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# COMMISSION

## COMMISSION DECISION

**of 30 May 2002**

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

*(Notified under document number C(2002) 1946)*

**(Text with EEA relevance)**

(2002/730/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 maintenance 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 and rolling stock 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 and rolling stock. 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.

[1] OJ L 235, 17.9.1996, p. 6.

(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 of the European Parliament and of its Council 2001/16/EC [2]. 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) 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.

(11) 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.

(12) The provisions concerning maintenance specific to each subsystem and those concerning degraded modes are set out in the corresponding TSIs. The maintenance TSI therefore only concerns questions relating to logistics centres for train maintenance.

(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 and a rolling stock register are published and updated each year. These registers will set out the main characteristics of the national infrastructure and rolling stock (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 registers.

(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 the 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 'maintenance' 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 and rolling stock of the trans-European high-speed rail system as defined in Annex I of Directive 96/48/EC, taking into account Article 2 hereunder.

*Article 2*

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,

[2] OJ L 110, 20.4.2001, p. 1.

— '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 application of the attached TSI is needed. If so, it will inform the Committee set up pursuant to Directive 96/48/EC.

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

*Article 3*

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

*Article 4*

This Decision is addressed to the Member States.

Done at Brussels, 30 May 2002.

*For the Commission*

Loyola DE PALACIO

*Vice-President*

*ANNEX*

# TECHNICAL SPECIFICATION FOR INTEROPERABILITY RELATING TO THE MAINTENANCE SUBSYSTEM

## 1. INTRODUCTION

### 1.1. TECHNICAL SCOPE

This TSI concerns the maintenance 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 maintenance 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 European Parliament and Council Decision No 1692/96/EC 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, point 1(b) to 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, point 3 to 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. SUBSYSTEM DEFINITION AND SCOPE

The aim of this technical specification is to define the technical and regulatory prescriptions together with the necessary and appropriate procedures for the constituents in the 'maintenance' subsystem and for the interfaces required to guarantee interoperability of the European high-speed network in compliance with the essential requirements of the 'maintenance' subsystem.

The definition of the domain concerned by the maintenance subsystem together with the field of application of the associated technical specification are derived from the maintenance or monitoring operations which should be applied as general practice in order to meet the requirements of interoperability.

In view of the geographical structure of the European high-speed network and the commercial speeds at which trains are operated, it will be possible to schedule rosters so that each train can return at staggered intervals to a designated base in its country of origin where the complex maintenance operations will be carried out at frequencies compatible with the design and reliability of high-speed trains. Indeed, the design of high-speed trains integrates highly reliable technical solutions and functional architecture incorporating redundancy with a very high level of availability which is far superior to a conventional rake of coaches with one or two locomotives. In addition, monitoring or testing devices which use automatic isolation equipment make it easier to identify the current functional status of the trainset so that it can be formed in such a way as to continue in commercial service until its return to the maintenance centre.

The conditions under which some repair work can be undertaken to allow the safe return of the rolling stock to the agreed maintenance depot and the special operating conditions for the rolling stock when it is in a degraded state, shall be agreed, case by case, between the infrastructure managers and the railway undertakings, according to particular characteristics of the rolling stock and to the circulation rules or regulations of the countries concerned.

In no event must any major corrective maintenance operation (except those required by specific situations, see Annex I to this TSI) or inspection be performed outside the dedicated trainset maintenance facilities. As a result, trainset maintenance logistics facilities covered by the present TSI shall be expressly restricted to operations ensuring interoperability. Such operations concern the restocking of consumable materials (water and sand), cleaning (the inside and outside of trainsets) and toilet emptying.

Generally speaking, maintenance arrangements specific to each subsystem covered by a TSI shall, if necessary at all, be set out in the corresponding TSI.

As regards the reliability and functional architecture of trainsets as well as the maintenance organisation used, maintenance is organised so as to be compatible with economically acceptable and profitable trainset operation.

From this standpoint, facilities falling within the field of application of the 'maintenance' technical specification for interoperability (TSI) are those required to:

— clean the inside and outside of the trainsets,

— deal with retention toilets,

— restock the water and sand supplies.

## 3. **ESSENTIAL REQUIREMENTS**

3.1. In accordance with Article 4(1) of Directive 96/48/EC, the trans-European high-speed rail system, its subsystems and their interoperability constituents must meet the relevant essential requirements as specified in Annex III to the Directive.

3.2. The essential requirements are related to:

— safety,

— reliability and availability,

— health,

— environmental protection,

— technical compatibility.

According to Directive 96/48/EC, the essential requirements may be general in scope and are applicable across the board to the entire trans-European high-speed rail system and may contain specific features for each subsystem and its constituents.

3.3. Requirements specific to the 'maintenance' subsystem (facilities and procedures used in maintenance centres handling interoperable high-speed trainsets) responding to and in addition to the considerations laid down in Annex III to the Directive are specified as follows:

— **Safety**

*Essential requirement 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.'

The fulfilment of this essential requirement may be considered as achieved when conformity to the prescriptions of point 4.2.2.2.5 (sand restocking equipment) of the present TSI is certified.

*Essential requirement 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.'

This essential requirement is not relevant to the maintenance subsystem.

*Essential requirement 1.1.3:*

'The components used must withstand any normal or exceptional stresses that have been specified during their period in service. The safety repercussions of any accidental failures must be limited by appropriate means.'

This essential requirement is not relevant to the maintenance subsystem.

*Essential requirement 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 a fire.'

For the fixed installations of the maintenance subsystem, the fulfilment of this essential requirement may be considered as achieved when conformity of these installations with national regulations is demonstrated.

*Essential requirement 1.1.5:*

'Any devices intended to be handled by users must be so designed as not to impair their safety if used foreseeably in a manner not in accordance with the posted instructions.'

This essential requirement is not relevant to the 'maintenance' subsystem.

— **Reliability and availability**

*Essential requirement 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.'

High-speed trainsets incorporate high-reliability technical solutions and functional architectural features with built-in redundancy ensuring maximum trainset availability. In addition monitoring/control equipment combined with automatic-isolation systems makes easier the knowledge of the functional status of trainsets and enables them to be configured in a way that guarantees continued operation of the trainset in commercial service until its return to the maintenance depot.

Consequently no specific measure needs to be taken with regard to the 'maintenance' subsystem to ensure trainset reliability and availability in the context of this essential requirement.

— **Health**

*Essential requirement 1.3.1:*

'Materials likely, by virtue of the way they are used, to constitute a health hazard to those having access to them must not be used in trains and railway infrastructures.'

For the fixed installations of the maintenance subsystem, the fulfilment of this essential requirement may be considered as achieved when conformity of these installations with EC Directives and national regulations is demonstrated.

*Essential requirement 1.3.2:*

'Those materials must be selected, deployed and used in such a way as to restrict the emission of harmful and dangerous fumes or gases, particularly in the event of fire.'

For the fixed installations of the maintenance subsystem, the fulfilment of this essential requirement may be considered as achieved when conformity of these installations with national regulations is demonstrated.

*Essential requirement 2.5.1:*

'The technical installations and the procedures used in the maintenance centres must not constitute a danger to human health.'

For the fixed installations of the 'maintenance' subsystem, the fulfilment of this essential requirement may be considered as achieved when conformity of these installations with national regulations is demonstrated.

— **Environmental protection**

*Essential requirement 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.'

This essential requirement is not relevant to the 'maintenance' subsystem.

*Essential requirement 1.4.2:*

'The materials used in the trains and infrastructures must prevent the emission of fumes or gas which are harmful and dangerous to the environment, particularly in the event of fire.'

For the fixed installations of the maintenance subsystem, the fulfilment of this essential requirement may be considered as achieved when conformity of these installations with national regulations is demonstrated.

*Essential requirement 1.4.3:*

'The rolling stock and energy-supply systems must be designed and manufactured in such way as to be electromagnetically compatible with the installations, equipment and public or private networks with which they might interfere.'

This essential requirement is not relevant to the maintenance subsystem.

*Essential requirement 2.5.2:*

'The technical installations and the procedures used in the maintenance centres must not exceed the permissible levels of nuisance with regard to the surrounding environment.'

For the fixed installations of the maintenance subsystem, the fulfilment of this essential requirement may be considered as achieved when conformity of these installations with national regulations is demonstrated.

— **Technical compatibility**

*Essential requirement 1.5:*

'The technical characteristics of the infrastructures 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.'

The fulfilment of this essential requirement may be considered as achieved when conformity to the prescriptions of points 4.2.2.1, 4.2.2.2.1, 4.2.2.2.2 and 4.2.2.2.4 of Chapter 4, as well as points 5.3.1 and 5.3.5 of Chapter 5 of the present TSI is certified.

*Essential requirement 2.5.3:*

'The maintenance installations (handling) high-speed trains must be such as to enable safety, health and comfort operations to be carried out on all trains for which they have been designed.'

The fulfilment of this essential requirement may be considered as achieved when conformity to the prescriptions of points 4.2.2.1, 4.2.2.2.1, 4.2.2.2.2, 4.2.2.2.4, 4.2.2.2.5 and 4.2.2.2.6 of Chapter 4, as well as points 5.3.1 and 5.3.5 of Chapter 5 of the present TSI is certified.

3.4. Verification that the essential requirements governing the subsystem and its constituents have been complied with is established in accordance with the provisions laid down in Directive 96/48/EC.

## 4. **CHARACTERISATION OF THE SUBSYSTEM**

The high-speed trans-European rail system as covered by the provisions of Directive 96/48/EC and of which the maintenance subsystem forms a part, is an integrated system the coherence of which must be verified particularly regarding the basic parameters, the interfaces and the performance levels with a view to ensuring system interoperability in the respect of the essential requirements.

Regarding interoperability, the maintenance subsystem is characterised as follows:

4.1. BASIC PARAMETERS OF THE 'MAINTENANCE' SUBSYSTEM

The maintenance subsystem is not characterised by the basic parameters listed in Annex II (Section 3) to Directive 96/48/EC.

4.2. INTERFACES OF MAINTENANCE SUBSYSTEM

4.2.1. **Subsystem interface**

Regarding technical compatibility, the interfaces of the maintenance subsystem are concerned with:

— the infrastructure subsystem,

— the rolling stock subsystem.

4.2.2. **These interfaces are characterised by:**

4.2.2.1. *Interface with the infrastructure subsystem*

— Stabling tracks

  — Stabling tracks must have an overhead line to supply power to the train.

  — Their geometrical characteristics (including length) have to be in accordance with the prescriptions of point 4.3.3.5 of the infrastructure TSI.

  — If a toilet discharge trolley is used, the minimum distance between track centres must be 6 m and a running path for the trolleys shall be provided.

4.2.2.2. *Interface with the rolling stock subsystem*

4.2.2.2.1. Trainset exterior cleaning facilities

— It must be possible for the front windows of drivers' cabs to be cleaned both from the ground and from platform heights of 550 mm and 760 mm using suitable (with particular regard to health and safety aspects) cleaning equipment, in all stations and facilities at which the trains call or are stabled.

— When washing machines are used they shall be able to clean the outer sides of single or double-deck trainsets over a height of:

  — 1 000 to 3 500 mm for a single-deck trainset,

  — 500 to 4 300 mm for double-deck trainsets.

  It must be possible for the speed at which the trainset passes through the train washing plant to be adapted to suit each washing plant, i.e. between 4 and 6 km/h.

— Products used for washing trains must comply with local environmental-protection regulations.

4.2.2.2.2. Toilet discharge systems

— The technology of the trainset toilets shall allow the sealed toilets (using clear or recycled water) to be emptied at three-day intervals, so that the emptying operations can be performed on a scheduled basis at designated depots.

— Toilets discharge installation (fixed or mobile) shall be compatible with the characteristics either of one of the sealed system either with the other one.

— A mobile trolley may be provided to enable evacuation when needed thereby allowing the rolling stock to continue in commercial service until its return to the home depot.

— Any mobile discharge trolleys needed shall perform all of the following functions:

  — suction (the limit value for the suction vacuum is set at 0,2 bar),

  — rinsing (only applies to retention toilet discharge equipment),

  — pre-loading or filling with additive (only applies to retention toilet discharge equipment),

  — discharge.

4.2.2.2.3. Trainset interior cleaning equipment

— A 3 000 VA at 230 V, 50 Hz electrical power supply connection shall be provided in each coach for powering industrial cleaning equipment. This power must be available simultaneously in all the coaches of a trainset. Electric power sockets inside the train must be spaced such that no part of the coach that must be cleaned is more than 12 m from one of the sockets.

4.2.2.2.4. Water restocking equipment

— The new equipment for water supply on the interoperable network shall be supplied with drinking water in accordance with Directive 98/83/EC, and their mode of operation must ensure that water delivered at the last element of the fixed part of these installations complies with the quality specified by this same Directive for water intended for human consumption.

4.2.2.2.5. Sand restocking equipment

— Sandboxes are normally filled during scheduled maintenance operations in specialised workshops in charge of trainset maintenance. However, if required, sand meeting local specifications for this use shall be made available to fill sand boxes so that rolling stock can continue in commercial service until it returns to its maintenance centre.

4.2.2.2.6. Special requirements for stabling of trains

The trains must be designed so that:

— the trainsets respect, during their stabling, the level of noise stipulated in the rolling stock TSI,

— periodic monitoring is not necessary when they are stabled under voltage,

— they can be configured for different functional levels (standby, preparation, etc.),

— an absence of voltage does not damage any train constituents,

— stabled trains can be safely secured against all risks of unexpected movement.

They must in particular incorporate parking brakes to ensure that operating rules applicable locally can be observed whenever the use of such brakes is required.

4.2.3. **Regulatory and operational provisions**

To ensure coherence of the trans-European railway system, the abovementioned interfaces shall be subject to the following regulatory and operational requirements:

(None)

4.3. SPECIFIED PERFORMANCE OF THE MAINTENANCE SUBSYSTEM

The performance criteria which the maintenance subsystem must meet correspond to the performances specified for each of the following line categories of the trans-European high-speed rail system, as relevant:

— lines specially built for high-speed running,

— lines specially upgraded for high speed,

— lines specially upgraded for high speed which have special features.

In the case of the maintenance subsystem, the performance requirements are the same for all three categories of line.

## 5. **INTEROPERABILITY CONSTITUENTS**

5.1. In keeping with 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'.

5.2. The interoperability constituents are subject to relevant provisions in Directive 96/48/EC and are the following as concerns this TSI:

— toilet discharge systems: connections,

— equipment for cleaning trainset interiors: electrical sockets,

— equipment for restocking of water and sand supplies: water filling (inlet) adapters.

5.3. These interoperability constituents are the subject of specifications in the form of performance requirements. Conformity assessment and/or fitness for use is focused through interoperability constituent interface requirements as a priority, with reference to design or descriptive characteristics being exceptional.

5.3.1. The specifications for the toilet discharge system connections interoperability constituent are the following:

— The connections (3" for emptying and 1" for rinsing) and their seals must comply with figures 1 and 2 respectively of Annex IV.

5.3.2. The interfaces of the toilet discharge system connections interoperability constituent are characterised as follows:

(None)

5.3.3. The specifications for the trainset interior cleaning equipment, electrical sockets interoperability constituent are the following:

— The interior sockets must comply with the dimensions laid down in EN Standard 60 309.1, and must fulfil the dimensional characteristics of the socket stated on page 22 of EN Standard 60 309.2 (socket with two poles + earth) and the characteristics specified in Sections 8.3.1 and 8.3.1.1 of Standard EN 50 153.

5.3.4. The interfaces of the trainset interior cleaning equipment, electrical sockets interoperability constituent are characterised as follows:

(None)

In as much as the specifications of the interoperability constituent trainset interior cleaning equipment, electrical sockets make reference to European specifications drawn up by the European standardisation bodies – CEN, CENELEC and ETSI – as instructed by the Commission, the latter specifications themselves must be drawn up on a performance basis and only exceptionally on a prescriptive basis.

The relevant European specifications are:

— Standard EN 60 309.1,

— Standard EN 60 309.2 (p. 22),

— Standard EN 50 153 (Section 8.3.1 and 8.3.1.1),

— Directive 98/83/EC (quality of the water).

5.3.5. The specifications of the interoperability constituent water filling adapters are the following:

— The water filling adapters shall be as shown in Figure 3 of Annex V.

5.3.6. The interfaces of the water filling adapters interoperability constituent are characterised as:

(None).

## 6. **ASSESSMENT OF CONFORMITY AND/OR SUITABILITY FOR USE**

6.1. INTEROPERABILITY CONSTITUENTS

6.1.1. **Conformity assessment procedures (modules)**

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

Assessment procedures for conformity, descriptions of the testing methods for in the interoperability constituents: toilet discharge system connections, trainset interior cleaning equipment (electrical sockets) and water filling adapters, as defined in Chapter 5 of this TSI, are indicated in Annex II, Tables II.1, II.2 and II.3 to this TSI.

As far as required by the modules specified in Annex III to this TSI, the assessment of conformity 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 in accordance with Article 13(1) 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 not required for interoperability constituents of the maintenance subsystem.

6.1.2. **Application of modules**

*Assessment of conformity*

For the assessment procedure of each interoperability constituent of the maintenance subsystem, the manufacturer or his authorised representative established within the Community shall apply the internal control of production procedure (module A) indicated in Annex III (III.1) to this TSI.

*Definition of assessment procedures*

The assessment procedures are defined in Annex III to this TSI.

The conformity assessment shall cover the phases and characteristics as indicated by X in the Tables II.1, II.2 and II.3 of Annex II to this TSI.

6.2. MAINTENANCE 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) and Annex VI to Directive 96/48/EC and in accordance with the provisions of the relevant modules as specified in Annex III to this TSI.

If the adjudicating entity can demonstrate that tests or verifications for previous applications remain valid in the new application, then the notified body shall take them into account in the conformity assessment.

Assessment procedures for the EC verification of the maintenance subsystem, list of specifications and descriptions of the testing procedures are indicated in Annex II, Table II.4 to this TSI.

As far as specified in this TSI, the EC verification of the maintenance subsystem shall take account of 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 maintenance subsystem in accordance with Article 18(1) and Annex V to Directive 96/48/EC.

6.2.2. **Application of modules**

6.2.2.1. *Fixed installations*

For the verification procedure of the maintenance subsystem (fixed installations), the adjudicating entity or its authorised representative established within the Community may choose either:

— the unit verification procedure (module SG) indicated in Annex III (III.5) to this TSI, or

— the full quality assurance with design examination procedure (module SH2) indicated in Annex III (III.6) to this TSI.

The module SH2 may be chosen only where all activities contributing to the subsystem project 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 Table II.4 of Annex II to this TSI.

6.2.2.2. *On-board installations*

For the verification procedure of the maintenance subsystem (on-board installations), the adjudicating entity or its authorised representative established within the Community may choose either:

— the type-examination procedure (module SB) indicated in Annex III (III.2) to this TSI, for the design and development phase, in combination with:

— either the production quality assurance procedure (module SD) indicated in Annex III (III.3), or the product verification procedure (module SF) indicated in Annex III (III.4) to this TSI, for the production phase, or

— the full quality assurance with design examination procedure (module SH2) indicated in Annex III (III.6) to this TSI, for all phases.

The module SD may be chosen only where all activities contributing to the subsystem project to be verified (manufacturing, assembling, installation) are subject to a quality system for production, final product inspection and testing, approved and surveyed by a notified body.

The module SH2 may be chosen only where all activities contributing to the subsystem project 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 Table II.5 of Annex II to this TSI.

## 7. **IMPLEMENTING THE MAINTENANCE TSI**

7.1. IMPLEMENTATION PROCEDURE AND TIMING

7.1.1. **Procedure**

The implementation of the specifications on maintenance equipment are based on the following general steps:

Step 1:

The rolling stock roster project is examined by both the infrastructure manager and the railway undertaking.

Step 2:

An economic study is carried out by both the infrastructure manager and the railway undertaking, on the basis of which the initial roster may be modified.

7.1.2. **Timing**

Because of:

— the time needed to build or modify the fixed installations, and to put into place the mobile toilet discharge trolleys,

— the principle by which compliance with interoperability requirements of the already existing fixed installations is only possible if incorporated into long-term renewal and repair schedules,

the timing of implementation will have to be negotiated between the infrastructure manager and the railway undertaking.

In particular, if the railway undertaking wishes to start to operate the interoperable route within a time not compatible with those constraints, then the infrastructure manager and the railway undertaking will negotiate temporary solutions (drawing up temporary rolling stock rosters for example).

7.1.3. **Implementation of maintenance equipment (lines of all categories)**

7.1.3.1. *Stabling tracks*

First step: the infrastructure manager and the railway undertaking examine together the rolling stock roster project proposed by the railway undertaking, and identify the areas of the interoperable network, on the route under consideration, where the trainsets should (according to this rolling stock roster project) have to be stabled and where there are not (or not enough) stabling tracks meeting the requirements of the TSI.

Second step: the infrastructure manager and the railway undertaking carry out together an economic study, possibly leading to modifications of the rolling stock roster. Those modifications, regarding the number and/or the location of the trainsets stabling areas, minimise the number of the new (complying with the maintenance TSI) stabling tracks that will have to be built, and also the number of already existing stabling tracks that will have to be brought into conformity with this TSI.

7.1.3.2. *Water supply facilities*

First step: the infrastructure manager and the railway undertaking examine together the rolling stock roster project proposed by the railway undertaking, and identify the areas of the interoperable network, on the route under consideration, where the trainsets should (according to this rolling stock roster project) be supplied with water, and where there are not (or not enough) water supply facilities meeting the requirements of the TSI.

Second step: the infrastructure manager and the railway undertaking carry out together an economic study possibly leading to modifications of the rolling stock roster. Those modifications, regarding the number and/or the location of the areas where the trainsets will be supplied with water, minimise the number of the new (complying with the maintenance TSI) water supply facilities that will have to be built, and also the number of already existing facilities that will have to be brought into conformity with this TSI.

7.1.3.3. *Mobile toilet discharge trolleys*

First step: the infrastructure manager and the railway undertaking examine together the rolling stock roster project proposed by the railway undertaking, and identify the areas of the interoperable network, on the route under consideration, where it should be possible (according to this rolling stock roster project) to discharge the trainsets toilets when needed, and where there are not (or not enough) toilet emptying fixed facilities allowing this operation on those trainsets.

Second step: the infrastructure manager and the railway undertaking carry out together an economic study leading to modifications of the rolling stock roster. Those modifications, regarding the number and/or the location of the areas where it will be possible to discharge the trainsets toilets when needed, minimise the number of mobile toilet discharge trolleys (complying with the maintenance TSI) that will have to be placed on those areas.

7.2. SPECIFIC CASES: DETAILS OF APPLICATION

(None).

7.3. RECOMMENDATION

With the aim of continually improving the water quality in the vehicles for high-speed traffic, it is recommended that installations dealt with in point 4.2.2.2.4 be employed in such a manner that the vehicles are filled with water of a quality complying with Directive 83/18/EC. In that case, the not fixed installations, the hoses and nozzles, should be handled with care in order to keep water quality.

*ANNEX I*

**SPECIFIC SITUATIONS**

As specified in the TSI, the redundancies incorporated into high-speed trainsets at the design stage should enable preventive and corrective maintenance work to be carried out mostly at the designated rolling stock maintenance depot.

However, certain types of damage, examples of which are listed below, can lead:

— either to degraded operating modes for the rolling stock and operating restrictions (speed restriction, coach shutdowns, etc.),

— or to the need for corrective maintenance at the train terminus.

As it is important for financial reasons not to equip every terminus with special facilities, nor to tie up supplies of little used spare parts, and in view of the difficulty of keeping staff trained for several types of rolling stock, corrective maintenance operations should be dealt with according to one of the following four arrangements:

— basic repairs that can be carried out by train staff without any specific knowledge of the type of rolling stock,

— repairs carried out with specialist support from the home depot via a phone link,

— repairs carried out by a team from the home depot sent immediately to the spot,

— isolation of the failed component and trainset returned to base in non-commercial service.

The specific operating conditions in degraded mode or following partial or temporary repairs must be approved on a case-by-case basis according to the specifics of the rolling stock and the rules or regulations governing the working of trains in the countries crossed (bilateral agreements required).

Examples of possible damage:

— evidence of wheel flats

— hot axle box

— seized axle

— entrance doors jammed

— air conditioning failure

— broken windows

— pantograph disabled

— toilets out of order

— faulty train control equipment (TVM, LZB, RS 4 codes…)

— horn or headlights failure

— damage to suspension spring

— damage to bogie

— damage to dampers

— damage to coupling

— trainset power supply failure

— lighting failure

— …

*ANNEX II*

## ASSESSMENT OF CONFORMITY

ASSESSMENT OF INTEROPERABILITY CONSTITUENTS

### II.1. **Scope**

This Annex indicates the assessment of conformity of interoperability constituents: toilet discharge system connections, trainset-interior cleaning equipment (electrical sockets) and water filling adapters of the maintenance subsystem.

### II.2. **Characteristics**

The characteristics of the interoperability constituents to be assessed in the different phases of design and production are marked by X in Table II.1, Table II.2 and Table II.3.

Table II.1.

Assessment of the interoperability constituent: toilet discharge system connections

| 1 | | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|
| Characteristics to be assessed | | Assessment in the following phase | | | | |
| | | Design and development phase | | | | Production phase (series) |
| Characteristic | Clause | Design review | Review of manufacturing process | Type test | In service experience | |
| Type and dimensions | 5.3.1 | X | n.a. | n.a. | n.a. | X |
| n.a.: not applicable. | | | | | | |

Table II.2.

Assessment of the interoperability constituent: trainset-interior cleaning equipment (electrical sockets)

| 1 | | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|
| Characteristics to be assessed | | Assessment in the following phase | | | | |
| | | Design and development phase | | | | Production phase (series) |
| Characteristic | Clause | Design review | Review of manufacturing process | Type test | In service experience | |
| Type and dimensions | 5.3.3 | X | n.a. | n.a. | n.a. | X |
| n.a.: not applicable. | | | | | | |

Table II.3.

Assessment of the interoperability constituent: water filling adapters

| 1 | | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|
| Characteristics to be assessed | | Assessment in the following phase | | | | |
| | | Design and development phase | | | | Production phase (series) |
| Characteristic | Clause | Design review | Review of manufacturing process | Type test | In service experience | |
| Type and dimensions | 5.3.5 | X | n.a. | n.a. | n.a. | X |
| n.a.: not applicable. | | | | | | |

ASSESSMENT OF THE MAINTENANCE SUBSYSTEM

II.3. **Scope**

This Annex indicates the assessment of conformity of the maintenance subsystem.

II.4. **Characteristics**

The characteristics of the subsystem to be assessed in the different phases of design, installation and operation are marked by X in Tables II.4 (for fixed installations) and II.5 (for on-board installations).

Table II.4.

Assessment of the maintenance subsystem (fixed installations)

| 1 | | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| Characteristics to be assessed | | Assessment in the following phase | | | |
| | | Design and development phase | Production phase | | |
| Characteristic | Clause | Design review | Construction, assembling, mounting | Assembled, before putting into service | Validation under full operation conditions |
| *Washing machine* | | | | | |
| Height to clean | 4.2.2.2.1 | X | n.a. | n.a. | X |
| Speed | 4.2.2.2.1 | X | n.a. | n.a. | X |
| *Mobile emptying system* | | | | | |
| Functions | 4.2.2.2.2 | X | n.a. | n.a. | X |
| Pressure | 4.2.2.2.2 | X | n.a. | n.a. | X |
| Compatibility with on-board toilets | 4.2.2.2.2 | X | n.a. | n.a. | X |
| *Stabling tracks* | | | | | |
| Length and geometrical characteristics | | X | n.a. | n.a. | X |
| *Water and sand supply facilities* | | | | | |
| Quality of water | 4.2.2.2.4 | X | n.a. | n.a. | X |
| Availability of sand | 4.2.2.2.5 | X | n.a. | n.a. | X |
| Quality of sand | 4.2.2.2.5 | X | n.a. | n.a. | X |

n.a.: not applicable.

Table II.5.

