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ANNEX 1

ANNEX

to the

COMMISSION REGULATION

concerning the technical specification for interoperability relating to "safety in railway tunnels" of the rail system of the European Union

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1.	Introduction	4
1.1.	Technical scope	4
1.1.1.	Scope related to tunnels	4
1.1.2.	Scope related to rolling stock	4
1.1.3.	Scope related to operational aspects	4
1.1.4.	Risk scope, risks that are not covered by this TSI	5
1.2.	Geographical scope	5
2.	Definition of aspect/scope	5
2.1.	General	5
2.2.	The risk scenarios	6
2.2.1.	‘Hot’ incidents: Fire, explosion followed by fire, emission of toxic smoke or gases..	7
2.2.2.	‘Cold’ incidents: collision, derailment	7
2.2.3.	Prolonged stop	7
2.2.4.	Exclusions	7
2.3.	The role of emergency response services	8
2.4.	Definitions	8
3.	Essential requirements	10
4.	Characterisation of the subsystem	11
4.1.	Introduction	11
4.2.	Functional and technical specifications of the subsystems	12
4.2.1.	Subsystem Infrastructure	12
4.2.2.	Subsystem Energy	16
4.2.3.	Subsystem rolling stock	17

4.3.	Functional and technical specifications of the interfaces.....	19
4.3.1.	Interfaces with the Control-Command-Signalling subsystem	19
4.3.2.	Interfaces with the Traffic Management and Operation subsystem.....	19
4.4.	Operating rules	20
4.4.1.	Emergency rule	20
4.4.2.	Tunnel emergency plan	20
4.4.3.	Exercises	20
4.4.4.	Isolation and Earthing procedures.....	21
4.4.5.	Provision of on-train safety and emergency information to passengers	21
4.4.6.	Operational rules related to trains running in tunnels	21
4.5.	Maintenance rules	22
4.5.1.	Infrastructure	22
4.5.2.	Maintenance of rolling stock.....	22
4.6.	Professional qualifications	22
4.6.1.	Tunnel specific competence of the train crew and other staff	22
4.7.	Health and safety conditions	23
4.7.1.	Self-rescue device	23
4.8.	Infrastructure and Rolling stock registers	23
4.8.1.	Register of infrastructure.....	23
4.8.2.	Rolling Stock Register	23
5.	Interoperability constituents.....	23
6.	Assessment of conformity and/or suitability for use of the constituents and verification of the subsystem	23
6.1.	Interoperability constituents.....	23
6.2.	Subsystems.....	23
6.2.1.	EC verification (general).....	23
6.2.2.	Procedures for EC verification of a subsystem (modules).....	24
6.2.3.	Existing solutions	24
6.2.4.	Innovative solutions	24
6.2.5.	Assessment of maintenance	24
6.2.6.	Assessment of operational rules.....	24

6.2.7.	Additional requirements for assessment of specifications concerning the IM	25
6.2.8.	Additional requirements for assessment of specifications concerning the RU.....	26
7.	Implementation	26
7.1.	Application of this TSI to new subsystems.....	26
7.1.1.	General	26
7.1.2.	New rolling stock	26
7.1.3.	New Infrastructure	26
7.2.	Application of this TSI to subsystems already in service	26
7.2.1.	Upgrade or renewal of rolling stock.....	26
7.2.2.	Upgrade and renewal measures for tunnels	27
7.2.3.	Operation subsystem	27
7.2.4.	Operation of new rolling stock in existing tunnels	27
7.3.	Specific cases	27
7.3.1.	General	27
7.3.2.	Operational rules related to trains running in tunnels (clause 4.4.6)	27
Appendix A: Standards or Normative Documents Referred to in this TSI.....		28
Appendix B: Assessment of the Subsystems		29

1. INTRODUCTION

1.1. Technical scope

- (a) This TSI concerns the following subsystems as defined in Directive 2008/57/EC: control-command and signalling ('CCS'), infrastructure ('INF'), energy ('ENE'), operation ('OPE'), and rolling stock (locomotives and passenger units 'LOC&PAS').
- (b) The purpose of this TSI is to define a coherent set of tunnel specific measures for the infrastructure, energy, rolling stock, control-command and signalling and operation subsystems, thus delivering an optimal level of safety in tunnels in the most cost-efficient way.
- (c) It shall permit free movement of vehicles which are in compliance with this TSI to run under harmonised safety conditions in railway tunnels.
- (d) Only measures, designed to reduce specific tunnel risks, are prescribed in the present TSI. Risks related to pure railway operation, such as derailment and collision with other trains, are addressed by general railway safety measures.
- (e) The existing safety level shall not be reduced in a country as stipulated in Directive 2004/49/EC Art 4.1. Member states can retain more stringent requirements, as long as these requirements do not prevent the operation of TSI compliant trains.
- (f) Member States can prescribe new and more stringent requirements for specific tunnels in accordance with Directive 2004/49/EC Art 8; such requirements shall be notified to the Commission before they are introduced. Such higher requirements must be based on a risk analysis and must be justified by a particular risk situation. They shall be the result of a consultation of the Infrastructure Manager and of the relevant authorities for emergency response, and they shall be subject to a cost-benefit assessment.

