



Goal-setting Principles for Railway Safety

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Contents



Introduction	4
Summary	4
Status of the document	4
Why have we issued these goal-setting railway safety principles?	4
Who is this document for?	5
Relationship to interoperability and standards on the mainline railway	6
1. Health and Safety by design	9
Summary	9
Factors	9
Where are the legal requirements for health and safety by design?	11
Where can I find further guidance on health and safety by design?	11
2. Infrastructure principles	12
Summary	12
Where can I find the specific legal requirements for infrastructure safety?	21
Where can I find further guidance information on infrastructure safety?	21
3. Station and stabling areas principles and guidance	22
Summary	22
Where can I find further guidance on stations and stabling areas safety?	30
Where can I find the specific legal requirements for stations and stabling areas safety?	30
4. Electric traction system principles and guidance	31
Where can I find the specific legal requirements for electric traction systems safety?	34
Where can I find further guidance on electric traction safety?	35
5. Train control system principles and guidance	36
Summary	36
Where can I find the specific legal requirements for railway control system safety?	39
Where can I find further guidance on railway control systems safety?	39
6. Level crossing principles	40
Summary	40
Where can I find the specific legal requirements for level crossing safety?	41
Where can I find further guidance on level crossing safety?	41
7. Train principles	42

Summary	42
Where can I find the specific legal requirements for train safety?	43
Where can I find further guidance on train safety?	43

Introduction

Summary

This introduction explains why ORR has decided to publish a set of goal-setting railway safety principles.

Status of the document

This document sets out ORR's expectations for the high-level health and safety outcomes that should be achieved by the railway (the "principles") when complying with the health and safety legislation related to the railway. It does not place additional burdens on dutyholders but highlights the factors which should be addressed by those designing and putting into use new railways or rail vehicles, including major upgrades and renewals from the earliest stage of such projects). -

The document is not intended to address operational safety, but addresses how the design of railway, railway vehicles, works, plant and equipment should take account of how it will be operated and maintained, including any reasonable foreseeable misuse. The design of railway, railway vehicles, works, plant and equipment should also take into account the sustainability, resilience and whole life factors.

Why have we issued these goal-setting railway safety principles?

Her Majesty's Railway Inspectorate (HMRI) was historically responsible for giving statutory "approval" to new or altered works, plant and equipment. To enable the industry to be clear about the expectations of the inspectors and engineers responsible for considering applications for approval, HMRI published guidance on the most important safety principles and how they might be achieved. HMRI last fully updated its "railway safety principles and guidance" in 2005, shortly before its functions transferred to the Office of Rail Regulation (from October 2015 called the Office of Rail and Road).

- Since 2005 there have been a number of changes to the safety and technical legislation relevant to the railway which have been primarily driven by the development of European railway legislation.. These changes form part of a general move from 'rules' based safety management to a 'goal-setting' approach. The most significant recent legislation is: Railways (Interoperability) Regulations 2011 (RIR) and the associated European Technical Specifications for Interoperability (TSIs)

- Common safety method on risk evaluation and assessment – EU Regulation 402/2013/EU (CSM RA)
- Construction (Design Management) Regulations 2015 (CDM)
- Railways and Other Guided Transport Systems (Safety) Regulations 2006 (ROGS)

An important change introduced by ROGS was revocation of the Railways and Other Transport Systems (Approval of Works, Plant and Equipment) Regulations 1994, ending HMRI's responsibility for approving new or altered works, plant and equipment. The obligation to ensure safe railway was designed and built passed to the duty holder by way of 'Safety Verification'. Since 2013 on the mainline railway this has been overtaken by the common safety method on risk evaluation and assessment.

However, ORR retained a role in technical authorisations on parts of the mainline network as a consequence of interoperability legislation. The introduction of RIR 2011 extended the scope of interoperability legislation to the whole of the mainline railway, supported by a revised suite of TSIs completed in 2015.

This extension of the legislation, and ORR's authorisation role, has led to ORR's decision to update and re-publish our high-level expectations for new or altered works, railway vehicles, plant and equipment. While our authorisation role only extends to the mainline, we believe many of these expectations are equally applicable to all the railways and guided transport systems (with the exception of tramways who are now responsible for producing principles specific to their sector) for which we are the health and safety regulator.

Where new railway infrastructure is commissioned, it is a statutory requirement (through the CDM) that these projects achieve the aims of health and safety by design throughout the process from planning, through to construction, maintenance and decommissioning. Health and safety by design is the key and ultimate principle for dutyholders. And while the industry has made progress in achieving health and safety by design, it is some way off a consistent approach. We expect that this guidance to help and encourage the industry to understand to develop this more consistent approach and incorporating health safety by design will lead to health and safety benefits and cost savings.

Who is this document for?

The principles contained in this document apply to the design and placing into service of new or altered works, railway vehicles, plant and equipment capable of affecting safety on:

- Mainline railways
- Non-mainline railways (e.g. metro systems)
- Heritage railways

Certain elements of the safety principles may not apply to all the types of railway listed above and where this is the case, it is set out in subsequent chapters in the guidance.

This document has been prepared with the following groups of people in mind;

- Health and safety managers in the rail industry;
- Those designing or putting into use new or altered works, railway vehicles, plant or equipment;
- Other managers in roles which affect safety, particularly in the development and implementation of standards;
- Staff working on the railway and their representatives;
- ORR railway inspectors and engineers

This document will allow you to:

- identify the high level safety principles relevant to you or your organisation or project;
- understand your responsibilities and help make sure you meet your duties; and
- find more detailed information if you need to.

Relationship to interoperability and standards on the mainline railway

Much of the UK domestic legislation arise from EU directives on railways and has been drafted with to achieve compatibility with EU directives. It is therefore expected that authorisations under interoperability legislation would also comply with the EU directives on interoperability.

The document deliberately does not set out detailed or mandatory requirements for how to achieve compliance with the principles. Nor does it replace or duplicate more detailed requirements contained in technical specifications for interoperability or domestic health and safety regulations. Where the high level principles are dealt with in more detail in other documents, the guide contains links to those documents.

