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[1] Text with EEA relevance

EN

Acts whose titles are printed in light type are those relating to day-to-day management of agricultural matters, and are generally valid for a limited period.

The titles of all other acts are printed in bold type and preceded by an asterisk.

II

(Non-legislative acts)

DECISIONS

COMMISSION DECISION

of 26 April 2011

concerning a technical specification for interoperability relating to the 'energy' subsystem of the trans-European conventional rail system

(notified under document C(2011) 2740)

(Text with EEA relevance)

(2011/274/EU)

THE EUROPEAN COMMISSION,

Having regard to the Treaty on the Functioning of the European Union,

Having regard to Directive 2008/57/EC of the European Parliament and the Council of 17 June 2008 on the interoperability of the rail system within the Community [1], and in particular Article 6(1) thereof,

Whereas:

(1) In accordance with Article 2(e) and Annex II to Directive 2008/57/EC, the rail system is subdivided into structural and functional subsystems, including an energy subsystem.

(2) By Decision C(2006) 124 final of 9 February 2006, the Commission gave a mandate to the European Railway Agency (the Agency) to develop technical specifications for interoperability (TSIs) under Directive 2001/16/EC of the European Parliament and of the Council of 19 March 2001 on the interoperability of the trans-European conventional rail system [2]. Under the terms of that mandate, the Agency was requested to draw up the draft TSI related to the energy subsystem of the conventional rail system.

(3) Technical specifications for interoperability (TSI) are specifications adopted in accordance with the Directive 2008/57/EC. The TSI in Annex covers the energy subsystem in order to meet the essential requirements and ensure the interoperability of the rail system.

(4) The TSI in Annex should refer to Commission Decision 2010/713/EU of 9 November 2010 on modules for the procedures for assessment of conformity, suitability for use and EC verification to be used in the technical specifications for interoperability adopted under Directive 2008/57/EC of the European Parliament and of the Council [3].

(5) In accordance with Article 17(3) of Directive 2008/57/EC, Member States are to notify to the Commission and other Member States the conformity assessment and verification procedures to be used for the specific cases, as well as the bodies responsible for carrying out these procedures.

(6) The TSI in Annex should be without prejudice to the provisions of other relevant TSIs which may be applicable to energy subsystems.

(7) The TSI in Annex should not impose the use of specific technologies or technical solutions except where this is strictly necessary for the interoperability of the rail system within the Union.

(8) In accordance with Article 11(5) of Directive 2008/57/EC, the TSI in Annex should allow, for a limited period of time, for interoperability constituents to be incorporated into subsystems without certification if certain conditions are met.

[1] OJ L 191, 18.7.2008, p. 1.
[2] OJ L 110, 20.4.2001, p. 1.
[3] OJ L 319, 4.12.2010, p. 1.

(9) To continue to encourage innovation and to take into account the experience acquired, the TSI in Annex should be subject to periodic revision.

(10) The measures provided for in this Decision are in conformity with the opinion of the Committee established in accordance with Article 29(1) of Directive 2008/57/EC,

HAS ADOPTED THIS DECISION:

Article 1

A Technical Specification for Interoperability (TSI) relating to the energy subsystem of the trans-European conventional railway, is hereby adopted by the Commission.

The TSI shall be as set out in the Annex to this Decision.

Article 2

This TSI shall be applicable to all new, upgraded or renewed infrastructure of the trans-European conventional rail system as defined in Annex I to Directive 2008/57/EC.

Article 3

The procedures for assessment of conformity, suitability for use and EC verification set out in Chapter 6 of the TSI in Annex shall be based on the modules defined in Decision 2010/713/EU.

Article 4

1. During a transition period of 10 years, it shall be permissible to issue an EC certificate of verification for a subsystem that contains interoperability constituents not holding an EC Declaration of conformity or suitability for use, on the condition that the provisions set out in Section 6.3 of the Annex are met.

2. The production or upgrade/renewal of the subsystem with use of the non-certified interoperability constituents must be completed within the transition period, including the placing in service.

3. During the transition period Member States shall ensure that:

(a) the reasons for non-certification of the interoperability constituent are properly identified in the verification procedure referred to in paragraph 1;

(b) the details of the non-certified interoperability constituents and the reasons for non-certification, including the application of national rules notified under Article 17 of Directive 2008/57/EC, are included by the National Safety Authorities in their annual report referred to in Article 18 of Directive 2004/49/EC of the European Parliament and of the Council [1].

4. After the transition period and with the exceptions allowed under Section 6.3.3 on maintenance, interoperability constituents shall be covered by the required EC declaration of conformity and/or suitability for use before being incorporated into the subsystem.

Article 5

In accordance with Article 5(3)(f) of Directive 2008/57/EC, the TSI in Annex, Chapter 7, sets out a strategy for migrating towards a full interoperable energy subsystem. This migration needs to be applied in conjunction with Article 20 of that Directive which specifies the principles of the application of the TSI to the renewal and upgrading projects. Member States shall notify to the Commission a report on the implementation of Article 20 of Directive 2008/57/EC 3 years after the entry into force of this Decision. This report will be discussed in the context of the Committee set up in Article 29 of Directive 2008/57/EC and, where appropriate, the TSI in Annex will be adapted.

Article 6

1. With regard to those issues classified as specific cases set out in Chapter 7 of the TSI, the conditions to be complied with for the verification of the interoperability pursuant to Article 17(2) of Directive 2008/57/EC shall be those applicable technical rules in use in the Member State which authorise the placing in service of the subsystems covered by this Decision.

2. Each Member State shall notify to the other Member States and to the Commission within 6 months of the notification of this Decision:

(a) the applicable technical rules mentioned in paragraph 1;

(b) the conformity assessment and checking procedures to be applied with regard to the application of the technical rules mentioned in paragraph 1;

(c) the bodies it appoints for carrying out the conformity assessment and checking procedures of the specific cases mentioned in paragraph 1.

[1] OJ L 164, 30.4.2004, p. 44.

Article 7

This Decision shall apply from 1 June 2011.

Article 8

This Decision is addressed to the Member States.

Done at Brussels, 26 April 2011.

For the Commission
Siim KALLAS
Vice-President

ANNEX

DIRECTIVE 2008/57/EC ON THE INTEROPERABILITY OF THE RAIL SYSTEM WITHIN THE COMMUNITY

TECHNICAL SPECIFICATION FOR INTEROPERABILITY

'Energy' Subsystem for conventional rail

1. INTRODUCTION

1.1. **Technical scope**

This TSI concerns the energy subsystem of the trans-European conventional rail system. The energy subsystem is included in the list of subsystems in Annex II to the Directive 2008/57/EC.

1.2. **Geographical scope**

The geographical scope of this TSI is the trans-European conventional rail system as described in Annex I Chapter 1.1 to the Directive 2008/57/EC.

1.3. **Content of this TSI**

In accordance with Article 5(3) of the Directive 2008/57/EC, this TSI:

(a) indicates its intended scope — Chapter 2;

(b) lays down essential requirements for energy subsystem — Chapter 3;

(c) establishes the functional and technical specifications to be met by the subsystem and its interfaces vis-à-vis other subsystems — Chapter 4;

(d) determines the interoperability constituents and interfaces that must be covered by European specifications, including European standards, which are necessary to achieve interoperability within the rail system — Chapter 5;

(e) states, in each case under consideration, which procedures are to be used in order to assess the conformity or the suitability for use of the interoperability constituents on the one hand, and the EC verification of the subsystems, on the other hand — Chapter 6;

(f) indicates the strategy for implementing the TSI. In particular, it is necessary to specify the stages to be completed in order to make a gradual transition from the existing situation to the final situation in which compliance with the TSI shall be the norm — Chapter 7;

(g) indicates, for the staff concerned, the professional qualifications and health and safety conditions at work required for the operation and maintenance of the subsystem concerned, as well as for the implementation of the TSI — Chapter 4.

Moreover, in accordance with Article 5(5), provision may be made for specific cases; these are indicated in Chapter 7.

Lastly, this TSI also comprises, in Chapter 4, the operating and maintenance rules specific to the scope indicated in paragraphs 1.1 and 1.2 above.

2. DEFINITION AND SCOPE OF THE SUBSYSTEM

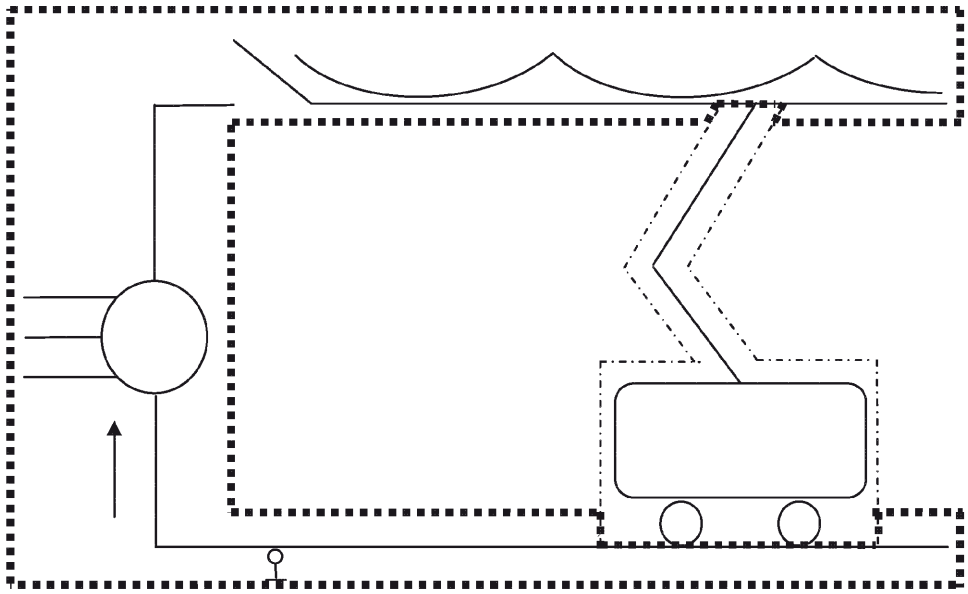
2.1. **Definition of the energy subsystem**

The Energy TSI specifies those requirements which are necessary to assure the interoperability of the rail system. This TSI covers all fixed installations, DC or AC that are required to supply, with respect to the essential requirements, traction energy to a train.

The energy subsystem also includes the definition and quality criteria for interaction between a pantograph and the overhead contact line. As the ground level conductor rail (third rail) and contact shoe system is not a 'target' system, this TSI does not describe the characteristics or functionality of such a system.

Figure 1

Energy subsystem



The energy subsystem consists of:

(a) substations: connected on the primary side to the high-voltage grid, with transformation of the high-voltage to a voltage and/or conversion to a power supply system suitable for the trains. On the secondary side, substations are connected to the railway contact line system;

(b) sectioning locations: electrical equipment located at intermediate locations between substations to supply and parallel contact lines and to provide protection, isolation and auxiliary supplies;

(c) separation sections: equipment required to provide the transition between electrically different systems or between different phases of the same electrical system;

(d) contact line system: a system that distributes the electrical energy to the trains running on the route and transmits it to the trains by means of current collectors. The contact line system is also equipped with manually or remotely controlled disconnectors which are required to isolate sections or groups of the contact line system according to operational necessity. Feeder lines are also part of the contact line system;

(e) return circuit: all conductors which form the intended path for the traction return current and which are additionally used under fault conditions. Therefore, so far as this aspect is concerned, the return circuit is part of the energy subsystem and has an interface with the infrastructure subsystem.

In addition, according to the Directive 2008/57/EC, the energy subsystem includes:

(f) on-board parts of the electric consumption measuring equipment— for measurement of electric energy taken from or returned to (during regenerative braking) the contact line by the vehicle, supplied from the external electric traction system. The equipment is integrated into and put into service with the traction unit, and is in the scope of the conventional rail locomotives and passenger rolling stock TSI (CR LOC&PAS).

The Directive 2008/57/EC also foresees that the current collectors (pantographs), which transmit electrical energy from the overhead contact line system to the vehicle, are in the rolling stock subsystem. They are installed and are integrated into and put into service with the rolling stock and are in the scope of CR LOC&PAS TSI.

However, the parameters relating to the quality of current collection are specified in CR ENE TSI.

2.1.1. *Power supply*

The power supply system has to be designed such that every train will be supplied with the necessary power. Therefore, the supply voltage, current draw of each train and the operating schedule are important aspects for performance.

As with any electrical device, a train is designed to operate correctly with a nominal voltage and a nominal frequency applied at its terminals, i.e. the pantograph(s) and wheels. Variations and limits of these parameters need to be defined in order to assure the anticipated train performance.

Modern, electrically powered trains are often capable of using regenerative braking to return energy to the power supply, reducing power consumption overall. The power supply system can be designed to accommodate such regenerative braking energy.

In any power supply, short-circuits and other fault conditions may occur. The power supply needs to be designed so that the controls detect these faults immediately and trigger measures to remove the short-circuit current and isolate the affected part of the circuit. After such events, the power supply has to be able to restore supply to all installations as soon as possible in order to resume operations.

2.1.2. *Overhead contact line and pantograph*

A compatible geometry of the overhead contact line to the pantograph is an important aspect of interoperability. As far as geometrical interaction is concerned, the height of the contact wire above the rails, the variation in contact wire height, the lateral deviation under wind pressure and the contact force have to be specified. The geometry of the pantograph head is also fundamental to assure good interaction with the overhead contact line, taking into account vehicle sway.

In order to support interoperability of European networks, the pantographs specified in CR LOC&PAS TSI are the target.

The interaction between an overhead contact line and a pantograph represents a very important aspect in establishing reliable power transmission without undue disturbances to railway installations and the environment. This interaction is mainly determined by:

(a) static and aerodynamic effects dependent upon the nature of the pantograph contact strips and the design of the pantograph, the shape of the vehicle on which the pantograph(s) is (are) mounted and the position of the pantograph on the vehicle,

(b) the compatibility of the contact strip material with the contact wire,

(c) the dynamic characteristics of the overhead contact line and pantograph(s) for single unit or multiple unit trains,

(d) the number of pantographs in service and the distance between them, since each pantograph can interfere with the others on the same overhead contact line section.

2.2. **Interfaces with other subsystems and within the subsystem**

2.2.1. *Introduction*

The energy subsystem interfaces with some of the other subsystems of the rail system in order to achieve the envisaged performance. These are listed below:

2.2.2. *Interfaces concerning power supply*

(a) Voltage and frequency and their permissible ranges interface with the rolling stock subsystem.

(b) The power installed on the lines and the specified power factor determines the performance of the rail system and interfaces with the rolling stock subsystem.

(c) Regenerative braking reduces energy consumption and interfaces with the rolling stock subsystem.

(d) Electrical fixed installations and on-board traction equipment need to be protected against short circuits. Circuit breaker tripping in substations and on trains has to be coordinated. Electrical protection interfaces with the rolling stock subsystem.

(e) Electrical interference and harmonic emissions interface with the rolling stock and control-command and signalling subsystems.

(f) The current return circuit has some interfaces with control-command and signalling and infrastructure subsystems.

2.2.3. *Interfaces concerning overhead line equipment and pantographs and their interaction*

(a) The contact wire gradient and rate of change of gradient needs special attention in order to avoid loss of contact and excessive wear. The contact wire height and gradient interfaces with the infrastructure and rolling stock subsystems.

(b) Vehicle and pantograph sway interfaces with the infrastructure subsystem.

(c) The quality of current collection depends on the number of pantographs in service, their spacing and other traction-unit-specific details. The arrangement of pantographs interfaces with the rolling stock subsystem.

2.2.4. *Interfaces concerning phase and system separation sections*

(a) To pass transitions between different power supply system and phase separation sections, without bridging, the number and arrangement of pantographs on trains shall be stipulated. This interfaces with the rolling stock subsystem.

(b) To pass transitions of power supply system and phase separation sections, without bridging, control of train current is required. This interfaces with the control-command and signalling subsystem.

(c) When passing through power supply system separation sections, lowering of pantograph(s) may be required. This interfaces with the control-command and signalling subsystem.

3. ESSENTIAL REQUIREMENTS

According to Article 4(1) of the Directive 2008/57/EC, the rail system, its subsystems and their interoperability constituents shall fulfil the essential requirements set out in general terms in Annex III to the Directive. The following table indicates basic parameters of this TSI and their correspondence to the essential requirements as explained in Annex III to the Directive.

TSI Clause	TSI Clause Title	Safety	R&A	Health	Environ-mental protection	Tech. Compatibility
4.2.3	Voltage and frequency	—	—	—	—	1.5 2.2.3
4.2.4	Parameters relating to supply system performance	—	—	—	—	1.5 2.2.3
4.2.5	Continuity of power supply in case of disturbances in tunnels	1.1.1 2.2.1	1.2	—	—	—
4.2.6	Current capacity, DC systems, trains at standstill	—	—	—	—	1.5 2.2.3
4.2.7	Regenerative braking	—	—	—	1.4.1 1.4.3	1.5 2.2.3
4.2.8	Electrical protection coor-dination arrangements	2.2.1	—	—	—	1.5

TSI Clause	TSI Clause Title	Safety	R&A	Health	Environ-mental protection	Tech. Compatibility
4.2.9	Harmonics and dynamic effects for AC systems	—	—	—	1.4.1 1.4.3	1.5
4.2.11	External electromagnetic compatibility		—	—	1.4.1 1.4.3 2.2.2	1.5
4.2.12	Protection of the environment	—	—	—	1.4.1 1.4.3 2.2.2	—
4.2.13	Geometry of the overhead contact line	—	—	—	—	1.5 2.2.3
4.2.14	Pantograph gauge	—	—	—	—	1.5 2.2.3
4.2.15	Mean contact force	—	—	—	—	1.5 2.2.3
4.2.16	Dynamic behaviour and quality of current collection	—	—	—	1.4.1 2.2.2	1.5 2.2.3
4.2.17	Pantograph spacing	—	—	—	—	1.5 2.2.3
4.2.18	Contact wire material	—	—	1.3.1 1.3.2	1.4.1	1.5 2.2.3
4.2.19	Phase separation sections	2.2.1	—	—	1.4.1 1.4.3	1.5 2.2.3
4.2.20	System separation sections	2.2.1	—	—	1.4.1 1.4.3	1.5 2.2.3
4.2.21	Electric energy consumption measuring equipment	—	—	—	—	1.5
4.4.2	Management of power supply	1.1.1 1.1.3 2.2.1	1.2	—	—	—
4.4.3	Execution of works	1.1.1 2.2.1	1.2	—	—	1.5
4.5	Maintenance rules	1.1.1 2.2.1	1.2	—	—	1.5 2.2.3
4.7.2	Protective provisions of substations and sectioning locations	1.1.1 1.1.3 2.2.1	—	—	1.4.1 1.4.3 2.2.2	1.5
4.7.3	Protective provisions of overhead contact line system	1.1.1 1.1.3 2.2.1	—	—	1.4.1 1.4.3 2.2.2	1.5
4.7.4	Protective provisions of current return circuit	1.1.1 1.1.3 2.2.1	—	—	1.4.1 1.4.3 2.2.2	1.5
4.7.5	Other general requirements	1.1.1 1.1.3 2.2.1	—	—	1.4.1 1.4.3 2.2.2	—
4.7.6	High visibility clothing	2.2.1	—	—	—	—

4. CHARACTERISATION OF THE SUBSYSTEM

4.1. **Introduction**

The rail system, to which the Directive 2008/57/EC applies, and of which the subsystem is a part, is an integrated system whose consistency shall be verified. This consistency must be checked, in particular, with regard to the specifications of the subsystem, its interfaces vis-à-vis the system in which it is integrated, as well as the operating and maintenance rules.

The functional and technical specifications of the subsystem and its interfaces, described in chapters 4.2 and 4.3, do not impose the use of specific technologies or technical solutions, except where this is strictly necessary for the interoperability of the rail network. But innovative solutions for interoperability may require new specifications and/or new assessment methods. In order to allow technological innovation, these specifications and assessment methods shall be developed by the process described in chapters 6.1.3 and 6.2.3.

Taking account of all the applicable essential requirements, the energy subsystem is characterised by the specifications set out in clauses 4.2 to 4.7. A list of parameters relevant for the energy subsystem which shall be collected in the Register of infrastructure is in Annex C to this TSI.

Procedures for the EC verification of the energy subsystem are indicated in clause 6.2.4 and Annex B, Table B.1, to this TSI.

For Specific Cases, see Chapter 7.5;

Where reference is made to EN standards, any variations called 'national deviations' or 'special national conditions' in the EN do not apply.

4.2. **Functional and technical specifications of the subsystem**

4.2.1. *General provisions*

The performance to be achieved by the Energy subsystem shall correspond to the relevant performance of the rail system, with respect to:

— the maximum line speed, type of train, and

— the power demand of the trains at the pantographs.

4.2.2. *Basic parameters characterising the energy subsystem*

The basic parameters characterising the energy subsystem are:

— Power supply:

  — voltage and frequency (4.2.3),

  — parameters relating to supply system performance (4.2.4),

  — continuity of power supply in case of disturbances in tunnels (4.2.5),

  — current capacity, DC systems, trains at standstill (4.2.6),

  — regenerative braking (4.2.7),

  — electrical protection coordination arrangements (4.2.8),

  — harmonics and dynamic effects for AC systems (4.2.9), and

  — electric energy consumption measuring equipment (4.2.21).

— Geometry of the OCL and quality of current collection:

  — geometry of the overhead contact line (4.2.13),

  — pantograph gauge (4.2.14),

— mean contact force (4.2.15),

— dynamic behaviour and quality of current collection (4.2.16),

— pantograph spacing (4.2.17),

— contact wire material (4.2.18),

— phase separation sections (4.2.19), and

— system separation sections (4.2.20).

4.2.3. *Voltage and frequency*

Locomotives and traction units need standardisation of voltage and frequency. The values and limits of the voltage and frequency at the terminals of the substation and at the pantograph shall comply with EN50163:2004, clause 4.

The AC 25 kV 50 Hz system is to be the target supply system, for reasons of compatibility with the electrical generation and distribution systems and standardisation of substation equipment.

However, due to the high investment costs needed to migrate from other system voltages to the 25 kV system and the possibility of using multi-system traction units, the use of the following systems for new, upgraded or renewed subsystems is permitted:

— AC 15 kV 16,7 Hz,

— DC 3 kV, and

— DC 1,5 kV.

Nominal voltage and frequency shall be listed in the Register of infrastructure (see Annex C).

4.2.4. *Parameters relating to supply system performance*

The design of the energy subsystem is determined by the line speed for the planned services and the topography.

Therefore the following parameters have to be taken in consideration:

— the maximum train current,

— the power factor of trains, and

— the mean useful voltage.

4.2.4.1. Maximum train current

The Infrastructure Manager shall declare the maximum train current in the Register of infrastructure (see Annex C).

The energy subsystem design shall ensure the ability of the power supply to achieve the specified performance and permit the operation of trains with a power less than 2 MW without current limitation as described in clause 7.3 of EN50388:2005.

4.2.4.2. Power factor of trains

The power factor of trains shall be in accordance with requirements in Annex G and EN50388:2005 clause 6.3.

4.2.4.3. Mean useful voltage

The calculated mean useful voltage 'at the pantograph' shall comply with EN50388:2005, clauses 8.3 and 8.4, using the design data for the power factor according to Annex G.

4.2.5. *Continuity of power supply in case of disturbances in tunnels*

The power supply and the overhead contact line system shall be designed to enable continuity of operation in case of disturbances in tunnels. This shall be achieved by sectioning overhead contact line in accordance with clause 4.2.3.1 of the SRT TSI.

4.2.6. *Current capacity, DC systems, trains at standstill*

The overhead contact line of DC systems shall be designed to sustain 300 A (for a 1.5 kV supply system) and 200 A (for a 3 kV supply system), per pantograph when the train is at standstill.

This shall be achieved using a static contact force as defined in clause 7.1 of EN50367:2006.

Where the overhead contact line has been designed to sustain higher values for maximum current at standstill, this shall be declared by the Infrastructure Manager in the Register of infrastructure (see Annex C).

The OCL shall be designed taking into account the temperature limits in accordance with EN50119:2009 clause 5.1.2.

4.2.7. *Regenerative braking*

AC power supply systems shall be designed to permit the use of regenerative braking as a service brake, able to exchange power seamlessly either with other trains or by any other means.

DC power supply systems shall be designed to permit the use of regenerative braking as a service brake at least by exchanging power with other trains.

Information about possibility of the use of regenerative braking shall be provided in the Register of infrastructure (see Annex C).

4.2.8. *Electrical protection coordination arrangements*

Electrical protection coordination design of the energy subsystem shall comply with the requirements detailed in EN50388:2005, clause 11 except Table 8 which is replaced by Annex H to this TSI.

4.2.9. *Harmonics and dynamic effects for AC systems*

The CR energy subsystem and rolling stock must be able to work together without interference problems, such as over-voltages and other phenomena described in EN50388:2005 clause 10.

4.2.10. *Harmonic emissions towards the power utility*

Harmonic emissions towards the power utility shall be dealt with by the Infrastructure Manager taking into account European or national standards and the requirements of the power utility.

No conformity assessment is required within this TSI.

4.2.11. *External electromagnetic compatibility*

External electromagnetic compatibility is not a specific characteristic of the rail network. Energy supply installations shall comply with the Essential Requirements of the EMC Directive 2004/108/EC.

No conformity assessment is required within this TSI.

4.2.12. *Protection of the environment*

Protection of the environment is covered by other European legislation concerning the assessment of the effects of certain projects on the environment.

No conformity assessment is required within this TSI.

4.2.13. *Geometry of the overhead contact line*

Overhead contact line shall be designed for use by pantographs with the head geometry specified in the CR LOC&PAS TSI clause 4.2.8.2.9.2.

The contact wire height, gradient of the contact wire in relation to the track and the lateral deviation of the contact wire under the action of a cross-wind all govern the interoperability of the rail network.

4.2.13.1. Contact wire height

The nominal contact wire height shall be in the range of 5,00 – 5,75 m. For the relation between the contact wire heights and pantograph working heights see EN50119:2009 figure 1.

The contact wire height may be lower in cases related to gauge (like bridges, tunnels). The minimum contact wire height shall be calculated in accordance with EN50119:2009 clause 5.10.4.

The contact wire may be higher in cases e.g. level crossings, loading areas, etc. In these cases the maximum design contact wire height shall not be greater than 6,20 m.

Taking into account tolerances and uplift in accordance with EN50119:2009 figure 1, the maximum contact wire height shall not be greater than 6,50 m.

The nominal contact wire height shall be listed in the Register of infrastructure (see Annex C).

4.2.13.2. Variation in contact wire height

The variation in contact wire height shall fulfil the requirements imposed by EN50119:2009 clause 5.10.3.

The contact wire gradient specified in EN50119:2009 clause 5.10.3 may be exceeded on an exceptional basis where a series of restrictions on the contact wire height e.g. level crossings, bridges, tunnels, prevents compliance; in this case when applying the requirements of clause 4.2.16, only the requirement related to the maximum contact force shall be complied with.

4.2.13.3. Lateral deviation

The maximum permissible lateral deviation of the contact wire normal to the design track centre line under the action of cross wind is given in Table 4.2.13.3.

Table 4.2.13.3

Maximum lateral deviation

Pantograph length	Maximum lateral deviation
1 600 mm	0,40 m
1 950 mm	0,55 m

The values shall be adjusted taking into account the movement of the pantograph and track tolerances according to Annex E.

In the case of the multi-rail track, the requirement shall be fulfilled for each pair of rails (designed, to be operated as separated track) that is intended to be assessed against TSI.

The pantograph profiles that are permitted to operate on the route, shall be listed in the Register of infrastructure (see Annex C).

4.2.14. *Pantograph gauge*

No part of the energy subsystem shall enter the mechanical kinematic pantograph gauge (see Annex E figure E.2) except for the contact wire and steady arm.

The mechanical kinematic pantograph gauge for interoperable lines is determined using the method shown in Annex E clause E.2 and the pantograph profiles defined in CR LOC&PAS TSI clause 4.2.8.2.9.2.

This gauge shall be calculated using a kinematic method, with values:

— for the pantograph sway — e_{pu} — of 0,110 m at the lower verification height — $h'_u \leq 5{,}0$ m, and

— for the pantograph sway — e_{po} — of 0,170 m at the upper verification height — h'_o — 6,5 m,

in accordance with Annex E clause E.2.1.4 and other values in accordance with Annex E clause E.3.

4.2.15. *Mean contact force*

The mean contact force F_m is the statistical mean value of the contact force. F_m is formed by the static, dynamic and aerodynamic components of the pantograph contact force.

The static contact force is defined in EN50367:2006 clause 7.1. The ranges of F_m for each of the power supply systems are defined in Table 4.2.15.

Table 4.2.15

Ranges of the mean contact force

Supply system	F_m up to 200 km/h
AC	60 N < F_m< 0,00047*v^2 + 90 N
DC 3 kV	90 N < F_m< 0,00097*v^2 + 110 N
DC 1,5 kV	70 N < F_m< 0,00097*v^2 + 140 N

where [F_m] = mean contact force in N and [v] = speed in km/h.

In accordance to clause 4.2.16, overhead contact lines shall be designed to be capable to sustain this upper limit force curve given in Table 4.2.15.

4.2.16. *Dynamic behaviour and quality of current collection*

The overhead contact line shall be designed in accordance with the requirements for dynamic behaviour. Contact wire uplift at the design speed shall comply with the stipulations in Table 4.2.16.

The quality of current collection has a fundamental impact on the life of a contact wire and shall, therefore, comply with agreed and measurable parameters.

Compliance with the requirements on dynamic behaviour shall be verified by assessment of:

— Contact wire uplift

and either

— Mean contact force F_m and standard deviation σ_{max}

or

— Percentage of arcing

The Contracting Entity shall declare the method to be used for verification. The values to be achieved by the chosen method are set out in Table 4.2.16.

Table 4.2.16

Requirements for dynamic behaviour and current collection quality

Requirement	For v > 160 km/h	For v ≤ 160 km/h
Space for steady arm uplift	$2S_0$	
Mean contact force F_m	See clause 4.2.15	
Standard deviation at maximum line speed σ_{max} (N)	0.3 F_m	
Percentage of arcing at maximum line speed, NQ (%) (minimum duration of arc 5 ms)	≤ 0,1 for AC systems ≤ 0,2 for DC systems	≤ 0,1

For definitions, values and test methods refer to EN50317:2002 and EN50318:2002.

S_0 is the calculated, simulated or measured uplift of the contact wire at a steady arm, generated in normal operating conditions with one or more pantographs with a mean contact force F_m at the maximum line speed. When the uplift of the steady arm is physically limited due to the overhead contact line design, it is permissible for the necessary space to be reduced to 1,5 S_0 (refer to EN50119:2009 clause 5.10.2).

Maximum force (F_{max}) on an open route is usually within the range of F_m plus three standard deviations σ_{max}; higher values may occur at particular locations and are given in EN50119:2009, Table 4 clause 5.2.5.2.

For rigid components such as section insulators in overhead contact line systems, the contact force can increase up to a maximum of 350 N.