1.1.1. *Scope related to tunnels*

- (a) This TSI applies to new, renewed and upgraded tunnels which are located on the European Union rail network, and which are in accordance with the definition in clause 2.4 of this TSI.
- (b) Stations that are in tunnels shall be in conformity with the national rules on fire safety. When they are used as safe areas, they shall comply only with the specifications for clauses 4.2.1.5.1, 4.2.1.5.2 and 4.2.1.5.3. of this TSI. When they are used as fire fighting points, they shall comply only with the specifications of clauses 4.2.1.7 (c) and 4.2.1.7 (e) of this TSI.

1.1.2. *Scope related to rolling stock*

- (a) This TSI applies to rolling stock which is in the scope of the LOC&PAS TSI.
- (b) Rolling stock categorised "A" or "B" according to the previous SRT TSI (Commission Decision 2008/163/EC) shall retain its category in this TSI as defined in clause 4.2.3.

1.1.3. Scope related to operational aspects

- (a) This TSI applies to the operation of all units of rolling stock which are running in tunnels described in clause 1.1.1.

1.1.3.1. Operation of freight trains

- (a) When each vehicle of a freight train or dangerous goods train as defined in clause 2.4 complies with the structural TSIs which apply to it (LOC&PAS, SRT, NOI, CCS, WAG) and when the dangerous goods wagon(s) comply with Annex II of Directive 2008/68/EC, the freight train or dangerous goods train operated according to the requirements of the OPE TSI shall be allowed to circulate in all tunnels of the European Union rail system.

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

- (a) 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 people in the neighbourhood of a tunnel where collapse of the structure could have catastrophic consequences.
- (b) Where a risk analysis comes to the conclusion that other tunnel incidents might be of relevance, specific measures to deal with these scenarios shall be defined.
- (c) Risks not covered by this TSI are as follows:
- (1) Health and safety of staff involved in maintenance of the fixed installations in tunnels.
 - (2) Financial loss due to damage to structures and trains, and consequently the losses resulting from non-availability of the tunnel for repairs.
 - (3) Trespass into the tunnel through the tunnel portals.
 - (4) Terrorism, as a deliberate and premeditated act which is designed to cause wanton destruction, injury and loss of life.

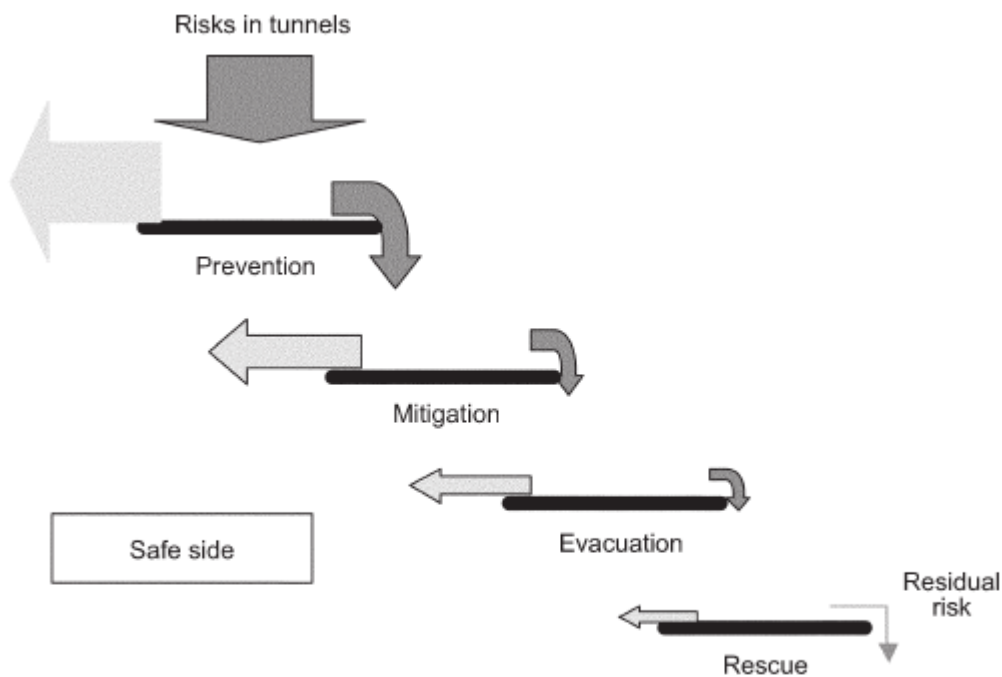
1.2. Geographical scope

- (a) The geographical scope of this TSI is the network of the whole rail system, composed of:
- The trans-European conventional rail system network (TEN) as described in Annex I section 1.1 “Network” of Directive 2008/57/EC
 - The trans-European high-speed rail system network (TEN) as described in Annex I section 2.1 “Network” of Directive 2008/57/EC
 - Other parts of the network of the whole rail system, following the extension of scope described in Annex I section 4 of Directive 2008/57/EC,
- and excludes the cases referred to in Article 1(3) of Directive 2008/57/EC.

