

COMMISSION DECISION

of 30 May 2002

concerning the technical specification for interoperability relating to the infrastructure subsystem of the trans-European high-speed rail system referred to in Article 6(1) of Council Directive 96/48/EC

*(notified under document number C(2002) 1948)***(Text with EEA relevance)**

(2002/732/EC)

THE COMMISSION OF THE EUROPEAN COMMUNITIES,

Having regard to the Treaty establishing the European Community,

Having regard to Council Directive 96/48/EC of 23 July 1996 on the interoperability of the trans-European high-speed rail network ⁽¹⁾, and in particular Article 6(1) thereof,

Whereas:

- (1) In accordance with Article 2(c) of Directive 96/48/EC, the trans-European high-speed rail system is subdivided into structural or functional subsystems. These subsystems are described in Annex II to the Directive.
- (2) In accordance with Article 5(1) of the Directive, each of the subsystems shall be covered by a technical specification for interoperability (TSI).
- (3) In accordance with Article 6(1) of the Directive, draft TSIs shall be drawn up by the joint representative body.
- (4) The Committee set up under Article 21 of Directive 96/48/EC has appointed the European Association for Railway Interoperability (AEIF) as the joint representative body in accordance with Article 2(h) of the Directive.
- (5) The AEIF has been given a mandate to draw up a draft TSI for the infrastructure subsystem in accordance with Article 6(1) of the Directive. This mandate has been established in accordance with the procedure laid down in Article 21(2) of the Directive.
- (6) The AEIF has drawn up the draft TSI, together with an introductory report containing a cost-benefit analysis as provided for in Article 6(3) of the Directive.
- (7) The draft TSI has been examined by the representatives of the Member States, in the framework of the Committee set up by the Directive, in the light of the introductory report.

- (8) As specified in Article 1 of Directive 96/48/EC, the conditions for achieving interoperability of the trans-European high-speed rail system concern the design, construction, upgrading and operation of the infrastructures and rolling stock contributing to the functioning of the system to be put into service after the date of entry into force of the Directive. With regard to the infrastructures already in service at the time of entry into force of this TSI, the TSI should be applied from the time when work is envisaged on these infrastructures. However, the degree to which the TSI is applied will vary according to the scope and extent of the works foreseen and the costs and the benefits generated by the intended applications. In order for such partial works to concur into achieving full interoperability, they need to be underpinned by a coherent implementation strategy. In this context, a distinction should be made between upgrading, renewal and maintenance-related replacement.

- (9) It is recognised that Directive 96/48/EC and the TSIs do not apply to renewals or maintenance-related replacement. It is desirable however that the TSIs should apply to renewals, as will be the case for the TSIs for the conventional rail system under Directive 2001/16/EC. In the absence of a mandatory requirement and taking into account the extent of the renewal work, Member States are encouraged, where they are able to do so, to apply the TSIs to renewals and maintenance-related replacement.

- (10) In its current version, the TSI, which is the subject of this Decision, covers features specific to the high-speed system; as a general rule, it does not address the common aspects of the high-speed and conventional rail system. The interoperability of the latter is the subject of another Directive ⁽²⁾. Given that verification of interoperability has to be established by reference to the TSIs, in accordance with Article 16(2) of Directive 96/48/EC, it is necessary, during the transition period between the publication of this Decision and the

⁽¹⁾ OJ L 235, 17.9.1996, p. 6.

⁽²⁾ 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 (OJ L 110, 20.4.2001, p. 1.

publication of the Decisions adopting the 'conventional rail' TSIs, to lay down the conditions to be complied with in addition to the TSI attached. For these reasons it is necessary that each Member State informs the other Member States and the Commission of the relevant national technical rules in use for achieving interoperability and meeting the essential requirements of Directive 96/48/EC. In addition, those rules being national, it is necessary that each Member State informs the other Member States and the Commission of the bodies it appoints for carrying out the procedure for the assessment of conformity or suitability for use as well as the checking procedure in use for verifying the interoperability of subsystems within the meaning of Article 16(2) of Directive 96/48/EC. Member States shall apply, as far as possible, the principles and criteria provided for in Directive 96/48/EC for the implementation of Article 16(2) in the case of those national rules. As to the bodies in charge of those procedures, Member states will make use, as far as possible, of bodies notified under Article 20 of Directive 96/48/EC. The Commission will carry out an analysis of this information (national rules, procedures, bodies in charge of implementing procedures, duration of these procedures) and, where appropriate, will discuss with the Committee the necessity of any measure to be taken.

- (11) The TSI, which is the subject of this Decision, does not impose the use of specific technologies or technical solutions except where this is strictly necessary for the interoperability of the trans-European high-speed rail network.
- (12) The TSI, which is the subject of this Decision, is based on best available expert knowledge at the time of preparation of the corresponding draft. Developments in technology or social requirements may make it necessary to amend or supplement this TSI. Where appropriate, a review or updating procedure will be initiated in accordance with Article 6(2) of Directive 96/48/EC.
- (13) In some cases, the TSI, which is the subject of this Decision, allows a choice between different solutions, making it possible to apply definitive or transitional interoperable solutions that are compatible with the existing situation. In addition, Directive 96/48/EC provides for special implementing provisions in certain specific cases. Furthermore, in the cases provided for in Article 7 of the Directive Member States must be allowed not to apply certain technical specifications. It is therefore necessary that the Member States ensure that an infrastructure register is published and updated each year. This register will set out the main characteristics of the national infrastructure (e.g. the basic parameters) and their concordance with the

characteristics prescribed by the applicable TSIs. To this end, the TSI, which is the subject of this Decision, indicates precisely which information must appear in the register.

- (14) The application of the TSI which is the subject of this Decision must take into account specific criteria relating to technical and operational compatibility between the infrastructures and the rolling stock to be placed in service and the network into which they are to be integrated. These compatibility requirements entail a complex technical and economical analysis that is to be done on a case by case basis. The analysis should take into account:
- the interfaces between the different subsystems referred to in Directive 96/48/EC,
 - the different categories of lines and rolling stock referred to in that Directive, and
 - the technical and operational environments of the existing network.

That is why it is essential to establish a strategy for the implementation of the TSI which is the subject of this Decision, which should indicate technical stages to move from the present network conditions to a situation where the network is interoperable.

- (15) The provisions of this Decision are in conformity with the opinion of the Committee set up by Directive 96/48/EC,

HAS ADOPTED THIS DECISION:

Article 1

The TSI relating to the 'infrastructure' subsystem of the trans-European high-speed rail system referred to in Article 6(1) of Directive 96/48/EC is hereby adopted by the Commission. The TSI is set out in the Annex to this Decision. The TSI is fully applicable to the infrastructure of the trans-European high-speed rail system as defined in Annex I of Directive 96/48/EC, taking into account Article 2 and Article 3 hereunder.

Article 2

1. With regard to the aspects that are common to the high-speed and the conventional rail systems, but not covered in the attached TSI, the conditions to be complied with for the verification of the interoperability within the meaning of Article 16(2) of Directive 96/48/EC are the applicable technical rules in use in the Member State which authorises the placing in service of the subsystem concerned 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:

- the list of the applicable technical rules mentioned under Article 2(1),
- the conformity assessment and checking procedures to be applied with regard to the application of these rules,
- the bodies it appoints for carrying out those conformity assessment and checking procedures.

Article 3

1. For the purposes of this Article:

- 'upgrading' means major work to modify a subsystem or part of a subsystem which changes the performance of the subsystem,
- 'renewal' means major work to replace a subsystem or part of a subsystem which does not change the performance of the subsystem,
- 'maintenance-related replacement' means replacement of components by parts of identical function and performances in the context of predictive or corrective maintenance.

2. In the case of upgrading, the contracting entity will submit a dossier describing the project to the Member State concerned. The Member State will examine the dossier and, taking into account the implementation strategy in Chapter 7 of the attached TSI, will (where appropriate) decide whether the scale of the work requires the need for a new authorisation for placing in service under Article 14 of Directive 96/48/EC. Such authorisation for placing in service is necessary whenever the level of safety may objectively be affected by the work envisaged.

Where a new authorisation for placing in service under Article 14 of Directive 96/48/EC is necessary, the Member State decides whether:

- (a) the project includes full application of the TSI, in which case the subsystem will be subject to the EC verification procedure in Directive 96/48/EC; or
- (b) full application of the TSI is not yet possible. In this case the subsystem will not be in full conformity with the TSI and the EC verification procedure in Directive 96/48/EC shall be applied only in respect of the parts of the TSI applied.

In these two cases the Member State will inform the Committee, set up pursuant to Directive 96/48/EC, of the dossier including the parts of TSI being applied and the degree of interoperability being achieved.

3. In the case of renewal and maintenance-related replacement, application of the attached TSI is voluntary.

Article 4

The relevant parts of the Commission Recommendation 2001/290/EC ⁽³⁾ on the basic parameters of the trans-European high-speed rail system no longer have effect from the date of entry into force of the attached TSI.

Article 5

The attached TSI shall enter into force six months after notification of this Decision.

Article 5

This Decision is addressed to the Member States.

Done at Brussels, 30 May 2002.

For the Commission
Loyola DE PALACIO
Vice-President

⁽³⁾ OJ L 100, 11.4.2001, p. 17.

ANNEX

TECHNICAL SPECIFICATION FOR INTEROPERABILITY RELATING TO THE INFRASTRUCTURE SUBSYSTEM**1. INTRODUCTION****1.1. TECHNICAL SCOPE**

This TSI concerns the infrastructure subsystem, which is one of the subsystems listed in Annex II(1) to Directive 96/48/EC.

This TSI is part of a set of six TSIs, which cover all the eight subsystems defined in the Directive. The specifications concerning the 'users' and 'environment' subsystems, which are necessary to ensure interoperability of the trans-European high-speed rail system in compliance with the essential requirements, are set out in the TSIs concerned.

More information about the infrastructure subsystem is given in Chapter 2.

1.2. GEOGRAPHICAL SCOPE

The geographical scope of this TSI is the trans-European high-speed rail system as described in Annex I to Directive 96/48/EC.

Reference shall be made in particular to the lines of the trans-European rail network described in Decision No 1692/96/EC of the European Parliament and of the Council of 23 July 1996 on Community guidelines for the development of the trans-European transport network or in any update to the same Decision as a result of the revision provided for in Article 21 of that Decision.

1.3. CONTENT OF THIS TSI

In accordance with Article 5(3) and with Annex I(1)(b) of Directive 96/48/EC, this TSI:

- (a) specifies the essential requirements for the subsystems and their interfaces (Chapter 3);
- (b) establishes the basic parameters described in Annex II(3) of that Directive, which are necessary to meet the essential requirements (Chapter 4);
- (c) establishes the conditions to be complied with to achieve the specified performances for each of the following categories of line (Chapter 4):
 - category I: specially built high-speed lines equipped for speeds generally equal to or greater than 250 km/h;
 - category II: specially upgraded high-speed lines equipped for speeds of the order of 200 km/h;
 - category III: specially upgraded high-speed lines which have special features as a result of topographical, relief or town-planning constraints, on which the speed must be adapted to each case.
- (d) establishes implementing provisions in certain specific cases (Chapter 7);
- (e) determines the interoperability constituents and interfaces which must be covered by European specifications, including European standards, which are needed in order to achieve interoperability within the trans-European high-speed rail system while meeting the essential requirements (Chapter 5);
- (f) states, in each case under consideration, which of the modules defined in Decision 93/465/EEC or, where appropriate, which specific procedures are to be used in order to assess either the conformity or the suitability for use of the interoperability constituents, as well as 'EC' verification of the subsystems (Chapter 6).

2. DEFINITION OF THE INFRASTRUCTURE SUBSYSTEM/SCOPE OF APPLICATION

- 2.1. The infrastructure subsystem of the trans-European high-speed rail system comprises all the fixed plant serving to fulfil the following functions, in compliance with the essential requirements:

- confinement of the vehicles to their path, including their carriage and guidance within an unobstructed space, together with the safety equipment necessary to guarantee this function,
- passenger boarding and alighting from trains stopped in stations.

The fixed plant therefore includes, *inter alia*:

- the plain track, excluding points and crossings, which acts as the guideway,
- points and crossings which serve to modify the vehicles' path,
- the structures, e.g. bridges and tunnels, that allow, under specific conditions, the crossing of obstacles,
- the necessary safety and protective equipment to maintain the integrity of the subsystem,
- the associated infrastructures in stations (platforms, access areas, etc.).

This fixed plant corresponds to the 'fixed installations' defined in Annex I to EEC Regulation No 2598/70 of 18 December 1970, except for the signalling and telecommunications installations and plant for transforming and carrying electric power, which are the subject of specific TSIs, which are built on the lines defined in Article 10(2) and Annex I of Decision No 1692/96/EC of the European Parliament and of the Council of 23 July 1996.

- 2.2. The aspects of the infrastructure subsystem relating to the interoperability of the trans-European high-speed rail system are described below, with the principles adopted concerning them:

Plain line track

The plain line track constitutes the physical guideway for the vehicles, the characteristics of which enable the interoperable vehicles to run under the desired conditions of safety and with the specified performance.

The following elements of the plain line track are involved in the interoperability of the infrastructure subsystem:

(a) The structure gauge and the distance between track centres

The interfaces which concern the rolling stock, control command and signalling and energy subsystems: loading gauge of the rolling stock, clearance gauge of fixed plant and clearance gauge of pantographs.

These interfaces define the distance between the vehicle envelopes, the pantograph and the lineside structures, and between the vehicles themselves when passing. Besides the necessary requirements to prevent vehicles fouling the structure gauge, these interfaces also allow the derivation of the lateral aerodynamic forces affecting the vehicles and, reciprocally, the fixed plant.

The lines of the existing European rail network present a broad range of structure gauges due to the historical context that prevailed when they were built. In order to eventually achieve harmonisation of this situation, a target structure gauge is proposed for future construction, while allowing leeway to use existing gauges when compliance with the target gauge would involve excessive modifications.

In accordance with Article 5(4) of Directive 96/48/EC, this does not prevent adoption of larger structure gauges that might be necessary for running other trains.

(b) *Track gauge and guideway*

The distance between the two rails, as well as the shapes of the wheels and rails coming into mutual contact, is defined in great detail in order to ensure compatibility of the infrastructure with the rolling stock subsystem.

Furthermore, this compatibility takes into account existing lines, which form a large part of the interoperable network.

(c) *Track loading*

The forces exerted by the vehicles on the track, which determine both the conditions relating to safety against vehicle derailment and the characteristics of the track's ability to withstand them, stem solely from the contact between the wheels and the rails and from any associated braking equipment when this acts directly on the rail.

These forces include:

- vertical forces — static, due to the weight of the vehicle spread over the wheelsets, quasi-static in curves, due to transfer of the vertical loads as a result of lateral accelerations not compensated by track cant, and dynamic, due to the track geometry and the vehicles' behaviour,
- lateral forces, which are quasi-static in curves, due to lateral accelerations not compensated by track cant, and dynamic, due to the track geometry and the vehicles' behaviour,
- longitudinal forces due to vehicle accelerations and decelerations when braking and accelerating.

For each of these three types of load, one or more characteristic criteria of the mechanical interaction between the vehicle and the track are defined as limits not to be exceeded by the vehicle and, conversely, as the minimum loadings which the track must be able to withstand. According to Article 5(4) of Directive 96/48/EC, these criteria are not an impediment to choosing higher limit values as appropriate for running other trains. These characteristic safety criteria of the vehicle-track interaction are the interfaces with the rolling stock subsystem.

Switches and crossings

In addition to those already mentioned under plain line track, the following switchgear elements are linked to the interoperability of the infrastructure subsystem:

- (a) *Specific wheel-rail contact points at switches and crossings and the mechanical loads on the diverging track of a switch*, which allow to control the risk of derailment, constitute interfaces with the rolling stock subsystem.
- (b) *Command, control and locking systems*, which ensure that the wheels follow the correct path when running over points, constitute an interface with the operation subsystem.

Civil engineering works and lineside structures

In addition to the abovementioned effects on plain line track, high-speed traffic has a critical effect on the dynamic behaviour of railway underbridges, on the aerodynamic forces acting on some lineside installations and on pressure variations in tunnels.

The following components of the civil engineering and lineside structures are relevant to the interoperability of the infrastructure subsystem:

(a) *Dynamic mechanical effects*

These depend, where structures supporting railway loads are concerned, on the frequency of repetition of the vehicle axle loads, and they constitute an interface with the rolling stock subsystem.

(b) *Aerodynamic loads on lineside structures*

Depend on the aerodynamic characteristics of the interoperable trainsets, and therefore constitute interfaces with the rolling stock subsystem.

(c) *Pressure variations in tunnels*

The pressure variations which the passengers may have to withstand as vehicles run through tunnels are a function, mainly, of the running speed, of the cross-sectional area, length and aerodynamic shape of the trainset, and the tunnel length and cross-sectional area. They are limited to an acceptable value from the standpoint of passengers' health and therefore constitute an interface with the rolling stock subsystem.

Associated infrastructures in stations

The infrastructure subsystem includes the means allowing passengers to board trains: station platforms and their fittings and fixtures. The following elements are involved in the interoperability of the subsystem:

- the height and length of platforms,
- pressure effects when trains run through underground stations.

These interfaces relate to the rolling stock subsystem.

Protection and safety equipment

The lineside security, vehicle intrusion and hotbox detectors, which involve interfaces with the rolling stock, control command and signalling and operation subsystems.

Also included in the scope of this TSI are:

- the arrangements necessary to ensure the monitoring and maintenance of the facilities, in keeping with the essential requirements,
- the arrangements necessary within the infrastructure to ensure conservation of the environment, in keeping with the environment subsystem,
- certain arrangements designed to ensure passenger safety in the event of malfunctioning of the high-speed trains, as per the requirements of the operation subsystem.

3. ESSENTIAL REQUIREMENTS

3.1. According to Article 4(1) of Directive 96/48/EC the trans-European high-speed rail system, its subsystems and its interoperability constituents must fulfil the essential requirements set out in general terms in Annex III to the Directive.

3.2. The essential requirements concern:

- safety,
- reliability and availability,
- human health,
- environmental protection,
- technical compatibility.

The essential requirements may, according to Directive 96/48/EC, be of general nature and applicable to the whole of the trans-European high-speed network or have special features that are specific to each subsystem and its constituents. Fulfilment of the essential requirements will ensue, for the infrastructure subsystem, from complying with the specifications described in Chapter 4 for the subsystem and Chapter 5 for the interoperability constituents, as demonstrated by a positive result of the assessment procedures described in Chapter 6.

- 3.3. In the case of the infrastructure subsystem, the specific features, in addition to the considerations set out in Annex III to the Directive, are the following.

SAFETY

According to Annex III to Directive 96/48/EC, the general requirements for safety that are relevant to the infrastructure subsystem are the following:

- ‘1.1.1. The design, construction or assembly, maintenance and monitoring of safety-critical components, and more particularly of the components involved in train movements must be such as to guarantee safety at the level corresponding to the aims laid down for the network, including those for specific degraded situations.
- 1.1.2. The parameters involved in the wheel/rail contact must meet the stability requirements needed in order to guarantee safe movement at the maximum authorised speed.
- 1.1.3. The components used must withstand any specified normal or exceptional loading throughout their period in service. The safety repercussions of any accidental failures must be limited by appropriate means.
- 1.1.4. The design of fixed installations and rolling stock and the choice of the materials used must be aimed at limiting the generation, propagation and effects of fire and smoke in the event of fire.’

In order to meet these general requirements, the infrastructure must, at the level of safety corresponding to the aims laid down for the network:

- allow trains to run without the risk of derailment or collisions between them or with other vehicles or fixed obstacles, and avoiding unacceptable risks associated with the proximity of the electric traction supply,
- withstand without failure the vertical, lateral and longitudinal loads, whether static or dynamic, exerted by the trainsets, in the specified track environment and while achieving the required performance,
- permit the monitoring and maintenance of the installations necessary to keep the critical components in safe condition,
- not comprise materials prone to generate noxious fumes in the event of fire; this requirement concerns only those infrastructure elements located in confined air spaces (tunnels, covered cuts and underground stations). This is required to address human health requirements.

In addition, the following subsystem-specific requirements are relevant to the infrastructure subsystem:

- ‘2.1.1. Appropriate steps must be taken to prevent access to or undesirable intrusions into installations on lines travelled at high-speed.

Steps must be taken to limit the dangers to which persons are exposed, particularly in stations through which trains pass at high-speed.

Infrastructures to which the public has access must be designed and made in such a way as to limit any human health hazards (stability, fire, access, evacuation, platforms, etc).

Appropriate provisions must be laid down to take account of the particular safety conditions in very long tunnels.’

In order to meet these specific requirements, the infrastructure subsystem must, at the level of safety corresponding to the aims laid down for the network:

- ensure that access to the installations, other than the platform areas accessible to passengers, is normally only possible for authorised staff,

- permit control of the risk of intrusion by undesirable persons or vehicles into the railway premises,
- ensure that the areas accessible to passengers in the course of normal line operation are located far enough away from the tracks carrying trains at high-speed or suitably segregated from those tracks to preclude any risk to their safety, and are provided with the necessary access ways to evacuate passengers, in underground stations in particular,
- allow disabled passengers appropriate means of access and evacuation to/from public areas made accessible to them, by appropriate measures,
- ensure that passengers may be kept clear of hazardous areas in the event that a high-speed train stops out of course outside the station areas provided for the purpose,
- ensure that in long tunnels special measures are taken to reduce or control fire hazards and to facilitate the evacuation of passengers.

Compliance with these safety requirements shall be deemed to have been met when the assessment procedures described in Chapter 6 demonstrate that the detailed specifications of Chapters 4 and 5 applying to the following parameters, elements and constituents are fulfilled and that due account is taken of the possible consequences of the failure of the safety-related elements mentioned below.

Parameters relevant to the safety requirement

The parameters listed below and characterised in Chapter 4 of this TSI, having a bearing on collision and derailment risks, are relevant to the safety requirement:

(a) *Minimum infrastructure gauges (Parameter 1 — 4.1.1 and 4.3.3.1)*

The structure gauges selected shall allow:

- on newly built high-speed lines, ensure that high-speed trains pass with a sufficient margin of clearance for their foreseeable technical design changes in the distant future,
- on existing lines, to ensure that these same trainsets may pass with reduced margins, so that implementation of the necessary modifications can be phased in over time.

(b) *Minimum radius of curvature (Parameter 2 — 4.1.2 and 4.3.3.8)*

The minimum radius of curvature of the track alignment, taken together with the track cant, defines the maximum cant deficiency for a given running speed. The cant deficiency is itself one of the elements that determine track loading.

The infrastructure shall take account of the performance abilities and the technical limitations of the rolling stock. In the context of maintaining the potential speeds, acceleration capability and the requirements of braking and stopping are relevant.

The minimum radius of the curves shall therefore be determined such that the cant and cant deficiency limits defined for these interoperability elements are complied with at the maximum line speed.

(c) *Maximum track loading (Parameter 4 — 4.1.4 and 4.3.3.16)*

The lateral and vertical forces are critical determinants of both the dynamic behaviour of the vehicles on the track and the fatigue behaviour of the track superstructure.

These vertical and lateral forces shall meet the following requirements in order to ensure safe running at the maximum authorised speed:

- (1) concerning the vertical static forces: the infrastructure shall be designed to withstand at least the maximum axleload defined in the rolling stock TSI for the interoperable vehicles, irrespective of the type or maximum speed of those vehicles,

- (2) concerning the vertical and lateral quasi-static and dynamic forces: the infrastructure shall be designed to withstand at least the maximum loads corresponding to the characteristic safety criteria of the vehicle/track interaction as defined by the following limits applicable to traffic at speed:

- vertical dynamic forces: a limit is imposed on these total dynamic forces as a function of the nominal wheel load,
- lateral dynamic forces: the total lateral force exerted by a wheelset on the track, which could cause the track to be shifted in the ballast, shall not exceed the limit value, which is a function of the nominal axleload (PRUD'HOMME limit).

The ratio of the dynamic lateral and vertical forces of a wheel on the rail must not exceed the derailment coefficient.

These limits take into account the quasi-static forces that result from the permissible cant deficiencies, the latter serving to define the parameters relating to curve radii, and the permissible conditions of track geometry, taken up in this TSI (Chapter 4). Those parameters are set down as the necessary conditions for carrying out vehicle acceptance tests.

Furthermore, the geometry of the wheel-rail contact shall be such as to promote stable running of the bogies, which entails limiting the equivalent conicity according to the running speed. Compliance with this value of equivalent conicity must be obtained, as far as infrastructure is concerned, by an appropriate, documented choice of the track gauge, rail cant and railhead profile, on plain line track and in switches alike.

- (3) concerning the longitudinal forces and the loads from associated braking equipment: braking forces may, on the one hand, cause the rail to slip in the rail fastening systems and/or the wheels to slide, and on the other cause the temperature of the rail to rise when, in the case of brakes not using adhesion, the energy is dissipated in the rail. It is therefore crucial to limit the maximum braking effort. The safety criteria considered relate on the one hand to the total maximum acceleration and deceleration transferred to the track by a train's power and braking systems, and on the other hand to the maximum temperature rise that can be generated in the rail by braking systems that do not use adhesion. The latter condition equates to limiting the amount of kinetic energy liable to be dissipated in the rail by those braking systems.

Elements of the subsystem relevant to the safety requirement

The following elements of the subsystem are critical to safety and their detailed characteristics must meet the requirements defined in Chapter 4 of this TSI:

The running stability of the bogies determines the level of the lateral loads applied to the track. It is defined by the following elements:

- track gauge (4.3.3.10),
- rail inclination (4.3.3.11),
- railhead profile (4.3.3.12),
- equivalent conicity (4.3.3.9).

The following elements also determine the level of vertical forces (4.3.3.16), lateral forces (4.3.3.17) and longitudinal forces exerted on the track and on switches and crossings:

- cant (4.3.3.7),
- cant deficiency (4.3.3.8),
- geometrical quality of the track (4.3.3.18),
- resistance of the track and switches and crossings to braking and acceleration forces (4.3.3.21),
- effects of cross winds (4.3.3.23).

Running over turnout tracks at high-speed requires particularly sound design and location of turnouts in the alignment, as follows:

- due to the discontinuity of curvature occurring on the diverging track, the cant deficiency must be specially limited,
- the switch rails and swing noses of common and diamond crossings must be equipped with locking systems,
- the profiles of switch rails, and the functional dimensions (fits and clearances) of switches and crossings must match the wheel profiles and the dimensional tolerances of the wheelsets.

The following elements of the subsystem control the passage of vehicles over switches and crossings:

- cant deficiency in switches and crossings (4.3.3.8b),
- switches and crossings (4.3.3.19 and 4.3.3.20).

Structures shall be designed against the effects of railway loading so as to:

- fulfil the structural strength and deflection criteria required in response to the actions of both high-speed trains and maintenance vehicles. The design load models for such structures shall take account of these conditions,
- continually fulfil the track safety and wheel-rail contact requirements, in particular under the dynamic effects of high-speed trains. A limiting criterion to characterise the interoperable vehicles with respect to these actions is therefore defined, which ensures that structures designed according to the ENV Standards accept these vehicles.

The elements of the subsystem relevant to structures are:

- vertical loads on structures (4.3.3.13),
- transverse horizontal loads on structures (4.3.3.14),
- longitudinal loads on structures (4.3.3.15).

Access to, or intrusion by people or vehicles into railway premises may present a risk for traffic, the nature and criticality of which is common to all types of train, whether interoperable or not. When such risk is deemed to be substantial, suitable protection such as fencing around the railway land, protective railings on road bridges and/or road vehicle intrusion detectors shall be installed.

Control of the risks of unwanted access or intrusion by persons or vehicles is the subject of national regulations of each of the Member States concerned, which enforces them according to the specific hazard of the site considered. The element relevant to this risk is:

- access and intrusions into line installations (4.3.3.25)

Constituents relevant to safety requirement

The components listed below are interoperability constituents taken up in Chapter 5 of this TSI which come under the heading of interfaces relating to the safety requirement:

- the rail (constituent 5.2.1),
- rail fastening systems (constituent 5.2.2), and track sleepers and bearers (constituent 5.2.3),
- switches and crossings (constituent 5.2.4).

RELIABILITY AND AVAILABILITY

According to Annex III to Directive 96/48/EC, the general requirements pertaining to reliability and availability that are relevant to the infrastructure subsystem are the following:

- ‘1.2. The monitoring and maintenance of fixed or movable components that are involved in train movements must be organised, carried out and quantified in such a manner as to maintain their operation under the intended conditions.’

To meet this requirement, the following conditions must be fulfilled:

- the safety-critical interfaces whose characteristics are liable to change in the course of system operation must be the focus of monitoring and maintenance plans that define the conditions for monitoring and correcting those elements.

This requirement in particular concerns the following elements of the subsystem, already addressed by the safety requirement:

- track gauge (4.3.3.10),
 - cant (4.3.3.7),
 - geometrical quality of the track (4.3.3.18),
 - switches and crossings (4.3.3.19 and 4.3.3.20).
- the infrastructure must be designed in such manner as to allow easy maintenance with resources suited to carrying out the maintenance plan. The products used for making the safety-critical interfaces must have adequate wear characteristics, and the service vehicles, inspection and maintenance vehicles necessary for carrying out the maintenance plan must be able to run and work on the line. This requirement concerns the following elements:
 - grade of the rail steel (constituent 5.2.1),
 - structures, vertical static loads (4.3.3.13).

HEALTH

In accordance with Annex III to Directive 96/48/EC, the general requirements pertaining to human health that are relevant to the infrastructure subsystem are the following:

- ‘1.3.1. Materials likely, in their mode of usage, to constitute a health hazard to those having access to them must not be used in trains and railway infrastructures.
- 1.3.2. The choice, deployment and usage of these materials must be made so as to restrict the emission of harmful and dangerous fumes or gases, particularly in the event of fire.’

These general requirements relate to fire protection of the various elements of the infrastructure subsystem. Given the low density of the fire load of the products making up the infrastructure (track and civil engineering works), this requirement concerns only the case of underground facilities receiving passengers in normal service. No requirement is therefore made as concerns the products making up the interfaces of the track and of the civil engineering works other than these specific facilities.

Regarding the latter, the Community directives on health, applicable in a general way to structures must be applied, irrespective of whether such structures are related to the interoperability of the trans-European high-speed rail system.

Besides compliance with these general requirements, the pressure variations to which passengers and railway personnel are liable to be subjected when running in tunnels, covered cuts and underground stations, and the air velocities to which passengers in underground stations may be exposed shall be limited; in platform and underground station areas accessible to passengers, the risks of electric shock must be prevented.

- Measures must therefore be taken, either through a sound choice of the air cross section of the concerned structures, or through auxiliary devices, in order to meet a health criterion, based on the maximum pressure variation experienced in the tunnel when a train passes,
- Measures must be taken, in underground stations, either through construction features reducing the pressure variations coming from adjacent tunnels, or through auxiliary devices, to limit the air velocities to a value acceptable for humans,
- Measures must be taken in spaces accessible to passengers to prevent unacceptable risk of electric shock.

Elements of the subsystem relevant to the health requirement

- works below ground level such as tunnels and cut-and-covers (4.3.3.6),
- passenger platforms (4.3.3.26),
- underground stations (4.3.3.27).

ENVIRONMENTAL PROTECTION

According to Annex III of Directive 96/48/EC, the general requirements pertaining to environmental protection that are relevant to the infrastructure subsystem are the following:

- ‘1.4.1. The repercussions on the environment of the establishment and operation of the trans-European high-speed rail system must be assessed and taken into account at the design stage of the system in accordance with the Community provisions in force,
- 1.4.2. The materials used in the trains and infrastructure must prevent the emission of fumes or gases which are harmful and dangerous to the environment, particularly in the event of fire.’

Besides compliance with these general requirements, outside noise and vibrations transmitted to sites close to a high-speed railway infrastructure must be kept within limits suitable to protect neighbouring populations.

Parameters relevant to the environmental requirement

- Boundary characteristics linked to outside noise (Parameter 17, 4.1.7 and 4.2.3.1.2).
- Boundary characteristics linked to outside vibrations (Parameter 18, 4.1.8 and 4.2.3.1.2).

TECHNICAL COMPATIBILITY

According to Annex III of Directive 96/48/EC, the general requirements pertaining to technical compatibility that relate to the infrastructure subsystem are the following:

- ‘1.5. The technical characteristics of the infrastructure and fixed installations must be compatible with each other and with those of the trains to be used on the trans-European high-speed rail system.

If adherence to these characteristics proves difficult on certain sections of the network, temporary solutions, which ensure compatibility in the future, may be implemented.’

To meet this requirement, the following conditions must be fulfilled:

- the structure gauges, the distance between track centres, the track alignment, track gauge, maximum up and down gradients as well as the length and height of passenger platforms of the lines of the interoperable European network shall be set such as to ensure the lines' mutual compatibility and compatibility with the interoperable vehicles,
- the equipment that may be necessary in future to allow trains other than high-speed trains to run on the lines of the trans-European high-speed rail system, must not impede the running of the interoperable trainsets,

- the electrical transmission characteristics of the track superstructure must be compatible with the electrification and control command and signalling systems used.

Parameters relevant to the technical compatibility requirement

- Minimum structure gauge of the infrastructure (parameter 1 — 4.1.1 and 4.3.3.1):

besides the safety requirement already mentioned, the structure gauge of the infrastructure shall allow correct operation of the pantograph in contact with the overhead line equipment,

- Minimum curve radius (parameter 2 — 4.1.2 and 4.3.3.8):

besides the safety requirement already mentioned, the choice of curve radii for the lines, and hence the minimum radius of the curves, determine the magnitude of the lateral movements — both the maximum amplitude and the mean amplitude in operation — of the vehicle suspensions. Determining this parameter in terms of mean and maximum values allows optimisation of suspension design,

- Track gauge (parameter 3 — 4.1.3 and 4.3.3.10):

the distance between the rails (gauge) shall be set at the reference standard value of 1 435 mm, the value most commonly found on the European networks,

- Minimum length of platforms (parameter 5 — 4.1.5):

the minimum length of the platforms in the stations of the trans-European high-speed rail system shall be compatible with the length of the trainsets that must stop there to serve passengers,

- Height of platforms (parameter 6 — 4.1.6 and 4.3.3.26):

the height of the platforms in the stations of the trans-European high-speed rail system shall be compatible with the height of the steps of the trainsets that must stop there to serve passengers,

- Maximum falling and rising gradients (parameter 24 — 4.1.11 and 4.3.3.4):

the maximum up and down gradients of the lines of the trans-European high-speed rail system shall be compatible with the power and braking characteristics specified for the interoperable trainsets, without bringing about unacceptable speed reductions in up gradients nor risks of not complying with stopping distances on down gradients,

- Minimum distance between track centres (parameter 25 — 4.1.12 and 4.3.3.2):

the minimum track centre distances shall be set to a value compatible with the interoperable vehicles' bodies' resistance to aerodynamic forces when trains cross.

Elements relevant to the technical compatibility requirement

- Cant deficiency (4.3.3.8):

the cant deficiency — a function of the track's radius of curvature and cant — is the element of the track alignment interface which determines the level of lateral accelerations imparted to the vehicle,

- Hotbox detectors (4.3.3.24):

when hotbox detectors are necessary on interoperable lines in order for other trains to run (hot axlebox detection is built into the vehicles of interoperable high-speed stock), the detector systems used must neither introduce a constraint for high-speed operation nor be disturbed by the running of interoperable trains,

- Electrical characteristics of the superstructure (4.3.3.28):

the electrical characteristics of the track shall be such that it adequately passes the traction return current (energy subsystem) and handles any other functions associated with certain types of train control systems (control-command and signalling subsystem). The properties of the rail fastening system must also be compatible with the latter requirement.

- 3.4. Conformity of the infrastructure subsystem and its constituents with the essential requirements is verified in accordance with the provisions set out in Directive 96/48/EC.

4. DESCRIPTION OF THE INFRASTRUCTURE SUBSYSTEM

The trans-European high-speed railway system, to which Directive 96/48/EC applies and of which the infrastructure subsystem is a part, is an integrated system which requires the basic parameters, interfaces and performance to be verified in particular so as to ensure that the system is interoperable in respect of the essential requirements.

From the standpoint of interoperability, the infrastructure subsystem is characterised by the following basic parameters, interfaces, and performance requirements:

4.1. BASIC PARAMETERS OF THE INFRASTRUCTURE SUBSYSTEM

The basic parameters of the infrastructure subsystem as concerns high-speed lines are described and set out in this chapter. The particular requirements to ensure compatibility of upgraded and connecting lines are detailed in Point 4.3.

The basic parameters for achieving interoperability are those listed in Annex II to Directive 96/48/EC. Nine of them relate to the infrastructure:

- minimum infrastructure gauge (1),
- minimum radius of curvature (2),
- track gauge (3),
- maximum track loading (4),
- minimum platform length (5),
- platform height (6),
- boundary characteristics in relation to outside noise (17),
- boundary characteristics in relation to outside vibrations (18),
- characteristics linked to the access of disabled persons (22).

In addition to these basic parameters, the following should also be considered:

- maximum pressure variation in tunnels (23),
- maximum falling and rising gradients (24),
- minimum distance between track centres (25).

A certain number of interfaces are associated with the basic parameters. The full list of interfaces and the elements that characterise them is given in Point 4.2.

4.1.1. *Minimum infrastructure gauge (Parameter 1)*

The minimum gauge of the infrastructure to be used for the high-speed lines to be built shall comply with the reference kinematic profile GC (refer to Annex G).

The minimum infrastructure gauge of existing high-speed lines, of upgraded and connecting lines need only be brought up to the GC on those lines for which an economic study demonstrates the advantages of such an investment.

The applicable provisions for the 'minimum clearance gauge' element (4.3.3.1) are defined in Point 4.3.3 for the different line categories concerned and in Point 7.3 for lines with specific features.

4.1.2. **Minimum radius of curvature (Parameter 2)**

When designing the lines for high-speed operation, the minimum radius of curvature selected shall be such that, for the cant (4.3.3.7) set for the curve under consideration the cant deficiency (4.3.3.8) does not exceed, when running at the maximum speed for which the line is planned, the values indicated in Point 4.3.3 on 'Specified performance'.

On tracks where only slow movements of the interoperable trainsets take place (station and passing tracks, depot and stabling tracks), the minimum horizontal design radius for any isolated curve shall not be less than 150 m. In actual operation, even allowing for variations of the alignment, the minimum effective lateral radius shall not be less than 125 m. As for the vertical alignment profile, the curve radius shall not be less than 600 m on a crest and 900 m in a hollow. Details of the requirements concerning this parameter in respect of lines travelled on at low speed are given in Point 4.3.3 'Specified performance' under the element 'Stabling tracks: minimum horizontal and vertical radius of curvature, falling and rising gradients, distance between tracks' (4.3.3.5).

4.1.3. **Track gauge (Parameter 3)**

The nominal distance between rails (gauge) in the infrastructure subsystem shall be 1 435 mm. It corresponds to the distance between the active sides of the railhead, measured at a height of 14,5 mm ($\pm 0,5$ mm) below the running surface.

At the design stage and, later, during construction and operation, the gauge shall be maintained within the limits specified in Point 4.3.3 'Specified performance' concerning the 'track gauge and tolerances' element (4.3.3.10).

4.1.4. **Maximum track stressing (Parameter 4)**

Vertical forces

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

- maximum static axle load allowed for interoperable trains, as defined with its acceptable tolerances in Point 4.1.2 of the rolling stock TSI.

The maximum static load P_0 for a motored axle shall not exceed:

- In the case of rolling stock designed to operate on specially constructed high-speed lines at speeds equal to or greater than 250 km/h:

$$P_0 < \text{or} = 17 \text{ t/axle where } V > 250 \text{ km/h;}$$

$$P_0 \text{ or} = 18 \text{ t/axle where } V = 250 \text{ km/h;}$$

where V = Maximum service speed.

The static load P_0 for a non-powered axle shall not exceed 17 t,

- in the case of rolling stock designed to operate on specially upgraded high-speed lines at speeds of the order of 200 km/h:

the technical rules in use on these lines are applicable and must be laid down in the Infrastructure Register.

These maximum values are to be considered with a 2 % tolerance for the average axle load of the whole trainset. Furthermore, for each individual axle load, a 4 % tolerance is acceptable.

In addition, the difference in static load between each side of the same vehicle shall not exceed 6 %.

- the maximum dynamic wheel load, as defined in Point 4.1.1 of the rolling stock TSI, which may be exerted by interoperable high-speed trainsets, shall not exceed the following limits:
- 180 kN for vehicles when their maximum speed is greater than 200 km/h but less than or equal to 250 km/h,
- 170 kN for vehicles when their maximum speed is greater than 250 km/h but less than or equal to 300 km/h,
- 160 kN for vehicles when their maximum speed is greater than 300 km/h.

The track superstructure shall also take into account the technical characteristics (axle load, speed) of non-interoperable trains which may be authorised on the line.

The specifications for track resistance to vertical loads are given in Point 4.3.3 under elements 'resistance of track and switches and crossings to vertical forces' (4.3.3.16) and 'track stiffness' (4.3.3.22).

Lateral forces

The track, switches and crossings shall be able to withstand at least the following lateral forces, which are defined in Point 4.1.1 of the rolling stock TSI:

- the maximum total dynamic lateral force exerted by a wheelset on the track:

$(\Sigma Y)_{\max} = 10 + \frac{P}{3}$ kN, P being the maximum static load per axle, in kN, of the vehicles admitted to the line (service vehicles, high-speed and other trains). This limit is specific to the risk of lateral shift for ballasted tracks under lateral dynamic forces,

- the ratio of the lateral to the vertical forces of a wheel:

$(Y/Q)_{\lim} = 0,8$, Y and Q being respectively the dynamic lateral and vertical wheel force on the rail. This limit characterises the risk of wheel climbing the rail.

The track superstructure shall also take into account the technical characteristics (axle load, speed, cant deficiency) of non-interoperable trains which may be allowed to run on the line.

The specifications for track resistance to lateral forces are set out in Point 4.3.3 for 'resistance of track and switches and crossings to lateral forces' element (4.3.3.17).

Longitudinal forces

The track, switches and crossings shall withstand the longitudinal forces defined in Point 4.1.1 of the rolling stock TSI, corresponding to maximum accelerations and decelerations of 2,5 m/s² exerted by the high-speed interoperable trains, as well as the attendant temperature rise effects. The track superstructure shall also withstand longitudinal forces of non-interoperable trains intended to run on the line (service vehicles and other trains) corresponding to the above accelerations and decelerations.

The specifications of track resistance to longitudinal forces are given in Point 4.3.3 for the 'resistance of track and switches and crossings to braking and starting forces' element (4.3.3.21).

4.1.5. Minimum platform length (Parameter 5)

The length of the platforms shall allow for passenger access and egress through all doors of interoperable trains to which they may have access, in normal commercial operation.

Provided that the requirements of Point 7.3 of this TSI are observed, the useful length of the platforms accessible to passengers shall be at least 400 m on new lines to be built and lines upgraded for high-speed. On existing lines for high-speed and on lines upgraded for high-speed, only those stations where high-speed trains stop under normal service conditions are concerned. When, on these lines, application of the provisions of Chapter 7 'Implementation' for increasing the length of existing platforms is difficult, the Infrastructure Manager shall render some platforms in stations available for commercial service to the operators who shall then organise their service appropriately.

4.1.6. ***Platform height (Parameter 6)***

The platforms' characteristics shall be compatible with the boarding arrangements of the interoperable rolling stock.

Provided that the requirements of Point 7.3 are observed, two values are allowed for platform height: 550 and 760 mm.

These values may be changed according to the performance expected from the lines, as per the provisions of Point 4.3.3 'Specified performance' (4.3.3.26: passenger platforms).

4.1.7. ***Boundary characteristics linked to outside Noise (Parameter 17)***

The noise level generated by the trans-European high-speed rail system should remain acceptable for its surroundings and be kept within limits suitable to protect neighbouring populations and their activities.