4.2.17. *Pantograph spacing*

The overhead contact line shall be designed for a minimum of two pantographs operating adjacently, having a minimum spacing centre line to centre line of the pantograph head as set out in Table 4.2.17:

Table 4.2.17

Pantograph spacing

Operating Speed (km/h)	AC Minimum distance (m)			3 kV DC Minimum distance (m)			1,5 kV DC Minimum distance (m)		
Type	A	B	C	A	B	C	A	B	C
160 < v ≤ 200	200	85	35	200	115	35	200	85	35
120 < v ≤ 160	85	85	35	20	20	20	85	35	20
80 < v ≤ 120	20	15	15	20	15	15	35	20	15
v ≤ 80	8	8	8	8	8	8	20	8	8

If applicable, the following parameters shall be declared in the Register of infrastructure (see Annex C):

— the distance design type (A or B or C) for the OCL according to Table 4.2.17,

— the minimum spacing between adjacent pantographs below those shown in the Table 4.2.17,

— the number of pantographs above two, for which the line has been designed.

4.2.18. *Contact wire material*

The combination of contact wire material and contact strip material has a strong impact on the wear on both sides.

Permissible materials for contact wires are copper and copper-alloy (excluding copper-cadmium-alloys). The contact wire shall comply with the requirements of EN50149:2001 clauses 4.1, 4.2 and 4.5 to 4.7 (excluding Table 1).

For AC lines the contact wire shall be designed to permit the use of plain carbon contact strips (CR LOC&PAS TSI clause 4.2.8.2.9.4.2). Where the IM accepts other contact strip material an entry shall be made in the Register of infrastructure (see Annex C).

For DC lines the contact wire shall be designed to accept contact strip materials in accordance with CR LOC&PAS TSI clause 4.2.8.2.9.4.2.

4.2.19. *Phase separation sections*

The design of phase separation sections shall ensure that trains can move from one section to an adjacent one without bridging the two phases. Power consumption shall be brought to zero according to EN50388:2005 clause 5.1.

Adequate means (except the short separation section as in Annex F — fig. F.1) shall be provided to allow a train that is stopped within the phase separation section to be restarted. The neutral section shall be connectable to the adjacent sections by remotely controlled disconnectors.

The design of separation sections shall normally adopt solutions as described in EN50367:2006 Annex A.1 or in Annex F to this TSI. Where an alternative solution is proposed, it shall be demonstrated that the alternative is at least as reliable.

Information on the design of phase separation sections and permissible configuration of raised pantographs shall be provided in the Register of infrastructure (see Annex C).

4.2.20. *System separation sections*

4.2.20.1. General

The design of system separation sections shall ensure that vehicles can move from one power supply system to an adjacent different power supply system without bridging the two systems. A system separation between AC and DC system needs additional measures to be taken in the return circuit as defined in EN50122-2:1998, clause 6.1.1.

There are two methods for traversing system separation sections:

(a) with pantograph raised and touching the contact wire,

(b) with pantograph lowered and not touching the contact wire.

The neighbouring Infrastructure Managers shall agree either (a) or (b) according to the prevailing circumstances. The method to be adopted shall be recorded in the Register of infrastructure (see Annex C).

4.2.20.2. Pantographs raised

If system separation sections are traversed with pantographs raised to the contact wire, their functional design is specified as follows:

— the geometry of different elements of the overhead contact line shall prevent pantographs short-circuiting or bridging both power systems,

— provision shall be made in the energy subsystem to avoid bridging of both adjacent power supply systems should the opening of the on-board circuit breaker(s) fail,

— variation in contact wire height along the entire separation section shall fulfil requirements set in EN50119:2009 clause 5.10.3.

The pantograph arrangements that are permitted to traverse the system separation with pantographs raised shall be provided in the Register of infrastructure (see Annex C).

4.2.20.3. Pantographs lowered

This option shall be chosen if the conditions of operation with pantographs raised cannot be met.

If a system separation section is traversed with pantographs lowered, it shall be designed so as to avoid the bridging by an unintentionally raised pantograph. Equipment shall be provided to switch off both power supply systems should a pantograph remain raised, e.g. by detection of short circuits.

4.2.21. *Electric energy consumption measuring equipment*

As it is specified in clause 2.1 of this TSI, requirements for the on-board electric energy consumption measuring equipment are set out in the CR LOC&PAS TSI.

If an electric energy consumption measuring equipment is installed, it shall be compatible with CR LOC&PAS TSI clause 4.2.8.2.8. This equipment can be used for billing purposes and the data provided by it shall be accepted for billing in all Member States.

4.3. **Functional and technical specifications of the interfaces**

4.3.1. *General requirements*

From the standpoint of technical compatibility, the interfaces are listed in subsystem order as follows: rolling stock, infrastructure, control and command and signalling, traffic operation and management. They also include indications to safety in railway tunnels TSI (SRT TSI).

4.3.2. *Locomotives and Passenger Rolling Stock*

CR ENE TSI		CR LOC&PAS TSI	
Parameter	Clause	Parameter	Clause
Voltage and frequency	4.2.3	Operation within range of voltages and frequencies	4.2.8.2.2

CR ENE TSI		CR LOC&PAS TSI	
Parameter	Clause	Parameter	Clause
Max train current	4.2.4.1	Max power and current from OCL	4.2.8.2.4
Power factor of trains	4.2.4.2	Power factor	4.2.8.2.6
Current capacity DC systems trains at standstill	4.2.6	Maximum current at standstill for DC systems	4.2.8.2.5
Regenerative braking	4.2.7	Regenerative brake with energy to OCL	4.2.8.2.3
Electrical protection coordination arrangements	4.2.8	Electrical protection of the train	4.2.8.2.10
Harmonics and dynamic effects for AC systems	4.2.9	System energy disturbances for AC systems	4.2.8.2.7
Geometry of the overhead contact line	4.2.13	Working range in height of pantograph	4.2.8.2.9.1
		Pantograph head geometry	4.2.8.2.9.2
Pantograph gauge	4.2.14	Pantograph head geometry	4.2.8.2.9.2
		Gauging	4.2.3.1
Mean contact force	4.2.15	Pantograph static contact force	4.2.8.2.9.5
		Pantograph contact force and dynamic behaviour	4.2.8.2.9.6
Dynamic behaviour and quality of current collection	4.2.16	Pantograph contact force and dynamic behaviour	4.2.8.2.9.6
Pantograph spacing	4.2.17	Arrangements of pantographs	4.2.8.2.9.7
Contact wire material	4.2.18	Contact strip material	4.2.8.2.9.4.2
Separation sections:		Running through phase or system separation section	4.2.8.2.9.8
phase	4.2.19		
system	4.2.20		
Electric energy consumption measuring equipment	4.2.21	Energy consumption measuring function	4.2.8.2.8

4.3.3. *Infrastructure*

CR ENE TSI		CR INF TSI	
Parameter	Clause	Parameter	Clause
Pantographs gauge	4.2.14	Structure gauge	4.2.4.1
Protective provisions of:		Protection against electric shock	4.2.11.3
— OCL system	4.7.3		
— current return circuit	4.7.4		

4.3.4. *Control-Command and Signalling*

The interface for power control at phase and system separation sections is an interface between the energy and the rolling stock subsystems. However, it is controlled via the control-command and signalling subsystem and consequently the interface is specified in the CR CCS TSI and the CR LOC & PAS TSI.

Since the harmonic currents generated by rolling stock affect the control-command and signalling subsystem through the energy subsystem, this subject is dealt within the control-command and signalling subsystem.

4.3.5. *Traffic Operation and Management*

The Infrastructure Manager is required to have systems in place to communicate with the Railway Undertakings.

CR ENE TSI		CR OPE TSI	
Parameter	Clause	Parameter	Clause
Management of power supply	4.4.2	Description of the line and the relevant lineside equipment associated with the lines worked over	4.2.1.2.2
		Informing the driver in real time	4.2.1.2.3
Execution of works	4.4.3	Modified elements	4.2.1.2.2.2

4.3.6. *Safety in Railway Tunnels*

CR ENE TSI		SRT TSI	
Parameter	Clause	Parameter	Clause
Continuity of power supply in case of disturbances in tunnels	4.2.5	Segmentation of overhead line or conductor rails	4.2.3.1

4.4. **Operating rules**

4.4.1. *Introduction*

To meet the essential requirements in Chapter 3, the operating rules specific to the subsystem concerned by this TSI are as follows:

4.4.2. *Management of power supply*

4.4.2.1. Management of power supply under normal conditions

Under normal conditions in order to conform to clause 4.2.4.1, the maximum permissible train current shall not exceed the value contained in the Register of Infrastructure (see Annex C).

4.4.2.2. Management of power supply under abnormal conditions

Under abnormal conditions the maximum permissible train current (see Annex C) can be lower. The Infrastructure Manager shall give notice of the variation to the Railway Undertakings.

4.4.2.3. Management of power supply in case of danger

Procedures shall be implemented by the Infrastructure Manager to manage the power supply adequately in an emergency. Railway undertakings operating and companies working on the line shall be given notice of the temporary measures, of their geographic location, their nature and the means of signalling. The responsibility for earthing shall be defined in the emergency plan to be written by the Infrastructure Manager. Conformity assessment shall be carried out by checking the existence of communications channels, instructions, procedures and devices to be used in emergency.

4.4.3. *Execution of works*

In certain situations involving pre-planned works, it may be necessary to temporarily suspend the specifications of the energy subsystem and its interoperability constituents defined in chapters 4 and 5 of the TSI. In this case, the Infrastructure Manager shall define the appropriate exceptional operating conditions needed to ensure safety.

The following general provisions apply:

— the exceptional operating conditions not complying with the TSIs shall be temporary and planned,

— railway undertakings operating and companies working on the line shall be given notice of these temporary exceptions, of their geographic location, their nature and the means of indication.

4.5. **Maintenance rules**

The specified characteristics of the power supply system (including substations and sectioning locations) and the overhead contact line shall be upheld during their lifetime.

A maintenance plan shall be drawn up to ensure that the specified characteristics of the energy subsystem required to assure interoperability are upheld within the specified limits. The maintenance plan shall contain in particular the description of professional competences for the staff and of the personal protective safety equipment to be used by it.

Maintenance procedures shall not downgrade safety provisions such as the continuity of return current circuit, limitation of overvoltages and detection of short circuits.

4.6. **Professional qualifications**

The IM is responsible for the professional qualifications and competence of the staff which operates and controls the energy subsystem; the IM has to ensure that the processes for competence assessment are clearly documented. The competence requirements for the maintenance of the energy subsystem shall be detailed in the maintenance plan (see clause 4.5).

4.7. **Health and safety conditions**

4.7.1. *Introduction*

The health and safety conditions of staff required for the operation and maintenance of the energy subsystem and for the implementation of the TSI, are described in the following clauses.

4.7.2. *Protective provisions of substations and sectioning locations*

Electrical safety of the traction power supply systems' shall be achieved by designing and testing these installations according to EN50122-1:1997, clauses 8 (excluding reference to EN50179) and 9.1. Substations and sectioning locations shall be barred against unauthorised access.

The earthing of substations and sectioning locations shall be integrated into the general earthing system along the route.

For each installation, it shall be demonstrated that return current circuits and earthing conductors are adequate by design review. It shall be demonstrated that the provisions for protection against electric shock and rail potential, as designed, have been installed.

4.7.3. *Protective provisions of overhead contact line system*

Electrical safety of the overhead contact line system and protection against electric shock shall be achieved by compliance with EN50119:2009 clause 4.3 and EN50122-1:1997 clauses 4.1, 4.2, 5.1, 5.2 and 7, excluding requirements for connections for track circuits.

The earthing provisions of the overhead contact line system shall be integrated into the general earthing system along the route.

For each installation, it shall be demonstrated that earthing conductors are adequate, by design review. It shall be demonstrated that the provisions for protection against electric shock and rail potential, as designed, have been installed.

4.7.4. *Protective provisions of current return circuit*

Electrical safety and functionality of the current return circuit shall be achieved by designing these installations according to EN50122-1:1997, clauses 7 and 9.2 to 9.6 (excluding reference to EN 50179).

For each installation it shall be demonstrated that return current circuits are adequate by design review. It shall also be demonstrated that the provisions for protection against electric shock and rail potential, as designed, have been installed.

4.7.5. *Other general requirements*

In addition to clauses 4.7.2 to 4.7.4, and the requirements specified in the maintenance plan (see clause 4.5), precautions shall be taken to ensure health and safety for maintenance and operations staff, in accordance with the European regulations and the national regulations that are compatible with European legislation.

4.7.6. *High Visibility Clothing*

Staff engaged in the maintenance of the energy subsystem, when working on or near the track, shall wear reflective clothes, which bear the CE mark (and therefore satisfy the provisions of Council Directive 89/686/EEC of 21 December 1989 on the approximation of the laws of the Member States relating to personal protective equipment ([1]).

4.8. **Register of Infrastructure and European register of authorised typed of vehicles**

4.8.1. *Introduction*

In accordance with Articles 33 and 35 of the Directive 2008/57/EC, each TSI shall indicate precisely the information that must be included in the European register of authorised types of vehicles and Register of Infrastructure.

4.8.2. *Register of infrastructure*

Annex C to this TSI indicates which information concerning the energy subsystem shall be included in the Register of infrastructure. In all cases when any part or whole of an energy subsystem is made compliant with this TSI, an entry shall be made in the Register of Infrastructure as indicated in Annex C and the relevant clause in chapters 4 and 7.5 (specific cases).

4.8.3. *European register of authorised types of vehicles*

Annex D to this TSI indicates which information concerning the energy subsystem shall be included in the European register of authorised types of vehicles.

5. INTEROPERABILITY CONSTITUENTS

5.1. **List of constituents**

The interoperability constituents are covered by the relevant provisions of the Directive 2008/57/EC, and are listed below so far as the energy subsystem is concerned.

Overhead contact line: The Interoperability Constituent overhead contact line consists of the components listed below to be installed within an energy subsystem, and the associated design and configuration rules.

The components of an overhead contact line are an arrangement of wire(s) suspended over the railway line for supplying electricity to electric trains, together with associated fittings, in-line insulators and other attachments including feeders and jumpers. It is placed above the upper limit of the vehicle gauge, supplying vehicles with electrical energy through pantographs.

The supporting components such as cantilevers, masts and foundations, return conductors, auto-transformer feeders, switches and other insulators are not part of the interoperability constituent overhead contact line. They are covered by subsystem requirements so far as interoperability is concerned.

([1]) OJ L 399, 30.12.1989, p. 18.

The conformity assessment shall cover the phases and characteristics as indicated in clause 6.1.3 and by X in the Table A.1 of Annex A to this TSI.

5.2. **Constituents' performances and specifications**

5.2.1. *Overhead contact line*

5.2.1.1. Geometry of the OCL

The design of the overhead contact line shall comply with clause 4.2.13.

5.2.1.2. Mean contact force

The overhead contact line shall be designed by using the mean contact force F_m stipulated in clause 4.2.15.

5.2.1.3. Dynamic behaviour

Requirements for dynamic behaviour of the overhead contact line are set out in clause 4.2.16.

5.2.1.4. Space for uplift

The overhead contact line shall be designed providing the required space for uplift as set out in clause 4.2.16.

5.2.1.5. Design for pantograph spacing

The overhead contact line shall be designed for a pantograph spacing as specified in clauses 4.2.17.

5.2.1.6. Current at standstill

For DC systems, the overhead contact line shall be designed for the requirements set out in clause 4.2.6.

5.2.1.7. Contact wire material

The contact wire material shall comply with the requirements set out in clause 4.2.18.

6. ASSESSMENT OF CONFORMITY OF THE INTEROPERABILITY CONSTITUENTS AND EC VERIFICATION OF THE SUBSYSTEMS

6.1. **Interoperability Constituents**

6.1.1. *Conformity assessment procedures*

The conformity assessment procedures of interoperability constituents as defined in Chapter 5 of this TSI shall be carried out by application of relevant modules.

Assessment procedures for particular requirements for interoperability constituent are set out in clause 6.1.4.

6.1.2. *Application of modules*

The following modules for conformity assessment of interoperability constituents are used:

— CA Internal production control

— CB EC type examination

— CC Conformity to type based on internal production control

— CH Conformity based on full quality management system

— CH1 Conformity based on full quality management system plus design examination

Table 6.1.2

Modules for conformity assessment to be applied for ICs

Procedures	Modules
Placed on the EU market before entry in force of this TSI	CA or CH
Placed on the EU market after entry in force of this TSI	CB+CC or CH1

The modules for conformity assessment of interoperability constituents shall be chosen from those shown in Table 6.1.2.

In the case of products placed on the market before the publication of this TSI, the type is considered to have been approved and therefore EC type examination (module CB) is not necessary, provided that the manufacturer demonstrates that tests and verification of interoperability constituents have been considered successful for previous applications under comparable conditions and are in conformity with the requirements of this TSI. In this case these assessments shall remain valid in the new application. If it is not possible to demonstrate that the solution is positively proven in the past, the procedure for ICs placed on the EU market after publication of this TSI applies.

6.1.3. *Innovative solutions for Interoperability Constituents*

If an innovative solution is proposed for an interoperability constituent as defined in clause 5.2, the manufacturer or his authorised representative established within the Community shall state the deviations from the relevant clause of this TSI and submit them to the Commission for analysis.

In case the analysis results in a favourable opinion, the appropriate functional and interface specifications for the constituent and the assessment method will be developed under the authorisation of the Commission.

The appropriate functional and interface specifications and the assessment methods so produced shall be incorporated in the TSI by the revision process.

By the notification of a decision of the Commission, taken in accordance with Article 29 of the Directive, the innovative solution may be permitted to be used before being incorporated into the TSI by the revision process.

6.1.4. *Particular assessment procedure for Interoperability Constituent — OCL*

6.1.4.1. Assessment of dynamic behaviour and quality of current collection

The assessment of the dynamic behaviour and the quality of the current collection involves the overhead contact line (energy subsystem) and the pantograph (rolling stock subsystem).

A new design of overhead contact line shall be assessed by simulation according to EN50318:2002 and by measurement of a test section of the new design according to EN50317:2002.

For the purposes of simulation and analysis of the results, representative features (for example tunnels, crossovers, neutral sections etc.) shall be taken into account.

The simulations shall be made using at least two different TSI compliant [1] types of pantograph for the appropriate speed [2] and supply system, up to the design speed of the proposed Interoperability Constituent overhead contact line.

It is permitted to perform the simulation using types of pantograph that are under the process of IC certification, provided that they fulfil the other requirements of CR LOC&PAS TSI.

The simulation shall be performed for single pantograph and multiple pantographs with spacing according to the requirements set in clause 4.2.17.

In order to be acceptable, the simulated current collection quality shall be in accordance with clause 4.2.16 for uplift, mean contact force and standard deviation for each of the pantographs.

If the simulation results are acceptable, a site dynamic test with a representative section of the new overhead contact line shall be undertaken.

For the above mentioned site test, one of the two types of the pantograph chosen for the simulation, shall be installed on a rolling stock that allows the appropriate speed on the representative section.

[1] i.e. pantographs certificated as Interoperability Constituent according to CR or HS TSIs.
[2] i.e. the speed of the two types of pantograph shall be at least equal to the design speed of the simulated overhead contact line.

The tests shall be performed at least for the worst case arrangements of the pantographs derived from the simulations and shall fulfil the requirements set out in clause 4.2.17.

Each pantograph shall produce a mean contact force up to the envisaged design speed of the OCL under test as required by clause 4.2.15.

In order to be acceptable, the measured current collection quality shall be in accordance with clause 4.2.16, for uplift, and either mean contact force and standard deviation or percentage of arcing.

If all the above assessments are passed successfully, the tested overhead contact line design shall be considered to be compliant and may be used on lines where the characteristics of the design are compatible.

Assessment of dynamic behaviour and quality of current collection for interoperability constituent pantograph are set out in clause 6.1.2.2.6 of CR LOC&PAS TSI

6.1.4.2. Assessment of current at standstill

The conformity assessment shall be carried out in accordance with EN50367:2006, Annex A.4.1.

6.1.5. *EC declaration of conformity of Interoperability Constituents*

According to Annex IV clause 3 of the Directive 2008/57/EC, the EC declaration of conformity shall be accompanied by statement setting out the condition of use:

— nominal voltage and frequency,

— maximum design speed.

6.2. **Energy subsystem**

6.2.1. *General provisions*

At the request of the applicant, the Notified Body carries out EC verification in accordance with Annex VI to the Directive 2008/57/EC, and in accordance with the provisions of the relevant modules.

If the applicant demonstrates that tests or verifications of an energy subsystem have been successful for previous applications of a design in similar circumstances, the Notified Body shall take these tests and verifications into account for the EC verification.

Assessment procedures for particular requirements for subsystem are set out in clause 6.2.4.

The applicant shall draw up the EC declaration of verification for the energy subsystem in accordance with Article 18(1) of and Annex V to the Directive 2008/57/EC.

6.2.2. *Application of modules*

For the EC verification procedure of the energy subsystem the applicant or its authorised representative established within the Community may choose either:

— module SG: EC verification based on unit verification, or

— module SH1: EC verification based on full quality management system plus design examination.

6.2.2.1. Application of module SG

In case of module SG, the Notified Body may take into account evidence of examinations, checking or tests that have been successfully performed, under comparable conditions by other bodies [1] or by (or on behalf of) the applicant.

[1] The conditions to trust checking and tests must be similar to the conditions respected by a Notified Body to subcontract activities (see §6.5 of the Blue Guide on the New Approach).

6.2.2.2. Application of module SH1

The module SH1 may be chosen only where the activities contributing to the proposed subsystem to be verified (design, manufacturing, assembling, installation) are subject to a quality management system for design, production, final product inspection and testing, approved and surveyed by a Notified Body.

6.2.3. *Innovative solutions*

If the subsystem includes an innovative solution as defined in clause 4.1, the applicant shall state the deviation from the relevant clauses of the TSI and submit them to the Commission.

In case of favourable opinion, the appropriate functional and interface specifications, and the assessment methods for this solution will be developed.

The appropriate functional and interface specifications and the assessment methods so produced shall then be incorporated in the TSI by the revision process. By the notification of a decision of the Commission, taken in accordance with Article 29 of the Directive, the innovative solution may be permitted to be used before being incorporated into the TSI by the revision process.

6.2.4. *Particular assessment procedures for Subsystem*

6.2.4.1. Assessment of mean useful voltage

The assessment shall be carried out in accordance with EN50388:2005, clauses 14.4.1, 14.4.2 (simulation only) and 14.4.3.

6.2.4.2. Assessment of regenerative braking

The assessment for AC power supply fixed installations shall be carried out according to EN50388:2005, clause 14.7.2.

The assessment for DC power supply shall be carried out by a design review.

6.2.4.3. Assessment of electrical protection coordination arrangements

The assessment shall be carried out for design and operation of substations in accordance with EN50388:2005 clause 14.6.

6.2.4.4. Assessment of harmonic and dynamic effects for AC systems

The assessment, based on a compatibility study, shall be conducted according to EN50388:2005 clause 10.3 taking into account over-voltages given in EN 50388:2005 clause 10.4.

6.2.4.5. Assessment of dynamic behaviour and quality of current collection (integration into a subsystem)

If the overhead contact line to be installed on a new line is certificated as an Interoperability Constituent, measurements of the interaction parameters in accordance with EN50317:2002 shall be used to check the correct installation.

These measurements shall be carried out with an Interoperability Constituent pantograph, exhibiting the mean contact force characteristics as required by clause 4.2.15 of this TSI for the envisaged design speed of the overhead contact line.

The main goal of this test is to identify construction errors but not to assess the design in principle.

The installed overhead contact line can be accepted if the measurement results comply with the requirements in clause 4.2.16 for uplift, and either mean contact force and standard deviation or percentage of arcing.

Assessment of dynamic behaviour and quality of current collection for integration of the pantograph into rolling stock subsystem are set out in clause 6.2.2.2.14 of CR LOC&PAS TSI

6.2.4.6. Assessment of maintenance plan

The assessment shall be carried out by verifying the existence of the maintenance.

The Notified Body is not responsible for assessing the suitability of the detailed requirements set out in the plan.

6.3. **Subsystem containing Interoperability Constituents not holding an EC declaration**

6.3.1. *Conditions*

During the transition period provided in Article 4 of this Decision, a Notified Body is permitted to issue an EC certificate of verification for a subsystem, even if some of the interoperability constituents incorporated within the subsystem are not covered by the relevant EC declarations of conformity and/or suitability for use according to this TSI, if the following criteria are complied with:

— the conformity of the subsystem has been checked against the requirements of Chapter 4 and in relation to Chapter 6.2. to 7 (except 'Specific Cases') of this TSI by the Notified Body.

Furthermore the conformity of the ICs to Chapters 5 and 6.1 does not apply, and

— the interoperability constituents, which are not covered by the relevant EC declaration of conformity and/or suitability for use, have been used in a subsystem already approved and put in service in at least one of the Member State before the entry in force of this TSI.

EC Declarations of conformity and/or suitability for use shall not be drawn up for the interoperability constituents assessed in this manner.

6.3.2. *Documentation*

The EC certificate of verification of the subsystem shall indicate clearly which interoperability constituents have been assessed by the Notified Body as part of the subsystem verification.

The EC declaration of verification of the subsystem shall indicate clearly:

— which interoperability constituents have been assessed as part of the subsystem,

— confirmation that the subsystem contains the interoperability constituents identical to those verified as part of the subsystem,

— for those interoperability constituents, the reason(s) why the manufacturer did not provide an EC declaration of conformity and/or suitability for use before its incorporation into the subsystem, including the application of national rules notified under Article 17 of Directive 2008/57/EC.

6.3.3. *Maintenance of the subsystems certified according to 6.3.1*

During the transition period as well as after the transition period has ended, until the subsystem is upgraded or renewed (taking into account the decision of Member State on application of TSIs), the interoperability constituents which do not hold an EC Declaration of conformity and/or suitability for use and of the same type are permitted to be used as maintenance related replacements (spare parts) for the subsystem, under the responsibility of the body responsible for maintenance. In any case the body responsible for maintenance must ensure that the components for maintenance related replacements are suitable for their applications, are used within their area of use, and enable interoperability to be achieved within the rail system while at the same time meeting the essential requirements. Such components must be traceable and certified in accordance with any national or international rule, or any code of practice widely acknowledged in the railway domain.

7. IMPLEMENTATION

7.1. **General**

The Member State shall specify for TEN lines those parts of the energy subsystem, which are required for interoperable services (e.g. overhead contact line over tracks, sidings, stations, marshalling yards) and therefore need to comply with this TSI. In specifying these elements the Member State shall consider the coherence of the system as a whole.

7.2. **Progressive strategy towards interoperability**

7.2.1. *Introduction*

The strategy described in this TSI applies to new, upgraded and renewed lines.

Modification of existing lines to bring them into conformity with the TSIs may entail high investment costs and, consequently, can be progressive.

In accordance with the conditions laid down in Article 20(1) of the Directive 2008/57/EC, the migration strategy indicates the way existing installations shall be adapted when it is economically justified to do so.

7.2.2. *Migration strategy for voltage and frequency*

The choice of power supply system is a Member State decision. The decision should be taken on economic grounds, taking into account at least the following factors:

— the existing power supply system in that Member State,

— any connection to railway line in neighbouring countries with an existing electrical power supply.

7.2.3. *Migration strategy for pantographs and OCL geometry*

The overhead contact line shall be designed for use by at least one of the pantographs with the head geometry (1 600 mm or 1 950 mm) specified in the CR LOC&PAS TSI clause 4.2.8.2.9.2.

7.3. **Application of this TSI to new lines**

Chapters 4 to 6 and any specific provisions in paragraph 7.5 below apply in full to the lines coming within the geographical scope of this TSI (cf. paragraph 1.2) which will be put into service after this TSI enters into force

7.4. **Application of this TSI to existing lines**

7.4.1. *Introduction*

Whilst the TSI can be fully applied to new installations, implementation on existing lines may require modifications of existing equipment. The degree of necessary modification will depend on the extent of conformity of the existing equipment. The following principles apply in the case of the CR TSI, without prejudice to clause 7.5 (Specific cases).

Where Article 20(2) of the Directive 2008/57/EC applies meaning that an authorisation of placing into service is required, the Member State decides which requirements of the TSI must be applied taking into account the migration strategy.

Where Article 20(2) of the Directive 2008/57/EC does not apply because a new authorisation of placing into service is not required, the conformity with this TSI is recommended. Where it is not possible to achieve conformity, the contracting entity informs the Member State of the reason thereof.

When the Member State requires placing new equipment into service, the Contracting Entity shall define the practical measures and different phases of the project which are necessary to achieve the required levels of performance. These project phases may include transition periods for placing equipment into service with reduced levels of performance.

An existing subsystem may allow the circulation of TSI-conform vehicles whilst meeting the essential requirements of Directive 2008/57/EC. The infrastructure manager should be able in this case, on a voluntary basis, to complete the Register of Infrastructure set out in Article 35 of Directive 2008/57/EC. The procedure to be used for the demonstration of the level of compliance with the basic parameters of the TSI shall be defined in the specification of the Infrastructure Register to be adopted by the Commission in accordance with that Article.

7.4.2. *Upgrading/renewal of the OCL and/or the power supply*

It is possible to gradually modify all or part of the Overhead Contact Line and/or the power supply system — element by element — over an extended period of time to achieve conformance with this TSI.

However the conformity of the entire subsystem can only be declared when all elements have been brought into conformity with the TSI.

The process of upgrading/renewal should take into consideration the need of maintaining compatibility with the existing energy subsystem and other subsystems. For a project including elements not being TSI conform, the procedures for the assessment of conformity and EC verification to be applied should be agreed with the Member State.

7.4.3. *Parameters related to maintenance*

While maintaining the energy subsystem, formal verifications and authorisations for placing into service are not required. However, maintenance replacements may be as far as reasonably practicable, be undertaken in accordance with the requirements of this TSI contributing to the development of interoperability.

7.4.4. *Existing subsystem that are not subject to a renewal or upgrading project*

A subsystem in current operation may permit trains conforming to the requirements of the HS and CR rolling stock TSIs to operate whilst meeting the essential requirements. The Infrastructure Manager may in this case, on a voluntary basis, complete the Register of infrastructure in accordance with Annex C to this TSI to show the level of compliance with the basic parameters of this TSI.

7.5. **Specific cases**

7.5.1. *Introduction*

The following special provisions are permitted in the specific cases below:

(a) 'P' cases: permanent cases;

(b) 'T' cases: temporary cases, where it is recommended that the target system is reached by 2020 (an objective set in Decision No 1692/96/EC of the European Parliament and Council of 23 July 1996 on Community guidelines for the development of the trans-European transport network [1], as amended by Decision N° 884/2004/EC of the European Parliament and of the Council [2].

7.5.2. *List of specific cases*

7.5.2.1. Particular features on the Estonian network

P case

All the basic parameters from clause 4.2.3 to 4.2.20 are not applicable for lines with 1 520 mm track and they are an open point.

7.5.2.2. Particular features on the French network

7.5.2.2.1. Voltage and frequency (4.2.3)

T case

The values and limits of the voltage and frequency at the terminals of the substation and at the pantograph of the 1,5 kV DC electrified lines:

— Nimes to Port Bou,

— Toulouse to Narbonne,

may extend the values set out in EN50163:2004, clause 4 (U_{max2} close to 2 000 V).

