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Guidance on the Safety in Railway Tunnels Technical Specification for Interoperability

Issue One: September 2013

Rail Industry Guidance Note for the Infrastructure, Energy, Control-Command and Rolling Stock Subsystems

Guidance on the Safety in Railway Tunnels Technical Specification for Interoperability

Issue record

Issue	Date	Comments
One	September 2013	Original document: Guidance on the Safety in Railway Tunnels Technical Specification for Interoperability (SRT TSI). This document provides guidance on interpreting the requirements of the SRT TSI. It specifically gives guidance on the requirements for the Infrastructure, Energy, Control Command and Signalling, and Rolling Stock Sub systems

Superseded documents

The following Railway Group documents are superseded, either in whole or in part as indicated:

Superseded documents	Sections superseded	Date when sections are superseded
GI/RT7019, issue one, Safety in Railway Tunnels - Requirements for Lighting	Appendix A	December 2013

Other parts of GI/RT7019 issue one are superseded by GI/RT7019 issue two, Requirements for Lighting in Railway Tunnels.

GI/RT7019, issue one ceases to be in force and is withdrawn as of 07 December 2013.

Supply

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Highways Appendix A Safety in Railway Tunnels

Guidance on the Safety in Railway Tunnels Technical Specification for Interoperability

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Guidance on the Safety in Railway Tunnels Technical Specification for Interoperability

Part 1 Introduction

G 1.1 Purpose of this document

G 1.1.1 This document gives guidance on interpreting the requirements of the Safety in Railway Tunnels Technical Specification for Interoperability (SRT TSI). It specifically gives guidance on the requirements for the Infrastructure, Energy, Control Command and Signalling, and Rolling Stock Sub systems. It does not constitute a recommended method of meeting any set of mandatory requirements.

G 1.1.2 The requirements within the SRT TSI are intended to ensure compatibility between the sub-systems where tunnel-specific measures are provided. For example, the fire performance of the tunnel lining is designed to ensure that it is capable of resisting the maximum fire load that could be generated by rolling stock which is expected to use the tunnel.

G 1.2 The structure of this document

G 1.2.1 Relevant requirements in the SRT, High Speed Rolling Stock (HS RST) Conventional Rail Locomotives and Passenger (CR LOC & PAS) and Rolling Stock Freight Wagons (CR WAG) TSI are reproduced with a grey background in this document.

G 1.2.2 Guidance is provided as a series of sequentially numbered clauses prefixed 'G' immediately below the greyed text to which it relates. Where there is no guidance given, this is stated.

G 1.2.3 Specific responsibilities and compliance requirements are laid down in the TSI itself.

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G 1.4 Approval and authorisation of this document

G 1.4.1 The content of this document was approved by Infrastructure Standards Committee on 10 July 2013.

G 1.4.2 This document was authorised by RSSB on 30 July 2013.

Part 2 Introduction

G 2.1 Technical and geographical scope

1.	INTRODUCTION
1.1.	Technical scope
1.1.1.	Tunnel safety as a part of general safety
1.1.2.	Tunnel length
1.1.3.	Fire safety categories of passenger rolling stock
1.1.3.1.	Rolling stock for tunnels up to 5 km in length
1.1.3.2.	Rolling stock for all tunnels
1.1.3.3.	Rolling stock in tunnels with underground stations
1.1.4.	Underground stations
1.1.5.	Dangerous goods
1.1.6.	Particular safety requirements in member states
1.1.7.	Risk scope, risks that are not covered by this TSI
1.2.	Geographical scope
1.3.	Content of this TSI

G 2.1.1 Although there are categorisations applied for the rolling stock (for example, Category A and B) there is no parallel categorisation system defined for the infrastructure. This is an omission and confusingly, the rolling stock categorisations include reference to infrastructure parameters such as tunnel length.

G 2.1.2 Appendix A of this document contains a table that maps each SRT TSI requirement to a generic hazard where applicable.