Assessment of the maintenance subsystem (on-board installations)

| 1 | | 2 | 3 | 4 |
|---|---|---|---|---|
| Characteristics to be assessed | | Module for assessment in the following phase | | |
| | | Design and development phase | | Production phase |
| Characteristic | Clause | Design review | Type test | Serial production quality |
| *Toilet emptying* | | | | |
| Technology of trainset toilets allowing to be emptied at three-day intervals | 4.2.2.2.2 | X | n.a. | n.a. |
| *Power supply for internal cleaning* | | | | |
| Power — Voltage | 4.2.2.2.3 | X | X | n.a. |
| Availability of electrical sockets | 4.2.2.2.3 | X | n.a. | n.a. |
| Spacing of sockets | 4.2.2.2.3 | X | n.a. | n.a. |
| *Trainsets standby* | | | | |
| Stationary noise level | 4.2.2.2.6 | X | X | n.a. |
| Capability of being stabled with no crew aboard and with auxiliary power supply sustained | 4.2.2.2.6 | X | n.a. | n.a. |
| Parking brake | 4.2.2.2.6 | X | n.a. | n.a. |

n.a.: not applicable

*ANNEX III*

**ASSESSMENT PROCEDURES (MODULES)**

**III.1. 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 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 Annex IV(3) to Directive 96/48/EC and in Article 13(3) thereof. The EC declaration of conformity 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 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 in 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.

**III.2. MODULE SB (EC Type-examination)**

*EC verification of maintenance subsystem*

1. This module describes the part of 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 a type of a maintenance subsystem, representative for the production envisaged,

— complies with this TSI and any other applicable TSI, which demonstrate that the essential requirements of Directive 96/48/EC have been met,

— complies with the other regulations deriving from the Treaty.

2. The adjudicating entity or its authorised representative established within the Community must lodge an application for EC verification (through type-examination) 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, as described in point 3.

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

A type may cover several versions of the subsystem 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 so required for specific test or examination methods and specified in the TSI or in the European specifications referred to in Article 10 of Directive 96/48/EC, also a specimen or specimens of a subassembly or assembly or a specimen of the subsystem in a pre-assembled condition has to be delivered.

The technical documentation must enable the design, manufacture, installation and operation of the subsystem to be understood, and shall enable conformity with the provisions of Directive 96/48/EC and of the TSI to be assessed. It must, as far as relevant for such assessment, cover the design, manufacture and operation of the subsystem.

It must include:

— a general description of the subsystem, overall design and structure,

— conceptual design and manufacturing drawings and schemes of components, subassemblies, assemblies, circuits, etc.,

— descriptions and explanations necessary for the understanding of said drawings and schemes and the operation of the product,

— 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 Article 10 of Directive 96/48/EC and the relevant clauses have not been applied in full,

— a list of the interoperability constituents, to be incorporated into the subsystem,

— technical documentation as regards the manufacturing and the assembling of the subsystem,

— a list of manufacturers, involved in the subsystem's design, manufacturing, assembling and installation,

— conditions for use and maintenance of the subsystem (restrictions of running time or distance, wear limits etc),

— a list of the European specifications referred to in Article 10 of Directive 96/48/EC or in the technical design specification,

— results of design calculations made, examinations carried out, etc.,

— test reports.

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

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 subsystem at the completion of the design process;

4.3. if type tests are requested in the TSI, verify that the specimen(s) of the subsystem or of assemblies or subassemblies of the subsystem, required for carrying out type tests, 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 specifications concerned;

4.4. identify the elements which have been designed in accordance with the relevant provisions of the TSI and the European Specifications referred to in Article 10 of Directive 96/48/EC, as well as the elements which have been designed without applying the relevant provisions of those European specifications;

4.5. perform or have performed the appropriate examinations and necessary tests in accordance with points 4.2 and 4.3 to establish whether, where the relevant European specifications have been chosen, these have actually applied;

4.6. perform or have performed the appropriate examinations and necessary tests in accordance with points 4.2 and 4.3 to establish whether, where the adjudicating entity or the manufacturer(s) have chosen to apply the relevant European specifications (standards), these have actually been applied;

4.7. agree with the applicant the location where the examinations and necessary tests will be carried out.

5. Where the type meets the provisions of Directive 96/48/EC and 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 adjudicating entity and the manufacturer(s), 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 adjudicating entity or its authorised representative established within the Community is denied a 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 subsystem which must receive additional approval where such changes may affect the conformity with the requirements of Directive 96/48/EC and the TSI or the prescribed conditions for use of the subsystem. This additional approval is given in the form of an addition to the original EC 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 applies for such a prolongation by a written confirmation that no such modifications have been made, and the notified body issues a prolongation for another period of validity as in point 5, if no contrary information is existent. This procedure can be reiterated.

8. Each notified body must communicate to the other notified bodies the relevant information concerning the EC 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 adjudicating entity or its authorised representative established within the Community must keep with the technical documentation copies of type-examination certificates and their additions throughout the service life of the subsystem, it must be sent to any other Member State who so requests.

**III.3. Module SD (Production quality assurance)**

*EC verification of maintenance 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 a maintenance subsystem, for which an EC type-examination certificate has already been issued by a notified body,

   — complies with this TSI and any other applicable TSI, which demonstrates that the essential requirements of Directive 96/48/EC have been met,

   — complies with the other regulations deriving from the Treaty and may be put into service.

   The notified body is carrying out the procedure, under the condition, that the adjudicating entity and the manufacturers involved are satisfying the obligations of point 2.

2. For the subsystem, being subject of the EC verification procedure, the adjudicating entity must contract only with manufacturers, whose activities contributing to the subsystem project to be verified (manufacturing, assembling, installation) are subject to an approved quality system for 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', in the sense of these provisions, also includes companies:

   — responsible for the whole subsystem project (including in particular responsibility for subsystem integration (main contractor)),

   — performing assembling (assemblers) and installation of the subsystem.

   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 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 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,

   — the technical documentation of the approved type and a copy of the type-examination certificate, issued after the completion of the type-examination procedure of module SB.

   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 overall compliance of the subsystem with the type as described in the type-examination certificate and overall compliance of the subsystem with the requirements of the TSI. For other manufacturers (subsuppliers) the quality system has to ensure compliance of their relevant contribution to the subsystem with the type as described in the type-examination certificate and 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., and for the main contractor,

— responsibilities and powers of the management with regard to overall subsystem quality, including in particular the subsystem integration management.

The examinations, tests and checking shall cover all of the following stages:

— structure of subsystem, including, in particular, civil-engineering activities, constituent assembly, final 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 — 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 as referred to in point 3.1 must have permanent access for inspection purposes to the locations of building sites, production workshops, locations of assembling and installation, storage areas and, where appropriate, prefabrication or testing facilities and, more general, 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 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 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 must 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 (manufacture, assembling or installation) for the subsystem being the subject of the EC verification procedure mentioned in point 6.

4.5. Additionally the notified body(ies) may pay unexpected visits to the sites mentioned in point 4.2. of the applicant(s). At the time of such visits, the notified body may conduct complete or partial audits and may carry out or cause to be carried out tests, in order to check the proper functioning of the quality system where necessary. It must provide the applicant(s) with an inspection report and also, if an audit has been carried out, with an audit report, and, if a test has been carried out with a test 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 point 3.4, points 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 production quality assurance), including coordination of the surveillance of the quality systems as in point 6.5, with a notified body of its choice. The adjudicating entity or his authorised representative within the Community must inform the manufacturers involved of this choice and of the application.

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

It must include:

— the technical documentation regarding the approved type, including the type-examination certificate, as issued after completion of the procedure defined in module SB, and, if not included in this documentation,

  — 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 of Directive 96/48 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 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 in point 3.2, are covered by quality systems of the manufacturers 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.

6.3. The notified body must examine the application concerning the validity of the type-examination and the type-examination certificate.

6.4. The notified body must then examine, if all stages of the subsystem as mentioned in the last subparagraph of point 3.2 are sufficiently and properly covered by the approval and surveillance of the quality system(s) of the applicant(s).

If the conformity of the subsystem with the type as described in the EC type-examination certificate and the compliance of the subsystem with the requirements of Directive 96/48/EC and 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 for the main contractor 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 in point 4, must coordinate the surveillance activities of any other notified body responsible for that task, in order to be ensured 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 under its responsibility and together with the other notified body(ies).

6.6. Where the subsystem meets the requirements of Directive 96/48/EC and the TSI, the notified body must then, based on the type-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 of the technical file and must contain at least the information included in Annex V to 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 Article 18(3) of Directive 96/48/EC, 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,

— the EC type-examination certificate for the subsystem and the accompanying technical documentation,

— certificate of EC verification of the notified body as mentioned in point 6.5, accompanied by corresponding calculation notes and countersigned by itself, stating that the project complies with the Directive 96/48/EC 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 points 4.4 and 4.5 and in particular.

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.

### III.4. Module SF (product verification)

*EC verification of maintenance 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 a maintenance subsystem, for which already a EC type-examination certificate has been issued by a notified body,

— complies with this TSI and any other applicable TSI, which demonstrates that the essential requirements of Directive 96/48/EC have been met,

— 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 product 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. Within that part of the procedure the adjudicating entity or his authorised representative established within the Community checks and attests that the subsystem 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 the TSI that apply to them.

4. The adjudicating entity must take all measures necessary in order that the manufacturing process (including assembling and integration of interoperability constituents) ensures conformity of the subsystem with the type as described in the EC type-examination certificate and with the requirements of the TSI that apply to them.

5. The technical documentation must enable the design, manufacture, installation and operation of the subsystem to be understood, and shall enable conformity with the type as described in the type-examination certificate and the requirements of the Directive and the TSI to be assessed.

It must include:

— the type-examination certificate and its accompanying documents and additions, and, as far as not included in the documents accompanying the EC type-examination certificate,

— a general description of the subsystem, overall design and structure,

— 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 specification, that have been applied,

— the necessary supporting evidence for their adequacy, in particular where European specification 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 specification If the TSI is requiring further information for the technical documentation, this has to be included.

6. The notified body must carry out the appropriate examinations and tests in order to check the conformity of the subsystem with the type as described in the EC type-examination certificate and with the requirements of Directive 96/48/EC and the TSI by examination and testing of every subsystem, manufactured as a serial product, as specified under Point 4.

7. Verification by examination and testing of every subsystem (as a serial product).

7.1. The notified body must carry out the tests, examinations and verifications, to ensure conformity subsystem as serial products with the essential requirements of the Directive and of the TSI. The examinations, tests and checking shall extend to the following stages as provided for in the TSI:

— structure of subsystem, including constituent assembly and overall adjustments,

— final testing of the subsystem,

— and, whenever specified in the TSI, the validation under full operational conditions.

7.2. All subsystems (as serial products) must be individually examined and appropriate tests and verifications as set out in the TSI and in the relevant European Specifications (or equivalent tests) shall be carried out in order to verify their conformity with the type as described in the type-examination certificate and the requirements of the TSI that apply to them.

8. The notified body may agree with the adjudicating entity the locations where the tests will be carried out and may agree that final testing of the subsystem and, whenever required in the TSI, tests or validation under full operating conditions, are carried out by the adjudicating entity under direct supervision and attendance of the notified body.

9. The notified body must have permanent access for testing and verification purposes to 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.

10. Where the subsystem meets the requirements of Directive 96/48/EC and the TSI, the notified body must then, based on the tests, verifications and checking carried out on all serial products as indicated in point 7, and required in the TSI and in the European specification referred to in Article 10 of Directive 96/48/EC, 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 of the technical file and must contain at least the information included in Annex V of Directive 96/48/EC.

11. 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 Article 18(3) of Directive 96/48/EC, 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,

— EC type-examination certificate and accompanying technical documentation,

— certificate of EC verification of the notified body as mentioned under point 10, 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.

12. 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.

13. 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.

### III.5. Module SG (Unit verification)

*EC verification of maintenance 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 a maintenance subsystem:

— complies with this TSI and any other applicable TSI, which demonstrates that the essential requirements of Directive 96/48/EC have been met,

— 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 TSI to be assessed.

It must include:

— a general description of the subsystem, overall design and structure,

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

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 checking 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 of the technical file and must contain at least the information included in Annex V to 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 Article 18(3) of Directive 96/48/EC, 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 in 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.

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.

**III.6. Module SH2 (Full quality assurance with design examination)**

*EC verification of maintenance 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 a maintenance subsystem:

— complies with this TSI and any other applicable TSI, which demonstrates that the essential requirements of Directive 96/48/EC have been met,

— 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, being 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 overall compliance of the subsystem with the requirements of 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 of Directive 96/48/EC 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 overall design and subsystem quality, including in particular the subsystem integration management.

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, final 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 — 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 — 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 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 their 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 reassessment 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 in 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 general, 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 in point 6.

4.5. Additionally the notified body(ies) may pay unexpected visits to the sites mentioned in 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 point 3.4, points 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 in points 4.4 and 4.5, with a notified body of its choice. The adjudicating entity or its authorised representative established 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 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 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.

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 in point 3.2 are sufficiently and properly covered by the approval and surveillance of quality system(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 for the main contractor 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 in point 4, must coordinate the surveillance activities of any other notified body responsible for that task, in order to be ensured 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(s),

— to witness the surveillance audits as in point 4.4,

— to initiate additional audits as in point 4.5 under its responsibility and together with the other notified body(s).

6.6. Where the subsystem meets the requirements of Directive 96/48/EC and 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 of 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, 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 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 in 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 in points 4.4 and 4.5.

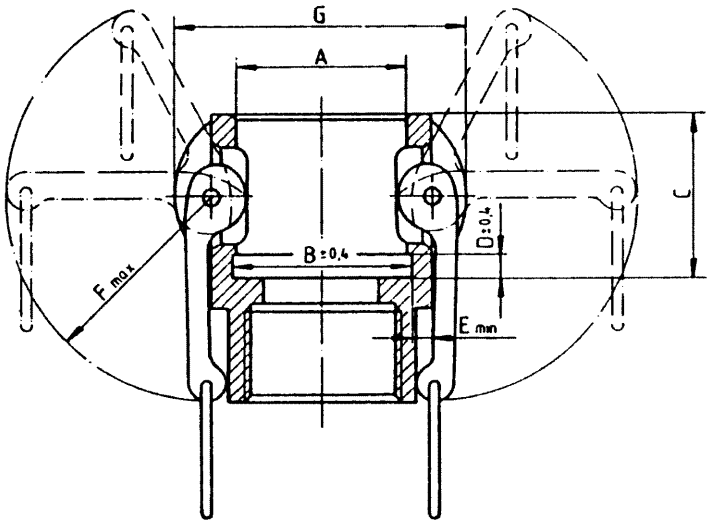
7. The complete records accompanying the certificate of EC verification must be lodged with the adjudicating entity or its authorised representative in support of the certificate of EC verification issued by the notified body and must be attached to the EC declaration of verification drawn up by the 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.

*ANNEX IV*

**CONNECTIONS FOR THE TOILET DISCHARGE SYSTEM**

3″ Connection of evacuation and 1″ Connection for flushing (outer parts)



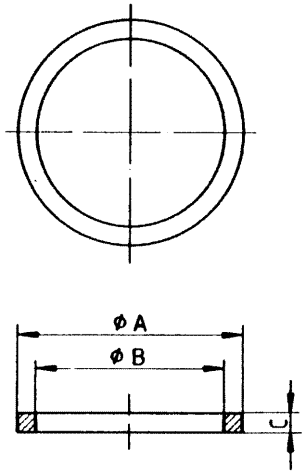

| | A | B | C | D | E | F | G |
|---|---|---|---|---|---|---|---|
| 3″ connection | 92,20 | 104 | 55 | 7,14 | 4 | 82,55 | 133,3 |
| 1″ connection | 37,24 | 40,5 | 37,5 | 7,14 | 2,4 | 44,45 | 65 |

Material: stainless steel

General tolerances ± 0,1

Figure 1

Joints




| | A | B | C |
|---|---|---|---|
| 3″ joint | 94,45 | 76,20 | 6,35 |
| 1″ joint | 39,69 | 26,98 | 6,35 |

General tolerances ± 0,1

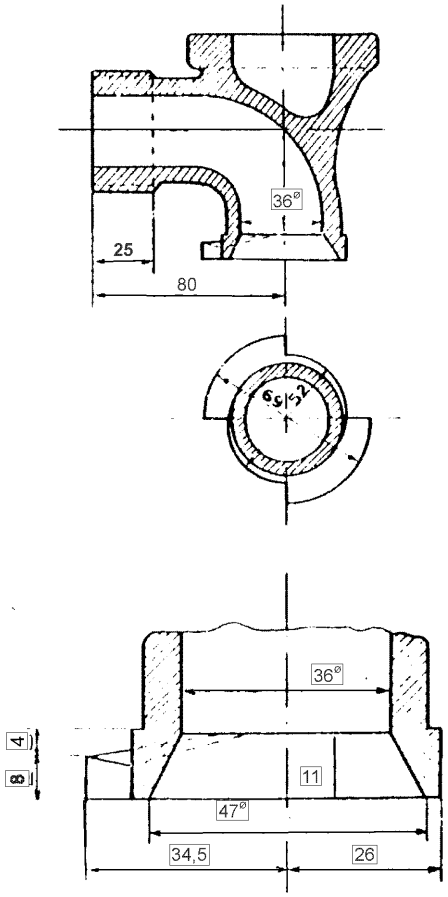
Material: Elastomer, faeces-resistant e.g. FPM (fluor rubber)

Figure 2

*ANNEX V*

**INLET CONNECTIONS FOR WATER TANKS**

Inlet connections for water tanks




□ = Obligatory

Figure 3

# COMMISSION DECISION

## of 30 May 2002

## concerning the technical specification for interoperability relating to the control-command and signalling 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) 1947)*

**(Text with EEA relevance)**

(2002/731/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 pursuant to 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 control-command and signalling subsystem in accordance with Article 6(1) of the Directive. This mandate was 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 and rolling stock 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 and rolling stock. 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 Commission Directive 2001/16/EC [2]. 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) Existing high-speed lines and rolling stock are already equipped with control-command and signalling systems that meet the essential requirements of Directive 96/48/EC. Such systems were developed and implemented according to national rules. In order to

[1] OJ L 235, 17.9.1996, p. 6.

[2] OJ L 110, 20.4.2001, p. 1.

allow the operation of interoperable services, it is necessary to develop interfaces between those existing systems and new TSI compatible equipment. Basic information concerning those existing systems is provided in Annex B to the attached TSI. 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 full implementation of the TSI attached, to lay down the conditions to be complied with in addition to the attached TSI. For these reasons it is necessary that each Member State informs the other Member States and the Commission, for each one of the systems mentioned in Annex B, of the 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 and a rolling stock register are published and updated each year. These registers will set out the main characteristics of the national infrastructure and rolling stock (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 registers.

(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 the technical stages to move from the present network conditions to a situation where the network is interoperable.

(15) The target system described in the attached TSI builds upon computer-based technology with a life expectancy significantly lower than current traditional railway signalling and telecommunication facilities. As such, they call for a proactive rather than reactive deployment strategy to avoid potential system obsolescence prior to system deployment reaching maturity levels. In addition, the adoption of a too fragmented deployment throughout the European rail network would give rise to major costs and operational overheads. The development of a coherent trans-European implementation plan for the target system would contribute to a harmonious development of the whole of the trans-European rail network in compliance with the EU strategy for the TEN-transport network. Such a plan should build upon the corresponding national

implementation plans and should provide an appropriate knowledge base for decision support by the different stakeholders, in particular, by the Commission in the allocation of financial support to railway projects. The Commission will coordinate the development of such a plan, in accordance with Article 155(2) of the Treaty establishing the European Community.

(16) 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 'control-command and signalling' 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 and rolling stock of the trans-European high-speed rail system as defined in Annex I to Directive 96/48/EC, taking into account Article 2 and Article 3 hereunder.

*Article 2*

1. With regard to the systems referred to in Annex B to 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*

Member States shall establish a national implementation plan of the attached TSI according with the criteria specified in its Chapter 7. They shall forward this implementation plan to the other Member States and the Commission not later than six months after notification of this Decision.

*Article 5*

Commission Decisions 1999/569/EC ([3]) and 2001/260/EC ([4]) have no further effect from the date of entry into force of the attached TSI.

*Article 6*

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

*Article 7*

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 216, 14.8.1999, p. 23.
([4]) OJ L 93, 3.4.2001, p. 53.

*ANNEX*

# TECHNICAL SPECIFICATION FOR INTEROPERABILITY RELATING TO THE CONTROL-COMMAND AND SIGNALLING SUBSYSTEM

## 1. INTRODUCTION

### 1.1. *TECHNICAL SCOPE*

This TSI concerns the control-command and signalling subsystem, which is one of the subsystems listed in Annex II(1) to Directive 96/48/EC. It is referred to in this document as 'control-command' or 'CC'.

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 control-command and signalling 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) of and with Annex I(1)(b) to 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) to 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. SUBSYSTEM DEFINITION AND SCOPE

### 2.1. *GENERAL*

*Definition: control-command subsystem*. The control-command subsystem is defined as that set of functions and their implementation which allow the safe and predictable movement of rail traffic in order to meet the desired operational activities.

*Scope:* The TSI control-command defines the essential requirements for those parts of the control-command subsystem that have relevance to interoperability, and therefore are subject to EC declaration of verification.

The features of the control-command subsystem that are related to the interoperability of the trans-European high-speed rail system are determined by:

(1) the Functions that are essential for the safe control of the railway traffic, and that are essential for operations, including those required under degraded conditions;

(2) Interfaces,

(3) the level of Performance required to meet the essential requirements.

The requirements on the necessary functions, interfaces and performance are introduced in the characterisation of control-command, which is described in section 4 where the supporting standards are referenced.

### 2.2. *OVERVIEW*

The interoperability of the trans-European high-speed rail network depends in part on the ability of the on-board control-command equipment to work with the various trackside equipment installed upon it [1].

#### 2.2.1. INTEROPERABILITY

Technical interoperability ensures that the trains are able to run safely on the interoperable lines, receiving the necessary control-command data from the trackside. Technical interoperability is obtained by providing the trains with the correct functions, interfaces and performance for the infrastructure over which the service is to pass. Technical interoperability is the prerequisite for operational interoperability, in which the driving is based on consistent information displayed in the cabs and is in accordance with signalling principles defined for the high-speed network that are independent of the technology used.

#### 2.2.2. CLASSES OF CONTROL-COMMAND INTERFACES BETWEEN TRACK AND TRAIN

Interoperability of the control-command functions is to be founded upon the development of unified specifications of the interfaces which provide for interoperability. In the meantime, the specification of the interfaces presently used for interoperable services (termed class B) are subject to the requirements of this TSI. Each class B specification shall be managed as follows. Member States have the responsibility to ensure that during their life the class B systems are managed in the interests of interoperability, in particular any changes to these specifications are to be managed such that interoperability is not prejudiced.

Two classes of control-command interfaces between track and train are defined:

class A: the unified control-command interfaces — these interfaces are defined in Chapter 4. Annex A includes the specifications that define the interoperability requirements of the class A control-command interfaces,

[1] Assembly: because of the mobility of the on-board part, the control-command subsystem is divided in two parts: on-board assembly and trackside assembly (see Figure 1 in Annex D).

class B: control-command interfaces and applications existing before entry into force of Directive 96/48/EC limited to those described in Annex B. These can be implemented as STMs ([2]).

In order to achieve interoperability, the trains' on-board control-command assembly will consist of:

— the class A radio and data communication interfaces to the infrastructure, in case of operation with class A Infrastructure,

— the class B radio and data communication interfaces to the infrastructure, in case of operation with class B infrastructure.

Section 7 describes the requirements for the transition phase from the class B interfaces to the class A interfaces for radio and for signalling purposes.

2.2.3. LEVELS OF APPLICATION

Control-command interfaces provide for the means of data transmission to, and sometimes from, the trains. The class A specifications called up by this TSI provide options from which a project may choose the means of transmission that meet its requirements. By convention, three levels of application are defined:

level 1: the data transmission requirement is met by intermittent (Eurobalise) and in some cases semi continuous (Euroloop or radio infill) transmission along the track. The detection of trains is achieved by track-based equipment, usually track circuits or axle counters. Information is communicated to the driver from either the line side, or cab-signalling,

level 2: the data transmission requirement is met by radio (GSM-R) transmission along the track. For some functions, the radio transmission requires complementing by intermittent (Eurobalise) transmission. The detection of trains is achieved by track-based equipment, usually track circuits or axle counters. Information is communicated to the driver by cab-signalling,

level 3: the data transmission requirement is met by radio (GSM-R) transmission along the track. For some functions, the radio transmission requires complementing by intermittent (Eurobalise) transmission. The detection of trains is achieved by train-based equipment reporting to the command-control data-processing system. Information is communicated to the driver by cab-signalling.

The requirements of this TSI apply to all levels of application. The implementation issue is addressed in Chapter 7. A train equipped with class A interfaces for a given level of application shall be able to operate with that level of application and any lower one.

2.2.4. NETWORK BORDERS

The localised interfaces between the trackside control-command systems of neighbouring railways shall provide for the passage without restrictions of trains operating the high-speed services between the networks.

## 3. THE ESSENTIAL REQUIREMENTS OF THE CONTROL-COMMAND SUBSYSTEM

3.1. *GENERAL*

Article 4(1) of Interoperability Directive 96/48/EC, requires that the trans-European high-speed rail system, subsystems and their interoperability constituents meet the essential requirements set out in general terms in Annex III to the Directive. The essential requirements are:

— safety,

— reliability and availability,

— health,

([2]) STM: the specific transmission module (STM) allows class A on-board equipment to operate on lines fitted with class B signalling by using the class B data.

— environmental protection,

— technical compatibility.

The Directive allows that the essential requirements may be generally applicable to the whole trans-European high-speed rail system or be specific to each subsystem and its interoperability constituents.

3.2. *SPECIFIC ASPECTS FOR THE CONTROL-COMMAND SUBSYSTEM*

The essential requirements are taken in turn, below. The requirements apply to all control-command systems employing class A interfaces. The class B interfaces have specific features.

3.2.1. SAFETY

Every project to which this specification is applicable shall put into effect the measures necessary to demonstrate that the level of risk of an incident occurring that is within the scope of the control-command systems is not higher than the objective required for the service. For this purpose, Annex A, index 1, shall be used.

For class A equipment, the global safety objective for the subsystem is apportioned between the on-board and trackside assemblies. For the safety-related part of one on-board assembly as well as for one trackside assembly, the safety requirement for ETCS level 2 is: tolerable hazard rate of $10^{-9}$/hour (for random failures) corresponding to safety integrity level 4 (preliminary value to be confirmed and to be extended for other ETCS levels). The detailed requirements are specified in Annex A, index 2a.

For class B equipment used for high speed operation, it is the responsibility of the Member State to guarantee that appropriate safe speed enforcement is performed by the class B system, and to state the speed limit.

3.2.2. RELIABILITY AND AVAILABILITY

(a) For class A interfaces, the global reliability and availability objectives for the subsystem are apportioned between the on-board and trackside assemblies. The requirements are specified in Annex A, index 2b.

(b) The quality of the maintenance organisation for all systems comprising the control-command subsystem shall ensure that the level of risk is controlled regarding constituent age and wear. The quality of the maintenance shall ensure that safety is not prejudiced because of these activities. Annex A, index 2c shall be applied.

3.2.3. HEALTH

Precautions shall be taken to ensure that the materials used in and the design of control-command systems do not constitute a health hazard to persons having access to them.

This TSI does not introduce any additional requirement to the ones already requested by applicable European regulations.

3.2.4. ENVIRONMENTAL PROTECTION

3.2.4.1. The control-command systems, if subjected to excessive heat or fire, shall not exceed limits for the emission of fumes or gases which are harmful to the environment.

3.2.4.2. The control-command systems shall not contain substances which may during their normal use abnormally contaminate the environment.

3.2.4.3. The control-command systems shall be subject to the European legislation in force controlling the limits to the emission of and the susceptibility to electromagnetic interference along the boundaries of railway property.

This TSI does not introduce any additional requirement to the ones already required by applicable European regulations.

3.2.5. TECHNICAL COMPATIBILITY

Technical compatibility includes the functions, interfaces and performances required to achieve interoperability. In order to fulfil this essential requirement and achieve interoperability, the requirements of section 4 of this TSI must be met in full.

The requirements of technical compatibility are therefore presented in two categories:

— the first category sets out the general engineering requirements for interoperability, that is environmental conditions, internal electromagnetic compatibility (EMC) within the railway boundaries, and installation. These compatibility requirements are defined in this section;

— the second category describes what the control-command subsystem has to do in order that interoperability is achieved. This category forms the major part of this interoperability specification.

3.2.5.1. ***Engineering compatibility***

3.2.5.1.1. **Physical environmental conditions**

(a) Systems complying with the class A interface requirements shall be capable of operating under the climatic and physical conditions which exist along the relevant part of the trans-European high-speed network (e.g. defined according to climatic zones). For this purpose Annex A, index 3, shall be used.