7.5.2.2.2. Mean Contact Force (4.2.15)

P case

For DC 1,5 kV line the mean contact force is in the following range:

[1] OJ L 228, 9.9.1996, p. 1.
[2] OJ L 167, 30.4.2004, p. 1.

Table 7.5.2.2.2

Ranges of the mean contact force

DC 1,5 kV	70 N < Fm< 0,00178*v^2 + 110 N with a value of 140 N at standstill

7.5.2.3. Particular features on the Finnish network

7.5.2.3.1. Geometry of the overhead contact line — contact wire height (4.2.13.1)

P case

Nominal contact wire height is 6,15 m, minimum 5,60 m and maximum 6,60 m.

7.5.2.4. Particular features on the Latvian network

P case

All the basic parameters from clauses 4.2.3 to 4.2.20 are not applicable for lines with 1 520 mm track and they are an open point.

7.5.2.5. Particular features on the Lithuanian network

P case

All the basic parameters from clauses 4.2.3 to 4.2.20 are not applicable for lines with 1 520 mm track and they are an open point.

7.5.2.6. Particular features on the Slovenian network

7.5.2.6.1. Pantograph gauge (4.2.14)

P case

For Slovenia for renewal and upgrade of existing lines with regard to existing gauge of the structures (tunnels, overpasses, bridges) the mechanical kinematic pantograph gauge is in accordance with the pantograph profile 1 450 mm as defined in standard EN 50367, 2006, figure B.2.

7.5.2.7. Particular features on the UK network for Great Britain

7.5.2.7.1. Contact wire height (4.2.13.1)

P case

In Great Britain, for upgrade or renewal of the existing energy subsystem, or the construction of new energy subsystems on existing infrastructure, the nominal contact wire height adopted shall not be less than 4 700 mm.

7.5.2.7.2. Lateral deviation (4.2.13.3)

P cases

In Great Britain, for new, upgraded or renewed energy subsystems the permissible lateral deviation of the contact wire in relation to the design track centre line under the action of cross — winds shall be 475 mm (unless a lower value is declared in the register of infrastructure) at a wire height of less than or equal to 4 700 mm including allowances for construction, temperature effects and mast deflection. For wire heights above 4 700 mm, this value shall decrease by 0,040 x (wire height (mm) – 4 700) mm.

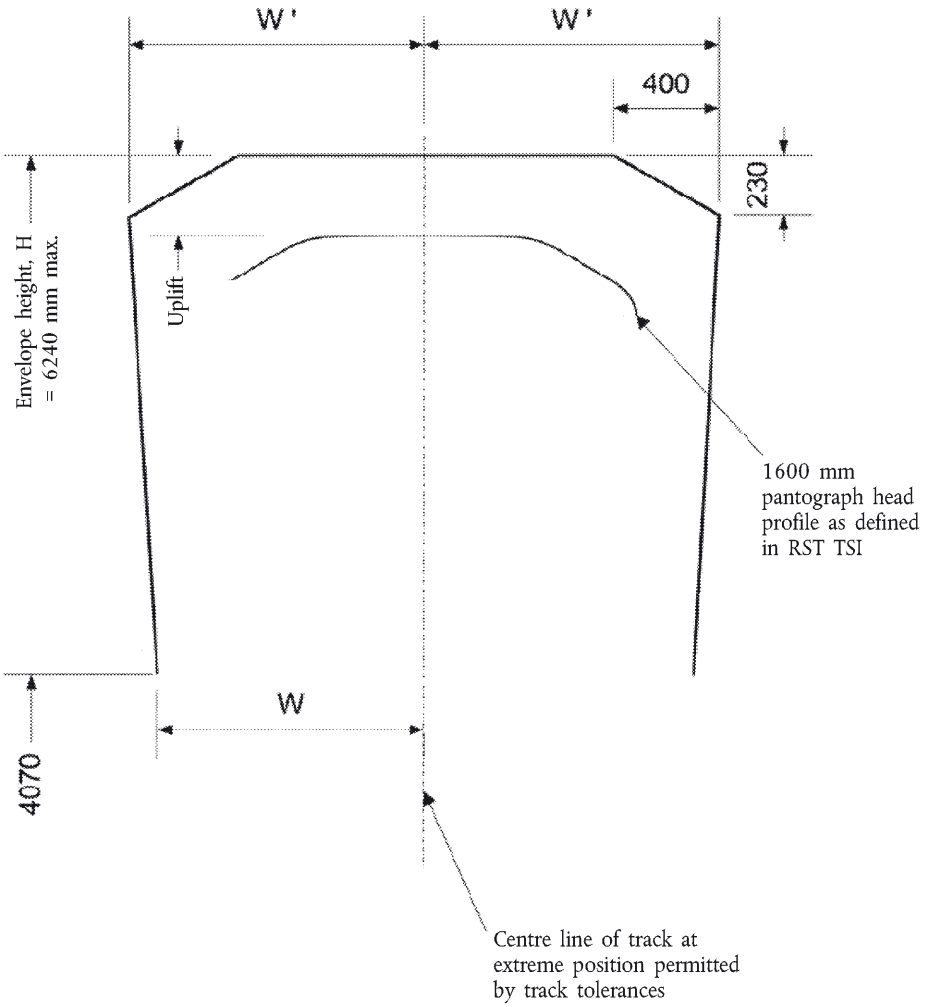
7.5.2.7.3. Pantograph gauge (4.2.14 and Annex E)

P cases

In Great Britain, for upgrade or renewal of the existing energy subsystem, or the construction of new energy subsystems on existing infrastructure, the mechanical kinematic pantograph gauge is defined in the diagram below (Figure 7.5.2.7).

Figure 7.5.2.7

Pantograph gauge



The diagram shows the extreme envelope within which movements of the pantograph head shall remain. The envelope shall be placed on the extreme position of track centre-lines permitted by track tolerances, which are not included. The envelope is an absolute gauge, not a Reference Profile subject to adjustments.

At all speeds up to line speed; maximum cant; maximum wind speed at which unrestricted operation is possible, and extreme wind speed, defined in the register of infrastructure:

$W = 800 + J$ mm, when $H \leq 4\,300$ mm; and

$W' = 800 + J + (0{,}040 \times (H - 4\,300))$ mm, when $H > 4\,300$ mm.

Where:

H = Height to top of envelope above rail level (in mm). The dimension is the sum of the contact wire height and the provision for uplift.

J = 200 mm on straight track.

J = 230 mm on curved track.

J = 190 mm (minimum) where constrained by clearance to civil infrastructure that cannot be economically increased.

Additional allowances shall be made including wear of contact wire, mechanical clearance, static or dynamic electrical clearance.

7.5.2.7.4. 600/750 V DC Electrified Railway using ground level conductor rails

P case

Lines equipped with the electrification system operating at 600/750 V DC and utilising ground level top-contact conductor rails in a three and/or four rail configuration shall continue to be upgraded, renewed and extended where this is economically justified. National Standards shall apply.

7.5.2.7.5. Protective provisions of overhead contact line system (4.7.3)

P case

In the reference to EN50122-1:1997 clause 5.1, the special national condition to this clause (5.1.2.1) shall apply.

8. LIST OF ANNEXES

A. *Conformity assessment of Interoperability Constituents*

B. *EC verification of the energy subsystem*

C. *Register of infrastructure, information on the energy subsystem*

D. *European register of authorised types of vehicles, information required by the energy subsystem*

E. *Determination of the mechanical kinematic pantograph gauge*

F. *Phase and system separation section solutions*

G. *Power factor*

H. *Electrical protection: main circuit breaker tripping*

I. *List of referenced standards*

J. *Glossary*

ANNEX A

CONFORMITY ASSESSMENT OF INTEROPERABILITY CONSTITUENTS

A.1. **Scope**

This Annex indicates the conformity assessment of interoperability constituent (overhead contact line) of the energy subsystem.

For existing interoperability constituents, the process described in Chapter 6.1.2. shall be followed.

A.2. **Characteristics**

The characteristics of the interoperability constituent to be assessed applying modules CB or CH1 are marked by an X in Table A.1. The production phase shall be assessed within the subsystem.

Table A.1

Assessment of the interoperability constituent: overhead contact line

	Assessment in the following phase				Particular assessment procedures
	Design and development phase			Production phase	
Characteristic — Clause	Design review	Manufacturing process review	Type Test	Product quality (series production)	
Geometry — 5.2.1.1	X	N/A	N/A	N/A	
Mean contact force — 5.2.1.2	X	N/A	N/A	N/A	
Dynamic behaviour — 5.2.1.3	X	N/A	X	N/A	Conformity Assessment as per clause 6.1.4.1 by validated simulation according to EN50318:2002 for design review, and measurements according to EN50317:2002 for type test
Space for uplift — 5.2.1.4	X	N/A	X	N/A	Validated simulation according to EN50318:2002 for Design review and measurement according to EN50317:2002 for Type Tests with mean contact force according to clause 4.2.15
Design for pantograph spacing — 5.2.1.5	X	N/A	N/A	N/A	
Current at standstill — 5.2.1.6	X	N/A	X	N/A	Acc. to clause 6.1.4.2
Contact wire material — 5.2.1.7	X	N/A	X	N/A	

N/A: not applicable

ANNEX B

EC VERIFICATION OF THE ENERGY SUBSYSTEM

B.1. **Scope**

This Annex indicates the EC verification of the energy subsystem.

B.2. **Characteristics and Modules**

The characteristics of the subsystem to be assessed in the different phases of design, installation and operation are marked by X in Table B.1.

Table B.1

EC verification of the energy subsystem

Basic parameters	Assessment phase				
	Design develop. phase	Production phase			
	Design review	Construction, assembly, mounting	Assembled, before putting into service	Validation under full operating conditions	Particular assessment procedures
Voltage and frequency — 4.2.3	X	N/A	N/A	N/A	
Parameters relating to system performance — 4.2.4	X	N/A	N/A	N/A	Assessment of mean useful voltage acc. to clause 6.2.4.1
Continuity of power supply in case of disturbances in tunnels — 4.2.5	X	N/A	X	N/A	
Current capacity, DC systems, trains at standstill — 4.2.6	X (*)	N/A	N/A	N/A	
Regenerative braking — 4.2.7	X	N/A	N/A	N/A	Acc. to clause 6.2.4.2
Electrical protection coordination arrangements — 4.2.8	X	N/A	X	N/A	Acc. to clause 6.2.4.3
Harmonics and dynamic effects for AC systems — 4.2.9	X	N/A	N/A	N/A	Acc. to clause 6.2.4.4
Geometry of the overhead contact line: contact wire height — 4.2.13.1	X (*)	N/A	N/A	N/A	
Geometry of the overhead contact line: Variation in contact wire height — 4.2.13.2	X (*)	N/A	N/A	N/A	
Geometry of the overhead contact line: Lateral deviation — 4.2.13.3	X (*)	N/A	N/A	N/A	

Basic parameters	Assessment phase				
	Design develop. phase	Production phase			
	Design review	Construction, assembly, mounting	Assembled, before putting into service	Validation under full operating conditions	Particular assessment procedures
Pantograph gauge — 4.2.14	X	N/A	N/A	N/A	
Mean contact force — 4.2.15	X (*)	N/A	N/A	N/A	
Dynamic behaviour and quality of current collection — 4.2.16	X (*)	N/A	X	N/A	Verification as per clause 6.1.4.1 by validated simulation according to EN50318:2002 for design review. Verification of assembled overhead contact line as per clause 6.2.4.5 by measurements according to EN 50317:2002
Pantograph spacing — 4.2.17	X (*)	N/A	N/A	N/A	
Contact wire material — 4.2.18	X (*)	N/A	N/A	N/A	
Phase separation sections — 4.2.19	X	N/A	N/A	N/A	
System separation sections — 4.2.20	X	N/A	N/A	N/A	
Management of power supply in case of danger — 4.4.2.3	X	N/A	X	N/A	
Maintenance rules — 4.5	N/A	N/A	X	N/A	Acc. to clause 6.2.4.6
Protection against electric shock 4.7.2, 4.7.3, 4.7.4	X	X	X	N/A[1)]	1) Validation under full operating conditions shall only be done when the validation in the phase 'Assembly before putting into service' is not possible

N/A: not applicable
(*) only to be carried out if the overhead contact line has not been assessed as an interoperability constituent

ANNEX C

REGISTER OF INFRASTRUCTURE, INFORMATION ON THE ENERGY SUBSYSTEM

C.1. **Scope**

This Annex covers the information concerning the energy subsystem to be included in the Register of infrastructure for each homogeneous section of compliant lines which has to be established according to clause 4.8.2.

C.2. **Characteristics to be Described**

Table C.1 contains those characteristics of the energy subsystem interoperability for which data are to be given for each line section.

Table C.1

Information to be given in the Register of infrastructure

Parameter, interoperability element	Clause
Voltage and frequency	4.2.3
Maximum train current	4.2.4.1
Maximum current at standstill, DC systems only	4.2.6
Conditions to accommodate regenerated energy	4.2.7
Nominal contact wire height	4.2.13.1
Accepted pantograph profile(s)	4.2.13.3
Maximum line speed with one operating pantograph (if applicable)	4.2.17
Distance design type of OCL	4.2.17
Minimum spacing between adjacent pantograph (if applicable)	4.2.17
Number of pantographs above two for which the line has been designed (if applicable)	4.2.17
Permitted contact strip material	4.2.18
Phase separation sections: type of separation section used Information on operation, configuration of raised pantograph	4.2.19
System separation sections: type of separation section used Information on operation: tripping of circuit breaker, lowering of pantographs	4.2.20
Specific Cases	7.5
Any other divergence from the TSI requirements	

ANNEX D

EUROPEAN REGISTER OF AUTHORISED TYPES OF VEHICLES, INFORMATION REQUIRED BY THE ENERGY SUBSYSTEM

D.1. **Scope**

This Annex covers the information concerning the energy subsystem to be included in the European register of authorised types of vehicles.

D.2. **Characteristics to be described**

Table D.1 contains those characteristics of the energy subsystem interoperability for which data are to be given in the European register of authorised types of vehicles.

Table D.1

Information to be given in the European register of authorised types of vehicles

Parameter, interoperability element	Information	CR LOC&PAS TSI Clause
Electrical Protection of the train	Breaking capacity of on-board circuit breaker (kA), trains operating on a 15 kV 16,7 Hz line	4.2.8.2.10
Arrangement of pantographs	Spacing	4.2.8.2.9.7
Current limitation device fitted	Type/Rating	4.2.8.2.4
Fitment of automatic power control devices	Type/Rating	4.2.8.2.4
Regenerative brake fitted	Yes/No	4.2.8.2.3
Presence of on-board energy metering	Yes/No	4.2.8.2.8
Energy related Specific Cases		7.3
Any other divergence from the TSI requirements		

ANNEX E

DETERMINATION OF THE MECHANICAL KINEMATIC PANTOGRAPH GAUGE

E.1. **General**

E.1.1. *Space to be cleared for electrified lines*

In the case of lines electrified by an overhead contact line, an additional space should be cleared:

— to accommodate the OCL equipment,

— to allow the free passage of the pantograph.

This annex deals with the free passage of the pantograph (pantograph gauge). The electrical clearance is considered by the Infrastructure Manager.

E.1.2. *Particularities*

The pantograph gauge differs in some aspects from the obstacle gauge:

— the pantograph is (partly) live and, for this reason, an electrical clearance is to be complied with, according to the nature of the obstacle (insulated or not),

— the presence of insulating horns should be taken into account, where necessary. Therefore a double reference contour has to be defined to take account of the mechanical and electrical interference simultaneously,

— in collecting condition, the pantograph is in permanent contact with the contact wire and, for this reason, its height is variable. So is the height of the pantograph gauge.

E.1.3. *Symbols and abbreviations*

Symbol	Designation	Unit
b_w	Half-length of the pantograph bow	m
$b_{w,c}$	Half-length of the pantograph bow conducting length (with insulating horns) or working length (with conducting horns)	m
$b'_{o,mec}$	Width of mechanical kinematic pantograph gauge at upper verification point	m
$b'_{u,mec}$	Width of mechanical kinematic pantograph gauge at lower verification point	m
$b_{h,mec}$	Width of mechanical kinematic pantograph gauge at intermediate height, h	m
d_l	Lateral deviation of contact wire	m
D_o	Reference cant taken into account by the vehicle for the pantograph gauge	m
e_p	Pantograph sway due to the vehicle characteristics	m
e_{po}	Pantograph sway at the upper verification point	m
e_{pu}	Pantograph sway at the lower verification point	m
f_s	Margin to take account of the raising of the contact wire	m
f_{wa}	Margin to take account of the wear of the pantograph contact strip	m
f_{ws}	Margin to take account of the bow trespassing the contact wire due to the pantograph sway	m

Symbol	Designation	Unit
h	Height in relation to the running surface	m
h'_{co}	Reference roll centre height for the pantograph gauge	m
h'	Reference height in the calculation of the pantograph gauge	m
h'_o	Maximum verification height of the pantograph gauge in a collecting position	m
h'_u	Minimum verification height of the pantograph gauge in a collecting position	m
h_{eff}	Effective height of the raised pantograph	m
h_{cc}	Static height of the contact wire	m
I'_0	Reference cant deficiency taken into account by the vehicle for the pantograph gauging	m
L	Distance between rail centres of a track	m
l	Track gauge, distance between the rail running edges	m
q	Transverse play between axle and bogie frame or, for vehicles not fitted with bogies, between axle and vehicle body	m
qs'	Quasi-static movement	m
s'_o	Flexibility coefficient taken into account by agreement between the vehicle and the infrastructure for the pantograph gauging	
$S'_{i/a}$	Allowed additional overthrow on the inside/outside of the curve for pantographs	m
w	Transverse play between bogie and body	m
ϑ	Mounting tolerance of the pantograph on the roof.	radian
τ	Transverse flexibility of the mounting device on the roof.	m
Σ_j	Sum of the (horizontal) safety margins covering some random phenomena (j = 1, 2 or 3) for the pantograph gauge	

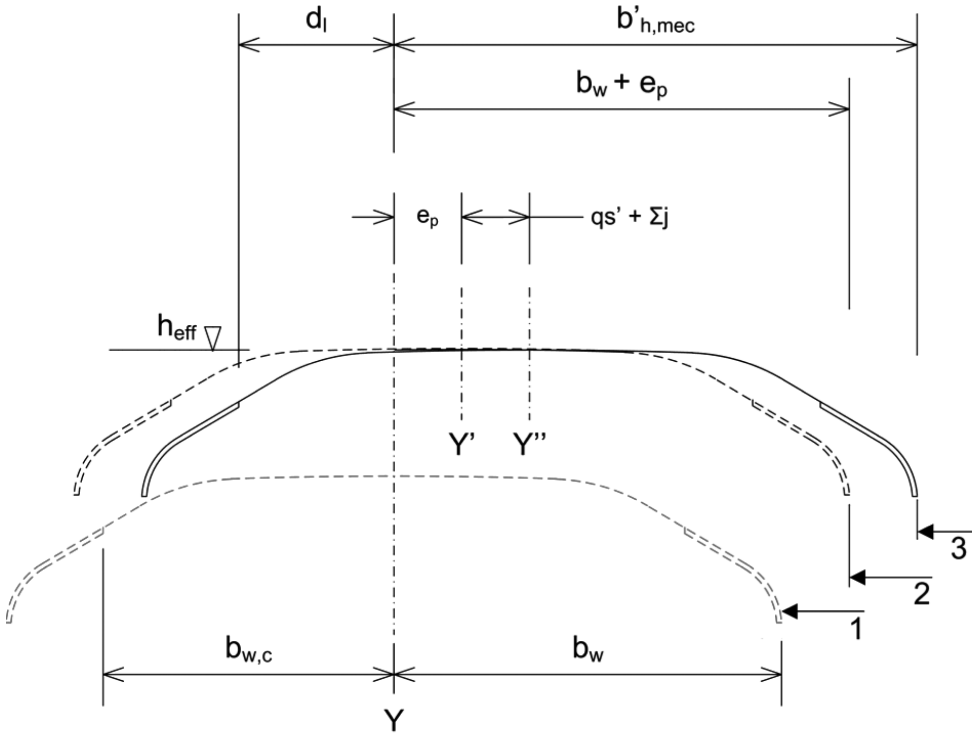
Subscript a: refers to the outside of the curve.

Subscript i: refers to the inside of the curve.

E.1.4. *Basic principles*

Figure E.1

Pantograph gauges



Caption:

Y: Centre line of the track

Y': Centre line of the pantograph — for deriving the free passage reference profile

Y'': Centre line of the pantograph — for deriving the mechanical kinematic pantograph gauge

1: Pantograph profile

2: Free passage reference profile

3: Mechanical kinematic gauge

The pantograph gauge is only met if the mechanical and electrical gauges are complied with simultaneously:

— the free passage reference profile includes the pantograph collector head length and the pantograph sway e_p, which applies up to the reference cant or cant deficiency,

— live and insulated obstacles shall remain outside the mechanical gauge,

— non-insulated obstacles (earthed or at a potential different from the OCL) shall remain outside the mechanical and electrical gauges.

Figure E.1 shows the pantograph mechanical gauges.

E.2. **Determination of the mechanical kinematic pantograph gauge**

E.2.1. *Determination of the width of the mechanical gauge*

E.2.1.1. Scope

The width of the pantograph gauge is mainly determined by the length and displacements of the pantograph under consideration. Beyond specific phenomena, phenomena similar to those of the obstacle gauge are found in the transverse displacements.

The pantograph gauge shall be considered at the following heights:

— the upper verification height h'_o,

— the lower verification height h'_u.

Between those two heights, it can be considered that gauge width varies in a linear way.

The various parameters are shown in figure E.2.

E.2.1.2. Calculation methodology

The pantograph gauge width shall be determined by the sum of the parameters defined below. In the case of a line run by various pantographs, the maximum width should be considered.

For the lower verification point with h = h'_u:

$$b'_{u(i/a),mec} = (b_w + e_{pu} + S'_{i/a} + qs'_{i/a} + \Sigma_j)_{\max}$$

For the upper verification point with h = h'_o:

$$b'_{o(i/a),mec} = (b_w + e_{po} + S'_{i/a} + qs'_{i/a} + \Sigma_j)_{\max}$$

NOTE i/a = inside/outside curve.

For any intermediate height h, width is determined by means of an interpolation:

$$b'_{h,mec} = b'_{u,mec} + \frac{h - h'_u}{h'_o - h'_u} \cdot (b'_{o,mec} - b'_{u,mec})$$

E.2.1.3. Half-length b_w of the pantograph bow

The half-length b_w of the pantograph bow depends of the type of pantograph used. The pantograph profile(s) to be considered are defined in CR LOC&PAS TSI clause 4.2.8.2.9.2.

E.2.1.4. Pantograph sway e_p

The sway mainly depends on the following phenomena:

— play $q + w$ in the axle boxes and between bogie and body,

— the amount of body inclination taken into account by the vehicle (depending on the specific flexibility s'_0, the reference cant D'_0 and the reference cant deficiency I'_0),

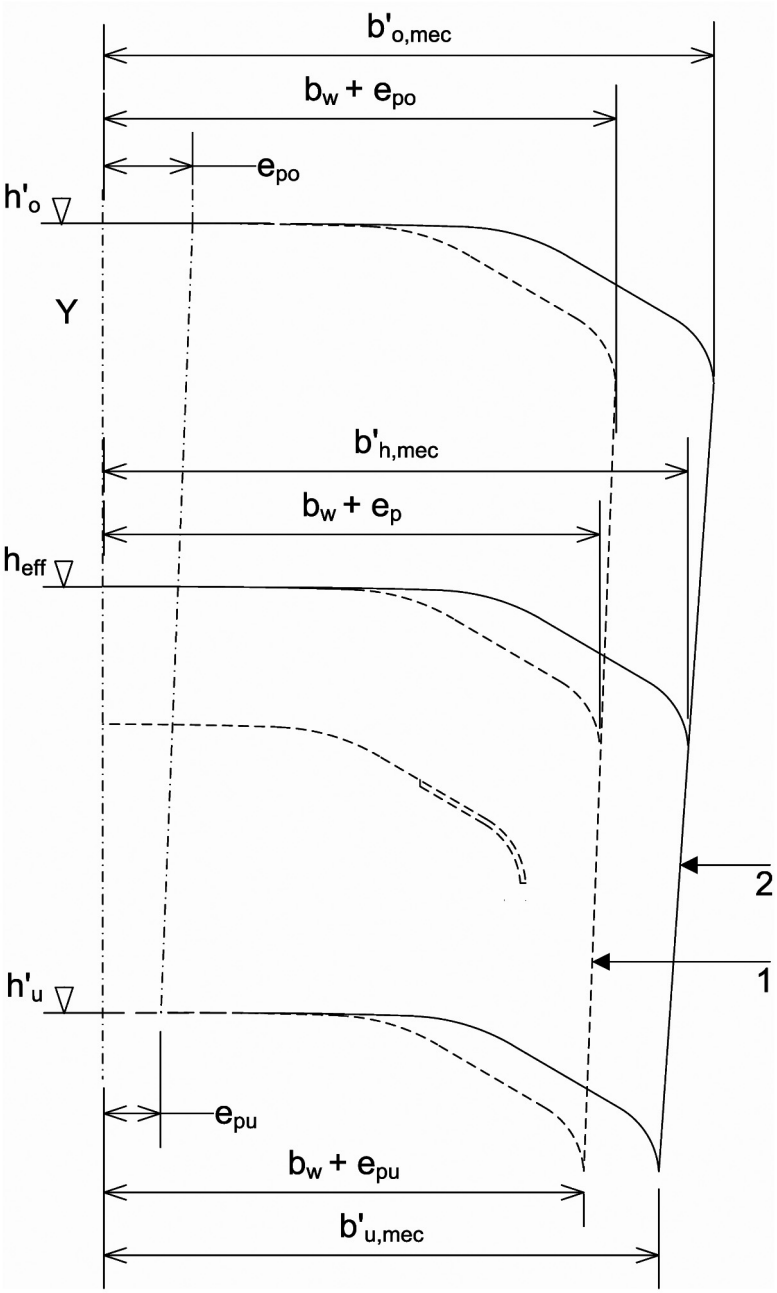
— the mounting tolerance ϑ of the pantograph on the roof,

— the transverse flexibility τ of the mounting device on the roof,

— the height under consideration h'.

Figure E.2

Determination of the width of the mechanical kinematic gauge of the pantograph at different heights



Caption:

Y: Centre of the track

1: Free passage reference profile

2: Mechanical kinematic pantograph gauge

E.2.1.5. Additional overthrows

The pantograph gauge has a specific additional overthrows. In case of standard track gauge the following formula applies:

$$S'_{i/a} = \frac{2{,}5}{R} + \frac{l - 1{,}435}{2}$$

For other track gauges the national rules apply.

E.2.1.6. Quasi-static effect

Since the pantograph is installed on the roof, the quasi-static effect plays an important role in the calculation of the pantograph gauge. That effect is calculated from the specific flexibility s_0', reference cant D'_0 and reference cant deficiency I'_0:

$$qs'_i = \frac{s'_0}{L}[D - D'_0]_{>0}(h - h'_{c0})$$

$$qs'_a = \frac{s'_0}{L}[I - I'_0]_{>0}(h - h'_{c0})$$

NOTE: Pantographs are normally mounted on the roof of a power unit, whose reference flexibility s_0' is generally smaller than that of the obstacle gauge s_0.

E.2.1.7. Allowances

According to gauge definition, the following phenomena should be considered:

— loading dissymmetry,

— the transverse displacement of the track between two successive maintenance actions,

— the cant variation occurring between two successive maintenance actions,

— oscillations generated by track unevenness.

The sum of the abovementioned allowances is covered by Σ_j.

E.2.2. *Determination of the height of the mechanical gauge*

Gauge height shall be determined on the basis of the static height h_{cc}, of the contact wire at the local point under consideration. The following parameters should be considered:

— the raising f_s of the contact wire generated by the pantograph contact force. The value of f_s depends on the OCL type and so shall be determined by the Infrastructure Manager in accordance with clause 4.2.16,

— the raising of the pantograph head due to the pantograph head skew generated by the staggered contact point and the wear of the collector strip $f_{ws} + f_{wa}$. The permissible value of f_{ws} is shown in CR LOC&PAS TSI and f_{wa}. depends on maintenance requirements.

The height of the mechanical gauge is given by the following formula:

$$h_{eff} = h_{cc} + f_s + f_{ws} + f_{wa}$$

E.3. **Reference parameters**

Parameters for the kinematic mechanical pantograph gauge and for determination of the maximum lateral deviation of the contact wire shall be as follows:

— l - according to track gauge

— s_0 = 0,225

— h_{c0} = 0,5 m

— I_0 = 0,066 m and D_0 = 0,066 m

— h'_o = 6,500 m and h'_u = 5,000 m

E.4. **Calculation of maximum lateral deviation of contact wire**

The maximum lateral deviation of the contact wire shall be calculated by taking into consideration the total movement of the pantograph with respect to the nominal track position and the conducting range (or working length, for pantographs without horns made from a conducting material) as follows:

$$d_l = b_{w,c} + b_w - b'_{h,mec}$$

$b_{w,c}$ – defined in clause 4.2.8.2.9.1 and 4.2.8.2.9.2 of CR LOC&PAS TSI.

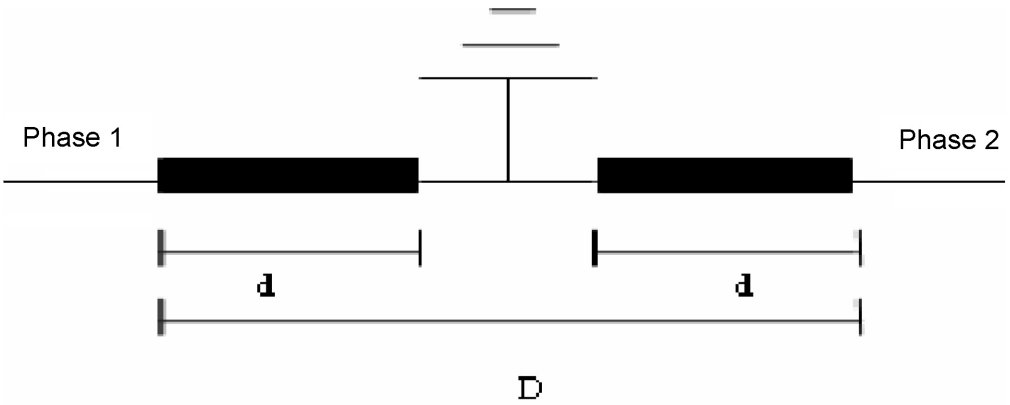
ANNEX F

PHASE AND SYSTEM SEPARATION SECTION SOLUTIONS

Phase separation section designs are described in EN50367:2006, Annex A.1.3 (long neutral section) and in Annex A.1.5 (split neutral section - the overlaps can be replaced by double section insulators) or described in the Figures F.1 or F.2.