2. DEFINITION OF ASPECT/SCOPE

2.1. General

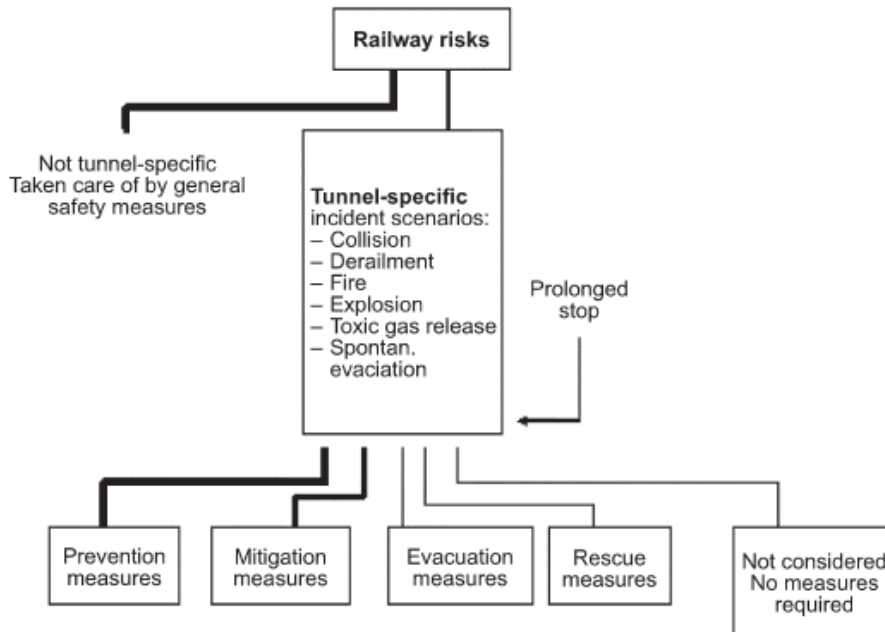
- (a) The line of defence for the promotion of safety in tunnels comprises four successive layers: Prevention, mitigation, evacuation and rescue.
- (b) The largest contribution is in the area of prevention followed by mitigation and so on.
- (c) The layers of safety combine to produce a low level of residual risk.



- (d) A major feature of railways is their inherent ability to prevent accidents through the traffic running on a guide-way and generally being controlled and regulated using a signalling system.

2.2. The risk scenarios

- (a) This TSI provides measures which could prevent or mitigate the difficulty of evacuation or rescue operations following a tunnel-specific railway incident.



- (b) Relevant measures have been identified, which will control or significantly reduce the risks arising from the tunnel-specific incident scenarios identified above.
- (c) 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.
- (d) The measures prescribed can be considered as a response to the following three types of incident.

2.2.1. *'Hot' incidents: Fire, explosion followed by fire, emission of toxic smoke or gases.*

- (a) The main danger is fire. Fire is understood as a combination of heat, flames and smoke.
- (b) 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.

Ventilation is shut down to prevent smoke distribution. For rolling stock of category B, the passengers in the affected area will move to a non-affected area of the train where they are protected from fire and fumes

Whenever possible the train leaves the tunnel. Passengers are evacuated, directed by the train crew, or by self-rescue, to a safe area in the open air.

If appropriate, the train may stop at a fire fighting point inside the tunnel. Passengers are evacuated, directed by the train crew, or by self-rescue, to a safe area.

If a fire extinguishing system can extinguish the fire, the incident will become a 'cold' incident.

- (c) The fire starts in the tunnel.

If fire starts in a tunnel or in a technical room, the driver is instructed to act appropriately depending on the local circumstances in compliance with the tunnel-specific incident scenarios, described in the Emergency Plan.

2.2.2. *'Cold' incidents: collision, derailment*

- (a) The tunnel specific measures concentrate on access/egress facilities to support evacuation and the intervention of the emergency response services.
- (b) The difference compared to the hot incidents is that there is no time constraint due to the presence of a hostile environment created by a fire.

2.2.3. *Prolonged stop*

- (a) Prolonged stop (an unplanned stop in a tunnel, without the occurrence of a hot or cold incident, for longer than 10 minutes) is not by itself a threat to passengers and staff.
- (b) However it may lead to panic and to spontaneous, uncontrolled evacuation that exposes people to dangers present in a tunnel environment.

2.2.4. *Exclusions*

- (a) The scenarios that have not been dealt with are listed in clause 1.1.4.