G 2.1.3 The SRT TSI covers specific risks to the safety of passengers and on-board staff in tunnels for subsystems such as underground stations and dangerous goods. Hazards that are not covered by the SRT TSI include:

- a) Terrorism.
- b) Health and safety of staff involved in the maintenance of the fixed installations in tunnels.
- c) Financial loss due to damage to structures and trains.
- d) Trespass into a tunnel.
- e) Impact of a derailed train on a tunnel structure.
- f) Safety problems caused by aerodynamic effects of passing trains.

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Part 3 Guidance on the Infrastructure Subsystem

G 3.1 Subsystem infrastructure

Extract from SRT TSI

4.2.2. Subsystem Infrastructure

For the installation of safety equipment in tunnels, allowance shall be made for the actions of aerodynamic effects produced by passing trains.

G 3.1.1 No GB guidance is associated with the above.

Extract from SRT TSI

4.2.2.1. Installation of switches and crossings

The Infrastructure manager shall ensure that only the minimum number of switch and crossing layouts is installed in accordance with the design, safety and operational requirements.

G 3.1.2 The likelihood of a derailment is increased where switches and crossings (S&C) are present within a tunnel. The occurrence of a derailment may result in a fire breaking out on the train, or alternatively it may prevent a train that is on fire from being evacuated from the tunnel. For long tunnels, the presence of S&C may be unavoidable.

Extract from SRT TSI

4.2.2.2. Prevent unauthorised access to emergency exits and equipment rooms

For equipment rooms and emergency exits, physical systems, e.g. locks, shall be used to prevent unauthorised access from outside; from inside, it shall always be possible to open the doors for evacuation.

G 3.1.3 Access to tunnel equipment rooms and to emergency tunnel exits are confusingly combined within the TSI. For tunnel equipment rooms and for emergency exits, unauthorised access from outside the tunnel is required to be prevented by the use of locked doors.

G 3.1.4 Access to tunnel equipment rooms from inside the tunnel for the purpose of maintenance and rescue, is required for train staff and rescue services.

G 3.1.5 Access to emergency exits from inside the tunnel for the purposes of maintenance and rescue, is required for passengers, train staff and rescue services.

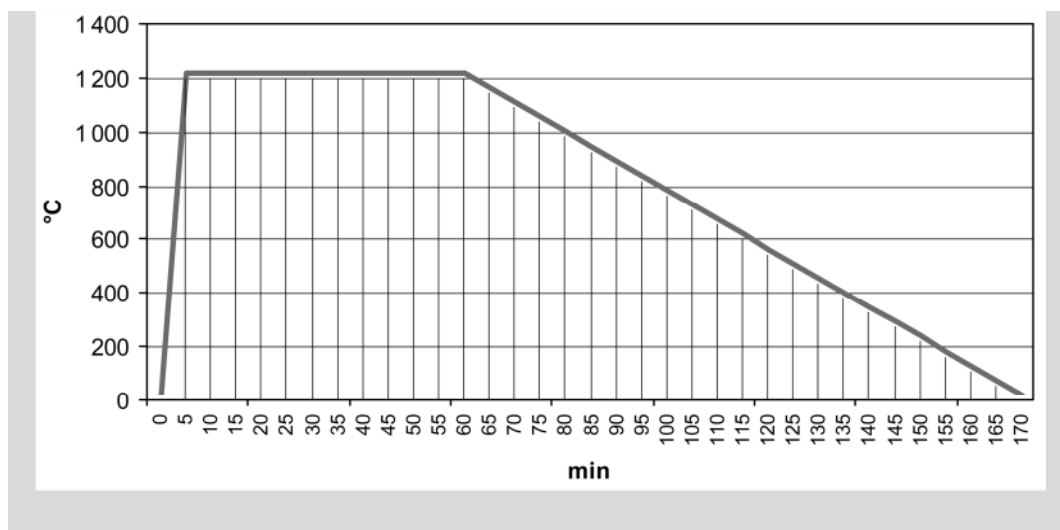
Extract from SRT TSI

4.2.2.3. Fire protection requirements for structures

This specification applies to all tunnels, irrespective of their length.

The integrity of the structure shall be maintained, in the event of fire, for a period of time sufficiently long to permit self-rescue and evacuation of passengers and staff and the intervention of rescue services without the risk of structural collapse.