Figure F.1

Separation section with neutral section insulators



In the case of Figure F.1, the neutral sections (d) may be formed by neutral section insulators and the dimensions shall be as follows:

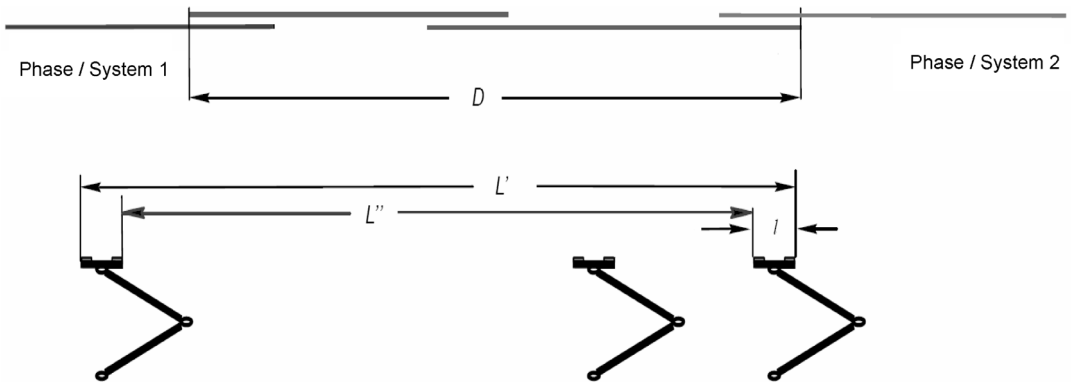
$D \leq 8$ m

This small length ensures that the probability of a train stopping inside the phase separation does not require the adequate means to restart.

The length of d shall be chosen in accordance with the system voltage, maximum line speed and the maximum pantograph width.

Figure F.2

Split neutral section



Conditions: $L' > D + 2l$ $D < 79$ m

$L'' > 80$ m

The span covering three consecutive pantographs shall be greater than 80 m (L′′). The intermediate pantograph may be arranged at any position within this span. Depending on the minimum spacing between two adjacent operating pantographs the infrastructure manager shall state the maximum operating train speed. No electrical connection may exist between pantographs in service.

ANNEX G

POWER FACTOR

This Annex deals only with inductive power factor and power consumption over the range of voltage from U_{min1} to U_{max1} defined in EN 50163.

Table G.1 gives the total inductive power factor λ of a train. For the calculation of λ, only the fundamental of the voltage at pantograph is taken into account.

Table G.1

Total inductive power factor λ of a train

Instantaneous train power P at the pantograph MW	Category I and II of HS TSI lines (b)	TSI line category III; IV; V;VI; VII and Classical lines
P > 2	≥ 0,95	≥ 0,95
0 ≤ P ≤ 2	a	a

For yards or depot, the power factor of the fundamental wave shall be ≥ 0,8 (NOTE 1) under the following conditions: the train is hotelling with traction power switched off and all auxiliaries running and the active power being drawn is greater than 200 kW.

The calculation of overall average λ for a train journey, including the stops, is taken from the active energy W_P (MWh) and reactive energy W_Q (MVArh) given by a computer simulation of a train journey or metered on an actual train.

$$\lambda = \frac{1}{\sqrt{1 + \left(\frac{W_Q}{W_P}\right)^2}}$$

a In order to control the total power factor of the auxiliary load of a train during the coasting phases, the overall average λ (traction and auxiliaries) defined by simulation and/or measurement shall be higher than 0,85 over a complete timetable journey. (typical journey between two stations including commercial stops).

b applicable to trains in conformity with the HS TSI 'rolling stock'.

During regeneration, inductive power factor is allowed to decrease freely in order to keep voltage within limits.

NOTE 1: Higher power factors than 0,8 will result in better economic performance due to a reduced requirement for fixed equipment provision.

NOTE 2: on line categories III to VII, for rolling stock existing before publication of this TSI, the Infrastructure Manager may impose conditions e.g. economic, operating, power limitation for acceptance of interoperable trains having power factors below the value specified in Table G.1.

ANNEX H

ELECTRICAL PROTECTION: MAIN CIRCUIT BREAKER TRIPPING

Table H.1

Action on circuit breakers at an internal fault within a traction unit

Power supply system	When any internal defect fault occurs within the traction units Sequence of tripping for:	
	Substation feeder circuit breaker	Traction unit circuit breaker
AC 25 000 V-50 Hz	Immediate tripping [a]	Immediate tripping
AC 15 000 V-16,7 Hz	Immediate tripping [a]	Primary side of the transformer: Tripping shall be staged [b] Secondary side of the transformer: Immediate tripping
DC 750 V, 1 500 V and 3 000 V	Immediate tripping [a]	Immediate tripping

[a] The tripping of the circuit breaker should be very rapid for high short-circuits currents. As far as possible, the traction unit circuit breaker should trip in order to try to avoid the substation circuit breaker tripping.
[b] If breaking capacity of the circuit breaker allows it, then tripping shall be immediate. Then, as far as possible, the traction unit circuit breaker should trip in order to try to avoid the substation circuit breaker tripping.

NOTE 1 New and modernised traction units should be equipped with high speed circuit breakers capable of breaking the maximum short-circuit current in the shortest possible time.

NOTE 2 Immediate tripping means that for high short-circuit current, sub-station or train breaker should operate without introducing intentional delay. If the first stage relay does not act, then the second stage relay (back up protection relay) will act about 300 ms later. As information, with first stage relay, and by state of the art, duration of the highest short circuit current seen from the sub-station breaker is given hereafter:

For AC 15 000 V-16,7 Hz -> 100 ms

For AC 25 000 V-50 Hz -> 80 ms

For DC 750 V, 1 500 V and 3 000 V -> 20 to 60 ms

ANNEX I

LIST OF REFERENCED STANDARDS

Table I.1

List of referenced standards

Index No.	Reference	Document name	Version	BP(s) concerned
1	EN 50119	Railway applications — Fixed installations — Electric traction overhead contact lines	2009	Current capacity, DC systems, trains at standstill (4.2.6), Contact wire height (4.2.13.1), Variation in contact wire height (4.2.13.2), Dynamic behaviour and quality of current collection (4.2.16), System separation sections (4.2.20), Protective provisions of overhead contact line system (4.7.3)
2	EN 50122-1	Railway applications — Fixed installations — Electrical safety, earthing and bonding — — Part 1: Protective provisions relating to electrical safety and earthing	1997	Protective provisions of substations and sectioning locations (4.7.2), Protective provisions of overhead contact line system (4.7.3), Protective provisions of current return circuit (4.7.4)
3	EN 50122-2	Railway applications — Fixed installations — Electrical safety, earthing and bonding — — Part 2: Protective provisions against the effects of stray currents caused by d.c. traction systems	1998	System separation sections (4.2.20)
4	EN 50149	Railway applications — Fixed installations — Electric traction — Copper and copper alloy grooved contact wires	2001	Contact wire material (4.2.18)
5	EN 50317	Railway applications — Current collection systems — Requirements for and validation of measurements of the dynamic interaction between pantograph and overhead	2002	Dynamic behaviour and quality of current collection (4.2.16)
6	EN 50318	Railway applications — Current collection systems — Validation of simulation of the dynamic interaction between pantograph and overhead contact line	2002	Dynamic behaviour and quality of current collection (4.2.16)

Index No.	Reference	Document name	Version	BP(s) concerned
7	EN 50367	Railway applications — Current collection systems — Technical criteria for the interaction between pantograph and overhead line (to achieve free access)	2006	Current capacity, DC systems, trains at standstill (4.2.6), Mean contact force (4.2.15), Phase separation sections (4.2.19)
8	EN 50388	Railway applications — Power supply and rolling stock — Technical criteria for the coordination between power supply (substation) and rolling stock to achieve interoperability	2005	Parameters relating to supply system performance (4.2.4), Electrical protection coordination arrangements (4.2.8), Harmonics and dynamic effects for AC systems (4.2.9), Phase separation sections (4.2.19)
9	EN 50163	Railway applications — Supply Voltages of Traction Systems	2004	Voltage and frequency (4.2.3)

ANNEX J

GLOSSARY

Defined term	Abbr.	Definition	Source/Reference
Contact line system		System that distributes the electrical energy to the trains running on the route and transmits it to the trains by means of current collectors	
Contact force		Vertical force applied by the pantograph to the OCL	EN 50367:2006
Contact wire uplift		Vertical upward movement of the contact wire due to the force produced from the pantograph	EN 50119:2009
Current collector		Equipment fitted to the vehicle and intended to collect current from a contact wire or conductor rail	IEC 60050-811, definition 811-32-01
Gauge		Set of rules including a reference contour and its associated calculation rules allowing defining the outer dimensions of the vehicle and the space to be cleared by the infra-structure NOTE: According to the calculation method implemented, the gauge will be a static, kinematic or dynamic	
Lateral deviation		Lateral stagger of contact wire in maximum crosswind	
Level crossing		An intersection at the same elevation of a road and one or more rail tracks	
Line speed		Maximum speed measured in kilometres per hour for which a line has been designed.	
Maintenance plan		A series of documents setting out the infra-structure maintenance procedures adopted by an Infrastructure Manager	
Mean contact force		Statistical mean value of the contact force	EN 50367:2006
Mean useful voltage train		Voltage identifying the dimensioning train and enables the effect on its performance to be quantified	EN 50388:2005
Mean useful voltage zone		Voltage giving an indication of the quality of the power supply in a geographic zone during the peak traffic period in the timetable	EN 50388:2005
Minimum contact wire height		A minimum value of the contact wire height in the span in order to avoid the arcing between one or more contact wires and vehicles in all conditions	
Nominal contact wire height		A nominal value of the contact wire height at a support in the normal conditions	EN 50367:2006

Defined term	Abbr.	Definition	Source/Reference
Nominal voltage		Voltage by which an installation or part of an installation is designated	EN 50163:2004
Normal service		Planned timetable service	
Overhead contact line	OCL	Contact line placed above (or beside) the upper limit of the vehicle gauge and supplying vehicles with electric energy through roof-mounted current collection equipment	IEC 60050-811-33-02
Reference contour		A contour, associated to each gauge, showing the shape of a cross-section and used as a basis to work out the sizing rules of the infra-structure, on the one hand and of the vehicle, on the other hand	
Return circuit		All conductors which form the intended path for the traction return current and the current under fault conditions	EN 50122-1:1997
Static contact force		Mean vertical force exerted upwards by the pantograph head on the OCL, and caused by the pantograph-raising device, whilst the pantograph is raised and the vehicle is standstill	EN 50367:2006

COMMISSION DECISION

of 26 April 2011

concerning a technical specification for interoperability relating to the 'infrastructure' subsystem of the trans-European conventional rail system

(notified under document C(2011) 2741)

(Text with EEA relevance)

(2011/275/EU)

THE EUROPEAN COMMISSION,

Having regard to the Treaty on the Functioning of the European Union,

Having regard to Directive 2008/57/EC of the European Parliament and of the Council of 17 June 2008 on the interoperability of the rail system within the Community [1], and in particular Article 6(1) thereof,

Whereas:

(1) In accordance with Article 2(e) of and Annex II to Directive 2008/57/EC, the rail system is subdivided into structural and functional subsystems, including an infrastructure subsystem.

(2) By Decision C(2006) 124 final of 9 February 2006, the Commission gave a mandate to the European Railway Agency (the Agency) to develop technical specifications for interoperability (TSIs) under Directive 2001/16/EC of the European Parliament and of the Council of 19 March 2001 on the interoperability of the trans-European conventional rail system [2]. Under the terms of that mandate, the Agency was requested to draw up the draft TSI related to the infrastructure subsystem of the conventional rail system.

(3) Technical specifications for interoperability (TSI) are specifications adopted in accordance with Directive 2008/57/EC. The TSI in Annex covers the infrastructure subsystem in order to meet the essential requirements and ensure the interoperability of the rail system.

(4) The TSI in Annex does not fully deal with all essential requirements. In accordance with Article 5(6) of Directive 2008/57/EC technical aspects which are not covered are identified as open points in Annex F of this TSI.

(5) The TSI in Annex should refer to Commission Decision 2010/713/EU of 9 November 2010 on modules for the procedures for assessment of conformity, suitability for use and EC verification to be used in the technical specifications for interoperability adopted under Directive 2008/57/EC of the European Parliament and of the Council [3].

(6) In accordance with Article 17(3) of Directive 2008/57/EC, Member States are to notify to the Commission and other Member States the conformity assessment and verification procedures to be used for the specific cases, as well as the bodies responsible for carrying out these procedures.

(7) The TSI in Annex should be without prejudice to the provisions of other relevant TSIs which may be applicable to infrastructure subsystems.

(8) The TSI in Annex should not impose the use of specific technologies or technical solutions except where this is strictly necessary for the interoperability of the rail system within the Union.

(9) In accordance with Article 11(5) of Directive 2008/57/EC, the TSI in Annex should allow, for a limited period of time, for interoperability constituents to be incorporated into subsystems without certification if certain conditions are met.

(10) To continue to encourage innovation and to take into account the experience acquired, the TSI in Annex should be subject to periodic revision.

(11) The measures provided for in this Decision are in conformity with the opinion of the Committee established in accordance with Article 29(1) of Directive 2008/57/EC,

HAS ADOPTED THIS DECISION:

Article 1

A technical specification for interoperability (TSI) relating to the infrastructure subsystem of the trans-European conventional railway, is hereby adopted by the Commission.

The TSI shall be as set out in the Annex to this Decision.

[1] OJ L 191, 18.7.2008, p. 1.
[2] OJ L 110, 20.4.2001, p. 1.
[3] OJ L 319, 4.12.2010, p. 1.

Article 2

This TSI shall be applicable to all new, upgraded or renewed infrastructure of the trans-European conventional rail system as defined in Annex I to Directive 2008/57/EC.

Article 3

1. With regard to those issues classified as open points set out in Annex F of the TSI, the conditions to be complied with for the verification of the interoperability pursuant to Article 17(2) of Directive 2008/57/EC shall be those applicable technical rules in use in the Member State which authorise the placing in service of the subsystems covered by this Decision.

2. Each Member State shall notify to the other Member States and to the Commission within six months of the notification of this Decision:

(a) the applicable technical rules mentioned in paragraph 1;

(b) the conformity assessment and checking procedures to be applied with regard to the application of the technical rules mentioned in paragraph 1;

(c) the bodies it appoints for carrying out the conformity assessment and checking procedures of the open points mentioned in paragraph 1.

Article 4

1. The Member State shall define which lines of the conventional trans-European transport network (TEN-T) as established by Decision No 1692/96/EC of the European Parliament and of the Council [1] are intended to be classified as core TEN lines or other TEN lines on the basis of the categories given in Section 4.2.1 of this TSI. Member States shall notify this information to the Commission within a period of one year from the date of application of this Commission Decision.

2. The Commission, in cooperation with the Agency and the Member States, shall coordinate the classification referred to in paragraph 1, especially with regard to the border crossings and its consistency with the European Deployment Plan on European Rail Traffic Management System as referred to in Commission Decision 2009/561/EC [2].

3. The final classification resulting from the coordination shall be examined by the Committee set up by Council Directive 96/48/EC [3] and, after discussion, made public by the Agency.

4. The Member State shall take into account the classification published by the Agency when defining its national migration plan.

Article 5

The procedures for assessment of conformity, suitability for use and EC verification set out in Chapter 6 of the TSI in Annex shall be based on the modules defined in Decision 2010/713/EU.

Article 6

1. During a transition period of 10 years, it shall be permissible to issue an EC certificate of verification for a subsystem that contains interoperability constituents not holding an EC declaration of conformity or suitability for use, on the condition that the provisions set out in Section 6.6 of the Annex are met.

2. The production or upgrade/renewal of the subsystem with use of the non-certified interoperability constituents must be completed within the transition period, including the placing in service.

3. During the transition period Member States shall ensure that:

(a) the reasons for non-certification of the interoperability constituents are properly identified in the verification procedure referred to in paragraph 1;

(b) the details of the non-certified interoperability constituents and the reasons for non-certification, including the application of national rules notified under Article 17 of Directive 2008/57/EC, are included by the National Safety Authorities in their report referred to in Article 18 of Directive 2004/49/EC of the European Parliament and of the Council [4].

4. After the transition period and with the exceptions allowed under Section 6.6.3 on maintenance, interoperability constituents shall be covered by the required EC declaration of conformity and/or suitability for use before being incorporated into the subsystem.

Article 7

In accordance with Article 5(3)(f) of Directive 2008/57/EC, Chapter 7 of the TSI in Annex, sets out a strategy for migrating towards a full interoperable infrastructure subsystem. This migration needs to be applied in conjunction with Article 20 of that Directive which specifies the principles of the application of the TSI to the renewal and upgrading projects. Member States shall notify to the Commission a report on the implementation of Article 20 of Directive 2008/57/EC 3 years after the entry into force of this Decision. This report will be discussed in the context of the Committee set up in Article 29 of Directive 2008/57/EC and, where appropriate, the TSI in Annex will be adapted.

[1] OJ L 228, 9.9.1996, p. 1.
[2] OJ L 194, 25.7.2009, p. 60.
[3] OJ L 235, 17.9.1996, p. 6.
[4] OJ L 164, 30.4.2004, p. 44.

Article 8

1. With regard to those issues classified as specific cases set out in Chapter 7 of the TSI, the conditions to be complied with for the verification of the interoperability pursuant to Article 17(2) of Directive 2008/57/EC shall be those applicable technical rules in use in the Member State which authorise the placing in service of the subsystems covered by this Decision.

2. Each Member State shall notify to the other Member States and to the Commission within six months of the notification of this Decision:

(a) the applicable technical rules mentioned in paragraph 1;

(b) the conformity assessment and checking procedures to be applied with regard to the application of the technical rules mentioned in paragraph 1;

(c) the bodies it appoints for carrying out the conformity assessment and checking procedures of the specific cases mentioned in paragraph 1.

Article 9

This Decision shall apply from 1 June 2011.

Article 10

This Decision is addressed to the Member States.

Done at Brussels, 26 April 2011.

For the Commission
Siim KALLAS
Vice-President

ANNEX

DIRECTIVE 2008/57/EC ON THE INTEROPERABILITY OF THE RAIL SYSTEM WITHIN THE COMMUNITY

TECHNICAL SPECIFICATION FOR INTEROPERABILITY

'Infrastructure' subsystem for conventional rail

1. INTRODUCTION

1.1. **Technical scope**

This TSI concerns the infrastructure subsystem and part of the maintenance subsystem of the trans-European conventional rail system. They are included in the list of subsystems in Annex II (1) to Directive 2008/57/EC.

1.2. **Geographical scope**

The geographical scope of this TSI is the trans-European conventional rail system as described in Annex I (1.1) to Directive 2008/57/EC.

1.3. **Content of this TSI**

In accordance with Article 5(3) of Directive 2008/57/EC, this TSI:

(a) indicates its intended scope (Chapter 2);

(b) lays down essential requirements for the infrastructure subsystem (Chapter 3);

(c) establishes the functional and technical specifications to be met by the subsystem and its interfaces vis-à-vis other subsystems (Chapter 4);

(d) determines the interoperability constituents and interfaces which must be covered by European specifications, including European standards, which are necessary to achieve interoperability within the trans-European conventional rail system (Chapter 5);

(e) states, in each case under consideration, which procedures are to be used in order to assess the conformity or the suitability for use of the interoperability constituents, on the one hand, or the EC verification of the subsystems, on the other hand (Chapter 6);

(f) indicates the strategy for implementing this TSI (Chapter 7);

(g) indicates, for the staff concerned, the professional competences and health and safety conditions at work required for the operation and maintenance of the subsystem, as well as for the implementation of this TSI (Chapter 4).

In accordance with Article 5(5) of the Directive 2008/57/EC, provisions for specific cases are indicated in Chapter 7.

This TSI also sets out, in Chapter 4, the operating and maintenance rules specific to the scope indicated in paragraphs 1.1 and 1.2 above.

2. DEFINITION AND SCOPE OF SUBSYSTEM

2.1. **Definition of the infrastructure subsystem**

This TSI covers:

(a) the infrastructure structural subsystem;

(b) the part of the maintenance functional subsystem relating to the infrastructure subsystem (that is: washing plants for external cleaning of trains, water restocking, refuelling, fixed installations for toilet discharge and electrical shore supplies).

The elements of the infrastructure subsystem are described in Annex II (2.1. Infrastructure) to Directive 2008/57/EC.

The scope of this TSI therefore includes the following aspects of the infrastructure subsystem:

(a) Line layout,

(b) Track parameters,

(c) Switches and crossings,

(d) Track resistance to applied loads,

(e) Structures resistance to traffic loads,

(f) Track geometrical quality and limits on isolated defects,

(g) Platforms,

(h) Health, safety and environment,

(i) Provision for operation,

(j) Fixed installations for servicing trains.

Further details are set out in Section 4.2.3 of this TSI.

2.2. **Interfaces of this TSI with other TSIs**

Section 4.3 of this TSI sets out the functional and technical specification of the interfaces with the following subsystems, as defined in the relevant TSIs:

(a) Rolling stock subsystem,

(b) Energy subsystem,

(c) Control command and signalling subsystem,

(d) Traffic operation and management subsystem.

Interfaces with the persons with reduced mobility TSI (PRM TSI) are described in Section 2.3 below.

Interfaces with the safety in railway tunnels TSI (SRT TSI) are described in Section 2.4 below.

2.3. **Interfaces of this TSI with the persons with reduced mobility TSI**

All requirements relating to the infrastructure subsystem for the access of persons with reduced mobility to the railway system are set out in the persons with reduced mobility TSI.

This TSI does not therefore include requirements relating to this aspect of the infrastructure subsystem.

2.4. **Interfaces of this TSI with the safety in railway tunnels TSI**

All requirements relating to the infrastructure subsystem for safety in railway tunnels are set out in the safety in railway tunnels TSI.

This TSI does not therefore include requirements relating to this aspect of the infrastructure subsystem.

2.5. **Inclusion of infrastructure into the scope of the noise TSI**

The scope of this TSI excludes noise mitigation, pending the proposal referred to in the technical specification for interoperability relating to the subsystem 'rolling stock — noise', which specifies the following:

'Technical specification for interoperability relating to the subsystem "rolling stock — noise"

Commission Decision of 23 December 2005 (2006/66/EC).

This Decision shall become applicable six months after the date of its notification.

7.2. TSI Revision

… the EC will deliver to "the Article 21 Committee", at the latest seven years after the date of entry into force of this TSI, a report and, if needed, a proposal for revising this TSI about following issues:

5. the inclusion of infrastructure into the scope of the Noise TSI in coordination with the TSI Infrastructure;'

3. ESSENTIAL REQUIREMENTS

The following table indicates references to the essential requirements set out in Annex III to Directive 2008/57/EC that are delivered by the requirements for basic parameters set out in Chapter 4.

Table 1

Basic parameters of the infrastructure subsystem corresponding to the essential requirements

Section	Basic parameters of CR INF subsystem	Safety	Reliability Availability	Health	Environmental protection	Technical compatibility
4.2.4.1	Structure gauge	1.1.1				1.5-§1
4.2.4.2	Distance between track centres	1.1.1				1.5
4.2.4.3	Maximum gradients	1.1.1				1.5-§1
4.2.4.4	Minimum radius of horizontal curve					1.5-§1
4.2.4.5	Minimum radius of vertical curve					1.5-§1
4.2.5.1	Nominal track gauge					1.5-§1
4.2.5.2	Cant	1.1.1				
4.2.5.3	Rate of change of cant					1.5-§1
4.2.5.4	Cant deficiency	1.1.1				1.5-§1
4.2.5.5	Equivalent conicity	1.1.1, 1.1.2				1.5
4.2.5.6	Railhead profile for plain line	1.1.1, 1.1.2				1.5-§1
4.2.5.7	Rail inclination	1.1.1, 1.1.2				1.5-§1
4.2.5.8	Track stiffness					1.5
4.2.6.1	Means of locking	1.1.1, 1.1.2				
4.2.6.2	In-service geometry of switches and crossings	1.1.1, 1.1.2	1.2			1.5
4.2.6.3	Maximum unguided length of fixed obtuse crossings	1.1.1, 1.1.2				1.5
4.2.7.1	Track resistance to vertical loads	1.1.1, 1.1.2, 1.1.3				1.5-§1
4.2.7.2	Longitudinal track resistance	1.1.1, 1.1.2, 1.1.3				1.5-§1
4.2.7.3	Lateral track resistance	1.1.1, 1.1.2, 1.1.3				1.5-§1
4.2.8.1	Resistance of new bridges to traffic loads	1.1.1, 1.1.3				1.5-§1
4.2.8.2	Equivalent vertical loading for new earthworks and earth pressure effects	1.1.1, 1.1.3				1.5-§1
4.2.8.3	Resistance of new structures over or adjacent to tracks	1.1.1, 1.1.3				1.5-§1
4.2.8.4	Resistance of existing bridges and earthworks to traffic loads	1.1.1, 1.1.3				1.5-§1
4.2.9.1	Determination of immediate action, intervention, and alert limits	1.1.1, 1.1.2	1.2			1.5-§1

Section	Basic parameters of CR INF subsystem	Safety	Reliability Availability	Health	Environmental protection	Technical compatibility
4.2.9.2	Immediate action limit for track twist	1.1.1, 1.1.2	1.2			1.5-§1
4.2.9.3	Immediate action limit for variation of track gauge	1.1.1, 1.1.2	1.2			1.5-§1
4.2.9.4	Immediate action limit for cant	1.1.1	1.2			1.5-§1
4.2.10.1	Usable length of platforms					1.5
4.2.10.2	Width and edge of platforms	1.1.1				
4.2.10.3	End of platforms	1.1.1				
4.2.10.4	Height of platforms	1.1.1, 2.1.1-§3				1.5-§1
4.2.10.5	Offset of platforms	1.1.1, 2.1.1-§3				1.5-§1
4.2.11.1	Maximum pressure variation in tunnels	2.1.1-§ 2, 2.1.1-§ 4				
4.2.11.2	Noise and vibration limits and mitigation measures				1.4.1, 1.4.4, 1.4.5	
4.2.11.3	Protection against electric shock	2.1.1-§3				
4.2.11.4	Safety in railway tunnels	1.1.1, 1.1.4, 2.1.1-§1, 2.1.1-§4		1.3	1.4.2	
4.2.11.5	Effect of crosswinds	1.1.1				
4.2.12.1	Distance markers		1.2			
4.2.13.2	Toilet discharge		1.2	1.3.1		1.5-§1
4.2.13.3	Train external cleaning facilities		1.2			1.5-§1
4.2.13.4	Water restocking		1.2	1.3.1		1.5-§1
4.2.13.5	Refuelling		1.2	1.3.1		1.5-§1
4.2.13.6	Electric shore supply		1.2			1.5-§1
4.4.1	Exceptional conditions relating to pre-planned works		1.2			
4.4.2	Degraded operation		1.2			
4.4.3	Protection of workers against aerodynamic effects	2.1.1-§2				
4.5	Maintenance plan		1.2			
4.6	Professional competences	1.1.5	1.2			
4.7	Health and safety conditions	2.1.1-§2, 2.1.1-§3, 2.1.1-§4	1.2	1.3	1.4.2	1.5

4. DESCRIPTION OF THE INFRASTRUCTURE SUBSYSTEM

4.1. **Introduction**

(1) The trans-European conventional railway system, to which Directive 2008/57/EC applies and of which the infrastructure and maintenance subsystems are parts, is an integrated system whose coherence must be verified, with the objective of assuring the interoperability of the system in respect of the essential requirements.

(2) Article 5(7) of the Directive says 'the TSIs shall not be an impediment to decisions by the Member States concerning the use of infrastructures for the movement of vehicles not covered by the TSIs'.

Therefore, when designing a new or upgraded conventional line, consideration should be given to all trains which may be authorised on the line.

(3) The limiting values set out in the present TSI are not intended to be imposed as usual design values. However the design values must be within the limits set out in this TSI.

(4) The functional and technical specifications of the subsystem and its interfaces, described in Sections 4.2 and 4.3, do not impose the use of specific technologies or technical solutions, except where this is strictly necessary for the interoperability of the trans-European conventional rail network. But innovative solutions for interoperability could require new specifications and/or new assessment methods. In order to allow technological innovation, these specifications and assessment methods shall be developed by the process described in Section 6.2.3.

4.2. **Functional and technical specifications of subsystem**

4.2.1. *TSI categories of line*

(1) Annex I (1.1) to the Directive recognises that the conventional rail network may be subdivided into different categories. In order to deliver interoperability cost-effectively this TSI defines 'TSI categories of line'. The functional and technical specifications of this TSI vary according to the TSI categories of line.

(2) The requirements to be met by the infrastructure subsystem are specified for each of the following TSI categories of line of the trans-European conventional rail system, as relevant. These TSI categories of line may be used for the classification of existing lines insofar the relevant performance parameters will be met in consistency with the national migration plan.

Table 2

TSI categories of line for the conventional rail infrastructure subsystem

TSI categories of line		Types of traffic		
		Passenger traffic (P)	Freight traffic (F)	Mixed traffic (M)
Types of line	New core TEN line (IV)	IV-P	IV-F	IV-M
	Upgraded core TEN line (V)	V-P	V-F	V-M
	New other TEN line (VI)	VI-P	VI-F	VI-M
	Upgraded other TEN line (VII)	VII-P	VII-F	VII-M

(3) Note that passenger hubs, freight hubs and connecting lines are included in the above TSI categories of line, as appropriate.

(4) The TSI category of line for every section of track shall be published in the Register of Infrastructure.

4.2.2. *Performance parameters*

(1) The performance levels of the TSI categories of line defined in Section 4.2.1 are characterised by following performance parameters:

(a) gauge,

(b) axle load,

(c) line speed,

(d) train length.

(2) The performance levels for each TSI category of line are set out in Table 3 hereunder.

Table 3

Performance parameters for TSI categories of line

TSI categories of line		Gauge	Axle load (t)	Line speed (km/h)	Train length (m)
	IV-P	GC	22,5	200	400
	IV-F	GC	25	140	750
	IV-M	GC	25	200	750
	V-P	GB	22,5	160	300
	V-F	GB	22,5	100	600
	V-M	GB	22,5	160	600
	VI-P	GB	22,5	140	300
	VI-F	GC	25	100	500
	VI-M	GC	25	140	500
	VII-P	GA	20	120	250
	VII-F	GA	20	100	500
	VII-M	GA	20	120	500

Notes: (P) = passenger traffic, (F) = freight traffic, (M) = mixed traffic, gauge GA, GB, GC are as defined in EN 15273-3:2009 Annex C.

(3) Article 5(7) of Directive 2008/57/EC states:

'The TSIs shall not be an impediment to decisions by the Member States concerning the use of infrastructures for the movement of vehicles not covered by the TSIs.'

It is therefore permissible to design new and upgraded lines such that they will also accommodate larger gauges, higher axle loads, greater speeds and longer trains than those specified.

(4) It is permissible for specific locations on the line to be designed for line speed and/or train lengths less than those set out in Table 3, where duly justified to meet geographical, urban or environmental constraints.

(5) Infrastructure designed to the minimum requirements of this TSI does not provide the capability to meet both maximum speed and maximum axle load in combination. The infrastructure is only capable of being exploited at maximum speed for axle loads less than the maximum set out in Table 3, and similarly the infrastructure is only capable of being exploited at maximum axle load for speeds less than the maximum set out in Table 3.

(6) The actual performance parameters for each section of track shall be published in the Register of Infrastructure.