2.3. The role of emergency response services

- (a) The definition of the role of the emergency response services is a matter for the relevant national legislation.
- (b) The measures specified in this TSI for rescue are based on the assumption that the emergency response services intervening in a tunnel incident shall protect lives as a priority.
- (c) It is assumed that they are expected to:
- (1) 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 the final place of safety
- (2) In a ‘cold’ incident type
- Rescue people
 - Provide initial help to people with critical injuries
 - Free trapped people
 - Conduct evacuation to the final place of safety
- (d) No demands on time or performance requirements are included in this TSI.
- (e) Considering that incidents in railway tunnels involving multiple fatalities are rare, it is implicit that there might be events, with an extremely low probability, for which even well-equipped emergency response services would be restricted, such as a major fire involving a freight train.
- (f) If the expectations of the emergency response services expressed in emergency plans go beyond the assumptions described above, then additional measures or tunnel equipment can be provided.

2.4. Definitions

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

- (a) **Railway tunnel:** A railway tunnel is an excavation or a construction around the track provided to allow the railway to pass 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. Where certain requirements apply only to longer tunnels, thresholds are mentioned in the relevant clauses.
- (b) **Safe area:** a safe area is a temporary survivable space, inside or outside the tunnel, for passengers and staff to find refuge after they have evacuated from a train.
- (c) **Fire fighting point:** a fire fighting point is a defined location, inside or outside the tunnel, where fire fighting equipment can be used by rescue services and where passengers and staff can evacuate from a train.
- (d) **Technical rooms:** 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.
- (e) **Freight train:** 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.

- (f) All definitions related to rolling stock are defined in the LOC&PAS TSI and the WAG 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.

Element of the infrastructure sub-system	Ref. Clause	Safety	Reliability Availability	Health	Environmental protection	Technical compatibility
Prevent unauthorised access to emergency exits and technical rooms	4.2.1.1.	2.1.1				
Fire resistance of tunnel structures	4.2.1.2.	1.1.4 2.1.1				
Fire reaction of building material	4.2.1.3.	1.1.4 2.1.1		1.3.2	1.4.2	
Fire detection	4.2.1.4.	1.1.4 2.1.1				
Evacuation facilities	4.2.1.5.	1.1.5 2.1.1				
Escape walkways	4.2.1.6.	2.1.1				
Fire fighting points	4.2.1.7.	2.1.1				1.5
Emergency communication	4.2.1.8.	2.1.1				

Element of the energy sub-system	Ref. Clause	Safety	Reliability Availability	Health	Environmental protection	Technical compatibility
Segmentation of overhead line or conductor rails	4.2.2.1.	2.2.1				

Element of the energy sub-system	Ref. Clause	Safety	Reliability Availability	Health	Environmental protection	Technical compatibility
Overhead line or conductor rail earthing	4.2.2.2.	2.2.1				
Electricity supply	4.2.2.3.	2.2.1				
Requirements for electrical cables in tunnels	4.2.2.4.	2.2.1 1.1.4		1.3.2	1.4.2	
Reliability of electrical installations	4.2.2.5.	2.2.1				

Element of the rolling stock sub-system	Ref. Clause	Safety	Reliability Availability	Health	Environmental protection	Technical compatibility
Measures to prevent fire	4.2.3.1	1.1.4 2.4.1		1.3.2	1.4.2	
Measures to detect and control fire	4.2.3.2	1.1.4 2.4.1				
Requirements related to emergencies	4.2.3.3	2.4.1	2.4.2			1.5 2.4.3
Requirements related to evacuation	4.2.3.4	2.4.1				

4. CHARACTERISATION OF THE SUBSYSTEM

4.1. Introduction

- (a) The European Union rail system, to which Directive 2008/57/EC applies and of which the subsystems are parts, has been developed to become an integrated system for which the consistency must be verified.
- (b) 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.

- (c) 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

- (a) 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 that is sufficiently long to permit self-rescue, evacuation of passengers and staff and intervention of the emergency response services. That period of time shall be in accordance with the evacuation scenarios considered 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 main structure of the tunnel shall withstand the temperature of the fire for a period of time that is sufficient to allow evacuation of the endangered tunnel zones and neighbouring structures. This period of time shall be reported in the emergency plan.

4.2.1.3. Fire reaction of building material

This specification applies to all tunnels.

- (a) This specification applies to construction products and building elements inside tunnels.
- (b) Tunnel building material shall fulfil the requirements of classification A2 of Commission Decision 2000/147/EC. Non-structural panels and other equipment shall fulfil the requirements of classification B of Commission Decision 2000/147/EC.
- (c) Materials that would not contribute significantly to a fire load shall be listed. They are allowed to not comply with the above.

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 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 the evacuation of trains that use 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 passengers and staff during the time needed for the complete evacuation from the safe area to a final place of safety.
- (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.
- (d) The lay-out of an underground safe area and its equipment shall take into account the control of smoke, in particular to protect people who use the self-evacuation facilities.

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 the emergency response services.
- (b) One of the following solutions shall be selected for access points from a train to the safe area:
 - (1) Lateral and/or vertical emergency exits to the surface. These exits shall be provided at least every 1 000 m.
 - (2) Cross-passages between adjacent independent tunnel tubes, which enable the adjacent tunnel tube to be employed as a safe area. Cross-passages shall be provided at least every 500 m.
 - (3) Alternative technical solutions providing a safe area with a minimum equivalent safety level are permitted. The equivalent level of safety for passengers and staff shall be demonstrated using the Common Safety Method on risk assessment.
- (c) 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.