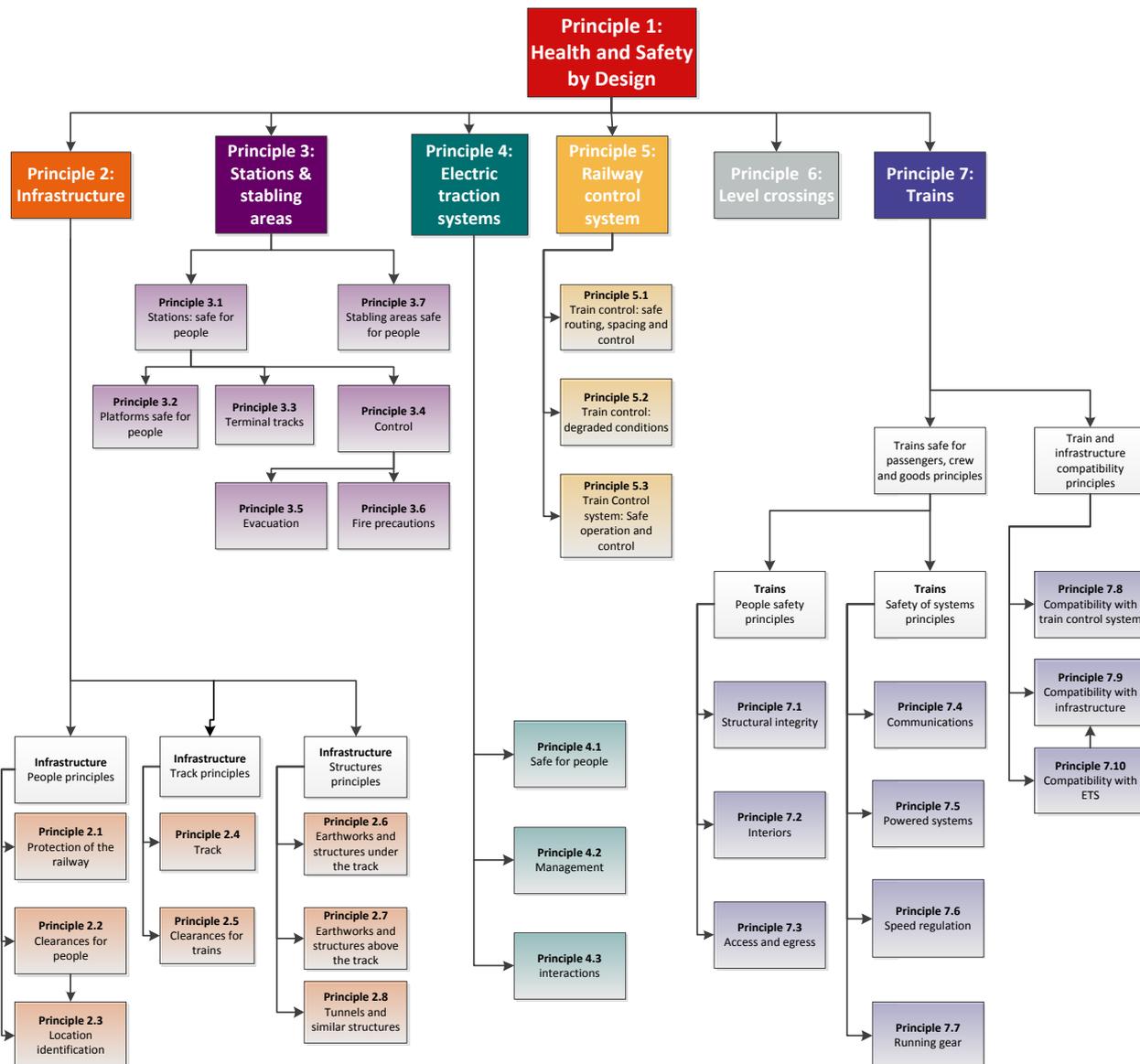
We continue to believe that responsibility for agreeing and producing technical standards and guidance is best delivered by the industry itself. At a European level, this is delivered through strong industry participation in the development of TSIs and other standards. In the UK, the mainline industry collaborates on the development of complementary technical and operating standards through RSSB, and the heritage and tramways sectors have taken responsibility for their own technical guidance and standards. This guidance is not intended to supersede, duplicate or conflict with these documents. Where European or domestic industry standards and guidance support compliance with the principles, they are sign-posted in the document.

Structure and content of the guidance

This guidance sets out principles relating to:

- Health and safety by design
- Infrastructure
- Stations and stabling areas (sidings and depots)
- Electric traction systems
- Railway control systems
- Level crossings
- Trains

The flowchart sets out how the principles are arranged.



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The principles describe the health and safety performance required by an item of works, plant or equipment in relation to people or other items of work, plant or equipment.

Each of the principles comprises a number of factors which should be taken into account in order to achieve the outcome described in the principle. This is not an exhaustive list of factors nor are they listed in fixed order of priority.

1. Health and Safety by design

Summary

This chapter explains the overarching principle of health and safety by design which is the ultimate goal of all the other railway safety principles set out in this document.

Principle 1

The railway shall ensure the elimination, or reduction and control, of health and safety risks in infrastructure, railway vehicles, products or processes by considering and addressing early at the design stage any potential risks from their construction, manufacture of equipment so that it is safe to use on the railway, installation, commissioning, operation, maintenance, de-commissioning and dismantling or demolition.

Factors

1.1 To help you achieve this principle, which underpins all the others, you must:

- a) assess the impact of introducing new or altered works, plant or equipment on the whole railway system throughout the project's lifecycle (i.e. construction, manufacture, installation, commissioning, operation, maintenance, de-commissioning and dismantling or demolition).
- b) design out the risks and impacts so far as is reasonably practicable.
- c) ensure residual risks can be effectively controlled, where elimination is not reasonably practicable, and explain how this is communicated to those who will control the risks in the future.
- d) regularly evaluate the impact of design decisions on all aspects of the lifecycle of the works, plant or equipment, beginning at the earliest stages of a project and continuing as options are selected and changes are made.

1.2 To achieve the required outcome, you should at least consider:

- a) how the particular works, plant and equipment will interact with other new, altered or existing works, plant or equipment on the railway;
- b) how the particular works, plant and equipment will interact with those of other railways and other guided transport systems;
- c) what the works, plant and equipment will be used for, how it will be operated and how this affects the safety management system it is employed under;

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- d) New approaches used by the industry arising from information available following an investigation into an accident.
- e) management of occupational health issues for workers such as manual handling, hand/arm vibration, COSHH and noise.
- f) the impact of human factors including how people will interact with the plant and equipment;
- g) trespass, vandalism and wilful acts;
- h) how the railway interacts with its adjacent environment including physical interfaces, noise, vibration, and electrical and magnetic interference;
- i) the reliability and durability of the works, plant and equipment, and the level of maintenance required;
- j) how the works, plant and equipment will be inspected and maintained throughout their life, including their decommissioning and disposal;
- k) the control of risk posed when degradation occurs;
- l) the integrity of safety critical works, plant and equipment;
- m) the foreseeable climatic conditions in which the works, plant and equipment will be used including risks, where relevant, arising from climate change;
- n) environmental legislation on pollution, such as noise, fumes etc where this may affect worker safety ((other bodies may be responsible for enforcing breaches of environmental pollution duties).
- o) limiting fire load, ignition sources and fire spread; and
- p) the impacts on persons of reduced mobility.