(7) The published information relating to axle load shall use EN line categories and/or locomotive classes defined in EN 15528:2008 Annexes A, J and K in combination with the permitted speed. If the load carrying capability of a section of track exceeds the range of EN line categories and or locomotive classes specified, then additional information defining the load carrying capability may be provided.

(8) The published information relating to gauge shall state which of the gauges GA, GB or GC is provided. Additionally the published information shall include other gauges defined in EN 15273:2009 Annex D that are provided for multi-national agreements. The published information may include national gauges that are provided for domestic use.

4.2.3. *Basic parameters characterising the infrastructure subsystem*

4.2.3.1. List of basic parameters

(1) The basic parameters characterising the infrastructure subsystem, grouped according to the aspects listed in Section 2.1, are:

A. **Line layout:**

(a) Structure gauge (4.2.4.1),

(b) Distance between track centres (4.2.4.2),

(c) Maximum gradients (4.2.4.3),

(d) Minimum radius of horizontal curve (4.2.4.4),

(e) Minimum radius of vertical curve (4.2.4.5),

B. **Track parameters:**

(f) Nominal track gauge (4.2.5.1),

(g) Cant (4.2.5.2),

(h) Rate of change of cant (as a function of time) (4.2.5.3),

(i) Cant deficiency (4.2.5.4),

(j) Equivalent conicity (4.2.5.5),

(k) Railhead profile for plain line (4.2.5.6),

(l) Rail inclination (4.2.5.7),

(m) Track stiffness (4.2.5.8),

C. **Switches and crossings**

(n) Means of locking (4.2.6.1),

(o) In-service geometry of switches and crossings (4.2.6.2),

(p) Maximum unguided length of fixed obtuse crossings (4.2.6.3),

D. **Track resistance to applied loads**

(q) Track resistance to vertical loads (4.2.7.1),

(r) Longitudinal track resistance (4.2.7.2),

(s) Lateral track resistance (4.2.7.3),

E. **Structures resistance to traffic loads**

(t) Resistance of new bridges to traffic loads (4.2.8.1),

(u) Equivalent vertical loading for new earthworks and earth pressure effects (4.2.8.2),

(v) Resistance of new structures over or adjacent to tracks (4.2.8.3),

(w) Resistance of existing bridges and earthworks to traffic loads (4.2.8.4),

F. **Track geometrical quality and limits on isolated defects**

(x) Determination of immediate action, intervention, and alert limits (4.2.9.1),

(y) The immediate action limit for track twist (4.2.9.2),

(z) The immediate action limit for variation of track gauge (4.2.9.3),

(aa) The immediate action limit for cant (4.2.9.4),

G. **Platforms**

(bb) Usable length of platforms (4.2.10.1),

(cc) Width and edge of platforms (4.2.10.2),

(dd) End of platforms (4.2.10.3),

(ee) Height of platforms (4.2.10.4),

(ff) Offset of platforms (4.2.10.5),

H. **Health, safety and environment**

(gg) Maximum pressure variation in tunnels (4.2.11.1),

(hh) Noise and vibration limits and mitigation measures (4.2.11.2),

(ii) Protection against electric shock (4.2.11.3),

(jj) Safety in railway tunnels (4.2.11.4),

(kk) Effect of crosswinds (4.2.11.5),

I. **Provision for operation**

(ll) Distance markers (4.2.12.1),

J. **Fixed installations for servicing trains**

(mm) Toilet discharge (4.2.13.2),

(nn) Train external cleaning facilities (4.2.13.3),

(oo) Water restocking (4.2.13.4),

(pp) Refuelling (4.2.13.5),

(qq) Electric shore supply (4.2.13.6).

4.2.3.2. Requirements for basic parameters

(1) These requirements are described in the following paragraphs, together with any particular conditions that may be allowed in each case for the parameters and interfaces concerned.

(2) All requirements of Chapter 4 of the present TSI are given for lines built with the standard European track gauge, as defined in paragraph 4.2.5.1 for lines complying with the present TSI.

(3) The specifications for cant, rate of change of cant, cant deficiency, rate of change of cant deficiency and track twist are applicable to lines having a nominal track gauge of 1 435 mm. For a line having another nominal track gauge, the limits on these parameters shall be established in proportion to the nominal distance between the rails.

(4) In case of multi-rail track, requirements of this TSI are to be applied separately to each pair of rails designed to be operated as separate track.

(5) Requirements for lines representing specific cases, including lines built to another track gauge, are described under Section 7.6.

(6) A short section of track with devices to allow transition between different nominal track gauges is permitted. The location and type of transitions shall be published in the Register of Infrastructure.

(7) Requirements are described for the subsystem under normal service conditions. Consequences, if any, of the execution of works, which may require temporary exceptions as far as the subsystem performance is concerned, are dealt with in Section 4.4.

(8) The performance levels of conventional trains can be enhanced by adopting specific systems, such as vehicle body tilting. Special conditions are permitted for running such trains, provided they do not entail restrictions for other trains not equipped with such systems. The Register of Infrastructure shall record if such special conditions apply. The special conditions shall be publically available.

4.2.4. *Line layout*

4.2.4.1. Structure gauge

All TSI categories of line

(1) The structure gauge shall be set on the basis of the gauge set out in Table 3 of this TSI.

(2) Calculations of the structure gauge shall be done using the kinematic method in accordance with the requirements of Chapters 5, 7, 10 and the Annex C of EN 15273-3:2009.

(3) Where overhead electrification is provided, the pantograph gauges are set out in the CR ENE TSI.

4.2.4.2. Distance between track centres

All TSI categories of line

(1) The distance between track centres shall be set on the basis of the gauge set out in Table 3 of this TSI.

(2) Where appropriate the minimum distance between track centres shall also take into account aerodynamic effects. The rules for taking account of aerodynamic effects, and the distance between track centres at which aerodynamic effects need to be taken into account, are an open point.

(3) The minimum distance between track centres of a section of line shall be published in the Register of Infrastructure.

4.2.4.3. Maximum gradients

TSI categories of line IV-P and VI-P

(1) Gradients as steep as 35 mm/m are permitted for main tracks at the design phase provided the following 'envelope' requirements are observed:

(a) the slope of the moving average profile over 10 km is less than or equal to 25 mm/m,

(b) the maximum length of continuous 35 mm/m gradient does not exceed 6 km.

(2) Gradients of tracks through passenger platforms shall not be more than 2,5 mm/m, where passenger carriages are intended to be regularly attached or detached.

TSI categories of line IV-F, IV-M, VI-F and VI-M

(3) Maximum gradients as steep as 12,5 mm/m are permitted for main tracks at the design phase.

(4) For sections up to 3 km the maximum gradient of 20 mm/m is permitted.

(5) For sections up to 0,5 km the maximum gradient of 35 mm/m is permitted in locations, where trains are not intended to stop and start in normal operation.

(6) Gradients of tracks through passenger platforms shall not be more than 2,5 mm/m, where passenger carriages are intended to be regularly attached or detached.

TSI categories of line V-P, V-F, V-M, VII-P, VII-F and VII-M

(7) No values are specified for upgraded lines, as gradients are determined by the original construction of the line concerned.

All TSI categories of line

(8) Gradients of stabling tracks intended for parking rolling stock shall not be more than 2,5 mm/m unless specific provision is made to prevent the rolling stock from running away.

(9) Gradients and locations of changes in gradient shall be published in the Register of Infrastructure.

(10) In the case of stabling tracks, gradients need to be published in the Register of Infrastructure only when they exceed 2,5 mm/m.

4.2.4.4. Minimum radius of horizontal curve

All TSI categories of line

(1) The minimum design radius of horizontal curve shall be selected with regard to the local design speed of the curve.

(2) For stabling tracks or sidings the minimum horizontal design curve radius shall not be less than 150 m.

(3) The minimum radius of horizontal curve through platforms is set out in the PRM TSI.

(4) Reverse curves (other than reverse curves in marshalling yards where wagons are shunted individually) with radii in the range from 150 m up to 300 m shall be designed in accordance to EN 13803-2:2006 Section 8.4 to prevent buffer locking.

(5) The radius of the smallest horizontal curve of a section of line shall be published in the Register of Infrastructure.

4.2.4.5. Minimum radius of vertical curve

All TSI categories of line

(1) The radius of vertical curves (except for humps in marshalling yards) shall be at least 600 m on a crest or 900 m in a hollow.

(2) For humps in marshalling yards the radius of vertical curves shall be at least 250 m on a crest or 300 m in a hollow.

4.2.5. *Track parameters*

4.2.5.1. Nominal track gauge

All TSI categories of line

(1) European standard nominal track gauge shall be 1 435 mm.

(2) The nominal track gauge for a line shall be published in the Register of Infrastructure.

4.2.5.2. Cant

All TSI categories of line

(1) The design cant on tracks adjacent to station platforms shall not exceed 110 mm.

(2) The highest cant on a section of line shall be published in the Register of Infrastructure.

TSI categories of line IV-P, V-P, VI-P and VII-P

(3) The design cant shall be limited to 180 mm.

TSI categories of line IV-F, IV-M, V-F, V-M, VI-F, VI-M, VII-F and VII-M

(4) The design cant shall be limited to 160 mm.

TSI categories of line IV-F, IV-M, VI-F and VI-M

(5) On curves with a radius less than 290 m, the cant shall be restricted to the limit given by the following formula

$$D \leq (R-50) / 1{,}5$$

where D is the cant in mm and R is the radius in m.

4.2.5.3. Rate of change of cant (as a function of time)

All TSI categories of line

(1) The maximum rate of change of cant through a transition shall be 70 mm/s calculated at the maximum speed permitted for trains not fitted with a cant deficiency compensation system.

(2) However, if the cant deficiency at the end of the transition is less than or equal to 150 mm and the rate of change of cant deficiency through the transition is less than or equal to 70 mm/s, it is permissible to increase the maximum rate of change of cant to 85 mm/s.

4.2.5.4. Cant deficiency

All TSI categories of line

(1) The following specifications are applicable to interoperable lines having nominal track gauge as defined in paragraph 4.2.5.1 of the present TSI.

4.2.5.4.1. Cant deficiency on plain track and on the through route of switches and crossings

(1) The maximum cant deficiency at which trains are permitted to run shall take account of the acceptance criteria of the vehicles concerned, set out in HS and CR rolling stock TSIs.

(2) For trains which are not fitted with cant deficiency compensation systems, the cant deficiency on lines with speeds up to and including 200 km/h shall not exceed without any further demonstration the following:

(a) 130 mm (or 0,85 m/s^2 uncompensated lateral acceleration) for rolling stock approved to the Freight Wagons TSI (WAG TSI);

(b) 150 mm (or 1,0 m/s^2 uncompensated lateral acceleration) for rolling stock approved to Locomotives and Passenger RST TSI (LOC&PAS TSI).

(3) It is permissible for trains specifically designed to travel with higher cant deficiency (multiple units with lower axle loads; trains equipped with a cant deficiency compensation system) to run with higher cant deficiency values, subject to a demonstration that this can be achieved safely.

4.2.5.4.2. Abrupt change of cant deficiency on diverging track of switches

(1) The maximum design values of abrupt change of cant deficiency on diverging tracks shall be:

(a) 120 mm for switches allowing turnout speeds of 30 km/h ≤ V ≤ 70 km/h,

(b) 105 mm for switches allowing turnout speeds of 70 km/h < V ≤ 170 km/h,

(c) 85 mm for switches allowing turnout speeds of 170 km/h < V ≤ 200 km/h.

(2) An allowance of 20 mm on these values may be accepted for existing ranges of designs of switches.

4.2.5.5. Equivalent conicity

All TSI categories of line

(1) The limiting values for equivalent conicity quoted in Table 4 shall be calculated for the amplitude (y) of the wheelset's lateral displacement:

— $y = 3\ mm$ *if* $(TG - SR) \geq 7\ mm$

— $y = \left(\frac{(TG - SR) - 1}{2}\right)$, *if* $5\ mm \leq (TG - SR) < 7\ mm$

— $y = 2\ mm$ *if* $(TG - SR) < 5\ mm$

where TG is the track gauge and SR is the distance between the flange contact faces of the wheelset. No assessment of equivalent conicity is required for switches and crossings.

4.2.5.5.1. Design values for equivalent conicity

(1) Design values of track gauge, railhead profile and rail inclination for plain line shall be selected to ensure that the equivalent conicity limits set out in Table 4 are not exceeded.

Table 4

Equivalent conicity design limit values

Speed range (km/h)	Equivalent conicity	
	S 1002, GV 1/40	EPS
v ≤ 60	Assessment not required	Assessment not required
60 < v ≤ 160	0,25	0,30
160 < v ≤ 200	0,25	0,30

(2) The following wheelsets shall be modelled passing over the designed track conditions (simulated by calculation according to EN 15302:2008):

(a) S 1002 as defined in EN 13715:2006 Annex C with SR = 1 420 mm

(b) S 1002 as defined in EN 13715:2006 Annex C with SR = 1 426 mm

(c) GV 1/40 as defined in EN 13715:2006 Annex B with SR = 1 420 mm

(d) GV 1/40 as defined in EN 13715:2006 Annex B with SR = 1 426 mm

(e) EPS as defined in EN 13715:2006 Annex D with SR = 1 420 mm.

4.2.5.5.2. Requirements for controlling equivalent conicity in service

(1) Requirements for controlling equivalent conicity in service are an open point.

(2) Once the initial design of the track system has been established, an important parameter for the control of equivalent conicity in service is track gauge. Therefore pending closure of the open point, the values for mean track gauge and the requirements for actions to be taken in case of ride instability set out below shall be respected.

(3) The infrastructure manager shall maintain the mean track gauge on straight track and in curves of radius R > 10 000 m at or above the limit set out in Table 5 below.

Table 5

Minimum mean gauge in service on straight track and in curves of radius R > 10 000 m

Speed range (km/h)	Mean gauge (mm) over 100 m
v ≤ 60	assessment not required
60 < v ≤ 160	1 430
160 < v ≤ 200	1 430

(4) If ride instability is reported on a track respecting the requirement of Section 4.2.5.5 for rolling stock having wheelsets meeting the requirements for equivalent conicity set out in the HS and CR rolling stock TSIs, a joint investigation by the railway undertaking and the infrastructure manager is to be undertaken to determine the reason.

4.2.5.6. Railhead profile for plain line

All TSI categories of line

(1) The design of railhead profiles for plain line shall comprise:

(a) a lateral slope on the side of the railhead angled to between vertical and 1/16 with reference to the vertical axis of the railhead;

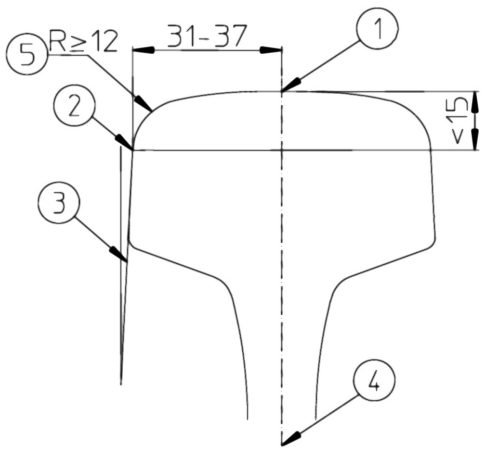
(b) the vertical distance between the top of this lateral slope and the top of the rail shall be less than 15 mm;

(c) a radius of at least 12 mm at the gauge corner;

(d) the horizontal distance between the crown of the rail and the tangent point shall be between 31 and 37 mm.

Figure 1

Railhead profile



1 Crown of rail

2 Tangent point

3 Lateral slope

4 Vertical axis of railhead

5 Gauge corner

4.2.5.7. Rail inclination

All TSI categories of line

4.2.5.7.1. Plain line

(1) The rail shall be inclined towards the centre of the track.

(2) The rail inclination for a given route shall be selected from the range 1/20 to 1/40.

(3) The value selected shall be declared in the Register of Infrastructure.

4.2.5.7.2. Requirements for switches and crossings

(1) The rail in switches and crossings shall be designed to be either vertical or inclined.

(2) If the rail is inclined, the designed inclination in switches and crossings shall be the same as for plain line.

(3) The inclination can be given by the shape of the active part of the railhead profile.

(4) For short sections of plain line between switches and crossings without inclination, the laying of rails without inclination is permitted.

(5) A short transition from inclined rail to vertical rail is permitted.

4.2.5.8. Track stiffness

All TSI categories of line

(1) Requirements for track stiffness as a complete system are an open point.

4.2.6. *Switches and crossings*

4.2.6.1. Means of locking

TSI categories of line IV-P, IV-F, IV-M, VI-P, VI-F and VI-M

(1) All movable parts of switches and crossings shall be equipped with a means of locking, except in marshalling yards and other tracks used only for shunting.

TSI categories of line V-P, V-F, V-M, VII-P, VII-F and VII-M

(2) All movable parts of switches and crossings shall be equipped with a means of locking where the maximum speed is more than 40 km/h, unless used exclusively in the trailing direction.

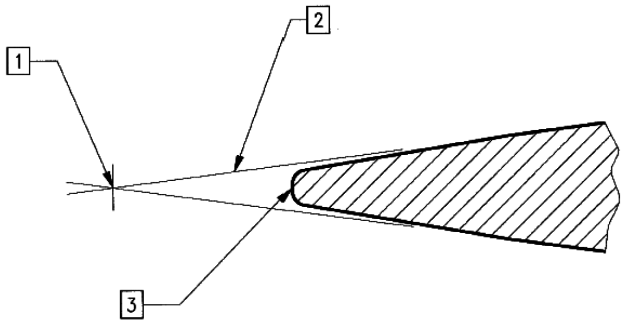
4.2.6.2. In-service geometry of switches and crossings

All TSI categories of line

(1) In this paragraph the TSI gives limiting in-service values that are compatible with geometrical characteristics of wheelsets as defined in the HS and CR rolling stock TSIs. It will be the task of the infrastructure manager to decide design values and to ensure, by means of the maintenance plan, that the in-service values do not fall outside the TSI limits. These limits are set as immediate action limits.

Figure 2

Point retraction in fixed common crossings



1 Intersection point (IP)

2 Theoretical reference line

3 Actual point (RP)

(2) The technical characteristics of switches and crossings shall comply with the following in-service values:

(a) Maximum value of free wheel passage in switches: 1 380 mm.

This value can be increased if the infrastructure manager demonstrates that the actuation and locking system of the switch is able to resist the lateral impact forces of a wheelset.

(b) Minimum value of fixed nose protection for common crossings: 1 392 mm.

This value is measured 14 mm below the running surface, and on the theoretical reference line, at an appropriate distance back from the actual point (RP) of the nose as indicated in Figure 2. For crossings with point retraction, this value can be reduced. In this case the infrastructure manager shall demonstrate that the point retraction is sufficient to guarantee that the wheel will not hit the nose at the actual point (RP).

(c) Maximum value of free wheel passage at crossing nose: 1 356 mm.

(d) Maximum value of free wheel passage at check rail/wing rail entry: 1 380 mm.

(e) Minimum flangeway width: 38 mm.

(f) Minimum flangeway depth: 40 mm.

(g) Maximum excess height of check rail: 70 mm.

(3) All relevant requirements for switches and crossings are also apllicable to other technical solutions using switch rails, for example side modifiers used in multi-rail track.

4.2.6.3. Maximum unguided length of fixed obtuse crossings

All TSI categories of line

(1) The design value of the maximum unguided length shall be equivalent to 1 in 9 ($tg\alpha = 0{,}11$, $\alpha = 6°20'$) obtuse crossing with a minimum 45 mm raised check rail and associated with a minimum wheel diameter of 330 mm on straight through routes.

4.2.7. *Track resistance to applied loads*

4.2.7.1. Track resistance to vertical loads

All TSI categories of line

(1) The track, including switches and crossings, shall be designed to withstand at least the following forces:

(a) the axle load according to the performance parameters for the TSI categories of line as defined in Table 3;

(b) the maximum dynamic wheel force exerted by a wheelset on the track. The HS and CR rolling stock TSIs define a limit on the maximum dynamic wheel force for defined test conditions. The resistance of the track to vertical loads shall be consistent with these values;

(c) the maximum quasi static wheel force exerted by a wheelset on the track. The HS and CR rolling stock TSIs define a limit on the maximum quasi static wheel force for defined test conditions. The resistance of the track to vertical loads shall be consistent with these values.

4.2.7.2. Longitudinal track resistance

All TSI categories of line

4.2.7.2.1. Design forces

(1) The track, including switches and crossings, shall be designed to withstand longitudinal forces arising from braking. The HS and CR rolling stock TSIs define limits on deceleration which shall be used to determine the longitudinal forces arising from braking.

(2) Track shall also be designed to withstand the longitudinal thermal forces arising from temperature changes in the rail and to minimise the likelihood of track buckling.

4.2.7.2.2. Compatibility with braking systems

(1) Track shall be designed to be compatible with the use of magnetic track brakes for emergency braking.

(2) The compatibility (or otherwise) of the design of track adopted with the use of braking systems independent of wheel-rail adhesion conditions for service braking and for emergency braking shall be published in the Register of Infrastructure. Braking systems independent of wheel-rail adhesion conditions include magnetic track brakes and eddy current track brakes.

(3) Where the track is compatible with the use of braking systems independent of adhesion conditions, the Register of Infrastructure shall state any limitation on the use of the braking systems on which compatibility depends, taking into account local climatic conditions and the expected number of repeated brake applications at a given location.

4.2.7.3. Lateral track resistance

All TSI categories of line

(1) The track, including switches and crossings, shall be designed to withstand at least:

(a) the maximum total dynamic lateral force exerted by a wheelset on the track. The HS and CR rolling stock TSIs define a limit on the lateral forces excerted by a wheel set on the track. The lateral resistance of the track shall be consistent with these values,

(b) the quasi static guiding force exerted by a wheelset on the track. The HS and CR rolling stock TSIs define a limit on the quasi static guiding force Yqst for defined radii and test conditions. The lateral resistance of the track shall be consistent with these values.

4.2.8. *Structures resistance to traffic loads*

(1) The requirements of EN 1991-2:2003 and Annex A2 to EN 1990:2002 issued as EN 1990:2002/A1:2005 specified in this chapter of the TSI are to be applied in accordance with the corresponding clauses in the national annexes to these standards if they exist.

4.2.8.1. Resistance of new bridges to traffic loads

All TSI categories of line — only for new structures on new or existing lines

4.2.8.1.1. Vertical loads

(1) Structures shall be designed to support vertical loads in accordance with the following load models, defined in EN 1991-2:2003:

(a) load model 71, as set out in EN 1991-2:2003 paragraph 6.3.2 (2)P;

(b) in addition, for continuous bridges, load model SW/0, as set out in EN 1991-2:2003 paragraph 6.3.3 (3)P.

(2) The load models shall be multiplied by the factor alpha (α) as set out in EN 1991-2:2003 paragraphs 6.3.2 (3)P and 6.3.3 (5)P.

(3) The value of alpha (α) shall be equal to or greater than the values set out in Table 6.

Table 6

Factor alpha(α) for the design of new structures

Types of line or TSI categories of line	Minimum factor alpha (α)
IV	1,1
V	1,0
VI	1,1
VII-P	0,83
VII-F, VII-M	0,91

(4) The load effects from the load models shall be enhanced by the dynamic factor phi (Φ) as set out in EN 1991-2:2003 paragraphs 6.4.3 (1)P and 6.4.5.2 (2).

4.2.8.1.2. Centrifugal forces

(1) Where the track on a bridge is curved over the whole or part of the length of the bridge, the centrifugal force shall be taken into account in the design of structures as set out in EN 1991-2:2003 paragraphs 6.5.1 (2), (4)P, (7).

4.2.8.1.3. Nosing forces

(1) The nosing force shall be taken into account in the design of structures as set out in EN 1991-2:2003 Section 6.5.2.

4.2.8.1.4. Actions due to traction and braking (longitudinal loads)

(1) Traction and braking forces shall be taken into account in the design of structures as set out in EN 1991-2:2003 paragraphs 6.5.3 (2)P, (4), (5) and (6). The direction of the traction and braking forces shall take account of the permitted directions of travel on each track.

4.2.8.1.5. Design track twist due to rail traffic actions

(1) The maximum total design track twist due to rail traffic actions shall not exceed the values set out in clause A2.4.4.2.2(3)P in Annex A2 to EN 1990:2002 issued as EN 1990:2002/A1:2005. The total design track twist comprises any twist which may be present in the track when the bridge is not subject to rail traffic actions, plus the track twist due to the total deformation of the bridge resulting from rail traffic actions.

4.2.8.2. Equivalent vertical loading for new earthworks and earth pressure effects

All TSI categories of line — only for new structures on new and existing lines

(1) Earthworks shall be designed to support vertical loads in accordance with the Load Model 71, as set out in EN 1991-2:2003 paragraph 6.3.6.4.

(2) Load model 71 shall be multiplied by the factor alpha (a) as set out in EN 1991-2:2003 paragraphs 6.3.2 (3)P. The value of a shall be equal to or greater than the values set out in Table 6.

4.2.8.3. Resistance of new structures over or adjacent to tracks

All TSI categories of line — only for new structures on new and existing lines

(1) Aerodynamic actions from passing trains shall be taken into account as set out in EN 1991-2:2003 paragraph 6.6.

4.2.8.4. Resistance of existing bridges and earthworks to traffic loads

All TSI categories of line — only for existing structures on new or existing lines

(1) Bridges and earthworks shall be brought to a specified level of interoperability according to the TSI category of line as defined in Section 4.2.1.

(2) The minimum capability requirements for structures for each TSI category of line are given in Annex E. The values represent the minimum target level that structures must be capable of for the line to be declared interoperable.

(3) The following cases are relevant:

(a) Where an existing structure is replaced by a new structure then the new structure shall be in accordance with the requirements of Chapter 4.2.8.1 or 4.2.8.2.

(b) If the minimum capability of the existing structures expressed by the published EN line category in combination with the permitted speed satisfies the requirements in Annex E then the existing structures satisfy the relevant interoperability requirements.

(c) Where the capability of an existing structure does not satisfy the requirements in Annex E and works (e.g. strengthening) are being carried out to raise the capability of the structure to meet the requirements of this TSI (and the structure is not to be replaced by a new structure) then the structure shall be brought into conformity with the requirements in Annex E.

(4) For the British network, in clauses (2) and (3) above the EN line category may be replaced by route availability (RA) number (delivered in accordance with the national technical rule notified for this purpose) and consequently reference to Annex E are replaced by reference to Annex C.

4.2.9. *Track geometrical quality and limits on isolated defects*

4.2.9.1. Determination of immediate action, intervention, and alert limits

All TSI categories of line

(1) The infrastructure manager shall determine appropriate immediate action, intervention and alert limits for the following parameters:

(a) lateral alignment — standard deviations (alert limit only),

(b) longitudinal level — standard deviations (alert limit only),

(c) lateral alignment — isolated defects — mean to peak values,

(d) longitudinal level — isolated defects — mean to peak values,

(e) track twist — isolated defects — zero to peak value subject to the immediate action limits set out in the Section 4.2.9.2,

(f) variation of track gauge — isolated defects — nominal track gauge to peak value subject to the immediate action limits set out in the Section 4.2.9.3,

(g) mean track gauge over any 100 m length — nominal track gauge to mean value, subject to the immediate action limits set out in the Section 4.2.5.5.2,

(h) cant — design to peak value subject to the immediate action limits set out in Section 4.2.9.4.

(2) The measurement conditions for these parameters are set out in Chapter 5 of EN 13848-1:2003 +A1:2008.

(3) When determining these limits, the infrastructure manager shall take into account the track quality limits used as the basis for vehicle acceptance. Requirements for vehicle acceptance are set out in the CR and HS rolling stock TSIs.

(4) The immediate action, intervention and alert limits adopted by the infrastructure manager shall be recorded in the maintenance plan required by Section 4.5 of this TSI.

4.2.9.2. The immediate action limit for track twist

All TSI categories of line

(1) The immediate action limit for track twist as an isolated defect is given as a zero to peak value. Track twist is defined as the algebraic difference between two cross levels taken at a defined distance apart, usually expressed as a gradient between the two points at which the cross level is measured. The cross level is measured at the nominal centres of the railheads.

(2) The track twist limit is a function of the measurement base applied (l) according to the formula:

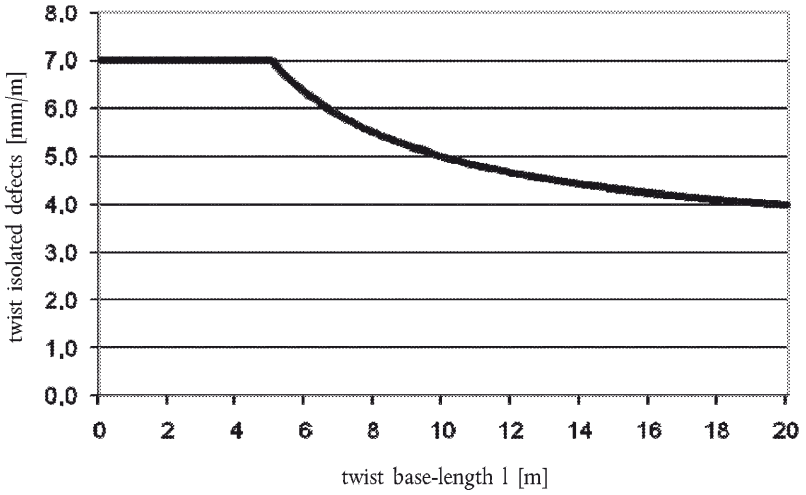
$$\text{Limit twist} = (20/l + 3)$$

(a) where l is the measurement base (in m), with 1,3 m k ≤ l ≤ 20 m,

(b) with a maximum value of 7 mm/m.

Figure 3

Limit for track twist for all TSI categories of line



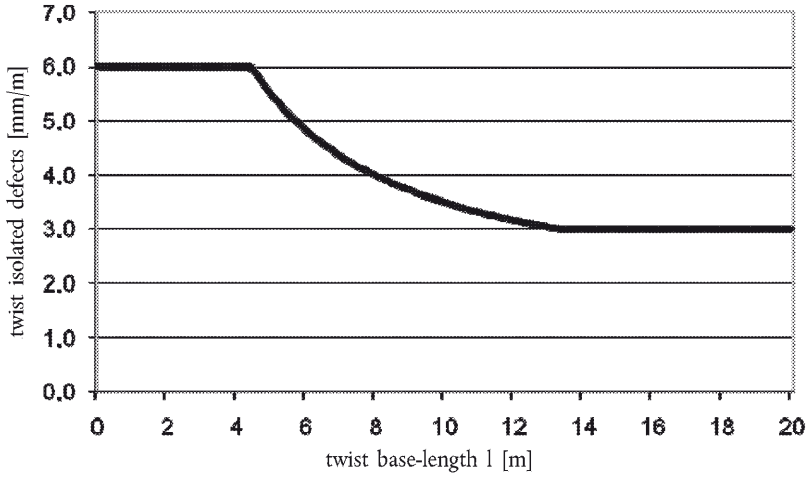
(3) (The infrastructure manager shall set out in the maintenance plan the basis on which it will measure the track in order to check compliance with this requirement. The basis of measurement shall include at least one measurement base between 2 and 5 m.