- (d) After passing the doors, the clear width shall continue to be at least 1,5m wide and 2,25m high.
- (e) The way in which 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 Infrastructure Manager.

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: on the side of the walkway
 - (2) Multiple-track tube: on both sides of the tube
 - (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 and reported 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 the specification referenced in appendix A, index 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 doors 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 tube on at least one side of the track and in a multiple track tunnel tube on both sides of the tunnel tube. In tunnel tubes 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 2.25m.
 - (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) Continuous handrails shall be installed between 0.8m and 1.1m above the 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. Fire fighting points

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

- (a) For the purpose of this clause, two or more consecutive tunnels will be considered as a single tunnel unless both of the following conditions are met:
 - (1) The separation between tunnels in open air is longer than the maximum length of the train intended to be operated on the line + 100 m and

- (2) The open air area and track situation around the separation between tunnels allow passengers to move away from the train along a safe space. The safe space shall contain all passengers of the maximum capacity of the train intended to be operated on the line.

(b) Fire fighting points shall be created

- (1) Outside both portals of every tunnel of >1km and
- (2) Inside the tunnel, according to the category of rolling stock that is planned to be operated, as summarized in the table below:

Tunnel length	Rolling stock category according to paragraph 4.2.3	Maximum distance from the portals to a fire fighting point and between fire fighting points
1 to 5 km	Category A or B	No fire fighting point required
5 to 20 km	Category A	5 km
5 to 20 km	Category B	No fire fighting point required
>20 km	Category A	5 km
>20 km	Category B	20 km

(c) Requirements for all fire fighting points:

- (1) 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 shall be described in the emergency plan.
- (2) 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)
- (3) The fire fighting points shall be accessible to the emergency response services. The way the emergency response services access the fire fighting point and deploy equipment shall be described in the emergency plan.
- (4) It shall be possible to switch off the traction energy supply and earth the fire fighting points electrical installation, either locally or remotely.

(d) Requirements for fire fighting points outside the portals of the tunnel

In addition to the requirements in 4.2.1.7 (c), fire fighting points outside the portals of the tunnel shall comply with the following requirements:

- (1) The open air area around the fire fighting point shall offer a minimum surface of 500 m².

(e) Requirements for fire fighting points inside the tunnel

In addition to the requirements in 4.2.1.7 (c), fire fighting points inside the tunnel shall comply with the following requirements

- (1) A safe area shall be accessible from the stopping position of the train. Dimensions of the evacuation route to the safe area shall consider the evacuation time (as specified in clause 4.2.3.4.1) and the planned capacity of the trains (referred to in clause 4.2.1.5.1) intended to be operated in the tunnel. The adequacy of the sizing of the evacuation route shall be demonstrated.
- (2) The safe area that is paired with the fire fighting point shall offer a sufficient standing surface relative to the time passengers are expected to wait until they are evacuated to a final place of safety.
- (3) There shall be an access to the affected train for emergency response services without going through the occupied safe area.
- (4) The lay-out of the fire fighting point 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 infrastructure manager 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 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) Remote control and switching of each 'switching section' shall be provided.
- (c) 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 a single section, close to the separation points between sections. These shall be either portable devices or 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 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 the 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 when the cables fulfil as a minimum the requirements of classification B2CA, s1a, a1, as per Commission Decision [2006/751/EC](#).

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 considered and included 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 locomotives) for operation on lines within the scope of this TSI, where the distance between fire fighting points or the length of tunnels does not exceed 5km.
 - (2) Category B passenger rolling stock (including passenger locomotives) for operation in all tunnels on lines within the scope of this TSI, irrespective of the length of the tunnels.
 - (3) Freight locomotives and self-propelling units designed to carry payload other than passengers, such as mail and freight for example, for operation in all tunnels on 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 fall under both categories and shall respect the requirements of both categories.
 - (4) Self-powered on-track machines, when in transport mode, for operation in all tunnels on lines within the scope of this TSI, irrespective of the length of the tunnels.
- (b) The rolling stock category shall be recorded in the technical file and will remain valid regardless of future revisions of this TSI.

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

Requirements are set out in the LOC&PAS TSI clause 4.2.10.2.1. These requirements shall also apply to the on-board CCS equipment.

4.2.3.1.2 Specific measures for flammable liquids

Requirements are set out in the LOC&PAS TSI clause 4.2.10.2.2.

4.2.3.1.3 Hot axle box detection

Requirements are set out in the LOC&PAS TSI clause 4.2.10.2.3.

4.2.3.2. Measures to detect and control fire

4.2.3.2.1 Portable fire extinguishers

Requirements are set out in the LOC&PAS TSI clause 4.2.10.3.1.

4.2.3.2.2 Fire detection systems

Requirements are set out in the LOC&PAS TSI clause 4.2.10.3.2.