The fire performance of the finished tunnel surface, whether in situ rock or concrete lining, has to be assessed. It shall withstand the temperature of the fire for a particular duration of time. The specified 'temperature-time curve' (EUREKA-curve) is given in the following figure. It is to be used for the design of concrete structures only.



- G 3.1.6 The Safety in Railway Tunnels drafting group adopted the EUREKA curve for railway tunnels as a requirement, as it features a progressive fall to ambient temperature, providing a definitive start and end point to the curve for the design of tunnel structures. This curve is based on a design fire established from the EUREKA EU – 499 'FIRETUN' tests.
- G 3.1.7 The requirement to maintain the integrity of the structure 'for a period of time sufficiently long to permit self-rescue and evacuation of passengers and staff and the intervention of rescue services' is intended to guard against the hazard of a tunnel collapse, thus preventing access and egress from the tunnel during the evacuation and rescue phases. It requires compatibility between the fire load generated by a burning TSI compliant train and the fire resistance of the tunnel.
- G 3.1.8 The temperature-time curve specified is intended for tunnels constructed using concrete linings. However, it is recognised that not all tunnels are constructed with concrete (for example, masonry) and in ground which is capable of self-support without the need for a lining, such as rock tunnels may not be lined. In such cases, it is necessary to assess the temperature-time performance of the tunnel structure for the design fire, taking into account the strategy for evacuation of the tunnel in the event of fire.
- G 3.1.9 Different temperature-time curves (for example ISO-curve and hydro-carbon curve) have been used in Europe for the provision of fire resistance in the design of structures. Such curves have mainly been developed for the design of buildings. The only curves developed specifically for tunnels were the (D) curves for railway (and road) tunnels, within the EUREKA project and the Rijkswaterstaat curve.

G 3.2 Fire safety requirements for tunnel structures and non-structural installations

Extract from SRT TSI

4.2.2.4. Fire safety requirements for building material

This specification applies to all tunnels, irrespective of their length.

This specification applies to building material and installations inside tunnels other than structures, which are covered in 4.2.2.3. They shall have low flammability, be non-flammable or protected, depending on the design requirements. The material for tunnel substructure 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.

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- G 3.2.1 The fire performance requirements in the SRT TSI clause 4.2.2.4 apply to structural elements of the tunnel (Class A2), other than the tunnel lining, and non-structural elements (Class B) inside the tunnel. The specified fire classifications for building materials are intended to slow the hazard of smoke spread due to fire in the tunnel during the evacuation and rescue phases, hindering access and egress from the tunnel.
- G 3.2.2 The person responsible for the fire safety of tunnels, in accordance with the Regulatory Reform (Fire Safety) Order 2005 and the Fire (Scotland) Act 2005, is required to undertake a fire risk assessment which includes consideration of any hazardous materials that are present in the tunnel. This also includes an assessment of the building materials used in the construction of tunnels (both structural and non-structural elements) and whether they are appropriate to minimize the risk arising from a fire, regardless of whether the works are permanent or temporary.
- G 3.2.3 Where building materials in tunnels perform a critical safety function (for example a signalling cable), the material choice should be based on satisfying the primary safety function. This may result in the use of a material with inferior fire safety performance characteristics (for example, a polyvinyl chloride (PVC) sheathed signalling or power cable). In such a case, the need to protect the material (for example, by enclosure with a material having good fire retardance characteristics), in particular to prevent the production of toxic fumes, should be considered.
- G 3.2.4 The fire performance of materials is established by type testing to demonstrate compliance with the requirements specified in SRT TSI clause 4.2.2.4.

Extract from SRT TSI

4.2.2.5. Fire detection

Technical rooms are enclosed spaces with doors for access / egress inside or outside the tunnel with safety installations which are necessary for the following functions: self rescue and evacuation, emergency communication, rescue and fire fighting and traction power supply. They shall be equipped with detectors which alert the infrastructure manager in case of fire.

- G 3.2.5 Consideration should be given to the use of automatic fire suppression systems within 'technical rooms', using systems such as oxygen depleting gas discharge that starves a fire of sufficient oxygen to burn and helps to sustain life.