TSI categories of line IV-F, IV-M, V-F, V-M, VI-F, VI-M, VII-F and VII-M

(4) If the radius of horizontal curve is less than 420 m and cant D > (R – 100)/2, track twist shall be limited according to the formula: Limit twist = (20/l + 1,5), with a maximum value between 6 mm/m and 3 mm/m depending on the twist base length as shown in Figure 4.

Figure 4

Limit for track twist for freight and mixed lines on small curves



4.2.9.3. The immediate action limit for variation of track gauge

All TSI categories of line

The immediate action limits for variation of track gauge are set out in Table 7.

Table 7

Immediate action limits for the variation of track gauge

Speed (km/h)	Dimensions (mm)	
	Nominal track gauge to peak value	
	Minimum track gauge	Maximum track gauge
V ≤ 80	– 9	+ 35
80 < V ≤ 120	– 9	+ 35

Speed (km/h)	Dimensions (mm)	
	Nominal track gauge to peak value	
	Minimum track gauge	Maximum track gauge
120 < V ≤ 160	– 8	+ 35
160 < V ≤ 200	– 7	+ 28

4.2.9.4. The immediate action limit for cant

TSI categories of line IV-P, V-P, VI-P and VII-P

(1) The in service cant shall be maintained within +/- 20 mm of the design cant, but the maximum cant permitted in service is 190 mm.

TSI categories of line IV-F, IV-M, V-F, V-M, VI-F, VI-M, VII-F and VII-M

(2) The in service cant shall be maintained within +/- 20 mm of the design cant, but the maximum cant permitted in service is 170 mm.

4.2.10. *Platforms*

(1) The requirements of this paragraph are only applicable to the passenger platforms where trains complying with the HS and CR rolling stock TSIs are intended to stop on normal service.

4.2.10.1. Usable length of platforms

All TSI categories of line

(1) The platform length shall be sufficient to accommodate the longest interoperable train intended to stop at the platform in normal service. When determining the length of trains intended to stop at the platform, consideration shall be given to both the current service requirements and the reasonably foreseeable service requirements at least ten years following the bringing into service of the platform.

(2) It is permissible to build only the length of platform required for the current service requirement provided passive provision is made for the reasonably foreseeable future service requirements.

(3) The usable length of a platform shall be declared in the Register of Infrastructure.

4.2.10.2. Width and edge of platforms

All TSI categories of line

(1) The PRM TSI sets out the requirements for platform width and edge of the platform.

4.2.10.3. End of platforms

All TSI categories of line

(1) The PRM TSI sets out the requirements for the end of the platform.

4.2.10.4. Height of platforms

All TSI categories of line

(1) The PRM TSI sets out the requirements for platform height.

4.2.10.5. Offset of platforms

All TSI categories of line

(1) The PRM TSI sets out the requirements for platform offset.

4.2.11. *Health, safety and environment*

4.2.11.1. Maximum pressure variations in tunnels

All TSI categories of line

(1) The maximum pressure variation in tunnels and underground structures along the outside of any train complying with the HS and CR rolling stock TSIs intended to run in the specific tunnel at speeds of greater than 190 km/h shall not exceed 10 kPa during the time taken for the train to pass through the tunnel, at the maximum permitted speed.

4.2.11.2. Noise and vibration limits and mitigation measures

All TSI categories of line

(1) Noise limits and mitigation measures are an open point.

(2) Vibration limits and mitigation measures are an open point.

4.2.11.3. Protection against electric shock

All TSI categories of line

(1) The requirements for protection against electric shock from the traction current system are ensured by the provisions set out in CR ENE TSI relating to the protective provisions of overhead contact line systems.

4.2.11.4. Safety in railway tunnels

All TSI categories of line

(1) Requirements for the safety in railway tunnels are set out in the SRT TSI.

4.2.11.5. Effect of crosswinds

All TSI categories of line

(1) Requirements for mitigating the effect of crosswinds are an open point.

4.2.12. *Provision for operation*

4.2.12.1. Distance markers

All TSI categories of line

(1) Distance markers shall be provided at regular intervals along the track.

(2) The nominal interval between distance markers shall be stated in the Register of Infrastructure.

4.2.13. *Fixed installations for servicing trains*

4.2.13.1. General

(1) This Section 4.2.13 sets out the infrastructure elements of the maintenance subsystem required for servicing trains.

(2) The location and type of fixed installations for servicing trains shall be published in the Register of Infrastructure.

4.2.13.2. Toilet discharge

All TSI categories of line

(1) Fixed installations for toilet discharge shall be compatible with the characteristics of the retention toilet system specified in the HS and CR rolling stock TSIs.

4.2.13.3. Train external cleaning facilities

All TSI categories of line

(1) Where a washing plant is provided it shall be able to clean the outer sides of single or double-deck trains between a height of:

(a) 1 000 to 3 500 mm for a single-deck train,

(b) 500 to 4 300 mm for double-deck trains.

(2) The washing plant shall be designed so that trains can to be driven through it at any speed between 2 km/h and 5 km/h.

4.2.13.4. Water restocking

All TSI categories of line

(1) Fixed equipment for water restocking shall be compatible with the characteristics of the water system specified in the HS and CR rolling stock TSIs.

(2) Fixed equipment for water supply on the interoperable network shall be supplied with drinking water meeting the requirements of the Council Directive 98/83/EC [1].

(3) The equipment's mode of operation shall ensure that water delivered to the rolling stock complies with the quality specified by Directive 98/83/EC.

4.2.13.5. Refuelling

All TSI categories of line

(1) Refuelling equipment shall be compatible with the characteristics of the fuel system specified in the CR rolling stock TSI.

4.2.13.6. Electrical shore supply

All TSI categories of line

(1) Where provided, electrical shore supply shall be by means of one or more of the power supply systems specified in the HS and CR rolling stock TSIs.

4.3. Functional and technical specification of the interfaces

From the standpoint of technical compatibility, the interfaces of the infrastructure subsystem with the other subsystems are like described in the following paragraphs.

4.3.1. *Interfaces with the rolling stock subsystem*

Table 8

Interfaces with the rolling stock subsystem, 'locomotives and passenger RST' TSI

Interface	Reference conventional rail infrastructure TSI	Reference conventional rail locomotives and passenger RST TSI
Track gauge	4.2.5.1 Nominal track gauge 4.2.5.6 Railhead profile for plain line 4.2.6.2 In-service geometry of switches and crossings	4.2.3.5.2.1 Mechanical and geometrical characteristics of Wheelset 4.2.3.5.2.2 Mechanical and geometrical characteristics of Wheels
Gauges	4.2.4.1 Structure gauge 4.2.4.2 Distance between track centres 4.2.4.5 Minimum radius of vertical curve	4.2.3.1. Gauging
Axle load and axle spacing	4.2.7.1 Track resistance to vertical loads 4.2.8.1 Resistance of new bridges to traffic loads 4.2.8.2 Equivalent vertical loading for new earthworks and earth pressure effects 4.2.8.4 Resistance of existing bridges and earthworks to traffic loads	4.2.3.2 Axle load and wheel load
Running characteristics	4.2.7.1 Track resistance to vertical loads 4.2.7.3 Lateral track resistance 4.2.8.1.3 Nosing forces	4.2.3.4.2.1 Limit values for running safely 4.2.3.4.2.2 Track loading limit values
Equivalent conicity	4.2.5.5 Equivalent conicity	4.2.3.4.3 Equivalent conicity
Longitudinal actions	4.2.7.2 Longitudinal track resistance 4.2.8.1.4 Actions due to traction and braking (logitudinal loads)	4.2.4.5 Braking performance
Minimum curve radius	4.2.4.4 Minimum radius of horizontal curve	4.2.3.6 Minimum curve radius
Horizontal curve radius	4.2.5.4 Cant deficiency	4.2.3.4.2.1 Limit values for running safety
Vertical curve acceleration	4.2.4.5 Minimum radius of vertical curve	4.2.3.1 Gauging

[1] OJ L 330, 5.12.1998, p. 32.

Interface	Reference conventional rail infrastructure TSI	Reference conventional rail locomotives and passenger RST TSI
Aerodynamic effect	4.2.4.2 Distance between track centres 4.2.8.3 Resistance of new structures over or adjacent to tracks 4.2.11.1 Maximum pressure variations in tunnels	4.2.6.2.1 Slipstream effects on assengers on platforms 4.2.6.2.2 Slipstream effects on workers on the track side 4.2.6.2.3 Head pressure pulse 4.2.6.2.4 Maximum pressure variations in tunnels
Crosswind	4.2.11.5 Effect of crosswinds	4.2.6.2.5 Crosswind
Installations for servicing trains	4.2.13.2 Toilet discharge 4.2.13.3 Train external cleaning facilities 4.2.13.4 Water restocking 4.2.13.5 Refuelling 4.2.13.6 Electric shore supply	4.2.11.3 Toilet discharge system 4.2.11.2.2 Exterior cleaning through a washing plant 4.2.11.4 Water refilling equipment 4.2.11.5 Interface for water refilling 4.2.11.7 Refuelling equipment 4.2.11.6 Special requirements for stabling of trains

Table 9

Interfaces with the rolling stock subsystem, 'freight wagons' TSI

Interface	Reference conventional rail infrastructure TSI	Reference conventional rail freight wagons TSI
Track gauge	4.2.5.1 Nominal track gauge 4.2.5.6 Railhead profile for plain line 4.2.6.2 In-service geometry of switches and crossings	4.2.3.4 Vehicle dynamic behaviour
Gauges	4.2.4.1 Structure gauge 4.2.4.2 Distance between track centres 4.2.4.5 Minimum radius of vertical curve	4.2.3.1 Kinematic gauge
Axle load and axle spacing	4.2.7.1 Track resistance to vertical loads 4.2.7.3 Lateral track resistance 4.2.8.1 Resistance of new bridges to traffic loads 4.2.8.2 Equivalent vertical loading for new earthworks and earth pressure effects 4.2.8.4 Resistance of existing bridges and earthworks to traffic loads	4.2.3.2 Static axle load and linear load
Running characteristics	4.2.7.1 Track resistance to vertical loads 4.2.7.3 Lateral track resistance (b)	4.2.3.4 Vehicle dynamic behaviour
Longitudinal actions	4.2.7.2 Longitudinal track resistance 4.2.8.1.4 Actions due to traction and braking (logitudinal loads)	4.2.4.1 Braking performance
Minimum curve radius	4.2.4.4 Minimum radius of horizontal curve	4.2.2.1. Interface (e. g. coupling) between vehicles, between sets of vehicles and between trains
Horizontal curve radius	4.2.5.4 Cant deficiency	4.2.3.5. Longitudinal compressive forces
Vertical curve acceleration	4.2.4.5 Minimum radius of vertical curve	4.2.3.1 Kinematic gauge
Aerodynamic effect	4.2.4.2 Distance between track centres 4.2.8.3 Resistance of new structures over or adjacent to tracks 4.2.11.1 Maximum pressure variations in tunnels	4.2.6.2 Aerodynamic effects
Crosswind	4.2.11.5 Effect of crosswinds	4.2.6.3 Cross winds

4.3.2. *Interfaces with the energy subsystem*

Table 10

Interfaces with the energy subsystem

Interface	Reference conventional rail infrastructure TSI	Reference conventional rail energy TSI
Gauges	4.2.4.1 Structure gauge	4.2.14 Pantograph gauge
Protection against electric shock	4.2.11.3 Protection against electric shock	4.7.3 Protective provisions of overhead contact line system 4.7.4 Protective provisions of current return circuit

4.3.3. *Interfaces with the control command and signalling subsystem*

Table 11

Interfaces with the control command and signalling subsystem

Interface	Reference conventional rail infrastructure TSI	Reference conventional rail control command and signalling TSI
Structure gauge set for CCS installations	4.2.4.1 Structure gauge	4.2.5 ETCS and EIRENE air gap interfaces 4.2.16 Visibility of track-side control-command objects
Use of eddy current brakes	4.2.7.2 Longitudinal track resistance	Annex A, Appendix 1, Section 5.2: Use of electric/magnetic brakes

4.3.4. *Interfaces with the operation and traffic management subsystem*

Table 12

Interfaces with the operation and traffic management subsystem

Interface	Reference conventional rail infrastructure TSI	Reference conventional rail operation and traffic management TSI
Use of eddy current brakes	4.2.7.2 Longitudinal track resistance	4.2.2.6.2 Brake performance
Operating rules	4.4 Operating rules	4.2.1.2.2.2 Modified elements 4.2.3.6 Degraded operation

4.4. **Operating rules**

4.4.1. *Exceptional conditions relating to pre-planned works*

(1) During pre-planned works, it may be necessary to temporarily suspend the specifications of the infrastructure subsystem and its interoperability constituents defined in Chapters 4 and 5 of this TSI. Specific operational provisions are set out in the CR Traffic Operation and Management TSI.

4.4.2. *Degraded operation*

(1) Events that affect the normal operation of a line may occur. The operational rules for dealing with such events are set out in the CR Traffic Operation and Management TSI.

4.4.3. *Protection of workers against aerodynamic effects*

(1) The infrastructure manager shall define the means for protecting workers against aerodynamic effects.

(2) For the trains complying with the HS and CR rolling stock TSIs, the infrastructure manager shall take into account the actual speed of the trains and the limit value of the aerodynamic effects given by the HS and CR rolling stock TSIs.

4.5. **Maintenance plan**

4.5.1. *Before placing a line in service*

(1) A maintenance file shall be prepared setting out at least:

(a) a set of values for immediate action limits,

(b) the measures taken (speed restriction, repair time) when prescribed values are exceeded,

related to the following elements:

i. requirements for controlling equivalent conicity in service,

ii. in service geometry of switches and crossings,

iii. track geometric quality and limits on isolated defects,

iv. platform edge as required by the 'People with reduced mobility' TSI.

4.5.2. *After placing a line in service*

(1) The infrastructure manager shall have a maintenance plan containing the items listed in Section 4.5.1 together with at least the following items related to the same elements:

(a) a set of values for intervention limits and alert limits,

(b) a statement about the methods, professional competences of staff and personal protective safety equipment necessary to be used,

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

(d) the means used to check that in-service values are respected.

4.6. **Professional competences**

(1) The professional competences required for the staff maintaining the infrastructure subsystem shall be detailed in the maintenance plan (see Section 4.5.2).

4.7. **Health and safety conditions**

(1) Health and safety conditions are dealt with compliance with requirements sections: 4.2.11.1 (Maximum pressure variation in tunnels), 4.2.11.2 (Noise and vibration limits and mitigation measures), 4.2.11.3 (Protection against electric shock), 4.2.10 (Platforms), 4.2.11.4 (Safety in railway tunnels), 4.2.13 (Fixed installations for servicing trains) and 4.4 (Operating rules).

4.8. **Register of infrastructure**

(1) In accordance with Article 35 of Directive 2008/57/EC, the Register of Infrastructure shall indicate the main features of the infrastructure subsystem.

(2) Annex D of this TSI indicates which information concerning the infrastructure subsystem shall be included in the Register of Infrastructure. The information to be included in the Register of Infrastructure required for other subsystems are set in the TSIs concerned.

5. INTEROPERABILITY CONSTITUENTS

5.1. **Basis on which interoperability constituents have been selected**

(1) The requirements of Section 5.3 are based on a traditional design of ballasted track with Vignole (flat-bottom) rail on concrete or wooden sleepers and fastening providing resistance to longitudinal slip by bearing on the rail foot.

(2) Components and subassemblies used for the construction of other designs of track are not considered to be interoperability constituents.

5.2. **List of constituents**

(1) For the purposes of this technical specification for interoperability, only the following elements, whether individual components or subassemblies of the track are declared to be 'interoperability constituents':

(a) the rail (5.3.1),

(b) the rail fastening systems (5.3.2),

(c) track sleepers (5.3.3).

(2) The following sections describe the specifications applicable to each of these constituents.

(3) Rails, fastenings and sleepers used for short length of track for specific purposes, for example in switches and crossings, at expansion devices, transition slabs and special structures, are not considered to be interoperability constituents.

5.3. **Constituents performances and specifications**

5.3.1. *The rail*

(1) The specifications of the 'rail' interoperability constituent are the following:

(a) railhead profile,

(b) moment of inertia of the rail cross section,

(c) rail hardness.

5.3.1.1. Railhead profile

(1) The railhead profile shall fulfil the requirements of Section 4.2.5.6 'Railhead profile for plain line'.

(2) The railhead profile shall allow requirements of Section 4.2.5.5.1 for 'Design values for equivalent conicity' to be met when used with a specified range of track gauge and rail inclinations consistent with the requirements of this TSI.

5.3.1.2. Moment of inertia of the rail cross section

(1) The moment of inertia is relevant to the requirements of Section 4.2.7 'Track resistance to applied loads'.

(2) The calculated value of moment of inertia (I) of designed rail section about the principal horizontal axis through the centre of gravity shall be at least 1 600 cm^4.

5.3.1.3. Rail hardness

(1) The rail hardness is relevant to the requirements of Section 4.2.5.6 'Railhead profile for plain line'.

(2) The rail hardness measured at the crown of the railhead shall be at least 200 HBW.

5.3.2. *The rail fastening systems*

(1) The rail fastening system is relevant to the requirements of Section 4.2.7.2 for 'Longitudinal track resistance' and Section 4.2.7.3 'Lateral track resistance' and Section 4.2.7.1 for 'Track resistance to vertical loads'.

(2) The rail fastening system shall comply in laboratory test conditions with the following requirements:

(a) the longitudinal force required to cause the rail to begin to slip (i.e. move in an inelastic way) through a single rail fastening assembly shall be at least 7 kN,

(b) the rail fastening shall resist application of 3 000 000 cycles of the typical load applied in a sharp curve, such that the performance of the fastening in terms of clamping force and longitudinal restraint is not degraded by more than 20 % and vertical stiffness is not degraded by more than 25 %. The typical load shall be appropriate to:

i. the maximum axle load the rail fastening system is designed to accommodate,

ii. the combination of rail, rail inclination, rail pad and type of sleepers with which the fastening system may be used.

5.3.3. *Track sleepers*

(1) Track sleepers shall be designed such that when they are used with a specified rail and rail fastening system they will have properties that are consistent with the requirements of 4.2.5.1 for 'Nominal track gauge', Section 4.2.5.5.2 for 'Requirements for controlling equivalent conicity in service (Table 5: Minimum mean gauge in service on straight track and in curves of radius R > 10 000 m)', Section 4.2.5.7 for 'Rail inclination' and Section 4.2.7 for 'Track resistance to applied loads'.

6. ASSESSMENT OF CONFORMITY OF INTEROPERABILITY CONSTITUENTS AND EC VERIFICATION OF THE SUBSYSTEMS

6.1. **Interoperability constituents**

6.1.1. *Conformity assessment procedures*

(1) The conformity assessment procedure of interoperability constituents as defined in Chapter 5 of this TSI shall be carried out by application of the relevant modules.

6.1.2. *Application of modules*

(1) The following modules for conformity assessment of interoperability constituents are used:

(a) CA 'Internal production control'

(b) CB 'EC type examination'

(c) CD 'Conformity to type based on quality management system of the production process'

(d) CF 'Conformity to type based on product verification'

(e) CH 'Conformity based on full quality management system'

(2) The modules for conformity assessment of interoperability constituents shall be chosen from those shown in Table 13.

Table 13

Modules for conformity assessment to be applied for interoperability constituents

Procedures	Rail	Rail fastening system	Track sleepers
Placed on the EU market before entry into force of this TSI	CA or CH	CA or CH	
Placed on the EU market after entry into force of this TSI	CB+CD or CB+CF or CH		

(3) In the case of products placed on the market before the publication of this TSI, the type is considered to have been approved and therefore EC type examination (module CB) is not necessary, provided that the manufacturer demonstrates that tests and verification of interoperability constituents have been considered successful for previous applications under comparable conditions and are in conformity with the requirements of this TSI. In this case these assessments shall remain valid in the new application. If it is not possible to demonstrate that the solution is positively proven in the past, the procedure for interoperability constituents placed on the EU market after publication of this TSI applies.

(4) The conformity assessment of interoperability constituents shall cover the phases and characteristics as indicated in Table 20 of Annex A to this TSI.

6.1.3. *Innovative solutions for interoperability constituents*

(1) If an innovative solution is proposed for an interoperability constituent as defined in Section 5.2, the manufacturer or his authorised representative established within the Community shall state the deviations from the relevant clause of this TSI and submit them to the Commission for analysis.

(2) In case the analysis results in a favourable opinion, the appropriate functional and interface specifications for the constituent and the assessment method will be developed under the authorisation of the Commission.

(3) The appropriate functional and interface specifications and the assessment methods so produced shall be incorporated in the TSI by the revision process.

(4) By the notification of a decision of the Commission, taken in accordance with Article 29 of the Directive, the innovative solution may be permitted to be used before being incorporated into the TSI by the revision process.

6.1.4. *EC declaration of conformity for interoperability constituents*

6.1.4.1. Interoperability constituents subject to other Community Directives

(1) Article 13(3) of Directive 2008/57/EC, states 'Where the interoperability constituents are the subject of other Community Directives covering other aspects, the EC declaration of conformity or suitability for use shall, in such instances, state that the interoperability constituents also meet the requirements of those other Directives.'

(2) According to Annex IV (3) of Directive 2008/57/EC, the EC declaration of conformity shall be accompanied by the statement setting out the condition of use.

6.1.4.2. EC declaration of conformity for the rail

(1) The EC declaration of conformity shall be accompanied by statement setting out the range of track gauge and rail inclination for which the railhead profile allows the requirements of Section 4.2.5.5.1 to be met.

6.1.4.3. EC declaration of conformity for rail fastening systems

(1) The EC declaration of conformity shall be accompanied by statement setting out:

(a) the combination of rail, rail inclination, rail pad and type of sleepers with which the fastening system may be used

(b) the maximum axle load the rail fastening system is designed to accommodate.

6.1.4.4. EC declaration of conformity for track sleepers

(1) The EC declaration of conformity shall be accompanied by statement setting out the combination of rail, rail inclination and type of rail fastening system with which the sleeper may be used.

6.2. **Infrastructure subsystem**

6.2.1. *General provisions*

(1) At the request of the applicant, the notified body carries out the EC verification of the infrastructure subsystem in accordance with Article 18 and Annex VI of Directive 2008/57/EC and in accordance with the provisions of the relevant modules.

(2) If the applicant demonstrates that tests or verifications of an infrastructure subsystem have been successful for previous applications of a design in similar circumstances, the notified body shall take these tests and verifications into account for the EC verification.

(3) The EC verification of the infrastructure subsystem shall cover the phases and characteristics indicated Table 21 in Annex B to this TSI. Particular assessment procedures for specific basic parameters of Infrastructure subsystem are included in Section 6.2.4.

(4) The applicant shall draw up the EC declaration of verification for the infrastructure subsystem in accordance with Article 18 of and Annex V to Directive 2008/57/EC.

6.2.2. *Application of modules*

(1) For the EC verification procedure of the infrastructure subsystem, the applicant may choose either:

(a) Module SG: EC verification based on unit verification, or

(b) Module SH1: EC verification based on full quality management system plus design examination.

6.2.2.1. Application of module SG

(1) In the case where EC verification is most effectively undertaken by using information collected by the infrastructure manager, contracting entity or the main contractors involved (for example data obtained using track recording vehicle or other measuring devices), the notified body shall take this information into account to assess conformity.

6.2.2.2. Application of module SH1

(1) The SH1 module may be chosen only where the activities contributing to the proposed subsystem to be verified (design, manufacturing, assembling, installation) are subject to a quality management system for design, production, final product inspection and testing, approved and surveyed by a notified body.

6.2.3. *Innovative solutions*

(1) If the subsystem includes an innovative solution as mentioned in Section 4.1, the applicant shall state the deviation from the relevant clauses of the TSI and submit them to the Commission.

(2) In case of favourable opinion, the appropriate functional and interface specifications, and the assessment methods for this solution will be developed.

(3) The appropriate functional and interface specifications and the assessment methods so produced shall then be incorporated in the TSI by the revision process.

(4) By the notification of a decision of the Commission, taken in accordance with Article 29 of the Directive, the innovative solution may be permitted to be used before being incorporated into the TSI by the revision process.

6.2.4. *Particular assessment procedures for subsystem*

6.2.4.1. Assessment of structure gauge

(1) Assessment of structure gauge is to be made using the results of calculations made by the infrastructure manager or the contracting entity on the basis of Chapters 5, 7, 10 and Annex C of EN 15273-3:2009.

6.2.4.2. Assessment of distance between track centres

(1) Assessment of the distance between track centres is to be made using the results of calculations made by the infrastructure manager or the contracting entity on the basis of Chapter 9 of EN 15273-3:2009.

6.2.4.3. Assessment of cant deficiency

(1) Section 4.2.5.4.1 states that 'It is permissible for trains specifically designed to travel with higher cant deficiency (multiple units with lower axle loads; trains equipped with a cant deficiency compensation system) to run with higher cant deficiency values, subject to a demonstration that this can be achieved safely'.

(2) The demonstration of safety is not subject to a notified body verification.

6.2.4.4. Assessment of design values for equivalent conicity

(1) Assessment of design values for equivalent conicity is to be made using the results of calculations made by the infrastructure manager or the contracting entity on the basis of EN 15302:2008.

6.2.4.5. Assessment of minimum value of mean track gauge

(1) The measurement method for track gauge is given in Section 4.2.1 of EN 13848-1:2003 + A1:2008.

6.2.4.6. Assessment of maximum pressure variations in tunnels

(1) Assessment of maximum pressure variation in the tunnel (10 kPa criterion) is to be made using the results of calculations made by the infrastructure manager or the contracting entity on the basis of all operational conditions with all the trains complying with the high speed and conventional rail rolling stock TSI and intended to run at speeds of greater than 190 km/h in the specific tunnel to be assessed.

(2) The input parameters to be used are to be such that the reference characteristic pressure signature of the trains set out in the HS rolling stock TSI is fulfilled.

(3) The reference cross section areas of the interoperable trains to be considered is to be, independently to each motor or trailer vehicle:

(a) 12 m^2 for vehicles designed for GC reference kinematic profile,

(b) 11 m^2 for vehicles designed for GB reference kinematic profile,

(c) 10 m^2 for vehicles designed for smaller kinematic profiles.

(4) The assessment may take into account the construction features which reduce the pressure variation (tunnel entrance shape, shafts, etc.) if any, as well as the tunnel length.

6.2.4.7. Assessment of geometry of switches and crossings

(1) Assessment of switches and crossings at the design phase is required to verify that the design values used are consistent with the in-service limiting values set out in Section 4.2.6.2.

(2) Assessment of fixed obtuse crossings at the design phase is also required to verify that the requirements for unguided length in Section 4.2.6.3 are met.

6.2.4.8. Assessment of new structures

(1) Assessment of structures is to be made by only checking the traffic loads used for design against the minimum requirements of 4.2.8.1, 4.2.8.2 and 4.2.8.3. The notified body is not required to review the design nor carry out any calculations. When reviewing the value of alpha used in the design according to 4.2.8.1 and 4.2.8.2 it is only necessary to check that the value of alpha satisfies Table 6.

6.2.4.9. Assessment of existing structures

(1) Assessment of existing structures is to be made by checking that the values of EN line categories (and if relevant locomotive classes) in combination with the permitted speed published by the infrastructure manager for the lines containing the structures satisfy the requirements of Annex E of this TSI.

6.2.4.10. Assessment of fixed installations for servicing trains

(1) Assessment of fixed installations for servicing trains is in the responsibility of the Member State concerned.

6.2.5. *Technical solutions giving presumption of conformity at design phase*

6.2.5.1. Assessment of track resistance for plain line

(1) Plain line ballasted track conforming to the following characteristics is deemed to have met the requirements set out in Section 4.2.7 related to track resistance to longitudinal, vertical and lateral forces:

(a) The requirements for track components, defined in Chapter 5 'Interoperability constituents' for the rail (5.3.1), rail fastening systems (5.3.2) and sleepers (5.3.3) interoperability constituents are met;

(b) There are at least 1 500 rail fastenings per rail, per kilometre length.

6.2.5.2. Assessment of track resistance for switches and crossings

(1) Switches and crossings in ballasted track conforming to the following characteristics are deemed to have met the requirements set out in Section 4.2.7 related to track resistance to longitudinal, vertical and lateral forces:

(a) The requirements defined in Chapter 5 'Interoperability constituents' for the rail (5.3.1) are met for the plain rails in the switches and crossings and corresponding switch rails and crossings are used;

(b) The requirements defined in Chapter 5 'Interoperability constituents' for rail fastening systems (5.3.2) are met by all fastenings, other than fastenings used at movable parts of switches and crossings;

(c) There are at least equivalent to 1 500 rail fastenings per rail, per kilometre length averaged over the length of the switches and crossings.

6.3. **EC verification when speed is used as a migration criterion**

(1) Section 7.4 permits a line to be put into service at a lower speed than the ultimate intended speed. This section sets out requirements for EC verification in this circumstance.

(2) Some limiting values set out in Chapter 4 depend on the intended speed of the route.

Conformity should be assessed at the intended ultimate speed; however it is permissible to assess speed dependant characteristics at the lower speed at the time of placing in service.

(3) The conformity of the other characteristics for the intended speed of the route remains valid.

(4) To declare the interoperability at this intended speed, it is only necessary to assess the conformity of the characteristics temporarily not respected, when they are brought up to the required level.

6.4. **Assessment of maintenance plan**

(1) Section 4.5 requires the infrastructure manager to have for each conventional line a maintenance plan for the infrastructure subsystem.

(2) The notified body shall confirm that the maintenance file exists and contains the items listed in Section 4.5.1. The notified body is not responsible for assessing the suitability of the detailed requirements set out in the maintenance file.

(3) The notified body shall include copy of the maintenance file required by Section 4.5.1 of this TSI in the technical file referred to in Article 18(3) of Directive 2008/57/EC.

6.5. **Assessment of Register of Infrastructure**

(1) Section 4.8 requires that the Register of Infrastructure shall indicate the main features of the infrastructure subsystem. The notified body is responsible for assessing that those features have been prepared for the Register of Infrastructure.

6.6. **Subsystems containing interoperability constituents not holding an EC declaration**

6.6.1. *Conditions*

(1) During the transition period provided for in Article 6 of this Decision, a notified body is permitted to issue an EC certificate of verification for a subsystem even if some of the interoperability constituents incorporated within the subsystem are not covered by the relevant EC declarations of conformity and/or suitability for use according to this TSI, if the following criteria are complied with:

(a) the conformity of the subsystem has been checked against the requirements of Chapter 4 and in relation to Chapters 6.2 to 7 (except 7.6. 'Specific cases') of this TSI by the notified body. Furthermore the conformity of the ICs to Chapter 5 and 6.1 does not apply, and

(b) the interoperability constituents, which are not covered by the relevant EC declaration of conformity and/or suitability for use, have been used in a subsystem already approved and put in service in at least one of the Member State before the entry in force of this TSI.

(2) EC declarations of conformity and/or suitability for use shall not be drawn up for the interoperability constituents assessed in this manner.

6.6.2. *Documentation*

(1) The EC certificate of verification of the subsystem shall indicate clearly which interoperability constituents have been assessed by the notified body as part of the subsystem verification.