4.2.3.2.3 Automatic fire fighting system for freight diesel units

Requirements are set out in the LOC&PAS TSI clause 4.2.10.3.3.

4.2.3.2.4 Fire containment and control systems for passenger rolling stock

Requirements are set out in the LOC&PAS TSI clause 4.2.10.3.4.

4.2.3.2.5 Fire containment and control systems for freight locomotives and freight self-propelling units

Requirements are set out in the LOC&PAS TSI clause 4.2.10.3.5.

4.2.3.3. Requirements related to emergencies

4.2.3.3.1. Emergency lighting system in the train

Requirements are set out in the LOC&PAS TSI clause 4.2.10.4.1.

4.2.3.3.2 Smoke control

Requirements are set out in the LOC&PAS TSI clause 4.2.10.4.2.

4.2.3.3.3. Passenger alarm and communication means

Requirements are set out in the LOC&PAS TSI clause 4.2.10.4.3.

4.2.3.3.4 Running capability

Requirements are set out in the LOC&PAS TSI clause 4.2.10.4.4.

4.2.3.4. Requirements related to evacuation

4.2.3.4.1 Passenger emergency exits

Requirements are set out in the LOC&PAS TSI clause 4.2.10.5.1.

4.2.3.4.2 Driver's cab emergency exits

Requirements are set out in the LOC&PAS TSI clause 4.2.10.5.2.

4.3. Functional and technical specifications of the interfaces

4.3.1. Interfaces with the Control-Command-Signalling subsystem

Interface with the CCS subsystem			
SRT TSI		CCS TSI	
Parameter	Clause	Parameter	Clause

Interface with the CCS subsystem			
SRT TSI		CCS TSI	
Radio communication	4.2.1.8 (a)	Mobile communication functions for railways GSM-R	4.2.4
Material characteristics	4.2.2.4 (a)	Essential requirements	Chapter 3
Material characteristics	4.2.3.1.1	Essential requirements	Chapter 3

4.3.2. *Interfaces with the Traffic Management and Operation subsystem*

Interface with the OPE subsystem			
SRT TSI		OPE TSI	
Parameter	Clause	Parameter	Clause
Emergency rule	4.4.1	Ensuring that the train is in running order	4.2.2.7
		Train departure	4.2.3.3
		Degraded Operation	4.2.3.6
Tunnel emergency plan	4.4.2	Managing an emergency situation	4.2.3.7
Exercises	4.4.3		
Provision of on-train safety and emergency information to passengers	4.4.5		
Tunnel specific competence of the train crew and other staff	4.6.1	Professional competency	4.6.1
		Specific elements for train crew and auxiliary staff	4.6.3.2.3

4.4. Operating rules

- (a) Operating rules are developed within the procedures described in the Infrastructure Manager safety management system. These rules take into account the documentation related to operation which forms a part of the technical file as required in Article 18(3) and set out in Annex VI of Directive [2008/57/EC](#).

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 detect any defect detrimental to its running behaviour and to take appropriate action.
- (b) In the case of an incident outside the tunnel, the operational rule is to stop a train with a defect that could be detrimental to its running behaviour before entering a tunnel.
- (c) In the case of an incident inside the tunnel the operational rule is to drive the train out of a tunnel, or to the next fire fighting point.

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 emergency response services and the relevant authorities for each tunnel. Railway Undertakings intending to use the tunnel shall be involved in the development or adaptation of the Emergency Plan. Station managers shall be equally involved if one or more stations in a tunnel are used as a safe area or a fire fighting point.
- (b) The emergency plan shall be consistent with the self-rescue, evacuation, fire-fighting and rescue facilities available.
- (c) Detailed tunnel-specific incident scenarios adapted to the local tunnel conditions shall be developed for the emergency plan.

4.4.3. *Exercises*

These rules apply to tunnels of > 1km.

- (a) Prior to the 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 disconnection of the traction power supply is required, the infrastructure manager shall make sure that relevant sections of the catenary or the conductor rail have been

disconnected, and inform the emergency response services before they enter 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 undertakings 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.
- (c) An operating rule shall be in place describing how the train crew ensures the complete evacuation of the train when this is necessary, including those people with hearing impairments that may be in closed areas.

4.4.6. Operational rules related to trains running in tunnels

- (a) Vehicles in conformity with the TSI as defined in clause 4.2.3 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 fire fighting points, 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. However, Infrastructure Managers of tunnels longer than 20km are permitted to require locomotives with a running capability equivalent to that of category B passenger rolling stock for hauling freight trains in such tunnels. This requirement shall be clearly stated in the Register of Infrastructure defined in clause 4.8.1 and in the Network Statement of the IM.
 - (4) On-track machines shall be deemed to comply with the tunnel safety requirements for rolling stock on all lines.
 - (5) Freight trains shall be admitted in all tunnels according to the conditions specified in clause 1.1.3.1. Operational rules may manage the safe operation of freight and passenger traffic, by separating these types of traffic for example.
- (b) Operation of Category A rolling stock is permitted on lines where the distance between fire fighting points, or the length of tunnels exceeds 5km, in the case where there are no passengers on board.

