATION OF THE SUBSYSTEM

6.1. Interoperability constituents
Not applicable, since no interoperability constituent has been defined in SRT TSI.

6.2. Subsystems

6.2.1. EC verification (general)
The EC verification of a Subsystem shall be performed according to one or a combination of the following modules as defined in Decision 2010/713/EU:

Module SB: EC-type examination

Module SD: EC verification based on quality management system of the production process

Module SF: EC verification based on product verification
Module SG: EC verification based on unit verification

Module SH1: EC verification based on full quality management system plus design examination

The approval process and the contents of the assessment shall be defined between the applicant and a Notified Body according to the requirements defined in this TSI and in conformance with the rules set out in section 7 of this TSI.

6.2.2. Procedures for EC verification of a subsystem (modules)
The applicant shall choose one of the modules or module combinations indicated in the following table.

Assessment procedures

<table>
<thead>
<tr>
<th>Subsystem to be assessed</th>
<th>Module SB+SD</th>
<th>Module SB+SF</th>
<th>Module SG</th>
<th>Module SH1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rolling Stock Subsystem</td>
<td>X</td>
<td>X</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Energy subsystem</td>
<td></td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Infrastructure subsystem</td>
<td></td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
</tbody>
</table>

The characteristics of the subsystem to be assessed during the relevant phases are indicated in Annex E.

6.2.3. Existing solutions
If an existing solution is already assessed for an application under comparable conditions and in service, then the following process applies:

The applicant shall demonstrate that results of tests and verifications for the previous assessment of the application are in conformity with the requirements of this TSI. In this case the previous type assessment of the subsystem related characteristics shall remain valid in the new application.

6.2.4. Innovative solutions
Innovative solutions are technical solutions which do meet the functional requirements and spirit of this TSI, but are not fully in compliance with it.

To request the use of an innovative solution, the applicant shall submit the proposed innovative solution to the Commission for analysis. The file should clarify which TSI requirement(s) are not met and should substantiate why the innovative solution should be accepted.
In case the analysis results in a favourable opinion, the appropriate functional and interface specifications as well as the assessment method which are necessary to be included in the TSI in order to allow the use of this constituent will be developed.

The appropriate functional and interface specifications and the assessment methods so produced shall be incorporated in the TSI by the revision process. By a decision taken in accordance with Article 29 of Directive 2008/57/EC, the innovative solution may be permitted to be used before the revised TSI is in force.

6.2.5. Assessment of maintenance
According to Article 18 (3) of Directive 2008/57/EC, a notified body shall be responsible for compiling the technical file, containing the documentation requested for operation and maintenance.

The notified body shall verify only that the documentation requested for operation and maintenance, as defined in clause 4.5 of this TSI, is provided. The notified body is not required to verify the information contained in the documentation provided.

6.2.6. Assessment of operational rules
In conformity with Articles 10 and 11 of Directive 2004/49EC, Railway Undertakings and Infrastructure Managers shall demonstrate compliance with the requirements of this TSI within their safety management system when applying for any new or amended safety certificate or safety authorisation. Compliance with operation rules of this TSI does not require assessment by a Notified Body.

6.2.7. Additional requirements for assessment of specifications concerning the IM

6.2.7.1. Prevent unauthorised access to emergency exits and equipment rooms
The assessment shall confirm that:

- Emergency exit doors to the surface and doors to technical rooms are provided with suitable locks
- The locks provided are consistent with the overall strategy for security for the tunnel and adjacent infrastructure
- Emergency exits are not lockable from the inside and shall be able to be opened by evacuating persons
- Access arrangements are in place for the emergency response services
6.2.7.2. Fire protection requirements for structures
The Notified Body shall assess conformity with the fire protection requirements for structures, defined in 4.2.1.2, by using the results of calculations made by the applicant.

6.2.7.3. Facilities for self-rescue, rescue and evacuation in the event of an incident
The Notified Body shall check that the solution adopted is clearly identified by a statement in the technical file and is in conformity with the requirements of 4.2.1.5. For assessing the evolution of the conditions in the safe area during an incident, the Notified Body shall verify that the doors and structures separating the safe area from the tunnel can withstand the elevation of temperature in the closest tube. Conditions in that tube are determined by the temperature-time curve chosen in § 4.2.1.2 (b) or, if that clause is not applicable, by a representative temperature-time curve.

6.2.7.4. Access and equipment for emergency response services
The Notified Body shall confirm, by verification of the technical file and also considering evidence of consultation with the emergency response services, that the corresponding requirements is in section 4.2.1 and 4.4 have been met:

6.2.7.5. Reliability of electrical installations
The Notified Body shall confirm only that a failure mode assessment complying with the functional requirements of 4.2.2.5 has been carried out.