The environmental impact study required to be carried out beforehand under Council Directive 85/337/EEC and stated in 4.2.3.1.1 below, must show that the noise levels perceived by neighbours along new or upgraded infrastructure (either noise levels generated by interoperable trains or global equivalent noise levels of the whole traffic, depending on the applicable criteria) do not exceed the noise levels defined by national rules in application, taking into account the noise emission characteristics of the interoperable trains as defined in the rolling stock TSI.

4.1.8. ***Boundary characteristics linked to outside vibrations (Parameter 18)***

Operating the trans-European high-speed rail system in a normal state of maintenance should not result in a level of ground-borne vibrations that would be unacceptable for its surroundings and the local activities.

The environmental impact study required to be carried out beforehand by Council Directive 85/337/EEC and stated in 4.2.3.1.1 below, must show that the vibration levels expected along new or upgraded infrastructure during the passage of interoperable trains do not exceed the vibrations levels defined by national rules in application, taking into account the characteristics of the interoperable trains as defined in the rolling stock TSI.

4.1.9. ***Characteristics linked to the access of disabled persons (Parameter 22)***

With two possible platform heights (550 mm and 760 mm) specified in the infrastructure TSI, it is unlikely that level access from platform to train will be achieved everywhere on the network. It will therefore be necessary to use technical and operational solutions to overcome this problem for disabled passengers. Several available solutions could be adopted on the trans-European high-speed network which include:

- rolling stock solutions:
 - bridging ramp integrated into rolling stock,
 - lift integrated into rolling stock.
- infrastructure solutions:
 - rising platform,
 - partially raised platform.

- operational solutions:
 - portable ramp deployed by operating staff,
 - mobile lift deployed by operating staff.

On high-speed lines to be built, the necessary provisions shall be made for an easy access to the platforms and trains by disabled persons, and, as far as reasonably practicable, without special assistance.

On upgraded and connecting lines, where existing stations do not always allow such means of easy access to platforms, the assistance of station operating staff will be required.

(See also 4.3.3.26 passenger platforms).

4.1.10. **Maximum pressure variations in tunnels (Parameter 23)**

Tunnels shall be designed such that the maximum pressure variation (defined as the difference between the extreme peak values of positive and negative pressure) along an interoperable train shall not be more than 10 000 Pascals during the passage of a train through the tunnel at the maximum speed permitted for the structure. This condition shall equally apply when trains of any type authorised to use the tunnel (high-speed trains, service and other trains) pass in the tunnel.

The specifications concerning the free cross-sectional area of the tunnel are given in Point 4.3 'Specified performance' for the 'tunnels and covered cuts' element (4.3.3.6).

4.1.11. **Maximum falling and rising gradients (Parameter 24)**

Provided that the requirements of Point 7.3 of this TSI are observed, the up and down gradients of new high-speed lines shall be limited to 35 mm/m.

The conditions applicable for this parameter on high-speed lines to be built, upgraded and connecting lines are specified in Point 4.3 'Specified performance' (4.3.3.4).

4.1.12. **Minimum distance between track centres (Parameter 25)**

The spacing between track centres on new high-speed lines shall be at least 4,5 m.

Different values for this dimension may be adopted on new lines yet-to-be-built and their connecting lines as well as on existing upgraded lines according to the performance expected of those lines. These variations are specified in Point 4.3.3 'Specified performance' (4.3.3.2).

4.2. INFRASTRUCTURE SUBSYSTEM INTERFACES

- 4.2.1. From the standpoint of technical compatibility, the interfaces of the infrastructure subsystem with the other subsystems, some of which are specified by the basic parameters defined in the previous section, are the following:

Interfaces with the rolling stock subsystem:

- gauges and clearances: this interface consists of all the gauges and clearances necessary so that trains can run: structure and platform gauges, the rolling stock's loading gauge, the pantograph clearance and distance between track centres,
- transfer of physical loads between the vehicle and the infrastructure, in the three directions — lateral, vertical and longitudinal — whether through the wheel-rail contact or via braking systems aboard the vehicles, which do not use wheel adhesion,

- track alignment, the characteristics of which define the operating conditions of the vehicle suspensions,
- reciprocal aerodynamic effects between fixed obstacles and the vehicles, and between the vehicles themselves when crossing,
- pressure effects when running through tunnels and underground stations, and air velocity effects in underground stations,
- accessibility of trains, in stations and on open track in the event that passengers must be evacuated,
- any train monitoring systems installed on the ground.

Interfaces with the ‘energy subsystem’:

- structure gauge set for the overhead line masts,
- electrical clearance for the overhead lines and the pantograph and its incidence on structures,
- transmission of traction currents by the track.

Interfaces with the ‘control-command and signalling subsystem’:

- structure gauge in respect of the elements of this subsystem installed along the track or fixed to the structures,
- transmission of signalling currents through the track.

Interfaces with the ‘operation subsystem’:

- accessibility of trains in stations and in the event of evacuation on open line,
- locking of track switches to secure trains on their designated paths,
- provision of breakdown recovery and rerailing means.

Interfaces with the ‘maintenance subsystem’:

- layout of service sidings for train stabling.

Interfaces with the ‘environment subsystem’:

- vibrations generated in the lineside environment,
- noise generated in the lineside environment.

4.2.2. The above interfaces are characterised by the following elements, regarding which the applicable requirements for achieving the performance levels specified for each category of line of the trans-European high-speed rail system are set out in Point 4.3.3 ‘Specified performance’:

- minimum structure gauge (4.3.3.1),
- distance between track centre-lines (4.3.3.2),
- aerodynamic effects on infrastructure (4.3.3.3),
- maximum rising and falling gradients (4.3.3.4),
- minimum horizontal and vertical radius of curves in stabling tracks (4.3.3.5),
- works below ground level such as tunnels and cut-and-covers (4.3.3.6),
- cant (4.3.3.7),

- cant deficiency (4.3.3.8),
- equivalent conicity (4.3.3.9),
- track gauge and tolerances (4.3.3.10),
- rail inclination (4.3.3.11),
- railhead profile (4.3.3.12),
- vertical loads on structures (4.3.3.13),
- transverse horizontal loads on structures (4.3.3.14),
- longitudinal loads on structures (4.3.3.15),
- resistance of track, switches and crossings to vertical loads (4.3.3.16),
- resistance of track, switches and crossings to lateral loads (4.3.3.17),
- track geometrical quality (4.3.3.18),
- points and crossings: forms of half sets of switches and crossings (4.3.3.19),
- points and crossings: functional conditions (4.3.3.20),
- resistance of track and switches to braking and starting forces (4.3.3.21),
- track stiffness (4.3.3.22),
- effects of lateral winds (4.3.3.23),
- hotbox detectors (4.3.3.24),
- access to or intrusion into line installations (4.3.3.25),
- passenger platforms (4.3.3.26),
- underground stations at high-speed (4.3.3.27),
- electrical transmission characteristics of the superstructure (4.3.3.28).

4.2.3. ***Regulatory and operational conditions***

To guarantee the coherence of the trans-European high-speed rail system, these interfaces are subject to the following regulatory and operational provisions:

4.2.3.1. **Regulatory conditions**

4.2.3.1.1. *Protection of the environment*

The Community requirements for environmental protection are set down in legislative and regulatory texts enacted by the Member States to enforce them; texts which must be complied with in the design of lines specially built for high-speed in the territory of each State concerned.

Environmental impact study:

By application of Council Directive 85/337/EEC concerning the assessment of the effects of certain projects on the environment, during the design of a line specially built for high-speed or on the occasion of line upgradings for high-speed the environmental impacts of the projects must be addressed in a preliminary study in accordance with the requirements of the national legislation of the State concerned enacted to apply the Community provisions.

The impact study must state:

- the measures taken to ensure that the specifications of this TSI relating to the 'Boundary characteristics linked to outside noise' parameter set out in Point 4.1.7 are complied with. Noise levels perceived by neighbours along new or upgraded infrastructures (either noise levels generated by interoperable trains or global equivalent noise levels of the whole traffic, depending on the applicable criteria) shall be calculated taking into account the maximum emission level of interoperable trains as defined in 4.1.8 of the rolling stock TSI, and should it be the case, of the traffic expected from all train types running on the line.
- the measures taken to ensure that the specifications of this TSI relating to the 'Boundary characteristics linked to outside vibrations' parameter set out in Point 4.1.8 are complied with during the passage of interoperable trains.

4.2.3.1.2. *Fire protection*

The constructional features of underground stations on high-speed lines shall meet the requirements set out in Directive 89/106/EEC of 21 December 1988 and its interpretative document concerning Essential Safety Requirement No 2, 'Fire Safety'. This requirement addresses the arrangements applicable to the buildings and station platforms accessible to passengers and in particular the items relating to emergency lighting and emergency exit signing equipment. Application of these measures shall take into account the fire load represented by any high-speed trains halted in the station.

The products used in the construction of underground stations on high-speed lines shall meet the technical specifications and European standards drawn up to protect facilities against fire, as per Article 4 of Directive 89/106/EEC or, should the former be lacking, as per the national regulations corresponding to these requirements in this TSI.

4.2.3.1.3. *Long tunnels*

Appropriate measures shall be taken to take into account the particular safety conditions in long tunnels. In the absence of active Community provisions, the applicable legislation shall be that defined by each Member State on whose territory the infrastructure project proceeds, or by an agreement between the Member States concerned in the case of an international project. Where no national rules have already been enacted, the adjudicating entity or the Infrastructure Manager shall submit its proposal for the provisions to be adopted to the National Authority of the Member State concerned, so the measures taken may be verified.

The provisions taken by the adjudicating entity shall permit free movement of interoperable trainsets such as described in the rolling stock TSI, Points 4.3.11, 4.3.13 and 4.3.14. The rolling stock characteristics thus specified are based on the following performance:

- the ability to maintain a speed of at least 80 km/h for 15 minutes with a fire on board,
- presence of temperature detectors in specific areas of the train,
- presence of an alarm, at passengers' disposal, which does not stop the train,
- fire resistance of the materials (possible ignition sources, fire load and smoke/fume properties),
- the adoption of measures to avoid the propagation of smoke and fumes (stopping the air conditioning system) and to protect passengers,
- on-board communication system connecting the train crew and the passengers.

These characteristics are the basis for defining the provisions to be adopted in the tunnel according to its own characteristics (length, type of tunnel: single or double track, cross section, etc.) as per the national rules so as to ensure a sufficient level of safety for the interoperable rolling stock at its dedicated speed.

In addition, if platforms are built in specific zones of the tunnel so as to provide easy egress either to protected rescue areas, or to the lateral path defined as per the applicable national rules, their height shall be between 550 and 760 mm so as to ensure compatibility with rolling stock access. These specific zones shall be indicated in the Infrastructure Register of the line concerned.

4.2.3.2. **Operational conditions**

4.2.3.2.1. *Commissioning*

This aspect is dealt with in Chapter 6.

4.2.3.2.2. *Maintenance plan*

A maintenance plan shall be drawn up by the Infrastructure Manager or his authorised representative to ensure that the specified characteristics of the interfaces of the infrastructure subsystem are upheld within the limits specified for them.

The maintenance plan must contain at least the following elements:

- a set of safety limit values (limit values leading to a limitation of train speeds) for the following parameters of track geometric quality: longitudinal level, cross level, alignment and gauge, as set for the track geometry measuring systems used by the Infrastructure Manager or his representative.

These values must be at most equal to those specified in the following standards and regulations:

- for the longitudinal level, line and track twist, the values indicated under 'track geometric quality' (4.3.3.18) in Point 4.3.3,
- for the average gauge dimension over 100 m, the values indicated under 'track gauge' (4.3.3.10) in Point 4.3.3 for the lines with different performance levels,
- an indication of the frequency of checks and of the tolerances on measured values of the geometrical standards and of the means used to check them, with for the latter an indication of the rules of equivalence with the values quoted in Point 4.3.3,
- the measures taken (speed restriction, repair time) when prescribed values are exceeded,
- the rules concerning safety margins for switches and crossings, complying with the requirements stated under 'switches and crossings' in Point 4.3.3 (4.3.3.20),
- an indication of the frequency at which the rails must be inspected and of the inspection means used,
- an indication of the frequency at which the track (rail fastening systems and sleepers) must be inspected.

4.2.3.2.3. *Exception for the case of execution of works*

The specifications of the infrastructure subsystem and its interoperability constituents defined in Chapters 4 and 5 of the TSI are applicable to lines in normal functional condition or in the case of unexpected malfunctions which require the application of the maintenance plan.

In certain situations involving pre-planned works, it may be necessary to temporarily suspend these provisions, so as to allow the execution of modifications to the infrastructure subsystem.

These temporary exceptions to the TSI rules shall be defined by the Infrastructure manager of the line concerned, who shall be careful that no risks to the safety of passing trains will result by applying the following general provisions:

- the exceptions allowed shall be temporary and planned in due course,
- railway undertakings operating on the line shall be given notice of these temporary exceptions, of their geographic location, their nature and the means of signalling, by means of notices describing where required, the type of specific signals used. A model of such notice shall be joined to the Infrastructure Register of the line concerned,
- any exception shall include complementary safety measures, so as to ensure that the safety level requirement continues to be met. These complementary measures may in particular consist of:
 - appropriate monitoring of the works involved,
 - temporary speed restrictions on the line section, which shall not allow a speed higher than is appropriate in the circumstances.

4.2.3.2.4. *Lateral space for passengers in the event of detrainment outside of a station*

On new lines built for high-speed, a sufficient space shall be provided alongside every track open to high-speed trains; this space must allow passengers to detrain on the side of the tracks opposite from the adjacent tracks if the latter are still to be operated during evacuation of the train. Where tracks are carried on engineering structures, the side of the lateral space away from the tracks shall comprise a protective parapet wall allowing passengers to exit safely.

On existing lines, upgraded for high-speed, a similar lateral space shall be provided at all locations where this provision is reasonably practicable. Where a sufficient space cannot be provided, both ends of the zone of restricted movement shall be signposted on site and operators shall be informed of this specific situation by its mention in the Infrastructure Register of the line concerned.

The particular provisions applicable in very long tunnels are specified in Point 4.2.3.1.3.

4.2.3.2.5. *Notices given to railway undertakings; means of breakdown recovery after derailment*

The Infrastructure Manager shall inform the railway undertakings concerned of the procedures by which they may be informed of temporary performance restrictions affecting the infrastructure, which may result from events not normally foreseeable.

The Infrastructure Manager shall also give notice to the railway undertakings intending to operate on a line of the interoperable trans-European high-speed rail network, of the available means for breakdown recovery and rerailling operations, of the location of the centres responsible for their management for the lines concerned, and of the procedures applicable for putting them into operation. Railway undertakings shall give notice to the Infrastructure Manager of the specific conditions which apply for recovery or rerailling operations for their trains. The latter shall ensure that the staff in charge of such recovery works have received sufficient information about those specific conditions relevant to the types of interoperable trains that each centre may have to deal with, depending on the lines covered.

4.2.3.2.6. *Infrastructure Register*

For each section of line of the trans-European high-speed rail system, a single document, called the 'Infrastructure Register' shall be drawn up by the adjudicating entity or its authorised representative, or the Infrastructure Manager. This document compiles the characteristics of the lines concerned for all the subsystems that include fixed equipment.

It permits:

- the Member State which is responsible for placing the subsystem into service to provide a document describing, for each line of the trans-European high-speed network, the main parameters governing their operation,

- the Infrastructure Manager, to provide a documentary record summarising the lines concerned, which allows tracking of the future evolutions in implementing the TSI,
- the Railway undertakings providing or looking to provide services on the line to be informed of its particular features and of parameters or interoperability specifications which depend on a specific choice of the Infrastructure Manager.

For the infrastructure subsystem, this document shall indicate for each homogeneous section of line and each particular equipment, the general or particular specifications which have been adopted, which need to be understood for operation of the line. These are listed in Annex E.

The adjudicating entity or Infrastructure Manager shall append this document to the EC declaration of verification of the infrastructure subsystem, as a part of the technical file described in Annex V to Directive 96/48/EC, to obtain authorisation for entry into service by the Member State.

4.3. SPECIFIED PERFORMANCE

The requirements that must be met by the elements characterising the interfaces of the infrastructure subsystem must match the performance levels specified for each of the following line categories of the trans-European high-speed rail system, as relevant:

- lines specially built for high-speed,
- lines specially upgraded for high-speed,
- lines with special characteristics, specially upgraded for high-speed.

In the case of the infrastructure subsystem, these performance levels are described in the following paragraphs, together with any particular conditions that may be allowed in each case for the parameters and interfaces concerned.

All performance levels and specifications of the present TSI are given for lines built with the standard European track gauge, as defined in Point 4.1.3 for interoperable lines. Lines built at another track gauge value are described, under specific cases, in Point 7.3.

These performance levels are described for the subsystem under normal service conditions, and for states resulting from maintenance operations. Consequences, if any, of the execution of modification works, or of heavy maintenance which may require temporary exceptions as far as the subsystem performance is concerned, are dealt with in Point 4.2.3.2.3.

The specified performance levels for lines representing specific cases are defined in Point 7.3.

4.3.1. ***Lines specially built for high-speed***

In order to make best use of the performance of interoperable trainsets, the lines of the trans-European high-speed rail system specially built for high-speed shall be designed to allow the passage of trains with a length of 400 metres and a maximum weight of 1 000 tonnes at speeds greater than or equal to 250 km/h, able to fit within the infrastructure gauge defined in Point 4.1.1 above. The parameters and elements specified in Points 4.1 and 4.3.3 allow, provided the conditions stated in this section are fulfilled, the building of infrastructure on which speeds up to 300 km/h may be allowed.

The speed of interoperable trainsets may, according to Annex I to Directive 96/48/EC, be increased to over 300 km/h, the necessary conditions for such performance may be provided for at the design stage for the parameters and interfaces concerned, when these entail some modifications related to running speed.

The performance levels of high-speed trains can also be enhanced by adopting specific systems, such as vehicle body tilting. Special conditions may be allowed for running such trains, provided they do not entail restrictions for high-speed trains not equipped with tilting.

Different requirements than those described for the basic performance levels, as specified below for each parameter or element concerned, may be adopted in the following cases:

- if, on certain sections of high-speed lines where the maximum speed envisaged for interoperable trainsets cannot be achieved for technical reasons, lower performance levels are adopted as concerns the maximum speed of the line.
- if, as the result of adopting particular constructional characteristics for the subsystem achieving the same level of performance, specific requirements can be adopted for certain parameters or interfaces,
- if, in order to allow higher-performing high-speed trains to run, for example at speeds exceeding 300 km/h, it is necessary to make special allowances for such trains affecting certain parameters or interfaces; adoption of such allowances shall be subordinated in this case to maintenance of the conditions applicable to other high-speed trains defined in Points 4.1 and 4.3.3.

Such requirements differing from those needed to achieve the basic performance levels of the network shall be applied for each relevant parameter or interface in a uniform way on each section of high-speed line to be built or being planned. Moreover, application of such provisions shall be stated in the 'Infrastructure Register', which compiles the characteristics of all the lines of the trans-European high-speed rail system.

These special requirements as they relate to the various parameters and interfaces concerned are described in Point 4.3.3.

4.3.2. *Lines specially upgraded for high-speed*

The lines of the trans-European rail system specially upgraded for high-speed are designed to allow trainsets 400 metres long weighing up to 1 000 tonnes to run at speeds under 250 km/h. On these lines, the performance levels of the interoperable trainsets specially designed for high-speed cannot be exploited fully.

The parameters and elements specified in order to achieve the basic performance levels of the network serve to build infrastructure allowing high speeds under 250 km/h.

Different conditions than those described for these basic performance levels are specified in the following subsection, for each parameter or interface concerned, and may be used on existing lines upgraded for high-speed on which the running speed of the interoperable trainsets being less than their maximum design speed — lower performance levels are adopted as concerns the line's maximum speed.

The performance of high-speed trains can nevertheless be enhanced by adopting special-purpose systems, such as body tilting, and special conditions may be allowed for running trains so equipped on upgraded lines, provided they do not result in restrictions being incurred on the same lines by the high-speed trains not so equipped.

Any application of such conditions must be published in the 'Infrastructure Register' which compiles the characteristics of lines of the trans-European high-speed rail network.

The special conditions are described in Point 4.3.3, under the relevant elements.

4.3.3. **Specifications applicable to the elements to achieve the intended performance levels**

The following paragraphs state, for each element and each parameter, the requirements to be met to achieve the performance levels specified for each line category.

4.3.3.1. **Minimum clearance gauge**

Lines specially built for high-speed

At the design stage, all the obstacles (structures, power supply and signalling equipment) shall meet the following requirements:

- the minimum structure gauge set for each of them on the basis of the GC reference kinematic profile defined in Annex G to this TSI,
- the gauge setting out the clearance for the pantographs, set for each obstacle: except for specific cases described in Point 7.3, the definition of the pantograph clearance, to be increased by the electrical insulation clearances, makes reference to the type of electrification selected for the new line, to the design height of the catenary and to the type of associated pantograph, all as defined in Points 4.1.2.1, 4.1.2.2, 4.1.2.3 and 4.3.2.3, Figure 4.1 and Annexes H and J to the energy TSI.

Existing high-speed lines, lines specially upgraded for high-speed and connecting lines

On existing high-speed lines, on lines upgraded for high-speed and on their connecting lines, the minimum structure gauge set for each of them on the basis of the GC reference kinematic profile may be applied, in the case of modification work, if an economic study demonstrates the advantages of such investment. If not, structure gauge set for each of them on the basis of the GB reference kinematic profile may be applied if economic conditions permit, or an existing smaller structure gauge may be kept. The economic study by the adjudicating entity or the Infrastructure Manager shall take into account costs and benefits expected to result from the enlarged gauge in relation with the other interoperable lines connected to the one concerned.

Except when specific cases described in Point 7.3, or the arrangements stated in Section 7 below are applied, suitable clearance for the pantographs gauge, to be increased by the electrical insulation clearances, must be allowed on existing electrified systems to allow passage of the types of pantograph liable to be used on the electrified system concerned, as described in Points 4.1.2.1, 4.1.2.2, 4.1.2.3 and 4.3.2.3, Figure 4.1 and Annexes H and J to the energy TSI

4.3.3.2. **Minimum distance between track centres**

Lines specially built for high-speed

At the design stage, the minimum distance between main track centres on lines specially built for high-speed shall be set to 4,50 m.

This value may be adapted to those shown in the following table, to suit the intended performance levels for the lines:

New lines	Speed of non-tilting trains	Minimum distance between track centres
	$V \leq 250 \text{ km/h}$	4,00 m
	$250 \text{ km/h} < V \leq 300 \text{ km/h}$	4,20 m

Lines specially built for high-speed and connecting lines

Provided that the requirements of Point 7.3 are complied with, at the design stage, the minimum distance between track centres on upgraded lines is set to the following values:

Upgraded lines	Train speed	Minimum distance between track centres
	$V \leq 230 \text{ km/h}$	determined on the basis of the reference kinematic profile retained
	$230 \text{ km/h} < V < 250 \text{ km/h}$	4,00 m

4.3.3.3. Aerodynamic effects on infrastructure**4.3.3.3.(a) Aerodynamic effects on structures*****Lines specially built for high-speed, lines specially upgraded for high-speed and connecting lines***

The aerodynamic (slipstream) effects caused by the passage of moving vehicles shall be taken into account when designing the line, considering the type of structures close to the track, as described in Point 6.6 of standard ENV 1991-3. The aerodynamic characteristics of high-speed trainsets specified in Point 4.2.13 of the rolling stock TSI are such that the trains may be considered to be well-streamlined in the sense of the abovementioned standard and to have less aerodynamic effect than a conventional train.

The minimum strength of the structures close to the track shall be checked in respect of high-speed train operation only, by applying, where relevant, the coefficient k_1 defined in Point 6.6.2 of standard ENV 1991-3, for trains with streamlined coaches. Closed structures less than 20 metres long should be studied in accordance with the provisions of Point 6.6.6 of this standard.

Checking procedures are laid down in standard ENV 1991-3, Point 6.6.

4.3.3.3.(b) Protection of workers against aerodynamic effects

Subject to the provisions set down in Point 4.2.3.2.4 concerning passenger evacuation, the Infrastructure Manager can freely define the means of protection for personnel authorised to access the lineside, following national rules. He shall take into account the aerodynamic effects generated by the trains as described in Point 4.2.13 of the rolling stock TSI, which defines the former for the maximum allowed speed of any interoperable train type, up to 300 km/h. For trains having maximum speeds higher than this limit, it is up to the Infrastructure Manager to lay down the complementary means of protection (increased protection distances, protection walls ...) which he judges appropriate.

4.3.3.4. Maximum rising and falling gradients***Lines specially built for high-speed, lines specially upgraded for high-speed and connecting lines***

Provided the requirements of Point 7.3 are observed, gradients as steep as 35 ‰ may be allowed for main tracks at the design phase, provided the following 'envelope' requirements are observed:

- the slope of the moving average profile over 10 km is less than or equal to 25 ‰,
- the maximum length of continuous 35 ‰ gradient does not exceed 6 000 m.

Lines specially upgraded for high-speed and connecting lines

On these lines, falling and rising gradients are generally less than the values allowed on high-speed lines yet to be built. Upgradings introduced for the operation of interoperable trains should comply with the preceding values for line gradients, except when specific local conditions require higher values; this being so, the acceptable falling and rising gradients values shall take into account the limiting characteristics of the rolling stock in traction and braking, as defined in Points 4.3.3, 4.3.4, 4.3.5 and 4.3.9 of the rolling stock TSI.

In choosing the maximum gradient value, consideration shall also be given, for the whole of the interoperable lines, to the expected performance of non-interoperable trains which might be authorised to run on the line, by application of Point 5(4) of the Directive.

4.3.3.5. Stabling tracks: minimum horizontal and vertical radius of curvature, falling and rising gradients, distance between track centres*Lines specially built for high-speed, lines specially upgraded for high-speed and connecting lines*

On tracks where interoperable trainsets move only at low speed (station and passing tracks, depot and stabling tracks), the minimum horizontal design radius for any isolated curve shall not be less than 150 m. Allowing for alignment variations in practice, the minimum effective radius shall not be less than 125 m.

Track horizontal alignments comprising a succession of curves and reverse curves in opposite directions shall be designed to the requirements of Annex H).

Vertical alignment of stabling and service tracks shall not include curves of less than 600 m radius on a crest or 900 m in a hollow.

Falling and rising gradients of stabling tracks intended for parking trains shall not be more than 2 mm/m. Subject to the requirements of Point 7.3, these tracks shall allow for stabling trains of 400 m length as defined per Point 4.1.3 of the rolling stock TSI with the associated tolerances, and, in the case that a toilet discharge trolley is to be used, the minimum track centre distance to an adjacent track shall be at least 6 m and a running path for the trolleys shall be provided.

4.3.3.6. Works below ground level such as tunnels and cut-and-covers

Tunnels shall be designed such that the maximum pressure variation (difference between the extreme positive and negative pressure peak values, having subtracted the natural pressure variations due to the difference in altitude between the tunnel entry and exit) along an interoperable train shall not exceed 10 000 Pascals during the time taken for the train to pass through the tunnel, at the maximum design speed.

The maximum aerodynamic characteristics of the interoperable trainsets to be taken into account are defined by the provisions set in Point 4.1.13 of the rolling stock TSI. These characteristics are based on the following train cross sectional areas, which can be applied independently to each motor or trailer vehicle:

- 12 m² for vehicles designed for GC loading gauge,
- 11 m² for vehicles designed for GB loading gauge,
- 10 m² for vehicles designed for smaller loading gauges.

These characteristics allow to calculate, for a given running speed, the tunnel cross section required to comply with the health criteria. In the case where the adjudicating entity, or the Infrastructure Manager, wants to make use of construction features which reduce the pressure variation (tunnel entrance shape, shafts, etc.), or in the case of non critical tunnels (very short or very long tunnels), he or she shall have a specific study made to demonstrate that the above criteria is fulfilled.

Lines specially built for high-speed

The free cross-sectional area of the tunnel shall be determined so as to comply with the maximum pressure variation indicated above, taking into account all the types of traffic planned to run in the tunnel at the maximum speed at which the respective vehicles are authorised to run.

Existing high-speed lines, lines specially upgraded for high-speed and connecting lines

On these lines, the required maximum pressure variation limit can be met by, among other means, reduced speeds as defined by applying the procedures previously stated to actual trains running through the tunnel.

In addition, the tunnel gauge should be compatible with the structure gauges and with the geometrical characteristics of the overhead line equipment and the pantograph/overhead line interaction as indicated for the 'gauge' element (4.3.3.1).

4.3.3.7. Track cant

The following specifications are applicable to interoperable lines the track gauge of which comply with that defined in Point 4.1.3.

Lines specially built for high-speed

The cant chosen for new high-speed lines during design shall be limited to 180 mm. On tracks in operation, a maintenance tolerance of ± 20 mm is allowed, subject to a maximum cant of 190 mm.

This value may be raised to 200 mm maximum on tracks reserved for passenger traffic alone.

Lines specially upgraded for high-speed and connecting lines

The cant chosen for upgraded existing lines during design shall be limited to 180 mm. On tracks in operation, a maintenance tolerance of ± 20 mm is allowed, subject to a maximum cant of 190 mm.

This value may be raised to 200 mm maximum on tracks reserved for passenger traffic alone.

The operational maintenance requirements of this element are the subject of the provisions of Point 4.2.3.2.2 (Maintenance plan) on service tolerances.

4.3.3.8. Cant deficiency

The following specifications are applicable to interoperable lines the track gauge of which comply with that defined in Point 4.1.3.

4.3.3.8.(a) Cant deficiency on plain track and on the main track of switches and crossings***Lines specially built for high-speed***

The cant deficiency value chosen in the design phase for these lines shall be limited to the values shown in the following table, according to the maximum speed of the line:

High-speed lines	Speed range (km/h)	Limiting value (mm)
	$250 \leq V \leq 300$	100
	$300 < V$	80

During design, the determination of the allowable curve radius for the layout in plan shall be made, based on the above elements of design (cant and cant deficiency).

Higher values of cant deficiency than shown in the above table may be allowed for lines whose construction involves very difficult topographical constraints. These are set out below in a specific paragraph on the subject below.

On lines, the radii of which have been defined on the basis of the cant deficiency values in the above table, interoperable high-speed trains equipped with special mechanisms (tilting) may be admitted to run with higher cant deficiency values, provided that adopting such values for those trains does not bring about restrictions for other interoperable trains. The maximum cant deficiency value shall be fixed, in the case of trains equipped with particular mechanisms (tilting trains *inter alia*), for each interoperable line, by application of the national regulations for the type of train concerned; the value applied shall be published in the Infrastructure Register of the line concerned. The approval of these trains to enter service shall be subject to the requirements of the rolling stock TSI.

Lines specially upgraded for high-speed and connecting lines

The design cant deficiency allowed for high-speed trains on upgraded existing lines and connecting lines shall be limited to the values in the table below, according to the line's maximum speed:

Upgraded lines	Speed range (km/h)	Limiting value (mm)
	$V \leq 160$	160
	$160 < V \leq 200$	150
	$200 < V \leq 230$	140
	$230 < V < 250$	130

At the design stage, the allowable radius of curvature of the layout in plan shall be determined, on the basis of the above elements (cant and cant deficiency).

The same values may be applied on existing high-speed lines.

Cant deficiency values higher than those in the above table may be allowed for lines whose construction involves very difficult topographical constraints. These are set out below in a specific paragraph on the subject.

On lines, the radii of which have been defined on the basis of the cant deficiency values in the above table, interoperable high-speed trains equipped with special mechanisms (tilting) may be admitted to run with higher cant deficiency values, provided that adopting such values for those trains does not bring about restrictions for other interoperable trains. The maximum cant deficiency value shall be fixed, in the case of trains equipped with particular mechanisms (tilting trains *inter alia*), for each interoperable line, by application of the national regulations for the type of train concerned; the value applied shall be published in the Infrastructure Register of the line concerned. The approval of these trains to enter service shall be subject to the requirements of the rolling stock TSI.

Lines specially built or upgraded for high-speed having special features

If, because of especially difficult topographical constraints, the curve radii of the line layout in plan prevent compliance with the cant deficiency values stated in the previous paragraphs, higher values may be adopted for this interface.

A reminder of these maximum limiting values is given in the following table.

Lines with special characteristics	Speed range (km/h)	Maximum limiting value (mm)
	$V \leq 160$	180
	$160 < V \leq 230$	165
	$230 < V \leq 250$	150
	$250 < V \leq 300$	130 ⁽¹⁾

⁽¹⁾ The maximum value of 130 mm may be raised to 150 mm for non ballasted tracks.

On lines, the radii of which have been defined on the basis of the cant deficiency values in the above table, interoperable high-speed trains equipped with special mechanisms (tilting) may be admitted to run with higher cant deficiency values, provided that adopting such values for those trains does not bring about restrictions for other interoperable trains. The maximum cant deficiency value shall be fixed, in the case of trains equipped with particular mechanisms (tilting trains *inter alia*), for each interoperable line, by application of the national regulations for the type of train concerned; the value applied shall be published in the Infrastructure Register of the line concerned. The approval of for these trains to enter service shall be subject to the requirements of the rolling stock TSI.

4.3.3.8.(b) Cant deficiency on diverging track of switches**Lines specially built for high-speed, lines specially upgraded for high-speed and connecting lines**

During project design, the maximum values of cant deficiency on diverging track shall be:

- 120 mm for switches allowing turnout speeds of $30 \text{ km/h} \leq V \leq 70 \text{ km/h}$,
- 105 mm for switches allowing turnout speeds of $70 \text{ km/h} < V \leq 170 \text{ km/h}$,
- 85 mm for switches allowing turnout speeds of $170 \text{ km/h} < V \leq 230 \text{ km/h}$.

A tolerance of 10 mm on these values may be accepted for existing switches laid on lines to be upgraded for high-speed.

4.3.3.9. Equivalent conicity

The wheel-rail interface is fundamental to explaining the dynamic running behaviour of a railway vehicle. It must therefore be understood and, among the parameters by which it is characterised, the one called 'equivalent conicity' plays an essential role since it allows the satisfactory appreciation of the wheel-rail contact on tangent track and on large-radius curves.

The kinematic movement of a free wheelset, with no inertia, running on a track, having a constant speed $V = dx/dt$, is described by the following differential equation:

$$d^2y / dx^2 + (2 \tan \gamma / e r_0) y = 0$$

where:

y is the lateral movement of the wheelset on the track

e is the track gauge

r_0 is the radius of the wheel when the wheelset is centred on the track

γ is the angle of the conical profile of the wheels

When γ is constant, the solution of this differential equation is a sinewave with a wavelength of λ :

$$\lambda = \frac{2\pi}{\sqrt{2 \tan \gamma}} \sqrt{r_0 e} \quad \text{Klingel's formula}$$

When the wheels do not have a conical profile, the 'equivalent conicity' is defined as the tangent of the cone angle ($\tan \gamma_e$) of a wheelset with coned wheels whose lateral movement has the same kinematic wavelength as the given wheelset (but only on tangent track and on large-radius curves).

Lines specially built for high-speed

On lines specially built for high-speed the equivalent conicity shall be less than the limiting values shown in the following table, depending upon the maximum speed of traffic:

Speed range (km/h)	Design value	In service, taking into account wheel and rail wear
$230 < V \leq 250$	0,25	0,30
$250 < V \leq 280$	0,20	0,25
$V > 280$	0,10	0,15

Equivalent conicity is not relevant for trains equipped with axles whose wheels rotate independently.

Compliance with these equivalent conicity values, taking into account the characteristics of the axle (wheel profile and distance between active faces of the wheel as defined in Point 4.2.10 of the rolling stock TSI), shall be obtained through an appropriate, documented choice, both on plain track and through switches, of the three following elements: track gauge and tolerances (4.3.3.10), rail inclination (4.3.3.11) and railhead profile (4.3.3.12).

Lines specially upgraded for high-speed and connecting lines

On lines specially upgraded for high-speed, the following maximum values of conicity shall be allowed:

Speed range (km/h)	Design value	In-service value, taking into account wheel and rail wear
$160 < V \leq 200$	0,30	0,40
$200 < V \leq 230$	0,25	0,35
$230 < V \leq 250$	0,25	0,30

N.B.: For speeds $V \leq 160$ km/h, no equivalent conicity value is specified.

4.3.3.10. Track gauge and tolerances

Track gauge is the distance between the gauge faces of the railheads measured at a height of 14,5 mm ($\pm 0,5$ mm) below the rail running surface.

For the calculation of the equivalent conicity, to take account of the change in contact points as the wheel advances, the track gauge shall be taken as the sliding mean of the measured gauge over a distance of 100 m.

The design studies of the group of components consisting of: the rails, the fastening systems and the track bearers shall enable the track gauge to be set at the following values:

Lines specially built for high-speed

The mean track gauge over 100 m on main lines and switches and crossings in main lines specially built for high-speed shall be within the ranges shown in the table below:

Speed range	Mean gauge (mm) over 100 m		
	Theoretical reference value	In service, on straight track and in curves of radius $R > 10\,000$ m	In service, in curves of radius $R \leq 10\,000$ m
230 km/h $< V \leq$ 250 km/h	1 435—1 437	1 433—1 442	1 433—1 445
250 km/h $< V \leq$ 280 km/h	1 435—1 437	1 434—1 440	1 434—1 443
$V > 280$ km/h	1 435—1 437	1 434—1 440	1 434—1 443

The theoretical reference value for track gauge is the design value which is selected by the adjudicating entity, or the Infrastructure Manager, depending on the chosen type of track or switch and crossing systems. This reference value shall be used, for equivalent conicity calculations, as defining the theoretical rail positions.

Values set down for the track in service shall be applied as extreme limiting values in the maintenance plan (4.2.3.2.2) which shall be enforced as soon as the line is put into service. If required, they are used for equivalent conicity calculations for the track in service.

This element may be modified, in conjunction with the elements 'rail inclination' (4.3.3.11), 'railhead profile' (4.3.3.12) and 'axle characteristics' (4.2.10 of the rolling stock TSI), in accordance with the requirements set out for the latter elements.

Lines specially upgraded for high-speed and connecting lines

The same specifications of mean gauge over 100 m as given above for lines specially built for high-speed shall apply to lines upgraded for high speeds of over 230 km/h. For lines upgraded for speeds less than or equal to 230 km/h, no value is specified for this element.

The operational requirements to be respected in maintenance of this element are the subject of the provisions of Point 4.2.3.2.2 (Maintenance plan) on in-service tolerances.

4.3.3.11. Rail inclination

This is the angle between the axis of symmetry of the new profile of a rail mounted on its support and the perpendicular to the running surface.

Lines specially built for high-speed

For line sections operated at speeds less than or equal to 280 km/h, a rail inclination of between 1 in 20 and 1 in 40 (1/20 and 1/40) shall be allowed, (nominal value 0,05 to 0,025 depending on the choice of track construction components), with a construction tolerance of 0,010 at commissioning.

For line sections operated at more than 280 km/h, the track shall normally be laid with a rail inclination of 1/20, which ensures the intended conicity values with the wheel profiles specified in the rolling stock TSI.

The track may nevertheless be laid with a different inclination than 1/20, proposed by the Infrastructure Manager, which may make it necessary to adopt new specifications for the elements 'railhead profile' (4.3.3.12), track gauge (4.3.3.10) and axle characteristics (4.2.10 of the rolling stock TSI). In this case, the Infrastructure Manager shall prove the compatibility of the new system, in terms of equivalent conicity (4.3.3.9), with the wheel profiles specified in the rolling stock TSI.

In the latter case, the infrastructure TSI shall be revised, in agreement with the rolling stock TSI group of the AEIF, to include the new values and their tolerances.

In switches and crossings on the sections of lines built specially for high-speed where the running speed is less than or equal to 250 km/h, the laying of rails without inclination shall be allowed provided that it is limited, on line sections designed for running at more than 200 km/h, to the switch and crossing work alone.

Lines specially upgraded for high-speed and connecting lines

On existing lines specially upgraded for high-speed, the requirements set out in the previous paragraph for line speeds of 280 km/h or less shall apply on plain line track.

Laying rails without inclination shall be allowed in switches and crossings on upgraded lines, provided that it is limited, on line sections designed for running at more than 200 km/h, to the switching and crossing work alone.

4.3.3.12. Railhead profile***Lines specially built for high-speed, lines specially upgraded for high-speed and connecting lines***

The railhead profile is defined on the rail design drawing as a succession of circles forming a continuous curve; this curve changes as a result of wear and generally tends towards a constant shape, whose measurement requires the use of high precision methods for establishing equivalent conicity.

The railhead profile shall comprise a lateral slope on the side of the railhead angled to between 1/20 and 1/17,2 with reference to the vertical axis of the railhead, followed by, in the direction of the upper surface, a succession of curves with radii of 12,7 or 13 mm, and then 80 and 300 mm, as far as the vertical axis of the railhead.

This element describing a track component is described in Section 5 on 'interoperability constituents' (5.2.1).

This feature may be modified, in conjunction with the elements 'rail inclination' (4.3.3.11), 'track gauge' (4.3.3.10) and 'axle characteristics' (4.2.10 of the rolling stock TSI) and according to the requirements set out in the previous paragraph with respect to rail inclination.

4.3.3.13. Vertical loads on structures

Lines specially built for high-speed, lines specially upgraded for high-speed and connecting lines

The vertical loads of one of the load models defined in Point 6.3 of standard ENV 1991-3 shall be used in the design calculations for structures on new lines; the α coefficient defined in Point 6.3.2 'Load model 71' shall be taken as at least equal to 1.

To guarantee their dynamic behaviour in current or future traffic, structures shall be calculated with ten reference convoys (see Annex I to the present TSI), whose set is called universal dynamic train (TDU). For each of the convoys, the determined acceleration at the middle span of each of the spans of the bridge (or elements of aprons), of the structure (or of its elements) must be lower than the acceptable acceleration (i.e. 0,35 g for a ballasted structure and 0,5 g for a non-ballasted structure); the deflection at the middle span shall be lower than the acceptable deflection (Annex G of the standard ENV 1991-3).

These checks shall be made for a speed range between 0 km/h and 1,2 V km/h, V being the potential speed of the line.

Methods can be developed to choose the most aggressive one among these convoys within the considered speed range for a given structure. For isostatic structures in particular the convoy to be retained can be determined according to the method of aggressiveness developed by the UIC.

A check has to ensure that the effects of the universal dynamic train must be included in the load models allowing to calculate resistance and deformations. If it is not the case, the universal dynamic train itself shall replace these load models.

The design of the track-bearing structures shall also take into account, to comply with Article 5(4) of the Directive, the technical characteristics (axle load, speed) of the non-interoperable trainsets that might be authorised to run on the line.

4.3.3.14. Transverse horizontal loads on structures

Lines specially built for high-speed, lines specially upgraded for high-speed and connecting lines

The track-bearing structures shall be designed to withstand the horizontal force from the centrifugal and nosing forces exerted by the vehicles, for all the vehicles expected to run on the line (service vehicles, high-speed vehicles and other trains).

Accordingly, the horizontal loads defined in Point 6.5 of standard ENV 1991-3, in Points 6.5.1 'Centrifugal forces' and 6.5.2 'Nosing forces', shall be used in the design calculations for structures on new lines.

In applying Point 6.5.1 (6)P, the calculation called for in reduced load model 71 (6.5.1(6)P(b)) shall be sufficient.

4.3.3.15. Longitudinal loads on structures

Lines specially built for high-speed, lines specially upgraded for high-speed and connecting lines

When designing structures for new lines, longitudinal forces shall be calculated according to the specifications in Points 6.5 of standard ENV 1991-3, (refer to 6.5.3 and 6.5.4.4). For application of 6.5.3.4, the limit of 1 000 tonnes for the total weight of high-speed trains defined above for a complete traffic unit shall be taken into account.

4.3.3.16. Resistance of the track, switches and crossings to vertical loads

Lines specially built for high-speed

The track and its component parts, in their normal service condition as well as in the conditions resulting from maintenance work, shall be able to withstand at least the maximum limiting vertical forces defined in Point 4.1.4 of this TSI.

This requirement is deemed to be met if the requirements with respect to the track components, defined in Chapter 5 'Interoperability constituents' for the rail (5.2.1), rail fastening systems (5.2.2) and sleepers and bearers (5.2.3) interoperability constituents are met.