Where are the legal requirements for health and safety by design?

The concept of health and safety by design is covered in a number of different areas of health and safety legislation including .

- European Commission Regulation 2013/402/EU on a common safety method for risk evaluation and assessment (CSM Risk Assessment)
- Technical Specifications for Interoperability (TSI's)
- Control of Noise at Work Regulations 2005
- Construction (Design Management) Regulations 2015
- Fire Precautions (Sub-surface Railway Stations) (England) Regulations 2009
- Health and Safety at Work etc. Act 1974
- Health and Safety (Safety, Signs and Signals) Regulations 1996
- Management of Health and Safety at Work Regulations 1999
- Railways and Other Guided Transport Systems Regulations 2006
- Railways Interoperability Regulations 2011
- Regulatory Reform (Fire Safety) Order 2005

Where can I find further guidance on health and safety by design?

Guidance on health and safety by design can be found in:

- Chapter 12 of our strategic risk document available at http://orr.gov.uk/__data/assets/pdf_file/0009/21402/2016-03-18-New-Strategic-Chapter-12-Health-and-Safety-by-Design.pdf
- ORR's guidance on [CSM risk assessment](#)
- ORR's website page on health and Safety by Design : [we will need to insert a link once it goes live]
- A list of the [applicable TSI's is available through RSSB.](#)

2. Infrastructure principles

Summary

This chapter explains the principles related to infrastructure safety and is divided into three sections:

- People principles;
- Track principles; and
- Structures principles

People

The section sets out the principles related to people on railway infrastructure. They are:

- Protection of the railway;
- Separation from the operational railway for people; and
- Location identification.

Principle 2.1: Protection of the railway

The railway should be protected against unwanted intrusion and unauthorised access.

Factors

2.1 To help you achieve this outcome, you should at least consider:

- a) the risk of unauthorised access and the provision of suitable barriers and signs;
- b) the need for authorised access by people (workers, emergency services etc) while deterring access to others;
- c) the particular risks of any electric traction system and how they will be controlled;
- d) the presence of earthworks and structures supporting, above or adjacent to the railway;
- e) the prevention of trespass and misuse at any level crossings;

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- f) the impact of activities adjacent to the railway;
- g) the provision of crash barriers where roads are adjacent to the railway; and
- h) visual distractions such as coloured or beams of light from road vehicles adjacent to the railway.



Principle 2.2: Separation from the operational railway for people

People carrying duties on the operational railway should be separated from it so that they are able to carry out their duties in safety. Where operational procedures permit people onto the infrastructure while trains are operating, adequate clearances should be provided to enable them to carry out their duties in safety.

Factors

2.2 To help you achieve this outcome, you should at least consider:

- a) the range of people permitted onto the infrastructure including the different needs of people who routinely and frequently go out on the infrastructure compared to those who do so only occasionally;
- b) the safety clearances on the track side taking into account the aerodynamic effect of passing trains;
- c) the provision of a place of safety or refuge and the time required to reach it by workers on or about the track;
- d) the appropriate marking of structures where clearances do not include allowances for personnel safety;
- e) the safety clearances for all walkways including those to signal posts and in sidings and depots;
- f) how emergency disembarkation of people on the train will be managed;
- g) the positioning and securing of any electric traction system equipment.
- h) Positioning of equipment, such that safe access is easily achieved.

Principle 2.3: Location identification

Appropriate means to identify defined locations on the infrastructure should be provided for the safe operation and maintenance of the railway.

Factors

2.3 To help you achieve this outcome, you should at least consider:

- a) the need to identify uniquely a particular exact location;
- b) the need to identify uniquely the structures;
- c) the method of operating the railway in both normal and abnormal conditions;
- d) the need to respond to foreseeable incidents and attendance by emergency services; the need for the identifying mark to be observed from both on and off the railway

Track

The section sets out the principles related to track on railway infrastructure. They are:

- Track; and
- Clearances for trains.

Principle 2.4: Track

The track should provide for the safe guidance and support of trains.

Factors

2.4 To help you achieve this outcome, you should at least consider:

- a) The static and dynamic forces imposed by trains on the range of track geometry;
- b) the transfer of loads to the supporting structures;
- c) the arrangements for the transfer of trains from one track to another;
- d) the effect of temperature on the performance of the track;
- e) the requirements of any signalling, train control or electric traction systems;
- f) the provision of adequate containment arrangements where the effects of derailment would be severe;
- g) the resistance of the rails to contamination;
- h) drainage;
- i) the arrangements at any level crossing;
- j) the means of detecting track failure, including alignment and geometry;
- k) the noise and vibration that may be generated and their effects.
- l) risks, where relevant, arising from climate change

Principle 2.5: Clearances for trains

There should be adequate and sufficient clearances between trains on adjacent tracks and between trains and structures and fixed equipment to ensure safe passage.

Factors

2.5 To help you achieve this outcome, you should at least consider:

- a) The static and dynamic forces imposed by trains on the range of track geometry;
- b) the static vehicle profile of trains taking account of the range of track geometry;
- c) the dynamic vehicle profile and behaviour of the trains at all permitted speeds taking account of the range of track geometry;
- d) the aerodynamic effects generated by trains passing through restricted spaces;
- e) the need to place equipment within the confines of the structures without affecting clearances;
- f) the maximum and minimum clearances required at platforms;
- g) special arrangements to locate and position the track in relation to structures;
- h) the means of maintaining clearances.

Structures principles

The section sets out the principles related to structures on railway infrastructure. They are:

- Earthworks and structures under the track;
- Earthworks and structures above the track; and
- Tunnels and similar structures.

Principle 2.6: Earthworks and structures under the track

Any earthworks and structures supporting the track must be capable of carrying and transferring the forces exerted by the trains.

Factors

2.6 To help you achieve this outcome, you should at least consider:

- a) the ground conditions in the locality;
- b) the static and dynamic track loading;
- c) the risk of collision from road, rail or water traffic and the likely impact damage;
- d) the risk of flooding and scour, and their effects including risks from climate change.;
- e) the risk of derailment and the need to provide for derailment containment;
- f) the positioning and securing of any electric traction system equipment;
- g) the activities adjacent to the railway; and
- h) the risk to earthworks and structures from the failure of pipes or other services under or running alongside the railway.
- i) The risk to earthworks from the effects of burrowing animals or invasive vegetation.