(b) The systems complying with the class B interface requirements shall conform at least to the physical environmental specifications applying to the corresponding class B system, in order to be capable of operating under the climatic and physical conditions which exist along the high-speed lines concerned.

3.2.5.1.2. **Electromagnetic compatibility**

The electromagnetic compatibility requirements (which include train detection requirements) are:

(a) internal control-command compatibility

On-board and trackside control-command assemblies shall not interfere with each other.

Class A and class B systems shall not interfere with each other.

(b) Compatibility between the control-command subsystem and other TSI subsystems.

Class A control-command equipment shall not interfere with other TSI subsystems, nor be interfered with by other TSI subsystems.

Neither the train operators nor the infrastructure controllers may install new systems which are not compatible with class A control-command equipment emissions and susceptibility.

(c) Compatibility between the railway and systems external to the trans-European high-speed network

This TSI does not introduce any requirements additional to those specified by applicable European regulations.

The following standards shall be applied:

— Annex A, index 4a (emission and susceptibility limits of control-command electronic equipment),

— Annex A, index 4b (immunity characteristics of train detection systems),

— Annex A, indices 12a and 12b (emission and susceptibility limits of balise and loop interfaces),

— Annex A, index 12c (emission and susceptibility limits of train radio interfaces).

3.2.5.2. ***Control-command compatibility***

Section 4, supported by Annexes A and B, defines the requirements for the interoperability of the control-command subsystem for each class of interface, class A and class B.

## 4. CHARACTERISATION OF THE SUBSYSTEM

The trans-European high-speed rail system, to which Directive 96/48/EC applies and of which the control-command subsystem is a part, is an integrated system which requires the functions, interfaces and performance (all of which are basic parameters) to be verified, in particular so as to ensure that the system is interoperable and that the essential requirements are met. Annex A lists the mandatory European specifications for the class A functions, interfaces and performance; Annex B lists the characteristics of the class B systems and the responsible Member States. The control-command characterisation is presented in the following order:

— functions

— interfaces internal to control-command

— interfaces to other TSIs

— performance.

The STMs, which enable the class A system to operate over class B infrastructure, are subject to the class B system requirements. The implementation of the class A functions and interfaces and the transition to it from the class B systems are subject to the requirements of section 7.

The TSI control-command describes the ERTMS characteristics, in accordance with the Directive 96/48/EC.

The basic parameters of the class B equipment are the subject of Annex B.

4.1. *BASIC PARAMETERS OF THE SUBSYSTEM — CLASS A EQUIPMENT*

4.1.1. BASIC PARAMETERS OF THE SUBSYSTEM: INTERNAL FUNCTIONS

This section specifies the functions of control-command class A equipment that are essential to interoperability. The ETCS functions required for interoperability are:

— the cab-signalling function,

— the automatic train protection function, comprising:

  — selecting the speed supervision mode,

  — defining and providing the intervention function,

  — setting the train characteristics,

— proving train integrity ([3]) (note: rolling stock TSI is also concerned),

— equipment health monitoring and failure mode support, comprising:

  — initialising the subsystem,

  — testing the subsystem in service,

  — testing the subsystem in depot,

  — providing failure mode support,

([3]) Train integrity: the status of the completeness of the train according to operational rules.

— exchanging data between the trackside assembly and the on-board assembly,

— managing the STMs,

— support to cab-signalling and automatic train protection, comprising:

  — supporting driving,

  — providing odometry,

  — recording data,

  — the vigilance function.

To achieve interoperability it is not necessary to standardise all the functions within the whole control-command and signalling subsystem. The principle followed is the definition of:

— trackside standard functions, able to read data from national interlocking and signalling systems and to translate such data into standard messages for the trains,

— standard interfaces for track-to-train and train-to-track communication,

— on-board standard functions, ensuring that every train will react to data received from trackside in a predictable way.

Only the above mentioned functionality is considered in this chapter.

The GSM-R functions required for interoperability are the voice and data communication between trackside and on-board.

— In Annex A, index 0a, the ETCS functional requirement specifications are indicated.

— In Annex A, index 0b, the GSM-R functional requirement specifications are indicated.

The control-command functions are classified in three categories:

M: standard functions whose implementation is mandatory. For example: the ETCS end-of-movement authority,

O: functions for which the implementation is optional, but if implemented a standard specification applies. For example: GSM-R fax transmission,

N: functions of the national part of control-command. For example: interlocking functions.

The classification of the functions is indicated within the text of the ETCS FRS and the GSM-R FRS.

ETCS functions shall be implemented in accordance with the technical specifications indicated in Annex A, indices 5, 6, 7, 8, 9, and their performance shall conform to indices 2 and 18.

The vigilance function shall be implemented on-board in accordance with Annex A, index 10. Implementation may be:

— outside the ERTMS/ETCS, with an optional interface to the ERTMS/ETCS equipment on-board, or

— inside the ERTMS/ETCS on-board equipment.

The infill data transmission function in ETCS level 1 applications is only mandatory on-board under the conditions defined in section 7.

GSM-R radio functions shall be implemented in accordance with the technical specifications indicated in Annex A, index 11.

4.1.2. BASIC PARAMETERS OF THE SUBSYSTEM: INTERNAL INTERFACE

Definition: internal interfaces are defined as those matters which concern two control-command interoperability constituents or assemblies, and describe the functional, electrical and/or mechanical conditions applying to the links between them. The voice and data transmission between the train and the trackside are part of the internal interfaces.

This section specifies the functions of control-command class A internal interfaces which are essential for interoperability.

4.1.2.1. ***Interface between on-board and trackside assembly***

(a) Radio communications with the train

Class A radio communication interfaces shall operate in the GSM-R bands, including the public bands and those frequency bands that are exclusively allocated for use by the railways. Annex A, index 12, shall apply to radio communications.

There shall be formalised procedures created which conform to the needs of a multilingual environment.

(b) Balise and loop communications with the train

Class A balise and loop communication interfaces shall comply with Annex A, index 12.

4.1.2.2. ***Interfaces between on-board interoperability constituents essential to interoperability***

The data communications characteristics of each interface shall be such as to enable the requirements of the functions and failure modes to be met.

(a) The interface between the class A radio and the cab-signalling/automatic train protection functions. These requirements are specified in Annex A, index 13a.

(b) Access to data recorded on-board for regulatory purposes. Each Member State shall have access to the recorded data that meets obligatory data-recording requirements for official and investigative purposes. This interface and the data formats are specified in Annex A, index 13b.

(c) Odometry: the interface between the odometry function and ETCS on-board functions shall meet the requirements of Annex A, index 13c.

(d) The STM interface: the interface between the class A functions and the STMs of Annex B is defined in Annex A, index 6.

4.1.2.3. ***Interfaces between trackside interoperability constituents essential to interoperability***

(a) Between the class A radio system and the ERTMS/ETCS: these requirements are specified in Annex A, index 14a.

(b) Between Eurobalise and the LEU: these requirements are specified in Annex A, index 14b.

(c) Between Euroloop and the LEU: these requirements are specified in Annex A, index 14c.

(d) Between the ERTMS/ETCS centres of neighbouring infrastructure controllers: these requirements are specified in Annex A, index 14d.

4.1.2.4. ***Key management***

Safety related data transmitted via radio are protected by mechanisms that need cryptographic keys. The infrastructure manager shall provide a management system that controls and manages the keys. A key management interface is required:

— between the key management systems of different infrastructure managers,

— between the key management system and the on-board and track-side ETCS.

The security of key management affects the safety of the control-command subsystem. Therefore a security policy is required for the key management system.

The requirements are specified in Annex A, index 15.

4.1.3. INTERFACES TO OTHER CC EQUIPMENT

The control-command track-side functions addressed by this TSI shall be able to read information from interlocking and other signalling systems and, depending upon the functions implemented, to transmit information to them.

Standardisation of this interface is not necessary to achieve interoperability, therefore this interface is not defined in European specifications.

4.2. *INTERFACES OF THE SUBSYSTEM TO OTHER SUBSYSTEMS*

Definition: external interfaces are defined as those matters that concern two TSI subsystems.

4.2.1. THE EXTERNAL CLASS A INTERFACES REQUIRED FOR INTEROPERABILITY

This section specifies the external interfaces of the control-command subsystem, as defined in this TSI, to the other TSI subsystems that are essential to interoperability. For the energy TSI, there are indirect requirements via the rolling stock TSI concerning in particular EMC. The external interfaces are:

the operations interfaces, comprised of:

A. functional and procedural requirements, ergonomics, and understanding of the MMI;

B. functional requirements of data-recording;

C. role of radio, and understanding;

the rolling stock interfaces, comprised of:

A. the guaranteed train braking performance and characteristics;

B. compatibility between track-based systems and the rolling stock (ETCS Level 1 and 2);

C. vehicle geometry and movement; the relationship of the antennae to the structure and kinematic gauges and track-geometry, including vehicle behaviour;

D. installation matters:

— the physical environment,

— electromagnetic compatibility (EMC) with the on-board electrical environment;

E. train data interfaces:

— brakes,

— train integrity,

— train length;

F. Electromagnetic compatibility between rolling stock and infrastructure systems;

the infrastructure interfaces, comprised of:

installation requirements.

The relevant standards are referenced, and these are listed in Annex A. The following explanations cover the major issues.

4.2.1.1. ***The operation interfaces***

The European high-speed network will be subject to unified operational requirements. These concern principally the trains. For the purposes of interoperability, the class A control-command interfaces shall provide the operators with the technical capability for:

A. compatibility with the operational requirements.

A unified set of cab-equipment associated with the class A interfaces. This will include the facility to enter the train characteristics as required by the automatic train protection logic.

The requirements for driving ergonomics.

Aid to limit misunderstanding due to differences in language (use of icons, formalised procedures);

B. the use of data-recording;

C. the use of radio for voice communication for operational purposes.

4.2.1.2. ***Rolling stock interfaces***

A. The train braking performance:

(i) the rolling stock TSI defines the braking performance of interoperable trains;

(ii) the class A control-command system shall provide the adaptability necessary to the real braking performance of the rolling stock;

(iii) upon a call for the emergency brake, the rolling stock subsystem shall prevent traction being applied. This requirement is promulgated in the rolling stock TSI.

B. Compatibility with track-based train detection:

(i) the rolling stock shall have the characteristics necessary for the operation of train detection systems. Annex A, index 16 shall be used;

(ii) rail-mounted train detection systems shall have the characteristics necessary to be activated by rolling stock which conforms to the rolling stock TSI.

C. Vehicle geometry and movement:

(i) the on-board antennae shall be positioned such that the vehicle kinematic gauge is respected as defined by the rolling stock TSI;

(ii) the position of the antennae on the rolling stock shall be such that reliable data communication is assured at the extremes of the track geometry capable of being traversed by the rolling stock. The movement and behaviour of the rolling stock shall be taken into account.

D. Installation matters:

(i) environmental conditions. the resistance to the on-board physical environment is defined in Annex A, index 3;

(ii) electromagnetic compatibility with the on-board electrical environment. To ensure that the on-board equipment for the control-command systems may be universally used for new rolling stock accepted for operation upon the trans-European high-speed network, there shall be applied to the electrical environment of the rolling stock and the susceptibility of the interoperable control-command system to electrical interference a common specification of electromagnetic compatibility as defined in Annex A, index 4a. Integration tests will be required;

(iii) isolation of ETCS on-board equipment.

E. Data interfaces:

the following sets of data interfaces with the train are required by class A equipment:

— brakes,

— train integrity (ETCS level 3),

— train length.

These interfaces shall be adaptable for rolling stock operating in multiple units.

The interface requirements between the radio communications and the rolling stock subsystem are specified in Annex A, index 11. The other interface requirements between the control-command functions and the rolling stock subsystem are specified in Annex A, index 17.

F. Electromagnetic compatibility between rolling stock and control-command trackside equipment: to ensure that new rolling stock accepted for use on all or part of the trans-European high-speed network will be compatible with the associated control-command infrastructure, there shall be a common specification describing the limits to conducted and induced traction current as well as electromagnetic field characteristics to be permitted; refer to Annex A, index 4b.

4.2.1.3. ***Infrastructure interfaces***

The infrastructure installation shall ensure that:

(a) the train detection system respects the requirements quoted in 4.2.1.2(B), above;

(b) the position of the antennae of the trackside subsystems is such that reliable data communication is assured at the extremes of the track geometry capable of being traversed by the rolling stock. The movement and behaviour of the rolling tock shall be taken into account. By definition, the communication antennae at the trackside shall not infringe the network's structure gauge. The respect of the structure gauge requirement of the European high-speed network is a matter for the infrastructure manager.

4.2.2. THE EXTERNAL CLASS B INTERFACES REQUIRED FOR INTEROPERABILITY

Only the following class A requirements shall apply to external class B interfaces:

— vehicle geometry and movement (see 4.2.1.2(C)),

— EMC (see section 7).

All other requirements are to be found by reference to Annex B.

4.3. *SPECIFIED PERFORMANCE FOR INTEROPERABILITY*

Class A systems have to fulfil technical performance requirements in accordance with Annex A, index 18.

Class B systems on interoperable trains have to offer all their available parameters and ranges of parameter values for optimal train running; in particular speed and braking performance of trains must be made usable by control-command braking parameters as far as economically reasonable.

4.4. *SPECIAL CASES: APPLICATION MODALITIES*

This subject is addressed in Chapter 7.

## 5. INTEROPERABILITY CONSTITUENTS

Section 5 describes the interoperability constituents adopted for the control-command subsystem.

5.1. *CONTROL-COMMAND INTEROPERABILITY CONSTITUENTS*

As described in section 2, the control-command subsystem is divided into two assemblies, trackside and on-board. An interoperability constituent can only belong to one of these assemblies.

The interoperability constituents in the control-command subsystem are listed in Tables 5.1 and 5.2:

— Table 5.1 lists the interoperability constituents of the control-command on-board assembly.

— Table 5.2 lists the interoperability constituents of the control-command trackside assembly.

Column 1 lists line number,

Column 2 is the name of the interoperability constituent,

Column 2a lists remarks, if any,

Column 3 lists the interfaces which are internal to the control-command TSI subsystem; an asterisk in this column indicates that a supporting European standard is not yet available,

Column 4 lists the interfaces to other TSI subsystems (external control-command interfaces),

Column 5 lists the characteristics to be assessed by reference to Annex A, which lists the relevant European specifications including test requirements,

Column 6 lists the modules (see Annex E) to be applied for assessment.

For each interoperability constituent the reference to European specifications to be applied is given in Annex A.

These interoperability constituents are specific to railway applications.

5.2. *GROUPING OF INTEROPERABILITY CONSTITUENTS*

The control-command interoperability constituents defined in Tables 5.1 and 5.2 may be combined to form a larger unit. The group is then defined by the functions of the integrated interoperability constituents and the remaining inter-faces on the outside of the group. The groups are defined in Tables 5.1 and 5.2. Each group has to be supported by European specifications. A group so formed is then to be considered as an interoperability constituent.

The declaration of conformity for an interoperability constituent requires that each of its interfaces referred to in Table 5 is supported by one or more European specifications. The specifications concerned will be referenced by Annex A. As long as a European specification is not available to support an interface given in Table 5, this interoperability constituent cannot be supported by a declaration of conformity. Therefore the interoperability constituent concerned shall be integrated into a group of interoperability constituents for which a declaration of conformity is then possible.

*Table 5.1a*

**Basic interoperability constituents in the on-board control-command assembly**

| 1 | 2 | 2a | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|
| Group No | Inter-operability constituent (IC) | Remarks | Control-command interfaces | Interfacing TSI subsystems | Characteristics to be assessed by reference to Annex A | Module |
| 1 | ERTMS/ETCS on-board | (Part of the UNISIG grouping of on-board ICs) | (a) *Odometry<br>(b) External STM<br>(c) ERTMS/GSM-R on-board<br>(d) *Safety information recorder<br>(e) Euroloop (trackside)<br>(f) Eurobalise (trackside) | Rolling stock (see section 4.2 TSI control-command) | 0a, 1, 2, 3, 4a, 5, 6, 7, 9, 10, 12a, 12b, 13, 17, 18 | H2 or B with D or B with F |
| 2 | Safety platform ([1]) on-board | (Part of the UNISIG grouping of on-board ICs) | Not applicable | Not applicable | 1, 2a, 2b | H2 or B with D or B with F |
| 3 | Safety information recorder | (Part of the UNISIG grouping of on-board ICs) | (a) *ERTMS/ETCS on-board<br>(b) *ERTMS/GSM-R on-board<br>(c) Safety information downloading tool (not being a control-command IC). | Operational issue: recording of safety information | 0, 1, 2, 3, 4a, 9, 13b | H2 or B with D or B with F |
| 4 | Odometry | (Part of the UNISIG grouping of on-board ICs) | *ERTMS/ETCS on-board | Rolling stock (see section 4.2 TSI control-command) | 0a, 1, 2, 3, 4a, 8, 13c, 17, 18 | H2 or B with D or B with F |

| 1 | 2 | 2a | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|
| Group No | Inter-operability constituent (IC) | Remarks | Control-command interfaces | Interfacing TSI subsystems | Characteristics to be assessed by reference to Annex A | Module |
| 5 | External STM | Interfaces only | ERTMS/ETCS on-board | Rolling stock (see section 4.2 TSI control-command) | 0a, 1, 2, 3, 4a, 6 | H2 or B with D or B with F |
| 6 | ERTMS/GSM-R on-board | Including radio MMI | (a) ERTMS/ETCS on-board<br>(b) ERTMS/GSM-R track-side<br>(c) *Safety information recorder | Rolling stock (see section 4.2 TSI control-command)<br>and operational issues:<br>— radio operational requirements,<br>— drivers cab ergonomics,<br>— operational rules,<br>— operational language,<br>— recording of safety information. | 0b, 2, 3, 4a, 11, 12c, 13a, 17 | H2 or B with D or B with F |

([1]) Definition of safety platform: a building block (generic product, independent of the application) made of hardware and base software (firmware and/or operating system and/or support tools), which can be used for building more complex systems (generic applications, i.e. classes of applications). Its safety acceptance and approval shall be carried out on the basis of a 'generic product' (i.e. independent of the application) safety case, as specified by standard ENV 50129.

An asterisk (*) indicates that initially a European standard for the interface will not be available.

Module H2 can be applied only when a sufficient degree of confidence in the ERTMS technologies exists through return of experience from commercial installations.

*Table 5.1b*

**Groups of interoperability constituents in the on-board CC assembly**

This table is an example to show the structure. Other groups may be proposed.

| 1 | 2 | 2a | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|
| Group number | Basic inter-operability constituents (Basic ICs) | Remarks | CC interfaces | Interfacing TSI subsystems | Characteristics to be assessed by reference to Annex A | Module |
| 1 | (a) Safety platform on-board<br>(b) ERTMS/ETCS on-board<br>(c) Safety information recorder<br>(d) Odometry | (UNISIG grouping of on-board ICs) | (a) External STM<br>(b) ERTMS/GSM-R on-board<br>(c) Euroloop (trackside)<br>(d) Eurobalise (trackside)<br>(e) Safety information downloading tool | Rolling stock (see section 4.2 TSI control-command)<br>and operational issues:<br>— radio operational requirements,<br>— driver's cab ergonomics,<br>— operational rules,<br>— operational language,<br>— recording of safety information. | 0a, 1, 2, 3, 4a, 5, 6, 7, 8, 9, 10, 12a, 12b, 13, 17, 18 | H2 or B with D or B with F |

Module H2 can be applied only when a sufficient degree of confidence in the ERTMS technologies exists through return of experience from commercial installations.

*Table 5.2a*

**Basic interoperability constituents in the trackside CC assembly**

| 1 | 2 | 2a | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|
| Number | Inter-operability constituent (IC) | Remarks | CC interfaces | Interfacing TSI subsystems | Characteristics to be assessed by reference to Annex A | Module |
| 1 | ERTMS/ETCS trackside | (RBC) | (a) ERTMS/ETCS trackside (neighbour RBC)<br>(b) ERTMS/GSM-R trackside | | 0a, 1, 2, 3, 4a, 5, 14a, 14d, 18 | H2 or B with D or B with F |
| 2 | Eurobalise | | (a) ERTMS/ETCS on-board<br>(b) LEU (Eurobalise) | Infrastructure | 0a, 1, 2, 3, 4a, 12a, 14b | H2 or B with D or B with F |
| 3 | Euroloop | (Part of the UNISIG grouping of trackside ICs) | (a) ERTMS/ETCS on-board<br>(b) *LEU (Euroloop) | Infrastructure | 0a, 1, 2, 3, 4a, 12b, 14c | H2 or B with D or B with F |
| 4 | LEU (Eurobalise) | Interface C and coding strategy only | Eurobalise (trackside) | | 0a, 1, 2, 3, 4a, 12a, 14b | H2 or B with D or B with F |
| 5 | LEU (Euroloop) | 'Interface C' and coding strategy only (Part of the UNISIG grouping of trackside ICs) | *Euroloop (trackside) | | 0a, 1, 2, 3, 4a, 12b, 14c | H2 or B with D or B with F |
| 6 | Safety platform trackside | | Not applicable | Not applicable | 1, 2a, 2b | H2 or B with D or B with F |

An asterisk (*) indicates that initially a European standard for the interface will not be available.

Module H2 can be applied only when a sufficient degree of confidence in the ERTMS technologies exists through return of experience from commercial installations.

*Table 5.2b*

**Groups of interoperability constituents in the trackside CC assembly**

This table is an example to show the structure. Other groups may be proposed.

| 1 | 2 | 2a | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|
| Group number | Basic interoperability constituents (basic ICs) | Remarks | CC interfaces | Interfacing TSI subsystems | Characteristics to be assessed by reference to Annex A | Module |
| 1 | (a) Safety platform trackside<br>(b) Eurobalise<br>(c) LEU (Eurobalise) | | ERTMS/ETCS on-board | Infrastructure | 0a, 1, 2, 3, 4a, 12a | H2 or B with D or B with F |
| 2 | (a) Safety platform trackside<br>(b) Euroloop<br>(c) LEU (Euroloop) | | ERTMS/ETCS on-board | Infrastructure | 0a, 1, 2, 3, 4a, 12b | H2 or B with D or B with F |

Module H2 can be applied only when a sufficient degree of confidence in the ERTMS technologies exists through return of experience from commercial installations.

## 6. ASSESSMENT OF CONFORMITY AND/OR SUITABILITY FOR USE AND EC DECLARATION OF VERIFICATION

6.1. *INTEROPERABILITY CONSTITUENTS*

6.1.1. CONFORMITY AND SUITABILITY FOR USE ASSESSMENT PROCEDURES (MODULES)

This section deals with the EC declaration of conformity for the control-command interoperability constituents.

An EC declaration of suitability for use is not required for interoperability constituents of the control-command subsystem.

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

The specifications for the performance, interfaces and functions required of each class A interoperability constituent are obtained by reference to Annex A. Tables 5.1a, 5.1b, 5.2a and 5.2b indicate for each interoperability constituent the indices of Annex A to be applied. The tests and test tool requirements which are mandatory to assess the conformity of the performance, interfaces and functions of each interoperability constituent are also obtained from these tables. Those European specifications to be applied to the defined interoperability constituents are identified in point 5.1.

The conformity assessment shall include safety, e.g. the demonstration that the application software is implemented in a safety platform that has a prior declaration of conformity in a way that achieves safety acceptance according to the Annex A, index 1. This shall also include the demonstration that other software modules possibly installed in the same platform do not interfere with ERTMS/ETCS application.

If interoperability constituents are combined into a group, the conformity assessment shall cover the remaining interfaces and the functions of the integrated interoperability constituents as identified in point 5.2.

The independent assessment in the safety acceptance and approval process as described in Annex A, index 1 may be accepted by the notified body, without it being repeated.

6.1.1.1. ***The specific transmission module (STM)***

The STM has to meet national requirements, and its approval is a responsibility of the Member State as stated in Annex B.

The verification of the STM interface to the ERTMS/ETCS on-board and certain associated external interfaces to the rolling stock TSI subsystem, as indicated in Table 5.1 require a conformity assessment carried out by a notified body. The notified body shall verify that the Member State has approved the national part of the STM.

6.1.1.2. ***EC declaration of conformity***

For each interoperability constituent or group of interoperability constituents, the content of the declaration must conform to Annex IV to Directive 96/48/EC.

An interoperability constituent is the smallest item for which a declaration of conformity may be obtained.

6.1.2. APPLICATION OF MODULES

6.1.2.1. ***Assessment of conformity***

For the assessment procedure of interoperability constituents of the control-command subsystem the manufacturer or his authorised representative established within the Community may choose the modules according to the indications in Tables 5.1a, 5.1b, 5.2a and 5.2b.

6.1.2.2. ***Definition of assessment procedures***

The assessment procedures are defined in Annex E to this TSI.

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

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

6.2. *CONTROL-COMMAND SUBSYSTEM*

This section deals with EC declaration of verification of the control-command subsystem. As stated in dection 2 the application of the control-command subsystem is treated as two assemblies:

— the on-board assembly,

— the trackside assembly.

For each assembly a declaration of verification is needed. The scope of the EC declaration of verification, according to Directive 96/48/EC, includes the verification of the integration of the interoperability constituents that are part of the relevant subsystem. Tables 6.1 and 6.2 define the characteristics to be verified, and reference European specifications to be applied.

The line specific implementation of the trackside assembly is defined in the register of infrastructure in accordance with Annex C.

The train specific implementation for the on-board assembly is defined in the register of rolling stock in accordance with Annex C.

The declaration of verification of trackside assembly and on-board assembly shall contain the information upon which the content of the register of infrastructure/register of rolling stock is based. The registers shall be verified and issued under the responsibility of the Member State which authorises the placing into service of the assembly. Verification of the register of infrastructure and register of rolling stock means that these are consistent with the formats given in Annex C and reflect the effective configuration of the assembly.

The following requirements apply to both the on-board assembly and the trackside assembly. Each assembly shall satisfy:

— the EC verification requirements of Directive 96/48/EC (Annex VI),

— the requirements on the EC declaration of verification of Directive 96/48/EC (Annex V).

The EC declaration of verification is the task of the awarding entity (this could be e.g. the infrastructure manager or the train operator).

The declaration of verification of on-board and trackside assemblies, together with the certificates of conformity, is sufficient to ensure that an on-board assembly will operate with a trackside assembly equipped with corresponding functions as defined in the register of rolling stock and in the register of infrastructure without an additional subsystem declaration of verification.

The references to the integration procedures and the test requirements of the on-board and trackside assemblies are specified in Annex A, indices 32 and 33.

*Trackside assembly functional integration verification:*

European specifications must be complemented by national specifications covering:

— the description of the line, characteristics such as gradients, distances, positions of route elements and balises/loops, locations to be protected,

— the signalling data and rules required to be handled by the ERTMS system.

A notified body is required for that part of the control-command trackside assembly for which European specifications are established.

The awarding entity may have the national elements of the trackside assembly assessed by an independent body to ensure that the application of national specifications fulfils the essential requirements.

The awarding entity may chose to use a notified body for this purpose.

The awarding entity shall present to the Member State evidence of the correct integration of the part described by the European specifications within control-command and signalling.

*Assessment procedures (modules)*

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

Assessment procedures for the EC verification of the trackside and on-board assemblies of the control-command subsystem, list of specifications and descriptions of the testing procedures are indicated in Tables 6.1 and 6.2 of this TSI.

As far as specified in this TSI, the EC verification of the trackside and on-board assemblies of the control-command subsystem shall take account of 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 trackside and on-board assemblies of the control-command subsystem in accordance with Article 18(1) of and Annex V to Directive 96/48/EC.

The independent assessment in the safety acceptance and approval process as described in Annex A, index 1, may be accepted by the notified body, without it being repeated.

6.2.1. APPLICATION OF MODULES

The adjudicating entity or its authorised representative established within the Community may choose for the verification procedure of the on-board assembly of the control-command subsystem either:

— the type-examination procedure (module SB) indicated in Annex E to this TSI for the design and development phase in combination with either the production quality assurance procedure (module SD) indicated in Annex E to this TSI for the production phase or the product verification procedure (module SF) indicated in Annex E to this TSI, or

— the full quality assurance with design examination procedure (module SH2 ([4])) indicated in Annex E to this TSI.