Other types of track components, or other types of track superstructure systems may be used, provided that the adjudicating entity or the Infrastructure Manager demonstrates by a technical study that the system of track construction, as laid, has a resistance to vertical loads equivalent to, or better than that required to withstand the abovementioned forces. This demonstration may be made by a stress calculation for the different track components (rails, sleepers or track bearers).

The choice of track components shall also, to comply with Article 5(4) of the Directive, take account of the technical characteristics (axle load, speed) of the non-interoperable trains that might run on the line.

Lines specially upgraded for high-speed and connecting lines

For this element, the requirements on existing lines specially upgraded for high-speed are met for the running of trains other than interoperable trains. The requirements set out in the previous paragraph and in Chapter 5 for the corresponding interoperability constituents may be waived on these lines.

The operational maintenance requirements for this element are the subject of the provisions of Point 4.2.3.2.2 (Maintenance plan).

4.3.3.17. Resistance of the track, switches and crossings to lateral loads

Lines specially built for high-speed

The track and its components, in their normal service condition as well as in the conditions resulting from maintenance work, shall be able to withstand the maximum limiting lateral forces exerted by high-speed interoperable vehicles, and, where required, by other vehicles. This limit is one of the parameters specifying the wheel-rail interface restated in Point 4.1.4 and shall be set to:

$$(\Sigma Y)_{\max} = 10 + \frac{P}{3} \text{ kN, where } P \text{ is the maximum axle load of the vehicles allowed to operate on the line.}$$

Provided the requirements of Point 7.3 are met, this requirement shall be deemed to have been met:

- by slab track,
- by ballasted track if the three following requirements are also met:
 - (1) the components of plain track and switches and crossings, except for the actual switches and crossings, comply with the requirements of Chapter 5 'Interoperability constituents' in respect of the rail (5.2.1), rail fastening systems (5.2.2) and sleepers and bearers (5.2.3) interoperability constituents;
 - (2) the main tracks operated at high-speed are laid on concrete sleepers for their whole length, except for short sections not exceeding 10 m, separated from one another by at least 50 m;
 - (3) the track comprises at least 1 600 fastening systems per rail, per kilometre length.

Other types of track components, or other types of track may be used, provided that the adjudicating entity or the Infrastructure Manager demonstrates by a technical study that the system of track construction, as laid, has a resistance to lateral loads equivalent to, or better than that required to withstand the abovementioned maximum limiting lateral forces. This demonstration may be made by a lateral resistance test. In this case, the conformity assessment shall be made under provisions laid down in Point 6.2.

Lines specially upgraded for high-speed and connecting lines, tracks laid in stations and stabling and service tracks

For this element, the requirements for existing lines upgraded for high-speed, for connecting tracks, for tracks in stations which are not operated at high-speed and for service and stabling tracks are met for trains other than interoperable trains. The requirements set out in the preceding paragraph and in Chapter 5 for the corresponding interoperability constituents may be waived on these lines.

The operational requirements to be respected in maintenance of this element are the subject of the provisions of Point 4.2.3.2.2 (Maintenance plan).

4.3.3.18. Track geometrical quality

Lines specially built for high-speed, lines specially upgraded for high-speed and connecting lines

Track geometry defects shall not exceed the following limits for longitudinal level, cross level, line and gauge:

Permissible local speed in km/h	Alignment		Longitudinal level	
	Values of quality level in mm		Values of quality level in mm	
	QN 1	QN 2	QN 1	QN 2
Absolute maximum value Δy_{\max}^0 and Δz_{\max}^0 (mean to peak)				
$v \leq 80$	12	14	12	16
$80 < v \leq 120$	8	10	8	12
$120 < v \leq 160$	6	8	6	10
$160 < v \leq 200$	5	7	5	9
$200 < v \leq 300$	4	6	4	8
Standard deviation Δy_{σ}^0 and Δz_{σ}^0				
$v \leq 80$	1,5	1,8	2,3	2,6
$80 < v \leq 120$	1,2	1,5	1,8	2,1
$120 < v \leq 160$	1,0	1,3	1,4	1,7
$160 < v \leq 200$	0,8	1,1	1,2	1,5
$200 < v \leq 300$	0,7	1,0	1,0	1,3
Note: QN 1 not applicable.				

- for longitudinal level and alignment: the QN3 values, defined as above (for absolute maximum values Δy_{\max}^0 and Δz_{\max}^0 max, QN 3 is defined as $QN\ 3 = 1,3 \times QN\ 2$),
- for track twist: the track twist limit is 5 mm/m for $V > 160$ km/h and 7 mm/m for $V \leq 160$ km/h, measured on the longitudinal base of 3 m,

- for the mean gauge over 100 m, the values given in the track gauge paragraphs (Point 4.3.3.10) of Point 4.3.3 herein for different line performance levels.

In the event that any of these values are exceeded, a speed restriction shall be imposed.

The operational requirements to be respected in maintenance of this element are the subject of the provisions of Point 4.2.3.2.2 (Maintenance plan) on in-service tolerances.

4.3.3.19. **Switches and crossings: profile of rails in switches and crossings**

(for the record)

4.3.3.20. **Switches and crossings: functional requirements**

Lines specially built for high-speed

The switch rails and swing noses of turnouts and diamond crossings shall be equipped with means of securing and locking.

Switches and crossings laid on high-speed lines yet to be built for speeds greater than or equal to 280 km/h, shall be built with swing noses. On future-build high-speed line sections and their connecting lines intended for a maximum speed of less than 280 km/h, switches and crossings with fixed point rails may be used.

The technical characteristics of these switches and crossings shall comply with the following requirements:

Definition	Nominal dimension (mm)	Construction tolerance (mm)	Tolerance during operation (mm)
1	2	3	4
Crossing gauge: A1, A2, A3, A4	1 435	+ 2 - 1	+ 5/- 2 ⁽²⁾
Flange groove width	40 ⁽¹⁾	+ 0,5 - 0,5	⁽¹⁾
Check-rail gauge: C1, C2, C3, C4	1 395	+ 0,5 - 0,5	≥ 1 393
Flangeway: B1, B2	1 355 ⁽¹⁾	≤ 1 356	≤ 1 356
Excess height of the check rail H	points: 0 ≤ H ≤ 60 crossings: 45 ≤ H ≤ 60	+ 2 - 1	+ 10

⁽¹⁾ The nominal flange groove, check-rail gauge and flangeway dimensions are construction values of crossings and check-rail and depend on the existing points and crossings. In any case, the minimal value of the check-rail gauge and the maximal value of the flangeway must be respected.

⁽²⁾ The tolerance of the crossing gauge may apply provided that the minimal value of the check-rail gauge and the maximal value of the flangeway are observed.

Lines specially upgraded for high-speed and connecting lines

Only the functional dimensions and clearances of the above paragraph shall be applied.

The operational requirements to be respected in maintenance of this element are the subject of the provisions of Point 4.2.3.2.2 (Maintenance plan) on in-service tolerances.

4.3.3.21. Resistance of the track, switches and crossings to braking and acceleration forces

The components of the infrastructure shall be able to withstand the mechanical and thermal stresses from vehicle braking and acceleration, as defined by the following interoperability criteria (defined by the rolling stock TSI).

Mechanical strength condition

The total braking effort of all the braking systems together shall not impart a deceleration (ratio of the braking effort to the weight on rail) of more than $2,5 \text{ m/s}^2$ during the highest-energy braking phases, both in terms of the ratio of the total, cumulative effort per train to the whole-train weight and in terms of the ratio of the mean maximum local force exerted by each axle-carrying unit (bogie or bissel truck) to that unit's weight on rail.

Thermal condition

Braking systems which are not dependent on wheel-rail adhesion and which dissipate kinetic energy through heating the rail ⁽¹⁾ shall not create braking forces of more than:

- case 1: 360 kN per train (single or multiple unit trainsets) in the case of emergency braking,
- case 2: for other braking cases, such as a normal service braking for speed reduction or non repetitive braking to a halt, or repetitive braking for speed control, pending the publication of the corresponding European specification or CEN standard, the use of the brake and the maximum braking force allowed under the latter conditions of use shall be determined by the Infrastructure Manager for each interoperable line concerned. These conditions shall be published in the Infrastructure Register of the line concerned.

Braking systems on board interoperable trains are adjustable to comply with the above values as set down in Point 4.2.15 of the rolling stock TSI.

The rail temperature increase depends not only on the braking forces described above, but also on the number of repetitive brake applications made on the same track section, in particular for the two last cases described. Thus it is up to the Infrastructure Manager to define, for the section of line concerned, the permissible brake force level as described in Section B hereafter, taking into account local climatic conditions.

In applying the above interface criteria, the following provisions shall be applied by Infrastructure Managers:

- A — Specifications relevant to the mechanical condition for the maximum braking force

The required track strength is ensured by the provisions hereunder:

Lines specially built for high-speed

The minimum resistance of the rail fastening system to rail slip in the longitudinal direction shall be higher than 9 kN, except for those 'sliding' fastening systems specifically designed to allow rail expansion at the ends of track bearing structures or in track expansion devices.

Provided the requirements of Point 7.3 of this TSI are observed, this requirement shall be deemed to be met if the requirements for track components set down in Chapter 5 'Interoperability constituents' relating to the rail (5.2.1), the rail fastening systems (5.2.2) and sleepers and bearers (5.2.3) interoperability constituents are met.

⁽¹⁾ The rail temperature increase due to energy dissipated in it amounts to $0,035 \text{ }^{\circ}\text{C}$ per kN of braking force per rail string; the case 1 described (for both rail strings) thus corresponds to rail temperature increases of around $6 \text{ }^{\circ}\text{C}$ per train.

Other types of track components, or other types of track superstructure systems may be used, provided that the adjudicating entity or the Infrastructure Manager demonstrates by a technical study that the system of track construction as a whole, as laid, has a resistance to longitudinal loads equivalent to, or better than that required to withstand the maximum longitudinal forces described in the previous paragraph for the mechanical and thermal conditions. This may be demonstrated by a longitudinal resistance test as per the applicable European specification or CEN standard. In that case, the conformity assessment shall be made under provisions laid down in Point 6.2.

Lines specially upgraded for high-speed and connecting lines

For this element, the requirements for existing lines specially upgraded for high-speed are satisfied for traffic other than interoperable trains. The requirements stated in the previous paragraph and in Chapter 5 with respect to the corresponding interoperability constituents may be waived on these lines.

B — Specifications relevant to the thermal condition for the maximum braking force created by braking systems independent of wheel-rail adhesion

The rail temperature increase depends on both rolling stock factors, and the properties of the line concerned (such as local climatic conditions and the required braking conditions), the following provisions shall be applied:

Lines specially built for high-speed, lines specially upgraded for high-speed and connecting lines

- On all the lines of the trans-European high-speed railway network, the Infrastructure Managers shall authorise the use of these types of brakes for emergency braking (case 1). The track structure characteristics described in Section A above, together with Point 4.3.3.17, ensure that this requirement can normally be met.
- For any line of the trans-European high-speed railway network, the Infrastructure Manager shall define, taking into account local specific features, the permissible conditions for operating brakes in case 2, which can be:
 - prohibition of this type of brakes for case 2: only emergency braking is allowed,
 - allowance for the use of such braking systems to the limit stated in Section A above.

As acceleration forces are generally smaller than braking forces, no special requirement is made, except for any combined load cases prescribed for the design of engineering structures (4.3.3.13).

4.3.3.22. Track stiffness

In order to reduce the vertical dynamic forces between wheels and rails, the track stiffness shall be limited by using suitable pads beneath the rails.

Lines specially built for high-speed

- The dynamic stiffness of the rail pad of fastening systems on concrete sleepers shall not exceed 600 MN/m.
- The overall dynamic stiffness of rail fastening systems on slab track shall not exceed 150 MN/m.

Subject to the requirements of Section 7.3 of this TSI, this requirement shall be deemed to be met if the requirements for track components set down in Chapter 5 'Interoperability constituents' for the fastening systems interoperability constituent (5.2.2) are met.

Other types of track components, or other types of track superstructure systems may be used, provided that the adjudicating entity or the Infrastructure Manager demonstrates by a technical study that the system of track construction as a whole, as laid, has a dynamic stiffness equivalent to, or better than that stated above for slab tracks. In this case, the conformity assessment shall be made under the provisions of Point 6.2.

Lines specially upgraded for high-speed and connecting lines

For this element, the requirements for existing lines specially upgraded for high-speed are satisfied for traffic other than interoperable trains. The requirements stated in the previous paragraph and in Chapter 5 with respect to the corresponding interoperability constituents may be waived on these lines.

4.3.3.23. Effects of cross winds

Interoperable vehicles are designed to ensure that their overturning or derailment safety criteria remain valid when the vehicles are subjected to cross winds of a maximum speed defined by the applicable European specifications or CEN standards.

Each Member State shall define for each interoperable line the rules to be applied to both vehicles and infrastructure to guarantee the stability of vehicles subjected to crosswinds. These rules shall be published in the Infrastructure Register for the interoperable line concerned.

If local points along the infrastructure covered by this TSI are at risk from higher wind speeds, either due to their geographic situation or to local specific features of the line (such as its altitude above surrounding ground level), the Infrastructure Manager must take the necessary measures to maintain the level of traffic safety, by:

- locally reducing train speeds, possibly temporarily during periods at risk of storms,
- installing equipment to protect the track section concerned from cross winds,
- or taking necessary steps to prevent vehicle overturning or derailment, by means of appropriate devices.

4.3.3.24. Hotbox detectors

The TSI on rolling stock prescribes train-borne systems for monitoring the temperature of their axle boxes.

If axle box temperature monitoring equipment must nevertheless be installed on the ground to monitor trains not yet equipped with such train-borne systems or other types of trains running on the line, this shall be compatible with, or made to be compatible with the interoperable high-speed trainsets. In particular, passage of interoperable trainsets past such detectors shall not cause spurious alarms which might halt or slow high-speed trains.

Interim measures that may be necessary to ensure such compatibility are specified in Chapter 7, 'Implementation'.

4.3.3.25. Access to or intrusions into the line installations

Lines specially built for high-speed, where the speed is equal to or higher than 300 km/h, shall include lateral protection of the railway right of way so as to prevent undesirable access or intrusions, at least at those sites where the associated risk may be considered as unacceptable.

So as to limit the risk of collision between road vehicles and interoperable trains, high-speed lines to be built shall not include level crossings open to road traffic. On existing lines upgraded for high-speed and on connecting lines, the Infrastructure Manager or his delegate shall apply the national regulatory provisions, for road level crossings and associated provisions which are appropriate to limit collisions with road vehicles as defined by the Member State. These national rules shall take into account, where required, the crash resistance characteristics of interoperable vehicles as defined in the rolling stock TSI, Point 4.1.7(b) and Annex A.

Other measures to prevent access or undesirable intrusion by persons or vehicles into the railway infrastructure are the subject of national regulations of the Member State responsible for commissioning the line.

4.3.3.26. **Passenger platforms**

Lines specially built for high-speed

Passengers must not be able to access areas of platforms close to tracks where trains may run at speeds of 250 km/h or more, except when trains are intended to stop, by either:

- limiting train speed on tracks adjacent to platforms,
- barriers or any other device limiting access to areas near the tracks.

Provided that the requirements of Point 7.3 are observed, either of the values 550 mm or 760 mm is allowed for platform heights; for a given project specially built for high-speed, a single height shall be set for all the platforms of stations on the line which are accessible to high-speed trains.

The tolerances with reference to the nominal relative positioning between track and platform are:

- platform height above the running surface, perpendicular to the running surface: $-30 \text{ mm} / +0 \text{ mm}$,
- distance between the edge of the platform and the centre of the track, parallel to the running surface: $-0 \text{ mm} / +50 \text{ mm}$.

On the parts of platforms accessible to passengers, all equipment with which the passengers may have contact shall be designed to prevent unacceptable risk of electric shock. Unless otherwise stated in Point 7.3, the provisions set down in Chapters 4 and 5 of standard EN 50 122—1 relative to public areas shall be enforced regarding such equipment.

Platforms at stations where interoperable trains stop shall allow disabled passengers access to the trains. The provisions of the appropriate European specifications or standards, relative to publicly accessible passenger platforms of inter-city railway networks, shall be enforced, particularly concerning the following items:

- floor covering and surface geometry, which shall allow an easy movement of wheelchairs and pushchairs,
- waiting and resting zones, which shall have seats with easy access and room to park wheelchairs,
- visual and audible information systems for passengers, which shall allow easy understanding on the part of people with visual or auditory disability.

Existing high-speed lines, lines specially upgraded for high-speed and connecting lines

With the exception of the specific cases described in Point 7.3, the provisions set down in the previous paragraph shall be progressively implemented on platforms of existing stations which are open to interoperable high-speed trains, by applying the implementation procedures described in Chapter 7.

Platform heights shall be adapted to the value which is set for the high-speed line for which the upgraded and connecting lines concerned are the main access.

If the existing situation does not allow easy access for disabled passengers, the railway undertaking shall provide means of assistance for the disabled, which shall be described in the 'Infrastructure Register' of the line concerned so as to inform passengers of this. These measures can be:

- mobile ramps for train access,
- rising platforms.

4.3.3.27. High-speed underground stations

In underground stations and other stations constituting a closed space, care shall be taken to ensure that the public are not subjected to dangerous pressure or slipstream effects generated by trains running at speed, as detailed in the rolling stock TSI.

Pressure effects result from pressure changes induced by the vehicles in the enclosed spaces of the access passages of underground stations, hence these sections shall be treated as tunnels, in terms of the requirements for the element 'works below ground level such as tunnels and cut-and-covers' (4.3.3.6) herein above.

The air streams to which passengers may be exposed in the station are of two kinds. Direct slipstream effects on platforms from trains running alongside, these are acceptable given the limitation of train speeds in stations imposed in the 'passenger platforms' element (4.3.3.26) above. On the other hand, pressure variations may travel between the enclosed spaces in which the trains run and the other spaces of the station, which may produce powerful air currents that passengers cannot withstand.

As each underground station is a special case, there is no single rule for quantifying this effect. It must therefore be the focus of a specific design study, except when the spaces in the station can be isolated from the spaces subjected to pressure variations by means of direct openings to the outside air of cross-sectional area at least half that of the access tunnel.

Failing that, a preliminary study of the station shall be made to limit the air velocities to which passengers are liable to be subjected to a value which is not harmful, as per the applicable national regulations.

In areas of underground stations accessible to passengers, all equipment with which the passengers may have contact shall be designed to prevent unacceptable risk of electric shock. Unless otherwise stated in Point 7.3, the provisions set down in Chapters 4 and 5 of standard EN 50 122-1, relative to public areas shall be enforced regarding such equipment.

Fire protection requirements are described in Point 4.2.3.1.3.

4.3.3.28. Electrical characteristics of the superstructure

The superstructure of the track, i.e. rails, sleepers and fastenings, shall permit, under specified conditions, the transmission of:

- the traction return currents between the vehicle and the substations,
- the signalling currents used by the control command and signalling system.

For the purpose of traction current return, the rail steel specification for this track component is normally sufficient. However, the track must be compatible with any relevant requirements in the energy TSI for the electrification system used.

To ensure transmission of the signalling currents that may be required for certain control command and signalling systems, it may be necessary to guarantee a certain level of isolation between the two rails. This characteristic is a function of the fastening system. The requirement may differ for different control command and signalling systems, according to the functions they must fulfil, the fastening system shall be certified, if it is acquired as one of the interoperability constituents, or checked, if it is integrated as one of the elements of the infrastructure subsystem, against a declared insulation value defined in the first case by the manufacturer and in the second case by the notified body that ascertains that the necessary coherence of this property of the fastening system with the control command and signalling system selected is observed.

The required characteristics and the assessment procedures for this feature of the fastening system are set out in Chapters 5 and 6 for the 'rail fastening systems' interoperability constituent.

5. INTEROPERABILITY CONSTITUENTS

5.1. DEFINITION OF INTEROPERABILITY CONSTITUENTS

According to Article 2(d) of Directive 96/48/EC:

interoperability constituents are 'any elementary component, group of components, subassembly or complete assembly of equipment incorporated or intended to be incorporated into a subsystem upon which the interoperability of the trans-European high-speed rail system depends either directly or indirectly'.

Interoperability constituents are dealt with by the relevant provisions of Directive 96/48/EC and included in the lists given in Annex A to this TSI.

The interoperability constituents are covered by specifications characterised by performance requirements. The assessment of conformity and/or suitability for use will be carried out by checking the performance requirements through the interoperability constituent's interfaces, recourse to conceptual or descriptive characteristics being an exception. In so far as is necessary, specifications for the interoperability constituents described below refer to the European specifications drafted at the Commission's request by the European standardisation bodies: CEN, CENELEC and ETSI; as the specifications for the interoperability constituents, they must be drafted on the basis of performance requirements and exceptionally on descriptive basis.

5.2. DESCRIPTION OF THE INTEROPERABILITY CONSTITUENTS OF THE INFRASTRUCTURE SUBSYSTEM

For the purposes of this technical specification for interoperability, the following interoperability elements, whether individual components or subassemblies of the track, are declared to be 'interoperability constituents'. Consequently, every group of constituents of an interoperable line incorporating all or part of the constituents listed below shall be required to be compliant with the specifications pertaining to each of the constituents involved.

- the rail, (5.2.1: railhead profile and rail steel grade)
- the rail fastening systems (5.2.2)
- track sleepers and bearers (5.2.3)
- switches and crossings (5.2.4).

The following sections describe the specifications applicable to each of these constituents.

5.2.1. **The rail**

In line with Annex IV(2) to the Directive, the intrinsic specifications of the 'rail' interoperability constituent are the following:

- the railhead profile shall comprise a side slope on the flank of the head angled at between 1/20 and 1/17,2 with reference to the vertical axis of the head, followed in moving towards the top surface of the head by a succession of curves with a radius of 12,7 or 13 mm, then 80 and 300 mm as far as the vertical axis of the railhead,
- the minimum mass of the rail shall be more than 53 kg/m,
- the steel grade of the rail shall be as defined by the CEN standard applicable.

The specifications of the 'rail' interoperability constituent make reference to the characteristics defined:

- *for plain line rails:*
 - the applicable railhead profile specifications are defined in Annex K2 to the present TSI,
 - the applicable rail steel grade specifications are defined in Annex K1 to the present TSI.

- *for rails specific to switches and crossings:*
 - the applicable railhead profile specifications shall be those adopted for the rail profiles defined in Annex L2 to the present TSI,
 - the applicable rail steel grade specifications shall be those defined in Annex L1 to the present TSI.

The detailed specifications and descriptions of the testing methods which shall be applied to the constituent 'rail' are described in Annex A of the TSI.

The assessment of conformity of the constituent 'rail' to the above specifications is subject to the provisions set in Point 6.1 of the TSI.

5.2.2. ***The rail fastening systems***

The applicable specifications for the 'rail fastening systems' interoperability constituent entailing definition of the constituent's interfaces, in the sense of Annex IV(2) to the Directive are the following:

- the minimum resistance to rail longitudinal slip in the fastening system shall be greater than 9 kN, except for 'sliding' fastening systems on structures and expansion joints,
- the resistance to repeated loading shall be at least the same as that required for main line track in the CEN Standard (test load of 70 to 80 kN depending on the stiffness of the rail pad),
- the dynamic stiffness of the rail pad shall not exceed 600 MN/m for fastening systems on concrete sleepers,
- the overall dynamic stiffness of the fastening systems for rail in slab track shall not exceed 150 MN/m,
- the minimal electrical resistance required is 5 kΩ; certain control command and signalling systems may make higher resistance values necessary, the value obtained in the test defined hereinafter shall be mentioned on the certificate of conformity and it shall be considered as the one certified for purposes of interoperability. The electrical resistance of the fastening system shall be evaluated and the product certification shall mention the insulation value guaranteed by the manufacturer in order to allow the adjudicating entity to ensure compatibility with the chosen control command and signalling system.
- the fastening systems shall have passed an assessment of in service behaviour,

The interfaces of the 'rail fastening systems' interoperability constituent which must be checked in the assessment of conformity are the rail, the rail inclination, the type of sleepers or track bearers and the simulated loads for each characteristic concerned. The performance of the 'rail fastening systems' interoperability constituent must be verified for all the combinations of rail and sleeper types used in the infrastructure subsystem.

The assessment of in service behaviour must also be made with those same combinations, on a line where the speed of the fastest trains shall be at least 160 km/h and the heaviest axle load of the rolling stock shall be at least 170 kN, where at least 1/3 of the fastening systems tested are laid on curves.

5.2.3. ***Track sleepers and bearers***

The applicable intrinsic specifications for the 'track sleepers and bearers' interoperability constituent are the following:

- the mass of the sleepers or track bearers used in ballasted track shall be at least 220 kg,
- concrete sleepers shall have a minimum length of 2,25 m.

The detailed specifications and descriptions of the testing methods which shall be applied to the constituent 'track sleepers and bearers' are described in Annex A to the present TSI.

The assessment of conformity of the constituent 'track sleepers and bearers' to the above specifications is subject to the provisions set in Point 6.1.

5.2.4. **Switches and crossings**

The switches and crossings are subassemblies of the superstructure. They contain some of the interoperability constituents mentioned before and their own design characteristics may be assessed for intrinsic compatibility.

The intrinsic specifications for the 'switches and crossings' interoperability constituent are the following:

- the rail constituents of the switches and crossings shall comply with the specifications of the 'rail' interoperability constituent,
- the plain line rail fastening systems used in switches and crossings outside of the switch and crossing zones shall comply with the specifications of the 'rail fastening systems' interoperability constituent,
- the functional design dimensions, namely the width of the flangeways, the dimension of nose protection, the running clearance, the height of raised check rails and the track gauge, shall meet the specifications of point 4.3.3 for the elements 'switches and crossings: functional conditions' (Point 4.3.3.20) and 'track gauge and tolerances' (Point 4.3.3.10) as concerns the design values and their tolerances,
- for each type of switch or crossing, the operational conditions of use shall be defined by the manufacturer, who shall determine and specify the following:
 - depending on their use in straight or curved layouts, the allowable speeds on the diverging line, to comply with the applicable specifications under Point 4.3.3 for the element 'cant deficiency on diverging track of switches and crossings' (Point 4.3.3.8 (b)): the cant deficiency on diverging track shall be limited to 85 mm or 100 mm according to the intended speed through the layout,
 - the permissible speeds on the main line route shall be set according to whether or not the switch has a swing-nose and as a function of the rail inclination, as per the specifications of Point 4.3.3 for the two elements 'switches and crossings: functional conditions' (4.3.3.20) and 'rail inclination' (4.3.3.11).

The applicable specifications for the 'switches and crossings' interoperability constituent make reference to the following characteristics:

rails and rail fastening systems used on plain line track in switches and crossings:

the applicable specifications and standards for these components are defined in the paragraphs relevant to these constituents,

intrinsic specifications for the subsystem:

- the functional dimensions are mentioned in Point 4.3.3.20 of this TSI,
- the operational conditions for running over the diverging line are given in Point 4.3.3 of this TSI.

The detailed specifications and descriptions of the testing methods which shall be applied to the constituent 'switches and crossings' are described in Annex A to the TSI.

The assessment of conformity of the constituent 'switches and crossings' to the above specifications is subject to the provisions set in Point 6.1 of the TSI.

6. ASSESSMENT OF CONFORMITY AND/OR SUITABILITY FOR USE

6.1. INTEROPERABILITY CONSTITUENTS

6.1.1. *Conformity and suitability for use assessment procedures (modules)*

The assessment procedure for conformity and suitability for use of interoperability constituents as defined in Chapter 5 of this TSI shall be carried out by application of modules as specified in Annex C to this TSI.

Assessment procedures for conformity and suitability for use, description of the testing methods for the interoperability constituents: rail, rail fastenings, track sleepers and bearers, and switches and crossings, as defined in Chapter 5 of this TSI, are indicated in Annex A to this TSI.

As far as required by the modules specified in Annex C of this TSI, the assessment of conformity and of suitability for use of an interoperability constituent shall be appraised by a notified body, when indicated in the procedure, with which the manufacturer or his authorised representative established within the Community has lodged the application.

The manufacturer of an interoperability constituent or his authorised representative established within the Community shall draw up an EC declaration of conformity or an EC declaration of suitability for use in accordance with Article 13(1) of, and Annex IV Chapter 3 to, Directive 96/48/EC before placing the interoperability constituent on the market. An EC declaration of suitability for use is only required for the interoperability constituent 'rail fastening system' of the infrastructure subsystem.

In the case where a constituent to be incorporated into the infrastructure subsystem has not received the EC declaration of conformity or the EC declaration of suitability for use, either because its intrinsic characteristics are different from those provided for in the TSI (new products), or because the specifications fulfilled are not those described in Annex A for the constituent under evaluation, the assessment of conformity shall be subject to the provisions set for the subsystem in Point 6.2 hereafter. In particular, the notified body shall check that the intrinsic characteristics and the suitability for use of the constituent under evaluation fulfil the relevant provisions of Chapter 4, which describe the functions required of the constituent in the subsystem. Provided a positive evaluation of the constituent has been obtained during the verification of an infrastructure project, further incorporation of this constituent shall be allowed in other projects, as far as the constituent's interfaces in the new application are identical to the initial application.

In this case, the properties and specifications of the constituent, which contribute to the requirements specified for the subsystem, shall be completely described with their interfaces during this initial verification to enable further evaluation as a constituent of the subsystem. Further conformity assessment of this constituent shall be done following the modules described in Point 6.1.2.1 below for 'new products'.

6.1.2. *Application of modules*

6.1.2.1. **Assessment of conformity**

Conventional products

For the assessment procedure of each interoperability constituent of the infrastructure subsystem, the properties of which satisfy the requirements of Annex A, the manufacturer or his authorised representative established within the Community shall apply the internal production control procedure (module A) indicated in Annex C, C.2 of this TSI for all phases of design and production.

The conformity assessment shall cover the phases and characteristics as indicated by X in the tables of Annex A, Tables A.1 to A.4 of this TSI.

'New products'

For further assessment procedures of any constituent of the infrastructure subsystem, having properties which differ from those described in Annex A, but having satisfied initially the verification procedure of an

infrastructure subsystem, and where application in the new subsystem is made with identical interfaces as for the initial application, the manufacturer or his authorised representative established within the Community may choose either:

- the examination procedure (module B) indicated in Annex C.3 of this TSI for the design and development phase in combination with the production quality assurance procedure (module D) indicated in Annex C.4 of this TSI for the production phase, or
- the examination procedure (module B) indicated in Annex C.3 of this TSI for the design and development phase in combination with the production verification procedure (module F) indicated in Annex C.5 of this TSI for the production phase, or
- the full quality assurance with design examination procedure (module H2) indicated in Annex C.6 of this TSI for all phases.

The module H2 may only be chosen where the manufacturer operates a quality system for design, production, final product inspection and testing, approved and supervised by a notified body.

The conformity assessment shall cover the phases and characteristics indicated by X in the tables of Annex A, Tables A.1 to A.4, of this TSI; this indication describes the properties of the 'new product' which contribute to the requirements of the subsystem as defined in Chapter 4 of this TSI, which have been verified by an initial assessment of a complete subsystem as indicated in Point 6.2, and completely described and specified for this initial application.

6.1.2.2. **Assessment of suitability for use**

For the assessment of use of the interoperability constituent 'rail fastening system' of the infrastructure subsystem, the manufacturer or his authorised representative established in the Community shall apply the type validation of in service experience (module V) indicated in Annex C.7 of this TSI.

6.1.2.3. **Definition of assessment procedures**

These assessments procedures are defined in Annex C of this TSI.

6.2. INFRASTRUCTURE SUBSYSTEM

6.2.1. **Assessment procedures (modules)**

At the request of the adjudicating entity or its authorised representative established within the Community, the notified body carries out the EC verification in accordance with Article 18(1) of and Annex VI to Directive 96/48/EC, and in accordance with the provisions of the relevant modules as specified in Annex C of this TSI.

If the adjudicating entity can demonstrate that tests or verifications of interoperability constituents have been considered successful for previous applications, these assessments shall remain valid in the new applications, and the notified body shall take them into account in the conformity assessment.

Assessment procedures for the EC verification of the infrastructure subsystem, list of specifications and descriptions of the testing procedures are indicated in Annex B, Tables B.1 to B.10 to this TSI.

As far as specified in this TSI, the EC verification of the infrastructure subsystem shall take into account its interfaces with other subsystems of the trans-European high-speed rail system.

The adjudicating entity shall draw up the EC declaration of verification for the infrastructure subsystem in accordance with Article 18(1) of and Annex V to Directive 96/48/EC.

6.2.2. **Application of modules**

For the verification procedure of the infrastructure subsystem, the adjudicating entity or its authorised representative in the Community may choose either:

- the unit verification procedure (module SG) indicated in Annex C.8 of this TSI, or
- full quality assurance with design examination procedure (module SH2) indicated in Annex C.9 of this TSI.

The SH2 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 system for design, production, final product inspection and testing, approved and surveyed by a notified body.

The assessment shall cover the phases and characteristics as indicated in Annex B, Tables B.1 to B.10 to this TSI.

If functions of the infrastructure subsystem are not completely met by the integration of interoperability constituents as defined in this TSI, but by other components, not defined as interoperability constituents in this TSI, the equivalence of the solutions thus retained for the subsystem must be verified at the subsystem verification phase of the procedure as indicated in Tables B.7 and B.8.

6.3. EC VERIFICATION AND PUTTING INTO SERVICE THE INFRASTRUCTURE SUBSYSTEM

EC verification of the infrastructure subsystem takes account of its compliance with the integrity of the trans-European high-speed rail system of which this subsystem forms part.

Authority to put the subsystem into service shall be given by a Member state, in accordance with Article 14 of Directive 96/48/EC and following the procedure of Annex VI to the Directive.

6.3.1. **Verification of track conformity**

The adjudicating entity, or its representative, or the Infrastructure Manager shall define, in connection with the State Authority concerned, the practical measures and the different phases which are necessary for allowing, in due time, the opening to service with the required performances. These phases may include transition periods of putting into service with reduced performances. In particular, for ballasted tracks, it may be necessary to proceed by means of successive phases of pre-commercial service at reduced speed, followed by speed incremental upraising depending on the total elapsed traffic, the latter taking into account the level of track stabilisation obtained by artificial means.

Before commissioning the infrastructure of a line built for high-speed, and under consideration of the phases of commissioning defined above, the line shall be submitted to one or several test runs to ensure the suitability of the track works as built under the conditions of high-speed running from the mechanical standpoint.

This test involves running a commercial trainset with mechanical characteristics as close as possible to those specified for interoperable trainsets, if not a trainset whose conformity to Directive 96/48/EC has been checked as a subsystem. The test runs shall be made up to speeds augmented as per the conditions foreseen in the rolling stock TSI for vehicle acceptance. The Member State responsible for putting the line into service, as stated in Point 6.2.4 of this TSI, shall set the parameters which must be measured during this test and be subsequently analysed, and the limits to be met by those parameters in order to grant the fitness for service.

At the least, these parameters shall include the following:

- lateral acceleration of the middle of the frame or of the bissel truck of the leading bogie of the trainset in the running direction and of the bogie of an intermediate vehicle,

- lateral acceleration of the coach body, as close as possible to the bogie or bissel, at the front and rear and in an intermediate vehicle of the train.

The limit values defined by the Member State for these parameters in view of granting fitness for service of the line shall not exceed the corresponding limits specified in CEN standard prENV 256 016 (currently draft version: CEN/TC 256 N 368 as by 22 March 1999 or UIC Leaflet 518, 2nd edition, 1 October 1999 issue).

When projects for upgrading existing lines are concerned, similar tests may also be carried out, if they are considered necessary depending on the nature of the upgrades involved, and on the specific requirements which have been notified to the adjudicating entity, or to the Infrastructure Manager, by the authority responsible for authorising the line to be put into service.

7. **IMPLEMENTING THE INFRASTRUCTURE TSI**

7.1. APPLICATION OF THIS TSI TO HIGH-SPEED LINE TO PUT INTO SERVICE

As to the high-speed lines within the geographic scope of this TSI (see Point 1.2) which will be put into service after the entry into force of this TSI, Chapters 2 to 6 are entirely applicable, as well as possible specific provisions of Point 7.3 hereafter.

7.2. APPLICATION OF THIS TSI TO HIGH-SPEED LINES ALREADY IN SERVICE

In respect of infrastructure installations already in operation, this TSI applies to components under the conditions specified in Article 3 of this Decision. In this particular context, it relates fundamentally to the application of a migration strategy that enables an economically justifiable adaptation of existing installations to be made taking into account the principle of grandfather rights. The following principles apply in the case of the TSI on infrastructure.

7.2.1. ***Typology of work***

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

Taking into account the foreseeable life span of the different parts of the infrastructure subsystem the list of those parts in descending order of difficulty of modification is as follows:

Civil engineering:

- line layout (radius of curves, the distance between track centres, up and down gradients),
- tunnels (clearance and cross-sectional area),
- railway structures (resistance to vertical loads),
- road structures (clearances),
- stations (passenger platforms);

Track superstructure:

- switches and crossings,
- running line superstructure;

Miscellaneous equipment:

For these three groups, the Infrastructure Manager will proceed as follows:

7.2.2. *Parameters and specifications concerning civil engineering*

They will be brought into conformity in the course of major infrastructure upgrading projects intended to improve line performance.

The elements concerning the civil engineering of infrastructures involve the most constraints, since more often than not they can only be modified when complete restructuring work is carried out (structures, tunnels, earth works).

In stations, account should also be taken, with regard to the conformity of the heights and lengths of platforms, of the assignment of an adequate number of tracks to receive interoperable trains, as well as the availability of ancillary equipment to help disabled passengers. The height of the designated high-speed platforms in any given station will be brought to a single height during an upgrading project.

7.2.3. *Parameters and characteristics concerning superstructure*

They are less critical as regards partial modifications, either because they can be gradually modified by areas of limited geographical extent or because certain components can be modified independently of the whole of which they form part.

They will be brought into conformity in the course of major infrastructure upgrading projects intended to improve line performance.

It is possible to gradually replace all or part of the superstructure elements by elements in conformity with the TSI. 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, i.e. when all the elements have been brought into conformity with the TSI.

Intermediate stages may, in this case, prove necessary in order to maintain the compatibility of the superstructure with the provisions of other subsystems (control and command and signalling, energy), as well as with the movement of trains not covered by the TSI.

7.2.4. *Parameters and characteristics concerning various equipment*

They will be brought into conformity in accordance with the needs expressed by operators using the stations concerned.

7.2.5. *Speed as migration criterion*

Account can also be taken of the fact that the performances selected, and in particular, line section speed, represent a possible parameter for the temporary adaptation of the characteristics of a line to the interoperability specifications where they can be modulated as a function of that parameter. This possibility, which makes it possible to open a route temporarily, should not, however, hinder the subsequent adoption, when this can be reasonably envisaged, of specifications corresponding to the highest speed, which offer the best possible network performances.

7.2.6. *Case of hot-box detectors*

The following migration strategy should be pursued with regard to the hotbox detectors specified in Point 4.3.3.24.

7.2.6.1. *Temporary situation during which there are no on-board protection systems that have been validated.*

During this period, the Infrastructure Manager by means of ground devices should carry out axle-box surveillance. The railway undertaking wishing to operate services under these conditions (no on-board detection) should contact the Infrastructure Manager in order to ensure that the detection devices in place actually allow surveillance of the axle boxes of its own trains, with an adequate monitoring frequency for the service envisaged.

7.2.6.2. **Definitive situation in which the on-board detection systems exist for high-speed trains and ground detection systems are maintained in order to permit surveillance of the axle boxes of other trains**

The Infrastructure Manager of the line concerned should adapt the surveillance system in such a way as to ensure that the movement of interoperable trains where the surveillance of axle boxes is assured by on-board devices is not disturbed by the ground system.

This can be achieved:

- either by ensuring recognition and discrimination in respect of the different types of train moving on the line, when passing the ground detectors,
- or by ensuring that the detection criteria applied by the ground systems are compatible with the on-board system criteria. In that case, detection by the ground systems constitutes a confirmation of the on-board detection, the use of the results of which should be the subject of a specific agreement between the infrastructure operator and the railway undertaking concerned.

7.3. **SPECIFIC CASES**

The following special provisions are authorised in the following specific cases. These specific cases are classified according to two categories: the provisions apply either permanently ('P' cases), or temporary ('T' cases). As to temporary cases, it is recommended that the target system is reached either by 2010 (cases 'T1'), 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, or by 2020 (cases 'T2').

7.3.1. ***Particular features on the German network (P case)***

Maximum falling and rising gradients

On the high-speed line between Cologne and Frankfurt (Rhein-Main), the maximum falling and rising gradients have been set at 40 ‰.

Pantograph gauge

On existing lines upgraded for high-speed, on connecting lines and in stations, the infrastructure gauge shall be set for a pantograph width of 1 950 mm.

7.3.2. ***Particular features on the Austrian network***

Pantograph gauge (T1 case)

On existing lines upgraded for high-speed, on connecting lines and in stations, the infrastructure gauge shall be set for a pantograph width of 1 950 mm.

7.3.3. ***Particular features on the Danish network***

Minimum length of passenger platforms and stabling tracks (P case)

On the lines of the Danish network, the minimum length for passenger platforms and stabling tracks is reduced to 320 m.

7.3.4. ***Particular features on the Spanish network***

Track gauge (P case)

With the exception of the high-speed lines between Madrid and Seville, and between Madrid and Barcelona to the French border, the lines of the Spanish network are laid with a track gauge of 1 668 mm.

Pantograph gauge (P case)

On existing lines built or upgraded for high-speed, on connecting lines and in stations, the infrastructure gauge shall be set for a pantograph width of 1 950 mm.

Track centre distance (P case)

On existing lines upgraded for high-speed and connecting lines, the distance between track centres may be reduced to a nominal value of 3,808 m.

7.3.5. Particular features on the Finnish network (P cases)**Track gauge**

The Finnish railway network is made up of lines laid to a gauge of 1 524 mm.

Structure gauge

The structure gauge must allow trains built to loading gauge FIN 1 ⁽¹⁾.

Pantograph gauge

The normal height of the contact wire is 6 150 mm.

Minimum length of passenger platforms and stabling tracks

On the lines of the Finnish network, the minimum usable length for passenger platforms and stabling tracks is set at 350 m.

Platform

The distance between the track centre line and the platform edge is 1 800 mm.

7.3.6. Particular features on the British network (P cases)**Platform height**

Platforms used on upgraded lines in Great Britain shall have a standard height of 915 mm with a tolerance of + 0/-50 mm. The platform horizontal distance (L) shall be chosen so as to make optimal use of the step positions on trains built to the UK1 loading gauge ⁽²⁾.

Minimum platform length

The minimum platform length is reduced to 300 m on the upgraded lines of the British network, so as to cope for the limitation of trains' length to 320 m on the upgraded lines of the network.

Stabling tracks: minimum length

On the upgraded lines of the British network, the length of stabling tracks may be limited so as to accommodate for a maximum train length of 320 m.

Structure gauge

The minimum structure gauge on upgraded lines in Great Britain shall allow passage of trains to the UK1 loading gauge.

⁽¹⁾ See Annex N.

⁽²⁾ See Annex M.

Pantograph gauge

On existing lines upgraded for high-speed and their connecting lines, the normal height of the contact wire is 4 720 mm (minimum 4 170 mm, maximum 5 940 mm).

Distance between track centres

The minimum nominal distance between track centres on upgraded lines in Great Britain shall be 3 165 mm.

7.3.7. Particular features on the network of Greece**Track gauge**

The Athinai—Patras line is laid to a gauge of 1 000 mm. A gradual upgrading to the gauge of 1 435 mm is foreseen (T2 case).

Structure gauge

The structure gauge of some sections of the Athinai—Thessaloniki—Idomeni line is limited to GA or GB (P case).

7.3.8. Particular features on Ireland and Northern Ireland networks (P cases)**Structure gauge**

The minimum structure gauge to be used on the lines in Ireland and Northern Ireland is the IRL1 ⁽¹⁾. Irish standard structure gauge.