Principle 2.7: Earthworks and structures above the track

Earthworks and structures above or adjacent to the railway must be capable of supporting the loads imposed upon them and afford protection to the railway.

Factors

2.7 To help you achieve this outcome, you should at least consider:

- a) the ground conditions in the locality;
- b) the loading on the structures over or adjacent to the railway;
- c) the risk of collision from road, rail or water traffic and the likely impact damage;
- d) the risk of flooding and scour, and their effects including risks from climate change;
- e) the risk of derailment and the need to provide for derailment containment;
- f) the positioning and securing of any electric traction system equipment;
- g) the activities adjacent to the railway;
- h) the risk to the railway from failure of pipes or other services crossing above or running alongside the railway;
- i) The risk to structures from the effects of invasive vegetation and burrowing animals.



Principle 2.8: Tunnels and similar structures

Tunnels and other enclosed spaces should provide a safe environment for people and for safe evacuation.

Similar structures

Tunnels are not necessarily sub-surface. Developments over the railway, deep cuttings or other structures may give rise to situations with similar characteristics to tunnels with respect to limited means of access and egress, means and time to escape to a place of safety, and lack of natural ventilation

Factors

2.8 To help you achieve this outcome, you should at least consider:

- a) the ground conditions in the locality;
- b) the length of tunnel, single or double track and cross-passages;
- c) the type and frequency of traffic, and type and length of trains relative to the length of the tunnel;
- d) the clearances within the tunnel;
- e) the fire load of the tunnel and equipment within it;
- f) any smoke and fire detection, and fire-fighting and suppression arrangements;
- g) the provision of fresh air and the arrangements to control smoke and other emissions;
- h) the aerodynamic effects generated by trains passing through restricted spaces;
- i) compatibility with rolling stock for emergency evacuation;
- j) a safe means of escape to a place of safety for all users in an acceptable time;
- k) the provision of emergency lighting, communications and route signing;
- l) the provision of safe access for emergency services;
- m) the risks of flooding;
- n) the means of de-energising any electric traction system; and
- o) the fencing and security arrangements at tunnel portals.

Where can I find the specific legal requirements for infrastructure safety?

Specific requirements for safety of railway infrastructure are set out in the following legislation.

Infrastructure TSI (Commission Regulation 2014/1299/EU)

Noise TSI (Commission Regulation 2014/1304/EU)

Persons with Reduced Mobility TSI (Commission Regulation 2014/1300/EU)

Safety in Railway Tunnels TSI (Commission Regulation 2014/1303/EU)

Fire Precautions (Sub-surface Railway Stations) (England) Regulations 2009

Fire (Scotland) Act 2005 [*in Scotland only*].

Railway Safety (Miscellaneous Provisions) Regulations 1997

Where can I find further guidance information on infrastructure safety?

Guidance on infrastructure safety can be found in.

- ERA application guidance on TSI's available at <http://www.era.europa.eu/Core-Activities/Interoperability/Pages/TSI-Application-Guide.aspx>
- [Railway Group Standards](#) issued by RSSB
- Guidance on the road/rail interface <http://orr.gov.uk/what-and-how-we-regulate/health-and-safety/guidance-and-research/infrastructure-safety/roadrail-interface-sites>

3. Station and stabling areas principles and guidance

Summary

This chapter explains the different principles and guidance that relate to station and stabling areas. There are two areas which relate to:

- Safe stations for people; and
- Safe stabling areas for people.

Principle 3.1: safe stations for people

Stations should provide for the free and safe movement of people and should not give rise to risk to health.

Factors

3.1 To help you achieve this outcome, you should at least consider:

- a) the movement and flow of people in an out of the station and to and from the platforms
- b) their waiting within a station in normal or abnormal operating conditions;
- c) the provisions to control overcrowding; the behaviour of people in enclosed areas; the sizing and treatment of surfaces of concourses, passageways, ramps, stairs, escalators and platforms;
- d) the suitability of escalators, lifts and passenger conveyors for the number of people they are to carry;
- e) the number, size and spacing of exits;
- f) the positioning of booking offices, ticket machines and retail outlets;
- g) the provision of communication equipment and signs;
- h) the provision of lighting;
- i) the provision of emergency lighting in the event of loss of power supplies;
- j) ventilation arrangements;

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- k) the integrity of the station structure and its ability to survive emergency situations;
- l) the security of people;
- m) the special arrangements necessary for sub-surface stations including the additional risks caused by fire and the need to segregate evacuation routes and provide ventilation control systems; and
- n) impact on people covered by the Persons of Restricted Mobility TSI.



Principle 3.2: platforms safe for people

Platforms should allow for the safe waiting of people and for their safe boarding and alighting from trains.

Factors

3.2 To help you achieve this outcome, you should at least consider:

- a) the protection arrangements for structural supports against derailment;
- b) the compatibility with the trains;
- c) stepping distances and heights between platforms and trains including for persons covered by PRM.
- d) the arrangements to control access to the platforms;
- e) the facilities for train crew and platform staff to observe boarding and alighting passengers and to safely manage train despatch;
- f) provision for people waiting on the platform and the movement of people on and between platforms;
- g) the need to avoid 'pinch points' at platform entrances and exits;
- h) the effect of platform edge screen doors on the station and other systems of the railway;
- i) the positioning of information boards and vending facilities where they may impact on passenger movement and create crowds.;
- j) the arrangements to deter trespass from the platform onto unauthorised parts of the railway;
- k) the surface treatment and drainage of platforms to avoid tripping and slipping;
- l) the need for platforms to be easily cleaned and the avoidance of places where debris can collect;
- m) the aerodynamic effects generated by trains passing through restricted spaces; and
- n) ventilation arrangements.

Principle 3.3: Terminal tracks

Where stations have terminal tracks, arrangements should be provided to stop a train and protect people and the station from the effects of an overrun

Factors

3.3 To help you achieve this outcome, you should at least consider:

- a) the protection arrangements for structural supports against derailment;
- b) the positioning of structural and other critical supports;
- c) the positioning of booking offices and retail outlets in the potential overrun area;
- d) the areas where people are likely to congregate in the potential overrun area;
- e) the overrun provisions and type of arresting device(s) provided;
- f) the protection that can be gained from automatic train protection or train stop systems;
- g) the effect on braking performance caused by the weather, or contaminants ;
and
- h) the balance of risk between damaging the train and injury to its passengers, and damaging the station and the people using the station.