G 3.3 Evacuation, rescue and self-rescue requirements from tunnels

Extract from SRT TSI

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

4.2.2.6.1. Definition of safe area

Definition: a safe area is a place inside or outside a tunnel where all of the following criteria apply

- Conditions are survivable
- Access for people is possible aided and unaided
- People may accomplish self-rescue if the opportunity is available, or may wait to be rescued by the rescue services using procedures detailed in the emergency plan
- Communication shall be possible, either by mobile phone or by fixed connection to the control centre of the IM.

- G 3.3.1 Following an incident in the tunnel and where it is necessary for a train to be evacuated following a stop, evacuation to a safe area will be directed by the train crew and coordinated with the infrastructure manager. Information concerning the incident and the status of the evacuation will be communicated to the fire and rescue services where their intervention is needed.

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- G 3.3.2 The emergency procedures to be adopted during an incident requiring evacuation are required to be included in the emergency plan for the tunnel as set out in the SRT TSI clause 4.4.3.1.
- G 3.3.3 The SRT TSI clause 1.1.4, allows a passenger station which is within the tunnel to be regarded as a safe area if it meets the requirements of the SRT TSI clause 4.2.2.6.1.

Extract from SRT TSI
4.2.2.6.2. General

The design of a tunnel shall take into account the need for provision of facilities to allow the self-rescue and evacuation of train passengers and staff and allow the rescue services to rescue people in the event of an incident in a tunnel.

The technical solutions described in 4.2.2.6.3 to 4.2.2.6.5 fulfil this requirement and one of them shall be selected.

- G 3.3.4 The design of a tunnel needs to make provision for passengers and staff that have evacuated the train in the event of a safety critical incident, and for the rescue services, to escape from the tunnel and to reach a 'safe area'. Provision of facilities for evacuation and rescue from the tunnel are intended to mitigate the risk that passengers, staff and rescue services are able to reach a safe area in a timescale which is compatible with the needs for evacuation and fire fighting, taking into account the rate of spread of smoke and the period over which the tunnel structure remains stable.

Extract from SRT TSI
4.2.2.6.3. Lateral and / or vertical emergency exits to the surface

These exits shall be provided at least every 1 000 m.

The minimum dimensions of lateral and or vertical emergency exits to the surface shall be 1,50 m wide and 2,25 m high. The minimum dimensions of the doors opening shall be 1,40 m wide x 2,00 m, high. Requirements or exits that function as main access routes for rescue services are described in 4.2.2.11. Access for rescue services.

All exits shall be equipped with lighting and signs.

- G 3.3.5 The maximum spacing of 1000 m has been adopted for the provision of emergency exits for tunnels comprising of a single bore, based on considerations of economy and smoke behaviour (for example, the rate of spread) in the event of a fire.
- G 3.3.6 For single bore tunnels, the emergency exits need to extend to the surface and are likely to be more expensive than cross passages for twin bore tunnels, where the distances are generally shorter and along a horizontal alignment.
- G 3.3.7 The maximum distance that can safely be utilised in a single bore tunnel is dependent upon the rate of spread of smoke at the walkway level and the time taken for people evacuating the train to reach the nearest emergency exit. It is recommended that simulation techniques for modelling movement of smoke (for example CFD) and people (for example PEDROUTE), are used.
- G 3.3.8 In comparison to twin bore tunnels, the size of single bore tunnels is likely to be greater (for example, where a circular profile has been adopted). Consequently, the smoke and hot gases arising from combustion, will rise to a higher level so that it will take longer for the smoke to descend to evacuating passengers. This provides more time for passengers to evacuate under the smoke layer. Consequently the conditions for evacuating passengers are likely to be safe for a longer period in single bore tunnels, thereby allowing the increased distance of 1000 m between emergency exits compared to twin bore tunnels (see clause G3.3.12).

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- G 3.3.9 The minimum dimensions for, the width of lateral and / or vertical emergency exits, and cross passages, have been selected to provide room for two people to pass ($2 \times 0.75 \text{ m} = 1.5 \text{ m}$), to allow for the possibility of transporting fire fighting equipment (minimum width 1.2 m) and to provide adequate headroom for people (2.25 m).
- G 3.3.10 The SRT TSI specification corresponds to the practice set out in UIC 779-9 and partially in the guidance contained within the United Nations Economic Commission for Europe (UNECE) Informal Document No. TRANS/AC.9/9, 01.12.2003. The design of a tunnel should take into account the need for provision of facilities to allow the self-rescue and evacuation of passengers and staff and to allow the rescue services to rescue people in the event of an incident in the tunnel. The technical solutions in the SRT TSI clauses 4.2.2.6.3 to 4.2.2.6.5 fulfil this requirement.