Track gauge

The railway networks of Ireland and Northern Ireland are made up of lines laid to a gauge of 1 602 mm. By application of Article 7(b) of Council Directive 96/48/EC, projects for new lines in Ireland and Northern Ireland shall keep that gauge.

Minimum radius of curvature

As a track gauge of 1 602 mm will be kept, the provisions of the present TSI concerning the minimum curve radius and the associated elements (track cant and cant deficiency) are not applicable on the railway networks of Ireland and Northern Ireland.

Minimum length of passenger platforms and stabling tracks

On the lines of Ireland and Northern Ireland networks, the minimum usable length for passenger platforms and stabling tracks used by high-speed trains is set at 215 m.

Platform height

On the lines of Ireland and Northern Ireland networks, platforms shall have a design height of 915 mm. Platform heights shall be chosen so as to make optimal use of the step positions on trains built to the IRL1 loading gauge.

Distance between track centres

The minimum distance between track centres on existing lines in Ireland and Northern Ireland shall be increased in advance of upgrading to ensure safe passing clearance between trains.

7.3.9. Particular features on the Netherlands network

Platform height is 840 mm on category II and III lines (P case).

⁽¹⁾ See Annex O.

7.3.10. **Particular features on the Portuguese network**

Track gauge of 1 668 mm on category II and III lines (P case).

7.3.11. **Particular features on the Swedish network (P cases)**

Minimum platform length

The minimum platform length in the case of low traffic lines is reduced to 225 m.

Stabling tracks: minimum length

The length of stabling tracks may be limited so as to accommodate for a maximum train length of 225 m.

7.4. CASES SPECIFIC TO THE TARGET SUBSYSTEM

Where the provisions relating to the specific cases indicated in Point 7.3 are applied, the awarding entity or, where appropriate, the Infrastructure Manager, shall ensure that the subsequent adoption of the target characteristics of this TSI remain possible.

This provision shall apply in particular to the following parameters:

- platform lengths: the position of stations will be chosen in such a way as to allow a length in excess of 400 m,
- pantograph clearance: in some cases economic constraints have led to the choice of continuous current electrification at the project design stage. In those cases, the awarding entity or, where appropriate, the Infrastructure Manager, will ensure that the size of the clearance is such as to enable, at the appropriate time, easier transition to an automating current electrification system which permits better train performance.

7.5. RECOMMENDATIONS

7.5.1. **Characteristics linked to the carriage of disabled persons (BP22)**

In addition to the provisions of Point 4.1.9, infrastructures have to take into account, as appropriate, the results of the COST 335 Action.

ANNEX A

INTEROPERABILITY CONSTITUENTS OF THE INFRASTRUCTURE SUBSYSTEM

A.1. Scope

This annex describes the Conformity assessment of the Interoperability Constituent 'Rail' of the infrastructure subsystem.

A.2. Characteristics to be assessed, testing methods and modules

The characteristics of the interoperability constituents to be assessed in the different phases of design, production and assembly are described in the following Sections A.3 to A.7.

In the associated Tables A.1 to A.4 the phases of design and production concerned by the assessment procedure are marked by an X in these tables.

A.3. Rails on plain line track and in switches and crossings

Table A.1.

Assessment of the interoperability constituent 'rails' for the EC declaration of conformity

1	2	3	4	5	6
Characteristics to be assessed	Assessment in the following phase				
	Design and development phase				Production phase
	Design review	Review of manufacturing process	Type test	In service experience	Product quality (series)
Type and dimensions tolerances (5.2.1(a))	X	X	n.a.	n.a.	X
Hardness (5.2.1(c))	X	X	n.a.	n.a.	X

n.a.: not applicable.

A.4. Rail fastening systems

Table A.2.

Assessment of the interoperability constituent 'rail fastening systems' for the EC declaration of conformity and suitability for use

1	2	3	4	5	6
Characteristics to be assessed	Assessment in the following phase				
	Design and development phase				Production phase
	Design review	Review of manufacturing process	Type test	In service experience	Product quality (series)
Longitudinal rail restraint ⁽¹⁾	n.a.	n.a.	X	n.a.	X
Effect of repeated loading	n.a.	n.a.	X	n.a.	X
Rail pad stiffness (4.3.3.22)	n.a.	n.a.	X	n.a.	X

1	2	3	4	5	6
Characteristics to be assessed	Assessment in the following phase				
	Design and development phase				Production phase
	Design review	Review of manufacturing process	Type test	In service experience	Product quality (series)
Electrical resistance (4.3.3.28)	n.a.	n.a.	X	n.a.	X
System vertical stiffness (slab track) (4.3.3.22)	n.a.	n.a.	X	n.a.	X
In service behaviour	n.a.	n.a.	n.a.	X	n.a.

n.a.: not applicable.

⁽¹⁾ Not relevant for 'sliding' fastening systems on structures and expansion joints.**A.5. Track sleepers and bearers**

Table A.3.

Assessment of the interoperability constituent 'sleepers and bearers' for the EC declaration of conformity

1	2	3	4	5	6
Characteristics to be assessed	Assessment in the following phase				
	Design and development phase				Production phase
	Design review	Review of manufacturing process	Type test	In service experience	Product quality (series)
Mass and dimensions	X	X	X	n.a.	X

n.a.: not applicable.

A.6. Switches and crossings

Table A.4.

Assessment of the interoperability constituent 'switches and crossings' for the EC declaration of conformity or suitability for use

1	2	3	4	5	6
Characteristics to be assessed	Assessment in the following phase				
	Design and development phase				Production phase
	Design review	Review of manufacturing process	Type test	In service experience	Product quality (series)
Switch rail profile (4.3.3.19)	X	X	n.a.	n.a.	X
Functional gauges in S and C design (4.3.3.20)	X	X	n.a.	n.a.	X
Movable point crossing (4.3.3.20)	X	n.a.	n.a.	n.a.	X
Cant deficiency in diverging track (4.3.3.8(b))	X	n.a.	n.a.	X ⁽¹⁾	n.a.
Gauge value in S&C (4.3.3.10)	X	X	n.a.	n.a.	X
Rail cant value in S&C (4.3.3.11)	X	X	n.a.	n.a.	X

n.a.: not applicable.

⁽¹⁾ This is a running test.

ANNEX B

ASSESSMENT OF THE INFRASTRUCTURE SUBSYSTEM

B.1. Scope

This annex indicates the assessment of conformity of the infrastructure subsystem.

B.2. Characteristics and modules

The characteristics of the subsystem to be assessed in the different phases of design, assembly, installation and operation are marked by X in Tables B.1 to B.10. These tables have been laid down so that each table corresponds to a different domain of a project of rail infrastructure, for the activities concerned. The aim of this presentation is to ease the verification procedure for such projects incorporating quite different technical activities depending on several undertakings.

Table B.1.

Assessment of the infrastructure subsystem for the EC verification of conformity
Domain: Civil engineering (general)

1	2	3	4	5
Characteristics to be assessed	Assessment in the following phase			
	Design and development phase	Production phase		
	Design review	Construction, assembling, mounting	Assembled before putting into service	Validation under full operation conditions
Track cant (4.3.3.7)	X	X	n.a.	n.a.
Radius of curvature (4.3.3.8)	X	X	n.a.	n.a.
Vertical and lateral radius of curvature of stabling tracks (4.3.3.5)	X	X	n.a.	n.a.
Rising and falling gradients (4.3.3.4)	X	X	n.a.	n.a.
Track centres distance (4.3.3.2)	X	X	n.a.	n.a.
Presence of a lateral space (4.2.3.2)	X	X	n.a.	n.a.
Environment protection(4.2.3.1.2)	X	X	n.a.	n.a.
Access – intrusions (4.3.3.25)	X	X	n.a.	n.a.
Effects of cross winds (4.3.3.23)	X	X	n.a.	n.a.
Infrastructure Register (4.2.3.2.6)	X	X	X	n.a.

n.a.: not applicable.

Table B.2.

Assessment of the infrastructure subsystem for the EC verification of conformity
Domain: Civil engineering (stations, general)

1	2	3	4	5
Characteristics to be assessed	Assessment in the following phase			
	Design and development phase	Production phase		
	Design review	Construction, assembling, mounting	Assembled before putting into service	Validation under full operation conditions
Platform height (4.3.3.26)	X	X	n.a.	n.a.
Platform length (4.1.5)	X	X	n.a.	n.a.
Protection against electric shocks (4.3.3.26 and 27)	X	X	n.a.	n.a.
Disabled passengers access (4.3.3.26)	X	X	n.a.	n.a.
Passengers protection (4.3.3.26)	X	X	n.a.	n.a.

n.a.: not applicable.

Table B.3.

Assessment of the infrastructure subsystem for the EC verification of conformity
Domain: Underground stations

1	2	3	4	5
Characteristics to be assessed	Assessment in the following phase			
	Design and development phase	Production phase		
	Design review	Construction, assembling, mounting	Assembled before putting into service	Validation under full operation conditions
Free air cross section, passenger protection in the station (4.3.3.27)	X	X	n.a.	n.a.
Protection against electric shocks	X	X	n.a.	n.a.
Minimum curve radius of stabling tracks and S shaped alignments (4.3.3.27)	X	X	n.a.	n.a.
Fire protection (national rules) (4.2.3.1.3)	X	X	n.a.	n.a.
Clearance gauge (4.1.1 and 4.3.3.1)	X	X	n.a.	n.a.
Pantograph gauge — energy TSI (4.1.2.1, 4.1.2.2, 4.1.2.3 and 4.3.2.3)	X	X	n.a.	n.a.

n.a.: not applicable.

Table B.4.

Assessment of the infrastructure subsystem for the EC verification of conformity
Domain: Structures (rail bridges and viaducts)

1	2	3	4	5
Characteristics to be assessed	Assessment in the following phase			
	Design and development phase	Production phase		
	Design review	Construction, assembling, mounting	Assembled before putting into service	Validation under full operation conditions
Vertical loads: static loading diagram — structure calculations (4.3.3.13)	X	n.a.	n.a.	n.a.
Vertical forces: dynamic calculations (4.3.3.13)	X	n.a.	n.a.	n.a.
Transverse horizontal loads: loading diagram — structure calculations (4.3.3.14)	X	n.a.	n.a.	n.a.
Longitudinal loads: loading diagram — structure calculations (4.3.3.15)	X	n.a.	n.a.	n.a.
Presence of a lateral space (4.2.3.2.4)	X	X	n.a.	n.a.
Pre-commissioning tests before putting into service	n.a.	n.a.	X	n.a.
n.a.: not applicable.				

Table B.5.

Assessment of the infrastructure subsystem for the EC verification of conformity
Domain: Structures (road bridges)

1	2	3	4	5
Characteristics to be assessed	Assessment in the following phase			
	Design and development phase	Production phase		
	Design review	Construction, assembling, mounting	Assembled before putting into service	Validation under full operation conditions
Clearance gauge (4.1.1 and 4.3.3.1)	X	X	n.a.	n.a.
Pantograph gauge — energy TSI (4.1.2.1, 4.1.2.2, 4.1.2.3 and 4.3.2.3)	X	X	n.a.	n.a.
Aerodynamic effects on structures calculations (4.3.3.3)	X	X	n.a.	n.a.
n.a.: not applicable.				

Table B.6.

Assessment of the infrastructure subsystem for the EC verification of conformity
Domain: Tunnels and cut-and covers

1	2	3	4	5
Characteristics to be assessed	Assessment in the following phase			
	Design and development phase	Production phase		
	Design review	Construction, assembling, mounting	Assembled before putting into service	Validation under full operation conditions
Free air cross section calculation (4.3.3.6)	X	X	n.a.	n.a.
Clearance gauge (4.1.1 and 4.3.3.1)	X	X	n.a.	n.a.
Pantograph gauge (4.3.3.1) Energy TSI (4.1.2.1, 4.1.2.2, 4.1.2.3 and 4.3.2.3)	X	X	n.a.	n.a.
Presence of a lateral space (4.2.3.2.4)	X	X	n.a.	n.a.
Very long tunnels Safety rules (4.2.3.1.4)	X	X	n.a.	n.a.

n.a.: not applicable.

Table B.7.

Assessment of the infrastructure subsystem for the EC verification of conformity
Domain: Superstructure (plain track)

1	2	3	4	5
Characteristics to be assessed	Assessment in the following phase			
	Design and development phase	Production phase		
	Design review	Construction, assembling, mounting	Assembled before putting into service	Validation under full operation conditions
Track gauge: theoretical reference value (4.3.3.10)	X	X	n.a.	n.a.
Equivalent conicity: equivalent conicity calculation (4.3.3.9)	X	X	n.a.	X
Rail cant: adopted value (4.3.3.11)	X	n.a.	n.a.	n.a.
Track resistance to vertical loads ⁽¹⁾ (4.3.3.16)	X	n.a.	n.a.	n.a.
Track resistance to transversal loads ⁽¹⁾ (4.3.3.17)	X	n.a.	n.a.	n.a.
Track resistance to braking forces ⁽¹⁾ (4.3.3.21)	X	n.a.	n.a.	n.a.
Track dynamic stiffness ⁽¹⁾ (4.3.3.22)	X	n.a.	n.a.	n.a.
In service behaviour ⁽¹⁾	n.a.	n.a.	n.a.	X

n.a.: not applicable.

⁽¹⁾ These verifications shall be made only if the corresponding components have not been granted a declaration of conformity as interoperability constituents.

Table B.8.

Assessment of the infrastructure subsystem for the EC verification of conformity
Domain: Superstructure (switches and crossings)

1	2	3	4	5
Characteristics to be assessed	Assessment in the following phase			
	Design and development phase	Production phase		
	Design review	Construction, assembling, mounting	Assembled before putting into service	Validation under full operation conditions
Functional conditions: type of S and C: (movable point crossing) ⁽¹⁾ (4.3.3.20)	X	X	n.a.	n.a.
Functional conditions: type of S and C: (cant deficiency in diverging track) ⁽¹⁾ (4.3.3.20)	X	n.a.	n.a.	n.a.
Functional conditions: functional dimensions (see maintenance plan) ⁽¹⁾ (4.3.3.20)	X	X	n.a.	n.a.
Functional conditions: locking devices (4.3.3.20)	X	X	n.a.	n.a.
Mechanical conditions: switch rail profile ⁽¹⁾ (4.3.3.19)	X	X	n.a.	n.a.

n.a.: not applicable.

⁽¹⁾ These verifications shall be made only if the corresponding components have not been granted a declaration of conformity as interoperability constituents.

Table B.9.

Assessment of the infrastructure subsystem for the EC verification of conformity
Domain: Superstructure (plain track and switches and crossings)

1	2	3	4	5
Characteristics to be assessed	Assessment in the following phase			
	Design and development phase	Production phase		
	Design review	Construction, assembling, mounting	Assembled before putting into service	Validation under full operation conditions
Maintenance plan: fixing of track geometry standards ⁽¹⁾ (4.2.3.2.2)	X	n.a.	X	n.a.
Maintenance plan: description of track geometry measuring systems ⁽¹⁾ (4.2.3.2.2)	X	n.a.	X	n.a.
Maintenance plan: fixing of track geometry measurements periodicity ⁽¹⁾ (4.2.3.2.2)	X	n.a.	X	n.a.
Maintenance plan: fixing of periodicity of track and S and C inspections ⁽¹⁾ (4.2.3.2.2)	X	n.a.	X	n.a.

1	2	3	4	5
Characteristics to be assessed	Assessment in the following phase			
	Design and development phase	Production phase		
	Design review	Construction, assembling, mounting	Assembled before putting into service	Validation under full operation conditions
Maintenance plan: fixing of periodicity of rail inspections ⁽¹⁾ (4.2.3.2.2)	X	n.a.	X	n.a.
Maintenance plan: description of rail inspection devices ⁽¹⁾ (4.2.3.2.2)	X	n.a.	n.a.	n.a.
Pre-commissioning results of tests before putting into service (4.2.3.2.1)	X	n.a.	X	n.a.

n.a.: not applicable.

⁽¹⁾ Maintenance plan: only the minimum requirements indicated in Section 4.2.3.2.2 for the contents of the maintenance plan, as well as the determination of the appropriate limits as being in conformity with those specified in Section 4.3.3 shall be assessed.

Table B.10.

Assessment of the infrastructure subsystem for the EC verification of conformity
Domain: Miscellaneous equipment

1	2	3	4	5
Characteristics to be assessed	Assessment in the following phase			
	Design and development phase	Production phase		
	Design review	Construction, assembling, mounting	Assembled before putting into service	Validation under full operation conditions
Clearance gauge (4.1.1 and 4.3.3.1)	X	X	n.a.	n.a.
Pantograph gauge (4.3.3.1) Energy TSI (4.1.2.1, 4.1.2.2, 4.1.2.3 and 4.3.2.3)	X	X	n.a.	n.a.
Aerodynamic effects calculation (4.3.3.3)	X	X	n.a.	n.a.
Compatibility of trackside installations with interoperable trains (4.3.3.24)	X	n.a.	X	n.a.

n.a.: not applicable.

ANNEX C

ASSESSMENT PROCEDURES (MODULES)

- for conformity of interoperability constituents and
- for the EC verification of the infrastructure subsystem.

C.1. Scope

This annex covers the modules for the assessment procedures for the conformity assessment of interoperability constituents and the EC verification of the infrastructure subsystem.

C.2. Module A (internal production control)*Conformity assessment of interoperability constituents*

1. This module describes the procedure whereby the manufacturer or his authorised representative established within the Community, who carries out the obligations laid down in Point 2, ensures and declares that the interoperability constituent concerned satisfies the requirements of the TSI that apply to it.
2. The manufacturer must establish the technical documentation described in Point 3.
3. The technical documentation must enable the conformity of the interoperability constituent with the requirements of this TSI to be assessed. It must, as far as relevant for such assessment, cover the design, manufacture and operation of the interoperability constituent. So far as relevant for the assessment, the documentation must contain:
 - a general description of the interoperability constituent,
 - conceptual design and manufacturing drawings and schemes of components, subassemblies, circuits, etc.,
 - descriptions and explanations necessary for the understanding of the said drawings and schemes and the operation of the interoperability constituent,
 - a list of the technical specifications (relevant TSI and/or European specifications with relevant clauses, referred to in the TSI), applied in full or in part,
 - descriptions of the solutions adopted to meet the requirements of this TSI, where the European specifications referred to in the TSI have not been applied in full,
 - results of design calculations made, examinations carried out, etc.,
 - test reports.
4. The manufacturer must take all the measures necessary in order that the manufacturing process ensures compliance of the manufactured interoperability constituent with the technical documentation referred to in Point 2 and with the requirements of the TSI that apply to it.
5. The manufacturer, or his authorised representative established within the Community, must draw up a written declaration of conformity. The content of this declaration has to include at least the information, indicated in Directive 96/48/EC, Annex IV(3) and in Article 13(3). The EC declaration of conformity and the accompanying documents must be dated and signed. The declaration must be written in the same language as the technical file and must contain the following:
 - the directive reference (Directive 96/48/EC and other directives to which the interoperability constituent may be subject),
 - the name and address of the manufacturer or his authorised representative established within the Community (give trade name and full address and in the case of authorised representative also give the trade name of the manufacturer or constructor),
 - description of interoperability constituent (make, type, etc.),

- description of the procedure (module) followed in order to declare conformity,
 - all the relevant descriptions met by the interoperability constituent and in particular its conditions of use,
 - reference to this TSI and to any other applicable TSI, and where appropriate reference to European Specifications,
 - identification of signatory having received power to engage the manufacturer or his authorised representative established within the Community.
6. The manufacturer or his authorised representative must keep a copy of the EC declaration of conformity with the technical documentation for a period of 10 years after the last interoperability constituent has been manufactured. Where neither the manufacturer nor his authorised representative is established within the Community, the obligation to keep the technical documentation available is the responsibility of the person who places the interoperability constituent on the Community market.
7. If additional to the EC declaration of conformity an EC declaration for suitability for use for the interoperability constituent is required by the TSI, this declaration has to be added after being issued by the manufacturer under the conditions of Module V.

C.3. Module B (type-examination)

Conformity assessment of interoperability constituents (new products)

1. This module describes that part of the procedure by which a notified body ascertains and attests that a type, representative of the production envisaged, meets the provisions of the TSI that apply to it.
2. The application for the type-examination must be lodged by the manufacturer or his authorised representative established within the Community with a notified body of his choice.

The application must include:

- the name and address of the manufacturer and, if the application is lodged by the authorised representative, his name and address in addition,
- a written declaration that the same application has not been lodged with any other notified body,
- the technical documentation, as described in Point 3.

The applicant must place at the disposal of the notified body a specimen, representative of the production envisaged and hereinafter called 'type'.

A type may cover several versions of the interoperability constituent provided that the differences between the versions do not affect the provisions of the TSI.

The notified body may request further specimens if needed for carrying out the test programme.

If no type tests are requested within the type-examination procedure (see Point 4.4.), and the type is sufficiently defined by the technical documentation, as described in Point 3, the notified body may agree, that no specimens are placed at their disposal.

3. The technical documentation must enable the conformity of the interoperability constituent with the provisions of the TSI to be assessed. It must, as far as relevant for such assessment, cover the design, manufacture and operation of the product. The technical documentation must contain:
 - a general type-description,
 - conceptual design and manufacturing drawings and schemes of components, subassemblies, circuits, etc.,
 - descriptions and explanations necessary for the understanding of said drawings and schemes and the operation of the product,

- conditions of integration of the interoperability constituent in its system environment (subassembly, assembly, subsystem) and the necessary interface conditions,
 - conditions for use and maintenance of the interoperability constituent (restrictions of running time or distance, wear limits etc.),
 - a list of the technical specifications, against which the conformity of the interoperability constituent is to be assessed (relevant TSI and/or European specification with relevant clauses),
 - descriptions of the solutions adopted to meet the requirements of the TSI in cases where the European specification referred to in the TSI have not been applied in full,
 - results of design calculations made, examinations carried out, etc.,
 - test reports.
4. The notified body must:
- 4.1. Examine the technical documentation;
- 4.2. If a design review is requested in the TSI, perform an examination of the design methods, the design tools and the design results to evaluate their capability to fulfil the requirements for conformity for the interoperability constituent at the completion of the design process;
- 4.3. If a review of the manufacturing process is requested in the TSI, perform an examination of the manufacturing process devised for manufacturing the interoperability constituent, to evaluate its contribution to product conformity, and/or examine the review carried out by the manufacturer at the completion of the design process;
- 4.4. If type tests are requested in the TSI, verify that the specimen(s) has (have) been manufactured in conformity with the technical documentation, and carry out or have carried out the type tests in accordance with the provisions of the TSI and the European specification referred to in the TSI;
- 4.5. Identify the elements which have been designed in accordance with the relevant provisions of the TSI and the European specification referred to in the TSI, as well as the elements which have been designed without applying the relevant provisions of those European specifications;
- 4.6. Perform or have performed the appropriate examinations and necessary tests in accordance with Points 4.2, 4.3 and 4.4 to establish whether, where the appropriate European specifications referred to in the TSI have not been applied, the solutions adopted by the manufacturer meet the requirements of the TSI;
- 4.7. Perform or have performed the appropriate examinations and necessary tests in accordance with Points 4.2, 4.3 and 4.4 to establish whether, where the manufacturer has chosen to apply the relevant European specification, these have actually been applied;
- 4.8. Agree with the applicant the location where the examinations and necessary tests will be carried out.
5. Where the type meets the provisions of the TSI, the notified body must issue a type-examination certificate to the applicant. The certificate must contain the name and address of the manufacturer, conclusions of the examination, conditions for its validity and the necessary data for identification of the approved type.

The time period of validity shall be no longer than three years.

A list of the relevant parts of the technical documentation must be annexed to the certificate and a copy kept by the notified body.

If the manufacturer or his authorised representative established within the Community is denied an EC type-examination certificate, the notified body must provide detailed reasons for such denial.

Provision must be made for an appeals procedure.

6. The applicant must inform the notified body, that holds the technical documentation concerning the EC type-examination certificate, of all modifications to the approved product which must receive additional approval where such changes may affect the conformity with the requirements of the TSI or the prescribed conditions for use of the product. This additional approval is given in the form of an addition to the original type-examination certificate, or a new certificate will be issued after withdrawal of the old certificate.
7. If no modifications as under Point 6 have been made, the validity of an expiring certificate can be extended for another period of validity. The applicant will apply for such a prolongation by a written confirmation that no such changes have been made, and the notified body issues a prolongation for another period of validity as in Point 5, if no contrary information exists. This procedure can be reiterated.
8. Each notified body must communicate to the other notified bodies the relevant information concerning the type-examination certificates it has withdrawn or refused.
9. The other notified bodies may receive copies of the type-examination certificates issued and/or their additions on request. The annexes to the certificates must be kept at the disposal of the other notified bodies.
10. The manufacturer or his authorised representative must keep, with the technical documentation, copies of EC type-examination certificates and their additions for a period of 10 years after the last product has been manufactured. Where neither the manufacturer nor his authorised representative is established within the Community, the obligation to keep the technical documentation available is the responsibility of the person who places the product on the Community market.

C.4. Module D (production quality assurance)

Conformity assessment of interoperability constituents ('new products')

1. This module describes the procedure whereby the manufacturer who satisfies the obligations of Point 2 ensures and declares that the interoperability constituent concerned is in conformity with the type as described in the EC type-examination certificate and satisfies the requirements of the Directive 96/48/EC and of the TSI that apply to it.
2. The manufacturer must operate an approved quality system for production, final product inspection and testing as specified in Point 3 and is subject to monitoring as specified in Point 4.
3. **Quality system**
 - 3.1. The manufacturer must lodge an application for assessment of his quality system with a notified body of his choice, for the interoperability constituents concerned.

The application must include:

- all relevant information for the product category representative for the interoperability constituents envisaged,
- the documentation concerning the quality system,
- the technical documentation of the approved type and a copy of the type-examination certificate.

- 3.2. The quality system must ensure compliance of the interoperability constituents with the type as described in the EC type-examination certificate and with the requirements of the Directive 96/48/EC and of the TSI that apply to them. All the elements, requirements and provisions adopted by the manufacturer shall be documented in a systematic and orderly manner in the form of written policies, procedures and instructions. The quality system documentation must permit a consistent interpretation of the quality programmes, plan, manuals and records.

It must contain in particular an adequate description of:

- the quality objectives and the organisational structure,
- responsibilities and powers of the management with regard to product quality,

- the manufacturing, quality control and quality assurance techniques, processes and systematic actions that will be used,
- the examinations and tests that will be carried out before, during and after manufacture, and the frequency with which they will be carried out,
- the quality records, such as inspection reports and test data, calibration data, qualification reports of the personnel concerned, etc.,
- the means to monitor the achievement of the required product quality and the effective operation of the quality system.

- 3.3. The notified body must assess the quality system to determine whether it satisfies the requirements referred to in Point 3.2. It presumes conformity with these requirements in respect of quality systems that implement the relevant harmonised standard. This harmonised standard shall be EN ISO 9001 of December 2000, completed if necessary to take into consideration the specificity of the interoperability constituent for which it is implemented.

The audit must be specific for the product category, which is representative for the interoperability constituent. The auditing team must have at least one member experienced as an assessor in the product technology concerned. The evaluation procedure must include an inspection visit to the manufacturer's premises.

The decision must be notified to the manufacturer. The notification must contain the conclusions of the examination and the reasoned assessment decision.

- 3.4. The manufacturer must undertake to fulfil the obligations arising out of the quality system as approved and to uphold it so that it remains adequate and efficient.

The manufacturer or his authorised representative shall keep the notified body, that has approved the quality system, informed of any intended updating of the quality system.

The notified body must evaluate the modifications proposed and decide whether the amended quality system will still satisfy the requirements referred to in Point 3.2 or whether a re-assessment is required.

It must notify its decision to the manufacturer. The notification must contain the conclusions of the examination and the reasoned assessment decision.

- 3.5. Each notified body must communicate to the other notified bodies the relevant information concerning the quality system approvals which it has withdrawn or refused.

- 3.6. The other notified bodies may receive copies of the quality system approvals issued on request.

4. Surveillance of the quality system under the responsibility of the notified body.

- 4.1. The purpose of surveillance is to make sure that the manufacturer duly fulfils the obligations arising out of the approved quality system.

- 4.2. The manufacturer must allow the notified body entrance, for inspection purposes, to the locations of manufacture, inspection and testing, and storage and must provide it with all necessary information, in particular:

- the quality system documentation,
- the quality records, such as inspection reports and test data, calibration data, qualification reports of the personnel concerned, etc.

- 4.3. The notified body must periodically carry out audits to make sure that the manufacturer maintains and applies the quality system and must provide an audit report to the manufacturer. The frequency of the audits shall be at least once a year.

- 4.4. Additionally the notified body may pay unexpected visits to the manufacturer. During such visits the notified body may carry out, or cause to be carried out, tests to verify that the quality system is functioning correctly, if necessary. The notified body must provide the manufacturer with a visit report and, if a test has taken place, with a test report.
5. The manufacturer must, for a period of 10 years after the last product has been manufactured, keep at the disposal of the national authorities:
- the documentation referred to in the second indent of Point 3.1,
 - the updating referred to in Point 3.4,
 - the decisions and reports from the notified body which are referred to in the final paragraph of Point 3.4, Points 4.3 and 4.4.
6. The manufacturer or his authorised representative established within the Community must draw up the EC declaration of conformity of the interoperability constituent.

The content of this declaration has to include at least the information, indicated in Directive 96/48/EC, Annex IV(3) and Article 13(3). The EC declaration of conformity and the accompanying documents must be dated and signed.

The declaration must be written in the same language as the technical file and must contain the following:

- the directive references (Directive 96/48/EC and other directives, to which the interoperability constituent may be subject),
- the name and address of the manufacturer or his authorised representative established within the Community (give trade name and full address and in the case of authorised representative also give the trade name of the manufacturer or constructor),
- description of interoperability constituent (make, type, etc.),
- description of the procedure (module) followed in order to declare conformity,
- all of the relevant descriptions met by the interoperability constituent and in particular its conditions of use,
- name and address of notified body (bodies) involved in the procedure followed in respect of conformity and date of examination certificates together with the duration and conditions of validity of the certificate,
- reference to this TSI and any other applicable TSI and where appropriate reference to European specification,
- identification of signatory having received power to engage the manufacturer or his authorised representative established within the Community.

The certificates to be referred to:

- the quality system approval and surveillance reports indicated in Points 3 and 4,
 - the type-examination certificate and its additions,
7. The manufacturer or his authorised representative must keep a copy of the EC declaration of conformity for a period of 10 years after the last interoperability constituent has been manufactured.

Where neither the manufacturer nor his authorised representative is established within the Community, the obligation to keep the technical documentation available is the responsibility of the person who places the interoperability constituent on the Community market.

8. If additional to the EC declaration of conformity an EC declaration of suitability for use for the interoperability constituent is requested in the TSI, this declaration has to be added, after being issued by the manufacturer under the conditions of Module V.

C.5. Module F (product verification)

Conformity assessment of interoperability constituents (new products)

1. This module describes that part of the procedure whereby a manufacturer or his authorised representative established within the Community checks and attests that the interoperability constituent concerned and subject to the provisions of Point 3 is in conformity with the type as described in the EC type-examination certificate and satisfies the requirements of the Directive 96/48/EC and the TSI that apply to it.
2. The manufacturer must take all measures necessary in order that the manufacturing process ensures conformity of the interoperability constituents with the type as described in the type-examination certificate and with the requirements of the TSI that apply to them.
3. The notified body must carry out the appropriate examinations and tests in order to check the conformity of the interoperability constituent with the type as described in the EC type-examination certificate and with the requirements of the Directive 96/48/EC and the TSI either by examination and testing of every interoperability constituent as specified in Point 4 or by examination and testing of interoperability constituents on a statistical basis, as specified in Point 5, at the choice of the manufacturer.
4. Verification by examination and testing of every interoperability constituent
 - 4.1. All products must be individually examined and appropriate tests as set out in the relevant European specifications referred to in Article 10 or equivalent tests shall be carried out in order to verify their conformity with the type as described in the EC type-examination certificate and the requirements of the Directive 96/48/EC and the TSI that apply to them.
 - 4.2. The notified body must draw up a written certificate of conformity relating to the tests carried out.
 - 4.3. The manufacturer or his authorised representative must ensure that he is able to supply the notified body's certificates of conformity on request.
5. Statistical verification
 - 5.1. The manufacturer must present his interoperability constituents in the form of homogeneous lots and shall take all measures necessary in order that the manufacturing process ensures the homogeneity of each lot produced.
 - 5.2. All interoperability constituents must be available for verification in the form of homogeneous lots. A random sample shall be drawn from each lot, interoperability constituents in a sample shall be individually examined and appropriate tests as set out in the relevant European specification referred to in Article 10, or equivalent tests, shall be carried out to ensure their conformity with the requirements of the Directive 96/48/EC and the TSI which apply to them and to determine whether the lot is accepted or rejected.
 - 5.3. The statistical procedure must use appropriate elements (statistical method, sampling plan etc.), depending on the characteristics to be assessed, as specified in the TSI which apply to them.
 - 5.4. In the case of accepted lots, the notified body shall draw up a written certificate of conformity relating to the tests carried out. All interoperability constituents in the lot may be put on the market except those interoperability constituents from the sample which were found not to be in conformity.

If a lot is rejected, the notified body or the competent authority must take appropriate measures to prevent the putting on the market of that lot. In the event of frequent rejection of lots the notified body may suspend the statistical verification.

- 5.5. The manufacturer or his authorised representative must ensure that he is able to supply the notified body's certificates of conformity on request.
6. The manufacturer or his authorised representative established within the Community must draw up the EC declaration of conformity of the interoperability constituent.

The content of this declaration has to include at least the information, indicated in Directive 96/48/EC, Annex IV(3) and in Article 13(3). The EC declaration of conformity and the accompanying documents must be dated and signed.

The declaration must be written in the same language as the technical file and must contain the following:

- the directive references (Directive 96/48/EC and other directives, to which the interoperability constituent may be subject),
- the name and address of the manufacturer or his authorised representative established within the Community (give trade name and full address and in the case of authorised representative also give the trade name of the manufacturer or constructor),
- description of interoperability constituent (make, type, etc.)
- description of the procedure (module) followed in order to declare conformity,
- all of the relevant descriptions met by the interoperability constituent and in particular its conditions of use,
- name and address of notified body (bodies) involved in the procedure followed in respect of conformity and date of examination certificates together with the duration and conditions of validity of the certificate,
- reference to this TSI and any other applicable TSI and where appropriate reference to European specification,
- identification of signatory having received power to engage the manufacturer or his authorised representative established within the Community.

The certificates to be referred to:

- the EC type-examination certificate and its additions,
 - the Certificate of conformity as mentioned under Point 5 or 6.
7. The manufacturer or his authorised representative must keep a copy of the EC declaration of conformity for a period of 10 years after the last interoperability constituent has been manufactured.

Where neither the manufacturer nor his authorised representative is established within the Community, the obligation to keep the technical documentation available is the responsibility of the person who places the interoperability constituent on the Community market.

8. If additional to the EC declaration of conformity an EC declaration of suitability for use for the interoperability constituent is requested in the TSI, this declaration has to be added, after being issued by the manufacturer under the conditions of Module V.

C.6. Module H2 (full quality assurance with design examination)

Conformity assessment of interoperability constituents (new products)

1. This module describes the procedure whereby a notified body carries out an examination of the design of an interoperability constituent and the manufacturer who satisfies the obligations of Point 2 ensures and declares that the interoperability constituent concerned satisfies the requirements of the Directive 96/48/EC and the TSI that apply to it.

2. The manufacturer must operate an approved quality system for design, manufacture and final product inspection and testing as specified in Point 3 and shall be subject to surveillance as specified in Point 4.

3. Quality system

- 3.1. The manufacturer must lodge an application for assessment of his quality system with a notified body.

The application must include:

- all relevant information for the product category representative for the interoperability constituent envisaged,
- the quality system's documentation.

- 3.2. The quality system must ensure compliance of the interoperability constituent with the requirements of the Directive 96/48/EC and of the TSI that apply to it. All the elements, requirements and provisions adopted by the manufacturer must be documented in a systematic and orderly manner in the form of written policies, procedures and instructions. This quality system documentation shall ensure a common understanding of the quality policies and procedures such as quality programmes, plans, manuals and records.

It must contain in particular an adequate description of:

- the quality objectives and the organisational structure,
- responsibilities and powers of the management with regard to design and product quality,
- the technical design specifications, including European specifications, that will be applied, and, where the European specifications referred to in Article 10 will not be applied in full, the means that will be used to ensure that the requirements of the Directive 96/48/EC and of the TSI that apply to the interoperability constituent will be met,
- the design control and design verification techniques, processes and systematic actions that will be used when designing the interoperability constituents pertaining to the product category covered,
- the corresponding manufacturing, quality control and quality assurance techniques, processes and systematic actions that will be used,
- the examinations and tests that will be carried out before, during and after manufacture, and the frequency with which they will be carried out,
- the quality records, such as inspection reports and test data, calibration data, qualification reports of the personnel concerned, etc.,
- the means to monitor the achievement of the required design and product quality and the effective operation of the quality system.

The quality policies and procedures shall cover in particular the assessment phases, as design review, review of manufacturing process and type tests, as they are specified in the TSI for different characteristics and performances of the interoperability constituent.

- 3.3. The notified body must assess the quality system to determine whether it satisfies the requirements referred to in Point 3.2. It shall presume compliance with these requirements in respect of quality systems that implement the relevant harmonised standard. This harmonised standard shall be EN ISO 9001 of December 2000, completed if necessary to take into consideration the specificity of the interoperability constituent for which it is implemented.

The audit must be specific for the product category, which is representative for the interoperability constituent. The auditing team must have at least one member experienced as an assessor in the product technology concerned. The evaluation procedure shall include an assessment visit to the manufacturer's premises.

The decision must be notified to the manufacturer. The notification must contain the conclusions of the examination and the reasoned assessment decision.

- 3.4. The manufacturer must undertake to fulfil the obligations arising out of the quality system as approved and to uphold it so that it remains adequate and efficient.

The manufacturer or his authorised representative must keep the notified body that has approved the quality system informed of any intended updating of the quality system.

The notified body must evaluate the modifications proposed and decide whether the amended quality system will still satisfy the requirements referred to in Point 3.2 or whether a re-assessment is required.

It must notify its decision to the manufacturer. The notification shall contain the conclusions of the examination and the reasoned assessment decision.

4. Surveillance of the quality system under the responsibility of the notified body

- 4.1. The purpose of surveillance is to make sure that the manufacturer duly fulfils the obligations arising out of the approved quality system.

- 4.2. The manufacturer must allow the notified body entrance for inspection purposes to the locations of design, manufacture, inspection and testing, and storage, and shall provide it with all necessary information, in particular:

- the quality system documentation,
- the quality records as foreseen by the design part of the quality system, such as results of analyses, calculations, tests, etc.,
- the quality records as foreseen by the manufacturing part of the quality system, such as inspection reports and test data, calibration data, qualification reports of the personnel concerned, etc.

- 4.3. The notified body must periodically carry out audits to make sure that the manufacturer maintains and applies the quality system and shall provide an audit report to the manufacturer. The frequency of the audits shall be at least once a year.

- 4.4. Additionally the notified body may pay unexpected visits to the manufacturer. At the time of such visits, the notified body may carry out tests or have them carried out in order to check the proper functioning of the quality system where necessary; it must provide the manufacturer with a visit report and, if a test has been carried out, with a test report.

5. The manufacturer must, for a period of 10 years after the last product has been manufactured, keep at the disposal of the national authorities:

- the documentation referred to in the second indent of the second subparagraph of Point 3.1,
- the updating referred to in the second subparagraph of Point 3.4,
- the decisions and reports from the notified body which are referred to in the final subparagraph of Points 3.4, 4.3 and 4.4.

6. Design examination

- 6.1. The manufacturer must lodge an application for examination of the design of the interoperability constituent with a notified body.

- 6.2. The application must enable the design, manufacture and operation of the interoperability constituent to be understood, and shall enable conformity with the requirements of the Directive 96/48/EC and the TSI to be assessed.

It must include:

- the technical design specifications, including European specifications, that have been applied,
- the necessary supporting evidence for their adequacy, in particular where the European specifications referred to in Article 10 have not been applied in full. This supporting evidence must include the results of tests carried out by the appropriate laboratory of the manufacturer or on his behalf.

- 6.3. The notified body must examine the application and where the design meets the provisions of the TSI that apply to it must issue a design examination certificate to the applicant. The certificate shall contain the conclusions of the examination, conditions for its validity, the necessary data for identification of the approved design and, if relevant, a description of the product's functioning.

The time period of validity shall be no longer than three years.

- 6.4. The applicant must keep the notified body that has issued the design examination certificate informed of any modification to the approved design. Modifications to the approved design must receive additional approval from the notified body that issued the design examination certificate where such changes may affect the conformity with the requirements of the TSI or the prescribed conditions for use of the product. This additional approval is given in the form of an addition to the original design examination certificate.
- 6.5. If no modifications as under Point 6.4 have been made, the validity of an expiring certificate can be extended for another period of validity. The applicant will apply for such a prolongation by a written confirmation that no such changes have been made, and the notified body issues a prolongation for another period of validity as in Point 6.3, if no contrary information exists. This procedure can be reiterated.
7. Each notified body must communicate to the other notified bodies the relevant information concerning the quality system approvals and the design examination certificates which it has withdrawn or refused.

The other notified bodies may receive copies of:

- the quality system approvals and additional approvals issued, and
 - the design examination certificates and additions issued
- on request.

8. The manufacturer or his authorised representative established within the Community must draw up the EC declaration of conformity of the interoperability constituent.

The content of this declaration has to include at least the information, indicated in Directive 96/48/EC, Annex IV(3) and in Article 13(3). The EC declaration of conformity and its accompanying documents must be dated and signed.

The declaration must be written in the same language as the technical file and must contain the following:

- the directive references (Directive 96/48/EC and other directives to which the interoperability constituent may be subject),
- the name and address of the manufacturer or his authorised representative established within the Community (give trade name and full address and in the case of authorised representative also give the trade name of the manufacturer or constructor),
- description of interoperability constituent (make, type, etc.),
- description of the procedure (module) followed in order to declare conformity,
- all of the relevant descriptions met by the interoperability constituent and in particular its conditions of use,
- name and address of the notified body(ies) involved in the procedure followed in respect of conformity and date of examination certificates together with the duration and conditions of validity of the certificate,
- reference to this TSI and other applicable TSI and where appropriate to European specifications,
- identification of signatory having received power to engage the manufacturer or his authorised representative established within the Community.

The certificates to be referred to:

- the quality system approval and surveillance reports indicated in Points 3 and 4,
- the design examination certificate and its additions.

9. The manufacturer or his authorised representative must keep a copy of the EC declaration of conformity for a period of 10 years after the last interoperability constituent has been manufactured.

Where neither the manufacturer nor his authorised representative is established within the Community, the obligation to keep the technical documentation available is the responsibility of the person who places the interoperability constituent on the Community market.

10. If additional to the EC declaration of conformity an EC declaration of suitability for use for the interoperability constituent is requested in the TSI, this declaration has to be added, after being issued by the manufacturer under the conditions of Module V.

C.7. Module V (type validation of in-service experience)

Suitability for use assessment of interoperability constituents

1. This module describes that part of the procedure by which a notified body ascertains and attests that a specimen, representative of the production envisaged, meets the provisions of the Directive 96/48/EC and of the TSI that apply to it for suitability for use, to be demonstrated by type validation of in service experience.
2. The application for the type-validation of in-service experience must be lodged by the manufacturer or his authorised representative established within the Community with a notified body of his choice.

The application must include:

- the name and address of the manufacturer and, if the application is lodged by the authorised representative, his name and address in addition,
- a written declaration that the same application has not been lodged with any other notified body,
- the technical documentation, as described in Point 3,
- the programme for validation of in service experience, as described in Point 4,
- the name and address of the company (infrastructure manager or railway enterprise), with which the applicant has obtained an agreement to contribute to a suitability for use assessment by in-service experience:
 - by operating the interoperability constituent in service,
 - by monitoring the in-service behaviour, and
 - by issuing a final report about in-service experience,
- the name and the address of the company, undertaking the maintenance of the interoperability constituent during the time period or running distance, required for in service experience,
- an EC declaration of conformity for the interoperability constituent, and
 - if Module B is required in the TSI, an EC type-examination certificate,
 - if Module H2 is required in the TSI, an EC design examination certificate.