(2) The EC declaration of verification of the subsystem shall indicate clearly:

(a) Which interoperability constituents have been assessed as part of the subsystem;

(b) Confirmation that the subsystem contains the interoperability constituents identical to those verified as part of the subsystem;

(c) For those interoperability constituents, the reason(s) why the manufacturer did not provide an EC Declaration of conformity and/or suitability for use before its incorporation into the subsystem, including the application of national rules notified under Article 17 of Directive 2008/57/EC.

6.6.3. *Maintenance of the subsystems certified according to 6.6.1*

(1) During the transition period as well as after the transition period has ended, until the subsystem is upgraded or renewed (taking into account the decision of Member State on application of TSIs), the interoperability constituents which do not hold an EC Declaration of conformity and/or suitability for use and of the same type are permitted to be used as maintenance related replacements (spare parts) for the subsystem, under the responsibility of the body responsible for maintenance.

(2) In any case the body responsible for maintenance must ensure that the components for maintenance related replacements are suitable for their applications, are used within their area of use, and enable interoperability to be achieved within the rail system while at the same time meeting the essential requirements. Such components must be traceable and certified in accordance with any national or international rule, or any code of practice widely acknowledged in the railway domain.

7. IMPLEMENTING THE INFRASTRUCTURE TSI

7.1. **Application of this TSI to conventional rail lines**

(1) Chapters 4 to 6 and any specific provisions in Sections 7.2 to 7.6 below apply in full to the lines coming within the geographical scope of this TSI which will be put into service as interoperable lines after this TSI enters into force.

(2) The Member States shall develop a national migration strategy which specifies for TEN lines those elements of the infrastructure subsystem, which are required for interoperable services (e.g. tracks, sidings, stations, marshalling yards) and therefore need to comply with this TSI. This migration strategy shall include plans related to renewal and upgrading. In specifying those elements the Member States shall consider the coherence of the system as a whole.

7.2. **Application of this TSI to new conventional rail lines**

(1) New core TEN lines (type IV) shall satisfy the requirements of TSI category of line IV-P, IV-F or IV-M.

(2) New other TEN lines (type VI) shall satisfy the requirements of TSI category of line VI-P, VI-F or VI-M. It is also permissible for the line to satisfy the requirements of TSI category of line IV-P, IV-F or IV-M respectively.

(3) For the purpose of this TSI a 'new line' means a line that creates a route where none currently exists.

(4) The following situations, for example to increase speed or capacity, may be considered as the construction of an upgraded line rather than a new line:

(a) the realignment of part of an existing route,

(b) the creation of a bypass,

(c) the addition of one or more tracks on an existing route, regardless of the distance between the original tracks and the additional tracks.

7.3. **Application of this TSI to existing conventional rail lines**

Four possible cases of application of this TSI are relevant.

7.3.1. *Upgrading of a line*

(1) In accordance with Directive 2008/57/EC, Article 2(m), 'upgrading' means any major modification work on a subsystem or part of a subsystem which improves the overall performance of the subsystem.

(2) The infrastructure subsystem of a line is considered to be upgraded when at least the performance parameters axle load and gauge as defined in Section 4.2.2 are met. In these cases , the Member State shall check that the file referred to in Article 20.1 of Directive 2008/57/EC meets the following requests:

(2.1) Upgrading of existing core TEN lines shall be in accordance with the requirements of TSI category of line V-P, V-F and V-M. (An upgrade to the requirements of type of line IV is permissible.)

(2.2) Upgrading of existing other TEN lines shall be in accordance with the requirements of TSI category of line VII-P, VII-F or VII-M. (An upgrade to the requirements of type of line VI is permissible.)

(2.3) For other TSI parameters, according to Article 20(1) of the Directive 2008/57/EC, the Member State decide to what extent the TSI need to be applied to the project.

(3) Where Article 20(2) of the Directive 2008/57/EC applies because the upgrading is subject of an authorisation of placing into service, the Member State decides which requirements of the TSI must be applied taking into account the migration strategy referred to in Section 7.1.

(4) Where Article 20(2) of the Directive 2008/57/EC does not apply because the upgrading is not subject of an authorisation of placing into service, the conformity with this TSI is recommended. Where it is not possible to achieve conformity, the contracting entity informs the Member State of the reasons thereof.

(5) For a project including elements not being TSI conform, the procedures for the assessment of conformity and EC verification to be applied should be agreed with the Member State.

7.3.2. *Renewal of a line*

(1) In accordance with Directive 2008/57/EC, Article 2(n), 'renewal' means any major substitution work on a subsystem or part subsystem which does not change the overall performance of the subsystem.

(2) For this purpose major substitution should be interpreted as a project undertaken to systematically replace elements of a line or a section of a line in consistency with the national migration plan. Renewal differs from a substitution in the framework of maintenance, referred to in Section 7.3.3 below, in that it gives the opportunity to achieve a TSI compliant route. A renewal is effectively the same case as upgrading, but without a change in performance parameters.

(3) Where Article 20(2) of the Directive 2008/57/EC applies because the renewal is subject of an authorisation of placing into service, the Member State decides which requirements of the TSI must be applied taking into account the migration strategy referred to in Section 7.1.

(4) Where Article 20(2) of the Directive 2008/57/EC does not apply because the renewal is not subject of an authorisation of placing into service, the conformity with this TSI is recommended. Where it is not possible to achieve conformity, the contracting entity informs the Member State of the reasons thereof.

(5) For a project including elements not being TSI conform, the procedures for the assessment of conformity and EC verification to be applied should be agreed with the Member State.

7.3.3. *Substitution in the framework of maintenance*

(1) Where the parts of a subsystem on a line are maintained, the formal verification and authorisation for placing into service is not required in accordance with this TSI. However, maintenance replacements should be, as far as is reasonably practicable, undertaken in accordance with the requirements of this TSI.

(2) The objective should be that maintenance replacements progressively contribute the development of an interoperable line.

(3) In order to get a valuable part of the infrastructure subsystem for a progressive process towards interoperability, a group of basic parameters should always be adapted together. These groups are the following:

(a) Line layout,

(b) Track parameters,

(c) Switches and crossings,

(d) Track resistance to applied loads,

(e) Structures resistance to traffic loads,

(f) Platforms.

(4) In such cases, account must be taken of the fact that each of these elements taken in isolation does not make it possible on its own to ensure the conformity of the whole: the conformity of a subsystem can only be stated globally, that is when all the elements have been brought into conformity with the TSI.

7.3.4. *Existing lines that are not subject to a renewal or upgrading project*

(1) An existing subsystem may allow the circulation of TSI-conform vehicles whist meeting the essential requirements of Directive 2008/57/EC. The infrastructure manager should be able in this case, on a voluntary basis, to complete the Register of Infrastructure set out in Article 35 of Directive 2008/57/EC in accordance with Annex D of this TSI.

(2) The procedure to be used for the demonstration of the level of compliance with the basic parameters of the TSI shall be defined in the specification of Register of Infrastructure to be adopted by the Commission in accordance with that Article.

7.4. **Speed as migration criterion**

(1) It is permissible to bring a line into service as an interoperable line at a lower speed than its intended ultimate line speed. However, when it is the case the line should not be constructed in a way that inhibits future adoption of the intended ultimate line speed.

(2) For example the distance between track centres shall be suitable for the intended ultimate line speed but the cant will need to be appropriate to the speed at the time the line is brought into service.

(3) Requirements for assessment of conformity in this circumstance are set out in Section 6.3.

7.5. **Compatibility of infrastructure and rolling stock**

(1) Rolling stock conforming to the rolling stock TSIs is not automatically compatible with all lines complying with this Infrastructure TSI. For example, a GC gauge vehicle is not compatible with a GB gauge tunnel.

(2) The design of the TSI categories of line as defined in Chapter 4 is generally compatible with the operation of vehicles categorised in accordance with EN 15528:2008 at up to the maximum speed as shown in Annex E. However there may be a risk of excessive dynamic effects including resonance in certain bridges which may further impact the compatibility of vehicles and infrastructure.

(3) Checks, based on specific operational scenarios agreed between the infrastructure manager and the railway undertaking, may be undertaken to demonstrate the compatibility of vehicles operating above the maximum speed shown in Annex E.

(4) As stated in Section 4.2.2 of this TSI, it is permissible to design new and upgraded lines such that they will also accommodate larger gauges, higher axle loads, greater speeds and longer trains than those specified.

7.6. **Specific cases**

The following specific cases may be applied on particular networks. These specific cases are classified as:

(a) 'P' cases: permanent cases,

(b) 'T' cases: temporary cases, where it is recommended that the target system is reached by 2020 (an objective set in Decision No 1692/96/EC, as amended by Decision No 884/2004/EC [2]).

The specific cases set out in Sections 7.6.1 to 7.6.13 should be read in conjunction with the relevant sections of Chapter 4. Unless otherwise indicated (for example, in the case of an additional requirement), the specific cases replace the corresponding requirements given in Chapter 4. Where the requirements of the relevant section in Chapter 4 are not subject to a specific case, those requirements have not been duplicated in Sections 7.6.1 to 7.6.13, and continue to apply unmodified.

7.6.1. *Particular features on the Estonian network*

The specific cases for 1 520/1 524 mm track gauge system are an open point.

7.6.2. *Particular features on the Finnish network*

7.6.2.1. Structure gauge (4.2.4.1)

P cases

All TSI categories of line — clauses (1) and (2)

(1) The Structure gauge shall be set on the basis of the gauge FIN 1.

(2) Calculations of the structure gauge shall be done using the static or kinematic method in accordance with the requirements of EN 15273-3:2009 Annex D Section D.4.4.

7.6.2.2. Minimum radius of horizontal curve (4.2.4.4)

P cases

All TSI categories of line — clause (4)

(4) Reverse curves with radii in the range from 150 m to 300 m shall be designed according to national rules notified for this purpose to prevent buffer locking.

7.6.2.3. Nominal track gauge (4.2.5.1)

P cases

All TSI categories of line — clause (1)

(1) The nominal track gauge shall be 1 524 mm.

7.6.2.4. Design values for equivalent conicity (4.2.5.5.1)

P cases

All TSI categories of line — clause (2)

(2) For the nominal track gauge of 1 524 mm the following wheelsets shall be modelled passing over the designed track conditions (simulated by calculation according to EN 15302:2008):

(a) S 1002 as defined in EN 13715:2006 Annex C with SR = 1 505 mm,

(b) S 1002 as defined in EN 13715:2006 Annex C with SR = 1 511 mm,

[2] OJ L 167, 30.4.2004, p. 1.

(c) GV 1/40 as defined in EN 13715:2006 Annex B with SR = 1 505 mm,

(d) GV 1/40 as defined in EN 13715:2006 Annex B with SR = 1 511 mm,

(e) EPS as defined in EN 13715:2006 Annex D with SR = 1 505 mm.

7.6.2.5. Requirements for controlling equivalent conicity in service (4.2.5.5.2)

P cases

All TSI categories of line — Table 5

Table 14

Minimum mean gauge in service on straight track and in curves of radius R > 10 000 m

Speed range (km/h)	Mean gauge (mm) over 100 m
v ≤ 60	assessment not required
60 < v ≤ 160	1 519
160 < v ≤ 200	1 519

7.6.2.6. In-service geometry of switches and crossings (4.2.6.2)

P cases

All TSI categories of line — clause (2)

(2) The technical characteristics of switches and crossings for the nominal track gauge of 1 524 mm shall comply with the following in-service values:

(a) Maximum value of free wheel passage in switches: 1 469 mm.

(b) Minimum value of fixed nose protection for common crossings: 1 478 mm.

(c) Maximum value of free wheel passage at crossing nose: 1 440 mm.

(d) Maximum value of free wheel passage at check rail/wing rail entry: 1 469 mm.

(e) Maximum excess height of the check rail is 55 mm.

Additional requirements in (a) and (b) remain unchanged.

7.6.3. *Particular features on the Hellenic network*

7.6.3.1. Performance parameters (4.2.2)

P cases

All TSI categories of line — clauses (2), (6) and (7)

(2) New and upgraded 1 000 mm lines (of Peloponnese) on the trans-European conventional rail system shall be designed to a gauge according to national rules notified for this purpose and have an axle load of 14 t.

(6) The actual performance parameters for each section of track for the 1 000 mm lines (on Peloponnese) shall be published in the Register of Infrastructure.

(7) The published information relating to axle load shall be published in combination with the permitted speed.

7.6.3.2. Structure gauge (4.2.4.1)

P cases

All TSI categories of line — clauses (1) and (2)

(1) The structure gauge for the 1 000 mm lines (of Peloponnese) shall be set according to national rules notified for this purpose.

7.6.3.3. Distance between track centres (4.2.4.2)

P cases

All TSI categories of line — clause (1) and (2)

(1) The distance between track centres for the 1 000 mm lines (of Peloponnese) shall be set on the basis of the gauge according to national rules notified for this purpose.

7.6.3.4. Maximum gradients (4.2.4.3)

P cases

TSI categories of line IV-F, IV-M, VI-F and VI-M — clauses (3) and (4)

(3) Maximum gradients as steep as 20 mm/m are permitted for main tracks at the design phase.

7.6.3.5. Minimum radius of horizontal curve (4.2.4.4)

P cases

All TSI categories of line — clause (2)

(2) For stabling tracks or sidings the minimum horizontal design curve radius for the 1 000 mm lines (of Peloponnese) shall not be less than 110 m.

7.6.3.6. Minimum radius of vertical curve (4.2.4.5)

P cases

All TSI categories of line — clause (1)

(1) Vertical alignment of stabling and service tracks for the 1 000 mm lines (of Peloponnese) shall not include curves of radii less than 500 m on a crest or in a hollow.

7.6.3.7. Nominal track gauge (4.2.5.1)

P cases

All TSI categories of line — clause (1)

(1) The nominal track gauge shall be either 1 435 mm or 1 000 mm.

7.6.3.8. In-service geometry of switches and crossings (4.2.6.2)

P cases

All TSI categories of line — clause (2)

(2) The technical characteristics of switches and crossings for the nominal track gauge of 1 000 mm (of Peloponnese) shall comply with the following in-service values:

(a) Maximum value of free wheel passage in switches: 946 mm.

(b) Minimum value of fixed nose protection for common crossings: 961 mm.

(c) Maximum value of free wheel passage at crossing nose: not applicable.

(d) Maximum value of free wheel passage at check rail/wing rail entry: 943 mm.

Additional requirements in (a) and (b) remain unchanged.

7.6.3.9. Track resistance to vertical loads (4.2.7.1)

P cases

All TSI categories of line — clause (a)

(a) The track for the 1 000 mm lines (of Peloponnese), including switches and crossings, shall be designed to withstand at least the maximum static axle load of 14 t.

7.6.3.10. Resistance of new bridges to traffic loads (4.2.8.1) — vertical loads (4.2.8.1.1)

P cases

All TSI categories of line — only for new structures on new or existing lines — clause (3)

(3) The value of alpha (a) for 1 000 mm lines (of Peloponnese) shall be equal to or greater than 0,75.

7.6.4. *Particular features on the Irish network*

7.6.4.1. Performance parameters (4.2.2) — clause (2) — Table 3, column 'train length'

(2) New and upgraded lines on the trans-European conventional rail system shall be designed to length of passenger trains at least 215 m and to length of freight trains at least 350 m, according to national rules notified for this purpose.

7.6.4.2. Structure gauge (4.2.4.1)

P cases

TSI categories of line IV-P, IV-F, IV-M, VI-P, VI-F and VI-M — clauses (1) and (2)

(1) The structure gauge shall be set on the basis of the IRL 1 uniform gauge according to national rules notified for this purpose.

TSI categories of line V-P, V-F, V-M, VII-P, VII-F and VII-M — clauses (1) and (2)

(1) The structure gauge shall be set on the basis of the IRL 2 uniform gauge according to national rules notified for this purpose.

7.6.4.3. Distance between track centres (4.2.4.2)

P cases

TSI categories of line IV-P, IV-F, IV-M, VI-P, VI-F and VI-M — clause (1) and (2)

(1) The minimum distance between track centres shall be set on the basis of the gauge IRL 1 according to national rules notified for this purpose.

TSI categories of line V-P, V-F, V-M, VII-P, VII-F and VII-M — clause (1) and (2)

(1) The minimum distance between track centres shall be set on the basis of the gauge IRL 2 according to national rules notified for this purpose.

7.6.4.4. Nominal track gauge (4.2.5.1)

P cases

All TSI categories of line — clause (1)

(1) The nominal track gauge shall be 1 600 mm.

7.6.4.5. Design values for equivalent conicity (4.2.5.5.1)

P cases

All TSI categories of line — clause (2)

(2) For the nominal track gauge of 1 600 mm the following wheelsets shall be modelled passing over the designed track conditions (simulated by calculation according to EN 15302:2008):

(a) S 1002 as defined in EN 13715:2006 Annex C with SR = 1 585 mm,

(b) S 1002 as defined in EN 13715:2006 Annex C with SR = 1 591 mm,

(c) GV 1/40 as defined in EN 13715:2006 Annex B with SR =1 585 mm,

(d) GV 1/40 as defined in EN 13715:2006 Annex B with SR = 1 591 mm,

(e) EPS as defined in EN 13715:2006 Annex D with SR = 1 585 mm.

7.6.4.6. Requirements for controlling equivalent conicity in service (4.2.5.5.2)

P cases

All TSI categories of line — Table 5

Table 15

Minimum mean gauge in service on straight track and in curves of radius R > 10 000 m

Speed range (km/h)	Mean gauge (mm) over 100 m
v ≤ 60	assessment not required
60 < v ≤ 160	1 595
160 < v ≤ 200	1 595

7.6.4.7. In-service geometry of switches and crossings (4.2.6.2)

P cases

All TSI categories of line — clause (2)

(2) The technical characteristics of switches and crossings for the nominal track gauge of 1 600 mm shall comply with the following in-service values:

(a) Maximum value of free wheel passage in switches: 1 546 mm.

(b) Minimum value of fixed nose protection for common crossings: 1 556 mm.

(c) Maximum value of free wheel passage at crossing nose: 1 521 mm.

(d) Maximum value of free wheel passage at check rail/wing rail entry: 1 546 mm.

Additional requirements in (a) and (b) remain unchanged.

7.6.5. *Particular features on the Latvian network*

The specific cases for 1 520/1 524 mm track gauge system are an open point.

7.6.6. *Particular features on the Lithuanian network*

The specific cases for 1 520/1 524 mm track gauge system are an open point.

7.6.7. *Particular features on the Polish network*

7.6.7.1. Structure gauge (4.2.4.1)

P cases

All TSI categories of line — clauses (1) and (2)

(1) The structure gauge for the 1 520 mm lines shall be set according to national rules notified for this purpose.

7.6.7.2. Nominal track gauge (4.2.5.1)

P cases

All TSI categories of line — additional clause (3)

(3) A nominal track gauge of 1 520 mm is permitted for lines used for servicing international traffic to/from 1 520/1 524 mm railway countries.

7.6.7.3. Design values for equivalent conicity (4.2.5.5.1)

P cases

All TSI categories of line — clause (2)

(2) For the nominal track gauge of 1 520 mm the following wheelsets shall be modelled passing over the designed track conditions (simulated by calculation according to EN 15302:2008):

(a) S 1002 as defined in EN 13715:2006 Annex C with SR = 1 503 mm,

(b) S 1002 as defined in EN 13715:2006 Annex C with SR = 1 509 mm,

(c) GV 1/40 as defined in EN 13715:2006 Annex B with SR = 1 503 mm,

(d) GV 1/40 as defined in EN 13715:2006 Annex B with SR = 1 509 mm,

(e) EPS as defined in EN 13715:2006 Annex D with SR = 1 503 mm.

7.6.7.4. Requirements for controlling equivalent conicity in service (4.2.5.5.2)

P cases

All TSI categories of line — Table 5

Table 16

Minimum mean gauge in service on straight track and in curves of radius R > 10 000 m for 1 520 mm lines

Speed range (km/h)	Mean gauge (mm) over 100 m
v ≤ 120	assessment not required
120 < v ≤ 160	1 515
160 < v ≤ 200	1 515

7.6.7.5. In-service geometry of switches and crossings (4.2.6.2)

P cases

All TSI categories of line — clause (2)

(2) The technical characteristics of switches and crossings for the nominal track gauge of 1 520 mm shall comply with the following in-service values:

(a) Maximum value of free wheel passage in switches: 1 460 mm.

(b) Minimum value of fixed nose protection for common crossings: 1 476 mm.

(c) Maximum value of free wheel passage at crossing nose: 1 436 mm.

(d) Maximum value of free wheel passage at check rail/wing rail entry: 1 460 mm.

Additional requirements in (a) and (b) remain unchanged.

7.6.7.6. Maximum unguided length of fixed obtuse crossings (4.2.6.3)

P cases

All TSI categories of line — clause (1)

(1) For the 1 520 mm track gauge system, the maximum design value of the unguided length shall be equivalent to 1 in 9 ($tg\alpha = 0{,}11$, $\alpha = 6°20'$) obtuse crossing with a minimum 44 mm raised check rail and associated with a wheel diameter greater than 330 mm on straight through routes.

7.6.8. *Particular features on the Portuguese network*

7.6.8.1. Structure gauge (4.2.4.1)

P cases

All TSI categories of line — clauses (1) and (2)

The structure gauge shall be set on the basis of the reference contours CPb, CPb+ or CPc.

Calculations of the structure gauge shall be done using the kinematic method in accordance with the requirements of EN 15273-3:2009 Annex D Section D.4.3.

For the three rail track system, the structure gauge shall be set on the basis of the CPb+ reference contour, centred on the track gauge 1 668 mm.

7.6.8.2. Nominal track gauge (4.2.5.1)

P cases

All TSI categories of line — clause (1)

(1) The nominal track gauge shall be 1 668 mm, 1 435 mm or both if the line is equipped with the three rail track system.

7.6.8.3. Design values for equivalent conicity (4.2.5.5.1)

P cases

All TSI categories of line — clause (2)

(2) For the nominal track gauge of 1 668 mm the following wheelsets shall be modelled passing over the designed track conditions (simulated by calculation according to EN 15302:2008):

(a) S 1002 as defined in EN 13715:2006 Annex C with SR = 1 653 mm,

(b) S 1002 as defined in EN 13715:2006 Annex C with SR = 1 659 mm,

(c) GV 1/40 as defined in EN 13715:2006 Annex B with SR = 1 653 mm,

(d) GV 1/40 as defined in EN 13715:2006 Annex B with SR = 1 659 mm,

(e) EPS as defined in EN 13715:2006 Annex D with SR = 1 653 mm.

7.6.8.4. Requirements for controlling equivalent conicity in service (4.2.5.5.2)

P cases

All TSI categories of line — Table 5

Table 17

Minimum mean gauge in service on straight track and in curves of radius R > 10 000 m

Speed range (km/h)	Mean gauge (mm) over 100 m
$v \leq 60$	assessment not required
$60 < v \leq 160$	1 663
$160 < v \leq 200$	1 663

7.6.8.5. In-service geometry of switches and crossings (4.2.6.2)

P cases

All TSI categories of line — clause (2)

The technical characteristics of switches and crossings for the nominal track gauge of 1 668 mm shall comply with the following in-service values:

(a) Maximum value of free wheel passage in switches: 1 613 mm.

(b) Minimum value of fixed nose protection for common crossings: 1 624 mm.

(c) Maximum value of free wheel passage at crossing nose: 1 589 mm.

(d) Maximum value of free wheel passage at check rail/wing rail entry: 1 613 mm.

Additional requirements in (a) and (b) remain unchanged.

7.6.9. *Particular features on the Romanian network*

7.6.9.1. In-service geometry of switches and crossings (4.2.6.2)

P cases

All TSI categories of line — clause (2)(f)

(2)(f) The technical characteristics of switches and crossings shall comply with an in-service value for minimum flangeway depth of 38 mm.

7.6.10. *Particular features on the Spanish network*

7.6.10.1. Structure gauge (4.2.4.1)

P cases

TSI categories of line V-P, V-F, V-M, VII-P, VII-F and VII-M — clauses (1) and (2)

(1) The structure gauge shall be set on the basis of the gauge GHE16 according to national rules notified for this purpose.

All TSI categories of line — additional clause (4)

(4) Structure gauge for 1 435 mm track gauge and structure gauge for 1 668 mm track gauge for each section of three rail track shall be published in the Register of Infrastructure.

7.6.10.2. Distance between track centres (4.2.4.2)

P cases

TSI categories of line IV-P, IV-F, IV-M, VI-P, VI-F and VI-M — clauses (1) and (2)

(1) The distance between track centres such for 1 668 mm as for 1 435 mm track gauge will be according to the maximum speed of the line.

Table 18

Distance between track centres on the Spanish network

Speed (km/h)	Distance between track centres (mm)
v ≤ 140	3 808
140 < v ≤ 160	3 920
160 < v ≤ 200	4 000

In justified cases the distance between track centres can be decreased to the next lower value of the table, and in lines with speeds less than 100 km/h it might be decreased, in extreme cases, to 3 674 mm.

TSI categories of line V-P, V-F, V-M, VII-P, VII-F and VII-M — clauses (1) and (2)

(1) The minimum distance between track centres such for 1 668 mm as for 1 435 mm track gauge shall be 3 808 mm.

On lines with speeds less than 100 km/h it might be decreased to 3 674 mm.

If the selected distance between track centres is less than 3 808 mm, then the safe passing clearance between trains shall be demonstrated.

7.6.10.3. Maximum gradients (4.2.4.3)

P cases

TSI categories of line IV-F, IV-M, VI-F and VI-M — clauses (3) and (4)

(3) Maximum gradients as steep as 20 mm/m are permitted for main tracks at the design phase.

7.6.10.4. Nominal track gauge (4.2.5.1)

P cases

All TSI categories of line — clause (1) and additional clause (3)

(1) The nominal track gauge shall be either 1 668 mm or 1 435 mm.

(3) The nominal track gauge of three rail tracks shall be 1 435 mm and 1 668 mm.

7.6.10.5. Design values for equivalent conicity (4.2.5.5.1)

All TSI categories of line — clause (2)

(2) For the nominal track gauge of 1 668 mm the following wheelsets shall be modelled passing over the designed track conditions (simulated by calculation according to EN 15302:2008):

(a) S 1002 as defined in EN 13715:2006 Annex C with SR = 1 653 mm,

(b) S 1002 as defined in EN 13715:2006 Annex C with SR = 1 659 mm,

(c) GV 1/40 as defined in EN 13715:2006 Annex B with SR = 1 653 mm,

(d) GV 1/40 as defined in EN 13715:2006 Annex B with SR = 1 659 mm,

(e) EPS as defined in EN 13715:2006 with Annex D SR = 1 653 mm.

7.6.10.6. Requirements for controlling equivalent conicity in service (4.2.5.5.2)

P cases

All TSI categories of line — Table 5

Table 19

Minimum mean gauge in service on straight track and in curves of radius R > 10 000 m

Speed range (km/h)	Mean gauge (mm) over 100 m
$v \leq 60$	assessment not required
$60 < v \leq 160$	1 663
$160 < v \leq 200$	1 663

7.6.10.7. In-service geometry of switches and crossings (4.2.6.2)

P cases

All TSI categories of line — clause (2)

The technical characteristics of switches and crossings for the nominal track gauge of 1 668 mm shall comply with the following in-service values:

(a) Maximum value of free wheel passage in switches: 1 618 mm.

(b) Minimum value of fixed nose protection for common crossings: 1 626 mm.

(c) Maximum value of free wheel passage at crossing nose: 1 590 mm.

(d) Maximum value of free wheel passage at check rail/wing rail entry: 1 620 mm.

Additional requirements in (a) and (b) remain unchanged.

7.6.11. *Particular features on the Swedish network*

On infrastructure with direct connection to the Finnish network and for infrastructure in harbours, the particular features of the Finnish network as specified in Section 7.6.2 of this TSI may be applied.

7.6.12. *Particular features on the UK network for Great Britain*

7.6.12.1. Performance parameters (4.2.2)

P cases

All TSI categories of line — clause (7)

(7) The published information relating to axle load shall use the route availability (RA) number (derived in accordance with the national technical rule notified for this purpose) in combination with the permitted speed.

If the load carrying capability of a section of track exceeds the range of route availability (RA) numbers, then additional information defining the load carrying capability may be provided.

7.6.12.2. Structure gauge (4.2.4.1)

P cases

TSI categories of line V-P, V-F, V-M, VII-P, VII-F and VII-M — clauses (1) and (2)

(1) For the upgrading or renewal of conventional lines with respect to structure gauge, the structure gauge to be achieved will be specific to the project concerned.

The application of the gauges shall be in accordance with the national technical rule notified for this purpose.

7.6.12.3. Distance between track centres (4.2.4.2)

P cases

TSI categories of line V-P, V-F, V-M, VII-P, VII-F and VII-M — clauses (1) and (2)

(1) The nominal distance between track centres shall be 3 400 mm on straight track and curved track with a radius of 400 m or greater.

Where topographical constraints prevent a nominal distance of 3 400 mm between track centres being achieved, it is permissible to reduce the distance between track centres provided special measures are put in place to ensure a safe passing clearance between trains.

Reduction in the distance between track centres shall be in accordance with the national technical rule notified for this purpose.

7.6.12.4. Nominal track gauge (4.2.5.1)

P cases

TSI categories of line V-P, V-F, V-M, VII-P, VII-F and VII-M — additional clause (3)

(3) For the 'CEN56 Vertical' design of switches and crossings a nominal track gauge of 1 432 mm is permitted.

7.6.12.5. In-service geometry of switches and crossings (4.2.6.2)

P cases

TSI categories of line V-P, V-F, V-M, VII-P, VII-F and VII-M — additional clause (4)

(4) For the 'CEN56 Vertical' design of switches and crossings, a minimum value of fixed nose protection for common crossings of 1 388 mm is permitted (measured 14 mm below the running surface, and on the theoretical reference line, at an appropriate distance back from the actual (RP) of the nose as indicated in figure 2).

7.6.13. *Particular features on the UK network for Northern Ireland*

On the UK network for Northern Ireland the particular features of the Irish network as specified in Section 7.6.4 of this TSI shall be applied.

ANNEX A

ASSESSMENT OF INTEROPERABILITY CONSTITUENTS

The characteristics of the interoperability constituents to be assessed by the notified body or the manufacturer in accordance with the selected module, in the different phases of design, development and production, are marked by 'X' in Table 20. Where no assessment is required, this is marked by 'n.a.' in the table.

There are no particular assessment procedures required for interoperability constituents of the infrastructure subsystem.

Table 20

Assessment of interoperability constituents for the EC declaration of conformity

Characteristics to be assessed	Assessment in the following phase			
	Design and development phase			Production phase
	Design review	Review of manufacturing process	Type test	Product quality (series)
5.3.1 The rail				
5.3.1.1 Railhead profile	X	X	n.a.	X
5.3.1.2 Moment of inertia of the rail cross section	X	n.a.	n.a.	n.a.
5.3.1.3 Rail hardness	X	X	n.a.	X
5.3.2 The rail fastening systems	n.a.	n.a.	X	X
5.3.3 Track sleepers	X	X	X	X

ANNEX B

ASSESSMENT OF THE INFRASTRUCTURE SUBSYSTEM

The characteristics of the subsystem to be assessed in the different phases of design, construction and operation are marked by 'X' in Table 21.