Extract from SRT TSI

4.2.2.6.4. Cross-passages to the other tube

Cross-passages between adjacent independent tunnels enable the adjacent tunnel to be employed as a safe area. They must be equipped with lights and signs. Minimum dimensions of the cross-passage are 2,25 m height x 1,50 m width. The minimum dimensions of the doors are 2,00 m height and 1,40 m width. Cross-passages in conformity with these requirements shall be provided at least every 500 m.

- G 3.3.11 For cross passages, the maximum spacing, between emergency exits, of 500 m has been adopted, based on considerations of economy and smoke behaviour (rate of spread for example) in the event of a fire, as for emergency exits from single structure tunnels (see clause G 3.3.9). The closer spacing (500 m compared to 1000 m for lateral and / or vertical emergency exits) permits quicker evacuation of passengers from the affected tunnel bore before moving to a safe area.
- G 3.3.12 Subject to consideration of safety issues in the non-fire incident tunnel bore, such as the control of train operations and isolation of traction power for electric trains, the non-fire incident tunnel may be deployed as a safe area for the evacuation of passengers. The non-fire incident tunnel should be maintained smoke free and smoke prevented from escaping from the tunnel bore containing the fire incident.

Extract from SRT TSI

4.2.2.6.5. Alternative technical solutions

Alternative technical solutions providing a safe area with a minimum equivalent safety level are permitted. A technical study shall be undertaken to justify the alternative solution which must be agreed by the Relevant National Authority.

- G 3.3.13 The provision of emergency exits and cross passages at the stated maximum spacing, are two commonly adopted solutions recognised as a satisfactory means of achieving evacuation of passengers to a safe area in the event of fire, within a reasonable time period. However, circumstances such as the high cost of emergency exit construction make it necessary to consider alternative technical solutions. These might involve the use of ventilation to create smoke free evacuation routes, or the provision of a larger tunnel bore to maintain the smoke at a higher level for longer.
- G 3.3.14 Where designers wish to deviate from the provisions of the SRT TSI, a technical study to demonstrate the acceptability of the alternative technical solution would be undertaken. The technical study is expected to involve consideration of rates of fire development and evacuation, and include consultation with relevant authorities (for example, the fire and rescue service).

G 3.4 Escape walkways

Extract from SRT TSI

4.2.2.7. Escape walkways

This specification applies to all tunnels of more than 500 m in length.

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

The width of the walkway shall be a minimum of 0,75 m. The minimum vertical clearance above the walkway shall be 2,25 m.

The minimum level of the walkway shall be within the height of the rail.

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 0,75 m, and the length of the obstacle shall not exceed 2 m.

Handrails shall be installed approximately 1 m above walkway providing a route to a safe area. Handrails shall be placed outside the required minimum clearance of the walkway. Handrails shall be angled at 30° to 40° to the longitudinal axis of the tunnel at the entrance to and exit from an obstacle.

- G 3.4.1 A walkway enables passengers and staff that have evacuated the train, and the fire and rescue services, to walk safely to the nearest exit from the tunnel in a timescale that is compatible with the provisions for evacuation and fire fighting. The provision of a walkway should mitigate the risks of tunnel collapse and reduce the time of exposure to smoke prior to reaching the nearest exit.
- G 3.4.2 The minimum provisions for walkways in single and double track tunnels allow for evacuation from at least one side of a train directly onto a walkway without the need for passengers to go onto the track.
- G 3.4.3 For tunnels with more than two tracks, access to a walkway should be achieved either by providing a walkway adjacent to each track, or by providing a safe means of accessing the nearest tunnel wall side walkway by crossing the track(s), for example, by utilising slab track combined with appropriate operational controls.
- G 3.4.4 The escape facilities provided in tunnels are intended for exceptional use in the event of needing to evacuate passengers from a tunnel. The minimum width of walkway (0.75 m) is based on an allowance of 700 mm for the width of a wheelchair and 50 mm clearance on the side adjacent to the tunnel wall to allow for movement of the hands. The minimum width provided includes the width required for the provision of a handrail.
- G 3.4.5 The minimum walkway level set out in the SRT TSI clause 4.2.2.7 is specified because there is a range of different levels adopted across Europe. For specific tunnel projects, an appropriate level needs to be determined, taking into account the requirements for gauging, safe evacuation from a train within the tunnel, and the economics of tunnel construction. It is suggested that the walkway does not go lower than the bottom of the rail.
- G 3.4.6 Where a potential obstacle to movement of people along the walkway arises due to the need to avoid equipment or facilities, for example lighting columns, the intention is to keep the length of the local constriction to a minimum.