The applicant must place at the disposal of the company, undertaking the operation of the interoperability constituent in service, a specimen or a sufficient number of specimens, representative of the production envisaged and hereinafter called 'type'. A type may cover several versions of the interoperability constituent provided that the differences between the versions are all covered by EC declarations of conformity and certificates as mentioned above.

The notified body may request further specimens if needed for carrying out the validation by in service experience to be put in service.

3. The technical documentation must enable the assessment of the product with the requirements of the Directive 96/48/EC and of the TSI. It must cover the operation of the interoperability constituent, and, as far as relevant for such assessment, cover also the design and manufacture.

The technical documentation must contain:

- a general type-description,
- the technical specification(s), against which the performance and in-service behaviour of the interoperability constituent is to be assessed (relevant TSI and/or European specification with relevant clauses),
- schemes of components, subassemblies, circuits, etc.,
- conditions of integration of the interoperability constituent in its system environment (subassembly, assembly, subsystem) and the necessary interface conditions,
- conditions for use and maintenance of the interoperability constituent (restrictions of running time or distance, wear limits etc.),
- descriptions and explanations necessary for the understanding of said drawings and schemes and the operation of the interoperability constituent

and, as far as is relevant for assessment,

- conceptual design and manufacturing drawings,
- results of design calculations made and examinations carried out,
- test reports.

If the TSI is requiring further information for the technical documentation, this has to be included.

A list of the European specifications referred to in the technical documentation, applied in full or in part, has to be attached.

4. The programme for the validation by in-service experience must include:
 - the required performance or behaviour in service of the interoperability constituent under trial,
 - the installation arrangements,
 - the duration of the programme — either time or distance,
 - the operating conditions and the service programme expected,
 - the maintenance programme,
 - the special in-service tests, if any, to be performed,
 - the batch size of the specimens — if more than one,
 - the inspection programme (nature, number and frequency of inspections, documentation),
 - criteria for tolerable defects and their impact on the programme,
 - the information to be included in the report of the company operating the interoperability constituent in-service (see Point 2).

5. The notified body must:
 - 5.1. Examine the technical documentation and the programme for validation by in-service experience,
 - 5.2. Verify that the type is representative and has been manufactured in conformity with the technical documentation,
 - 5.3. Verify that the programme for validation by in service experience is well adapted to assess the required performance and in service behaviour of the interoperability constituent,
 - 5.4. Agree with the applicant the programme and the location where the inspections and necessary tests will be carried out, and the body performing the tests (notified body or other competent laboratory),
 - 5.5. Monitor and inspect the progress of in service running, operation and maintenance of the interoperability constituent,
 - 5.6. Evaluate the report, to be issued by the company (infrastructure manager or railway enterprise) operating the interoperability constituent, and all other documentation and information, gained during the procedure (test reports, maintenance experience etc.),
 - 5.7. Assess, if the in service behaviour meets the requirements of the TSI.

6. Where the type meets the provisions of the TSI, the notified body must issue a suitability for use certificate to the applicant. The certificate must contain the name and address of the manufacturer, conclusions of the validation, conditions for its validity and the necessary data for identification of the approved type.

The time period of validity shall be no longer than three years.

A list of the relevant parts of the technical documentation must be annexed to the certificate and a copy kept by the notified body.

If the applicant is denied a suitability for use certification, the notified body must provide detailed reasons for such denial.

Provision must be made for an appeals procedure.

7. The applicant must inform the notified body, that holds the technical documentation concerning suitability for use certification, of all modifications to the approved product which must receive additional approval where such changes may affect the suitability for use or the prescribed conditions for use of the product. This additional approval is given in the form of an addition to the original suitability for use certificate, or a new certificate will be issued after withdrawal of the old certificate.
8. If no modifications as under Point 7 have been made, the validity of an expiring certificate can be extended for another period of validity. The applicant will apply for such a prolongation by a written confirmation that no such changes have been made, and the notified body issues a prolongation for another period of validity as in Point 6, if no contrary information exists. This procedure can be reiterated.
9. Each notified body must communicate to the other notified bodies the relevant information concerning the certificates of suitability for use it has withdrawn or refused.
10. The other notified bodies may receive copies of the certificates of suitability for use issued and/or their additions on request. The annexes to the certificates must be kept at the disposal of the other notified bodies.

11. The manufacturer or his authorised representative must keep, with the technical documentation, copies of suitability for use certificates and their additions for a period of 10 years after the last product has been manufactured.

Where neither the manufacturer nor his authorised representative is established within the Community, the obligation to keep the technical documentation available is the responsibility of the person who places the product on the Community market.

12. The manufacturer or his authorised representative established within the Community must draw up the EC declaration of suitability for use of the interoperability constituent.

The content of this declaration has to include at least the information, indicated in Directive 96/48/EC, Annex IV(3) and in Article 13(3). The EC declaration of suitability for use and the accompanying documents must be dated and signed.

The declaration must be written in the same language of the technical file and must contain the following:

- the directive references (Directive 96/48/EC),
- the name and address of the manufacturer or his authorised representative established within the Community (give trade name and full address and in the case of authorised representative also give the trade name of the manufacturer or constructor),
- description of interoperability constituent (make, type, etc.)
- all of the relevant descriptions met by the interoperability constituent and in particular its conditions of use,
- name and address of notified body(ies) involved in the procedure followed in respect of suitability for use and date of suitability for use certificate together with the duration and conditions of validity of the certificate,
- reference to this TSI and to any other applicable TSI, and where appropriate reference to European specification,
- identification of signatory having received power to engage the manufacturer or his authorised representative established within the Community.

13. The manufacturer or his authorised representative must keep a copy of the EC declaration of suitability for use for a period of 10 years after the last interoperability constituent has been manufactured.

Where neither the manufacturer nor his authorised representative is established within the Community, the obligation to keep the technical documentation available is the responsibility of the person who places the interoperability constituent on the Community market.

C.8. Module SG (unit verification)

EC verification of the infrastructure subsystem

1. This module describes the EC verification procedure whereby a notified body checks and certifies, at the request of an adjudicating entity or its authorised representative established within the Community, that an infrastructure subsystem:

- complies with the Directive 96/48/EC, this TSI and other applicable TSI,
- complies with the other regulations deriving from the Treaty and may be put into service.

2. The adjudicating entity or its authorised representative established within the Community must lodge an application for EC verification (through unit verification) of the subsystem with a notified body of his choice.

The application includes:

- name and address of the adjudicating entity or its authorised representative,
- the technical documentation.

3. The technical documentation must enable the design, manufacture, installation and operation of the subsystem to be understood, and shall enable conformity with the requirements of the directive and the TSI to be assessed.

It must include:

- a general description of the subsystem, overall design and structure,
- the Infrastructure Register, including all indications as specified in the TSI (Annex E),
- conceptual design and manufacturing drawings and schemes of subassemblies, circuits, etc.,
- technical documentation as regards the manufacturing and the assembling of the subsystem,
- the technical design specifications, including European specifications, that have been applied,
- the necessary supporting evidence for their adequacy, in particular where European specifications referred to in the TSI and the relevant clauses have not been applied in full,
- a list of the interoperability constituents, to be incorporated into the subsystem,
- a list of manufacturers, involved in the subsystem's design, manufacturing, assembling and installation,
- a list of the European specifications referred to in the TSI or in the technical design specification.

If the TSI requires further information for the technical documentation, this has to be included.

To enable the assessment of complex infrastructure projects comprising different construction elements, which are built or assembled in sequence, the application may be divided into several steps or phases, as described in Annex D of this TSI. The case being, each step or phase of the project shall be submitted in due time to the above requirements. The notified body responsible for the EC verification shall then examine if all steps or phases define a comprehensive and coherent sequence of design, production and construction activities enabling the overall conformity of the subsystem to be assessed.

4. The notified body must examine the application, and carry out the appropriate tests and verifications as set out in the TSI and/or in the European specifications referred to in the TSI, to ensure conformity with the essential requirements of the directive as provided for in the TSI.

The examinations, tests and checking shall extend to the following stages as provided for in the TSI:

- overall design,
- structure of subsystem, including, in particular and when relevant, civil engineering activities, constituent assembly, overall adjustments,
- final testing of the subsystem,
- and, whenever specified in the TSI, the validation under full operational conditions.

5. The notified body may agree with the adjudicating entity the locations where the tests will be carried out and may agree that final subsystem tests and, whenever required in the TSI, tests in full operating conditions, are carried out by the adjudicating entity under direct supervision and attendance of the notified body.
6. The notified body must have permanent access, for testing and verification purposes to the locations of design, building sites, production workshops, locations of assembling and installations, and where appropriate, prefabrication and testing facilities in order to carry out its tasks as provided for in the TSI.
7. Where the subsystem meets the requirements of the TSI, the notified body must then, based on the tests, verifications and checkings carried out as required in the TSI and in the European specifications referred to in the TSI, draw up the certificate of EC verification intended for the adjudicating entity or its authorised representative established within the Community, which in turn draws up the EC declaration of verification intended for the supervisory authority in the Member state where the subsystem is located and/or operates. The EC declaration of verification and the accompanying documents must be dated and signed. The declaration must be written in the same language as the technical file and must contain at least the information included in Annex V of Directive 96/48/EC.

8. The notified body shall be responsible for compiling the technical file that has to accompany the EC declaration of verification. The technical file has to include at least the information, indicated in Directive 96/48/EC, Article 18(3), and in particular as follows:
 - all necessary documents relating to the characteristics of the subsystem,
 - list of interoperability constituents incorporated into the subsystem,
 - copies of the EC declarations of conformity and, where appropriate, of the EC declarations of suitability for use, which said constituents must be provided in accordance with Article 13 of the Directive, accompanied, where appropriate, by the corresponding documents (certificates, quality system approval and surveillance documents) issued by the notified bodies on the basis of the TSI,
 - all elements relating to conditions and limits for use,
 - all elements relating to the instructions concerning servicing, constant or routine monitoring, adjustment and maintenance,
 - certificate of EC verification of the notified body as mentioned under Point 7, accompanied by corresponding calculation notes and countersigned by itself, stating that the project complies with the directive and the TSI, and mentioning, where appropriate, reservations recorded during performance of activities and not withdrawn; the certificate should also be accompanied, if relevant, by the inspection and audit reports drawn up in connection with the verification,
 - the Infrastructure Register, including all indications as specified in the TSI.
9. The complete records accompanying the certificate of EC verification must be lodged with the adjudicating entity or its authorised representative in support of the certificate of EC verification issued by the notified body and must be attached to the EC declaration of verification drawn up by the adjudicating entity intended for the supervisory authority.
10. The adjudicating entity or its authorised representative within the Community must keep a copy of the records throughout the service life of the subsystem; it must be sent to any other Member State who so requests.

C.9. Module SH2 (full quality assurance with design examination)

EC verification of the infrastructure subsystem

1. This module describes the EC verification procedure whereby a notified body checks and certifies, at the request of an adjudicating entity or its authorised representative established within the Community, that an infrastructure subsystem:
 - complies with the Directive 96/48/EC, this TSI and other applicable TSI,
 - complies with the other regulations deriving from the Treaty and may be put into service.

The notified body is carrying out the procedure, including a design examination of the subsystem under the condition, that the adjudicating entity and the manufacturers involved are satisfying the obligations of Point 2.

2. For the subsystem, subject of the EC verification procedure, the adjudicating entity must contract only with manufacturers, whose activities contributing to the subsystem project to be verified (design, manufacturing, assembling, installation) are subject to an approved quality system for design, manufacture and final product inspection and testing as specified in Point 3 and which shall be subject to surveillance as specified in Point 4.

The term 'manufacturer' also includes companies:

- responsible for the whole subsystem project (including in particular responsibility for subsystem integration (main contractor),
- performing design services or studies (e.g. consultants),
- performing assembling (assemblers) and installation of the subsystem. For manufacturers, performing only assembling and installation, a quality system for manufacture and final product inspection and testing is sufficient.

The main contractor responsible for the whole subsystem project (including in particular responsibility for subsystem integration), must operate in any case an approved quality system for design, manufacture and final product inspection and testing, as specified in Point 3 and which shall be subject to surveillance as specified in Point 4.

In the case, that the adjudicating entity is directly involved in the design and/or production (including assembling and installation), or that the adjudicating entity itself is responsible for the whole subsystem project (including in particular responsibility for subsystem integration), it has to operate an approved quality system for those activities, as specified in Point 3 and subject to surveillance as specified in Point 4.

3. Quality system

- 3.1. The manufacturer(s) involved and, if involved, the adjudicating entity, must lodge an application for assessment of their quality system with a notified body of their choice.

The application must include:

- all relevant information for the subsystem envisaged,
- the quality system's documentation.

For manufacturers only involved in a part of the subsystem project, the information is only requested for that specific relevant part.

- 3.2. For the main contractor, the quality system must ensure compliance of the subsystem with the requirements of the Directive 96/48/EC and the TSI. For other manufacturers (subsuppliers), the quality system has to ensure compliance of their relevant contribution to the subsystem with the requirements of the TSI.

All the elements, requirements and provisions adopted by the applicants must be documented in a systematic and orderly manner in the form of written policies, procedures and instructions. This quality system documentation shall ensure a common understanding of the quality policies and procedures such as quality programmes, plans, manuals and records.

It must contain in particular an adequate description of the following items:

- for all applicants:
 - the quality objectives and the organisational structure,
 - the corresponding manufacturing, quality control and quality assurance techniques, processes and systematic actions that will be used,
 - the examinations, the checking and tests that will be carried out before, during and after manufacture, assembling and installation and the frequency with which they will be carried out,
 - the quality records, such as inspection reports and test data, calibration data, qualification reports of the personnel concerned, etc.,
- for the main contractor and for the subsuppliers (only as far as relevant for their specific contribution to the subsystem project):
 - the technical design specifications, including European specifications, that will be applied and, where the European specifications referred to in Article 10 will not be applied in full, the means that will be used to ensure that the requirements of the TSI that apply to the subsystem will be met,
 - the design control and design verification techniques, processes and systematic actions that will be used when designing the subsystem,
 - the means to monitor the achievement of the required design and subsystem quality and the effective operation of the quality system,

- and for the main contractor:
 - responsibilities and powers of the management with regard to design and subsystem quality, including subsystem integration management,
 - the means to monitor the achievement of the required design and subsystem quality and the effective operation of the quality system.

The examinations, tests and checking shall cover all of the following stages:

- overall design,
 - structure of subsystem, including, in particular, civil engineering activities, constituent assembly, overall adjustment,
 - final testing of the subsystem,
 - and, where specified in the TSI, the validation under full operation conditions.
- 3.3. The notified body referred to in Point 3.1 must assess the quality system to determine whether it satisfies the requirements referred to in Point 3.2. It shall presume compliance with these requirements in respect of quality systems that implement the relevant harmonised standard. This harmonised standard shall be EN ISO 9001 of December 2000, completed if necessary to take into consideration the specificity of the subsystem for which it is implemented.

For applicants, which are only involved in assembling and installation, the harmonised standard shall be EN ISO 9001 of December 2000, completed if necessary to take into consideration the specificity of the subsystem for which it is implemented.

The audit shall be specific for the subsystem concerned, taking into consideration the specific contribution of the applicant to the subsystem. The auditing team must have at least one member experienced as an assessor in the subsystem technology concerned. The evaluation procedure shall include an assessment visit to the applicant's premises.

The decision must be notified to the applicant. The notification must contain the conclusions of the examination and the reasoned assessment decision.

- 3.4. The manufacturer(s) and, if involved the adjudicating entity must undertake to fulfil the obligations arising out of the quality system as approved and to uphold it so that it remains adequate and efficient.

They must keep the notified body, that has approved the quality system informed of any intended updating of the quality system.

The notified body must evaluate the modifications proposed and decide whether the amended quality system will still satisfy the requirements referred to in Point 3.2 or whether a re-assessment is required.

It must notify its decision to the applicant. The notification shall contain the conclusions of the examination and the reasoned assessment decision.

4. Surveillance of the quality system(s) under the responsibility of the notified body(ies)
- 4.1. The purpose of surveillance is to make sure that the manufacturer(s) and, if involved the adjudicating entity, duly fulfil the obligations arising out of the approved quality system.
- 4.2. The notified body(ies) as referred to under Point 3.1 must have permanent access for inspection purposes to the locations of design, building sites, production workshops, locations of assembling and installation, storage areas and, where appropriate, prefabrication or testing facilities and more generally, to all premises which it considers necessary for its task, in accordance with the applicant's specific contribution to the subsystem project.

4.3. The manufacturer(s), and if involved the adjudicating entity or its authorised representative established within the Community must send the notified body referred to under Point 3.1 (or have sent it) all the documents needed for that purpose and in particular the implementation plans and technical records concerning the subsystem (as far as relevant for the specific contribution of the applicant to the subsystem), in particular:

- the quality system documentation, including the particular means implemented to ensure that:
 - (for the main contractor) overall responsibilities and powers of the management for the compliance of the whole entire subsystem are sufficiently and properly defined,
 - the quality systems of each manufacturer are correctly managed for achieving integration at subsystem level,
- the quality records as foreseen by the design part of the quality system, such as results of analyses, calculations, tests, etc.,
- the quality records as foreseen by the manufacturing part (including assembling and installation) of the quality system, such as inspection reports and test data, calibration data, qualification reports of the personnel concerned, etc.

4.4. The notified body(ies) must periodically carry out audits to make sure that the manufacturer(s), and if involved, the adjudicating entity, maintain and apply the quality system and shall provide an audit report to them.

The frequency of the audits shall be at least once a year, with at least one audit during the time period of performing relevant activities (design, manufacture, assembling or installation) for the subsystem being the subject of the EC verification procedure mentioned under Point 6.

4.5. Additionally the notified body(ies) may pay unexpected visits to the sites mentioned under Point 4.2 of the applicant(s). At the time of such visits, the notified body may conduct complete or partial audits, in order to check the proper functioning of the quality system where necessary; it must provide the applicant(s) with an inspection report and, if an audit has been carried out, with an audit report.

5. The manufacturer(s) and, if involved the adjudicating entity must, for a period of 10 years after the last subsystem has been manufactured, keep at the disposal of the national authorities:

- the documentation referred to in the second indent of the second subparagraph of Point 3.1,
- the updating referred to in the second subparagraph of Point 3.4,
- the decisions and reports from the notified body which are referred to in the final subparagraph of Points 3.4, 4.4 and 4.5.

6. EC verification procedure

6.1. The adjudicating entity or its authorised representative established within the Community must lodge an application for EC verification of the subsystem (through full quality assurance with design examination), including coordination of surveillance of the quality systems as under Points 4.4 and 4.5, with a notified body of its choice. The adjudicating entity or its authorised representative within the Community must inform the manufacturers involved of his choice and of the application.

6.2. The application must enable the design, manufacture, installation and operation of the subsystem to be understood, and shall enable conformity with the requirements of the directive and the TSI to be assessed.

It must include:

- the technical design specifications, including European specifications, that have been applied,
- the necessary supporting evidence for their adequacy, in particular where the European specifications referred to in the TSI have not been applied in full. This supporting evidence must include the results of tests carried out by the appropriate laboratory of the manufacturer or on his behalf,

- the Infrastructure Register, including all indications as specified in the TSI,
- the technical documentation as regards the manufacturing and the assembling of the subsystem,
- a list of the interoperability constituents, to be incorporated into the subsystem,
- a list of all manufacturers, involved in the subsystem's design, manufacturing, assembling and installation,
- the demonstration, that all stages, as mentioned under Point 3.2, are covered by quality systems of the manufacturer(s) and/or of the adjudicating entity involved, and the evidence of their effectiveness,
- indication of the notified body(ies), responsible for the approval and surveillance of these quality systems.

To enable the assessment of complex infrastructure projects comprising different construction elements, which are built or assembled in sequence, the application may be divided into several steps or phases, as described in Annex D. The case being, each step or phase of the project shall be submitted in due time to the above requirements. The notified body responsible for the EC verification shall then examine if all steps or phases define a comprehensive and coherent sequence of design, production and construction activities enabling the overall conformity of the subsystem to be assessed.

- 6.3. The notified body must examine the application concerning the design examination and where the design meets the provisions of the Directive 96/48/EC and of the TSI that apply to it must issue a design examination report to the applicant. The report shall contain the conclusions of the design examination, conditions for its validity, the necessary data for identification of the design examined and, if relevant, a description of the subsystem's functioning.
- 6.4. The notified body must, concerning the other stages of the EC verification examine, if all stages of the subsystem as mentioned under Point 3.2 are sufficiently and properly covered by the approval and surveillance of the quality system(s) of the applicant(s).

If the compliance of the subsystem with the requirements of the TSI is based on more than one quality system, it has to examine in particular:

- if the relations and interfaces between the quality systems are clearly documented,
 - and if overall responsibilities and powers of the management for the compliance of the whole entire subsystem are sufficiently and properly defined.
- 6.5. The notified body responsible for the EC verification, if not carrying out the surveillance of the quality system(s) concerned as under Point 4, must coordinate the surveillance activities of any other notified body responsible for that task, in order to ensure that correct management of interfaces between the different quality systems in view of subsystem integration has been performed. This coordination includes the right of the notified body responsible for the EC verification:
 - to receive all documentation (approval and surveillance), issued by the other notified body(ies),
 - to witness the surveillance audits as under Point 4.4,
 - to initiate additional audits as under Point 4.5 together with the other notified body(ies).
 - 6.6. Where the subsystem meets the requirements of the Directive 96/48/EC and of the TSI, the notified body must then, based on the design examination and the approval and surveillance of the quality system(s), draw up the certificate of EC verification intended for the adjudicating entity or its authorised representative established within the Community, which in turn draws up the EC declaration of verification intended for the supervisory authority in the Member State within which the subsystem is located and/or operates.

The EC declaration of verification and the accompanying documents must be dated and signed. The declaration must be written in the same language as the technical file and must contain at least the information included in Annex V of Directive 96/48/EC.

- 6.7. The notified body shall be responsible for compiling the technical file that has to accompany the EC declaration of verification. The technical file has to include at least the information, indicated in Directive 96/48/EC, Art 18(3), and in particular as follows:
- all necessary documents relating to the characteristics of the subsystem,
 - list of interoperability constituents incorporated into the subsystem,
 - copies of the EC declarations of conformity and, where appropriate, of the EC declarations of suitability for use, which said constituents must be provided in accordance with Article 13 of the Directive, accompanied, where appropriate, by the corresponding documents (certificates, quality system approval and surveillance documents) issued by the notified bodies on the basis of the TSI,
 - all elements relating to the conditions and limits for use,
 - all elements relating to the instructions concerning servicing, constant or routine monitoring, adjustment and maintenance,
 - certificate of EC verification of the notified body as mentioned under Point 6.6, accompanied by corresponding calculation notes and countersigned by itself, stating that the project complies with the directive and the TSI, and mentioning, where appropriate, reservations recorded during performance of the activities and not withdrawn; the certificate should also be accompanied by the inspection and audit reports drawn up in connection with the verification, as mentioned under Point 4.4 and 4.5,
 - the Infrastructure Register, including all indications as specified in the TSI.
7. The complete records accompanying the certificate of EC verification must be lodged with the adjudicating entity or its authorised representative in support of the certificate of EC verification issued by the notified body and must be attached to the EC declaration of verification drawn up by the adjudicating entity intended for the supervisory authority.
8. The adjudicating entity or its authorised representative within the Community must keep a copy of the records throughout the service life of the subsystem; it must be sent to any other Member State who so requests.
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ANNEX D

DEFINITION OF PHASES FOR THE ASSESSMENT OF THE INFRASTRUCTURE SUBSYSTEM

D.1. SCOPE

This annex describes the different phases or steps into which the design, construction, and final assembly of an infrastructure subsystem is divided. For each step or phase, the technical documentation to be provided by the adjudicating entity to enable the verification of conformity of the subsystem is detailed.

As these technical elements are limited to the part of the technical documentation relevant for interoperability, by which a new or modified infrastructure subsystem may be granted an authorisation for operation by the National Authority, the Infrastructure Manager of the line concerned may be devoted the same role as the adjudicating entity, as indicated in the following sections.

D.2. LINES TO BE SPECIALLY BUILT FOR HIGH SPEED

The design and construction of a new railway infrastructure generally takes several years. Moreover, nonconformities of design or construction can entail substantial consequences if it is necessary to do corrective work on engineering works that are already on the way to completion. It is therefore essential to accurately define, according to the general adjudicating procedures adopted for the project, the phases at which the verification procedures by the notified body shall take place. For the infrastructure subsystem, the project phases which are to be assessed can in general be set out as follows:

- detailed design of the entire civil engineering and superstructure works,
- civil works execution design phase,
- civil works construction phase,
- superstructure execution design phase,
- superstructure construction phase,
- project commissioning phase.

Each of the above phases corresponds to different design or construction works which may overlap in time and which may be checked by distinct verifications, provided coherence is maintained throughout the subsystem as per this TSI.

D.2.1. *Detailed design of the entire civil engineering and superstructure works*

The purpose of this phase is to identify and state the technical specifications that are to serve as the basis for drafting the subsequent contracts for the execution design and construction of the civil works and superstructure.

As a first step, in order to allow the verifications by the designated notified body to proceed smoothly, the adjudicating entity, or the Infrastructure Manager, prepares and sends the latter, for the project concerned, a verification book which summarises the project definition information for the planned subsystem which shall be part of the technical file of the subsystem, as it emerges at this stage of definition, from the design having served as the basis for the Member State's decision to proceed. This verification book describes in a separate chapter the elements to be inserted in the Infrastructure Register, of the line concerned as defined in Section 4.2.3.2.6.

Considering the usual procedures followed in new infrastructure construction, the definition or specification of the characteristics of the subsystem may, at this stage, be incomplete, particularly as concerns the characteristics of certain interoperability parameters, elements and constituents which can only be defined following the adjudicating procedures for the contracts concerned. The adjudicating entity, or the Infrastructure Manager, shall advise the notified body of this

fact, giving an indication of the probable date on which the constructional decisions for each parameter, element or constituent will be taken and will be communicated to it. Every decision which further specifies or alters the choices made as to the interoperability parameters, elements and constituents shall be communicated by the adjudicating entity or the Infrastructure Manager to the notified body by issuing to the latter an updated version of the verification book for the line concerned.

In any case, an updated version of the verification book shall be addressed by the adjudicating entity or the Infrastructure Manager to the notified body on completion of each of the 'definition' phases in the above-listed project phases, for each construction lot and prior to the start of the construction works.

This phase of detailed design shall be considered completed when, for any given construction lot, the contracts drawn up in accordance with the specifications selected for the parameters and elements, and verified by the notified body, have been awarded to the general contractors concerned.

Based on the verification book, the parameters and elements which must be verified under the heading of detailed design of the entire civil engineering and superstructure works are the following, with the procedure to be followed for each indicated thereafter.

Infrastructure gauge, distance between track centres, lateral space, access and intrusions

The adjudicating entity or its authorised representative, or the Infrastructure Manager, shall draw up, for the purpose of verification by the notified body, a set of drawings of typical cross-sections of the plain line showing the arrangements planned for the four elements:

- gauge: the relevant drawings are made for the line sections on straight alignment as well as for the most extreme curves from the standpoint of the structure gauge. Each drawing shall include the following information:
 - the structure gauge, for each of tracks concerned, as it results from the choices made in response to the indications in the Infrastructure Register, and from the calculations to apply the relevant European specifications, or, pending their publication, UIC leaflets 505-4 and 506 as set out in Section 4.3.3 for the 'structure gauge' element (4.3.3.1), which calculations shall be appended to the drawings,
 - the pantograph clearance gauge, as it results from the choices made in response to the indications given in the Register of Infrastructure on the subject of the electrification system and from the calculations to apply UIC leaflets 606-1, 505-1 and 505-4 as set out in Section 4.3.3 for the 'structure gauge' element (4.3.3.1), which calculations shall be appended,
 - the positions of the fixed obstacles belonging to the other subsystems (energy, control-command and signalling),
 - the distance between track centres for each of the situations where this applies in the case of lines with more than two tracks;
- lateral space: the typical cross-sections mentioned above shall include the planned lateral spaces with the dimensions of their width and distance from the nearest rail marked thereon,
- accessways and intrusions: the typical cross-sections shall furthermore represent any fences planned by the adjudicating entity, or the Infrastructure Manager, according to the requirements of Section 4.3.3 (4.3.3.25), and the principle of the devices, if any, intended to limit the risks of intrusion by road vehicles.

Cants and curve radii

The adjudicating entity or its representative shall, for the purpose of verification by the notified body, have a list of the curves in the relevant line section of the project drawn up, to the degree of definition achieved at that stage of design, showing the radius of curvature, the theoretical cant and the cant deficiency that results from that cant at the selected maximum speed. The three values shall be indicated separately for each track if the tracks have different radius or cant characteristics.

If the project includes service or trainset stabling sidings which must be open to interoperable trainsets, the adjudicating entity or the Infrastructure Manager shall have a plan of these installations drawn up, showing the elements of their alignment and the radius of the curves on those sidings.

Rising and falling gradients

The adjudicating entity or its representative, or the Infrastructure Manager, shall, for the purpose of verification by the notified body, have a drawing made of the alignment showing the gradients planned to be used on the route at that stage of the design, as well as the planned radii of transition curves between the elements of the vertical alignment.

Environmental protection

The adjudicating entity or its representative, or the Infrastructure Manager, shall supply, for the purpose of verification by the notified body, the environmental impact study made according to the requirements set out by the Member State to comply with Council Directive 85/337/EC. This study shall state the vibration levels expected to arise along the infrastructures relative to the levels defined in the European specifications or the applicable regulations of the Member States, and describe the protection devices set in place to respect these levels.

Effect of crosswinds

The adjudicating entity or its representative, or the Infrastructure Manager shall determine the sites where crosswind speeds in excess of the acceptable limits are to be experienced, and where adequate wind protection shall be put in place.

*Length of platforms**Height of platforms*

For the purpose of verification of these two elements by the notified body, the adjudicating entity or its representative, or the Infrastructure Manager, shall have site plans drawn of the stations to be constructed, with the platforms' useful length and cross-sections of the platforms shown thereon.

D.2.2. Civil works execution design phase

This phase shall comprise the design work for all the engineering structures necessary for building the infrastructure, including earth structures, engineering structures, tunnels, and surface and underground stations. Construction of the main parts of these works which contain elements shall not go forward before the notified body has carried out its verification of the elements.

The verification of conformity for this phase shall as a rule be made for each work concerned by the provisions of this TSI. However, in the case where 'standard structures' are used, the relevant verifications of the design may be made on the basis of a common design file for a set of structures with identical features in a given construction lot.

The interface parameters and elements which shall be subject to verification of conformity in their design phase are listed below by type of structure:

1. All civil engineering works comprising structures close to the tracks or overhanging them, e.g. road bridges, shelters on passenger platforms, underground stations

structure gauge, distance between track centres, lateral space:

for each structure or lot of identical structures in the case of standard structures, the adjudicating entity or its representative, or the Infrastructure Manager, shall have cross-sections of the structures drawn, taken parallel to the tracks, with the following information marked thereon:

- structure gauge of each track,
- track centres distance,
- pantograph clearance for the selected type of electrification,
- position of the fixed obstacles associated with the structures but pertaining to other subsystems,
- lateral space planned within the structures.

erodynamic effects on structures:

The adjudicating entity or the Infrastructure Manager shall append to the file for each structure, as appropriate, the documents establishing that the structures concerned are designed to withstand the loads specified in Section 4.3.3 (4.3.3.3) for the relevant element (application of Section 6.6 of ENV 1991-3).

2. Specific verifications of railway bridges

structures: vertical loads
structures: transverse horizontal forces
structures: longitudinal loads

The adjudicating entity or the Infrastructure Manager shall append to the file for each structure, as appropriate, for purposes of verification by the notified body, the documents establishing that the structures concerned are designed to withstand the loads specified in Section 4.3.3.13, 4.3.3.14 and 4.3.3.15 for these three elements (application of ENV 1991 part 1).

3. Specific verifications of tunnels, cut-and-covers and underground stations

The adjudicating entity or the Infrastructure Manager shall append to the file for each structure, as appropriate, the documents establishing that the free cross-sectional area of the structures concerned meets the requirements of CEN Standard stated in Section 4.3.3.26 for the element 'works below ground level such as tunnels and cut-and-covers', limiting the pressure variations to 10 000 Pascals throughout the time of the trains' passage through the structure.

The provisions incorporated in very long tunnels as per Section 4.2.3.1.4, if any, shall be detailed in the technical file for the tunnel concerned.

Moreover, for underground stations, the adjudicating entity or the Infrastructure Manager shall append to the above file the study showing that the specifications relating to the limitation of the air velocities to which passengers may be subject in the areas to which they have access described in Section 4.3.3.27 for the element 'underground stations' are complied with.

4. Specific verifications of underground stations and platforms

The adjudicating entity or the Infrastructure Manager shall append to the file for each structure a set of descriptive documents of the measures taken to eliminate from the various installations to be made, unacceptable risk of electric shock for passengers.

D.2.3. Civil works construction phase

This phase comprises the actual construction of all the structures addressed in the previous phase, complying with the specifications drawn up in that phase. For any given structure, the phase commences when the construction contracts for the structure are let and ends when the structure is accepted prior to commissioning of the subsystem.

For certain structures (rail bridges), this phase may involve specific tests and measurements. These tests and measurements shall be carried out following the provisions set by national laws or rules in application on the territory of the Member State concerned.

D.2.4. Superstructure execution design phase

This phase comprises the design studies for all the assembled elements necessary for building the track: plain track, switches and crossings and expansion joints, and any other apparatus that includes interfaces with the other subsystems which have fixed elements connected to the track. It shall generally begin concurrently with the detailed design phase and shall end with the issuing of the procurement specifications for the elements and/or for the construction (laying) of the track.

The verification of conformity of this phase shall as a rule be made for each type of subassembly of the superstructure concerned by the provisions of this TSI and assembled into the subsystem: track, switches and crossings and expansion joints. If several different types of a basic subassembly are used in the construction of the subsystem, either because different technologies are employed or because variants of a given technology are used, the verification shall address each of the different types of subassembly used in the subsystem.

The interface parameters and elements which shall be subject to verification of conformity in their execution design phase are listed by type of subassembly:

1. Plain line track:

track gauge
track resistance to vertical, lateral and longitudinal forces
track stiffness

For each type of track to be incorporated into the subsystem, the adjudicating entity or its representative, or the Infrastructure Manager, shall create a file for the purpose of verification by the notified body, comprising the following items:

- the drawing of the rail type complying with the specifications drawn up for that component in Section 5,
- the drawing of the system of rail-to-sleeper fastenings, accompanied by the EC certificate of the tests made on that type of fastener according to the specifications of Section 5 for the component,
- the drawing of the sleepers or slab-track system used, accompanied by the EC certificates of the tests made according to the specifications of Section 5 for the component,
- an assembly drawing of the previously stated components fitted together, showing compliance with the nominal design track gauge values defined in Section 4.3.3.10,
- a layout drawing of the track as a whole on each construction lot; this layout shall show the type of track-laying planned on each homogenous line section, including an indication of the number of sleepers and fastening systems per length of track planned to be used under each type of laying envisaged, so as the switch areas and type of switch and the planned speed on the diverging track.

In the case where the track superstructure system is not built up from interoperability constituents as defined in Chapter 5, the file shall comprise the technical studies as per Sections 4.3.3.16, 4.3.3.17, 4.3.3.21 and 4.3.3.22 which demonstrate that the track system has the required performances in terms of resistance to vertical, transversal and longitudinal forces, and of dynamic stiffness. The track system chosen shall also be assessed for its in-service behaviour as described in Table B.7.

2. Switches, crossings and expansion joints

switches and crossings, point profiles and functional conditions

cant deficiency in track switches

For each type of switch or crossing to be incorporated into the subsystem, the adjudicating entity or its representative, or the Infrastructure Manager, shall create a file for the purpose of verification by the notified body, comprising the following items:

- a diagram of the mechanical and geometrical characteristics of the switch with an indication of the curve radii of the diverging route, of the angle of divergence, of the use of a swing nose when relevant and of the types of rail used in the switch or crossing according to the specifications in Section 5 for the rail component. This diagram shall moreover indicate the planned speed of running over the through track and the diverging track under the different track-laying systems planned to be used: layout on straight or curved track of the alignment; for each speed case planned, the cant deficiency on passing onto the diverging track shall be indicated.
- a drawing of the point securement and locking means used,
- a drawing of the cross-sections of the switch rail profiles showing their conformity to the specifications of Section 4.3.3.19,
- a drawing of the fastening systems on plain line track sections, accompanied by the EC certificate of test of that type of fastener made according to the specifications in Section 5 for that component,
- a drawing of the switch as a whole showing the functional dimensions in the switch and crossing defined in Section 4.3.3.20.

In the case where the switch and crossing system is not built up from interoperability constituents as defined in Chapter 5, the file shall comprise the technical studies as per Sections 4.3.3.16, 4.3.3.17, 4.3.3.21 and 4.3.3.22 which demonstrate that the track system has the required performances in terms of resistance to vertical, transversal and longitudinal forces, and of dynamic stiffness.

3. Geometrical quality of track

The adjudicating entity or the Infrastructure Manager shall, for the purpose of verification by the notified body, have the table of limiting values of track geometrical quality specified in Section 4.2.3.2.2 for the maintenance plan, drawn up.

D.2.5. *Superstructure construction phase*

This phase shall begin after the writing of the specifications during the preceding detailed design phase, as soon as the corresponding contracts are let. It shall end, for a given work lot, at acceptance of the lot, prior to subsystem commissioning.

The verification of conformity, in this phase, shall address the following elements:

Rails

The adjudicating entity or its representative, or the Infrastructure Manager, shall send to the notified body the EC certificates for the rails received from the rail manufacturer and laid on the track, the said certificate covering the verification of the dimensions of the products supplied pursuant to the specifications in Section 5 for the component.

Track geometrical quality

During acceptance of the track laying lots, the adjudicating entity or the Infrastructure Manager shall have the measurements of track geometry made and analysed for the purpose of verification by the notified body. The data reduction and analysis report shall demonstrate compliance with the limiting values defined in the superstructure design phase.

D.2.6. *Project commissioning phase*

This phase shall begin when all of the infrastructure work, including installation of all the subsystems comprising fixed ground equipment, is completed.

The adjudicating entity, or its representative, or the Infrastructure Manager shall define, in connection with the State Authority concerned, the practical measures and the different phases which are necessary for allowing, in due time, the opening to service with the required performances, as described in Section 4.2.3.2.1. These phases may include transition periods of putting into service with reduced performances.

The verification of conformity in this phase shall address the following elements:

Pre-commissioning tests

For one or more given work lots, following completion of the acceptance procedures on the corresponding construction lots, the adjudicating entity or its representative, or the Infrastructure Manager, shall have a pre-commissioning test made prior to service entry, under the conditions specified in Section 4.2.3.2.1 of this TSI, for the purpose of verification by the notified body. The notified body may make the measurements itself or, failing that, an independent certified laboratory may make them, in which case the report shall be subject to evaluation by the notified body.

The test report shall take up the list of parameters whose measurement has been requested by the authority responsible for declaring the line commissioned, with against each, the list of points where the specified limits have been reached or exceeded.

Maintenance plan

The adjudicating entity or its representative, or the Infrastructure Manager, shall, for the purpose of verification by the notified body, have the maintenance plan specified in Section 4.2.3.2.2 drawn up.

Line verification book

The adjudicating entity or its representative, or the Infrastructure Manager, shall, for the purpose of verification by the notified body, have the final version of the verification book for the relevant line drawn up. This verification book shall serve, following verification by the notified body, as the reference document guaranteeing that the requirements of this TSI have been complied with for the line about to be commissioned.

Infrastructure Register

Based on the final version of the verification book as approved by the notified body, the adjudicating entity or its representative, or the Infrastructure Manager, shall have the Infrastructure Register for the relevant line drawn up, as per the specifications in Section 4.2.3.2.6.

D.3. EXISTING LINES TO BE SPECIALLY UPGRADED FOR HIGH SPEED

In the case of larger modifications, if the project to upgrade an existing line for high speed operation falls within the scope of Directive 96/48/EC, the Infrastructure Manager shall begin the verification procedure with the assessment of detailed design.

The design and construction of substantial improvements to existing lines may involve partial modifications to installations possibly addressed by this TSI. It is therefore essential to accurately define, according to the procedures adopted with regards to the general contractorship of the works, the structures affected by modifications which may be addressed by the specifications in the preceding sections and the different phases during which the notified body shall be expected to carry out verifications.

The EC verification of conformity of the infrastructure subsystem shall in this case, depending on the works concerned and the project phases thus defined, be carried out by applying all or part of the procedures described in D.2 above, selecting from among those procedures only those pertaining to the elements addressed by the specifications in Section 4.3.3 for the line category concerned by the upgrading works.

ANNEX E

CHARACTERISTICS REQUIRED TO APPEAR IN THE INFRASTRUCTURE REGISTER

The Infrastructure Register shall allow:

- the Member State responsible for granting authorisation to place the subsystem into service to have at hand a document describing, for each line of the trans-European high-speed rail system, the basic parameters on which operation of that line depends,
- the Infrastructure Manager to have at hand a recapitulative document describing the lines concerned so that he can follow the subsequent evolutions in the implementation of the TSI,
- the railway undertakings that operate or wish to operate services on the line to be informed of the line's particular features, when the parameters or some of the interoperability specifications result from a choice made by the Infrastructure Manager.

The Infrastructure Register shall contain the following information relevant to the infrastructure subsystem:

- a descriptive map of the concerned line, showing the stations opened to interoperable high-speed train traffic,
- a line diagram showing:
 - where tracks cross (geographical location of crossovers),
 - noticeable features making it easier for a driver to situate himself geographically, giving their milepost position on the line in kilometres,
 - possible access ways to the railway right-of-way from the road network, with their kilometric position, to facilitate evacuation of passengers by road,
 - railway structures and tunnels whenever these comprise special arrangements for evacuating passengers,
- a diagram of each station where high-speed trains can call with an indication of the length of the tracks other than the main tracks and of the length and height of the platforms; the arrangements made to facilitate access by disabled passengers shall be mentioned thereon,
- the performance levels assigned in each homogeneous section of the line concerned, with an indication of the maximum speeds on each of them; if the line must also carry other trains besides interoperable trains, their respective performance levels must be mentioned,
- the type of electrification used on each of the homogenous line sections, with an indication of the heights of the overhead lines and the associated pantograph types,
- for each of the homogeneous line sections, a statement of the choices made concerning each of the characteristics of the line which it is necessary to know in order to operate the line, which are listed below:

Basic parameters:

- structure gauge: specify the structure and pantograph gauge used or the particular gauge selected,
- minimum radius of curvature: indicate minimum radius of curves in the plain line track of the line, the maximum cant and the maximum cant deficiency used; state the minimum radius used on sidings,
- track gauge: indicate if any specific case has been adopted,
- minimum length of platform: to be marked on the station diagram mentioned above,
- characteristics relating to access by disabled persons: to be marked on the station diagram mentioned above,

- maximum pressure change in tunnels: give the maximum pressure value selected if it is less than the requested limit value,
- maximum gradients: indicate the maximum gradient adopted on the line section, and its maximum length,
- minimum distance between track centres: indicate the minimum distance between centres which has been selected, or the 'specific case' adopted.

Other characteristics relevant to the infrastructure TSI:

- braking conditions for brakes that do not use wheel-rail adhesion: specify the accepted braking effort value (Case 2 or Case 3 of Section 4.3.3.21) for the type of brake concerned, or state that they are prohibited on the line,
- cant deficiency in switches and crossings: indicate the value actually used if it is less than the maximum permissible value,
- effect of cross-winds: indicate the arrangements adopted at the sites concerned;
- lateral space: indicate the width adopted for the lineside lateral space available, and its position relative to the rail (horizontal and vertical distances) in view of facilitating the organisation of evacuation measures, on open track as well as in tunnels.