For the verification procedure of the trackside assembly of the control-command subsystem, the adjudicating entity or its authorised representative established within the Community may choose either:

— the unit verification procedure (module SG) indicated in Annex E to this TSI, or

— the type-examination procedure (module SB) indicated in Annex E to this TSI for the design and development phase in combination with either the production quality assurance procedure (module SD) indicated in Annex E to this TSI for the production phase or the product verification procedure (module SF) indicated in Annex E to this TSI, or

— the full quality assurance with design examination procedure (module SH2) indicated in Annex E to this TSI.

The module SH2 may be chosen only where all activities contributing to the subsystem project 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.

([4]) Module SH2 can be applied only when a sufficient degree of confidence in the ERTMS technologies exists through return of experience from commercial installations.

*Table 6.1*

**Control-command verification requirements for on-board assembly**

| 1 | 2 | 2a | 3 | 4 | 5 |
|---|---|---|---|---|---|
| Number | Description | Remarks | CC interfaces | Interfacing TSI subsystems | Characteristics to be assessed by reference to Annex A unless otherwise specified |
| 1 | Vigilance supervision | Internal as a function in on-board control-command or external in RS subsystem | If vigilance supervision is external, then optional interface to ERTMS/ETCS on-board may exist | Rolling stock (brakes) | 0, 1, 2, 3, 4a, 10 |
| 2 | Train integrity supervision | In the case, where the train is configured for level 3, the train integrity supervision function must be supported via detection equipment rolling stock-side | ERTMS/ETCS on-board | Rolling stock | 0, 1, 2, 3, 4a, 5, 17 |
| 3 | Train detection | Requirements on rolling stock, because of e.g. track circuits and axle counters | | Rolling stock (train detection characteristics) | 4b, 16 |
| 4 | Key management | Security policy for key management | (a) ERTMS/ETCS trackside<br>(b) ERTMS/ETCS on-board | | 15 |

| 1 | 2 | 2a | 3 | 4 | 5 |
|---|---|---|---|---|---|
| Number | Description | Remarks | CC interfaces | Interfacing TSI subsystems | Characteristics to be assessed by reference to Annex A unless otherwise specified |
| 5 | Design, integration and validation of the assembly | 1. Engineering rules<br>2. Functional integration test<br>Tests to confirm correct functional operation of inter-working of a new combination of interoperability constituents<br>Tests in the real configuration<br>The notified body shall verify that the integration test requirements (issued by the Member State) for Annex B systems have been met<br>The test includes the ability of the down-loading tool to read and display the safety data recorded<br>Includes absence of unsafe interaction between interoperability constituents (possibly due to national add-ons)<br>3. The notified body shall insure the completeness of the safety approval process including safety case | All those implemented | Rolling stock<br>All those implemented | 34<br>32<br>+<br>integration test requirements for a specific Annex B system must be available in public domain when that system is put on the market for integration into an on-board assembly.<br>1, 2 |

*Table 6.2*

**Control-command verification requirements for trackside assembly**

| 1 | 2 | 2a | 3 | 4 | 5 |
|---|---|---|---|---|---|
| Number | Description | Remarks | CC interfaces | Interfacing TSI subsystems | Characteristics to be assessed by reference to Annex A unless otherwise specified |
| 1 | ERTMS/GSM-R trackside | | (a) ERTMS/GSM-R on-board<br>(b) ERTMS/ETCS trackside | | 0, 12c, 14a, |
| 2 | Train detection, including interference requirements from conducted interference | Trackside requirements:<br>1. lines with unknown detection/interference characteristics cannot receive a derogation,<br>2. they must be upgraded before they can be declared interoperable,<br>3. a notified body shall verify that nominated trains meet the requirements of a derogation | | Rolling stock (train detection characteristics) | 4b, 16 |
| 3 | Key management | Security policy for key management | ERTMS/ETCS trackside<br>ERTMS/ETCS on-board | | 15 |

| 1 | 2 | 2a | 3 | 4 | 5 |
|---|---|---|---|---|---|
| Number | Description | Remarks | CC interfaces | Interfacing TSI subsystems | Characteristics to be assessed by reference to Annex A unless otherwise specified |
| 4 | Design, integration and validation of the assembly | 1. Engineering rules<br>2. Functional integration test<br>Tests to confirm correct functional operation of interworking of a new combination of interoperability constituents<br>Tests in the real configuration<br>The notified body shall verify that the integration test requirements (issued by the Member State) for Annex B systems have been met<br>Includes absence of unsafe interaction between interoperability constituents (possibly due to national add-ons)<br>3. The notified body shall insure the completeness of the safety approval process including safety case. | All those implemented | All those implemented | 34<br>33<br>1, 2 |

## 7. IMPLEMENTATION OF THE TSI CONTROL-COMMAND

7.1. *PRINCIPLES AND DEFINITIONS*

As specified in Article 1 of Directive 96/48/EC, the conditions to achieve the interoperability of the trans-European high-speed rail system concern projects for and the construction, upgrading and operation of the infrastructure and rolling stock which contribute to the functioning of the system to be put into service after the date of entry into force of the Directive.

Regarding infrastructures and rolling stock already in service when this TSI enters into force, the TSI shall be applied when works are planned; however, the degree of application of the TSI varies as a function of the entity of such works.

In the case of control-command, the criteria defined in the following sections shall be applied.

7.2. *SPECIFIC ISSUES OF IMPLEMENTATION OF THE TSI CONTROL-COMMAND*

7.2.1. INTRODUCTION

7.2.1.1. ***General migration criteria***

It is recognised that ERTMS cannot be installed on all existing high-speed routes instantly for reasons which include installation capability aspects and economic considerations.

In the transition period between the current (pre-unified) situation and the universal application of control-command class A interfaces ([5]), there will be a number of interoperability solutions in the framework of this TSI, for both the European high-speed infrastructure including connecting lines and the European high speed trains. The unified concept recognises this and provision is made for modules known as STMs (specific transmission modules) to be added to the unified ERTMS system to enable a train fitted with appropriate STMs to operate over existing pre-unified infrastructure; alternatively an infrastructure may be equipped with both class A and class B ([6]) systems.

7.2.1.2. ***Use of class B systems for interoperable trains***

In a migration phase from pre-unified national systems to the unified system, if only part of the fleet is equipped with an on-board system able to handle the unified system according to class A, it may be neces-sary to have both systems fully or partially installed on a stretch of line.

There is no functional link between the two on-board systems except to manage transitions during train operation (and as required to satisfy the needs of the STMs for class B systems when STMs are used).

From a purely functional point, a system may also be built combining components from the unified and a pre-unified system. An example is the combination of an ERTMS/ETCS system level 1 using Eurobalise as a spot-transmission means and an infill function not based on a unified solution, but on a national system. This solution requires a data link between the unified and the pre-unified system. Therefore, the solution is not in accordance with either class A or class B. It cannot be declared interoperable.

There is, however, the possibility to use the combination as a national enhancement of an interoperable line. This is only permitted if trains not equipped with the data link between both systems can operate either on the unified or on the pre-unified system without information from the other system. If this is not possible, the line cannot be declared interoperable for the control-command subsystem.

([5]) Class A: see section 2.
([6]) Class B: see section 2.

7.2.1.3. ***Compatibility with other trains***

An interoperable infrastructure may be used for the movement of trains not compliant with the requirements of this TSI, according to Article 5(4) of Directive 96/48/EC, provided this does not create prejudice to the fulfilment of essential requirements.

Such trains may use a class B signalling infrastructure, if existing. ERTMS/ETCS also offers the possibility of sending information for an on-board class B apparatus via class A track-to-train communication. If this solution is applied, in any case full ERTMS/ETCS functionality shall be installed trackside and the corresponding information shall be sent to the trains, to allow movement of interoperable trains. Trains equipped with on-board class B systems modified to receive information from class A track-to-train communication may not be declared interoperable.

7.2.1.4. ***Registers***

For every implementation of the control-command subsystem on a given line, Annex C gives the list of the requirements for the on-board, to be addressed in the registers of infrastructure (TEN HS), indicating if these requirements concern M ([7]) or O ([8]) functions. These registers of infrastructure (TEN HS) shall be made available so that the constraints on train configuration may be known.

7.2.1.5. ***Timing criteria***

ETCS and GSM-R are computer-based systems with a life expectancy significantly lower than current traditional railway signalling and telecommunication facilities. As such, they call for a proactive rather than reactive deployment strategy to avoid potential system obsolescence prior to system deployment reaching maturity levels.

Notwithstanding this fact, the adoption of a too-fragmented deployment throughout the European rail network, mainly along the trans-European rail corridors, would give rise to major cost and operational overheads resulting from the needs to ensure backward compatibility and interconnection with a diversity of legacy facilities. Moreover, synergies in terms of time, cost and risk reduction might be reached by the reconciliation of common elements of different national implementation strategies — namely through joint procurement initiatives, collaboration in system validation and certification activities.

This manifold background calls for the setting-up of a coherent trans-European implementation plan for ERTMS (ETCS and GSM-R) that should contribute to an harmonious development of the whole of the trans-European rail network in compliance with the EU strategy for the TEN-transport network. Such a plan should build upon the corresponding national implementation plans and should provide an appropriate knowledge base for decision support to the different stakeholders — in particular, to the Commission in the allocation of financial support to railway infrastructure projects.

The emergence of a coherent European plan will necessarily require that the specific national implementation plans are underpinned by the adoption of a set of common generic guiding implementation principles that should be adhered to during its elaboration by the relevant railway authorities. Based on the criteria and requirements expressed in the previous paragraphs and the strategic objectives stated above these principles shall foresee:

*Trackside installations*

The fitting of ETCS or, respectively, GSM-R in the case of:

— new installations of signalling or radio part of a CC assembly,

— an upgrade of the signalling or the radio part of a CC assembly already in service that changes the functions or the performance of the subsystem,

([7]) M functions: see section 4.
([8]) O functions: see section 4.

*On-board installations*

The fitting of ETCS (if necessary complemented by STMs) or GSM-R in rolling stock intended for use on a line including at least a section equipped with class A interfaces (even if superimposed to a class B system), in the case of:

— new installations of signalling or radio part of a CC assembly,

— an upgrade of the signalling or the radio part of a CC assembly already in service that changes the functions or the performance of the subsystem,

*Legacy systems:*

The assurance that class B interfaces and functions are to remain as specified and that the Member State concerned shall provide the information required for their application, in particular, the information relevant to their approval.

Any non-adherence to these general principles in the elaboration of a national implementation plan should be justified by the Member State concerned on the basis of a file setting out the principles it wishes not to apply and the technical, administrative or economic reasons which justify the non-adherence.

Once a trans-European implementation plan is completed, all activities related to installation of control-command subsystems have to be justified by the contracting entities against this implementation plan in addition to all other applicable legislative requirements that are in force. Any proposed non-adherence by a contracting entity should be justified in the dossier submitted to the Member State in accordance with Article 3 of this TSI Decision.

Necessarily, the ERTMS implementation plan will be an evolving document that will have to be updated in order to reflect the real evolution of the deployment throughout the European rail network.

7.2.1.6. ***Competition criteria***

Any action to allow the movement of interoperable trains on other infrastructures or the movement of non-interoperable trains on interoperable infrastructures shall ensure that free competition between suppliers is not prejudiced. Specially, knowledge about relevant interfaces between already installed equipment and new equipment to be purchased shall be put at the disposal of all the interested suppliers.

7.2.2. IMPLEMENTATION: INFRASTRUCTURE (STATIONARY EQUIPMENT)

The following requirements apply to the three categories of line defined in Article 5c of the Directive:

— lines specially built for high speed,

— lines specially upgraded for high speed,

— lines specially upgraded for high speed which have special features as a result of topographical, relief or town-planning constraints.

The following cases in points 7.2.2.1, 7.2.2.2 and 7.2.2.3 (according to Article 1 of the Directive) apply to the abovementioned categories.

7.2.2.1. ***Lines to be constructed***

Lines to be constructed shall be equipped with the class A functions and interfaces according to the specifications referenced in Annex A. The control-command infrastructure shall provide the class A interfaces for the trains.

7.2.2.2. ***Lines to be upgraded (re-signalled)***

When control-command and signalling is upgraded, a line shall be equipped with the class A functions and interfaces according to the specifications given in Annex A. The control-command infrastructure shall provide the class A control-command interfaces for the trains in the same way as for lines to be constructed.

The upgrade may concern separately the GSM-R radio part, the ETCS part and the train detection part of the control-command subsystem.

After the upgrade the existing class B equipment may remain in use simultaneously with class A according to point 7.2.1.2.

Class B control-command equipment trackside EMC limits may remain in use until the control-command subsystem is upgraded.

The time interval in which a certain line is equipped with both class A and class B control-command equipment is a trackside transition phase. During this transition phase, it is allowed to use existing class B equipment on-board as a fallback arrangement to class A system: this does not allow an infrastructure manager to require class B systems on-board the interoperable trains for running on such a line.

7.2.2.3. ***Existing lines***

Lines existing before the entry in force of Directive 96/48/EC and, by extension and according to Article 7 of the Directive, lines belonging to a project which is at an advanced stage of development when this TSI is published may be declared as interoperable in the sense of this TSI (see Chapter 6) when they fulfil the requirements of the control-command subsystem described in this TSI.

The existing class B control-command equipment may remain in use (without installation of class A systems) during its life cycle, under the conditions indicated in point 7.2.1.5.

Class B control-command equipment trackside EMC limits may remain in use until the control-command subsystem is upgraded.

7.2.2.4. ***Registers of infrastructure (TEN HS)***

When a line is declared interoperable, the infrastructure manager shall provide railway undertakings with class A and class B information written down in the registers of infrastructure (TEN HS), following Annex C requirements.

In case European specifications for some interface between control-command and signalling and other subsystems are not available at the moment of installation (e.g., electromagnetic compatibility between train detection and RS), the corresponding characteristics and the standards applied shall be indicated in the registers of infrastructure (TEN HS).

This shall be possible, in any case, only for the items listed in Annex C.

7.2.3. IMPLEMENTATION: ROLLING STOCK (ON-BOARD EQUIPMENT)

Rolling stock specially built or upgraded (re-signalled) for high speed shall be equipped with class A interfaces for use on the trans-European high-speed network and shall ensure that the on-board functions, interfaces and minimum performance required by this TSI are included according to the routes concerned as described in Annex C.

Rolling stock equipment providing class A interfaces shall be able to accommodate additional modules providing class B interfaces (STMs) as may be required by the awarding authority.

Rolling stock equipped with only class B systems shall be considered acceptable for use on interoperable lines equipped with class B interfaces when it fulfils the requirements of the control-command subsystem described in this TSI. The existing class B control-command equipment may remain in use during its life cycle.

When running on a line which is equipped with both class A and class B systems, the class B systems may act as fallback arrangement for the class A system if the train is equipped with both class A and class B systems.

Class B control-command equipment on-board shall not interfere with other TSI subsystems nor with the other equipment installed upon the infrastructure of the European high-speed network.

Class B control-command equipment on-board shall not be susceptible to emissions from other TSI subsystems.

7.2.3.1. ***Registers of rolling stock (TEN HS)***

When a train is declared interoperable, the train specific implementation for the on-board assembly is defined in the registers of rolling stock (TEN HS) following Annex C requirements.

In case European specifications for some interface between control-command and signalling and other subsystems are not available at the moment of installation (e.g., electromagnetic compatibility between train detection and rolling stock, climatic conditions and physical conditions in which the train can work, geometric parameters of the train like length, maximal distance of axles in the train, length of the nose of the first and of the last car of the train, braking parameters), the corresponding characteristics and the standards applied shall be indicated in the registers of rolling stock (TEN HS).

This shall be possible, in any case, only for the items listed in Annex C.

7.2.4. CONDITIONS UNDER WHICH 'O' FUNCTIONS ARE REQUIRED

The 'O' functions are required in the following cases:

1. an ETCS level 3 trackside assembly requires train integrity supervision on-board;

2. an ETCS level 1 trackside assembly with infill requires corresponding infill functionality on-board if the release speed is set to zero for safety reasons (e.g. protection of danger points);

3. when ETCS requires data transmission by radio the data transmission services of GSM-R shall be implemented.

7.2.5. CHANGE CONTROL PROCEDURE

During the life cycle of the control-command and signalling subsystem, the evolution of the TSI requirements must be managed in the interest of interoperability.

Any evolution concerning class A and class B functions and interfaces must be controlled following a procedure to be established by the joint representative body applying Article 6(2) of Directive 96/48/EC.

*ANNEX A*

**SPECIFICATIONS FOR INTEROPERABILITY**

This Annex deals with requirements of this TSI only.

ERTMS references are to be reviewed after the consolidation phase.

The complete text of a specification is relevant for this TSI, unless otherwise indicated.

The European specifications quoted in this TSI are grouped into two columns: 'European specifications defining basic parameters' and 'Other European specifications'. To ensure interoperability, those European specifications defining basic parameters must be fully applied in every implementation; alternative solutions to satisfy the essential requirements are not allowed.

GLOBAL REQUIREMENTS

| Index No | Control-command TSI paragraph reference | Subject [1] | Scope [2] | European specifications defining basic parameters | Other European specifications |
|---|---|---|---|---|---|
| 0a | 4.1.1 | ETCS FRS | | UIC ETCS FRS version 4.29<br>EEIG 99E5362 version 2.00 | |
| 0b | 4.1.1 | GSM-R FRS | | EIRENE FRS version 5.0 | |
| 1 | 3.2.1 | Safety assurance | Informative documentation: prEN 50128 | | EN50126 September 1999<br>ENV50129 May 1998 |
| 2 | | RAMS | | | |
| 2a | 3.2.1<br>4.1.1 | Safety requirements | | ESROG<br>(reserved) | ENV50129 May 1998 |
| 2b | 3.2.2e | Reliability-availability- requirements | ERTMS/96s1266-(RAM chapter) to be used as input information<br>Informative documentation: EEIG 02S1266- version 6 | Reserved | EN 50126 September 1999 |
| 2c | 3.2b | Quality of maintenance | The procedures against which the quality of the maintenance of control-command equipment is to be judged | | EN 29000 and EN 29001 |
| 3 | 3.2.5.1.1<br>4.2.1.2d | Environmental physical conditions | The minimum requirements upon temperature, humidity, shock, vibration etc. that control-command equipment shall respect for use upon the high-speed network.<br>Informative documentation: EEIG 97S0665- version 5, prEN50125-3 | Reserved | EN 50125-1 September 1999<br>and EN 50155 November 1995 |

| Index No | Control-command TSI paragraph reference | Subject ([1]) | Scope ([2]) | European specifications defining basic parameters | Other European specifications |
|---|---|---|---|---|---|
| 4 | 3.2.5.1.2 | Electromagnetic compatibility: | | | |
| 4a | 3.2.5.1.2<br>4.2.1.2d | Electromagnetic compatibility | ERTMS/97s0665- to be used as input document.<br>For the purpose of EMC, frequency bands for intentional transmission (Eurobalise, Euroloop, and GSM-R) are excluded from the specifications indicated in this index.<br>Specific requirements for the Eurobalise air-gap are indicated in index 12a.<br>Specific requirements for the Euroloop air-gap are indicated in index 12b.<br>Specific requirements for GSM-R air-gap are indicated in index 12c. | | For on-board equipment:<br>EN 50121-3-2, September 2000, tables 4 and 6 in clause 7. Clauses 4, 5, and 6 are applicable for testing procedures.<br>EN 50121-3-2, September 2000, tables 7, 8, and 9 in clause 8. Clauses 4, 5, and 6 are applicable for testing procedures.<br>For trackside equipment:<br>EN 50121-4, September 2000, clause 5,<br>EN 50121-4, September 2000, clause 6. |
| 4b | 3.2.5.1.2b<br>4.2.1.2f | The immunity characteristics of train detection systems | To ensure that train detection systems are not perturbed by traction current.<br>Input for European specification is contained in the report to TSI CC. | | (reserved) |

([1]) This is the subject addressed in the paragraph referenced in the TSI.
([2]) This is a description of the intent of the standard required to support the TSI.

CONTROL COMMAND FUNCTIONS

| Index No | Control-command TSI paragraph reference | Subject ([1]) | Scope ([2]) | European specifications defining basic parameters | Other European specifications |
|---|---|---|---|---|---|
| 5 | | Provision of cab-signalling logic and ATP logic and associated functions. | | | |
| 5a | 4.1.1 | Normal operation | Scenarios ERTMS99E807 is input for test specifications<br>Informative documentation: Unisig subset-050-V200, Unisig subset-030-V200, Unisig subset-031-V200, Unisig subset-032-V200 | Test requirements (to be added in the next version of this TSI)<br>Unisig subset-026-V222<br>Unisig subset-043-V200<br>Unisig subset-046-V200<br>Unisig subset-047-V200<br>Unisig subset<br>Unisig subset-054-V200<br>Unisig subset-055-V222 | |

| Index No | Control-command TSI paragraph reference | Subject ([1]) | Scope ([2]) | European specifications defining basic parameters | Other European specifications |
|---|---|---|---|---|---|
| 5b | 4.1.1 | Degraded operation | The system requirements in response to failures<br>ERTMS/97E832 to be used as input for European specification | Unisig subset-026-V222 | |
| 6 | 4.1.1<br>4.1.2.2 | STM management | The functional and physical requirements on the STM interface to the Class A system<br>KER compatibility is to be addressed<br>Informative documentation: Unisig subset-058-V200 Unisig subset-059-V200 | Unisig subset-035-V200<br>Unisig subset-026-V222<br>Unisig subset-056-V200<br>Unisig subset-057-V200 | |
| 7 | 4.1.1 | MMI driver interface functional requirements. | The functional specification for communication between the driver and the on-board assembly. The driver's displays states what is required for driving e.g. cab signals, warning of intervention. It includes the input functions e.g. train characteristics, override functions, required for interoperable control-command purposes. It also includes the display of text messages<br>The cab signals define the minimum range of parameters made available in the cab that together satisfy all the circumstances that could be found upon the railways of the European high-speed network and that therefore make a system common for the whole network feasible. Such parameters would be permitted speed, target speed, target distance, that are the basis of cab-signalling and ATP.<br>Informative documentation: Cenelec WGA9D V21.DOC 12/04/2000, Cenelec WGA9D V05 DOC 27/03/2000, Cenelec WGA9D V11.DOC 12/04/2000, Cenelec WGA9D V06.DOC 12/01/2000, Cenelec WGA9D V08NS.DOC 27/03/2000 and Cenelec WGA9D V04.DOC 27/03/2000 | Unisig subset-033-V200<br>Unisig subset-026-V222<br>Unisig subset-035-V200 | |
| 8 | 4.1.1 | Odometry requirements | The functional requirements of the odometry subsystem required to support the range of performance expected of the equipment providing the class A interfaces. Location accuracy depends on odometry and the distance between balises. The requirements for speed and distance measurements on an interoperable train.<br>Note relation with index 6, STM | Unisig subset-041-V200 | |

| Index No | Control-command TSI paragraph reference | Subject ([1]) | Scope ([2]) | European specifications defining basic parameters | Other European specifications |
|---|---|---|---|---|---|
| 9 | 4.1.1 | Requirements for the on-board recording of operational data | The requirements for the choice of data parameters, regularity, accuracy, validation checks for the purposes of inspecting the proper driving of the train and the behaviour of safety related systems such that the requirements of the legal authorities in all Member States can be met | Unisig subset-026-V222<br>Unisig subset-027-V200 | |
| 10 | 4.1.1 | Vigilance (dead man's) system requirements | The definition of a vigilance function so that the train can operate acceptably on the European networks<br>Vigilance ensures that the driver is sufficiently alert (and by implication sufficiently alert to be aware of the signalling). If a timer is used, the timer can be reset by other driver actions on the train controls, traction controller, brakes, cab warning acknowledgement. It can be associated with a need to hold a lever in a given position (dead man function). The functionality required of the vigilance can be modified by the status of ATP and any cab warning system<br>Vigilance, ATP and cab warning systems are safety-related systems in the sense that they support the driver and provide protection to the train in the event of human inadequacy. The level of safety is determined by all these systems, and they are interdependent in the sense that the presence or absence of one can affect the functionality of the others. The management of the safety issues is facilitated by considering these systems to be in the scope of control-command.<br>UIC 641 is to be the basis for European specification | | |
| 11 | 4.1.1<br>4.2.1.2e | Radio | The definition of the radio system for voice and data communication to and from the trains | Eirene SRS<br>version 13<br>Test requirements (to be added in the next version of this TSI) | |

([1]) This is the subject addressed in the paragraph referenced in the TSI.
([2]) This is a description of the intent of the standard required to support the TSI.

INTERFACES BETWEEN ONBOARD AND TRACKSIDE ASSEMBLIES

| Index No | Control-command TSI paragraph reference | Subject ([1]) | Scope ([2]) | European specifications defining basic parameters | Other European specifications |
|---|---|---|---|---|---|
| 12 | | Data-transmission interfaces — between the train and the ground | | | |
| 12a | 3.2.5.1.2<br>4.1.2.1 | Balise | With reference to the Article 21 Committee Decision DV07, the details of the frequencies used are included in the European specifications. Technical compatibility with some class B systems requires the toggling function as defined in the European specifications. This is to be considered acceptable from the point of view of EMC | Unisig subset-036-V200<br>EUROSIG/WP3.1.2.3<br>ABB007<br>ABB020<br>ABB009<br>GA0347<br>Test requirements (to be added in the next version of this TSI) | ETSI EN 300 330-1, V1.3.1 (July 2000), up to and including sub-clause 7.2 ([3]) |
| 12b | 3.2.5.1.2<br>4.1.2.1 | Loop | Informative documentation: Unisig subset-050-V200 | Unisig subset-043-V200<br>Unisig subset-044-V200<br>Unisig subset-045-V200<br>Test requirements (to be added in the next version of this TSI) | |
| 12c | 3.2.5.1.2<br>4.1.2.1 | Radio | With reference to the Article 21 Committee Decision DV07, the details of the frequencies used are included in the European specifications | CEPT TR25-09<br>Test requirements (to be added in the next version of this TSI) | ETSI GSM TS phase 2 |

([1]) This is the subject addressed in the paragraph referenced in the TSI.
([2]) This is a description of the intent of the standard required to support the TSI.
([3]) The applicable up-link and tele-powering frequency ranges are defined in Unisig subset-036-V200.

INTERFACES ONBOARD BETWEEN CONTROL-COMMAND INTEROPERABILITY CONSTITUENTS

| Index No | Control-command TSI paragraph reference | Subject ([1]) | Scope ([2]) | European specifications defining basic parameters | Other European specifications |
|---|---|---|---|---|---|
| 13 | | On-board data communication interfaces | The data interfaces between control-command equipment supporting the cab signalling and automatic train protection functions, and between these functions and the train | | |
| 13a | 4.1.2.2 | Radio | Note, Unisig subset-037-022A and -023a dated 29.03.2000 are informative<br>Radio transmission FFFIS for Euroradio | Unisig subset-026-V222<br>Unisig subset-034-V200<br>Unisig subset-047-V200<br>Unisig subset-037-V200<br>Unisig subset-093-V200<br>Morane A11T6001-3 (July 1998)<br>Unisig subset-048-V200<br>Unisig subset-049-V200 | |
| 13b | 4.1.2.2 | Train data interface for analysis of operational data recorded on-board | The communications interface, common to the high-speed network, to the data analyser of the data stored in the control-command systems to ensure readability across all interested parties | Unisig subset-027-V200 | |
| 13c | 4.1.2.2 | Odometry interfaces | ERTMS/97e267 is to be the basis for a European specification<br>A specification will not be available in the first step | | |

([1]) This is the subject addressed in the paragraph referenced in the TSI.
([2]) This is a description of the intent of the standard required to support the TSI.

INTERFACES AT THE TRACKSIDE BETWEEN CONTROL-COMMAND INTEROPERABILITY CONSTITUENTS

| Index No | Control-command TSI paragraph reference | Subject ([1]) | Scope ([2]) | European specifications defining basic parameters | Other European specifications |
|---|---|---|---|---|---|
| 14 | | Trackside data communication interfaces between: | | | |
| 14a | 4.1.2.3 | ERTMS/GSMR and ERTMS/ETCS | | Unisig subset-026-V222<br>Unisig subset-037-V200<br>Unisig subset-093-V200<br>Morane A11T6001-3 (July 1998)<br>Unisig subset-049-V200 | |
| 14b | 4.1.2.3 | Eurobalise and LEU | | Unisig subset-036-V200 | |
| 14c | 4.1.2.3 | Euroloop and LEU | | Unisig subset-045-V200 | |
| 14d | 4.1.2.3 | ERTMS/ETCS and ERTMS/ETCS (RBC-RBC-handover) | | Unisig subset-039-V200 | |
| 15 | 4.2.4 | Key management | Informative documentation: Unisig subset-051-V200, Unisig subset-060-V111 | Unisig subset-038-V200 | |

([1]) This is the subject addressed in the paragraph referenced in the TSI.
([2]) This is a description of the intent of the standard required to support the TSI.