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G 3.5 Emergency lighting on escape routes

Extract from SRT TSI

4.2.2.8. Emergency lighting on escape routes

This specification applies to all continuous tunnels of more than 500 m length.

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

Illumination by means other than electricity is acceptable, provided that it fulfils the intended function.

Illumination is required as follows:

Single-track tube: one side (same as walkway)

Double-track tube: both sides.

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

The luminance shall be at least 1 lux at walkway level.

Autonomy and reliability: guaranteed power supply for emergency or other requirements to ensure availability for at least 90 minutes.

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

- manually from inside the tunnel at intervals of 250 m
- by the tunnel operator using more control

- G 3.5.1 The emergency lighting level of 1 lux on escape routes provides:
- a) Sufficient illuminance to guide passengers and staff to a safe area in the event of an emergency.
 - b) Assistance to train crews in their orientation and improves their visibility of the track.
- G 3.5.2 Emergency lighting mitigates the risk of people becoming disorientated on evacuation from the train, and to assist them in moving safely along the walkway to the nearest exit to a safe area.
- G 3.5.3 An assessment of the lighting required for emergency evacuation in upgraded and renewed tunnels should consider whether it is reasonably practicable to provide lighting taking into account:
- a) Documented arrangements for responding to incidents in the tunnel concerned (see GO/RT3118).
 - b) Signage provided in the tunnel (see GO/RT3413).
 - c) Provisions for evacuation of passengers in the tunnel (for example, walkways).
 - d) Any unusual features within the tunnel giving rise to particular hazards.
 - e) Availability of a suitable power supply.
 - f) Maintenance and renewal requirements for the lighting system.
- G 3.5.4 Enhanced levels of tunnel lighting, for example to assist maintenance staff on routine inspections, provide the ability to progress through the tunnel using tunnel lighting as the main means of illumination.

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- G 3.5.5 The lighting level requirement specified in the SRT TSI does not define the plane (horizontal or vertical) upon which the lighting level is achieved. Additionally, it does not state that the required lighting level should be at a maintained illuminance level. Great Britain (GB) practice for lighting of a walking or escape route includes such considerations.
- G 3.5.6 Emergency lighting for designated escape routes at sub-surface stations is set out in RIS-7702-INS.
- G 3.5.7 Where the need for the provision of tunnel lighting in an upgraded or renewed tunnel is established, the design of the system should also:
- a) Take account of the possible conditions of the tunnel following an emergency (for example, fire and smoke).
 - b) Consider when and how the lighting functions, including:
 - i) Permanently switched on.
 - ii) Switching on automatically following an incident or condition.
 - iii) Manual control.
 - c) Consider how the maintained illuminance is provided in the event of failure of the normal power supply.
- G 3.5.8 Where tunnel lighting is provided, an alternative power source is required to ensure that power is available for a period of at least 90 minutes following loss of the primary power supply. When determining the position of the emergency lighting, consideration should be given to the possibility of shadows that might be cast by the evacuating passengers and staff, and the associated risks arising from slips trips and falls during the evacuation.

Extract from SRT TSI

4.2.2.9. Escape signage

This specification applies to all tunnels of more than 100 m length.

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

Escape signs shall be installed on the sidewalks. The maximum distance between escape signs shall be 50 m.

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

- G 3.5.9 No GB guidance is associated with the above.