Other characteristics relating to other TSIs:

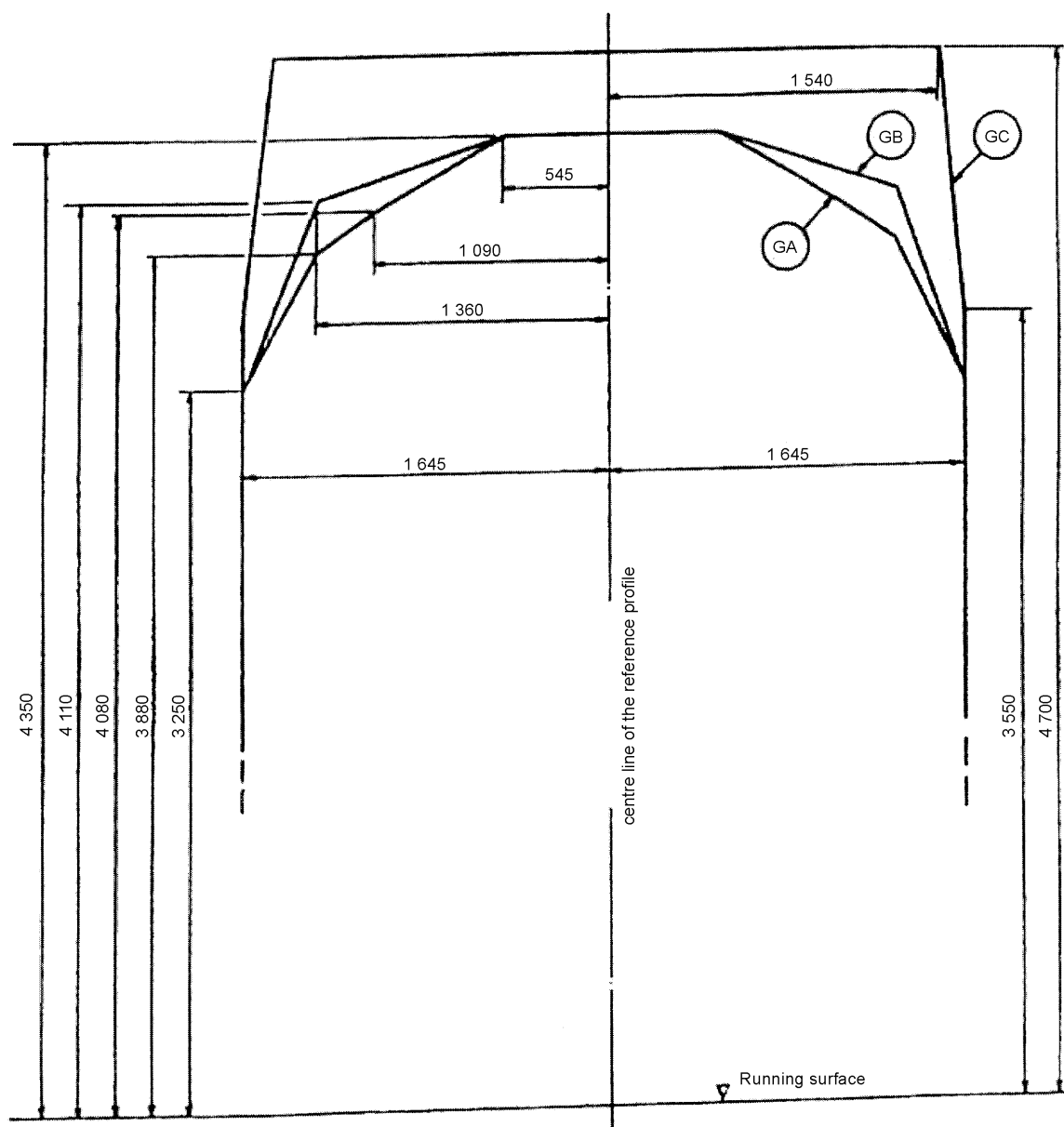
- type of electrification: indicate the voltage and catenary height characteristics,
 - control-command and signalling: indicate the type of line signalling and the type of signalling on sidings,
 - geographical mileposting: specify the type of kilometric mileposting used on the line, giving a summary description (panel on post, kilometre point marked on catenary mast or other),
 - model of temporary works notice, describing the signalling used for works;
 - climatic environment conditions to be met along the line,
 - where appropriate, state any special, additional arrangements required aboard the rolling stock for running in certain specific, very long tunnels, requested as a derogation from the rolling stock TSI;
 - state the location of the depots being in charge of breakdown recovery and re-railing means, and the corresponding activation procedures,
- for each of the homogenous line sections, mention must be made of the application of the community or national regulations that apply, as these relate to the essential requirements, without impeding interoperability of the line, to the extent that those requirements may include obligations to be fulfilled by the railway undertakings operating services on the line.
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ANNEX G

GA, GB AND GC KINEMATIC GAUGES

GA, GB AND GC KINEMATIC GAUGES

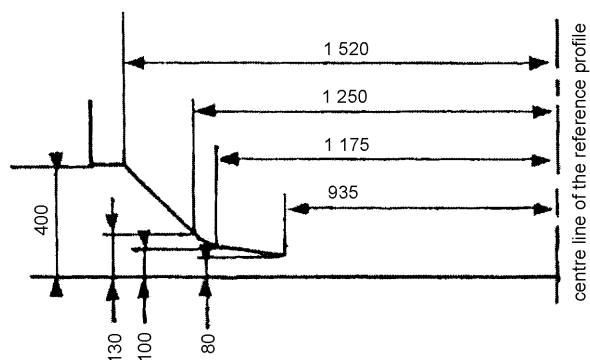
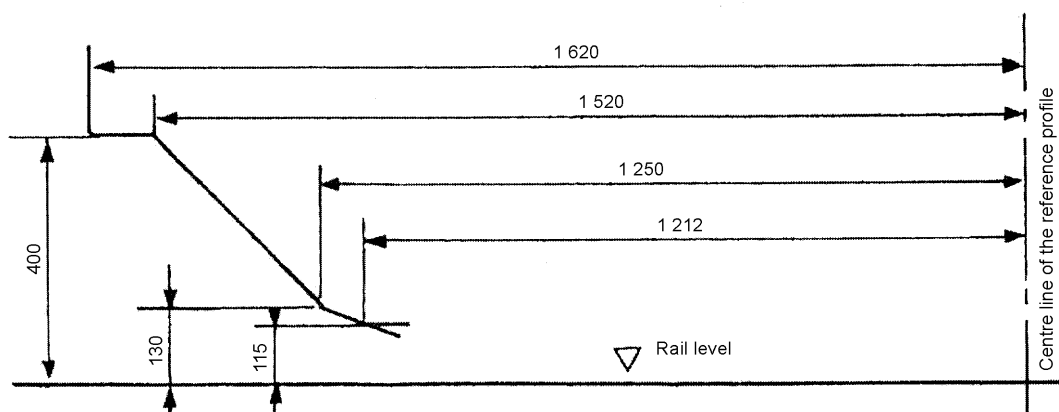
Reference profiles



N.B.: Up to a height of 3 250 mm, the reference profile of GA, GB and GC gauges is identical.

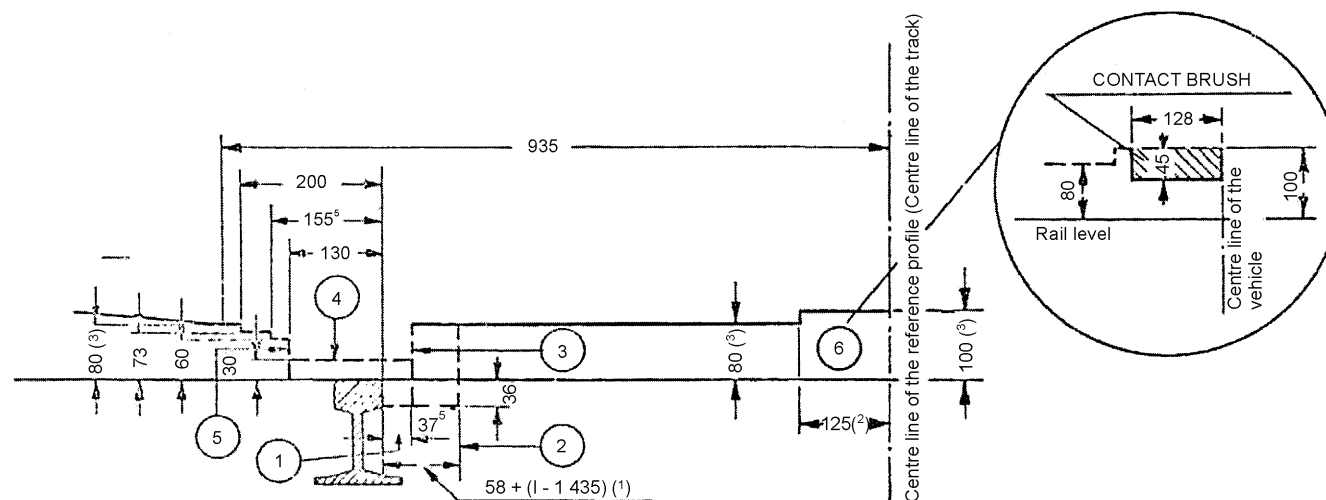
LOWER PARTS

A. Lines over which powered units used on international services run

B. Lines over which coaches, vans and wagons used on international services run
(with the exception of powered units used on international services)

Note: On inclined connections with a radius $R \geq 500$ m, the vertical measurements shown in diagrams A and B above must be reduced by $\frac{50\,000}{R}$ mm (R in m). If $625 \geq R \geq 500$ m, the measurement 80 in diagram A is cancelled.

A. Lines over which powered units used on international services run



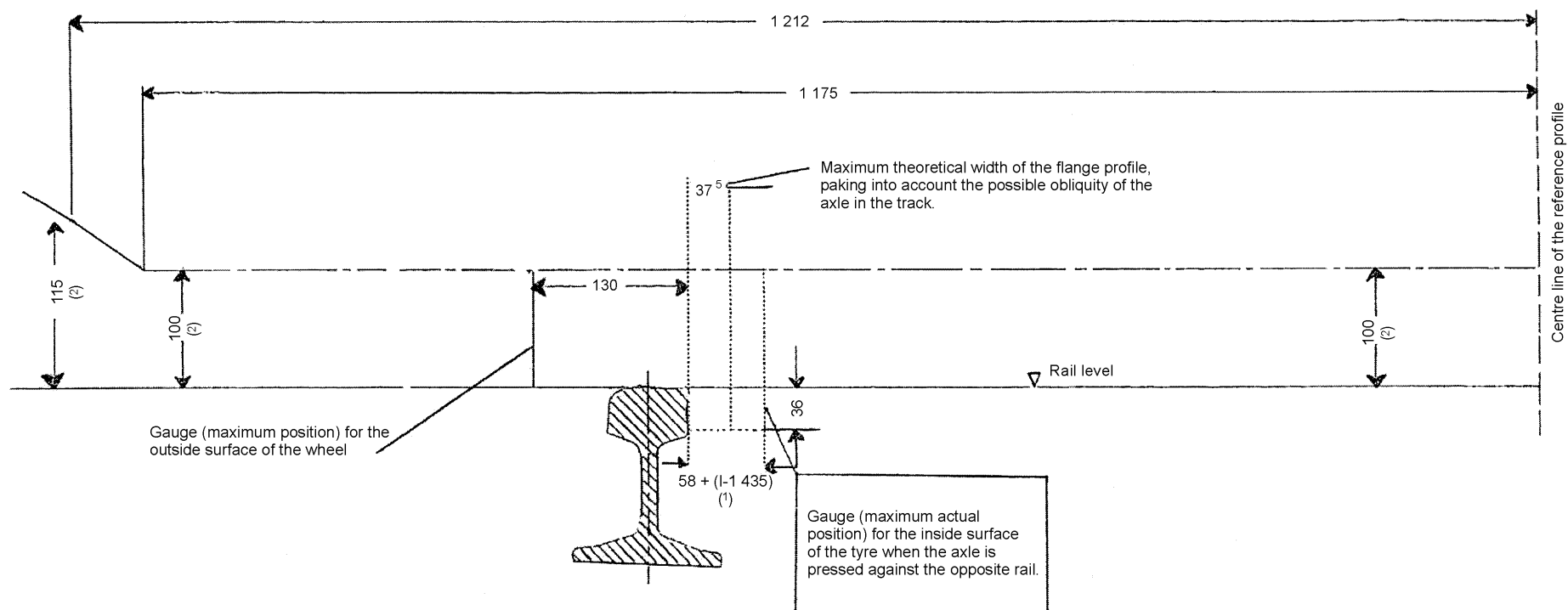
- ① Maximum theoretical width of the flange profile, taking into account the possible obliquity of the axle in the track.
- ② Gauge (maximum actual position) for the inside surface of the tyre when the axle is pressed against the opposite rail.
- ③ Maximum positioning of check-rails.
- ④ Gauge (maximum position) for the parts of the rolling stock adjacent to the wheels.
- ⑤ Gauge (maximum position) for the outside surface of the wheel.
- ⑥ Area for fixing contact ramps.

(1) l = width of track.

(2) Irrespective of radius $R \geq 250$ m and width of track $l \leq 1,465$ m.

(3) These dimensions are valid for flat track. They must be reduced by $\frac{50\,000}{R}$ mm (R in m) for inclined connections with a radius $R > 625$ m and cancelled if $625 \geq R \geq 500$ m.

B. Lines over which coaches, vans and wagons used on international services run, excluding powered units.



(1) l = width of track.

(2) On concave or convex inclined connections with a radius $R \geq 500$ m, this dimension must be reduced by $\frac{50\,000}{R}$ mm.

ANNEX H

REGULATIONS RELATING TO THE LAY-OUT OF S-CURVES

(Length of straight track likely to be required between a curve and a reverse curve)

Data used in the calculation

 R_1 and R_2 = Radii, in metres, of the curve and reverse curve concerned, with R_1 and $R_2 \geq 150$ m. L = Length, in metres, of straight track likely to be required between curves with radii R_1 and R_2 . I = Track gauge, in metres, in the area concerned.

Formulae to be applied

if $\frac{45}{R_1} + \frac{45}{R_2} - 0,45 - 2(1,470 - 1) \leq 0$ no straight section is necessary between the curve and reverse curve.

if $\frac{45}{R_1} + \frac{45}{R_2} - 0,45 - 2(1,470 - 1) \geq 0$ the length of the straight section required between the curve and reverse curve is:

$R_1 \leq R_2$	$L_1 = \sqrt{(R_1 + R_2) \left[\frac{45}{R_1} + \frac{45}{R_2} - 0,45 - 2(1,470 - 1) \right]}$ <p style="text-align: center;">when $\frac{45}{R_1} + 9 \frac{4R_2 - R_1}{R_2^2} \leq 0,45 + 2(1,470 - 1)$</p> $L_2 = 15 - \sqrt{(4R_2 - R_1) \left[0,45 + 2(1,470 - 1) - \frac{45}{R_1} \right]}$ <p style="text-align: center;">when $\frac{45}{R_1} + 9 \frac{4R_2 - R_1}{R_2^2} \geq 0,45 + 2(1,470 - 1)$</p>
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When $R_1 = R_2 = R$, these formulae can be simplified as follows:

$$L_1 = \sqrt{180 - R [0,90 + 4(1,470 - 1)]} \quad \text{when} \quad R \geq \frac{72}{0,45 + 2(1,470 - 1)}$$

$$L_2 = 15 - \sqrt{R [1,35 + 6(1,470 - 1)] - 135} \quad \text{when} \quad R \leq \frac{72}{0,45 + 2(1,470 - 1)}$$

The above formulae assume that the curves and reverse curves are tangent to one another or to the intermediate straight section. The length of the straight section must be increased, when a deviation angle (points and crossings) alters the swing movement of the vehicles, in order to offset the additional relative displacement of the buffers resulting there from.

These layouts allow a minimum radius of 190 m without straight track between the curves and of 150 m when at least 6 m of straight track is provided between the curves.

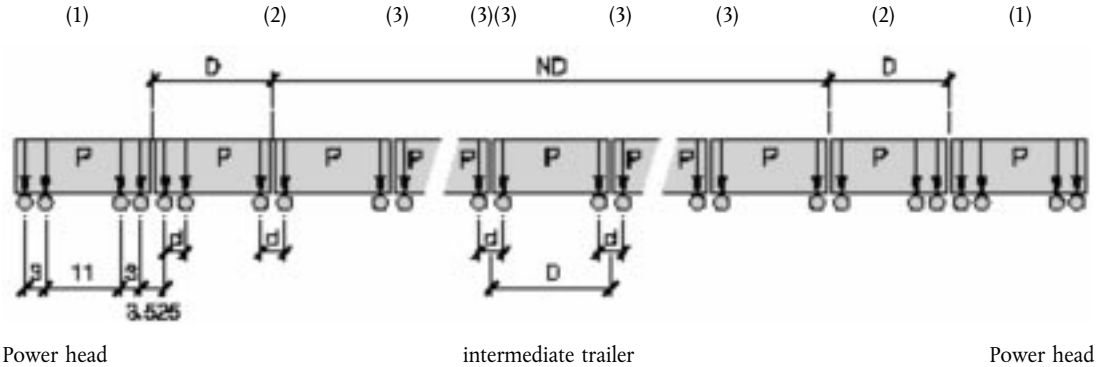
ANNEX I

UNIVERSAL DYNAMIC TRAIN

The universal dynamic train comprises the following ten reference trainsets:

Train	Number of intermediate vehicles N	Vehicle length D (m)	Bogie wheel base d (m)	Axle load P (kN)
A1	18	18	2,0	170
A2	17	19	3,5	200
A3	16	20	2,0	180
A4	15	21	3,0	190
A5	14	22	2,0	170
A6	13	23	2,0	180
A7	13	24	2,0	190
A8	12	25	2,5	190
A9	11	26	2,0	210
A10	11	27	2,0	210

Schematic of the trainsets listed above:



- (1) Power car
- (2) End trailer with coupling
- (3) Intermediate trailer

ANNEX K1

FLAT BOTTOM SYMMETRICAL RAILWAY RAILS 46 KG/M AND ABOVE — STEEL GRADES

The seven steel grades are given in Table 1. The five hardness ranges of the steel grades shall conform to those given in Table 1.

Table 1

Steel grades

Grade ⁽¹⁾	Hardness range (HBW)	Description	Branding lines
200	200-240	Carbon — manganese (C-Mn)	No branding lines
220	220-260	Carbon — manganese (C-Mn)	_____
260	260-300	Carbon — manganese (C-Mn)	_____ _____
260 Mn	260-300	Carbon — manganese (C-Mn)	_____ _____
320 Cr	320-360	Alloy (1 % Cr)	_____ _____ _____
350 HT	350-390 ⁽²⁾	Carbon — manganese (C-Mn) heat treated	_____ _____ _____
350 LHT	350-390 ⁽²⁾	Low alloy, heat treated	_____ _____ _____

⁽¹⁾ See Table 2 for chemical composition/mechanical properties.

⁽²⁾ If the hardness exceeds 390 HBW but is below 400 HBW then the rail is acceptable, provided that the rail microstructure is confirmed to be pearlitic.

Table 2(a)

Chemical composition/mechanical properties

Steel sample grade		% by mass								10 ⁻⁴ % (ppm) max		Rm min N/mm	Min elong %	Centre line running surface hardness HBW
		C	Si	Mn	P max	S	Cr	Al max	V max	N max	O	H		
200	Liquid	0,40/0,60	0,15/0,58	0,70/1,20	0,035	0,008/0,035	< 0,15	0,004	0,030	0,009	20 or	3,0 or		
	Solid	0,38/0,62	0,13/0,60	0,65/1,25	0,040	0,008/0,040	< 0,15	0,004	0,030	0,010	20	3,0	680	14 200/240
200	Liquid	0,50/0,60	0,20/0,60	1,00/1,25	0,025	0,008/0,035	< 0,15	0,004	0,030	0,008	20 or	3,0 or		
	Solid	0,50/0,60	0,20/0,60	1,00/1,25	0,025	0,008/0,025	< 0,15	0,004	0,030	0,008	20	3,0	770	12 220/260
260	Liquid	0,62/0,80	0,15/0,58	0,70/1,20	0,025	0,008/0,025	< 0,15	0,004	0,030	0,009	20 or	2,5 or		
	Solid	0,60/0,82	0,13/0,60	0,65/1,25	0,030	0,008/0,030	< 0,15	0,004	0,030	0,010	20	2,5	880	10 260/300
260 Mn	Liquid	0,55/0,75	0,15/0,60	1,30/1,70	0,025	0,008/0,025	< 0,15	0,004	0,030	0,009	20 or	2,5 or		
	Solid	0,53/0,77	0,15/0,60	1,25/1,75	0,030	0,008/0,030	< 0,15	0,004	0,030	0,010	20	2,5	880	10 260/300
320 Cr	Liquid	0,60/0,80	0,50/1,10	0,80/1,20	0,020	0,008/0,025	0,80/1,20	0,004	0,18	0,009	20 or	2,5 or		
	Solid	0,58/0,82	0,48/1,12	0,75/1,25	0,025	0,008/0,030	0,75/1,25	0,004	0,20	0,010	20	2,5	1 080	9 320/360
350 HT	Liquid	0,72/0,80	0,15/0,58	0,70/1,20	0,020	0,008/0,025	< 0,10	0,004	0,030	0,009	20 or	2,5 or		
	Solid	0,70/0,82	0,13/0,60	0,65/1,25	0,025	0,008/0,030	< 0,15	0,004	0,030	0,010	20	2,5	1 175	9 350/390
350 LHT	Liquid	0,72/0,80	0,15/0,58	0,70/1,20	0,020	0,008/0,025	0,30 max	0,004	0,030	0,009	20 or	2,5 or		
	Solid	0,70/0,82	0,13/0,60	0,65/1,25	0,025	0,008/0,030	0,30 max	0,004	0,030	0,010	20	2,5	1 175	9 350/390

X = Maximum level Re = Residual element

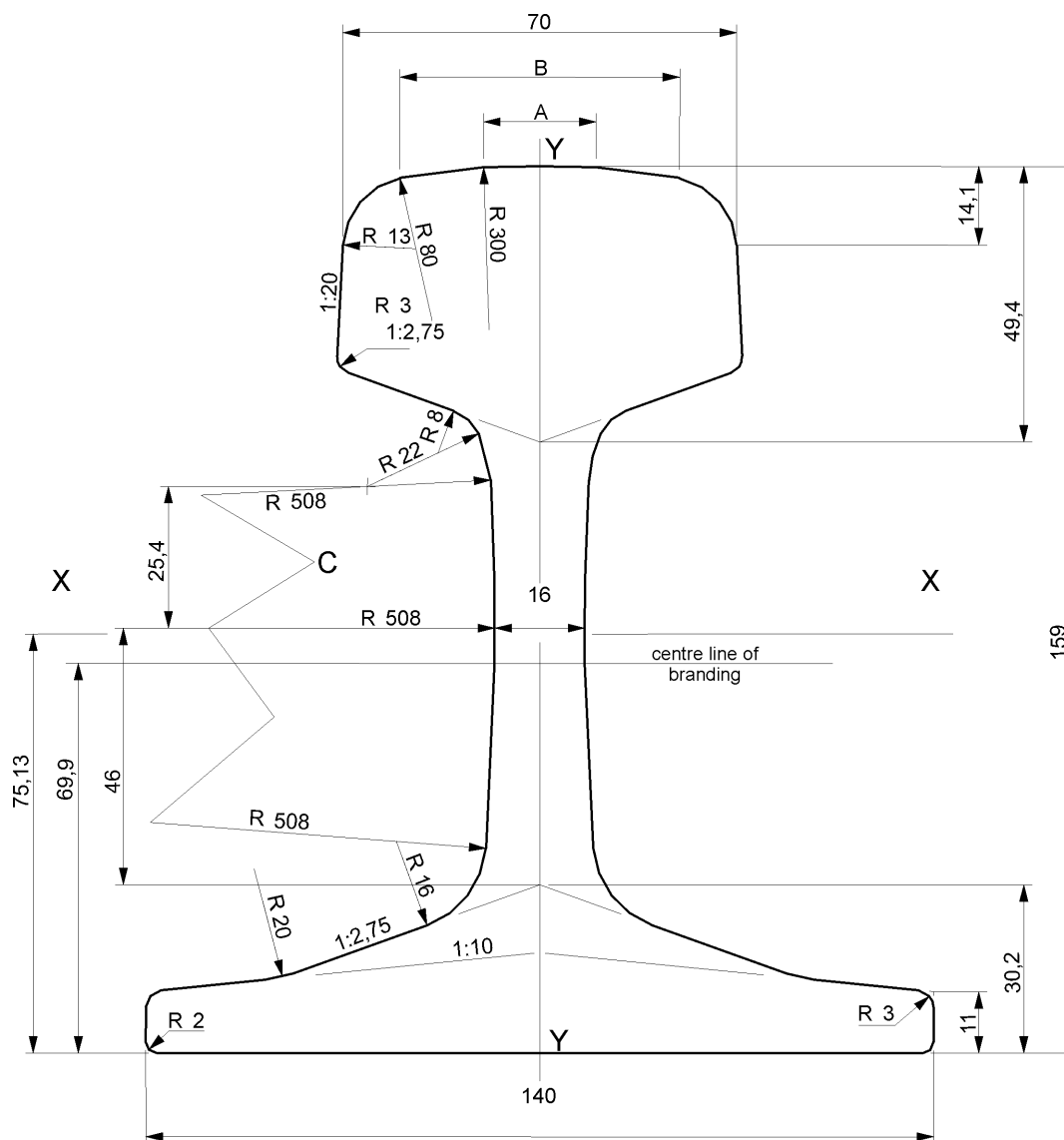
Table 2(b)

Max residual elements

	Mo	Ni	Cu	Sn	Sb	Ti	Nb	Cu and 10 Sn		
200, 220, 260, 260 Mn	0,02	0,10	0,15	0,030	0,020	0,025	0,01	< 0,35	Cr + Mo + Ni + Cu + V	< 0,35
320 Cr	0,02	0,10	0,15	0,030	0,020	0,025	0,01	< 0,35	Ni + Cu	< 0,16
350 HT	0,02	0,10	0,15	0,030	0,020	0,025	0,04	< 0,35	Cr + Mo + Ni + Cu + V	< 0,25
350 LHT	0,02	0,10	0,15	0,030	0,020	0,025	0,04	< 0,35	Mo + Ni + Cu + V	< 0,20

ANNEX K2

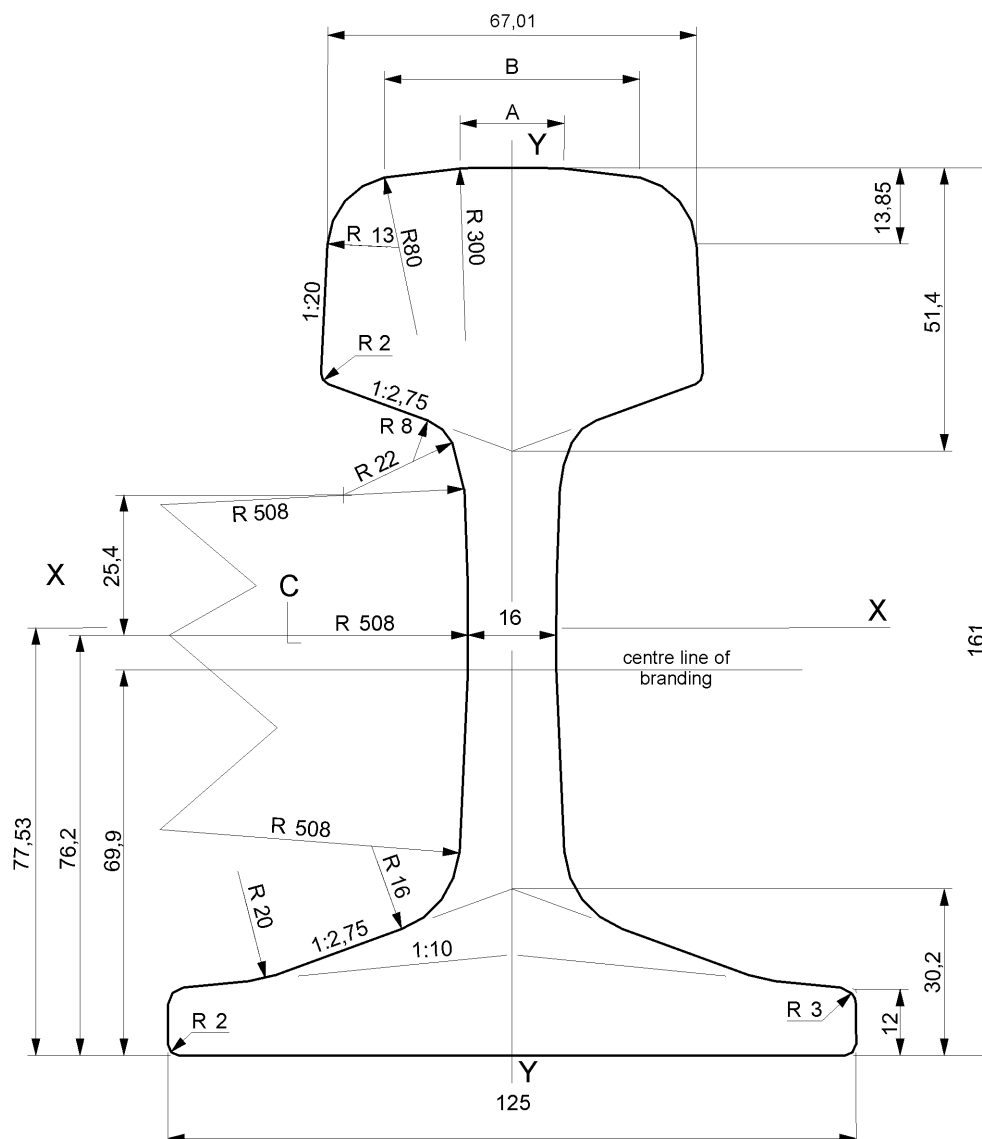
FLAT BOTTOM SYMMETRICAL RAILWAY RAILS 46 KG/M AND ABOVE — RAIL PROFILES



Cross-sectional area	69,77	cm ²
Mass per metre	54,77	kg/m
Moment of inertia x-x axis	2 337,9	cm ⁴
Section modulus — Head	278,7	cm ³
Section modulus — Base	311,2	cm ³
Moment of inertia y-y axis	419,2	cm ⁴
Section modulus y-y axis	59,9	cm ³

Indicative dimensions: A = 20,024
B = 49,727

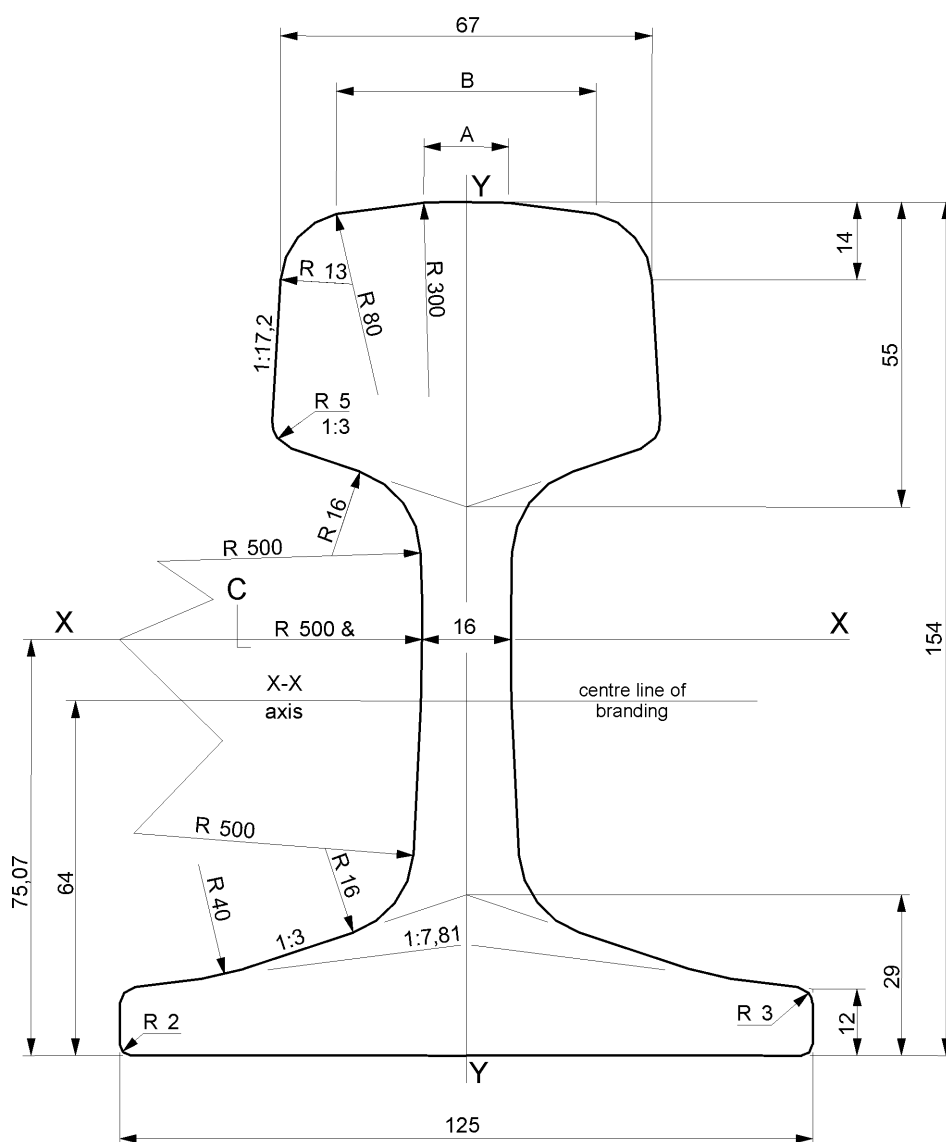
Rail profile 54 E 1



Cross-sectional area	68,56	cm ²
Mass per metre	53,82	kg/m
Moment of inertia x-x axis	2 307	cm ⁴
Section modulus — Head	276,4	cm ³
Section modulus — Base	297,6	cm ³
Moment of inertia y-y axis	341,5	cm ⁴
Section modulus y-y axis	54,6	cm ³

Indicative dimensions: A = 18,946 mm
B = 46,310 mm

Rail profile 54 E 2

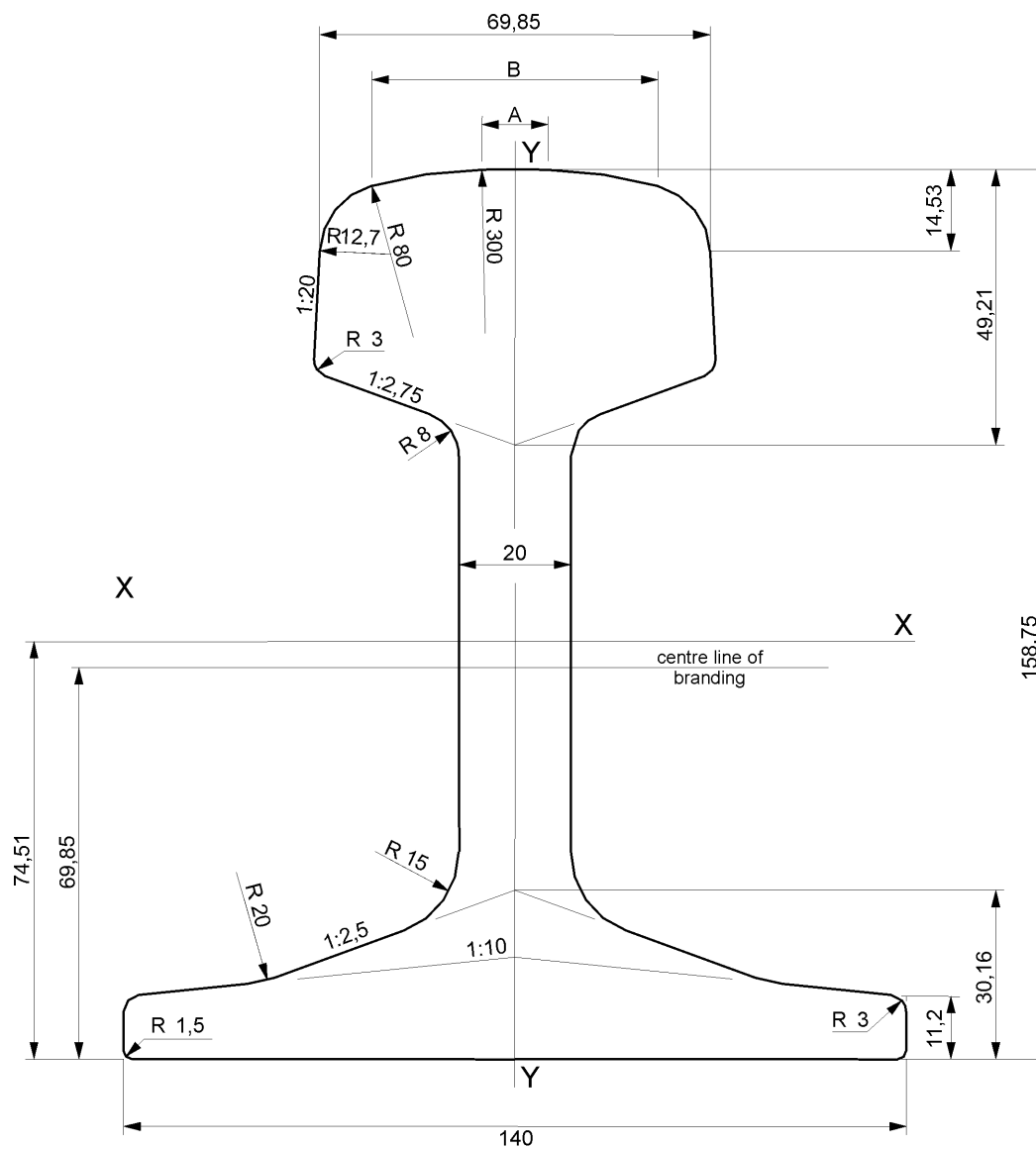


Cross-sectional area	69,52	cm ²
Mass per metre	54,57	kg/m
Moment of inertia x-x axis	2 074	cm ⁴
Section modulus — Head	262,8	cm ³
Section modulus — Base	276,3	cm ³
Moment of inertia y-y axis	354,8	cm ⁴
Section modulus y-y axis	56,8	cm ³

Indicative dimensions:

A =	15,267 mm
B =	46,835 mm

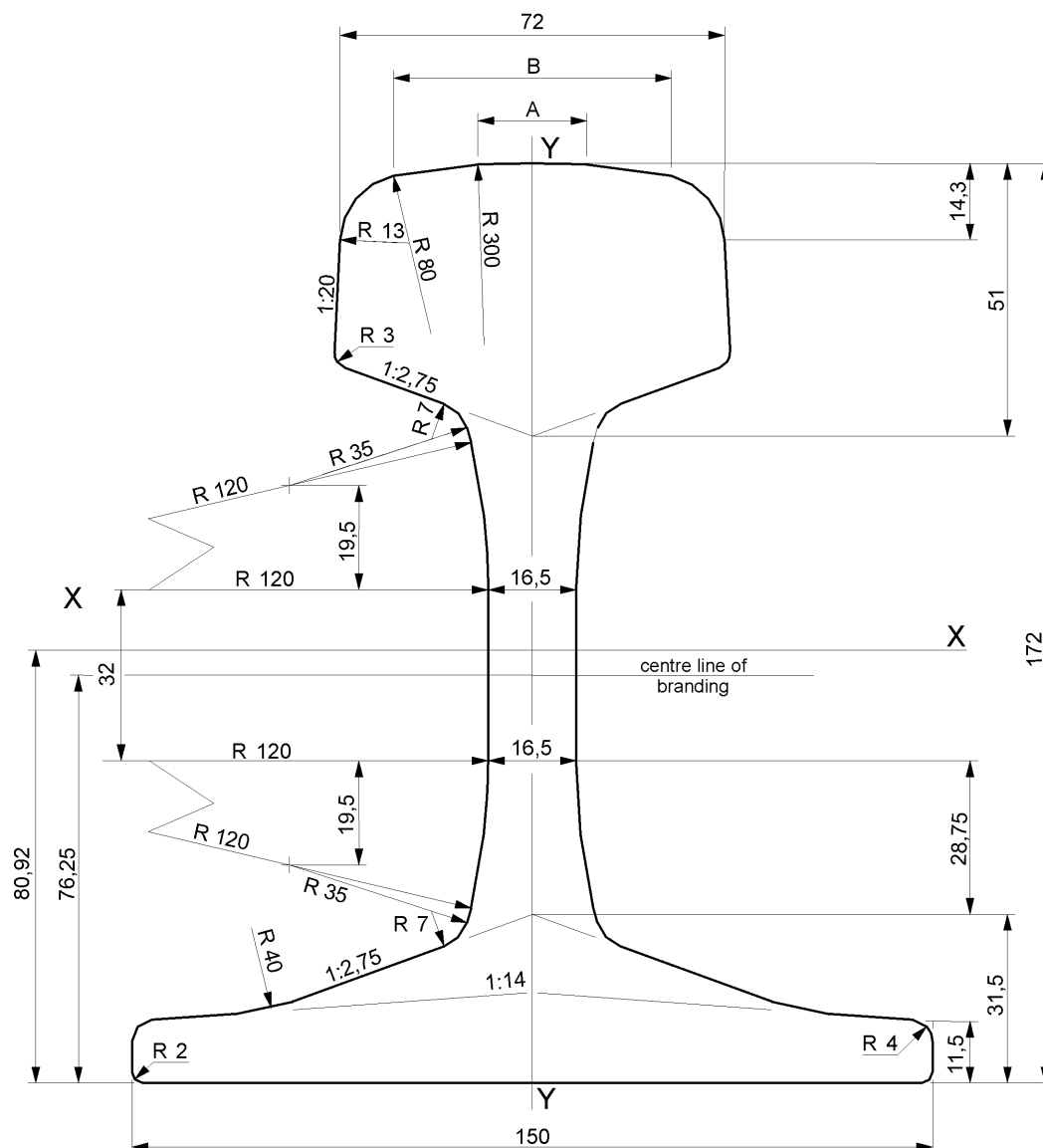
Rail profile 54 E 3



Cross-sectional area	71,69	cm ²
Mass per metre	56,3	kg/m
Moment of inertia x-x axis	2 321	cm ⁴
Section modulus — Head	275,5	cm ³
Section modulus — Base	311,5	cm ³
Moment of inertia y-y axis	421,6	cm ⁴
Section modulus y-y axis	60,2	cm ³

Indicative dimensions: A = 11,787 mm
B = 51,235 mm

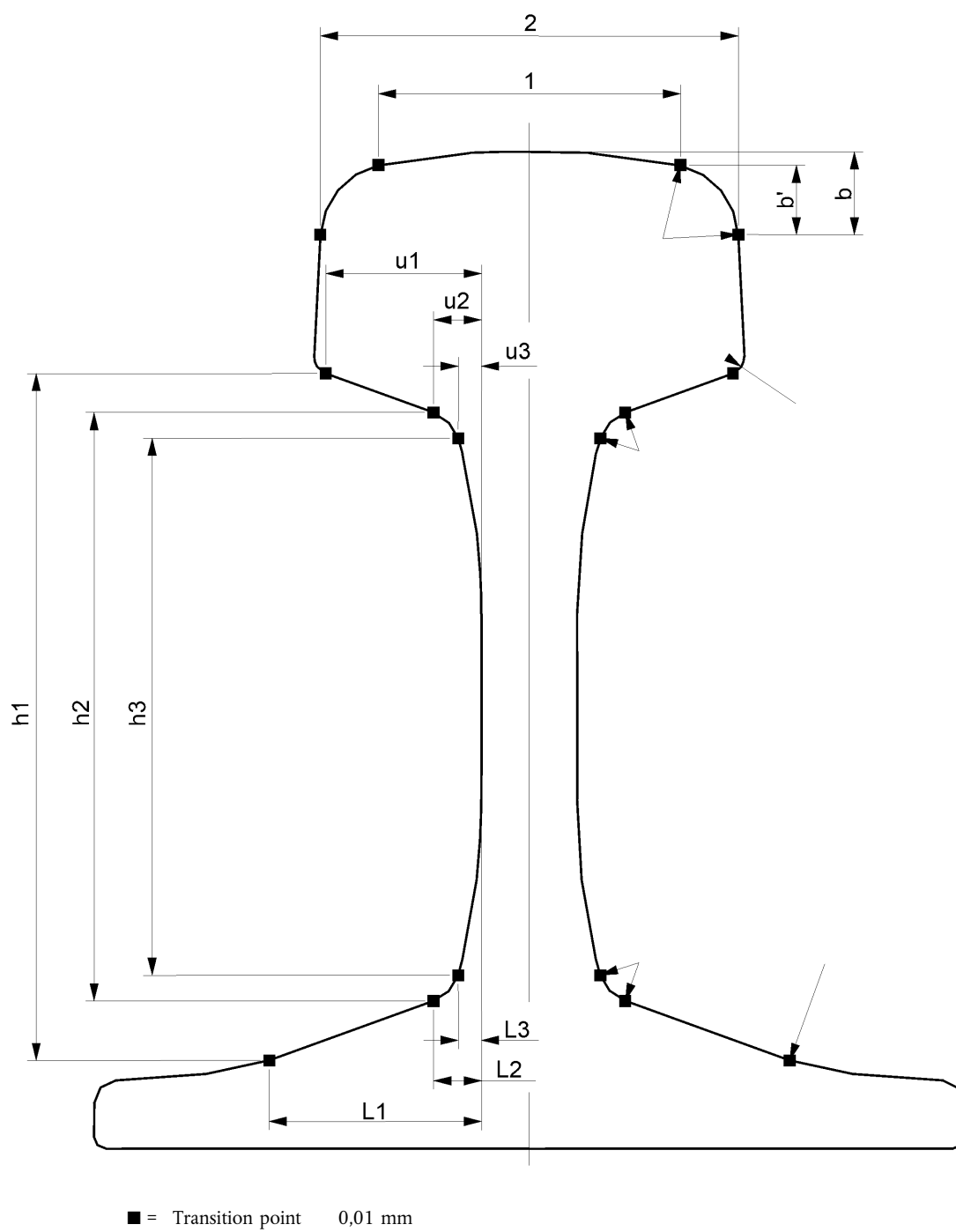
Rail profile 56 E 1



Cross-sectional area	76,70	cm ²
Mass per metre	60,21	kg/m
Moment of inertia x-x axis	3 038,3	cm ⁴
Section modulus — Head	333,6	cm ³
Section modulus — Base	375,5	cm ³
Moment of inertia y-y axis	512,3	cm ⁴
Section modulus y-y axis	68,3	cm ³

Indicative dimensions: A = 20,456
B = 52,053

Rail profile 60 E 1



Principal rail transition references

Rail transition references

Reference	Rail profile				
	54 E1	54 E2	54 E3	56 E1	60 E1
1	49,73	46,31	46,84	51,23	52,05
2	70,00	67,01	67,00	69,85	72,00
b	14,10	13,85	14,00	14,53	14,30
b ¹	12,04	12,08	11,92	11,61	12,00
h1	107,75	107,16	93,90	107,36	118,57
h2	92,25	92,25	83,20	92,16	101,50
h3	66,04	66,04	54,58	70,54	87,06
l1	35,92	34,97	32,13	33,01	36,61
l2	12,02	12,02	12,41	9,87	8,25
l3	1,54	1,54	1,52	0	3,20
u1	26,03	25,36	23,57	23,92	26,83
u2	7,30	7,30	11,18	5,27	8,25
u3	0,69	0,69	0,24	0	3,20

ANNEX L1

**SWITCH AND CROSSING RAILS USED IN CONJUNCTION WITH FLAT BOTTOM RAILWAYS RAILS
46 KG/M AND ABOVE — STEEL GRADES**

The eight steel grades are given in Table 1. The five hardness ranges of the steel grades shall conform to those given in Table 1.