COMPATIBILITY (NOT EMC) BETWEEN TRAINS AND TRACK-CIRCUITS

| Index No | Control-command TSI paragraph reference | Subject (1) | Scope (2) | European specifications defining basic parameters | Other European specifications |
|---|---|---|---|---|---|
| 16 | 4.2.1.2b | Rolling stock characteristics necessary to be compatible with train-detection systems | The specification that the rolling stock must respect in order that it will operate the train detection systems correctly<br>To be completed, e.g., to take into account inductivity in case of axleless wheelsets and minimum axleload | See Annex A | |

(1) This is the subject addressed in the paragraph referenced in the TSI.
(2) This is a description of the intent of the standard required to support the TSI.

DATA INTERFACES BETWEEN CONTROL-COMMAND AND ROLLING-STOCK

| Index No | Control-command TSI paragraph reference | Subject (1) | Scope (2) | European specifications defining basic parameters | Other European specifications |
|---|---|---|---|---|---|
| 17 | 4.2.1.2e | Train interfaces | To cover all data concerned by interoperability that may pass between the train and control-command equipment | Unisig subset-034-V200 | |

(1) This is the subject addressed in the paragraph referenced in the TSI.
(2) This is a description of the intent of the standard required to support the TSI.

CONTROL-COMMAND PERFORMANCE

| Index No | Control-command TSI paragraph reference | Subject (1) | Scope (2) | European specifications defining basic parameters | Other European specifications |
|---|---|---|---|---|---|
| 18 | 4.1.1<br>4.3 | Performance required | Annexes I and IV to Directive 96/48/EC set out performance definitions of the high-speed network | Unisig subset-041-V200 | |

(1) This is the subject addressed in the paragraph referenced in the TSI.
(2) This is a description of the intent of the standard required to support the TSI.

VERIFICATION REQUIREMENTS

| Index No | Control-command TSI paragraph reference | Subject ([1]) | Scope ([2]) | European specifications defining basic parameters | Other European specifications |
|---|---|---|---|---|---|
| 32 ([3]) | 6.2 | On-board assembly integration requirements | This shall be sufficient to ensure that the on-board assembly will operate correctly with the trackside assemblies (subsystem-verification considering the options as indicated in the register of rolling stock)<br>Practical running tests have to be performed after the installation of on-board control-command equipment<br>Special attention shall be given to electromagnetic compatibility between CC and rolling stock | Unisig subset (reserved) | |
| 33 | 6.2 | Trackside assembly integration requirements | This shall be sufficient to ensure that the trackside assembly will operate correctly with the on-board assemblies (subsystem verification considering the options as indicated in the register of infrastructure) | Unisig subset (reserved) | |
| 34 | Table 6.1<br>Table 6.2 | Installation requirements | The engineering rules that apply when installing the control-command assembly on-board and trackside respectively | Unisig subset-040-V200 | |
| 35 | | Glossary of terms and abbreviations | | Unisig subset-023-V200 | |

([1]) This is the subject addressed in the paragraph referenced in the TSI.
([2]) This is a description of the intent of the standard required to support the TSI.
([3]) Index Nos 19 to 31 are intentionally deleted.

**(SPECIFICATIONS FOR INTEROPERABILITY)**

**— to be updated —**

**Requirements from the control-command subsystem on the rolling stock subsystem upon obligatory conditions to be fulfilled in order to support the operation of track circuits and treadles (including 'axle counters')**

These requirements apply to interoperable high-speed trains according to Directive 96/48/EC and the TSI rolling stock. The term wheelset shall apply to any pair of wheels, even without a common axle.

Electrical resistance between tyres of a wheelset (or parts of the wheels replacing the tyres) of an empty vehicle:

— less than 0,01 Ohm when new or after re-tyring,

— less than 0,1 Ohm after overhaul of wheel sets with tyred wheels (without replacement of the tyre).

Conditions for measurement:

— voltage between 1,8 V and 2,0 V.

The distance between adjacent wheelsets must not exceed 17,5 m (16,4 m for running in the United Kingdom).

The distance between the front/end wheelset and the buffer head must not exceed 4,2 m.

*ANNEX B*

**CLASS B**

**USE OF ANNEX B**

This Annex presents the train-protection, control and warning systems and radio systems that predate the introduction of the class A train control systems and radio systems and that are authorised for use on the European high-speed network up to speed limits defined by the responsible Member State. These class B systems were not developed under unified European specifications, and therefore there may be proprietary specification rights with their suppliers. The provision and maintenance of these specifications shall not conflict with national regulations — especially those concerning patents.

During the transition phase in which these systems will be gradually replaced by the unified system, there will be a need to manage the engineering specifications in the interests of interoperability. This is the responsibility of the Member State concerned or its representative in cooperation with the respective system supplier in accordance with point 7.2.1.5 of this TSI.

Train operators needing to install one or more of these systems on their trains shall refer to the appropriate Member State. Annex C manages the corresponding geographical distribution of each system, requiring for each line a register of infrastructure describing the equipment type and the associated operational arrangements. By means of the register of infrastructure, the infrastructure manager ensures the coherence between the system and the rulebook under his authority.

The Member State shall provide to the train operator the advice necessary to obtain a safe installation compatible with the requirements of this TSI and Annex C.

The class B installations shall include the fallback arrangements, as required by Annex C.

For the class B systems, this Annex provides basic information. For each system listed, the Member State identified shall guarantee that its interoperability is maintained and shall provide the information required for the purposes of its application, in particular the information relevant to its approval.

*PART 1: SIGNALLING*

INDEX:

0. Use of Annex B

1. ASFA

2. ATB

3. BACC

4. Crocodile

5. Ebicab

6. Indusi/PZB

7. KVB

8. LZB

9. RSDD

10. SELCAB

11. TBL

12. TPWS

13. TVM

14. ZUB 123

For information only, systems not used in Member States:

15. EVM

16. LS

17. ZUB 121

*Remarks:*

— The selection of systems is based on the list elaborated in the EU research project EURET 1.2.

— System 9 (RSDD) was accepted as an additional system in the TSI meeting on 26 February 1998 in Paris.

— System 12 (TPWS) was accepted at the 26th AEIF Board meeting. TPWS on-board equipment includes the AWS functions.

— System 15 (EVM) is for information only, as Hungary is not a Member State.

— System 16 (LS) is for information only, as the Czech Republic and the Slovak Republic are not Member States.

— System 17 (ZUB 121) is for information only, as Switzerland is not a Member State.

— It is accepted that systems 14 and 17 (ZUB 123 and ZUB 121) are not compatible for mechanical reasons and therefore have individual descriptions.

**ASFA**

*Description:*

ASFA is a cab-signalling and ATP system installed on most lines of RENFE (1 676 mm), on metre gauge lines of FEVE, and on the new European gauge NAFA line.

ASFA is found on all lines being considered for interoperability.

Track-to-train communication is based on magnetically coupled resonant circuits in such a way that nine different data can be transmitted. A resonant circuit trackside is tuned to a frequency representing the signal aspect. The magnetically coupled on-board PLL is locked to the trackside frequency. The system is safety related, not fail safe, but safe enough to supervise the driver. It reminds the driver of the signalling conditions and obliges him to acknowledge restrictive aspects.

The trackside and on-board units are of conventional design.

*Main characteristics*

— Nine frequencies
range: 55 kHz to 115 kHz

— Three different train categories can be selected on-board

— Supervision:

  — acknowledgement of restrictive signal by driver within three seconds

  — continuous speed supervision (160 km/h or 180 km/h) after passing restrictive signal

  — speed check (60 km/h, 50 km/h or 35 km/h depending on train type) after passing a transponder 300 m in rear of signal

  — train trip at signal at danger

  — line speed.

— Reaction:
the emergency brake is called if any supervision is violated. The emergency brake can be released at standstill.

— Responsible Member State: Spain

**ATB**

ATB exists in two basic versions: ATB first generation and ATB new generation.

*Description of ATB First Generation:*

ATB first generation is installed on the vast majority of lines of NS.

The system consists of coded track circuits of rather conventional design and a computerised (ACEC) or conventional electronic (GRS) on-board equipment.

The data transmission between coded track circuits and on-board equipment is via inductively coupled air coil pick-up antennae above the rails.

*Main characteristics*

— Data transmission to trains:

  — 75 Hz carrier frequency

  — AM modulated speed codes

  — six speed codes (40, 60, 80, 130, 140) km/h

  — one exit code

— No train characteristics on board (speed code from wayside)

— Display to driver:

  — speed corresponding to speed code

  — gong in case of code change

  — bell in case the system requests brake application

— Supervision:

  — speed (continuous)

— Reaction:

  the emergency brake is called in the case of overspeed and the driver does not react to an acoustic warning.

Responsible Member State: the Netherlands

*Description of ATB new generation:*

ATC system partially installed on lines of NS.

The system consists of trackside balises and on-board equipment. An infill function based on a cable loop is also available.

The data transmission is between the active balise and an antenna on-board. The system is direction sensitive, the balises are mounted between the rails with a small offset from the centre.

ATBNG on-board equipment is fully interoperable with ATB first generation trackside equipment.

*Main characteristics*

— Data transmission to trains:

  — 100 kHz +/- 10 kHz (FSK)

  — 25 kbit/sec

  — 119 useful bits per telegram

— Train characteristics as input by the driver:

  — train length

  — maximum train speed

  — train braking characteristics

— Displays to the driver:

  — maximum line speed

  — target speed

  — target distance

  — braking curve

— Supervision:

  — line speed

  — speed restrictions

  — stopping point

  — dynamic brake profile

— Reaction:

  — optical pre warning

  — acoustic warning

  The emergency brake is called in the case of movement supervision is violated or the driver does not react to an acoustic warning.

— Responsible Member State: the Netherlands

**BACC**

*Description:*

BACC is installed on all lines exceeding 200 km/h on the network of FS and other lines, which are most of the lines under consideration for interoperability.

The system consists of conventional coded track circuits which operate at two carrier frequencies to deal with two train classes. The on-board equipment is computerised.

The data transmission between coded track circuits and on-board equipment is via inductively coupled air coil pick-up antennae above the rails.

*Main characteristics*

— Data transmission to trains:

  — 50 Hz carrier frequency

    — AM modulated speed codes

    — five speed codes

— 178 Hz carrier frequency

— AM modulated speed codes

— four additional speed codes

— Two possible train categories on board (speed code from wayside)

— Display to driver:

— speed corresponding to speed code

— signal aspect (one out of 10)

— Supervision:

— speed (continuous)

— stopping point

— Reaction:

Emergency brake in case of overspeed

— Responsible Member State: Italy

**Crocodile**

*Description:*

Crocodile is installed on all major lines of RFF, SNCB and CFL. Crocodile is found on all lines under consideration for interoperability.

The system is based on an iron bar in the track which is physically contacted by a brush on-board the train. The bar carries a tension of +/- 20V from a battery depending on the signal aspect. There is an indication to the driver and the driver has to acknowledge the warning. If not acknowledged, an automatic brake action is triggered. Crocodile does not supervise any speed or distance. It only acts as a vigilance system.

The trackside and on-board units are of conventional design.

*Main characteristics*

— DC powered bar (± 20 V)

— No train characteristics on-board

— Supervision:

acknowledgement by driver

— Reaction:

the emergency brake is called if the warning is not acknowledged. The emergency brake can be released after standstill.

— Responsible Member States: Belgium, France, Luxembourg

**Ebicab**

Ebicab exists in two versions: Ebicab 700 and Ebicab 900.

*Description of Ebicab 700:*

Fail-safe standard ATP system in Sweden, Norway, Portugal and Bulgaria. Identical software in Sweden and Norway enables cross-border trains without changing drivers or locomotives despite different signal systems and rules; different software in Portugal and Bulgaria.

The system consists of track side, balises and signal encoders or serial communication with electronic interlocking, and on-board computerised equipment.

The data transmission is between passive trackside balises (two to five per signal) and an on-board antenna underneath the vehicle which also supplies the balise with energy when passing. The coupling between balise and on-board is inductive.

*Main characteristics*

— Energising balises:

  — 27,115 MHz

  — amplitude modulation for clock pulses

  — 50 kHz pulse frequency

— Data transmission to trains:

  — 4,5 MHz

  — 50 kb/s

  — 12 useful bits of total 32 bits

— Linking:

  — signals are linked

  — boards, e.g. warning and speed boards are not necessarily linked, 50 % unlinked balises are acceptable for fail safety

— Train characteristics can be input by the driver:

  — maximum train speed

  — train length

  — train braking characteristics

  — specific properties of train for either allowing overspeeding or enforcing slow driving on specific sections

  — surface conditions

— Displays to the driver:

  — maximum line speed

  — target speed

  — advanced information on secondary targets for distance-to-go signalling or speed step signalling, five blocks may be supervised

  — speed restrictions beyond first signal

  — time to service brake intervention, three warnings

  — faults in way side or vehicle equipment

  — value of last retardation

  — brake pipe pressure and current speed

  — information in last passed balise

  — auxiliary information

— Supervision:

  — line speed, depending on overspeeding track capability and vehicle performance or enforcement of low speed for specific trains

  — multiple targets including signal information without optical signals

  — permanent, temporary and emergency speed restrictions may be implemented with unlinked balises

  — stopping point

  — dynamic brake profile

  — level crossing and landslide detector status

  — shunting

  — roll-away protection

  — slip compensation

  — authorised passing signal at stop, 40 km/h is supervised until the next main signal

— Reaction:

  audible warning when > 5 km/h, service brake when > 10 km/h over-speed. The service brake can be released by the driver when speed is within limits. Ebicab will brake sufficiently regardless of driver action. The emergency brake is only used in a real emergency e.g. where service braking is not sufficient. Release of emergency brake can occur when train is stationary.

— Implemented options:

  — radio block system with 'ETCS Level 3 like' functionality

  — train-to-track communication

— Responsible Member States: Portugal, Sweden

*Description of Ebicab 900:*

The system consists of track-side, balises and signal encoders or serial communication with electronic interlocking, and on-board computerised equipment.

The data transmission is between passive track side balises (two to four per signal) and an on-board antenna underneath the vehicle which also supplies the balise with energy when passing. The coupling between balise and on-board is inductive.

*Main characteristics*

— Energising balises:

  — 27 MHz

  — amplitude modulation for clock pulses

  — 50 kHz pulse frequency

— Data transmission to trains:

  — 4,5 MHz

  — 50 kb/s

  — 255 bits

— Linking:

  — signals are linked

  — boards, e.g. warning and speed boards are not necessarily linked, 50 % unlinked balises are acceptable for fail safety

— Train characteristics can be input by the driver:

  — train identification

  — maximum train speed

  — train length

  — train braking characteristics

  — train speed type (only if the train speed is between 140 km/h to 300 km/h)

  — train pressurisation

— Displays to the driver:

  — limit speed

  — target speed

  — overspeed

  — efficacy

  — ASFA alarm

  — brake rearmament

  — running past allowed

  — END

  — audible warning

  — braking pre-warning

  — red indicator

  — alphanumeric display

— Supervision:

  — line speed, depending on overspeeding track capability and vehicle performance or enforcement of low speed for specific trains

  — multiple targets including signal information without optical signals

  — permanent, temporary and emergency speed restrictions may be implemented with unlinked balises

  — stopping point

  — dynamic brake profile

  — level crossing and landslide detector status

  — shunting

  — roll away protection

  — slip compensation

  — authorised passing signal at stop, 40 km/h is supervised until the next main signal

— Reaction:

  Audible warning when > 3 km/h, service brake when > 5 km/h over-speed. The service brake can be released by the driver when speed is within limits. Ebicab will brake sufficiently regardless of driver action.

— Responsible Member State: Spain

**Indusi/PZB**

**(Induktive Zugsicherung/Punktförmige Zugbeeinflussung)**

*Description*

ATP system which is installed on lines in Austria and Germany under consideration for interoperability.

Magnetically coupled resonant circuits trackside and on-board transmit one information out of three to the train. The system is not considered fail safe, but safe enough to supervise the driver. It acts completely in background mode, that means that is does not give the driver any indications about signal aspects, it only indicates that the train is supervised.

*Main characteristics*

— Three frequencies:

  — 500 Hz

  — 1 000 Hz

  — 2 000 Hz

— Train characteristics can be input by the driver:

  braking characteristics (braking percentage and braking regime for three supervision categories)

— Supervision:

  — hardware version (not for Germany):

    — 500 Hz: immediate speed supervision

    — 1 000 Hz: acknowledgement of restrictive signal aspect, speed supervision depends on type of train

    — 2 000 Hz: immediate stop

  — microprocessor version:

    — 500 Hz: immediate speed supervision and following braking curve supervision

    — 1 000 Hz: acknowledgement of restrictive signal aspect, speed supervision depends on program with different braking curves, supervision by means of time and speed values for a limited distance; braking curves (over time and distance) triggered by 1 000 Hz, additionally over distance triggered by 500 Hz

    — 2 000 Hz: immediate stop

— Reaction:

  the emergency brake is called if supervision is violated. The emergency brake can be released under special conditions.

— Responsible Member States: Austria, Germany

**KVB**

*Description:*

Standard ATP system in France on the network of RFF; technically similar to Ebicab; partially installed on high-speed lines for some spot transmission and for supervision of temporary speed restrictions when speed levels are not provided by TVM codes.

The system consists of trackside balises including signal encoders and on-board computerised equipment. The system is an overlay system to conventional signalling equipment.

The data transmission is between passive trackside balises (two to nine per signal) and an on-board antenna underneath the vehicle which also supplies the balise with energy when passing. The coupling between balise and on-board is inductive. This data transmission is also used for spot information not related to ATP (doors, radio channels, etc.).

*Characteristics*

— Energising balises:

  — 27,115 MHz

  — amplitude modulation for clock pulses

  — 50 kHz pulse frequency

— Data transmission to trains:

  — 4,5 MHz

  — 50 kbit/sec

  — 12 useful bits (total 4 × 8 bits) type analogue

  — 172 useful bits (total 256 bits) type digital

— Except for trainsets, train characteristics must be input by the driver:

  — train category

  — maximum train speed

  — train length

  — train braking characteristics

— Displays to the driver:

  — state of speed supervision

  — release speed

— Supervision:

  — line speed

  — stopping point

  — dynamic brake profile

  — speed restrictions

— Reaction:

  Warning of the driver. The emergency brake is called if movement supervision is violated. Release of the emergency brake is possible only when the train is stationary.

— Responsible Member State: France

**LZB**

**(Linienförmige Zugbeeinflussung)**

*Description*

ATC system which is installed on all lines in Germany exceeding 160 km/h, which are significant parts of the lines under consideration for interoperability. LZB is also installed on lines in Austria and Spain.

The system consists of a trackside part, which again has the building parts:

— adaptation to interlocking systems and respective data transmission

— data processing and MMI in LZB centre

— data transmission to and from other LZB centres

— data transmission system to and from trains

The on-board equipment normally has an integrated Indusi function.

The data transmission between trackside and on-board is via trackside inductive cable loop and on-board ferrite antennae.

*Main characteristics*

— Data transmission to trains:

  — 36 kHz ± 0,4 kHz (FSK)

  — 1 200 bit/sec

  — 83,5 steps per telegram

— Data transmission from trains:

  — 56 kHz ± 0,2 kHz (FSK)

  — 600 bit/sec

  — 41 steps per telegram

— Train characteristics can be input by the driver:

  — train length

  — maximum train speed

  — train braking characteristics (braking percentage and braking regime)

— Displays to the driver:

  — valid operating mode, status of data transmission

  — maximum permitted speed/actual speed on a two pointer speedometer

  — target speed

  — distance to target

  — auxiliary indications

— Supervision:

  — line speed (maximum speed, temporary and permanent speed limitations)

  — maximum train speed

  — stopping point

  — direction of movement

  — dynamic speed profile

  — auxiliary functions, e.g. lowering of pantograph (see Annex C)

— Reaction:

the emergency brake is called if the movement supervision is violated. The emergency brake can be released in case of overspeed when speed is within limits.

— LZB operating rules:

DB uses the system as fully safety-relevant automatic train control, wayside signals are not required; in the case where wayside signals exist because of non-equipped trains, these signals are not valid for LZB-guided trains. LZB is typically connected with automatic motor and brake control.

— Responsible Member States: Austria, Germany, Spain

**RSDD**

**(Ripetizione Segnali Discontinua Digitale)**

*Description*

RSDD is an ATP system; it can be used alone or superimposed on the BACC infrastructure.

The on-board equipment is able to manage in a coordinated way information coming from the different sources.

The system consists of trackside balises and encoders, and an on-board antenna which also supplies the balise with energy when passing. The coupling is inductive.

From the logical point of view, two kinds of balises exist: 'system balises' containing information on the line ahead, and 'signalling balises' containing information on the signals aspect.

Three types of balises are foreseen, all using the same frequencies for up- and downlink, but with different capacity:

— energising frequency:

27,115 MHz

— data transmission to trains:

— 4,5 MHz

— 12/180 bit ASK modulation

— 1 023 bit FSK modulation

— train characteristics:

fixed train characteristics are loaded in maintenance facilities, while data depending on train composition are inserted by the driver. Special balises are used to calibrate the on-board odometer system, before it can be used for train supervision purposes.

— Displays to the driver:

— maximum permitted speed

— target speed

— actual train speed

— advanced information on secondary targets

— warnings before emergency brake intervention

— auxiliary information

— Supervision:

In normal condition (full supervision) the train controls the following characteristics:

— line speed, depending on overspeeding track capability and vehicle performances

— permanent and temporary speed restriction

— level Crossing

— stopping point

— dynamic brake profile

— shunting

If one or more characteristics of line cannot be sent to the on-board system (fault, etc.) it is possible to use the system in partial supervision. In this case the MMI is switched off and the driver has to drive according to lineside signals.

— Reactions:

— service brake

— emergency brake

— Responsible Member State: Italy

**SELCAB**

*Description*

ATC system which is installed on the high speed line Madrid-Seville as an extension of LZB in station areas. The on-board equipment LZB 80 (Spain) can also process SELCAB information.

The data transmission between trackside and on-board is via semi-continuous trackside inductive loop and on-board ferrite antennae.

*Main characteristics*

— Data transmission to trains:

— 36 kHz ± 0,4 kHz (FSK)

— 1 200 bit/sec

— 83,5 steps per telegram

— Train characteristics can be input by the driver:

— train length

— maximum train speed

— train braking characteristics

— Displays to the driver:

— maximum permitted speed/actual speed as two pointer speedometer

— target speed

— distance to target

— auxiliary indications

— Supervision:

— line speed

— stopping point

— direction of movement

— dynamic brake profile

— speed restrictions

— Reaction:

the emergency brake is called if the movement supervision is violated. The emergency brake in the case of overspeed can be released when the speed is within limits.

— Responsible Member States: Spain, United Kingdom

**TBL 1/2/3**

*Description*

TBL is an ATC system partially installed on lines of NMBS/SNCB (presently: 1 200 beacons and 120 trainborne equipment TBL1, 200 beacons and 300 trainborne equipment TBL2, all lines for speeds higher than 160 km/h equipped with TBL2).

The system consists of a trackside balise at each signal and an on-board equipment. The TBL1 is a warning system, TBL2/3 is a cab signal system. For TBL2/3, there are in-fill balises, and an infill cable loop is also available.

The trackside part is designated TBL2 in case of interface to relay interlockings, and TBL3 in case of serial interface to electronic interlocking.

The trainborne equipment is called TBL2. It includes the TBL2, the TBL1 and the Crocodile functions.

The data transmission is between the active balise and a set of air-coil antennae on-board. The system is direction sensitive, the balises are mounted between the rails with a small offset from the centre.

*Main characteristics*

— Data transmission to trains:

— 100 kHz ± 10 kHz (FSK)

— 25 kbit/sec

— 119 useful bits per telegram for TBL2/3

— five useful decimal data on 40 bits per telegram for TBL1

— Train characteristics as input by the driver (TBL2):

— train length

— maximum train speed

— train braking characteristics (brake weight, type of train, isolations, other specific parameters)

— language selection, identification parameters

— Displays to the driver:

— maximum speed (braking curve)

— target speed

— target distance

— train speed

— operating mode

— auxiliary indications

— Supervision:

  — line speed

  — speed restrictions (permanent and temporary)

  — specific restrictions for freight and other trains

  — stopping point

  — dynamic braking profile

  — direction of movement

  — vigilance of the driver

  — auxiliary functions (pantograph, radio commutation)

— Reaction:

  — acoustic and optical warnings

  — the emergency brake is called when the movement supervision is violated or the driver does not acknowledge the warning.

— Responsible Member States: Belgium, United Kingdom

**TPWS**

*Description*

TPWS is to improve safety, principally at junctions. It includes the functionality of AWS, shown in italics. TPWS applies to all lines considered to be interoperable.

The system assures the following functions.

*Warning to the driver at standard braking distance of the following restrictive conditions*:

— *signals not at clear*

— *permanent speed restrictions*

— *temporary speed restrictions*

Train protection (predetermined train characteristics) under the following circumstances:

— train exceeding permitted line speed at specified speed restrictions (speed trap)

— train approaching a stop signal at excess speed (speed trap)

— train passing a signal at danger (train stop)

The system is based on permanent magnets and coils generating fields in the track. The system is not considered fail safe, but incorporates measures and principles to reduce the probability of misleading the driver as low as reasonably practicable.

The TPWS indicates visually to the driver:

— *the state of the last magnet, clear or restrictive (the 'sunflower' indicator),*

— that it is the cause of a brake application,

— its fault/isolation status.

The TPWS controls are:

— *an acknowledgement button for the warning of a restrictive condition,*

— a button to pass a signal at danger valid only for a limited time after operation,

— isolation controls.

The TPWS audio indications are:

— *a 'bell tone' — signal at clear,*

— *a 'horn tone' — restrictive condition, that must be acknowledged.*

The TPWS system interfaces to the train brake system and provides a full emergency brake application if:

— *the 'horn tone' is not acknowledged within 2,5 seconds,*

— immediately the train passes the 'speed trap' at excess speed,

— imediately if the train passes a signal at danger.

The technology is not processor based, but this is not excluded.

*Other characteristics:*

— *Sequence of magnetic fields (North Pole, South Pole) to provide details of signal clear or not clear*

— One of a selection of sinusoidal electromagnetic fields in the region of 60 kHz for the speed trap and train stop functions (up to eight frequencies used)

— Train characteristics in terms of braking capacity are set by train wiring and give different maximum speeds at speed traps; no train characteristics input presently in service, but can be envisaged

— *Driver acknowledgement of a restrictive condition required within 2,5 seconds, otherwise the emergency brakes are called*

— The emergency brake is releasable one minute after the brake has been applied provided the brake demand has also been acknowledged

— Responsible Member State: United Kingdom

**TVM**

*Description*

TVM is installed on high-speed lines of RFF. The older version TVM 300 is installed on the line Paris-Lyon (LGV SE) and Paris-Tours/Le Mans (LGV A) lines; the later version TVM 430 on the line Paris-Lille-Calais (LGV N), on the SNCB part towards Brussels, on the line Lyon-Marseilles/Nimes (LGV Mediterranée) and through the Eurotunnel. TVM 430 is compatible with TVM 300.

TVM 300 and TVM 430 are based on coded track circuits as continuous transmission means and inductive loops or balises (KVB or TBL type) as spot transmission means.

The data transmission between coded track circuits and on-board equipment is via inductively coupled air coil pick-up antennae above the rails.

*Main characteristics*

— Data transmission to trains via track circuits:

  — various carrier frequencies (1,7; 2,0; 2,3; 2,6) kHz

  — FSK modulated speed codes

  — 18 speed codes (TVM 300)

  — 27 bits (TVM 430)

— Data transmission to trains via inductive loops:

  — TVM 300: 14 frequencies (1,3 to 3,8 kHz)

  — TVM 430: PSK modulated signal, 125 kHz, 170 bits

— Train characteristics on board introduced on locomotives for hauled trains in Eurotunnel (not on TGV, where fixed values are used)

— Display to driver:

  — Speed orders associated to colour light aspects

— Supervision:

  — speed (continuous)

  — braking triggering based on

    — stepping curve for TVM 300

    — parabolic curve for TVM 430

  — stopping point

— Reaction:

  the emergency brake is called in the case of overspeed.