Principle 3.4: control

Arrangements should be made and facilities to enable effective operational control of the station in co-ordination with the railway and with activities adjacent to the railway.

Factors

3.4 To help you achieve this outcome, you should at least consider:

- a) the means of co-ordinating activities on the railway with those within the station so they do not cause additional risks to each other;
- b) relationships and liaison arrangements with adjacent or connecting railway systems and with activities adjacent to the railway;
- c) the level and diversity of surveillance, communication and information required to control the activities within the station complex;
- d) the means of communication and the provision of information and instructions to workers and other people;
- e) the liaison arrangements at the station for the emergency services; and
- f) the availability of control facilities during emergency situations.

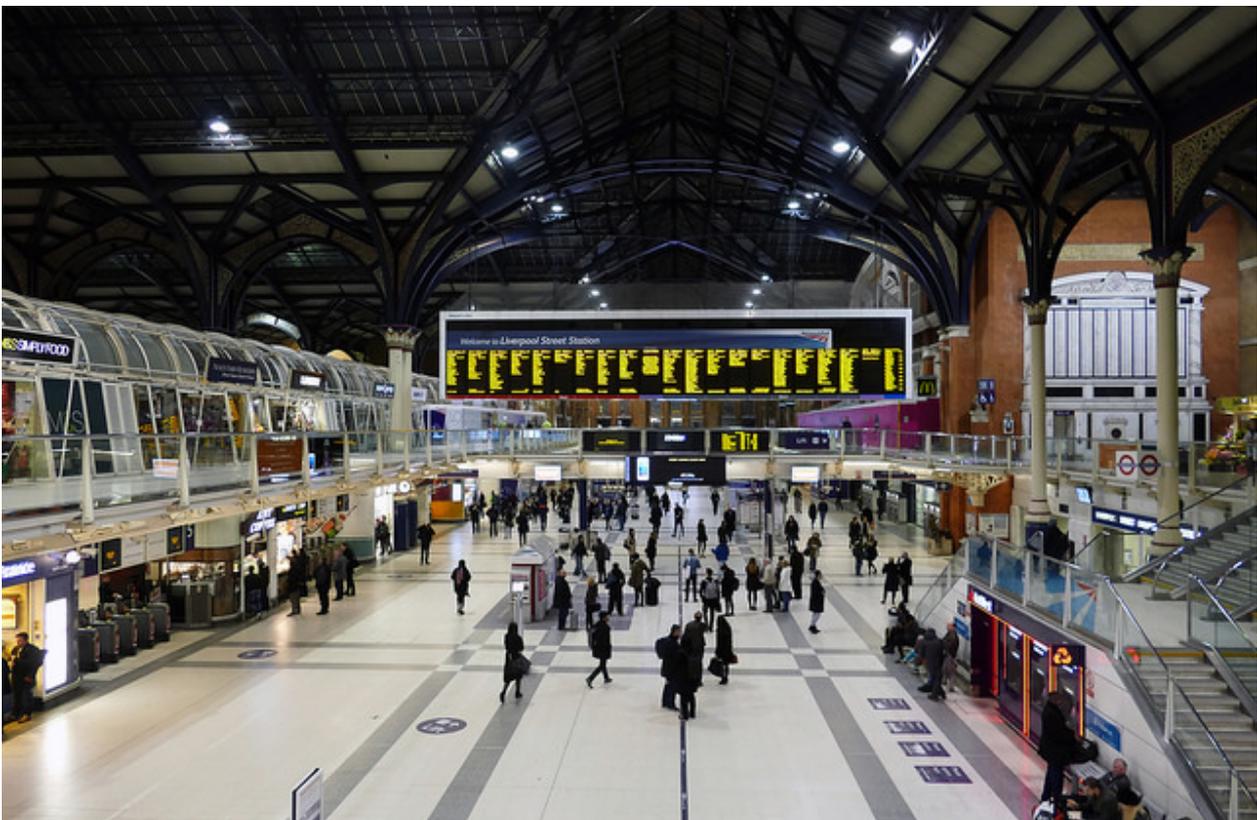
Principle 3.5: evacuation

The station and its control arrangements should allow for safe evacuation in an emergency.

Factors

3.5 To help you achieve this outcome, you should at least consider:

- a) the time taken to complete evacuation of the station;
- b) the protection of evacuation routes;
- c) access for emergency services, especially in sub-surface stations;
- d) information systems for evacuation of the station;
- e) the zoning of public address systems;
- f) the management of any ventilation system; and
- g) how people covered by the PRM TSI can be evacuated safely.



Principle 3.6: fire precautions

Stations should have fire and fume prevention and control measures commensurate with the fire risk and evacuation arrangements

Factors

3.6 To help you achieve this outcome, you should at least consider:

- a) minimising the fire load;
- b) the segregation of public areas of stations from non-public areas and high fire risk areas;
- c) the provision of fire detection and warning systems and fire suppression systems;
- d) ventilation and zoning for fume extraction systems to limit smoke from a fire spreading to other parts of the station;
- e) the aerodynamic effects generated by trains passing through restricted spaces;
- f) the provision and identification of initial fire-fighting equipment;
- g) facilities and systems for fire-fighters;
- h) the location of a suitable 'rendezvous' point where station staff will meet emergency services; and
- i) the additional risks caused by fire in a sub-surface station and the need to segregate evacuation routes and provide ventilation control systems.

Principle 3.7: stabling areas safe for people

The railway system should provide for the safe stabling, marshalling and maintenance of trains.

Factors

3.7 To help you achieve this outcome, you should at least consider:

- a) the segregation of the marshalling, stabling, servicing and maintenance areas from the running lines;
- b) the protection of people in these areas from danger from moving trains;
- c) the type of any electric traction system as overhead traction is generally safer. The position of any electric traction system, its sectioning and its means of isolation to facilitate train cleaning, servicing, maintenance or any other activities;
- d) protection of the area from activities adjacent to the railway;
- e) the need for adequate clearances and walkways;
- f) the need for identifiable crossing places; secure stabling of trains;
- g) segregation of road vehicles in the area from trains and people;
- h) the arrangements for the control of train movements within, into and from the area; and
- i) the provision of lighting for operational activities.
- j) The security of the site from trespass
- k) Choice of electric traction system, i.e. overhead generally better for worker safety than conductor rail; and
- l) Safe access to trains when working at height

Where can I find the specific legal requirements for stations and stabling areas safety?