6.2.8. Additional requirements for assessment of specifications concerning the RU

6.2.8.1 Self-rescue device

7. IMPLEMENTATION
This section defines the implementation strategy for the SRT TSI.

This TSI does not require modifications of subsystems which are already in service unless they are upgraded or renewed.

If not defined otherwise in section 7.5 ‘Specific Cases’, all new TSI compliant category B rolling stock is deemed to achieve a higher fire and tunnel safety level than non-TSI compliant rolling stock. This assumption is used to justify the safe operation of new TSI-compliant rolling stock in old non-TSI compliant tunnels. Therefore, all TSI compliant category B trains are deemed to be suitable for the safe integration in accordance with Article 15(1) of Directive 2008/57/EC with all non-TSI compliant tunnels within the geographical scope of this TSI. In addition, the checks related to technical compatibility as referred to in Directive 2008/57/EC in Articles 15(1), 22(2)(b) and 23(4), shall not concern basic parameters defined for rolling stock in this TSI.
Notwithstanding the above, measures over and above those set out in this TSI may be necessary to achieve the desired tunnel safety level. Such measures may only be imposed on the subsystems Infrastructure, Energy and Operations and shall not restrict the authorisation or use of TSI compliant rolling stock.

7.1. Application of this TSI to new subsystems

7.1.1. General
This TSI is applicable to all subsystems in its scope which are placed into service after the date of application of this TSI, except when defined otherwise in the sections below.

The application of this TSI to OTMs is voluntary. Where OTMs are not assessed and declared to be in conformity with this TSI, it shall be subject to national rules. In the latter case Articles 24 and 25 of Directive 2008/57/EC apply.

7.1.2. New rolling stock
For new rolling stock, the implementation rules as set out in the clause 7.1.1 of the LOC&PAS TSI shall be applied.

7.1.2.1 Particular transitional rules for material requirements
This paragraph is applicable to all units of rolling stock for which a contract is signed during a period of 2 years after entry into force of this TSI.

For those units, it is permitted to meet the requirements of Section 4.2.3.1.1 Material Requirements by using materials which are compliant with one of the following sets of standards:

- The British standards BS6853, GM/RT2130 issue 3;
- The German standard DIN 5510-2:2009 including toxicity measurements.

During this period, it is permitted to substitute individual materials by materials which are compliant with EN 45545, or in case EN 45545 is not available TS 45545-2:2009.

7.1.3 New Infrastructure
All tunnel projects, of which the contract for construction is awarded after the publication of this TSI, shall be realised in compliance with this TSI. Exceptions can be made for projects whose planning/design stage has reached a point where a change in the technical specification would lead to unacceptable delays and/or costs.
7.2. Application of this TSI to subsystems already in service

7.2.1. Upgrade or renewal of rolling stock
In case of renewal or upgrade of existing rolling stock, the LOC&PAS TSI guidance shall be applied.

7.2.2. Upgrade and renewal measures for tunnels
Taking into consideration Directive 2008/57/EC, Article 20(1), any modification of the basic parameters of the structural subsystems as set out in this TSI is deemed to affect the overall safety level of the infrastructure subsystem concerned. Therefore, Member States shall decide to which extend this TSI needs to be applied to the project. If not defined otherwise in section 7.5 ‘Specific Cases’, the result of renewal or upgrade works shall ensure compatibility of the fixed installations with SRT TSI compliant rolling stock.

Guidance to Member States: In case of upgrade and renewal of existing tunnels, this TSI shall be implemented as far as feasible within the project constraints. If a TSI requirement cannot be fully met, it is permitted to improve the original situation towards the TSI defined performance.
During upgrade or renewal the safety level of the fixed tunnel installations shall be maintained or improved.

7.2.3. Operations subsystem
Operational aspects and their implementation are set out in the OPE TSI.

When commissioning an upgraded or renewed tunnel, the requirements for new tunnels of this TSI apply.

7.3. TSI revision
- to be defined-

7.4. Exceptions for national, bilateral, multilateral or multinational agreements
- to be defined-

7.5. Specific cases

7.5.1. Introduction

7.5.2. List of specific cases
- to be defined-
Annex: open points

Fire spreading protection measures

The assessment of the demonstration that a FSPM ensures that fire and smoke will not extend in dangerous concentrations over a length of more than 30m within the passenger/staff areas inside a unit, for at least 15 minutes after the start of a fire is an open point.

The safety level to be met by systems, components, or functions participating to the FSPM and the resulting global safety level of the FSPM is an open point.