— Responsible Member States: Belgium, France

**ZUB 123**

*Description*

ATC system which is installed extensively on lines in Denmark under consideration for interoperability.

The system consists of the following parts:

trackside equipment:

— a track coupling coil (transponder), which is mounted outside the rails,

— in certain locations loops are used for in-fill purpose,

— a signal interface board which scans and derives the information to be transmitted,

on-board equipment

— the onboard unit with processing logic and receiving/transmitting equipment. It acts through a brake interface unit on the brakes,

— the vehicle coupling coil, mounted on the bogie, which receives data from the line,

— the axle mounted odometer pulse generator which supplies information for the distance covered and the actual speed,

— the cab display and operating panel.

The ZUB 123 on-board equipment is considered fail safe.

*Main characteristics*

— Three frequencies:

  — 50 kHz checking channel

  — 100 kHz energy channel

  — 850 kHz data channel

— Data transmission modes:

  — Time-division multiplex for serial transmission of telegrams with up to 96 useful bits

— On-board data processing:

  — vital computer processing (enhanced performance level)

— Display to the driver:

  — maximum authorised speed

  — actual speed

  — target speed

  — target distance

— Auxiliary indicators and buttons

  Train data input:

  — encoder panel, or

  — directly into the on-board unit

— Supervision:

  — line speed

  — stopping point

  — speed restrictions

  — dynamic brake profile

— Reaction:

  — the emergency brake is called if the movement supervision is violated.

  — the emergency brake in the case of overspeed can be released when the speed is within a defined value limit.

— Responsible Member State: Denmark

**EVM**

**(For information only)**

*Description*

EVM is installed on all main lines on the network of Hungarian State Railways (MAV). These lines are under consideration for interoperability. The major part of locomotive fleet is equipped.

The trackside part of the system consists of coded track circuits which operate one carrier frequency for information transmission. The carrier frequency is coded by 100 % amplitude modulation m using electronic encoder.

The data transmission between coded track circuits and on-board equipment is via inductively coupled air coil pick-up antennae above the rails.

*Main characteristics*

— Data transmission track to trains:

  — 75 Hz carrier frequency

  — amplitude modulated codes (100 %)

  — seven codes (six speed codes)

— Display to driver:

  — cab signal

  — signal aspects: stop, permitted speed at the next signal (15, 40, 80, 120, MAX), no transmission/failure, shunting mode

— Supervision:

  — speed limit

  — vigilance check every 1 550 m in case of $v_{actual} < v_{target}$,

  — vigilance check every 200 m in case of $v_{actual} > v_{target}$

  — stop aspect

  — shunting mode speed limitation

— Reaction:

  the emergency brake is triggered:

  — in the case of driver reaction missing

  — if the speed limit is still exceeded after vigilance signal

  — in case of a stop signal being passed with a speed exceeding 15 km/h

  — in shunting mode immediately after exceeding 40 km/h (the brake is activated in this case without any acoustic signal)

— Additional functions:

  — roll-away protection

  — comfort function (indication that the signal has been cleared when train is stationary)

— Responsible State: Hungary

**LS**

**(For information only)**

*Description*

LS is installed on all main lines on the network of Czech Railways (CD) and Railways of the Slovak Republic (ZSR) and on other lines with a speed exceeding 100 km/h. These lines are under consideration for interoperability.

The trackside part of the system consists of coded track circuits which operate one carrier frequency. The carrier frequency is coded by 100 % amplitude modulation. Almost the entire fleet of locomotives is equipped by the on-board equipment. The on-board part of the system has been upgraded and so the equipment is partly computerised.

The data transmission between coded track circuits and on-board equipment is via inductively coupled air coil pick-up antennae above the rails.

*Main characteristics*

— Data transmission to trains:

  — 75 Hz carrier frequency

    — AM modulated codes

    — four speed codes (including stop aspect)

— Display to driver:

  — cab signal

  — signal aspects: stop, limited speed, caution (speed limit 100 km/h), full speed

— Supervision:

  — speed limit/may be overridden by vigilance control

  — no distance supervision

— Reaction:

— emergency brake in case of missing driver reaction if speed limit is received

— Responsible States: Czech Republic, Slovak Republic

**ZUB 121**

**For information only**

*Description*

ATC system which is installed extensively in Switzerland on lines by SBB and BLS under consideration for interoperability.

The system consists of the following parts:

line equipment:

— determine travel direction to be influenced

— a track coupling coil (transponder), which is mounted inside the rails, lying off centre to coupling loop, which is mounted inside the rails, laying off centre. A previous coupling coil determines travel direction to be influenced by the following loop

— a signal interface board which scans and derives the information to be transmitted (not fail safe)

on-board equipment:

— the onboard unit with processing logic and receiving/transmitting equipment. It acts through a brake interface unit on the brakes.

— the vehicle coupling coil, mounted on the bogie, which receives data from the line. (With this equipment only transmission track to train possible)

— the axle-mounted odometer pulse generator, which supplies information for the distance covered, actual speed and driving direction

— the cab display and operating panel

— an input/output interface to the train-borne radio unit or the integrated train-borne information system (IBIS) to exchange vehicle data entered by the train driver

*Characteristics*

— Three frequencies:

  — 50 kHz checking channel

  — 100 kHz energy channel

  — 850 kHz data channel

— Data transmission modes:

  — Time-division multiplex for serial transmission of telegrams with up to 104 usable data bits

  — On-board data processing (not fail safe)

  — Single computer processing (supplementary performance level)

— Display to the driver:

  — one four-digit LCD showing:

    — '8 – – 8': no monitoring or

    — '8 8 8 8': monitoring the maximum train speed or

    — '– – – –': monitoring the maximum authorised line speed or

    — '6 0': target speed or

    — 'I I I I': information 'proceed' received by a loop

— Lamps and horn:

  — emergency brake applied

  — equipment failure

— Buttons:

  — testing button

  — emergency stop reset

  — release button (together with 'Signum' release button)

— Train data input:

  — train-borne radio-operating panel is used

— Supervision/commands:

  — line speed

  — stopping point

  — speed restrictions

  — dynamic brake profile

  — control of radio channels

— Reaction:

  — the emergency brake is called if the threshold speed is reached

  — abort speed monitoring if movement supervision is violated

— Responsible State: Switzerland

*PART 2: RADIO*

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2. UIC Radio Chapter 1 to 4 and 6

3. UIC Radio Chapter 1 to 4 and 6 and 7

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6. FS ETACS and GSM

These systems are currently in use in Member States. For detailed information, reference has to be made to the register of infrastructure as defined in Annex C.

**UIC Radio Chapter 1 to 4**

*Description*

This ground/train radio follows the technical regulations described in UIC code 751-3, third edition, 1.7.1984. It is a minimum subset necessary for international railway traffic.

The UIC radio is an analogue radio, which consists of lineside and mobile (train-borne) equipment.

Radio systems following this basic subset allow for simplex and duplex voice communication and use of operating signals (tones), but not for selective calls and for data transmission.

*Main characteristics*

— Frequencies:

  — train to ground:

    457,450 MHz..458,450 MHz.

  — ground to train:

    — band A: 467,400 MHz..468,450 MHz.

    — band B: 447,400 MHz..448,450 MHz (only to be used when band A is not available).

  — frequency spacing 25 kHz

  — duplex frequency couples 10 MHz apart

  — grouping of 4 channels, preferred 62 ... 65 for international traffic

  — agreement on frequencies used bilateral or multilateral

— Sensitivity:

  — > 1 μV at > 20 dB signal-to-noise ratio (mobile)

  — > 2 μV (lineside)

— Radiating power:

  — 6 W mobile

  — 6 W lineside

— Antenna characteristics:

  — λ/4 omnidirectional (mobile)

  — 4 m above rail (mobile)

  — omnidirectional or directional (lineside)

  — in tunnels leaky cables or very directional aerials (lineside)

  — terminating resistor 50 Ohms

— Polarisation:

  — vertical

  — in tunnels, any polarisation

— Frequency deviation:

  — < 1,75 kHz for operating tone

  — < 2,25 kHz for voice

— Modes of operation:

  — mode 1, duplex mode

  — mode 2, semiduplex mode

— Switchover of channels onboard

  — manually by input of channel number

  — automatic, depending on receiver voltage

— Operating tones:

  — channel free: 2 280 Hz

  — listening: 1 960 Hz

  — pilot: 2 800 Hz

  — warning: 1 520 Hz

— Responsible Member States: France, Germany, Luxembourg

**UIC Radio Chapter 1 to 4 and 6**

*Description*

This ground/train radio follows the technical regulations described in UIC code 751-3, third edition, 1.7.1984.

The UIC radio is an analogue radio, which consists of lineside and mobile (train-borne) equipment.

Radio systems following this basic subset allow for simplex and duplex voice communication and use of operating signals (tones), and for selective calls and for data transmission.

*Main characteristics*

— Frequencies:

  — train to ground:

    457,450 MHz..458,450 MHz.

  — ground to train:

    — band A: 467,400 MHz..468,450 MHz.

    — band B: 447,400 MHz..448,450 MHz (only to be used when band A is not available).

— frequency spacing 25 kHz

— duplex frequency couples 10 MHz apart

— grouping of 4 channels, preferred 62 ... 65 for international traffic

— agreement on frequencies used bilateral or multilateral

— Sensitivity:

— > 1 μV at > 20 dB signal-to-noise ratio (mobile)

— > 2 μV (lineside)

— Radiating power:

— 6 W mobile

— 6 W lineside

— Antenna characteristics:

— λ/4 omnidirectional (mobile)

— 4 m above rail (mobile)

— omnidirectional or directional (lineside)

— in tunnels leaky cables or very directional aerials (lineside)

— terminating resistor 50 Ohms

— Polarisation:

— vertical

— in tunnels, any polarisation

— Frequency deviation:

— < 1,75 kHz for operating tone

— < 2,25 kHz for voice

— Modes of operation:

— mode 1, duplex mode

— mode 2, semi-duplex mode

— Switchover of channels onboard

— manually by input of channel number

— automatic, depending on receiver voltage

— Operating tones:

— channel free: 2 280 Hz

— listening: 1 960 Hz

— pilot: 2 800 Hz

— warning: 1 520 Hz

— Telegram structure:

— synchronisation header: 1111 1111 0010

— 6-decimal train number BCD coded

— two positions of information four bits each

— 7 bit redundancy code, polynomial: 1110 000 1 (H = 4)

— Telegram transmission:

— 600 bits/sec

— FSK, '0' = 1 700 Hz, '1' = 1 300 Hz

— Messages (coding given in hexadecimal representation)

— lineside to train:

| | |
|---|---|
| — speech | 08 |
| — emergency stop | 09 |
| — test | 00 |
| — run faster | 04 |
| — run slower | 02 |
| — announcement by loudspeaker | 0C |
| — written order | 06 |
| — extension of telegram | 03 |

— Train to lineside:

| | |
|---|---|
| — communication desired | 08 |
| — acknowledgement of order | 0A |
| — advice | 06 |
| — test | 00 |
| — train staff wish to communicate | 09 |
| — telephone link desired | 0C |
| — extension of telegram | 03 |

— Responsible Member States: Austria, Belgium, Denmark, Germany, the Netherlands, Norway, Spain

**UIC Radio Chapter 1 to 4 and 6 and 7**

*Description*

This ground/train radio follows the technical regulations described in UIC code 751-3, third edition, 1.7.1984. Chapter 7 of the edition of 1.1.1988.

The UIC radio is an analogue radio, which consists of lineside and mobile (trainborne) equipment.

Radio systems following this basic subset allow for simplex and duplex voice communication and use of operating signals (tones), and for selective calls and for data transmission. The data transmission capabilities are extended. This feature is not considered mandatory in the UIC leaflet. If it cannot be assured by bilateral or multilateral agreement, it should be used on a national basis only.

*Main characteristics*

— Frequencies:

— Train to ground:

457,450 MHz..458,450 MHz

— ground to train:

— band A: 467,400 MHz..468,450 MHz.

— band B: 447,400 MHz..448,450 MHz (only to be used when band A is not available).

— frequency spacing 25 kHz

— duplex frequency couples 10 MHz apart

— grouping of 4 channels, preferred 62 ... 65 for international traffic

— agreement on frequencies used bilateral or multilateral

— Sensitivity:

— > 1 μV at > 20 dB signal to noise ratio (mobile)

— > 2 μV (lineside)

— Radiating power:

— 6 W mobile

— 6 W lineside

— Antenna characteristics:

— λ/4 omnidirectional (mobile)

— 4 m above rail (mobile)

— omnidirectional or directional (lineside)

— in tunnels leaky cables or very directional aerials (lineside)

— terminating resistor 50 Ohms

— Polarisation:

— vertical

— in tunnels, any polarisation

— Frequency deviation:

— < 1,75 kHz for operating tone

— < 2,25 kHz for voice

— Modes of operation:

— mode 1, duplex mode

— mode 2, semi-duplex mode

— Switchover of channels onboard:

— manually by input of channel number

— automatic, depending on receiver voltage

— Operating tones:

— channel free: 2 280 Hz

— listening: 1 960 Hz

— pilot: 2 800 Hz

— warning: 1 520 Hz

— Telegram structure:
  — sync. header: 1111 1111 0010
  — 6-decimal train number BCD coded
  — two positions of information four bits each
  — 7-bit redundancy code, polynomial: 1110 000 1 (H = 4)
— Telegram transmission:
  — 600 bits/sec
  — FSK, '0' = 1 700 Hz, '1' = 1 300 Hz
— Messages (coding given in hexadecimal representation)
  — lineside to train:

| | |
|---|---|
| — speech | 08 |
| — emergency stop | 09 |
| — test | 00 |
| — run faster | 04 |
| — run slower | 02 |
| — announcement by loudspeaker | 0C |
| — written order | 06 |
| — extension of telegram | 03 |

  — Train to lineside:

| | |
|---|---|
| — communication desired | 08 |
| — acknowledgement of order | 0A |
| — advice | 06 |
| — test | 00 |
| — train staff wish to communicate | 09 |
| — telephone link desired | 0C |
| — extension of telegram | 03 |

— Extension of telegram (only if requested by code 03)
  — radiotelephone system with simultaneous digital message transmission
    — duplex exchange of voice information
    — duplex exchange of data messages of any length
    — simplex exchange of voice information between mobiles in the same radio section
    — speech-data time-division multiplexing (mobile to lineside):
      — 260 msec data transmission
      — 780 msec compressed speech
    — HDLC frame structure according to ISO for data transmission (lineside to mobile)
    — 1 200 bit/sec
    — FSK, '0' = 1 800 Hz, '1' = 1 200 Hz
— Responsible Member State: France

**Introduction to United Kingdom systems**

The system called NRN (national radio network) is installed over the whole of the UK rail network including the high-speed lines which are the backbone of the UK high-speed network. These consist of:

— west coast main line (London-Glasgow)

— east coast main line (London-Edinburgh)

— Great Western main line (London-Bristol/South Wales)

The system called 'Cab secure' is installed in high traffic suburban areas around London, Liverpool and Glasgow, some of which may include lines forming part of the high-speed network. In addition, all main lines in the south-east, including the existing channel tunnel route from the coast to London Waterloo, are equipped with the cab secure system.

On lines where both systems exist, the main line passenger trains, plus freight and national trains are equipped with Cab secure radio. Trains are not equipped with both types of radio.

**BR 1845 issues G and H (lineside)**

**BR 1661 issue A (train-borne)**

**commonly called Cab secure radio**

*Description*

This ground/train radio follows the technical regulations described in railtrack specifications (BR specification 1845 issues G and H and in BR 1661 issue A).

The Cab secure radio is an analogue radio, which consists of lineside and mobile (trainborne) equipment.

Radio systems following this basic subset allow for duplex voice communication and use of operating signals (tones), and for selective calls and for data transmission.

*Main characteristics*

— Frequencies:

  — train to ground:

    448,34375..448,48125 MHz. (Note: There are additional channels for which the information is to be obtained.)

  — ground to train:

    454,84375 MHz..454,98125 MHz.

  — frequency spacing 12,5 kHz

  — duplex frequency couples 6,5 MHz apart

  — agreement on frequencies used bilateral or multilateral

— Sensitivity:

  — 1 μV at > 20 dB signal to noise ratio (mobile)

  — < 2 μV (lineside)

— Radiating power:

  — 10 W mobile

  — 10 W lineside

- Antenna characteristics:
  - λ/4 omnidirectional (mobile)
  - 4 m above rail (mobile)
  - omnidirectional or directional (lineside)
  - in tunnels leaky cables or very directional aerials (lineside)
  - terminating resistor 50 Ohms
- Polarisation:
  - vertical
  - in tunnels, horizontal
- Frequency deviation:
  - 300 Hz for CTCSS tones
  - 1,5 kHz for data transmission
  - 1,75 kHz for emergency tone
  - < 2,5 kHz for voice
- Modes of operation:
  - mode 1, duplex mode
- Switchover of channels onboard:
  - manually by input of channel number
  - automatic, depending on message sent from control centre
- Operating tones:
  - CTCSS: X, Y, Z, 203,5 Hz
  - emergency call: 1 520 Hz
- Telegram structure:
  - synchronisation header: 00100011 11101011
  - information elements
    - signalling telegrams (three bytes)
      - message type (system free, system busy, general call, emergency acknowledgement, etc.)
      - area code
      - channel number
    - data telegrams (eight bytes)
      - message type (system free, system busy, general call, emergency acknowledgement, etc.)
      - area Code
      - channel number plus train number in five decimal character or four-alphanumeric character BCD-coded format, or signal number (three bytes).
      - Train Stock number (6 digits) (three bytes)
  - 7–bit redundancy code, polynomial: 110011011 (H = 4)

— Telegram transmission:

  — 1 200 bit's

  — FFSK, '0' = 1 800 Hz, '1' = 1 200 Hz

— Messages (coding given in hexadecimal representation)

  — lineside to train:

    — test 00

    — speech 02

    — announcement by loudspeaker 04

    — wait at signal 06

    — emergency stop 0A

    — change area, system free 0C

    — change area, system busy 0E

  — train to lineside:

    — test 80

    — communication desired 82

    — set up signal number 84

    — emergency answer 86

    — busy 88

    — cancel call 90

    — DSD alarm 96

— Responsible Member State: United Kingdom

**BR 1609 issue 2**

**Commonly called national radio network (NRN)**

*Description*

This ground/train radio follows the technical regulations described in Railtrack specification BR 1609, issue 2, August 1987.

The national radio network is an analogue radio which consists of lineside and mobile (train-borne) equipment.

Radio systems following this basic subset allow for duplex voice communication (lineside), simplex voice communication (train-borne), broadcast mode and use of operating signals (tones), for selective calls and for data transmission.

*Main characteristics*

— Frequencies: sub-band 2 of the 174 MHz to 225 MHz band

  — 196,85 to 198,3 MHz train to ground

  — 204,85 to 206,3 MHz ground to train

  — frequency spacing 12,5 kHz

  — duplex frequency couples 8,0 MHz apart

  — not all the frequencies within the bands indicated are used

— Sensitivity:

  — < 0,6 μV at 12 dB signal-to-noise ratio (mobile)

  — < 0,3 μV at 12 dB signal-to-noise ratio (lineside)

— Radiating power:

  — > 25 W mobile

  — > 25 W lineside

— Antenna characteristics:

  — λ/4 omnidirectional (mobile)

  — 4 m above rail (mobile)

  — omnidirectional or directional (lineside)

  — terminating resistor 50 Ohms

  — no coverage in tunnels

— Polarisation:

  — vertical

— Modes of operation:

  — duplex mode (fixed to fixed)

  — simplex mode (fixed to mobile)

— Switchover of channels on-board

  — manual input of common signalling channel. Most journeys in the UK are within one area and the driver enters it at the start of the journey

  — automatic change to voice channel following a message sent from control centre

— Audio frequency range:

  — 300 Hz ...2 500 Hz for speech

— Frequency deviation:

  — < 2,5 kHz

— Message transmission:

  — 1 200 bits/sec

  — FFSK, '0' = 1 800 Hz, '1' = 1 200 Hz

— Message structure:

  — data modulation for all RF signalling shall conform to MPT1323 section 6, with message formats generally as defined in MPT1327

— Message types from a train:

  — complete number required. It will contain the identity of the radio. It is sent once after receipt of a 'channel free' telegram

  — clear-down

  — PTT telegram which is sent each time the transmitter is keyed. It gives the identity of the radio

  — auto-reply telegram when the radio is selectively called. It contains the identity of the radio

  — emergency call: It contains the identity of the radio. It does not require receipt of a free telegram

  — priority call

— Message types to a train:

  — selective calling telegram: this initiates an auto-reply telegram

  — channel free telegram

  — go to channel telegram: this directs the radio to a particular channel, opens the loudspeaker and sounds an alert tone

  — clear-down telegram: this clears the call, closes the loudspeaker and returns the radio to the call set-up channel

  — call fail telegram: this is the same as clear-down but also indicates call failure to the user

  — general call telegram: this is a special version of the 'go to channel instruction'

— Responsible Member State: United Kingdom

**FS ETACS and GSM**

*Description*

The solution for radio train-to-ground communication working today at FS is primarily based on the use of services supplied by the public operator on the analogue (ETACS) and the digital (GSM) mobile cellular networks in the 900 MHz band. These networks have been implemented with an external subsystem, developed by the operator together with FS in order to manage some special features as requested by FS, related for example to:

— addressing of train and station calls through functional numbers in place of the terminal number

— closed group features with specific barring conditions

— configuration and handling of specialised databases directly by FS people to characterise access rights to services for each kind of users, and so on.

Thanks to the wide radio coverage supplied by the two public cellular systems on the FS railway network, the general train-to-ground communication needs can be satisfied in this way.

The additional features were negotiated and implemented by FS in cooperation with the public service provider. They are implemented in highly reliable distributed computer systems. They are therefore part of the application layer in the ISO/OSI layer model.

— Responsible Member State: Italy

**UIC Radio Chapter 1—4 (TTT radio system installed at Cascais line)**

*Description*

This ground/train radio follows the technical regulations described in UIC code 751-3, third edition, 1.7.1984. It is a minimum subset necessary for international railway traffic.

The UIC radio is an analogue radio, which consists of lineside and mobile (train-borne) equipment.

Radio systems following this basic subset allow for simplex and half-duplex voice communication and use of operating signals (tones), but not for selective calls and for data transmission:

*Main characteristics*

Frequencies:

— Train to ground:

  457,700 MHz..457,800 MHz.

— Ground to train:

  Band A: 467,625 MHz. 467,875 MHz

— Frequency spacing 12,5 kHz

— Duplex frequency couples 10 MHz apart

— Grouping of four channels, preferred 62, 63, 73 and 75 for international traffic

Sensitivity:

— > 1 mV at > 20 dB signal-to-noise ratio (mobile)

— > 2 mV (lineside)

Radiating power:

— 6 W mobile

— 6 W lineside

Antenna characteristics:

— λ/4 omnidirectional (mobile)

— 4 m above rail (mobile)

— omnidirectional or directional (lineside)

— in tunnels leaky cables or helical antennas (lineside)

— terminating resistor 50 Ohms

Polarisation:

— vertical

— in tunnels, any polarisation

Frequency deviation:

— 0,9 *0,05 kHz for operating tone

— < 2,3 kHz for voice

Modes of operation:

— mode 1, half-duplex mode

— mode 1, simplex mode

Switchover of channels on board:

— manually by input of group number

— automatic inside the group, depending on receiver voltage

Operating tones:

— channel free: 2 280 Hz

— listening: 1 960 Hz

— pilot: 2 800 Hz

— warning: 1 520 Hz

Responsible Member State: Portugal

**TTT Radio System CP_N**

*Description*

This TTT radio system is a tailored one, designed for voice and data communications and according CP requirements.

The CP_N radio is an analogue radio, which consists of lineside and mobile (train-borne) equipment.

Radio system use digital selective call (according MPT 1 327—1 200 bit/s FFSK) and 50 baud subaudio FSK for base station signalling.

The radio allows simplex and half-duplex voice communication and half-duplex for selective calls and for data transmission.

*Main characteristics*

Frequencies:

— train to ground:

457,700 MHz..457,800 MHz.

— ground to train:

Band A: 467,625 MHz. 467,875 MHz

— frequency spacing 12,5 kHz

— duplex frequency couples 10 MHz apart

— grouping of four channels, preferred 62, 63, 73 and 75 for international traffic

Sensitivity:

— 1 mV at > 20 dB signal to noise ratio (mobile)

— 2 mV (lineside)

Radiating power:

— 6 W mobile

— 6 W lineside

Antenna characteristics:

— λ/4 omnidirectional (mobile)

— 4 m above rail (mobile)

— omnidirectional or directional (lineside)

— in tunnels leaky cables or helical antennas (lineside)

— terminating resistor 50 Ohms

Polarisation:

— vertical

— in tunnels, any polarisation

RF Modulation:

— radiomodem 1 200b/s, FM

— radiomodem (Tx only) 50 baud subaudio, FM

— voice in PM

Frequency deviation:

— 1,75 kHz for FFSK (1 200 bit/s)

— 0,3 kHz for FSK (50 baud)

— < 2,3 kHz for voice

Modes of operation:

— mode 1, half-duplex mode

— mode 1, simplex mode

Switchover of channels onboard

— manually by input of group number

— automatic inside the group, depending on receiver voltage

Telegram structure:

— according MPT 1327

Telegram transmission:

— 1 200 bits/sec

— FFSK, '0' = 1 800 Hz, '1' = 1 200 Hz

Responsible Member State: Portugal

*ANNEX C*

**LINE-SPECIFIC CHARACTERISTICS AND TRAIN-SPECIFIC CHARACTERISTICS FOR LINES AND TRAINS DECLARED AS INTEROPERABLE, AND RESULTING REQUIREMENTS**

1. **General requirements**

As stated in section 7, the line-specific characteristics defined in this Annex shall be included in the register of infrastructure by the infrastructure manager of lines declared as interoperable by the responsible Member State (Article 14 of Directive 96/48/EC) in the frame of the trans-European high-speed rail system (Annex I to Directive 96/48/EC).

As stated in section 7, the train-specific characteristics defined in this Annex shall be included in the register of rolling stock by the train operator of trains declared as interoperable in the frame of the trans-European high-speed rail system (Annex I to Directive 96/48/EC).

As stated in section 6.2, as a precondition for operating a train, the corresponding register of rolling stock and register of infrastructure have to be cross-checked for the sake of interoperability.

Annex C deals with those aspects of the control-command assemblies which are covered neither by Annex A nor by Annex B, and with the options permitted for class A and class B systems and interfaces (see Figure 1).

2. **Register of infrastructure**

This TSI allows some options of equipment, functions and infrastructure-related values. In addition, where European specifications do not cover the whole control-command trackside assembly, special requirements in the context of existing technical systems and in particular the use of specific operational requirements are possible and are the responsibility of the infrastructure controller.

Such information concerns for example:

— choices in the frame of technical compatibility requirements listed in Annex A,

— choices in the frame of technical compatibility requirements listed in Annex B,

— EMC-values (because of the use of equipment which is not covered by European specification referred to by TSIs, for instance axle-counter systems),

— climatic conditions and physical conditions along the line.

This information has to be available for and used by the train operators in the form of a line specific handbook (register of infrastructure) which can also contain other particularities of other TSIs (e.g., the TSI operation contains in the rule book Annex B systems and degraded modes)

The register of infrastructure may be specific to one line or a group of lines having the same characteristics.

The objective is that the requirements and characteristics stated in the register of infrastructure and in the register of rolling stock accord with the TSIs; particularly they must not be a hindrance to interoperability.

3. **Register of rolling stock**

In the frame of this TSI, for the train operator, some choices of equipment, functions and values related to the type of train are foreseen. In addition, because European specifications do not cover the whole onboard assembly control-command the infrastructure controller needs additional information concerning the use of class B systems, and the characteristics of the train which are relevant for trackside non-class B systems. This information concerns, for example:

— choices in the frame of technical compatibility requirements listed in Annex A,

— choices in the frame of technical compatibility requirements listed in Annex B,

— EMC values (because of the use on the lines concerned of equipment which is not covered by European specification referred to by TSIs, for instance track circuits being sensitive to traction currents and their harmonics and axle-counters systems being sensitive to electromagnetic fields),

— geometric and electrical parameters of the train such as length, maximal distance of axles in the train, length of the nose of the first and of the last car of the train, maximal electrical resistance between the wheels of an axle (in context with Annex A, item 16, because of the track-circuit design arrangement),

— braking parameters for class A system,

— braking parameters for class B systems,

— general braking parameters,

— types of brakes,

— eddy current brake installed,

— magnetic brake installed,

— climatic conditions and physical conditions in which the train is specified to operate.