Specific requirements for safety of railway stations and stabling areas are set out in the following legislation.

- Infrastructure TSI (Commission Regulation 2014/1304/EU)
- Persons with Reduced Mobility TSI
- Building Regulations 2010
- Construction (Design Management) Regulations 2015
- Fire (Scotland) Act 2005 [*in Scotland only*]
- Fire Precautions (Sub-surface Railway Stations) (England) Regulations 2009
- Regulatory Reform (Fire Safety) Order 2005
- Workplace (Health, Safety and Welfare) Regulations 1992

Where can I find further guidance on stations and stabling areas safety?

Guidance on railway stations and stabling areas safety can be found in:

- ERA application guidance on TSI's available at <http://www.era.europa.eu/Core-Activities/Interoperability/Pages/TSI-Application-Guide.aspx>
- [Railway Group Standards](#) issued by RSSB

4. Electric traction system principles and guidance

Summary

This chapter explains the different principles and guidance that relate to electric traction systems. There are three areas which relate to:

- Safe for people;
- Management; and
- Interactions.

Principle 4.1: electric traction safe for people

An electric traction system should be designed not to present health and safety risks to people.

Factors

4.1 To achieve this outcome you should ensure that:

- a) The nominal wire height for a newly electrified railway should be maximised to create so far as is practicable an environment where clearances are not compromised, eg, in station areas
- b) Clearances should be sufficient to provide safety for people working on or using the railway. Where clearances are compromised, effective screening is considered.
- c) the use of live non-insulated components should be avoided, if however, the design dictates that they are essential they should be positioned so that they are safe by position during normal operation
- d) If live non insulated conductors cannot be avoided in the design then they need to be suitably marked on drawings and identified on site such that they do not constitute a risk;
- e) the avoidance of dangerous touch potentials on structures within and adjacent to the railway;
- f) the arrangements at level crossings maximise the wire height and take account of the vehicle types likely to use that crossing, eg agricultural machinery;

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- g) the sectioning and isolation arrangements for normal operations, for maintenance should reflect and facilitate the time required for all maintenance work to be carried out in safe conditions
- h) this would include any work being carried beneath conductors to be carried out safely and in accordance with the Electricity at Work Regulations
- i) the arrangements to ensure that anyone who may foreseeably access the infrastructure are not exposed to danger; including management of parapet heights over electrified railways (bridge parapets of 1.8m represent the legal minimum for overhead electrified railways).



Principle 4.2: electric traction systems management

An electric traction system should provide for its safe management and operation.

Factors

4.2 To help you achieve this outcome, you should at least consider:

- a) communications between the electrical control centre, the electricity supplier, the railway control centre, the emergency services and trackside locations;
- b) the sectioning and isolating arrangements for normal operations, including for maintenance and in emergencies;
- c) the continuity of power supply and the effect of its loss;
- d) the power supply and return configuration and its management;
- e) earth fault and short-circuit protection;
- f) the monitoring of the status of the electric traction system equipment;
- g) the marking of electric traction system equipment and structures for location purposes; and
- h) special circumstances for sub-surface railways.

Principle 4.3: electric traction systems interactions

An electric traction system should not give rise or be subject to dangerous interactions within the railway or with other systems.

Factors

4.3 To help you achieve this outcome, you should at least consider:

- a) the characteristics of the trains using the electric traction system;
- b) the compatibility and separation of different electric traction systems;
- c) the interfaces with trains or other plant and equipment;
- d) the structures on the railway and the electrical clearances;
- e) the siting of both conductor rails and overhead line equipment to allow sufficient clearance so as not to foul the trains or interfere with other structures on the railway;
- f) the transfer of electro-magnetic fields which may be generated and their likely effects on other plant and equipment on the railway or adjacent to it; and
- g) the transfer of electrical effects and their likely impact on other plant and equipment in use on the railway or adjacent to it.

Where can I find the specific legal requirements for electric traction systems safety?

Specific requirements for safety of electric traction systems are set out in the following legislation.

- Energy TSI
- Infrastructure TSI
- Persons of Reduced Mobility TSI
- Electrical Equipment (Safety) Regulations 1994
- Electricity at work Regulations 1989
- Electromagnetic Compatibility Regulations 2006
- Railway (Miscellaneous Provisions) Safety Regulations 1997

Where can I find further guidance on electric traction safety?

Guidance on electric traction safety can be found in:

- ERA application guidance on TSI's available at <http://www.era.europa.eu/Core-Activities/Interoperability/Pages/TSI-Application-Guide.aspx>
- [Railway Group Standards and guidance](#) issued by RSSB
- Guidance issued by HSE <http://www.hse.gov.uk/pubns/books/hsr25.htm>

5. Train control system principles and guidance

Summary

This chapter explains the different principles and guidance that relate to train control systems:

Principle 5.1: safe routing spacing and control

The train control system shall provide for the safe routing, spacing and control of trains.

Factors

5.1 To help you achieve this outcome, you should consider:

- a) the prevention of collisions;
- b) protection against human error during operation;
- c) the type of trains permitted to operate on or likely to operate on the railway;
- d) the effects of the electric traction system;
- e) the type of track and track condition;
- f) the interface with communication and other systems;
- g) the protection of the railway from the train control system failing in an unsafe mode;
- h) the avoidance of the degradation of the train control system from the use of secondary or other interfacing systems;
- i) the capability of the train control system to be maintained without endangering the railway;
- j) the marking of train control equipment for location purposes and identification of lineside signals;
- k) the means of cancelling proceed indications in an emergency;
- l) the effects of possible modifications to the train control system, including any upgrades (e.g software) and their validation;
- m) the compatibility with level crossing arrangements;

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- n) interference from electrical sources
- o) protection of the train control system from malicious interference; and
- p) impact from new type of train control system being installed. This includes train control systems being overlaid on an existing train control system as well as replacement.



Principle 5.2: degraded conditions

The train control system should continue to provide for safe passage of trains permitted to run under degraded conditions.

Factors

5.2 To help you achieve this outcome, you should at least consider:

- a) design for levels of degraded conditions that correctly working parts of the train control system may continue to be used safely;
- b) protection from failure modes creating unsafe situations;
- c) the loss or restoration of power supplies creating unsafe situations;
- d) the identification of and communication with specific trains or signals;
- e) the making of general broadcasts to trains and signallers;
- f) alternative means of communication between the signaller and the driver of the train and between signallers;
- g) the controlled restoration of the whole train control system; and
- h) protection against human error during degraded operation.

Principle 5.3: safe operation and control

Sufficient arrangements and facilities should be provided for the safe operation of the railway and for a coordinated control between the railway and external organisations in the event of an emergency.