- (c) Operational rules shall be put in place to avoid panic and spontaneous, uncontrolled evacuation in the case of a prolonged stop of a train in a tunnel without the occurrence of a hot or cold incident.

4.5. Maintenance rules

4.5.1. Infrastructure

- (a) Before placing a tunnel into 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 these limits being exceeded,
 - (3) Identification of those elements which are relevant to emergency situations and their management,
 - (4) Necessary periodic checks and servicing activities to ensure the proper functioning of the parts and systems under (3).

4.5.2. Maintenance of rolling stock

The maintenance requirements for rolling stock are set out in the LOC&PAS TSI.

4.6. Professional qualifications

- (a) The professional qualifications of staff required for operations specific to tunnel safety within the subsystems covered 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

- (a) All professional staff driving and accompanying a train, as well as staff that authorise train movements, shall have the knowledge and ability to apply that knowledge to manage degraded situations in the event of an incident.
- (b) For staff undertaking the tasks of accompanying trains, the general requirements are specified in the OPE TSI.
- (c) Train crew as defined in the OPE TSI 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.
- (d) This involves in particular instructing the passengers to go to the next coach or to exit the train, and to lead them outside the train to a safe area.
- (e) 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.

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

4.7. Health and safety conditions

- (a) The health and safety conditions of staff required for operations specific to tunnel safety for the subsystems concerned by this TSI and for the implementation of the TSI are as follows:

4.7.1. Self-rescue device

- (a) 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 either the specification referenced in appendix A, index 2 or the specification referenced in appendix A, index 3. The RU shall choose one of the two solutions defined in these specifications.

4.8. Infrastructure and Rolling stock registers

4.8.1. Register of infrastructure

- (a) The characteristics of the infrastructure that must be recorded in the “register of railway infrastructure” are listed in the Commission Implementing Decision [2011/633/EU](#) of 15 September 2011 on the common specifications of the register of railway infrastructure.

4.8.2. Rolling Stock Register

- (a) The characteristics of the rolling stock that must be recorded in the “European register of authorised types of vehicles” are listed in the Commission Implementing Decision [2011/665/EU](#) of 4 October 2011 on the European register of authorized types of railway vehicles.

5. INTEROPERABILITY CONSTITUENTS

There are no interoperability constituents defined in the SRT TSI.

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 constituents have been defined in the SRT TSI.

6.2. Subsystems

6.2.1. EC verification (general)

- (a) 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

(b) 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)

(a) The applicant shall choose one of the modules or module combinations indicated in the following table.

Assessment procedures

Subsystem to be assessed	Module SB+SD	Module SB+SF	Module SG	Module SH1
Rolling Stock Subsystem	X	X		X
Energy subsystem			X	X
Infrastructure subsystem			X	X

(b) The characteristics of the subsystem to be assessed during the relevant phases are indicated in appendix B.

6.2.3. Existing solutions

(a) If an existing solution is already assessed for an application under comparable conditions and is in service, then the following process applies:

(b) The applicant shall demonstrate that the 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

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

- (b) If an innovative solution is proposed, the manufacturer or his authorised representative established within the European Union shall apply the procedure described in Article 8.

6.2.5. *Assessment of maintenance*

- (a) 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.
- (b) 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*

- (a) 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:

- (a) Emergency exit doors to the surface and doors to technical rooms are provided with suitable locks
- (b) The locks provided are consistent with the overall strategy for security for the tunnel and adjacent infrastructure
- (c) Emergency exits are not lockable from the inside and shall be able to be opened by evacuating persons
- (d) Access arrangements are in place for the emergency response services

6.2.7.2. Fire resistance of tunnel structures

- (a) 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 and/or tests made by the applicant, or by an equivalent method.
 - (1) To demonstrate that the integrity of the tunnel lining is maintained during a period of time that is sufficiently long to permit self-rescue, evacuation of passengers and staff and intervention of the emergency response services, demonstration that the tunnel lining can withstand a temperature of 450°C at ceiling level during that same period of time is sufficient.

- (2) Evaluation of the resistance of immersed tunnels or tunnels which can cause the collapse of important neighbouring structures shall be carried out according to a suitable ‘temperature-time curve’ chosen by the applicant.

This verification is not needed for rock tunnels without additional support.

6.2.7.3. Fire reaction of building material

- (a) For the assessment of 4.2.1.3 (c), the Notified Body shall only check that the list of material that would not contribute significantly to a fire is present.

6.2.7.4. Facilities for self-rescue, rescue and evacuation in the event of an incident

- (a) 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 clause 4.2.1.5. For assessing the evolution of the conditions in the safe area during an incident, the Notified Body shall verify that doors and structures separating the safe area from the tunnel can withstand the elevation of temperature in the closest tube.
- (b) In the case where clause 4.2.1.2 (b) applies, doors giving access to the safe areas can be assessed according to a different curve to that selected according to clause 6.2.7.2 (2) above.