Where no assessment by a notified body is required, this is marked by 'n.a.' in the table. This does not prevent the need for other assessments to be performed in the framework of other phases.

Definition of assessment phases:

(1) 'Design review': it includes checking of correctness of values/parameters against applicable TSI requirements.

(2) 'Assembly before putting into service': checking on site that the actual product complies with the relevant design parameters just before putting it into operation.

Column 3 gives references to Section 6.2.4 'Particular assessment procedures for subsystem'.

Table 21

Assessment of the infrastructure subsystem for the EC verification of conformity

Characteristics to be assessed	New line or upgrading/renewal project		Particular assessment procedures
	Design review	Assembly before putting into service	
	1	2	3
Structure gauge (4.2.4.1)	X	X	6.2.4.1
Distance between track centres (4.2.4.2)	X	X	6.2.4.2
Maximum gradients (4.2.4.3)	X	n.a.	
Minimum radius of horizontal curve (4.2.4.4)	X	X	
Minimum radius of vertical curve (4.2.4.5)	X	X	
Nominal track gauge (4.2.5.1)	X	n.a.	
Cant (4.2.5.2)	X	X	
Rate of change of cant (4.2.5.3)	X	X	
Cant deficiency (4.2.5.4)	X	n.a.	6.2.4.3
Equivalent conicity (4.2.5.5.1) — design	X	n.a.	6.2.4.4
Equivalent conicity (4.2.5.5.2) — in-service	Open point	Open point	6.2.4.5
Railhead profile for plain line (4.2.5.6)	X	n.a.	
Rail inclination (4.2.5.7)	X	n.a.	
Track stiffness (4.2.5.8)	Open point	Open point	
Means of locking (4.2.6.1)	X	X	
In-service geometry of switches and crossings (4.2.6.2)	n.a.	n.a.	6.2.4.7

Characteristics to be assessed	New line or upgrading/renewal project		Particular assessment procedures
	Design review	Assembly before putting into service	
	1	2	3
Maximum unguided length of fixed obtuse crossings (4.2.6.3)	X	n.a.	6.2.4.7
Track resistance to vertical loads (4.2.7.1)	X	n.a.	6.2.5
Longitudinal track resistance (4.2.7.2)	X	n.a.	6.2.5
Lateral track resistance (4.2.7.3)	X	n.a.	6.2.5
Resistance of new bridges to traffic loads (4.2.8.1)	X	n.a.	6.2.4.8
Equivalent vertical loading for new earthworks and earth pressure effects (4.2.8.2)	X	n.a.	6.2.4.8
Resistance of new structures over or adjacent to tracks (4.2.8.3),	X	n.a.	6.2.4.8
Resistance of existing bridges and earthworks to traffic loads (4.2.8.4)	n.a.	n.a.	6.2.4.9
Determination of immediate action, intervention and alert limits (4.2.9.1)	n.a.	n.a.	6.2.4.5
The immediate action limit for track twist (4.2.9.2)	n.a.	n.a.	
The immediate action limit for variation of track gauge (4.2.9.3)	n.a.	n.a.	
The immediate action limit for cant (4.2.9.4)	n.a	n.a.	
Usable length of platforms (4.2.10.1)	X	n.a.	
Width and edge of platforms (4.2.10.2)	See PRM	See PRM	
End of platforms (4.2.10.3)	See PRM	See PRM	
Height of platforms (4.2.10.4)	See PRM	See PRM	
Offset of platforms (4.2.10.5)	See PRM	See PRM	
Maximum pressure variation in tunnels (4.2.11.1)	X	n.a.	6.2.4.6
Noise and vibration limits and mitigation measures (4.2.11.2),	Open point	Open point	
Protection against electric shock (4.2.11.3)	See ENE	See ENE	
Safety in railway tunnels (4.2.11.4)	See SRT	See SRT	
Effect of crosswinds (4.2.11.5)	Open point	Open point	
Distance markers (4.2.12.1),	n.a.	X	
Toilet discharge (4.2.13.2)	n.a.	n.a	6.2.4.10

Characteristics to be assessed	New line or upgrading/renewal project		Particular assessment procedures
	Design review	Assembly before putting into service	
	1	2	3
Train external cleaning facilities (4.2.13.3)	n.a.	n.a.	6.2.4.10
Water restocking (4.2.13.4)	n.a.	n.a.	6.2.4.10
Refuelling (4.2.13.5)	n.a.	n.a.	6.2.4.10
Electric shore supply (4.2.13.6)	n.a.	n.a	6.2.4.10

ANNEX C

CAPABILITY REQUIREMENTS FOR STRUCTURES ACCORDING TO TSI CATEGORY OF LINE IN GREAT BRITAIN

The capability requirements for structures are defined in Table 22 by a combined parameter comprising of the route availability number and a corresponding maximum speed. The route availability number and maximum associated speed shall be considered as a single combined parameter.

The route availability number is a function of maximum axle load and geometrical aspects relating to the spacing of axles. route availability numbers are defined in the national technical rules notified for this purpose.

Table 22

Route availability number — maximum associated speed (miles per hour)

CR TSI INF TSI category of line	Passenger carriages (including coaches, vans and car carriers) (1) and light freight wagons (1) (2)	Freight wagons other vehicles	Locomotives and power heads (1) (3) (4)	Electric or diesel multiple units, power units and railcars (1) (2)
IV-P	RA2 (5) – 125	(8)	RA7 (9) – 125 RA8 (9) – 110 RA8 (10) – 100	RA3 (6) – 125 RA5 (7) – 100
IV-F	(8)	RA10 – 60 RA8 – 75 RA2 – 90	RA8 (10) – 90	(8)
IV-M	see IV-P	see IV-F	see IV-P	see IV-P
V-P	RA2 (5) – 100	(8)	RA7 (10) – 100 RA8 (9) – 100 RA8 (10) – 90	RA3 (6) – 100
V-F	(8)	RA8 – 60	RA8 (10) – 60	(8)
V-M	see V-P	RA8 – 75	see V-P	see V-P
VI-P	RA2 (5) – 90	(8)	RA8 (10) – 90	RA3 (6) – 90
VI-F	(8)	RA10 – 60	RA8 (10) – 60	(8)
VI-M	see VI-P	RA10 – 60 RA8 – 75 RA2 – 90	see VI-P	see VI-P
VII-P	RA1 (5) – 75	(8)	RA7 (10) (11) – 75	RA3 (6) – 75
VII-F	(8)	RA7 – 60	RA7 (10) – 60	(8)

CR TSI INF TSI category of line	Passenger carriages (including coaches, vans and car carriers) (1) and light freight wagons (1) (2)	Freight wagons other vehicles	Locomotives and power heads (1) (3) (4)	Electric or diesel multiple units, power units and railcars (1) (2)
VII-M	RA2 (5) – 75	RA7 – 75	RA7 (10) – 75	see VII-P

Notes

(1) Passenger carriages (including coaches, vans, car carriers), other vehicles, locomotives, power heads, diesel and electric multiple units, power units and railcars are defined in the RST TSI. Light freight wagons are defined as vans except that they are permitted to be conveyed in formations which are not intended to convey passengers.

(2) The requirements for structures are compatible with Passenger coaches, vans, car carriers, light freight wagons and vehicles in diesel and electric multiple units and power units with a length of 18 m to 27,5 m for conventional and articulated vehicles and with a length of 9 m to 14 m for regular single axles.

(3) Not used. (Note 3 to Table 24 in Annex E is not applicable for Great Britain).

(4) The requirements for structures are compatible with up to two adjacent coupled locomotives and/or power heads. The requirements for structures are compatible with a maximum speed of 75 miles per hour for three or more adjacent coupled locomotives and/or power heads (or a train of locomotives and/or power heads) subject to the locomotives and/or power heads satisfying the corresponding limits for freight wagons.

(5) The requirements for structures are compatible with an average mass per unit length over the length of each coach/vehicle of 2,75 t/m.

(6) The requirements for structures are compatible with an average mass per unit length over the length of each coach/vehicle of 3,0 t/m.

(7) The requirements for structures are compatible with an average mass per unit length over the length of each coach/vehicle of 3,25 t/m.

(8) No formal TSI specification defined.

(9) For locomotives and power heads with 4 axles.

(10) For locomotives and power heads with 4 or 6 axles.

(11) For TSI category of line VII-P the member state may indicate whether the requirements for locomotives and power heads apply.

ANNEX D

ITEMS TO BE INCLUDED IN THE REGISTER OF INFRASTRUCTURE

As stated in Section 4.8 of this TSI, this Annex indicates which information concerning the infrastructure subsystem shall be included in the Register of Infrastructure.

Table 23

Infrastructure subsystem items for the Register of Infrastructure

Infrastructure subsystem item	Section of this TSI
Route, boundaries and section of line concerned (description)	
Section of line	
TSI category of line	4.2.1
Gauge	4.2.2
EN line category (locomotive classes if relevant) in combination with permitted speed	4.2.2
Line speed	4.2.2
Train length	4.2.2
Conditions for running trains with specific systems to enhance performance level	4.2.3.2
Location and type of nominal track gauge transition sections	4.2.3.2
Minimum distance between track centres	4.2.4.2
Maximum gradients	4.2.4.3
Minimum radius of horizontal curve	4.2.4.4
Nominal track gauge	4.2.5.1
Cant	4.2.5.2
Rail inclination for plain line	4.2.5.7.1
Use of braking systems independent of wheel-rail adhesion conditions (longitudinal track resistance)	4.2.7.2
Usable length of platforms	4.2.10.1
Distance markers	4.2.12.1
Fixed installations for servicing trains (location and type)	4.2.13

ANNEX E

CAPABILITY REQUIREMENTS FOR STRUCTURES ACCORDING TO TSI CATEGORY OF LINE

The capability requirements for structures are defined in Table 24 by a combined quantity comprising of the EN line category (or if relevant locomotive class) and a corresponding maximum speed. The EN line category (and if relevant locomotive class) and maximum associated speed shall be considered as a single combined quantity.

Both EN line category and locomotive class are a function of axle load and geometrical aspects relating to the spacing of axles. EN line categories are set out in EN 15528:2008 Annex A and locomotive classes are set out in Annexes J and K of EN 15528:2008.

Table 24

EN line category — maximum associated speed (km/h)

TSI category of line	Passenger carriages (including coaches, vans and car carriers) [1] and light freight wagons [1] [2]	Freight wagons other vehicles	Locomotives and power heads [1] [3] [4]	Electric or diesel multiple units, power units and railcars [1] [2]
IV-P	B1 [5] – 200	[8]	D2 – 200 $L6_{19}$ $L6_{20}$ $L6_{21}$ $L6_{22}$ – 160 D4xL – 140	B1 [5] – 200 C2 [6] – 180 D2 [7] – 140
IV-F	[8]	E5 – 100 D4 – 120 B2 – 140	D2 – 140 D4xL – 120	[8]
IV-M	see IV-P	see IV-F	see IV-P	see IV-P
V-P	B1 [5] – 160	[8]	$L4_{21,5}$ – 160 $L4_{22,5}$ – 140 $L6_{19}$ $L6_{20}$ $L6_{21}$ $L6_{22}$ – 140	C2 [6] – 160 D2 [7] – 100
V-F	[8]	D4 – 100	$L4_{22,5}$ – 100 $L6_{19}$ $L6_{20}$ $L6_{21}$ $L6_{22}$ – 100	[8]
V-M	see V-P	see V-F	see V-P	see V-P
VI-P	B1 [5] – 140	[8]	D2 – 140 D4xL – 140	C2 [6] – 140 D2 [7] – 100
VI-F	[8]	E4 – 100	D2 – 100 D4xL – 100	[8]
VI-M	see VI-P	B2 – 140 D4 – 120 E4 – 100	D2 – 140 D4xL – 140	C2 [6] – 140 D2 [7] – 120
VII-P	A [5] – 120	[8]	$L4_{21,5}$ – 120	A [5] – 120
VII-F	[8]	C2 – 100	$L4_{21,5}$ – 100 $L6_{19}$ $L6_{20}$ $L6_{21}$ – 80	[8]
VII-M	B1 [5] – 120	see VII-F	see VII-P + VII-F	B1 [5] – 120

Notes

[1] Passenger carriages (including coaches, vans, car carriers), other vehicles, locomotives, power heads, diesel and electric multiple units, power units and railcars are defined in the RST TSI. Light freight wagons are defined as vans except that they are permitted to be conveyed in formations which are not intended to convey passengers.

[2] The requirements for structures are compatible with passenger coaches, vans, car carriers, light freight wagons and vehicles in diesel and electric multiple units and power units with a length of; 18 m to 27,5 m for conventional and articulated vehicles and with a length of 9 m to 14 m for regular single axles.

[3] When checking minimum infrastructure requirements the following EN line categories can be used as alternative minimum requirements to the stated locomotive classes: $L4_{21,5}$ $L4_{22,5}$ are covered by D2 and $L6_{19}$ $L6_{20}$ $L6_{21}$ $L6_{22}$ are covered by D4xL.

[4] The requirements for structures are compatible with up to two adjacent coupled locomotives and/or power heads. The requirements for structures are compatible with a maximum speed of 120 km/h for three or more adjacent coupled locomotives and/or power heads (or a train of locomotives and/or power heads) subject to the locomotives and/or power heads satisfying the corresponding limits for freight wagons.

[5] The requirements for structures are compatible with an average mass per unit length over the length of each coach/vehicle of 2,75 t/m.

[6] The requirements for structures are compatible with an average mass per unit length over the length of each coach/vehicle of 3,1 t/m.

[7] The requirements for structures are compatible with an average mass per unit length over the length of each coach/vehicle of 3,5 t/m.

[8] No formal TSI specification defined.

ANNEX F

LIST OF OPEN POINTS

Distance between track centres (see 4.2.4.2)

Requirements for controlling equivalent conicity in service (see 4.2.5.5.2)

Track stiffness (see 4.2.5.8)

Noise and vibration limits and mitigation measures (see 4.2.11.2)

Effect of crosswinds (see 4.2.11.5)

Specific cases for the Estonian network (see 7.6.1)

Specific cases for the Latvian network (see 7.6.5)

Specific cases for the Lithuanian network (see 7.6.6)

ANNEX G

GLOSSARY

Table 25

Terms

Defined term	TSI section	Definition
Actual point (RP)/ Praktischer Herzpunkt/ Pointe de cœur	4.2.6.2	Physical end of a crossing vee. See Figure 2, which shows the relationship between the actual point (RP) and the intersection point (IP).
Alert limit/ Auslösewert/ Limite d'alerte	4.2.9.1	Refers to the value which, if exceeded, requires that the track geometry condition is analysed and considered in the regularly planned maintenance operations.
Axle load/ Achsfahrmasse/ Charge à l'essieu	4.2.2, 4.2.7.1	Sum of the static vertical wheel forces exerted on the track through a wheelset or a pair of independent wheels divided by acceleration of gravity.
Cant/ Überhöhung/ Dévers de la voie	4.2.5.2 4.2.5.3 4.2.9.4	Difference in height, relative to the horizontal, of the two rails of one track at a particular location, measured at the centrelines of the heads of the rails.
Cant deficiency/ Überhöhungsfehlbetrag/ Insuffisance de devers	4.2.5.4	Difference between the applied cant and a higher equilibrium cant.
Common crossing/ Starres Herzstück/ Cœur de croisement	4.2.6.2	Arrangement ensuring intersection of two opposite running edges of turnouts or diamond crossings and having one crossing vee and two wing rails.
Core TEN line/ TEN Strecke des Kernnetzes/ Ligne du RTE déclarée corridor	4.2.1, 7.2, 7.3	A TEN line identified by a Member State as an important part of an international corridor in Europe.
Crosswind/ Seitenwind/ Vents traversiers	4.2.11.5	Strong wind blowing laterally to a line which may adversly affect the safety of trains running.
Degraded operation/ Gestörter Betrieb/ Exploitation degradee	4.4.2	Operation resulting from an unplanned event that prevents the normal delivery of train services.
Design value/ Planungswert/ Valeur de conception	4.2.4.4, 4.2.5.2, 4.2.5.4.2, 4.2.5.5.1, 4.2.5.7.2, 4.2.9.4, 4.2.6.2, 4.2.6.3	Theoretical value without manufacturing, construction or maintenance tolerances.
Distance between track centres/ Gleisabstand/ Entraxe de voies	4.2.4.2	The distance between points of the centre lines of the two tracks under consideration, measured parallel to the running surface of the reference track namely the less canted track.
Diverging track/ Zweiggleis/ Voie déviée	4.2.5.4.2	In the context of switches and crossings, a route which diverges from the through route.

Defined term	TSI section	Definition
Dynamic lateral force/ Dynamische Querkraft/ Effort dynamique transversal	4.2.7.3	The sum of dynamic forces exerted by a wheelset on the track in lateral direction.
Earthworks/ Erdbauwerke/ Ouvrages en terre	4.2.8.2, 4.2.8.4	Soil structures and soil-retaining structures that are subject to railway traffic loading.
EN line category/ EN Streckenklasse/ EN Catégorie de ligne	4.2.2, 4.2.8.4, 7.5, Annex E	The result of the classification process set out in EN 15528:2008 Annex A and referred to in that standard as 'line category'. It represents the ability of the infrastructure to withstand the vertical loads imposed by vehicles on the line or section of line for regular service.
Equivalent conicity/ Äquivalente Konizität/ Conicité équivalente	4.2.5.5	The tangent of the cone angle of a wheelset with coned wheels whose lateral movement has the same kinematic wave-length as the given wheelset on straight track and large-radius curves.
Excess height of check rail/ Radlenkerüberhöhung/ Surélévation du contre rail	4.2.6.2 (g)	Height of the check rail above the adjacent running rail (see dimension 7 on Figure 5 below).
Fixed nose protection/ Leitweite/ Cote de protection de pointe	4.2.6.2 (b)	Dimension between the crossing nose and check rail (see dimension No 2 on Figure 5 below).
Flangeway depth/ Rillentiefe/ Profondeur d'ornière	4.2.6.2 (f)	Dimension between the running surface and the bottom of flangeway (see dimension No 6 on Figure 5 below).
Flangeway width/ Rillenweite/ Largeur d'ornière	4.2.6.2 (e)	Dimension between a running rail and an adjacent check or wing rail (see dimension No 5 on Figure 5 below).
Free wheel passage at check rail/wing rail entry/ Freier Raddurchlauf im Radlenker-Einlauf/Flügelschienen-Einlauf/ Côte d'équilibrage du contre-rail	4.2.6.2 (d)	Dimension between the working face of the crossing check rail or wing rail and the gauge face of the running rail opposite across the gauge measured at entry to check rail or wing rail respectively. (see dimensions No 4 on Figure 5 below). The entry to the check rail or wing rail is the point at which the wheel is permitted to contact the check rail or wing rail.
Free wheel passage at crossing nose/ Freier Raddurchlauf im Bereich der Herzspitze/ Cote de libre passage dans le croisement	4.2.6.2 (c)	Dimension between the working face of the crossing wing rail and check rail opposite across the gauge (see dimension No 3 on Figure 5 below).
Free wheel passage in switches/ Freier Raddurchlauf im Bereich der Zungenvorrichtung/ Côte de libre passage de l'aiguillage	4.2.6.2 (a)	Dimension from the gauge face of one switch rail to the back edge of the opposite switch rail (see dimension No 1 on Figure 5 below).
Gauge/ Begrenzungslinie/ Gabarit	4.2.2	Set of rules including a reference contour and its associated calculation rules allowing definition of the outer dimensions of the vehicle and the space to be cleared by the infrastructure.

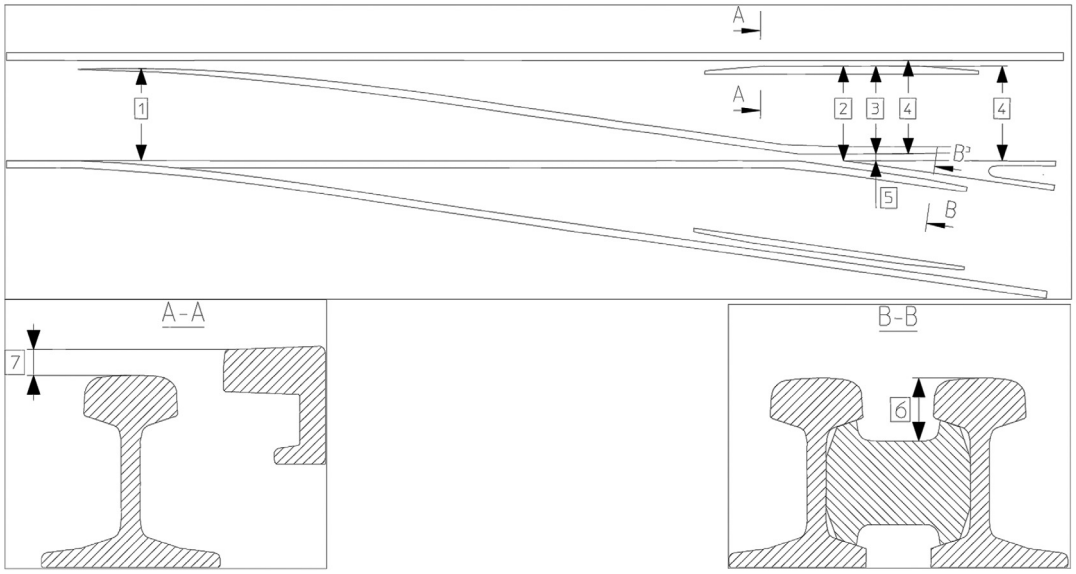
Defined term	TSI section	Definition
HBW/ HBW/ HBW	5.3.1.3	The non SI unit for steel hardness defined in EN ISO 6506-1:2005 Metallic materials — Brinell hardness test. Test method.
Immediate action limit/ Soforteingriffsschwelle/ Limite d'intervention immédiate	4.2.9.1, 4.2.9.2, 4.2.9.3, 4.2.9.4	The value which, if exceeded, requires taking measures to reduce the risk of derailment to an acceptable level.
Infrastructure manager/ Betreiber der Infrastruktur/ Gestionnaire de l'Infrastructure	4.2.5.5, 4.2.6.2, 4.2.9, 4.4.3, 4.5.2, 6.2.2.1, 6.2.4, 6.4, 7.3.4, 7.5	As defined in Article 2(h) of Directive 2001/14/EC of the European Parliament and of the Council of 26 February 2001 on the allocation of railway infrastructure capacity and the levying of charges for the use of railway infrastructure and safety certification (OJ L 75, 15.3.2001, p. 29).
In-service value/ Wert im Betriebszustand/ Valeur en exploitation	4.2.5.5.2 4.2.6.2 4.2.9.4	Value measured at any time after the infrastructure has been placed into service.
Intersection point (IP)/ Theoretischer Herzpunkt/ Point d'intersection théorique	4.2.6.2	Theoretical intersection point of the running edges at the centre of the crossing (see Figure 2).
Intervention limit/ Eingriffsschwelle/ Valeur d'intervention	4.2.9.1	The value, which, if exceeded, requires corrective maintenance in order that the immediate action limit shall not be reached before the next inspection;
Isolated defect/ Einzelfehler/ Défaut isolé	4.2.9.1 4.2.9.2	A discrete track geometry fault.
Line speed/ Streckengeschwindigkeit/ Vitesse de la ligne	4.2.2	Maximum speed for which a line has been designed.
Maintenance file/ Instandhaltungsdossier/ Dossier de maintenance	4.5.1	Elements of the technical file relating to conditions and limits of use and instructions for maintenance.
Maintenance plan/ Instandhaltungsplan/ Plan de maintenance	4.5.2	A series of documents setting out the infrastructure maintenance procedures adopted by an infrastructure manager.
Main tracks/ Hauptgleise/ Voies principales	4.2.4.3	Tracks used for running trains in service. The term excludes sidings, depots, stabling tracks and connecting lines.
Multi-rail track/ Mehrschienengleis/ Voie à multi écartement	4.2.3.2, 4.2.6.3	Track with more than two rails, where at least two pairs of respective rails are designed to be operated as separate single tracks, with or without different track gauges.
Nominal track gauge/ Nennspurweite/ Ecartement nominal de la voie	4.2.5.1	A single value that identifies the track gauge

Defined term	TSI section	Definition
Normal service/ Regelbetrieb/ Service régulier	4.2.3.2 4.2.10.1	The railway operating to a planned timetable service.
Other TEN line/ Weitere TEN Strecke/ Autre ligne du RTE	4.2.1, 7.2, 7.3	A TEN line not being a core TEN line.
Passive provision/ Vorsorge für künftige Erweiterungen/ Réservation pour extension future	4.2.10.1	Provision for the future construction of a physical extension to a structure (for example: increased platform length).
Performance parameter/ Leistungskennwert/ Paramètre de performance	4.2.2	Parameter describing a TSI category of line used as the basis for the design of infrastructure subsystem elements and as the indication of the performance level of a line.
Plain line/ Freie Strecke/ Voie courante	4.2.5.5 4.2.5.6 4.2.5.7	Section of track without switches and crossings.
Point retraction/ Spitzenbeihobelung/ Dénivelation de la pointe de cœur	4.2.6.2 (b)	The reference line in a fixed common crossing can deviate from the theoretical reference line. From a certain distance to the crossing point, the reference line of the vee can, depending on the design, be retracted from this theoretical line away from the wheel flange in order to avoid contact between both elements. This situation is described in Figure 2.
Rail inclination/ Schienenneigung/ Inclinaison du rail	4.2.5.5 4.2.5.7	An angle defining the inclination of the head of a rail when installed in the track relative to the plane of the rails (running surface), equal to the angle between the axis of symmetry of the rail (or of an equivalent symmetrical rail having the same railhead profile) and the perpendicular to the plane of the rails.
Rail pad/ Schienenzwischenlage/ Semelle sous rail	5.3.2	A resilient layer fitted between a rail and the supporting sleeper or baseplate.
Reverse curve/ Gegenbogen/ Courbes et contre-courbes	4.2.4.4	Two abutting curves of opposite flexure or hand.
Structure gauge/ Lichtraum/ Gabarit des obstacles	4.2.4.1	Defines the space in relation to the reference track that shall be cleared of all objects or structures and of the traffic on the adjacent tracks, in order to allow safe operation on the reference track. It is defined on the basis of the reference contour by application of the associated rules.
Switches/ Zungenvorrichtung/ Aiguillage	4.2.5.4.2 4.2.6.1	A unit of track comprising two fixed rails (stock rails) and two movable rails (switch rails) used to direct vehicles from one track to another track.
Switches and crossings/ Weichen und Kreuzungen/ Appareil de voie	4.2.5.4.1, 4.2.5.7.2, 4.2.6, 4.2.7.1, 4.2.7.2.1, 4.2.7.3, 5.2	Track constructed from sets of switches and individual crossings and the rails connecting them.

Defined term	TSI section	Definition
Through route/ Stammgleis/ Voie directe	4.2.5.4.1 4.2.6.3	In the context of switches and crossings a route which perpetuate the general alignment of the track.
Track gauge/ Spurweite/ Ecartement de la voie	4.2.5.1	The smallest distance between lines perpendicular to the running surface intersecting each railhead profile in a range from 0 to 14 mm below the running surface.
Track stiffness/ Steifigkeit des Gleises/ Rigidite de la voie	4.2.5.8	The global measure expressing the resistance of the track against the rail displacement that takes place under wheel loading.
Track twist/ Gleisverwindung/ Gauche	4.2.9.1, 4.2.9.2	Track twist is defined as the algebraic difference between two cross levels taken at a defined distance apart, usually expressed as a gradient between the two points at which the cross level is measured.
Train length/ Zuglänge/ Longueur du train	4.2.2	The length of a train, which can run on a certain line in normal operation.
TSI category of line/ TSI Streckenkategorie/ TSI Catégorie de ligne	4.2, 7.2, 7.3.1, 7.5, 7.6	Classification of a line according to type of traffic and type of line to select the needed level of performance parameters.
Type of line/ Streckenart/ Type de ligne	4.2.1, 7.3.1	Definition of the importance of a line (core or other) and the way of achieving parameters required for interoperability (new or upgraded).
Type of traffic/ Verkehrsart/ Type de trafic	4.2.1	Indicates for a TSI category of line the dominant traffic for the target system and the respective basic parameters.
Unguided length of an obtuse crossing/ Führungslose Stelle/ Lacune dans la traversée	4.2.6.3	Portion of obtuse crossing where there is no guidance of the wheel described as 'unguided distance' in EN 13232-3:2003.
Usable length of a platform/ Bahnsteignutzlänge/ Longueur utile de quai	4.2.10.1	The maximum continuous length of that part of platform in front of which a train is intended to remain stationary in normal operating conditions for passengers to board and alight from the train, making appropriate allowance for stopping tolerances. Normal operating conditions means that railway is operating in a non-degraded mode (e.g. rail adhesion is normal, signals are working, everything is working as planned).

Figure 5

Geometry of switches and crossings



1 Free wheel passage in switches
2 Fixed nose protection
3 Free wheel passage at crossing nose
4 Free wheel passage at check rail/wing rail entry
5 Flangeway width
6 Flangeway depth
7 Excess height of check rail

ANNEX H

LIST OF REFERENCED STANDARDS

Table 26

List of referenced standards

Index No	Reference	Document name	Version (year)	BP(s) concerned
1	EN 13715	Railway applications — Wheelsets and boogies — Wheels — Wheels tread	2006	Design values for equivalent conicity (4.2.5.5.1)
2	EN 13803-2	Rail applications — Track — Track alignment design parameters — Track gauges 1 435 mm and wider — Part 2: Switches and crossings and comparable alignment design situations with abrupt changes of curvature (with Amendment A1:2009)	2006	Minimum radius of horizontal curve (4.2.4.4)
3	EN 13848-1	Rail applications — Track — Track geometry quality — Part 1: Characterisation of track geometry (with Amendment A1:2008)	2003	Determination of immediate action, intervention and alert limits (4.2.9.1), Assessment of minimum value of mean track gauge (6.2.4.5)
4	EN 15273-3	Railway applications — Gauges — Part 3: Structure gauges	2009	Performance parameters (4.2.2), Structure gauge (4.2.4.1), Assessment of distance between track centres (6.2.4.2),
5	EN 15302	Railway applications — Method for determining the equivalent conicity	2008	Design values for equivalent conicity (4.2.5.5.1
6	EN 15528	Railway applications — Line categories for managing the interface between load limits of vehicles and infrastructure	2008	Resistance of existing bridges and earthworks to traffic loads (4.2.8.4 and Annex E),
7	EN 1990:2002/A1	Eurocode — Basis of structural design — Amendment A1	2005	Resistance of new bridges to traffic loads (4.2.8.1)

Index No	Reference	Document name	Version (year)	BP(s) concerned
8	EN 1991-2	Eurocode 1 — Actions on structures — Part 2: Traffic load on bridges	2003	Structures resistance to traffic loads (4.2.8), Resistance of new bridges to traffic loads (4.2.8.1), Equivalent vertical loading for new earthworks and earth pressure effects (4.2.8.2), Resistance of new structures over or adjacent to tracks (4.2.8.3)

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