Factors

5.3 To help you achieve this outcome, you should at least consider:

- a) the interfaces between the controls of the infrastructure, trains, stations and the emergency services;
- b) the communication with the controls of the infrastructure, trains, stations, the emergency services and people using the railway;
- c) the effective facilities for normal, abnormal and degraded conditions, and emergency situations; and
- d) the inter-relationships between control systems.

Where can I find the specific legal requirements for railway control system safety?

Specific requirements for safety of railway control systems are set out in the following legislation.

- Control Command and Signalling TSI
- Electricity at Work Regulations 1989
- Electromagnetic Compatibility Regulations 2006
- Railway Safety Regulations 1999 [or hopefully their replacements!]

Where can I find further guidance on railway control systems safety?

Guidance on electric traction safety can be found in:

- ERA application guidance on TSI's available at <http://www.era.europa.eu/Document-Register/Pages/TSI-Application-Guide.-CCS-TSI.aspx>
- [Railway Group Standards and guidance](#) issued by RSSB

6. Level crossing principles

Summary

This chapter explains the principle that relates to level crossings.

Principle 6.1: level crossings

Where a right of way crosses a railway, this should be by a overbridge or underbridge. Where there is no alternative to a right of way crossing the railway at track level, appropriate arrangements should be provided to warn and protect the users of the level crossing , and safeguard the railway.

Factors

6.1 To help you achieve this outcome, you should at least consider:

- a) Alternatives to a level crossing.
- b) undertaking a risk assessment to ensure that the level crossing and protective features are appropriate for the characteristics and volume of users; and the frequency and speed of trains;
- c) the types of level crossing users and the frequency and speed of expected rail, road and pedestrian traffic;
- d) the uniform visual appearance of each type of level crossing;
- e) the possibility of slow or abnormal road traffic using the level crossing;
- f) the type of road or path on either side of the level crossing;
- g) the need to deter trespass and straying onto the railway;
- h) the protection of the level crossing by the signalling system;
- i) the effect of equipment failure on the safety of trains and level crossing users;
- j) the arrangements to avoid danger if a level crossing user is trapped;
- k) the need for local operation; and
- l) the interface with any electric traction system.

Where can I find the specific legal requirements for level crossing safety?

Specific requirements for safety of level crossings are set out in the following legislation.

- Level Crossings Act 1983

Where can I find further guidance on level crossing safety?

Guidance on level crossing safety can be found in:

- [ORR's strategy for regulation of health and safety risks - Chapter 4: Level crossings](#)
- [Level crossings: A guide for managers, designers and operators](#)
- [The level crossings risk management human factors toolkit](#)
- [Rail guidance document on new/re-instated level crossings](#)
- [Railway Group Standards and guidance](#) issued by RSSB

7. Train principles

Summary

This chapter explains the different principles that relate to trains. There are two areas which relate to:

-
- Safe trains for passengers, crew and goods; and
 - Train and infrastructure compatibility.

Safe trains for passengers, crew and goods

The section sets out the principles related to safe trains for passengers, crew and goods. They are:

- People and goods safety
 - Structural integrity
 - Interiors
 - Access and egress
- Safety of systems
 - Communications
 - Powered systems
 - Speed regulation
 - Running gear

Principle 7.1: structural integrity

The structural integrity of trains should be maintained during normal operations and afford effective protection to people and goods carried in the event of an accident.

Factors

7.1 To help you achieve this outcome, you should at least consider:

- a) the maximum loads foreseeably arising in normal operations;
- b) the effects of a collision and the crashworthiness of a vehicle;
- c) the structural compatibility of all trains using the route unless there are arrangements to reduce further the risk of collision;
- d) the level of containment and containment arrangements of any goods carried and any foreseeable movement that may occur;
- e) the protection from and containment of fire;
- f) the integrity of attachment of equipment;
- g) the range and compatibility of coupling devices and other inter-train connections;
- h) compatibility with buffer stops or similar train arrestor devices;
- i) the arrangements for lifting the vehicle for both normal maintenance and emergency situations; and
- j) the ability of glazing to resist impact damage and withstand aerodynamic effects.

Principle 7.2: interiors

The interiors of trains should provide a health and safe environment for people and any goods carried.

Factors

7.2 To help you achieve this outcome, you should at least consider:

- a) compatibility with the body shell of the vehicle and the access and egress arrangements;
- b) intended passengers (including persons covered by the PRM TSI) and their foreseeable behaviour which can include sitting, standing, sleeping, moving about the train, and the taking of meals or refreshments;
- c) foreseeable events which may lead to injury and the arrangements which may be taken to mitigate against injury;
- d) foreseeable actions by people which may lead to injury to others;
- e) the stowage of luggage, goods and equipment, including bicycles and wheelchairs, and their retention in normal operation and during an incident or collision;
- f) the integrity of fixtures and fittings and their crashworthiness;
- g) the limitation of fire load, ignition sources and fire spread;
- h) the conditions and ergonomics to enable the train crew to operate the train safely;
- i) the heating, ventilation and lighting of the vehicle in both normal and degraded operation of the train or railway;
- j) train-borne noise;
- k) the retention of toilet and other waste;
- l) the interaction of security arrangements with safety arrangements; and
- m) the provision and marking of emergency or safety equipment to deal with incidents

Principle 7.3: access and egress

Trains should have a safe means of access, egress and retention of people and goods carried.

Factors

7.3 To help you achieve this outcome, you should at least consider:

- a) acceptable stepping distances to and from the platform including arrangements for persons covered by the PRM TSI;
- b) the size, number and arrangement of doors;
- c) the arrangements for the control of the doors;
- d) the arrangements to prevent the doors being opened when the train is moving;
- e) the arrangements to avoid trains departing with doors open;
- f) the hazards created by the doors moving; the arrangements to avoid trapping people in doors especially prior to departure from a station;
- g) the arrangements for emergency evacuation of the train;
- h) provision of equipment and arrangements for the escape of persons in an emergency and
- i) the arrangements for gaining access into the train in emergency situations.



Principle 7.4: communications

There should be effective means of communicating safety messages to passengers on the train or boarding and alighting from it; and between passengers and staff on the train both on board the train and to external controllers in event of an emergency.

Factors

7.4 To help you achieve this outcome, you should at least consider:

- a) communications between the train, train crew and control or signalling centres;
- b) communications between the members of the train crew on-board the train;
- c) communications between the train crew and passengers;
- d) passenger emergency alarm facilities;
- e) provision of information for passengers with either visual or auditory impairments; and
- f) availability of communication systems in degraded operations or emergency situations, including fire
- g) Prevention of malicious interference of any such communication equipment including any software.