This information has to be available for and to be used by the infrastructure managers by means of a train specific handbook (register of rolling stock) which can also address the possibility of or the need for auxiliary functions for the train to be manageable or to be managed by control-command, e.g., for passage of neutral sections, speed reduction in special circumstances depending of the train and line characteristics (tunnels) and particularities of other TSIs.

The register of rolling stock can be specific to one train or a category of trains having the same characteristics

4. **Lists of specific characteristics and requirements**

The following list is the mandatory requirement for the register of infrastructure and for the register of rolling stock in order to describe sufficiently the specific characteristics and requirements, and to facilitate interoperability. The list deals only with technical issues, the operational issues are contained in the TSI operation.

The requirements may be satisfied by the application of a standard. In this case, the reference concerned must be given in these handbooks.

Otherwise, any special requirements (methods of measurement) must be inserted into or appended to the register of rolling stock and the register of infrastructure.

For class B systems, the measures implemented in the context of the responsible Member State given in Annex B apply. The register of infrastructure shall include the following items:

— responsible Member State,

— name of Annex B system,

— version and placing-into-service date,

— speed restrictions and other class B specific conditions/requirements, due to system limitations,

— further details according to the lists below.

**List of specific technical characteristics and the requirements associated with an interoperable line (from A to B) and with an interoperable train (type xyz)**

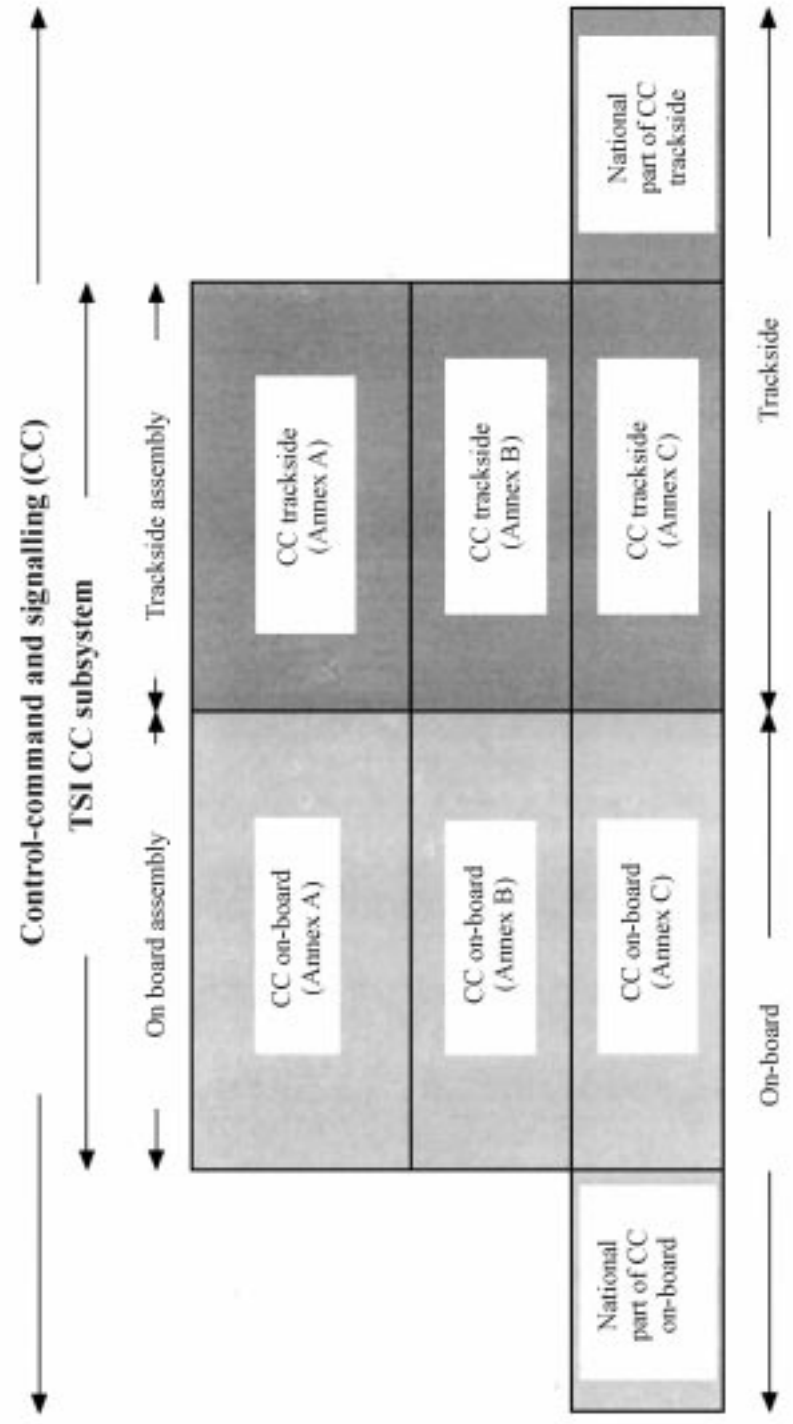
| No | Line (register of infrastructure) | Train (register of rolling stock) |
|---|---|---|
| 1 | (a) ERTMS/ETCS level of application, optional functions installed lineside and required on-board, and version number including the placing-in-service date,<br>(b) ERTMS/GSM-R radio, optional functions as specified in the FRS, and the version number including placing-in-service date. | (a) ERTMS/ETCS level of application, optional functions installed and version number including placing-in-service date,<br>(b) ERTMS/GSMR radio, optional functions according to the FRS and version number including placing-in-service date. |

| No | Line (register of infrastructure) | Train (register of rolling stock) |
|---|---|---|
| 2 | Indicate for:<br>(a) each class B train protection, control and warning system; and<br>(b) each class B radio system;<br>installed on the interoperable line, the versions (including period of validity, and if there is a need for more than one system to be active simultaneously). | Indicate for:<br>(a) each class B train protection, control and warning system; and<br>(b) each class B radio system;<br>installed on the interoperable train, the versions (including period of validity) and if there is a need of more than one system to be active simultaneously). |
| 3 | For ERTMS/ETCS level 1 with infill function:<br>which technical implementation is required of rolling stock | For ERTMS/ETCS level 1 with infill function:<br>which technical implementation is used. |
| 4 | Special technical conditions required to switch over between different class B train protection, control and warning systems. | Special conditions implemented on-board to switch over between different class B train protection, control and warning systems. |
| 5 | Special technical conditions required to switch over between different radio systems. | Special conditions implemented on-board to switch over between different radio systems. |
| 6 | Technical degraded modes of:<br>(a) ERTMS/ETCS;<br>(b) class B train protection, control and warning systems;<br>(c) ERTMS/GSM-R;<br>(d) class B radio systems;<br>(e) lineside signalling. | Available technical degraded modes for:<br>(a) ERTMS/ETCS;<br>(b) class B train protection, control and warning systems;<br>(c) ERTMS/GSM-R;<br>(d) class B radio systems. |
| 7 | Speed limits applied because of limited braking performance, e.g. because of braking distances available and because of gradients:<br>(a) to ERTMS/ETCS operating modes;<br>(b) to class B train protection, control and warning systems.<br>National technical rules for operating class B systems, relevant for the trains. | (a) Speed limits related to train characteristics and to be supervised by control-command,<br>(b) Braking characteristics input data for ERTMS/ETCS and class B train protection, control-and-warning systems. |
| 8 | Susceptibility of infrastructure-side control-command and signalling to emission from trains in terms of electromagnetic compatibility with respect to admission of trains. To be specified where available according to European standards (prEN 50238 and other future standards — to be defined) to meet safety and reliability/availability targets.<br>Permissibility to use Eddy-current brake (types)<br>Permissibility to use magnetic brake (types) | Electromagnetic emission of the train with respect to admission of the train in terms of electromagnetic compatibility. To be specified where available according to European standards (prEN 50238 and other future standards — to be defined) to meet safety and reliability/availability targets.<br>Eddy-current brake installed (type)<br>Magnetic brake installed (type) |
| 9 | Climatic conditions and physical conditions along the line (to be described in accordance with Annex A, index 3). | Climatic conditions and physical conditions in which the on-board assembly can work (to be described according to Annex A, index 3). |
| 10 | The requirements for technical solutions concerning implemented derogations according Directive 96/48/EC have to be described. | The rules for technical solutions concerning implemented derogations according Directive 96/48/EC have to be described. |

*ANNEX D*

TSI CC (high-speed rail system) — Figure 1

This figure shows the principle only



*ANNEX E*

## MODULES FOR EC DECLARATION OF CONFORMITY AND EC DECLARATION OF SUBSYSTEM VERIFICATION

### Module B (type-examination)

*Conformity assessment of interoperability constituents*

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 its 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 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 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,

(*) This clause is not applicable to the European specifications that are used to define basic parameters. These are indicated in Annex A.

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 specification 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 modifications 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 repeated.

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 will 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 established within the Community must keep with the technical documentation copies of the 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.

(*) This clause is not applicable to the European specifications that are used to define basic parameters. These are indicated in Annex A.

**Module D (production quality assurance)**

*Conformity assessment of interoperability constituents*

1. This module describes the procedure whereby the manufacturer or his authorised representative established within the Community 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 Decision 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 – 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 established within the Community 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 will 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 the 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 of 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 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 are:

— 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 established within the Community 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.

**Module F (product verification)**

*Conformity assessment of interoperability constituents*

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 of 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 EC type-examination certificate and with the requirements of the Directive 96/48/EC and 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 type-examination certificate and with the requirements of 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 the TSI or equivalent tests shall be carried out in order to verify their conformity with the type as described in the type-examination certificate and the requirements of the TSI that apply to them (*).

4.2. The notified body must draw up a written certificate of conformity for the approved products 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.

(*) This clause is not applicable to the European specifications that are used to define basic parameters. These are indicated in Annex A.

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 of Directive 96/48/EC, or equivalent tests, shall be carried out to ensure their conformity with the requirements of the Directive 96/48/EC and of 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 established within the Community 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 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 of 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 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 are:

— the EC type-examination certificate and its additions,

— the certificate of conformity as mentioned under point 4 or 5.

7. The manufacturer or his authorised representative established within the Community 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.

(*) This clause is not applicable to the European specifications that are used to define basic parameters. These are indicated in Annex A.

**Module H2** [1] **(full quality assurance with design examination)**

*Conformity assessment of interoperability constituents*

1. This module describes the procedure whereby a notified body carries out an examination of the design of an interoperability constituent and the manufacturer or his authorised representative established within the Community 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 of 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 of Directive 96/48/EC will not be applied in full, the means that will be used to ensure that the requirements of the Directive 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 — December 2001, completed if necessary to take into consideration the specificity of the interoperability constituent for which it is implemented.

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([1]) Module H2 can be applied only when a sufficient degree of confidence in the ERTMS technologies exists through return of experience from commercial installations.

(*) This clause is not applicable to the European specifications that are used to define basic parameters. These are indicated in Annex A.

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 reassessment 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 point 3.4, and points 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 Directive 96/48/EC and of 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 of Directive 96/48/EC 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 modifications 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 repeated.

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 will receive copies, on request, of:

— the quality system approvals and additional approvals issued, and

— the design examination certificates and additions issued.

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 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 of 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.

(*) This clause is not applicable to the European specifications that are used to define basic parameters. These are indicated in Annex A.

The certificates to be referred to are:

— 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 established within the Community 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.

**Module SB (type-examination)**

*EC verification of control-command subsystem* (**)

1. This module describes the part of 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 a type of a control-command subsystem, representative for the production envisaged,

— complies with this TSI and any other applicable TSI, which demonstrates that the essential requirements of the Directive 96/48/EC have been met,

— complies with the other regulations deriving from the Treaty.

2. The adjudicating entity or its authorised representative established within the Community must lodge an application for EC verification (through type-examination) 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, as described in point 3.

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

A type may cover several versions of the subsystem 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 so required for specific test or examination methods and specified in the TSI or in the European specification referred to in Article 10 of Directive 96/48/EC, also a specimen or specimens of a subassembly or assembly or a specimen of the subsystem in a pre-assembled condition has to be delivered.

The technical documentation must enable the design, manufacture, installation and operation of the subsystem to be understood, and shall enable conformity with the provisions of Directive 96/48/EC and of the TSI to be assessed. It must, as far as relevant for such assessment, cover the design, manufacture and operation of the subsystem.

It must include:

— a general description of the subsystem, overall design and structure,

— the Infrastructure or rolling stock register (as appropriate), including all indications as specified in the TSI,

— conceptual design and manufacturing drawings and schemes of components, subassemblies, assemblies, circuits, etc.,

— descriptions and explanations necessary for the understanding of said drawings and schemes and the operation of the product,

(**) This module applies to both on-board and trackside control-command assemblies.

— 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 Article 10 of Directive 96/48/EC and the relevant clauses have not been applied in full (*),

— a list of the interoperability constituents, to be incorporated into the subsystem,

— technical documentation as regards the manufacturing and the assembling of the subsystem,

— a list of manufacturers, involved in the subsystem's design, manufacturing, assembling and installation,

— conditions for use and maintenance of the subsystem (restrictions of running time or distance, wear limits, etc.),

— a list of the European specifications referred to in Article 10 of Directive 96/48/EC or in the technical design specification,

— results of design calculations made, examinations carried out, etc.,

— test reports.

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

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 subsystem at the completion of the design process,

4.3. if type tests are requested in the TSI, verify that the specimen(s) of the subsystem or of assemblies or subassemblies of the subsystem, required for carrying out type tests, 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 specifications concerned,

4.4. identify the elements which have been designed in accordance with the relevant provisions of the TSI and the European specifications referred to in Article 10 of Directive 96/48/EC, as well as the elements which have been designed without applying the relevant provisions of those European specifications (*);

4.5. perform or have performed the appropriate examinations and necessary tests in accordance with points 4.2 and 4.3 to establish whether, where the appropriate European specifications referred to in the TSI have not been applied, the solutions adopted meet the requirements of the TSI (*);

4.6. perform or have performed the appropriate examinations and necessary tests in accordance with points 4.2 and 4.3 to establish whether, where the relevant European specifications have been chosen, these have actually been applied;

4.7. agree with the applicant the location where the examinations and necessary tests will be carried out.

5. Where the type meets the provisions of Directive 96/48/EC and of the TSI, the notified body must issue an EC type-examination certificate to the applicant. The certificate must contain the name and address of the adjudicating entity and the manufacturer(s), 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 adjudicating entity or its authorised representative established within the Community is denied a type-examination certificate, the notified body must provide detailed reasons for such denial.

Provision must be made for an appeals procedure.

(*) This clause is not applicable to the European specifications that are used to define basic parameters. These are indicated in Annex A.

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 subsystem which must receive additional approval where such changes may affect the conformity with the requirements of Directive 96/48/EC and the TSI or the prescribed conditions for use of the subsystem. This additional approval is given in the form of an addition to the original EC 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 modifications 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 repeated.

8. Each notified body must communicate to the other notified bodies the relevant information concerning the EC type-examination certificates it has withdrawn or refused.

9. The other notified bodies will 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 adjudicating entity or its authorised representative established within the Community must keep with the technical documentation copies of type-examination certificates and their additions throughout the service life of the subsystem, it must be sent to any other Member State who so requests.

**Module SD (production quality assurance)**

*EC verification of control-command 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 a control-command subsystem, for which already an EC type-examination certificate has been issued by a notified body:

   — complies with this TSI and any other applicable TSI, which demonstrates that the essential requirements of Directive 96/48/EC have been met,

   — complies with the other regulations deriving from the Treaty and may be put into service.

   The notified body is carrying out the procedure, under the condition, that the adjudicating entity and the manufacturers involved are satisfying the obligations of point 2.

2. For the subsystem, being subject of the EC verification procedure, the adjudicating entity must contract only with manufacturers, whose activities contributing to the subsystem project to be verified (manufacturing, assembling, installation) are subject to an approved quality system for 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 assembling (assemblers) and installation of the subsystem.

   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 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 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.

(**) This module applies to both on-board and trackside control-command assemblies.

The application must include:

— all relevant information for the subsystem envisaged,

— the quality system's documentation.

— the technical documentation of the approved type and a copy of the type-examination certificate, issued after the completion of the type-examination procedure of module SB.

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 overall compliance of the subsystem with the type as described in the type-examination certificate and overall compliance of the subsystem with the requirements of the TSI. For other manufacturers (subsuppliers) the quality system has to ensure compliance of their relevant contribution to the subsystem with the type as described in the type-examination certificate and 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.,

and for the main contractor:

— responsibilities and powers of the management with regard to overall subsystem quality, including in particular the subsystem integration management.

The examinations, tests and checking shall cover all of the following stages:

— structure of subsystem, including, in particular, civil-engineering activities, constituent assembly, final 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 – 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 reassessment 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 as referred to under point 3.1 must have permanent access for inspection purposes to the locations of building sites, production workshops, locations of assembling and installation, storage areas and, where appropriate, prefabrication or testing facilities and, more general, 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 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 must 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 (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 and may carry out or cause to be carried out tests, in order to check the proper functioning of the quality system where necessary. It must provide the applicant(s) with an inspection report and also, if an audit has been carried out, with an audit report, and, if a test has been carried out with a test 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 point 3.4, and points 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 production quality assurance), including coordination of the surveillance of the quality systems as under point 6.5, with a notified body of its choice. The adjudicating entity or his authorised representative within the Community must inform the manufacturers involved of this choice and of the application.

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

It must include:

— the technical documentation regarding the approved type, including the type-examination certificate, as issued after completion of the procedure defined in module SB, and, if not included in this documentation:

  — 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 of Directive 96/48/EC 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 or rolling stock register (as appropriate), 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 manufacturers 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.

6.3. The notified body must examine the application concerning the validity of the type-examination and the type-examination certificate.

6.4. The notified body must then examine, if all stages of the subsystem as mentioned in the last subparagraph of point 3.2 are sufficiently and properly covered by the approval and surveillance of the quality system(s) of the applicant(s).

If the conformity of the subsystem with the type as described in the EC type-examination certificate and the compliance of the subsystem with the requirements of the Directive 96/48/EC and 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 for the main contractor 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 under its responsibility and together with the other notified body(ies).

6.6. Where the subsystem meets the requirements of Directive 96/48/EC and the TSI, the notified body must then, based on the type-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.

(*) This clause is not applicable to the European specifications that are used to define basic parameters. These are indicated in Annex A.

The EC declaration of verification 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 at least the information included in Annex V to 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, 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 the conditions and limits for use,

— all elements relating to the instructions concerning servicing, constant or routine monitoring, adjustment and maintenance,

— the EC type-examination certificate for the subsystem and the accompanying technical documentation,

— certificate of EC verification of the notified body as mentioned under point 6.5, 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 points 4.4 and 4.5 and in particular:

— the infrastructure or rolling stock register (as appropriate), 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 which so requests.

**Module SF (product verification)**

*EC verification of control-command 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 a control-command subsystem, for which already an EC type-examination certificate has been issued by a notified body:

— complies with this TSI and any other applicable TSI, which demonstrates that the essential requirements of Directive 96/48/EC have been met,

— 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 product 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.

(**) This module applies to both on-board and trackside control-command assemblies.

3. Within that part of the procedure the adjudicating entity or his authorised representative established within the Community checks and attests that the subsystem concerned is in conformity with the type as described in the EC type-examination certificate and satisfies the requirements of Directive 96/48/EC and the TSI that apply to them.

4. The adjudicating entity must take all measures necessary in order that the manufacturing process (including assembling and integration of interoperability constituents) ensures conformity of the subsystem with the type as described in the EC type-examination certificate and with the requirements that apply to them.

5. The technical documentation must enable the design, manufacture, installation and operation of the subsystem to be understood, and shall enable conformity with the type as described in the type-examination certificate and the requirements of the Directive and the TSI to be assessed.

It must include:

— the type-examination certificate and its accompanying documents and additions, and, as far as not included in the documents accompanying the EC type-examination certificate,

— a general description of the subsystem, overall design and structure,

— the infrastructure or rolling stock register (as appropriate), including all indications as specified in the TSI,

— 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 specification, that have been applied,

— the necessary supporting evidence for their adequacy, in particular where European specification 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 specification

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

6. The notified body must carry out the appropriate examinations and tests in order to check the conformity of the subsystem with the type as described in the EC type-examination certificate and with the requirements of Directive 96/48/EC and the TSI by examination and testing of every subsystem, manufactured as a serial product, as specified under point 4.

7. Verification by examination and testing of every subsystem (as a serial product)

7.1. The notified body must carry out the tests, examinations and verifications, to ensure conformity subsystem as serial products with the essential requirements of the Directive and of the TSI. The examinations, tests and checking shall extend to the following stages as provided for in the TSI:

— structure of subsystem, including constituent assembly and overall adjustments,

— final testing of the subsystem,

— and, whenever specified in the TSI, the validation under full operational conditions.

7.2. All subsystems (as serial products) must be individually examined and appropriate tests and verifications as set out in the TSI and in the relevant European specifications (or equivalent tests (*)) shall be carried out in order to verify their conformity with the type as described in the type-examination certificate and the requirements of the TSI that apply to them.

8. The notified body may agree with the adjudicating entity the locations where the tests will be carried out and may agree that final testing of the subsystem and, whenever required in the TSI, tests or validation under full operating conditions, are carried out by the adjudicating entity under direct supervision and attendance of the notified body.

9. The notified body must have permanent access for testing and verification purposes to 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.

(*) This clause is not applicable to the European specifications that are used to define basic parameters. These are indicated in Annex A.

10. Where the subsystem meets the requirements of Directive 96/48/EC and the TSI, the notified body must then, based on the tests, verifications and checkings carried out on all serial products as indicated in point 7 and required in the TSI and in the European specification referred to in Article 10 of Directive 96/48/EC, 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 of the technical file and must contain at least the information included in Annex V to Directive 96/48/EC.

11. 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,

— the infrastructure or rolling stock register (as appropriate), including all indications as specified in the TSI,

— 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,

— EC type-examination certificate and accompanying technical documentation,

— certificate of EC verification of the notified body as mentioned under point 10, 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.

12. 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.

13. 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 which so requests.

**Module SG (Unit verification)**

*EC verification of control-command 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 a control-command subsystem:

— complies with this TSI and any other applicable TSI, which demonstrates that the essential requirements of Directive 96/48/EC have been met,

— 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:

— the name and address of the adjudicating entity or its authorised representative

— the technical documentation.

(**) This module applies to the trackside control-command assembly.

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 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,

— 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 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.

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

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 to 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,

(*) This clause is not applicable to the European specifications that are used to define basic parameters. These are indicated in Annex A.

— 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 request.

**Module SH2** [2] **(full quality assurance with design examination)**

*EC verification of the control-command 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 a control-command subsystem:

— complies with this TSI and any other applicable TSI, which demonstrates that the essential requirements of Directive 96/48/EC have been met,

— 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, being 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.

(2) Module SH2 can be applied only when a sufficient degree of confidence in the ERTMS technologies exists through return of experience from commercial installations.

(**) This module applies to both on-board and trackside control-command assemblies.

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 overall compliance of the subsystem with the requirements of 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 of Directive 96/48/EC 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 overall design and subsystem quality, including in particular the subsystem integration management.

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, final adjustment,

— final testing of the subsystem,

(*) This clause is not applicable to the European specifications that are used to define basic parameters. These are indicated in Annex A.

— 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 — 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 — 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 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 their 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 general, 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 point 3.4, and points 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 established 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 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 or rolling stock register (as appropriate), 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.

6.3. The notified body must examine the application concerning the design examination and where the design meets the provisions of 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 quality system(s).

(*) This clause is not applicable to the European specifications that are used to define basic parameters. These are indicated in Annex A.

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 for the main contractor 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 be ensured 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 under its responsibility and together with the other notified body(ies).

6.6. Where the subsystem meets the requirements of Directive 96/48/EC and 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 to 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, 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 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 or rolling stock register (as appropriate), 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 which so requests.

# 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 (± 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:

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

$P_0$ or = 18 t/axle where V = 250 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 $m/s^2$ 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 rerailing 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 rerailing 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:

| | Speed of non-tilting trains | Minimum distance between track centres |
|---|---|---|
| New lines | V ≤ 250 km/h | 4,00 m |
| | 250 km/h < V ≤ 300 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:

| | Train speed | Minimum distance between track centres |
|---|---|---|
| Upgraded lines | V ≤ 230 km/h | determined on the basis of the reference kinematic profile retained |
| | 230 km/h < V < 250 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 $m^2$ for vehicles designed for GC loading gauge,

— 11 $m^2$ for vehicles designed for GB loading gauge,

— 10 $m^2$ 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:

| | Speed range (km/h) | Limiting value (mm) |
|---|---|---|
| High-speed lines | 250 ≤ V ≤ 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:

| | Speed range (km/h) | Limiting value (mm) |
|---|---|---|
| Upgraded lines | V ≤ 160 | 160 |
| | 160 < V ≤ 200 | 150 |
| | 200 < V ≤ 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.

| | Speed range (km/h) | Maximum limiting value (mm) |
|---|---|---|
| Lines with special characteristics | V ≤ 160 | 180 |
| | 160 < V ≤ 230 | 165 |
| | 230 < V ≤ 250 | 150 |
| | 250 < V ≤ 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 km/h ≤ V ≤ 70 km/h,

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

— 85 mm for switches allowing turnout speeds of 170 km/h < V ≤ 230 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

$\gamma$ is the angle of the conical profile of the wheels

When $\gamma$ is constant, the solution of this differential equation is a sinewave with a wavelength of $\lambda$:

$$\lambda = \sqrt{\frac{r_0 e}{2 \tan \gamma}}$$ 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 (± 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 ≤ 10 000 m |
| 230 km/h < V ≤ 250 km/h | 1 435—1 437 | 1 433—1 442 | 1 433—1 445 |
| 250 km/h < V ≤ 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:

$(\Sigma Y)_{max} = 10 + \frac{P}{3}$ kN, where P 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 $\Delta y^0_{max}$ and $\Delta z^0_{max}$ (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 $\Delta y^0_\sigma$ and $\Delta z^0_\sigma$ | | | | |
| $v \leq 80$ | 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 $\Delta y^0_{max}$ and $\Delta z^0_{max}$ max, QN 3 is defined as QN 3 = 1,3 × QN 2),

— for track twist: the track twist limit is 5 mm/m for V > 160 km/h and 7 mm/m for V<= 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<br>− 1 | + 5/− 2 ([2]) |
| Flange groove width | 40 ([1]) | + 0,5<br>− 0,5 | ([1]) |
| Check-rail gauge: C1, C2, C3, C4 | 1 395 | + 0,5<br>− 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<br>crossings: 45 ≤ H ≤ 60 | + 2<br>− 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 $m/s^2$ 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 °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 °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 mm / + 0 mm,

— distance between the edge of the platform and the centre of the track, parallel to the running surface: −0 mm / + 50 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 tempory 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.