6.2.7.5. Access and equipment for emergency response services

- (a) 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 in section 4.2.1 and 4.4 have been met:

6.2.7.6. Reliability of electrical installations

- (a) 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

- (a) The conformity assessment is described in the specifications referenced in Appendix A, indexes 2, 3, 4.

7. IMPLEMENTATION

This section defines the implementation strategy for the SRT TSI.

- (a) This TSI does not require modifications of subsystems which are already in service unless they are upgraded or renewed.
- (b) If not defined otherwise in section 7.3 ‘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 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.

- (c) 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

- (a) 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.
- (b) The application of this TSI to on-track machines is voluntary. Where on-track machines are not assessed and declared to be in conformity with this TSI, they 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

- (a) For new rolling stock, the implementation rules set out in clause 7.1.1 of the LOC&PAS TSI shall be applied.

7.1.3. New Infrastructure

- (a) This TSI is applicable to all new Infrastructure in its scope.

7.2. Application of this TSI to subsystems already in service

7.2.1. Upgrade or renewal of rolling stock

- (a) In case of renewal or upgrade of existing rolling stock, the implementation rules as set out in the clause 7.1.2 of LOC&PAS TSI shall be applied.

7.2.2. Upgrade and renewal measures for tunnels

- (a) 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 extent this TSI needs to be applied to the project. If not defined otherwise in section 7.3 ‘Specific Cases’, the result of renewal or upgrade works shall ensure that compatibility of the fixed installations with TSI compliant rolling stock is maintained or improved.

7.2.3. Operation subsystem

- (a) Operational aspects and their implementation are set out in the OPE TSI.

- (b) When commissioning an upgraded or renewed tunnel, the requirements for new tunnels in this TSI apply.

7.2.4. *Operation of new rolling stock in existing tunnels*

- (a) The category of new rolling stock intended to be operated in existing tunnels shall be selected according to clause 4.4.6 (a).
- (b) However, a Member State may allow operation of new rolling stock of category A in existing tunnels longer than 5km under the condition that the operation of such new rolling stock offers an equivalent or improved level of fire safety compared to the operation of previous rolling stock. The equivalent or improved level of safety to passengers and staff shall be demonstrated using the Common Safety Method on risk assessment.

7.3. **Specific cases**

7.3.1. *General*

- (a) The specific cases, as listed in the following clause, describe special provisions that are needed and authorised on particular networks of each Member State.
- (b) These specific cases are classified as “T” cases: “temporary” cases: it is planned that they can be included in the target system in the future. Consequently they will be re-examined in the course of future revisions of this TSI.
- (c) Any specific case applicable to rolling stock within the scope of this TSI is detailed in the LOC&PAS TSI.

7.3.2. *Operational rules related to trains running in tunnels (clause 4.4.6)*

- (a) **Specific case Italy (“T”)**

Additional prescriptions for rolling stock intended to be operated in existing Italian tunnels are detailed in the LOC&PAS TSI, clause 7.3.2.20.

- (b) **Specific case Channel Tunnel (“T”)**

Additional prescriptions for passenger rolling stock intended to be operated in the Channel Tunnel are detailed in the LOC&PAS TSI, clause 7.3.2.21.

Appendix A: Standards or Normative Documents Referred to in this TSI

	TSI		
Index N°	Characteristics to be assessed	Clause	Normative document
1	Design of escape signage	4.2.1.5.5	ISO 3864-1:2011
2	Specification and assessment of self-rescue device	4.7.1 6.2.8.1	EN 402:2003
3	Specification and assessment of self-rescue device	4.7.1 6.2.8.1	EN 403:2004
4	Assessment of self-rescue device	6.2.8.1	EN 13794:2002

Appendix B: Assessment of the Subsystems

For rolling stock, the sub-system characteristics that must be assessed in the different phases of design, development and production are specified in the LOC&PAS TSI.

For infrastructure and energy, the sub-system characteristics that must be assessed in the different phases of design, development and production are marked by X in the following table.

Characteristics to be assessed	New line or upgrading/renewal project		Particular assessment procedures
	Design review	Assembly before putting into service	
	1	2	3
4.2.1.1. Prevent unauthorised access to emergency exits and technical rooms	X	X	6.2.7.1
4.2.1.2. Fire resistance of tunnel structures	X		6.2.7.2
4.2.1.3. Fire reaction of building material	X		6.2.7.3
4.2.1.4. Fire detection in technical rooms	X	X	
4.2.1.5. Evacuation facilities	X		6.2.7.4
4.2.1.6. Escape walkways	X		
4.2.1.7 Fire fighting points	X		
4.2.1.8 Emergency communication	X		
4.2.2.1. Segmentation of overhead line or conductor rails	X	X	
4.2.2.2. Overhead line or conductor rail earthing	X	X	
4.2.2.3. Electricity supply	X		
4.2.2.4. Requirements for electrical cables in tunnels	X		
4.2.2.5. Reliability of electrical installations	X		