Principle 7.5: powered systems

The electrical and other powered systems and equipment on-board trains should not endanger other systems or people.

The systems covered by this principle include on-board electrical, mechanical, air or hydraulic systems or equipment including electric traction current collection, main and auxiliary power systems and all electrical control systems including software.

Factors

7.5 To help you achieve this outcome, you should at least consider:

- a) interference with other powered control systems;
- b) the positioning and protection of equipment and electrical conductors to avoid accidental contact by people;
- c) the effect of the loss of power supply and their effects;
- d) the effect of the loss of safety critical systems;
- e) retention of and protection from failed mechanical components
- f) the limitation of fire load and its protection, ignition sources, fire spread and smoke and fumes;
- g) unauthorised access to, or use of, equipment (including software systems) and the prevention of malicious interference;
- h) the availability of powered systems in degraded operations or emergency situations;
- i) bonding and short-circuit protection including RCD protection of sockets available for use by passengers; and
- j) avoidance or control of electro-magnetic fields which are known to be harmful to people.
- k) The safe management of any stored energy devices on the train in normal and emergency situations.
- l) the arrangements for safe maintenance of powered systems, including de-energisation during maintenance.
- m) The control of emissions; and
- n) The control of noise.

Principle 7.6: speed control and braking

The speed control and braking system of the train should meet the operational requirements of the railway without endangering people and goods carried.

The speed regulation system may include systems other than the braking system.

Factors

7.6 To help you achieve this outcome, you should at least consider:

- a) the requirement for the braking system to be continuous, capable of stopping and holding a divided train, and holding a stabled train;
- b) the acceleration and deceleration rates and the rate of change of those rates to avoid endangering the people and goods carried or damaging the vehicles and their couplings;
- c) the performance of the braking system under all foreseeable conditions of adhesion;
- d) the incapacity of the train driver;
- e) redundancy in the service braking;
- f) the availability of the braking system on demand;
- g) the overall braking performance provided by one or more braking systems;
- h) the transition between different types and combinations of braking systems;
- i) the gradients of the railway;
- j) the compatibility with the track and, in particular, the forces imposed on the track;
- k) the compatibility of the service braking performance with the train control system;
- l) the compatibility with the electric traction system, including the compatibility of any regenerative braking systems and the effects of the receptivity of the traction system on braking performance;
- m) minimising the risk of 'dragging' brakes;

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- n) minimising the release of toxic or other harmful substances from brake pads or blocks;
- o) the provision of a reliable indication of speed; and
- p) the compatibility with train control or driver advisory systems as they develop.



Principle 7.7: running gear (including wheels, axles and bogies)

The running gear should guide the train safely along the track.

Factors

7.7 To help you achieve this outcome, you should at least consider:

- a) the compatibility of the wheel and rail interface;
- b) the range of train operating speeds;
- c) the compatibility with the track geometry;
- d) the foreseeable track maintenance tolerances and the risk of the track being outside the normal condition tolerances;
- e) the arrangements for transfer between tracks;
- f) the effects of traction and braking forces;
- g) the effects of permitted forces imparted to the track or train body and within the components of the running gear;
- h) the risk and effects of component failure, particularly of wheel-sets and bearings;
- i) the effects of collisions with obstacles and the provision of effective obstacle deflection;
- j) the risk of derailment due to wheel unloading including from the influence of offset loads and locked suspensions;
- k) transfer of noise or vibration to the track or the train body;
- l) the integrity of attachment of equipment to the running gear; and
- m) effective electrical bonding of the vehicle to ensure safe operation on the railway.

Train and infrastructure compatibility

The section sets out the principles related to train and infrastructure compatibility. They are:

- Compatibility with train control systems
- Compatibility with infrastructure
- Compatibility with ETS

Principle 7.8: Compatibility with train control system

The train should be compatible with the train control system.

Factors

7.8 To help you achieve this outcome, you should at least consider:

- a) the service braking performance allowed for by the train control system;
- b) the acceleration and deceleration rates allowed for by the train control system;
- c) the effects of electro-magnetic interference and the arrangements to be employed to guard against interfering with the train control system;
- d) the compatibility with train position detection arrangements;
- e) the data transfer arrangements between the train and the train control system;
- f) the presentation and availability of train control information at the driving position; and
- g) the implications of moving to an ETCS train control system, including on going maintenance and transitions between ETCS and other train control systems used on a railway.

Principle 7.9: Compatibility with infrastructure

The train should be dimensionally compatible with the infrastructure and be capable of operating within the clearance envelope at all times

Factors

7.9 To help you achieve this outcome, you should at least consider:

- a) the allowances for safety clearances under static and dynamic conditions;
- b) the influence of the track geometry on the dynamic performance of the train;
- c) the centre and end throws of the train on curved track;
- d) the clearances between structures and trains;
- e) the clearances between trains on adjacent tracks;
- f) the length of platforms;
- g) the stepping distances at platforms; and
- h) operation in degraded mode with failure of suspension, door or other systems.



Principle 7.10: Compatibility with electric traction systems

Trains should be compatible with the electric traction system.

These factors also need to be taken into consideration for non-electric trains which operate on electric lines.

Factors

7.10 To help you achieve this outcome, you should at least consider:

- a) the electrical clearances between vehicles and electrical conductors;
- b) the position and geometry of electrical collector systems;
- c) the arrangements for return currents;
- d) the arrangements for regenerative braking;
- e) the effects of electric traction system short-circuits;
- f) the effects of electro-magnetic interference and the arrangements to be employed to guard against them; and
- g) effective electrical bonding of the vehicle to ensure safe operation on the railway.

Where can I find the specific legal requirements for train safety?

Specific requirements for safety of trains are set out in the following legislation.

- Command Control and Signalling TSI
- Equality Act 2010
- Locomotive and Passenger Vehicles TSI
- Noise TSI
- Operations and Traffic Management TSI
- Persons of Reduced Mobility TSI
- Railway Safety Regulations 1999
- Freight Wagons TSI
- Simple Pressure Vessels (Safety) Regulations 1991

Where can I find further guidance on train safety?

Guidance on train safety can be found in:

- [Railway Group Standards and guidance](#) issued by RSSB
- ERA application guidance on TSI's available at <http://www.era.europa.eu/Core-Activities/Interoperability/Pages/TSI-Application-Guide.aspx>
- ORR's guidance on [CSM risk assessment](#)



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