Table 1
Steel grades

Grade ⁽¹⁾	Hardness range (HBW)	Description	Branding lines
200	200-240	Carbon — manganese (C-Mn)	No branding lines
220	220-260	Carbon — manganese (C-Mn)	_____
260	260-300	Carbon — manganese (C-Mn)	_____ _____
260 X	260-300	Carbon — manganese-chromium (C-Mn-Cr)	_____ _____
260 Mn	260-300	Carbon — manganese (C-Mn)	_____ _____
320 Cr	320-360	Alloy (1 % Cr)	_____ _____ _____
350 HT	350-390 ⁽²⁾	Carbon — manganese (C-Mn) heat treated	_____ _____
350 LHT	350-390 ⁽²⁾	Low alloy, heat treated	_____ _____ _____

⁽¹⁾ See Table 2 for chemical composition/mechanical properties.

⁽²⁾ If the hardness exceeds 390 HBW but is below 400 HBW then the rail is acceptable, provided that the rail microstructure is confirmed to be pearlitic.

Table 2(a)

Chemical composition/mechanical properties

Steel sample grade		% by mass								10 ⁻⁴ % (ppm) max		Rm min N/mm	Min elong %	Centre line running surface hardness HBW
		C	Si	Mn	P max	S	Cr	Al max	V max	N max	O	H		
200	Liquid	0,40/0,60	0,15/0,58	0,70/1,20	0,035	0,008/0,035	< 0,15	0,004	0,030	0,009	20 or	3,0 or		
	Solid	0,38/0,62	0,13/0,60	0,65/1,25	0,040	0,008/0,040	< 0,15	0,004	0,030	0,010	20	3,0	680	200/240
220	Liquid	0,50/0,60	0,20/0,60	1,00/1,25	0,025	0,008/0,025	< 0,15	0,004	0,030	0,008	20 or	3,0 or		
	Solid	0,50/0,60	0,20/0,60	1,00/1,25	0,025	0,008/0,025	< 0,15	0,004	0,030	0,008	20	3,0	770	220/260
260	Liquid	0,62/0,80	0,15/0,58	0,70/1,20	0,025	0,008/0,025	< 0,15	0,004	0,030	0,009	20 or	2,5 or		
	Solid	0,60/0,82	0,13/0,60	0,65/1,25	0,030	0,008/0,030	< 0,15	0,004	0,030	0,010	20	2,5	880	260/300
260 X	Liquid	0,40/0,60	0,20/0,45	1,20/1,60	0,025	0,008/0,030	0,40/0,60	0,004	< 0,06	0,009	20 or	2,5 or		
	Solid	0,40/0,60	0,20/0,45	1,20/1,60	0,030	0,008/0,030	0,40/0,60	0,004	< 0,06	0,010	20	2,5	880	260/300
260 Mn	Liquid	0,55/0,75	0,15/0,60	1,30/1,70	0,025	0,008/0,025	< 0,15	0,004	0,030	0,009	20 or	2,5 or		
	Solid	0,53/0,77	0,15/0,60	1,25/1,75	0,030	0,008/0,030	< 0,15	0,004	0,030	0,010	20	2,5	880	260/300
320 Cr	Liquid	0,60/0,80	0,50/1,10	0,80/1,20	0,020	0,008/0,025	0,80/1,20	0,004	0,18	0,009	20 or	2,5 or		
	Solid	0,58/0,82	0,48/1,12	0,75/1,25	0,025	0,008/0,030	0,75/1,25	0,004	0,20	0,010	20	2,5	1 080	320/360
350 HT	Liquid	0,72/0,80	0,15/0,58	0,70/1,20	0,020	0,008/0,025	< 0,10	0,004	0,030	0,009	20 or	2,5 or		
	Solid	0,70/0,82	0,13/0,60	0,65/1,25	0,025	0,008/0,030	< 0,15	0,004	0,030	0,010	20	2,5	1 175	350/390
350 LHT	Liquid	0,72/0,80	0,15/0,58	0,70/1,20	0,020	0,008/0,025	0,30 max	0,004	0,030	0,009	20 or	2,5 or		
	Solid	0,70/0,82	0,13/0,60	0,65/1,25	0,025	0,008/0,030	0,30 max	0,004	0,030	0,010	20	2,5	1 175	350/390

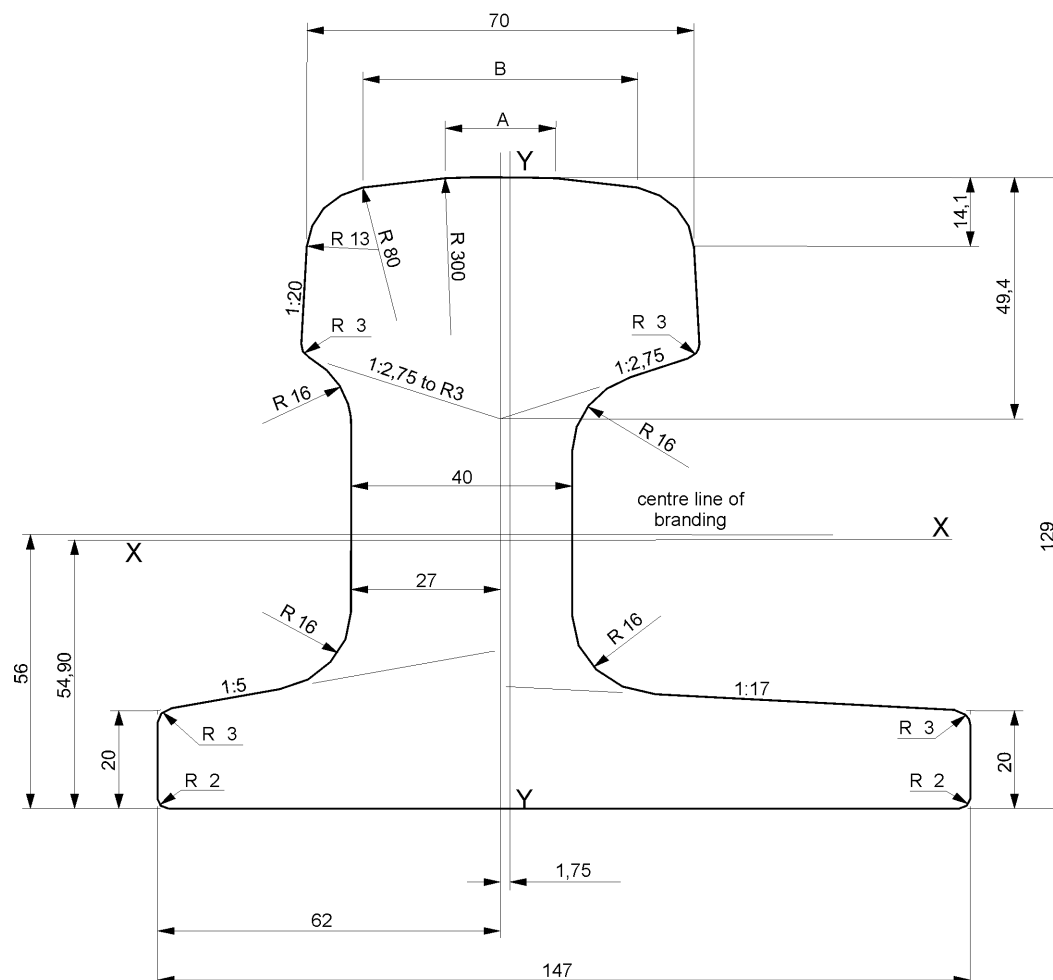
X = Maximum level Re = Residual element

Table 2(b)

Max residual elements

	Cr	Mo	Ni	Cu	Sn	Sb	Ti	Nb	Cu and 10 Sn		
200, 220, 260, 260 Mn	0,15	0,02	0,10	0,15	0,030	0,020	0,025	0,01	< 0,35	Cr + Mo + Ni + Cu + V	< 0,35
320 Cr, 260X	—	0,02	0,10	0,15	0,030	0,020	0,025	0,01	< 0,35	Ni + Cu	< 0,16
350 HT	0,10	0,02	0,10	0,15	0,030	0,020	0,025	0,04	< 0,35	Cr + Mo + Ni + Cu + V	< 0,25
350 LHT	—	0,02	0,10	0,15	0,030	0,020	0,025	0,04	< 0,35	Mo + Ni + Cu + V	< 0,20

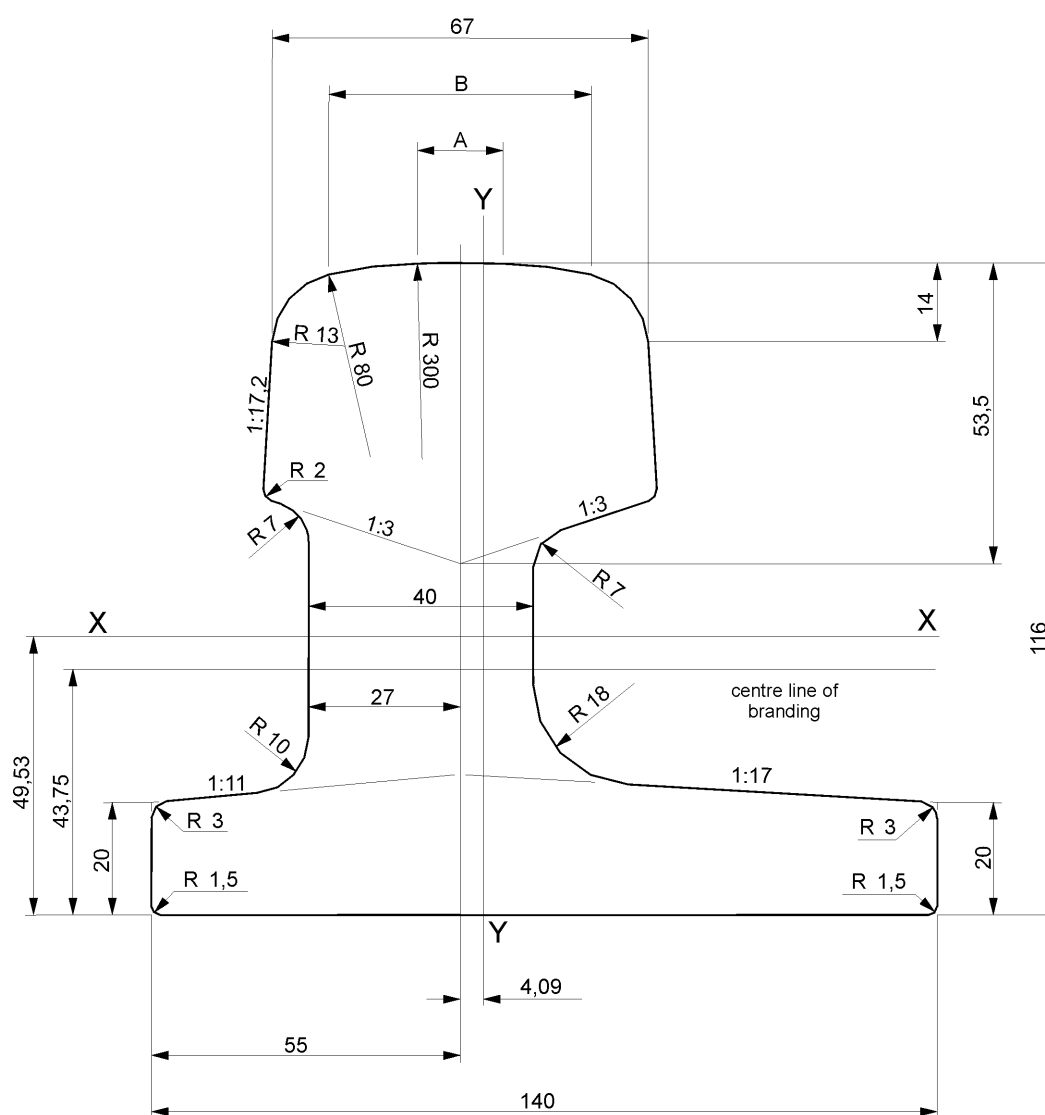
ANNEX L2

CHECK RAILS USED IN CONJUNCTION WITH FLAT BOTTOM RAILWAY RAILS 46 KG/M AND ABOVE —
RAIL PROFILES

Cross-sectional area	87,83	cm ²
Mass per metre	68,95	kg/m
Moment of inertia x-x axis	1 544,0	cm ⁴
Section modulus-Head	208,4	cm ³
Section modulus-Base	281,3	cm ³
Moment of inertia y-y axis	767,6	cm ⁴
Section modulus y-y axis left	120,4	cm ³
Section modulus y-y axis right	92,2	cm ³

Indicative dimensions: A = 20,025 mm
B = 49,727 mm

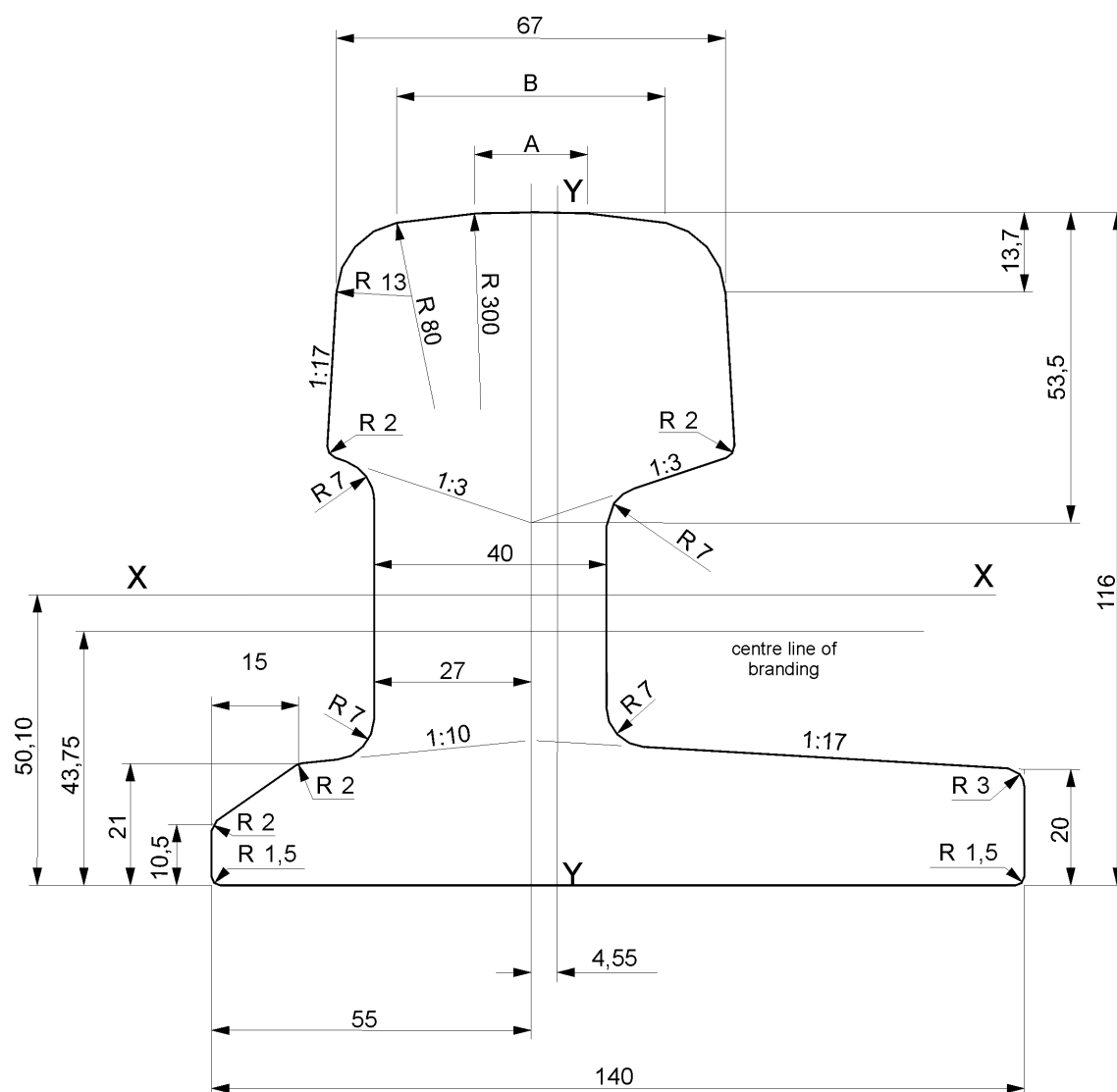
Rail profile 54 E1 A1



Cross-sectional area	80,43	cm ²
Mass per metre	63,14	kg/m
Moment of inertia x-x axis	1 098,4	cm ⁴
Section modulus-Head	165,3	cm ³
Section modulus-Base	221,7	cm ³
Moment of inertia y-y axis	681,9	cm ⁴
Section modulus y-y axis left	115,4	cm ³
Section modulus y-y axis right	84,3	cm ³

Indicative dimensions: A = 15,267 mm
B = 46,835 mm

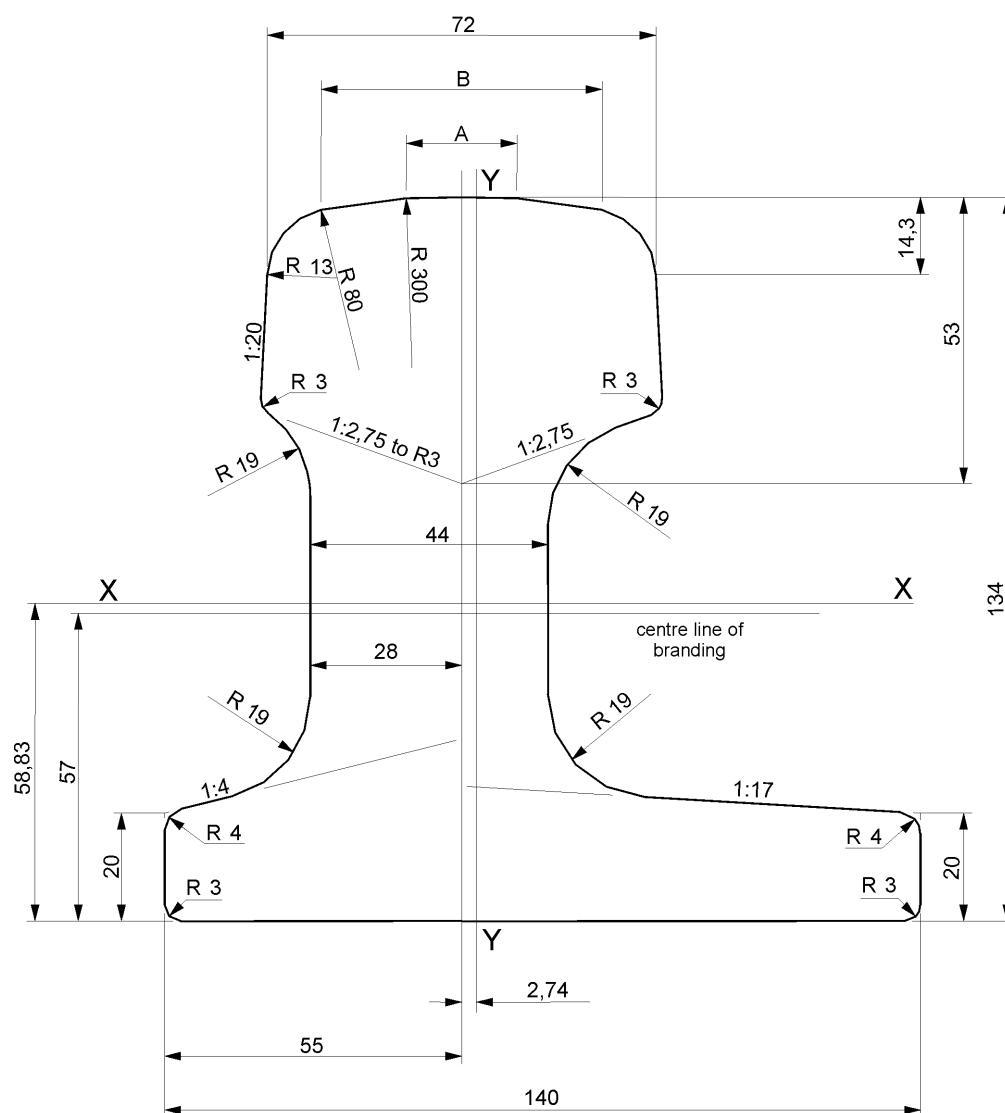
Rail profile 49 E1 A1



Cross-sectional area	79,18	cm ²
Mass per metre	62,15	kg/m
Moment of inertia x-x axis	1 091,5	cm ⁴
Section modulus-Head	165,6	cm ³
Section modulus-Base	217,9	cm ³
Moment of inertia y-y axis	658,9	cm ⁴
Section modulus y-y axis left	110,7	cm ³
Section modulus y-y axis right	81,9	cm ³

Indicative dimensions: A = 19,514 mm
B = 46,232 mm

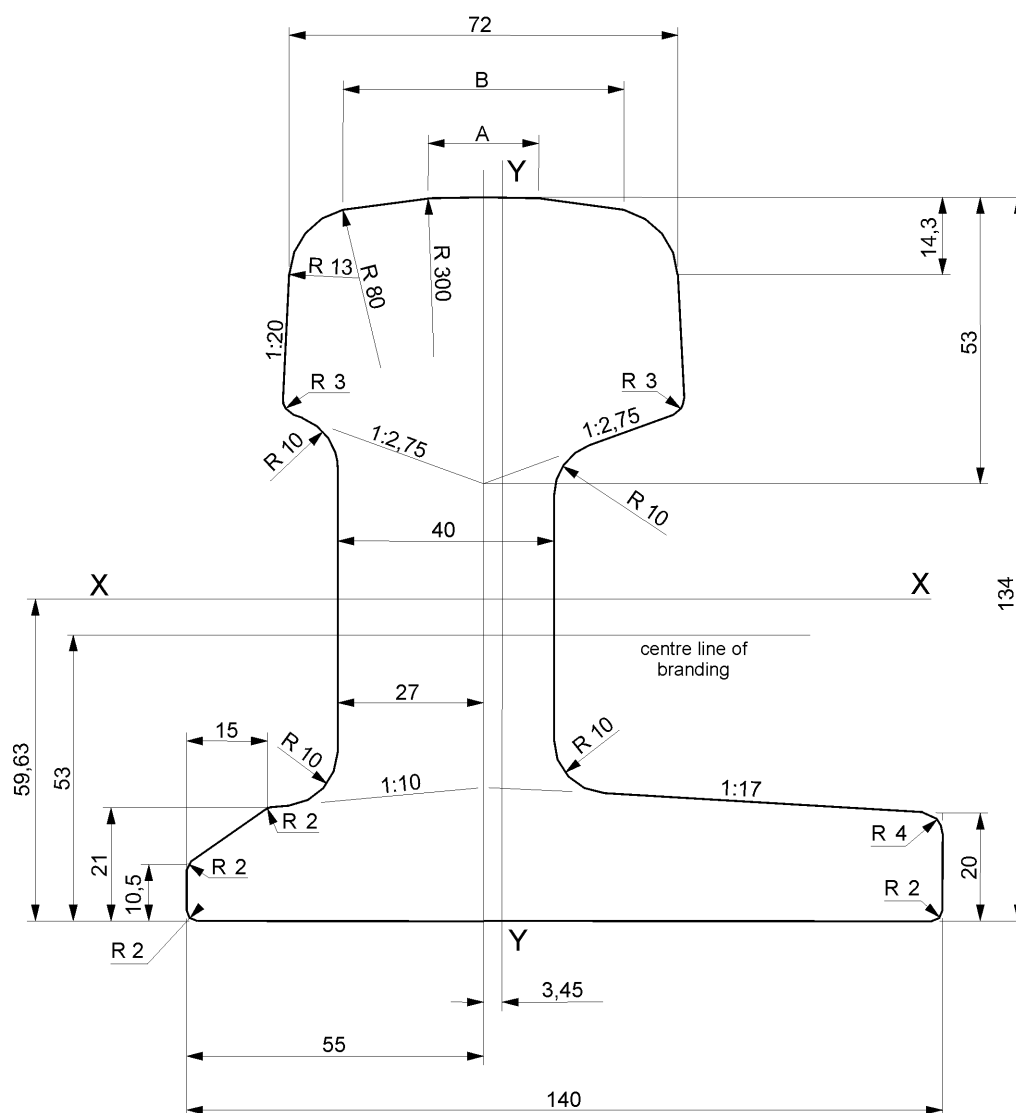
Rail profile 49 E1 A2



Cross-sectional area	92,95	cm ²
Mass per metre	72,97	kg/m
Moment of inertia x-x axis	1 726,9	cm ⁴
Section modulus-Head	229,7	cm ³
Section modulus-Base	293,5	cm ³
Moment of inertia y-y axis	741,2	cm ⁴
Section modulus y-y axis left	128,4	cm ³
Section modulus y-y axis right	90,1	cm ³

Indicative dimensions: A = 20,456 mm
B = 52,053 mm

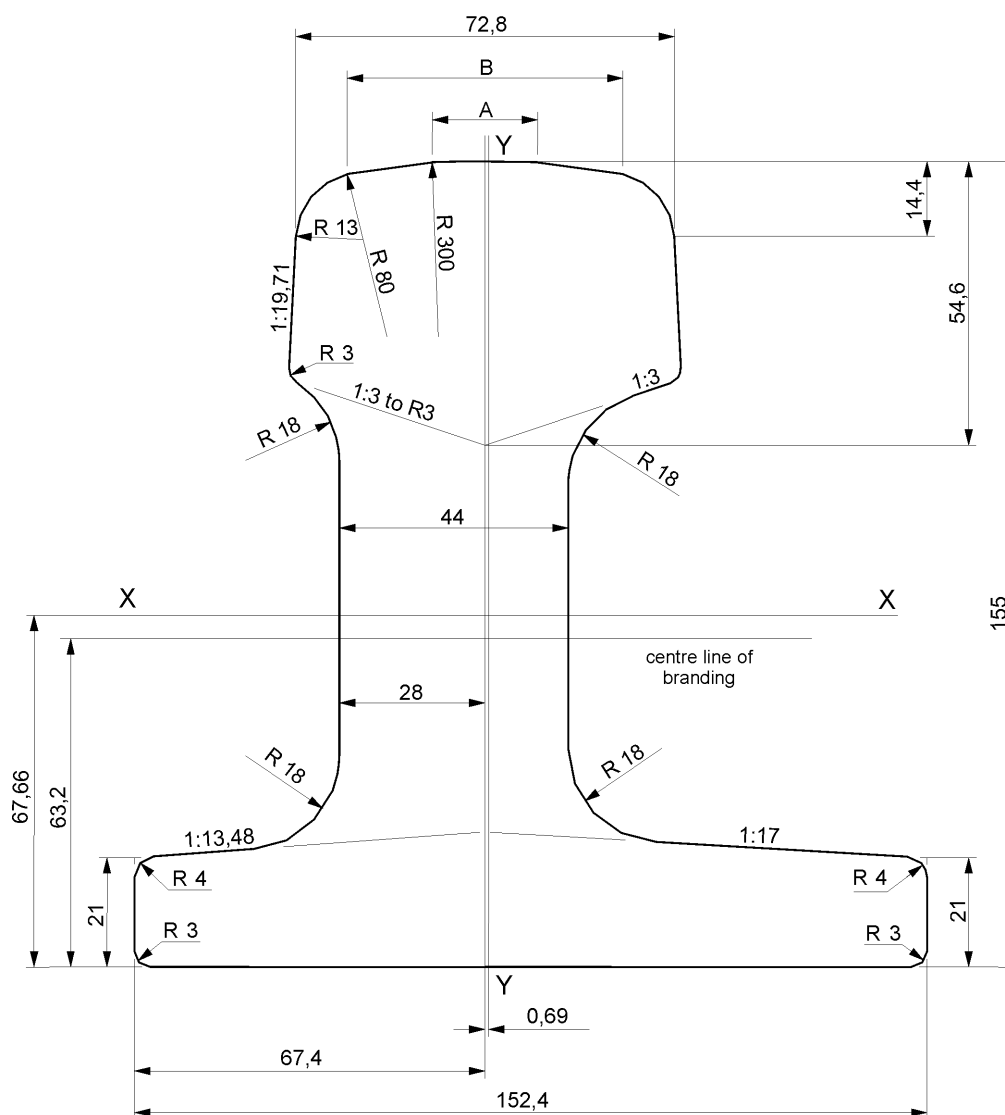
Rail profile 60 E1 A1



Cross-sectional area	87,95	cm ²
Mass per metre	69,04	kg/m
Moment of inertia x-x axis	1 688,2	cm ⁴
Section modulus-Head	227,0	cm ³
Section modulus-Base	283,1	cm ³
Moment of inertia y-y axis	695,6	cm ⁴
Section modulus y-y axis left	119,0	cm ³
Section modulus y-y axis right	85,3	cm ³

Indicative dimensions: A = 20,456 mm
B = 52,053 mm

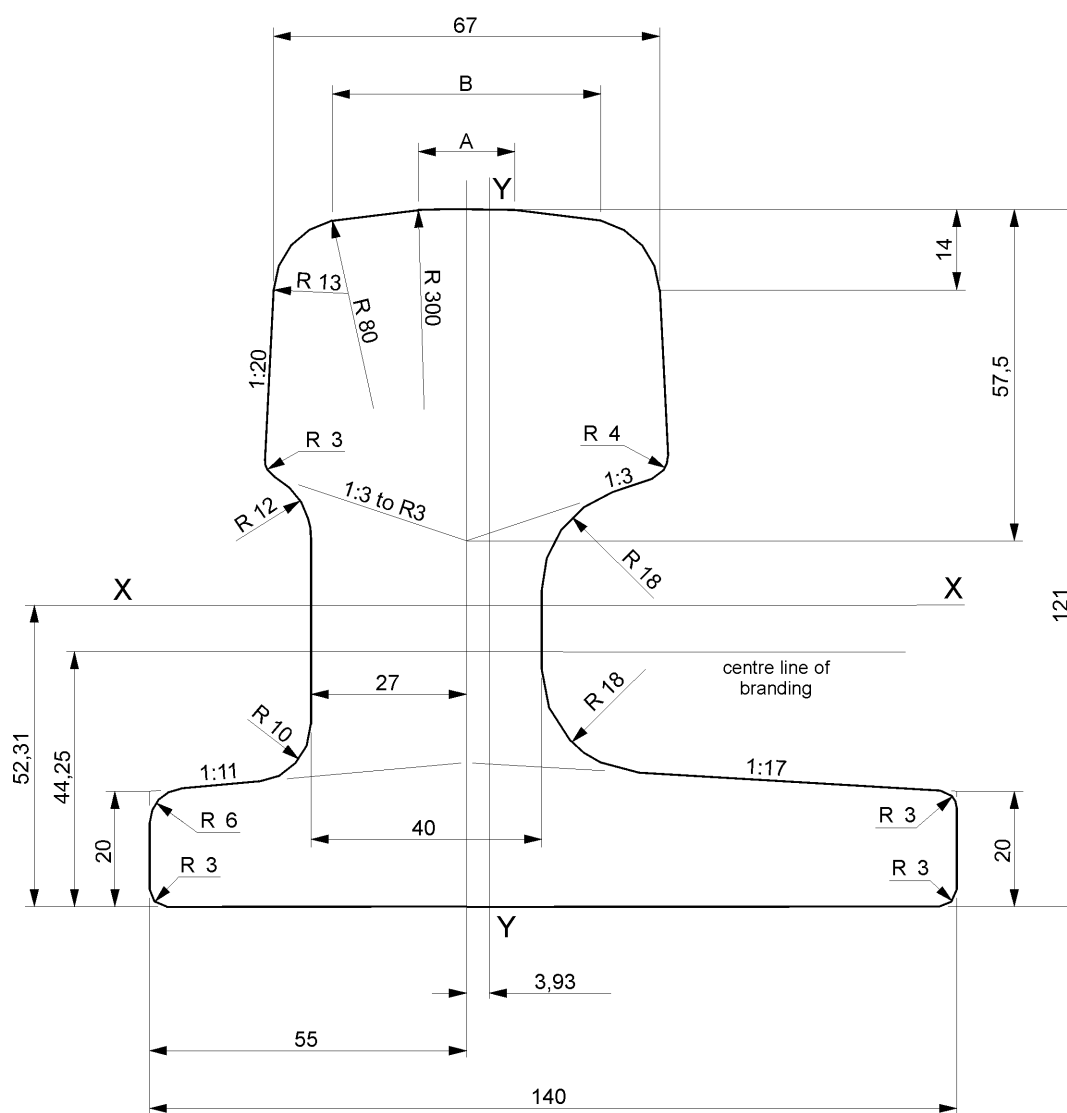
Rail profile 60 E1 A2



Cross-sectional area	106,54	cm ²
Mass per metre	83,64	kg/m
Moment of inertia x-x axis	2 722,8	cm ⁴
Section modulus-Head	311,7	cm ³
Section modulus-Base	402,4	cm ³
Moment of inertia y-y axis	897,3	cm ⁴
Section modulus y-y axis left	131,8	cm ³
Section modulus y-y axis right	106,4	cm ³

Indicative dimensions: A = 20,290 mm
B = 53,033 mm

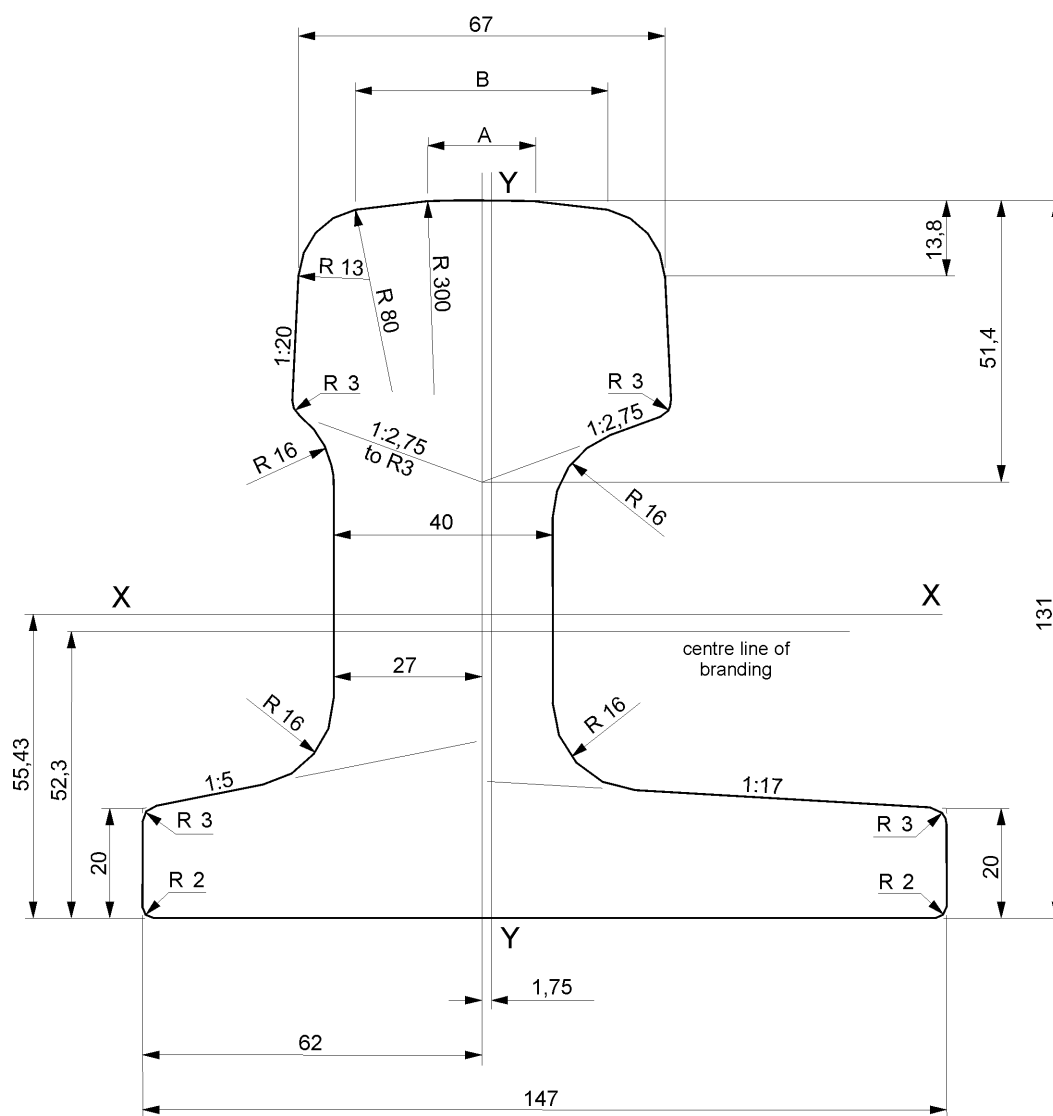
Rail profile 60 E1 A3



Cross-sectional area	83,85	cm ²
Mass per metre	65,82	kg/m
Moment of inertia x-x axis	1 244,3	cm ⁴
Section modulus-Head	181,1	cm ³
Section modulus-Base	237,9	cm ³
Moment of inertia y-y axis	692,3	cm ⁴
Section modulus y-y axis left	117,5	cm ³
Section modulus y-y axis right	85,4	cm ³

Indicative dimensions: A = 16,703 mm
B = 46,617 mm

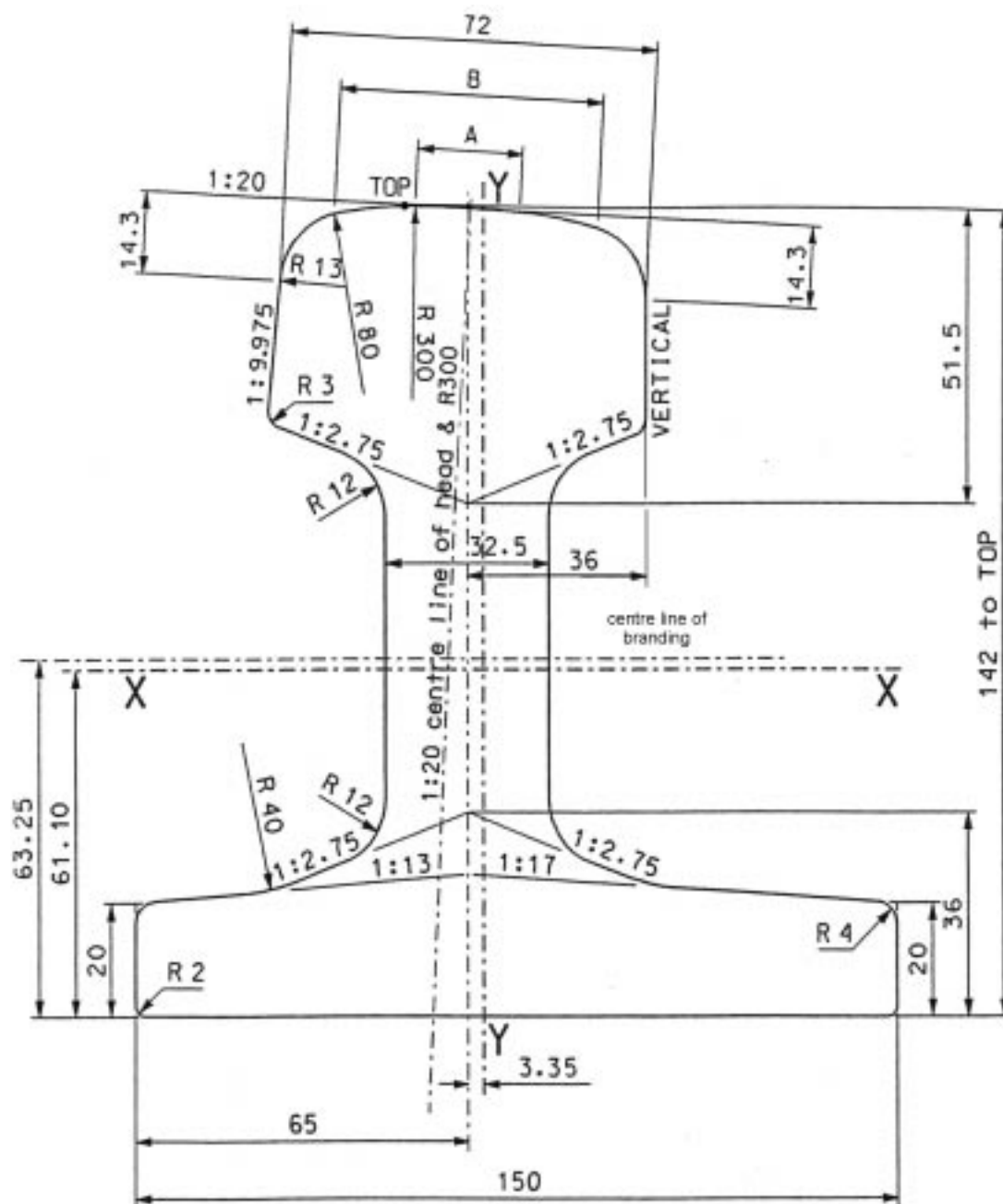
Rail profile 54 E1 A2



Cross-sectional area	88,22	cm ²
Mass per metre	69,25	kg/m
Moment of inertia x-x axis	1 587,3	cm ⁴
Section modulus-Head	210,0	cm ³
Section modulus-Base	286,4	cm ³
Moment of inertia y-y axis	761,7	cm ⁴
Section modulus y-y axis left	119,5	cm ³
Section modulus y-y axis right	91,5	cm ³

Indicative dimensions: A = 19,721 mm
B = 46,188 mm

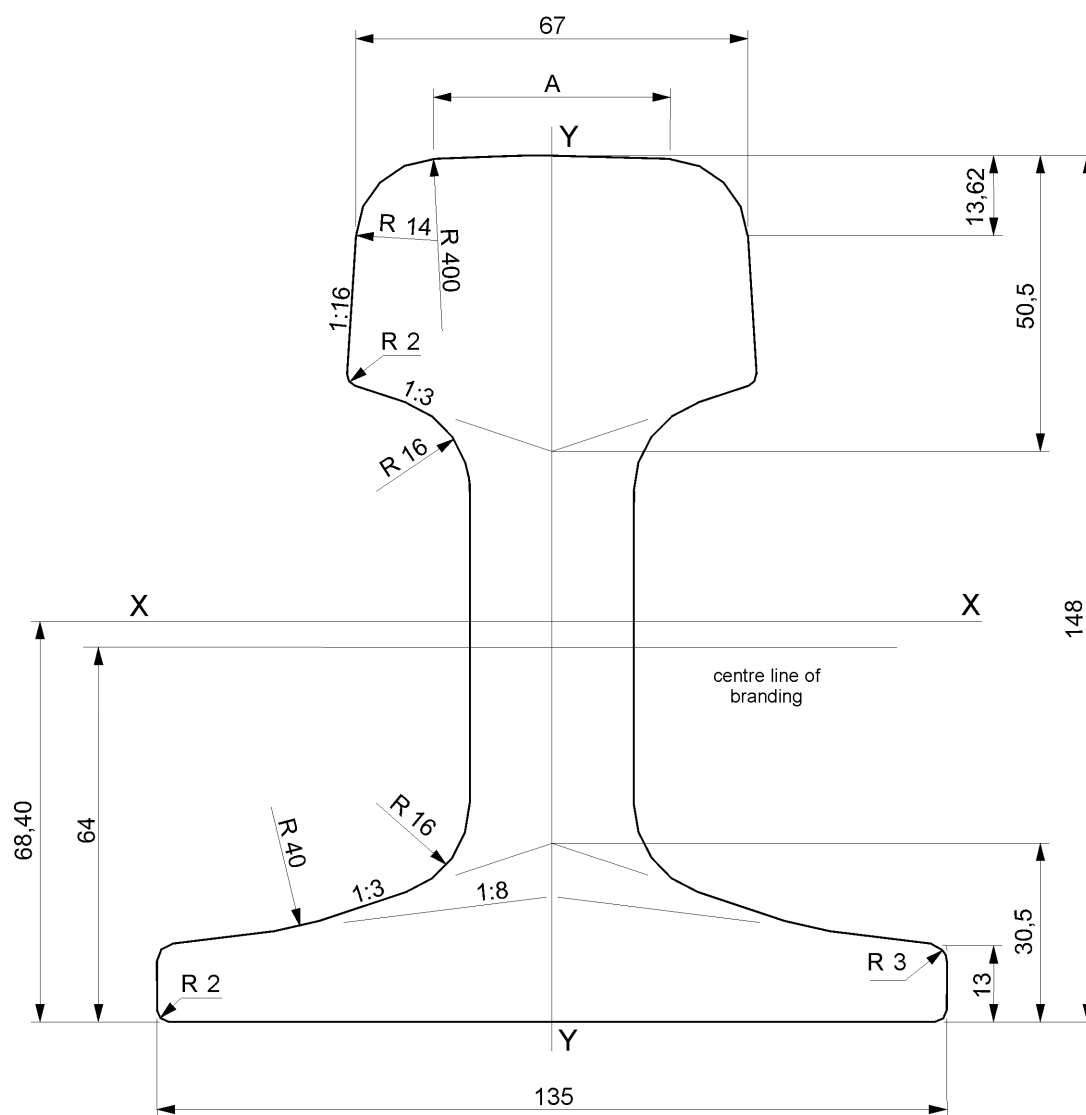
Rail profile 54 E2 A1



Cross-sectional area	88,93	cm ²
Mass per metre	69,81	kg/m
Moment of inertia x-x axis	2 024,9	cm ⁴
Section modulus-Head	250,3	cm ³
Section modulus-Base	331,4	cm ³
Moment of inertia y-y axis	764,2	cm ⁴
Section modulus y-y axis left	111,8	cm ³
Section modulus y-y axis right	93,6	cm ³

Indicative dimensions: A = 20,456 mm
B = 52,053 mm

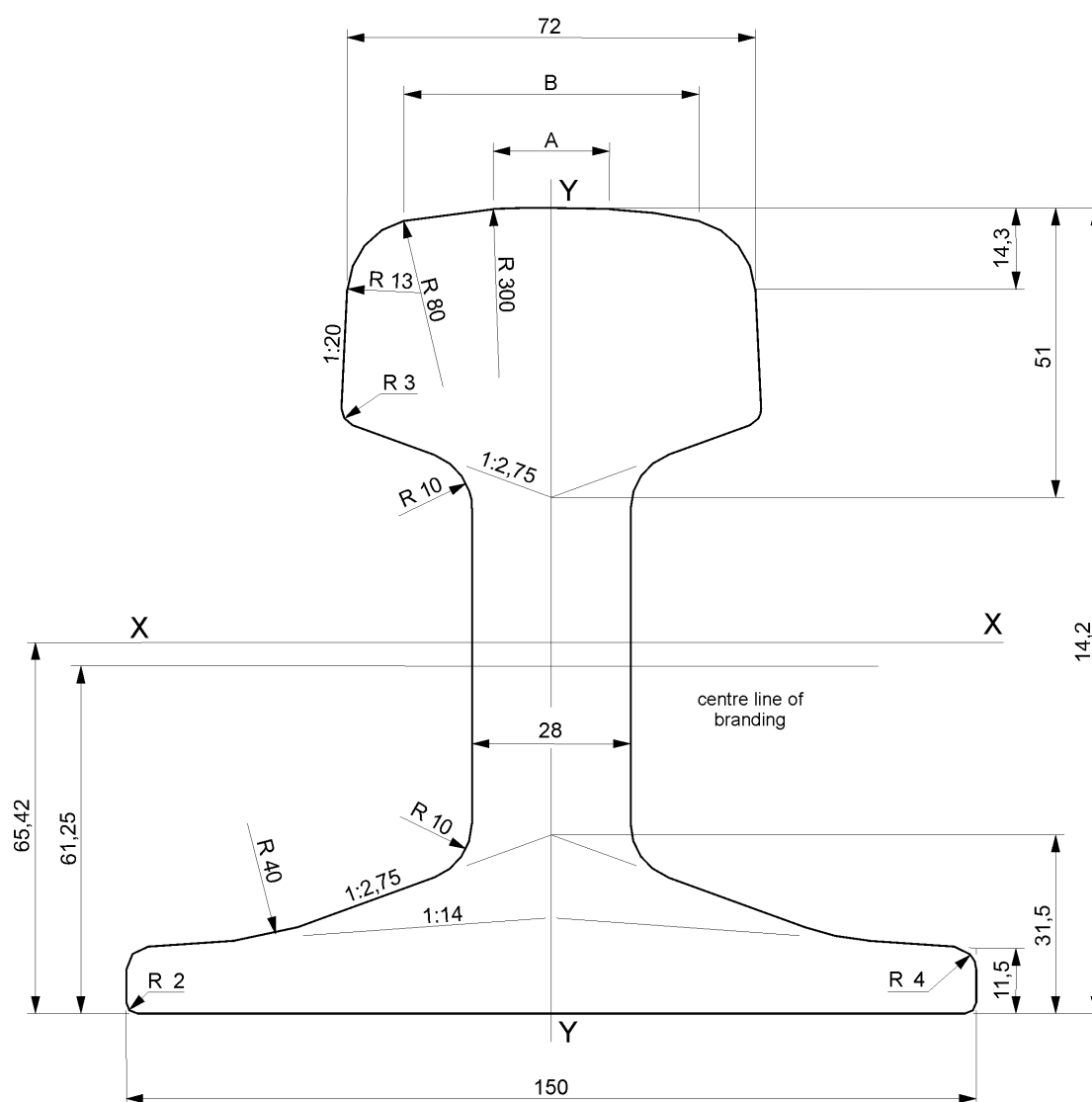
Rail profile 60 E1 A4



Cross-sectional area	77,66	cm ²
Mass per metre	60,96	kg/m
Moment of inertia x-x axis	1 997,3	cm ⁴
Section modulus-Head	250,9	cm ³
Section modulus-Base	292,0	cm ³
Moment of inertia y-y axis	437,8	cm ⁴
Section modulus y-y-axis	64,9	cm ³

Indicative dimensions: A = 40,471 mm

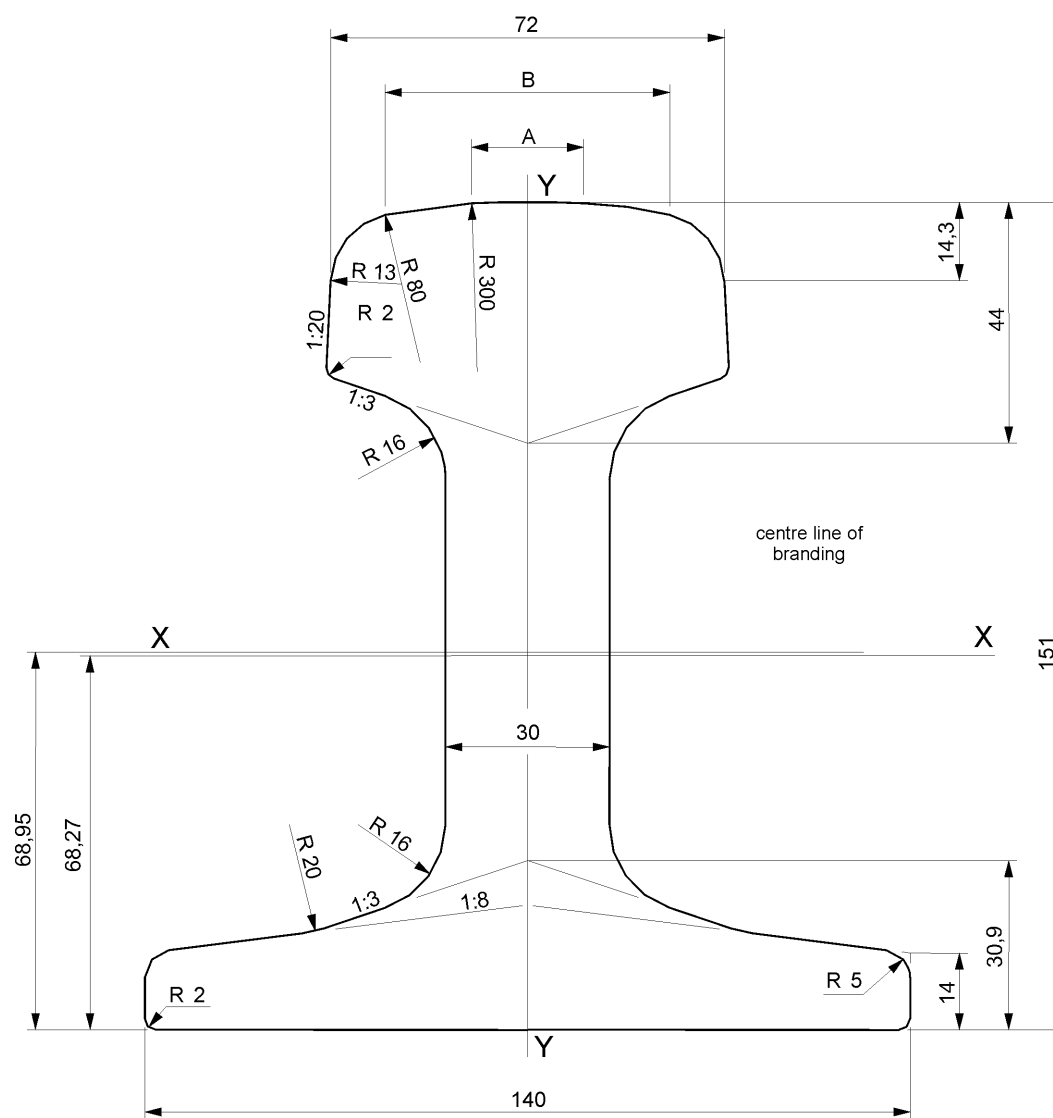
Rail profile 50 E1 T1



Cross-sectional area	77,84	cm ²
Mass per metre	61,11	kg/m
Moment of inertia x-x axis	1 866,5	cm ⁴
Section modulus-Head	243,7	cm ³
Section modulus-Base	285,3	cm ³
Moment of inertia y-y axis	519,9	cm ⁴
Section modulus y-y-axis	69,3	cm ³

Indicative dimensions: A = 20,456 mm
B = 52,053 mm

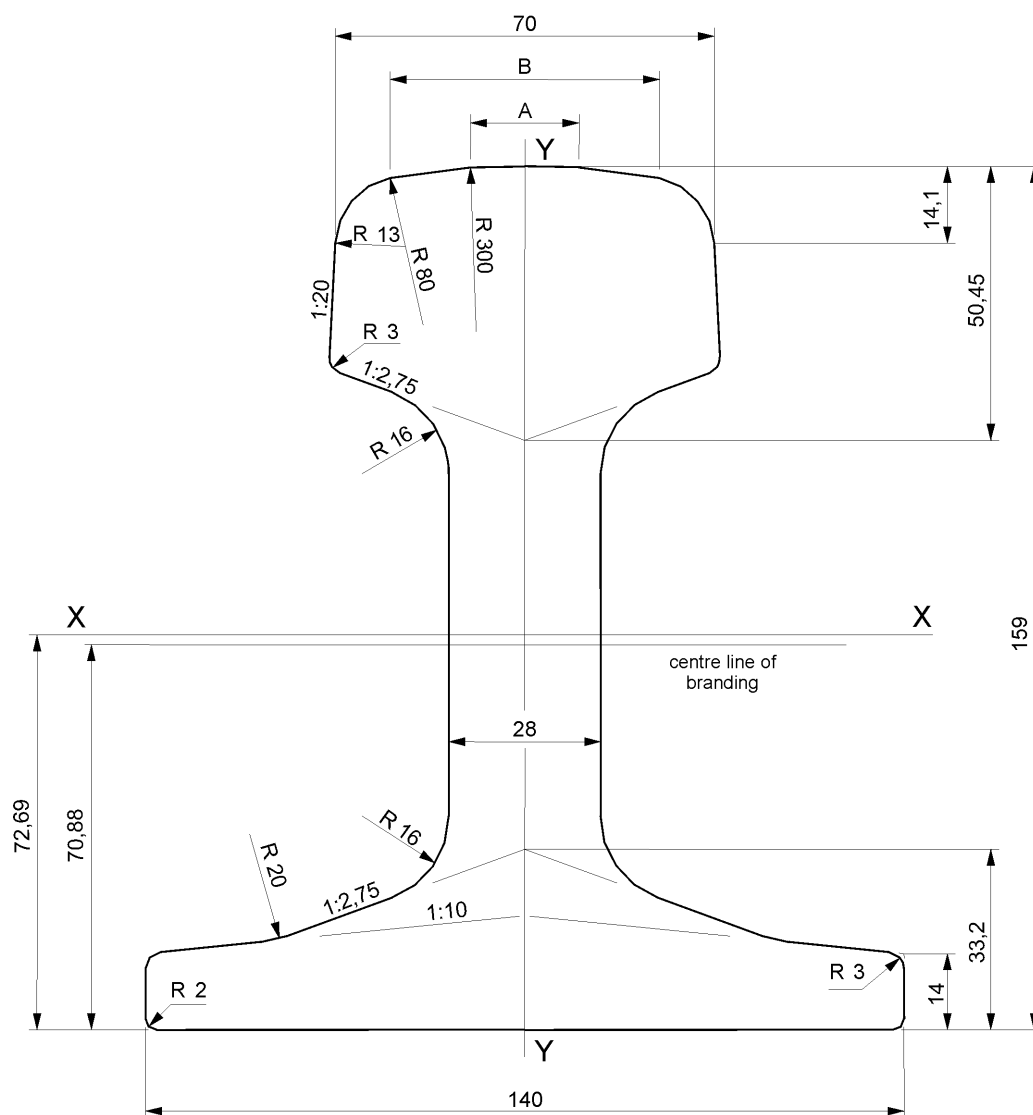
Rail profile 60 E1 T1



Cross-sectional area	80,22	cm ²
Mass per metre	62,97	kg/m
Moment of inertia x-x axis	2 166,0	cm ⁴
Section modulus-Head	261,8	cm ³
Section modulus-Base	317,3	cm ³
Moment of inertia y-y axis	493,2	cm ⁴
Section modulus y-y-axis	70,5	cm ³

Indicative dimensions: A = 20,456 mm
B = 52,053 mm

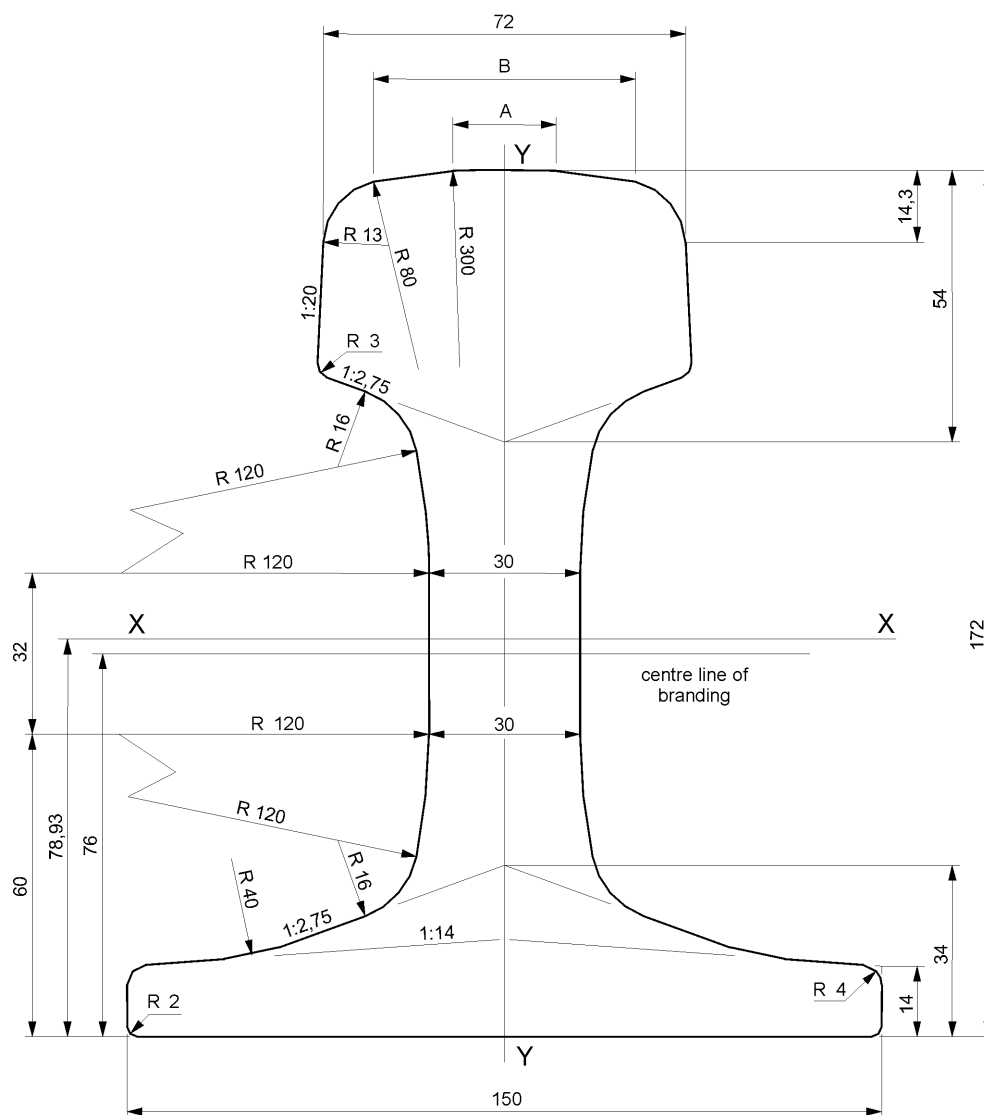
Rail profile 50 E2 T1



Cross-sectional area	83,32	cm ²
Mass per metre	65,40	kg/m
Moment of inertia x-x axis	2 513,8	cm ⁴
Section modulus-Head	291,3	cm ³
Section modulus-Base	345,8	cm ³
Moment of inertia y-y axis	504,1	cm ⁴
Section modulus y-y-axis	72,0	cm ³

Indicative dimensions: A = 20,025 mm
B = 49,727 mm

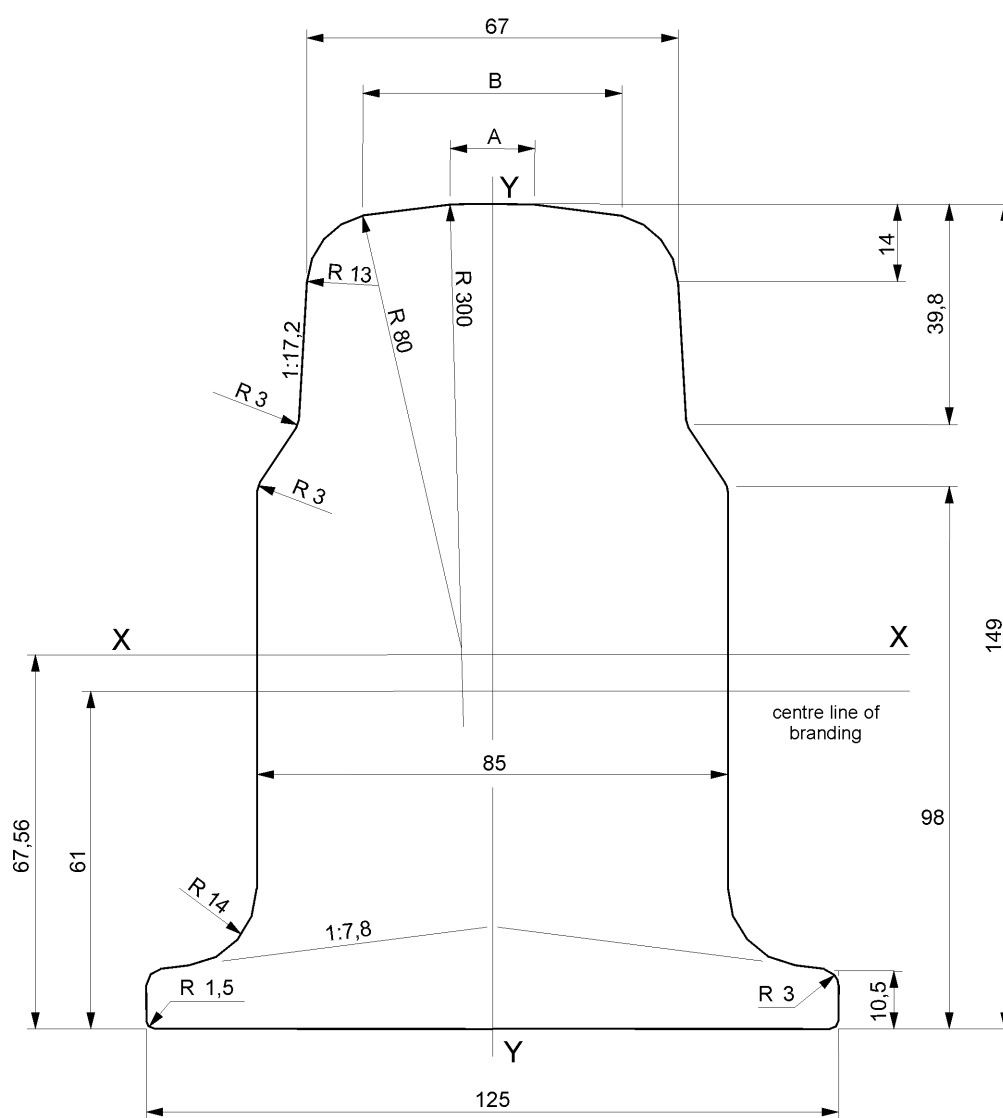
Rail profile 54 E1 T1



Cross-sectional area	94,57	cm ²
Mass per metre	74,24	kg/m
Moment of inertia x-x axis	3 301,4	cm ⁴
Section modulus-Head	354,7	cm ³
Section modulus-Base	418,3	cm ³
Moment of inertia y-y axis	615,3	cm ⁴
Section modulus y-y-axis	82,0	cm ³

Indicative dimensions: A = 20,456 mm
B = 52,053 mm

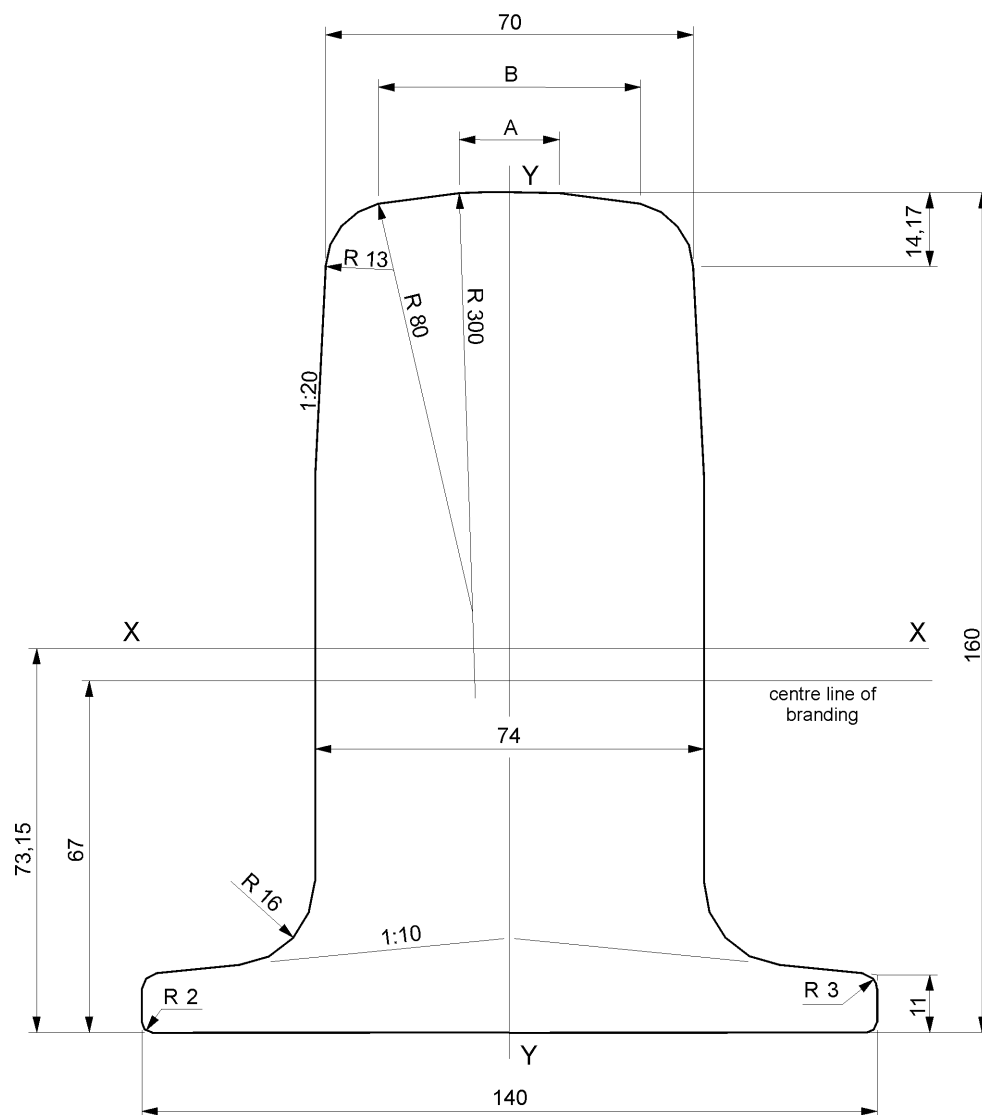
Rail profile 60 E1 T2



Cross-sectional area	123,00	cm ²
Mass per metre	96,55	kg/m
Moment of inertia x-x axis	2 234,0	cm ⁴
Section modulus-Head	274,3	cm ³
Section modulus-Base	330,6	cm ³
Moment of inertia y-y axis	779,9	cm ⁴
Section modulus y-y-axis	124,8	cm ³

Indicative dimensions: A = 15,267 mm
B = 46,835 mm

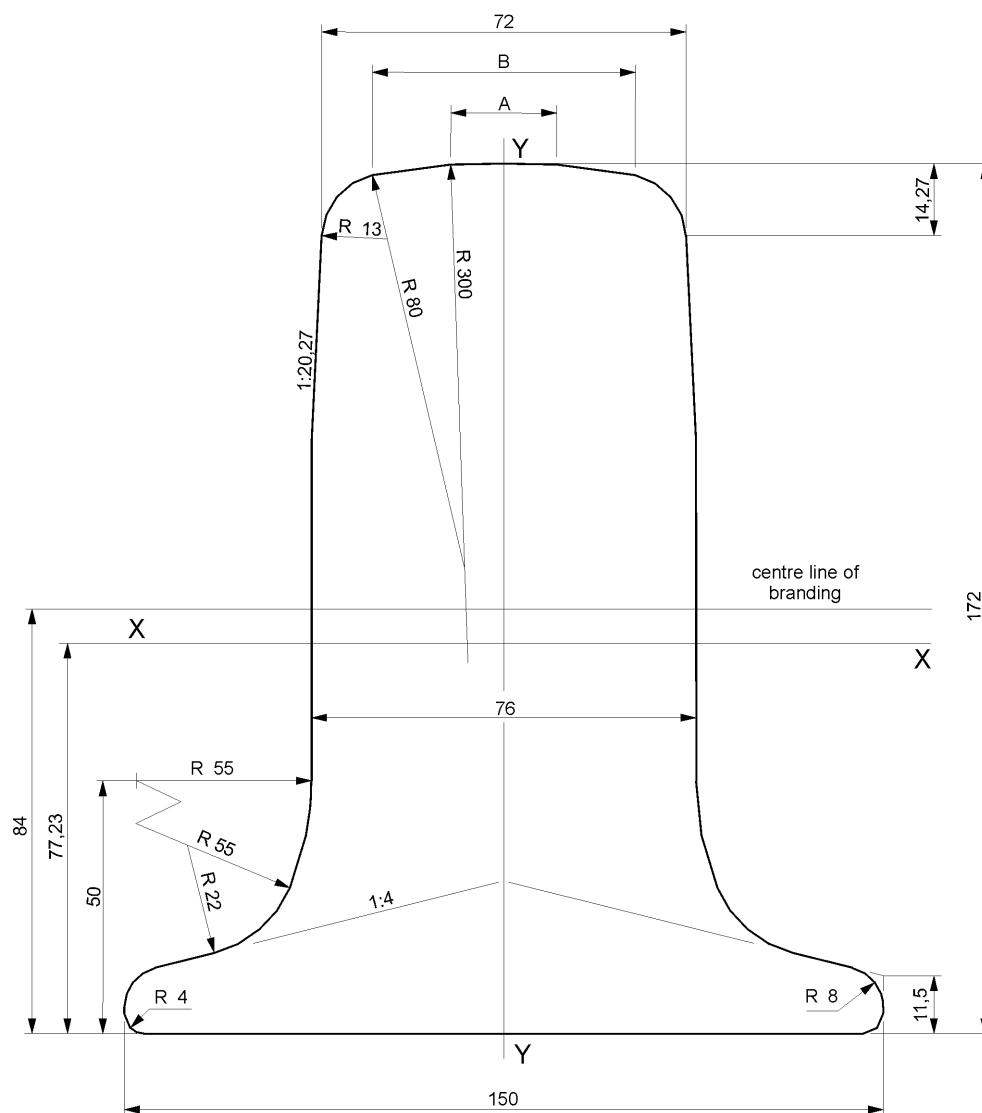
Rail profile 49 E1 F1



Cross-sectional area	124,83	cm ²
Mass per metre	98,00	kg/m
Moment of inertia x-x axis	2 818,5	cm ⁴
Section modulus-Head	324,5	cm ³
Section modulus-Base	385,3	cm ³
Moment of inertia y-y axis	762,4	cm ⁴
Section modulus y-y-axis	108,9	cm ³

Indicative dimensions: A = 19,045 mm
B = 49,866 mm

Rail profile 54 E1 F1



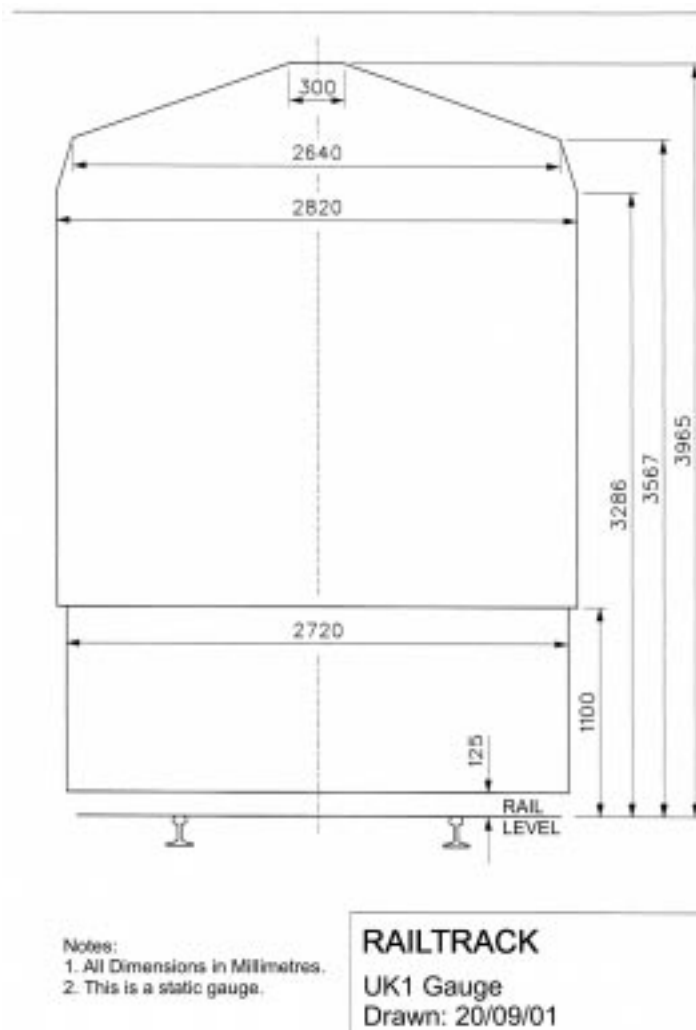
Cross-sectional area	141,71	cm ²
Mass per metre	111,24	kg/m
Moment of inertia x-x axis	3 737,3	cm ⁴
Section modulus-Head	394,3	cm ³
Section modulus-Base	483,9	cm ³
Moment of inertia y-y axis	992,3	cm ⁴
Section modulus y-y-axis	132,3	cm ³

Indicative dimensions: A = 20,976 mm
B = 51,978 mm

Rail profile 60 E1 F1

ANNEX M

UK1 GAUGE

**Definition of UK1 gauge**

The approach in the United Kingdom is to maximise the vehicle gauge whilst ensuring that the swept envelope of the vehicle is within the structure gauge at each point along the routes.

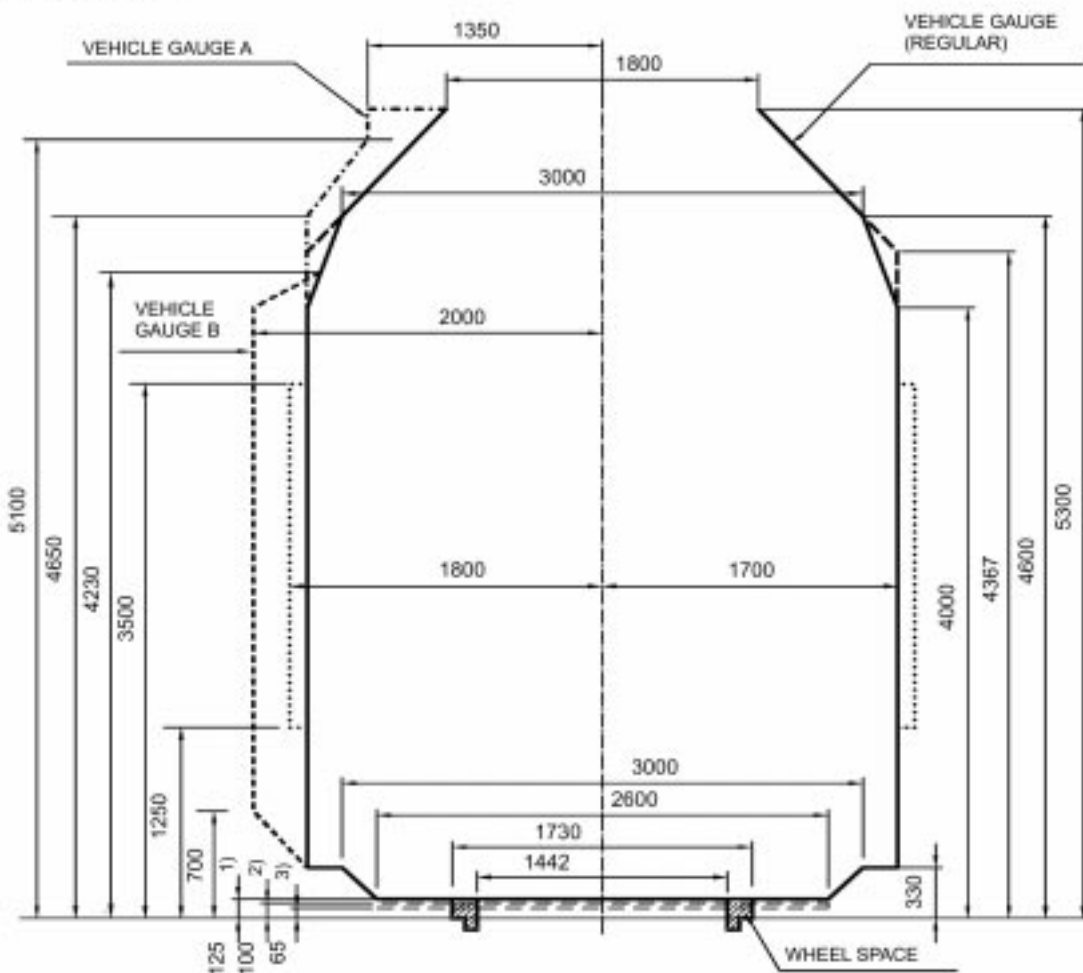
As a result the UK1 gauge has initially been defined as a vehicle gauge.

1. The diagram gives the basic dimensions for the UK1 gauge. (static on a straight level track).
2. The horizontal and vertical profile below 1 100 mm ARL must not be infringed under any combination of vehicle load, wear, suspension travel and geometric conditions.
3. The effects of cant and kinematic movements combined with bogie spacing and bogie overhang, which require enlarged clearances on curves, have to be considered on a case by case basis.

ANNEX N

FIN1 GAUGE

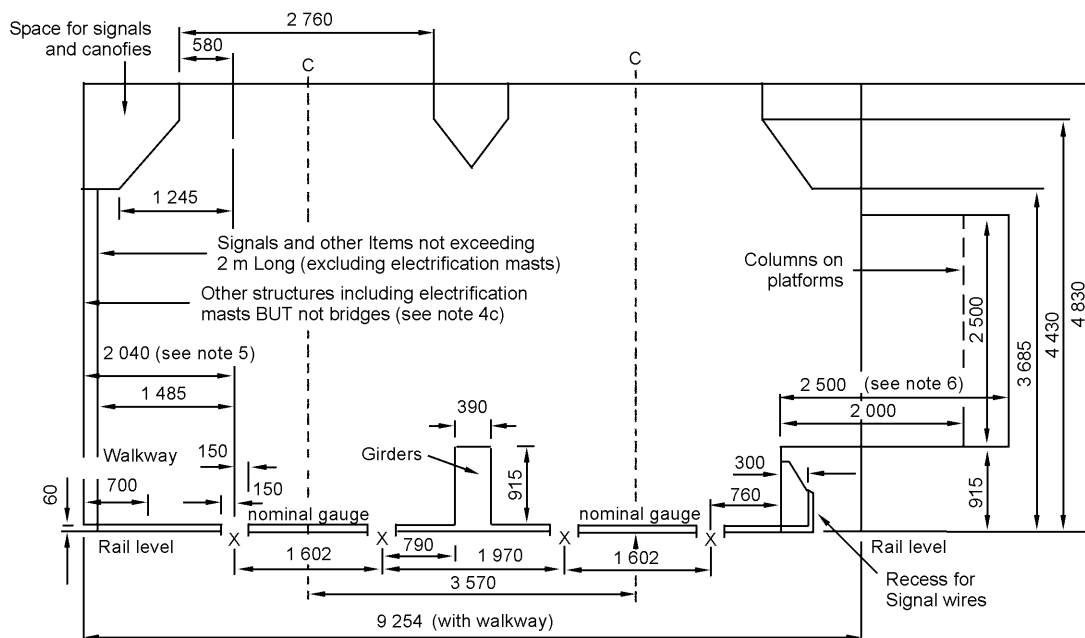
FIN1 GAUGE



ANNEX O

IRL1 GAUGE

THE STANDARD STRUCTURE GAUGE



Notes:

1. On horizontal curves, due allowance must be made for curvature and cant effects.
2. On vertical curves, due allowance must be made for the effects of such curvature.
3. The underclearance protrusion limit of 60 mm for structures, is subject to all the restrictions set down in standard PW4. The protrusion figure is zero for the Dublin Suburban Area (see standard PW4 for minor exceptions).
4. **Bridges:**
 - (a) The vertical height of 4 830 mm is a finished height. If extra ballast is proposed, or a track fit is necessary, in order to improve longitudinal profile, a greater height must be provided. Under certain circumstances the figure of 4 830 may be reduced to 4 690 mm.
 - (b) Bridge and structure heights must be increased by the values given in Table A, where cant is involved.

Table A

CANT	H
0	4 830
10	4 843
20	4 857
30	4 870
40	4 883
50	4 896
60	4 910
70	4 923
80	4 936
90	4 949
100	4 963

CANT	H
110	4 976
120	4 989
130	5 002
140	5 016
150	5 029
160	5 042
165	5 055

- (c) Bridge abutments must be 4 500 mm from nearest running edge subject to curvature effects.
- (d) If electrification is envisaged and there is a level crossing nearby, the vertical clearance must be increased to 6 140 mm.
5. There is an allowance for a 700 mm wide walkway. Where no walkway is provided, the dimension referred to may be reduced to 1 790 mm.
6. See standard PW39 for comprehensive schedule of platform widths.
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