*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,

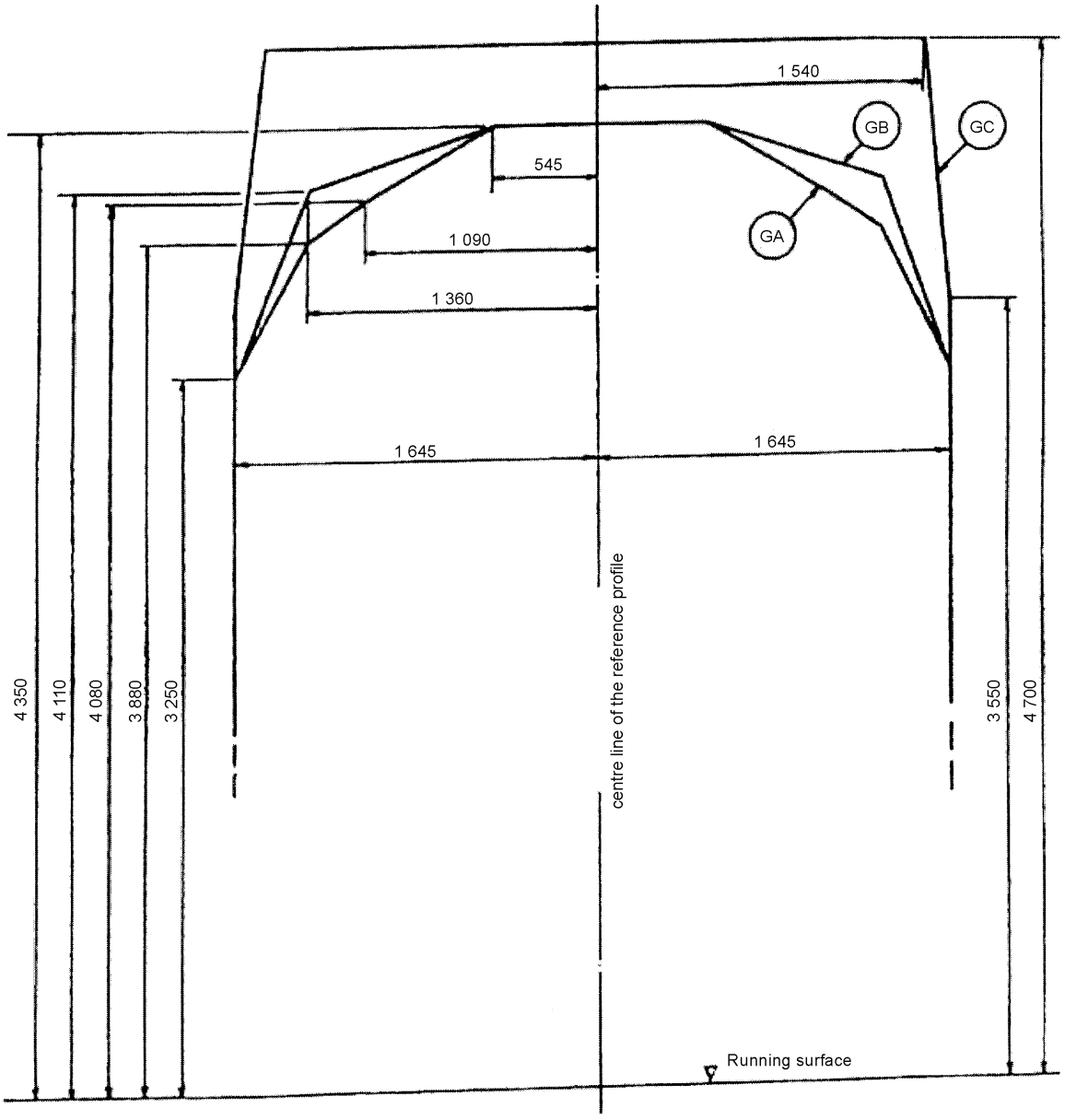
— for each of the homogenous line sections, mention must be made of the application of the community or national regulations that apply, as these relate to the essential requirements, without impeding interoperability of the line, to the extent that those requirements may include obligations to be fulfilled by the railway undertakings operating services on the line.

*ANNEX G*

**GA, GB AND GC KINEMATIC GAUGES**

GA, GB AND GC KINEMATIC GAUGES

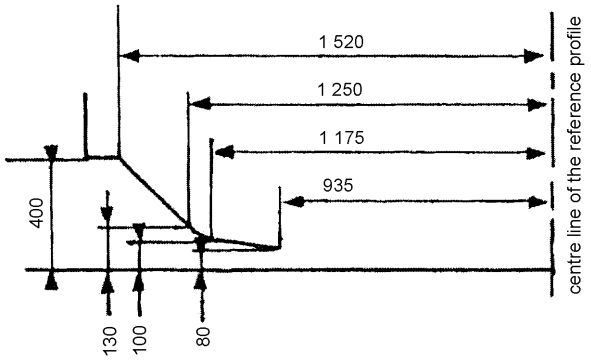
**Reference profiles**



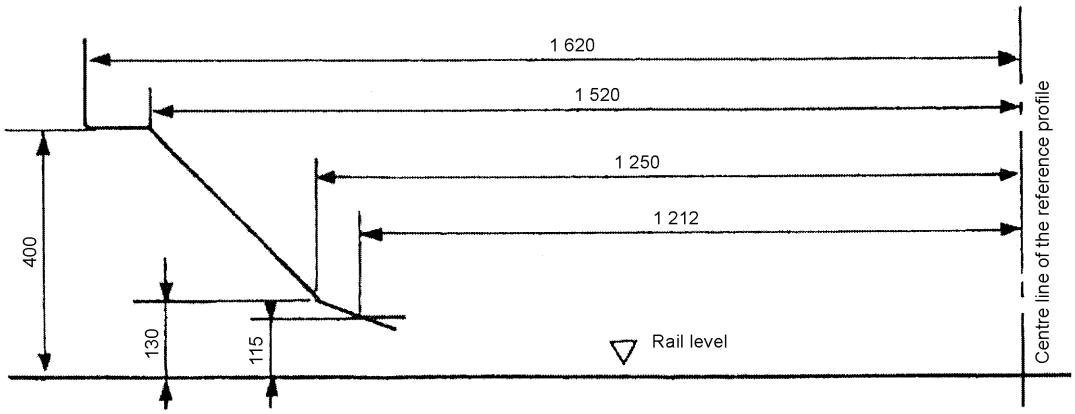

*N.B.*: Up to a height of 3 250 mm, the reference profile of GA, GB and GC gauges is identical.

LOWER PARTS

A. **Lines over which powered units used on international services run**



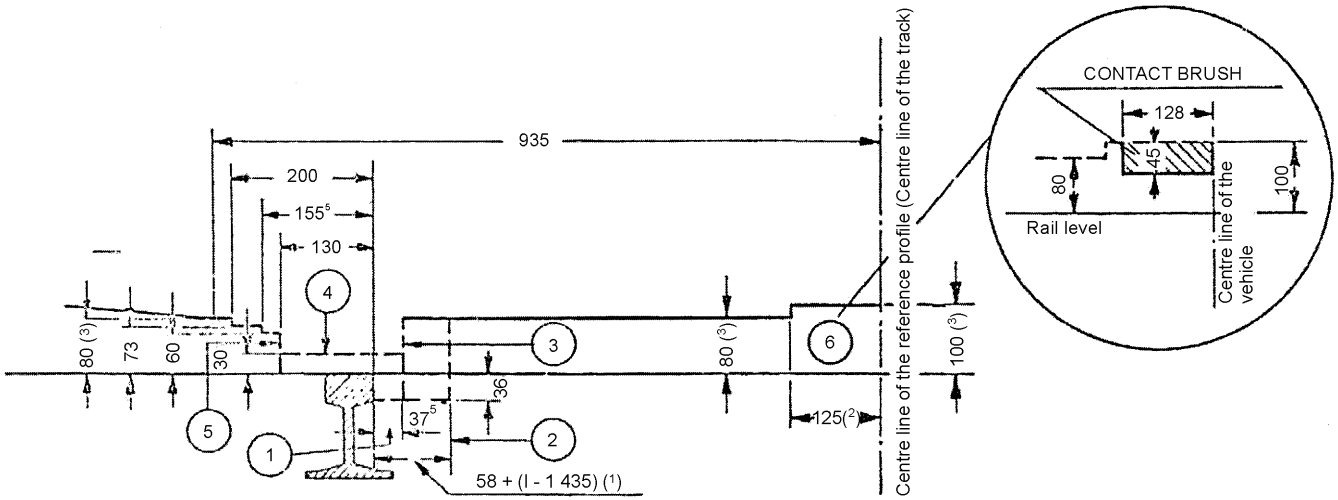

B. **Lines over which coaches, vans and wagons used on international services run**
(with the exception of powered units used on international services)




*Note:* On inclined connections with a radius R ≥ 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 ≥ R ≥ 500 m, the measurement 80 in diagram A is cancelled.

KINEMATIC GAUGE FOR THE LOWER PARTS IN THE AREA OF THE RAIL, THE AREA TAKEN UP BY TRACK BRAKES AND THE AREA OF THE CENTRE LINE OF THE TRACK

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.

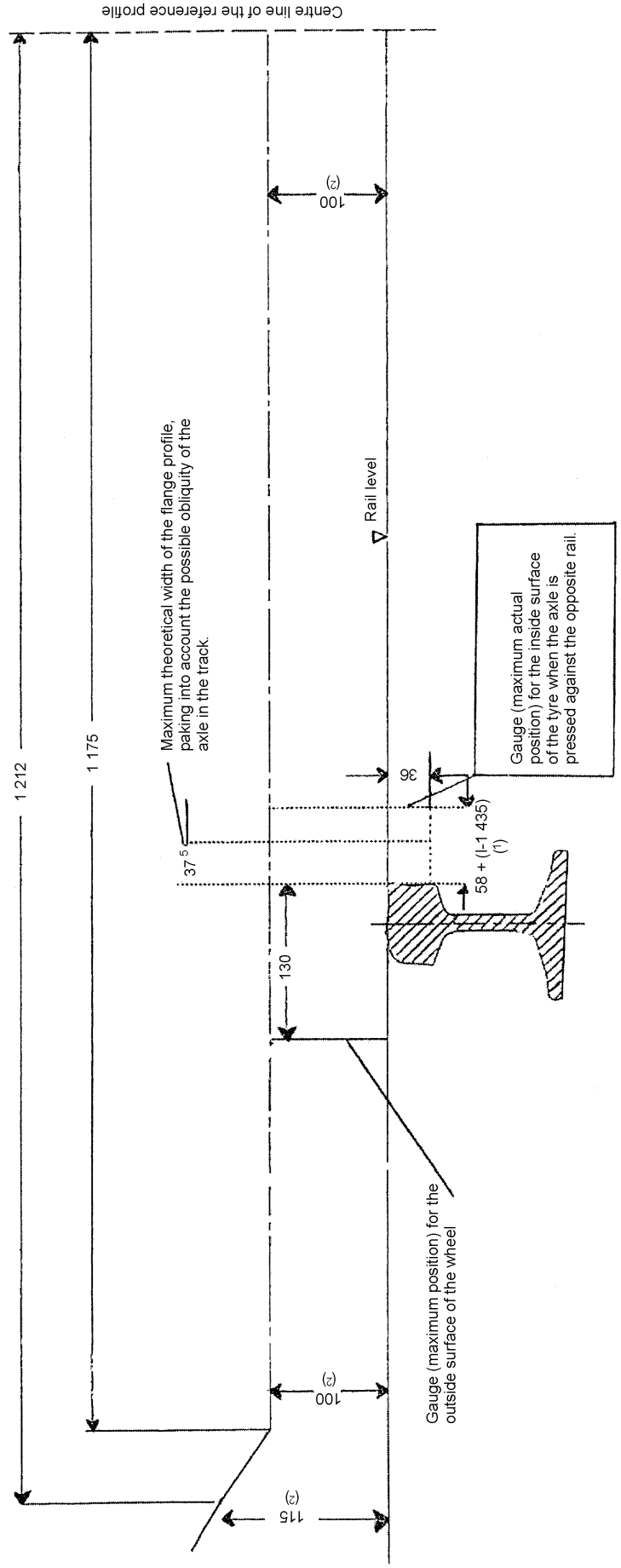
(1) l = width of track.

(2) Irrespective of radius R ≥ 250 m and width of track l ≤ 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 ≥ R ≥ 500 m.

KINEMATIC GAUGE FOR THE LOWER PARTS

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 ≥ 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 an 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 an reverse curve is:

| | |
|---|---|
| $R_1 \leq R_2$ | $L_1 = \sqrt{(R_1 + R_2)\left[\frac{45}{R_1} + \frac{45}{R_2} - 0{,}45 - 2(1{,}470 - 1)\right]}$ when $\frac{45}{R_1} + 9\,\frac{4R_2 - R_1}{R_2^2} \leq 0{,}45 + 2(1{,}470 - 1)$ <br> $L_2 = 15 - \sqrt{(4R_2 - R_1)\left[0{,}45 + 2(1{,}470 - 1) - \frac{45}{R_1}\right]}$ when $\frac{45}{R_1} + 9\,\frac{4R_2 - R_1}{R_2^2} \geq 0{,}45 + 2(1{,}470 - 1)$ |

When $R_1 = R_2 = R$, these formulae can be simplified as follows:

$L_1 = \sqrt{180 - R\,[0{,}90 + 4(1{,}470 - 1)]}$ when $R \geq \frac{72}{0,45 + 2(1,470 - 1)}$

$L_2 = 15 - \sqrt{R\,[1{,}35 + 6(1{,}470 - 1)] - 135}$ when $R \leq \frac{72}{0,45 + 2(1,470 - 1)}$

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*

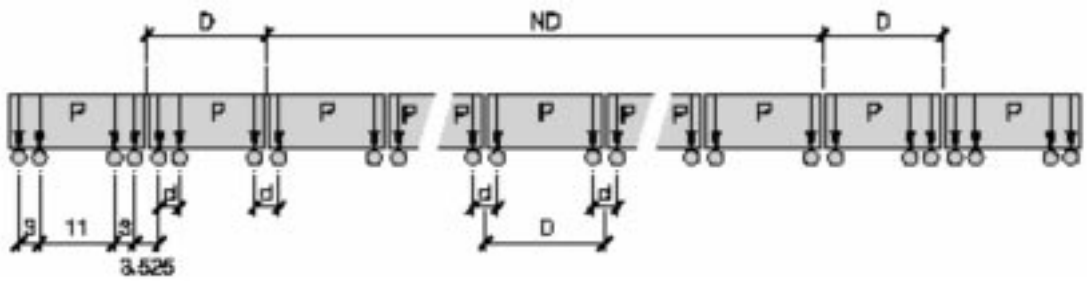
**UNIVERSAL DYNAMIC TRAIN**

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) (2) (3) (3)(3) (3) (3) (2) (1)




Power head intermediate trailer Power head

(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 | Min elong | Centre line running surface |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | C | Si | Mn | P max | S | Cr | Al max | V max | N max | O | H | N/mm | % | hardness HBW |
| 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

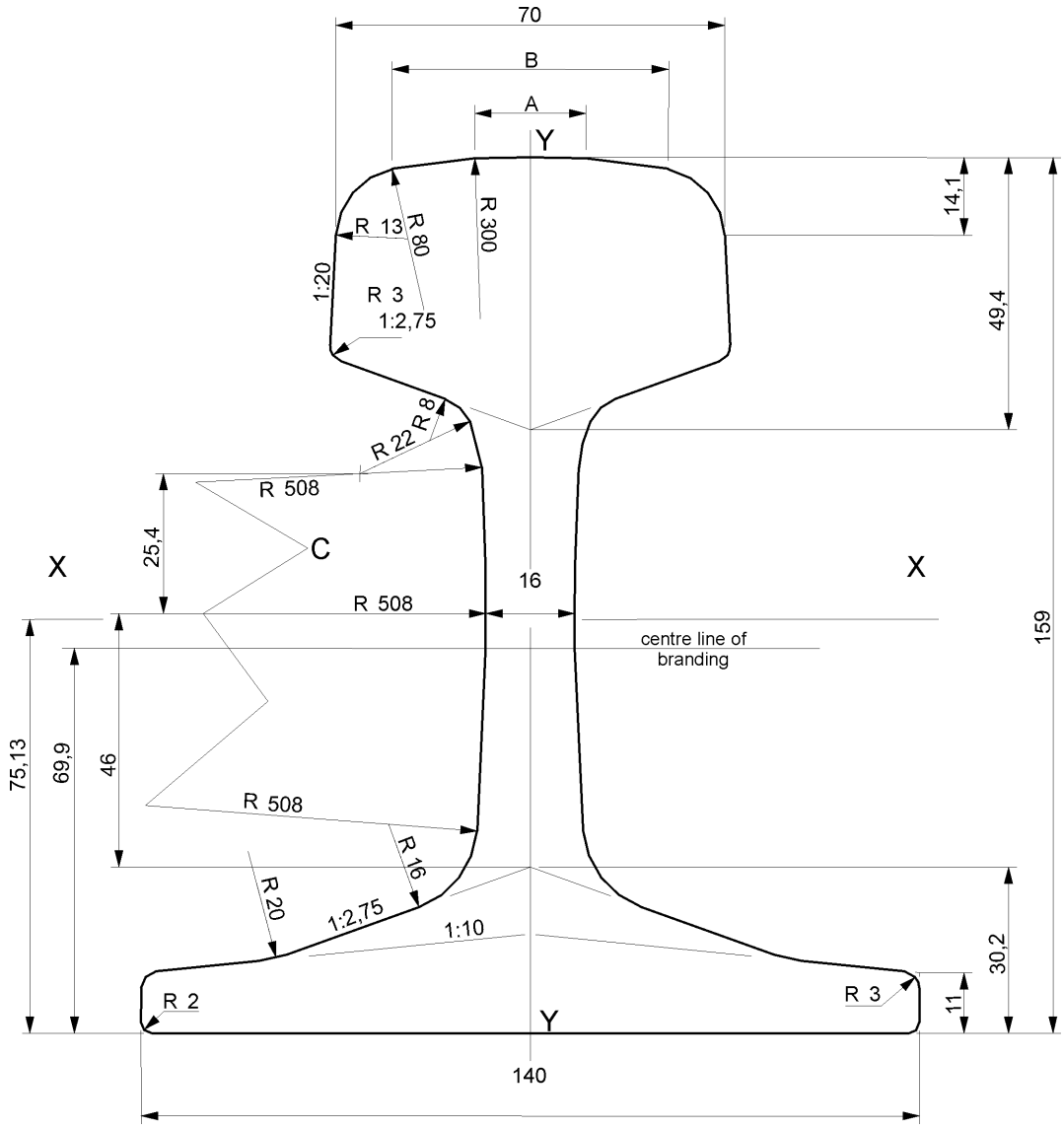
*Table 2(b)*

**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*

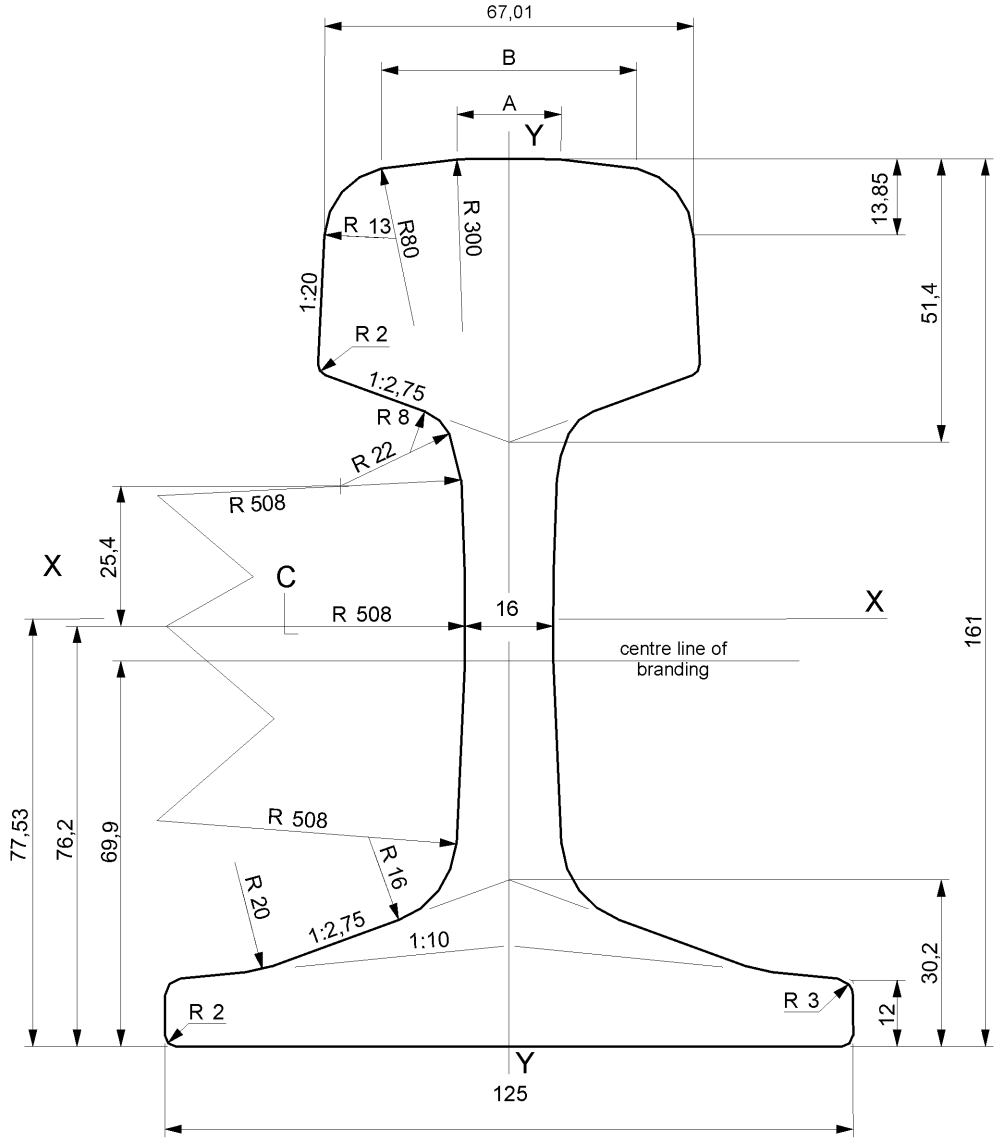
**FLAT BOTTOM SYMMETRICAL RAILWAY RAILS 46 KG/M AND ABOVE — RAIL PROFILES**




| | | |
|---|---|---|
| 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

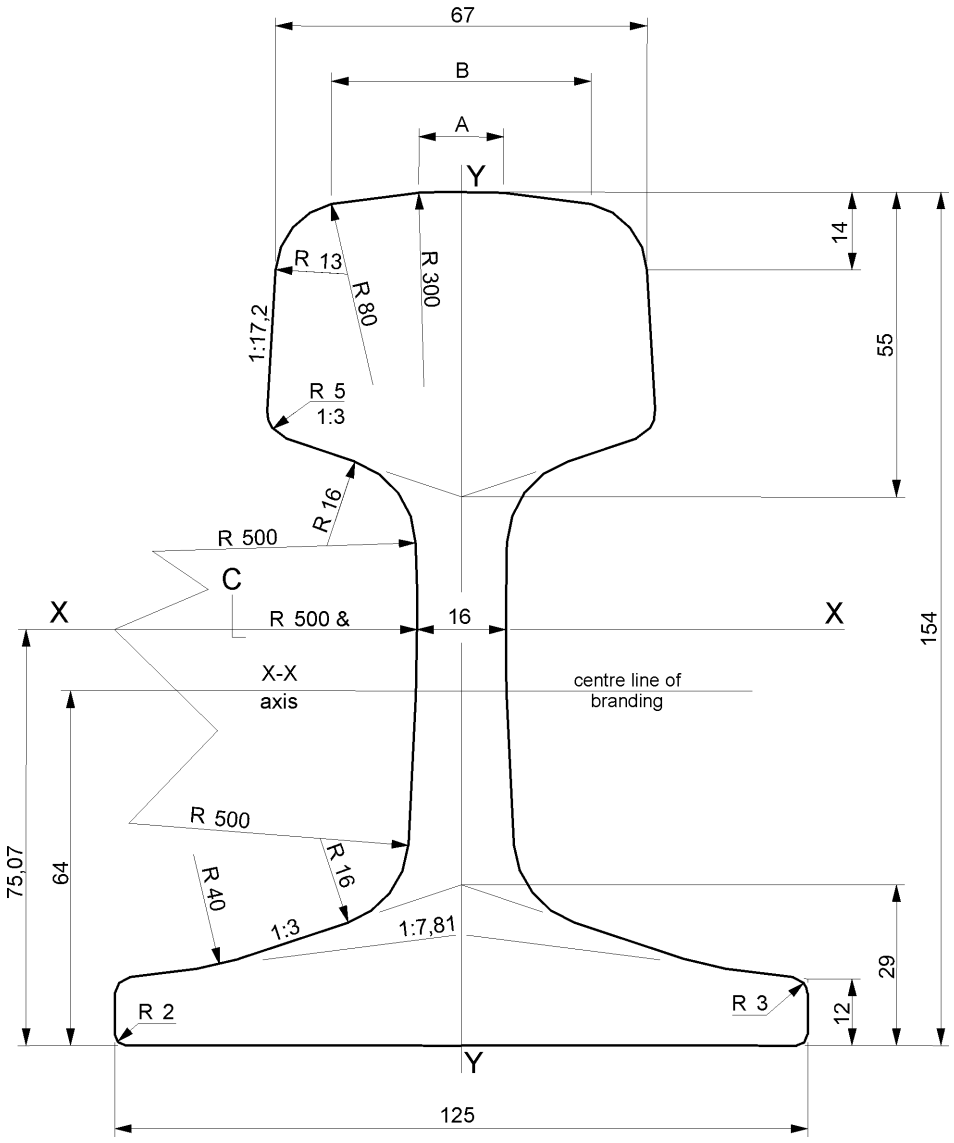
**Rail profile 54 E 1**




| | | |
|---|---|---|
| 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

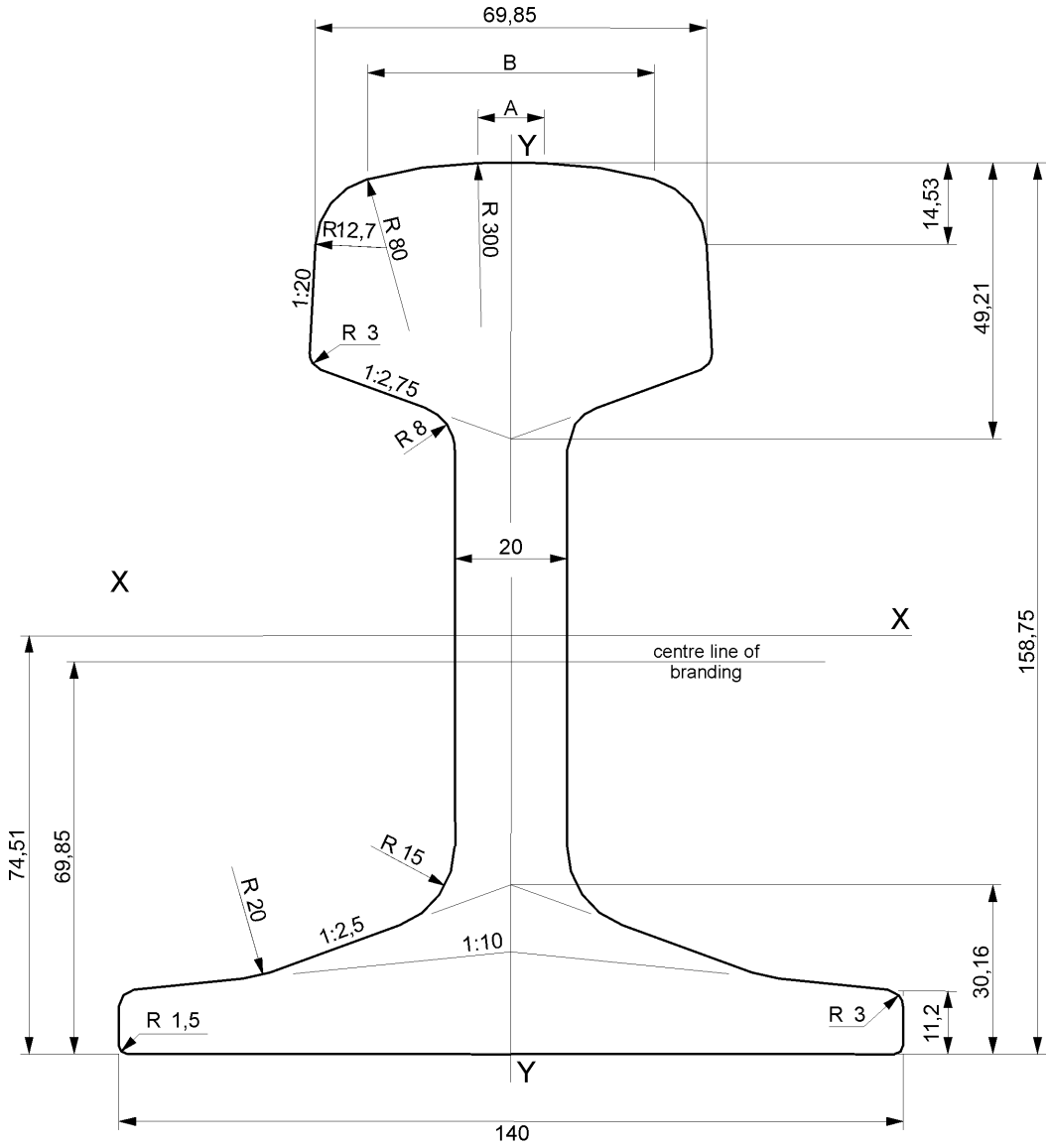
**Rail profile 54 E 2**




| | | |
|---|---|---|
| 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

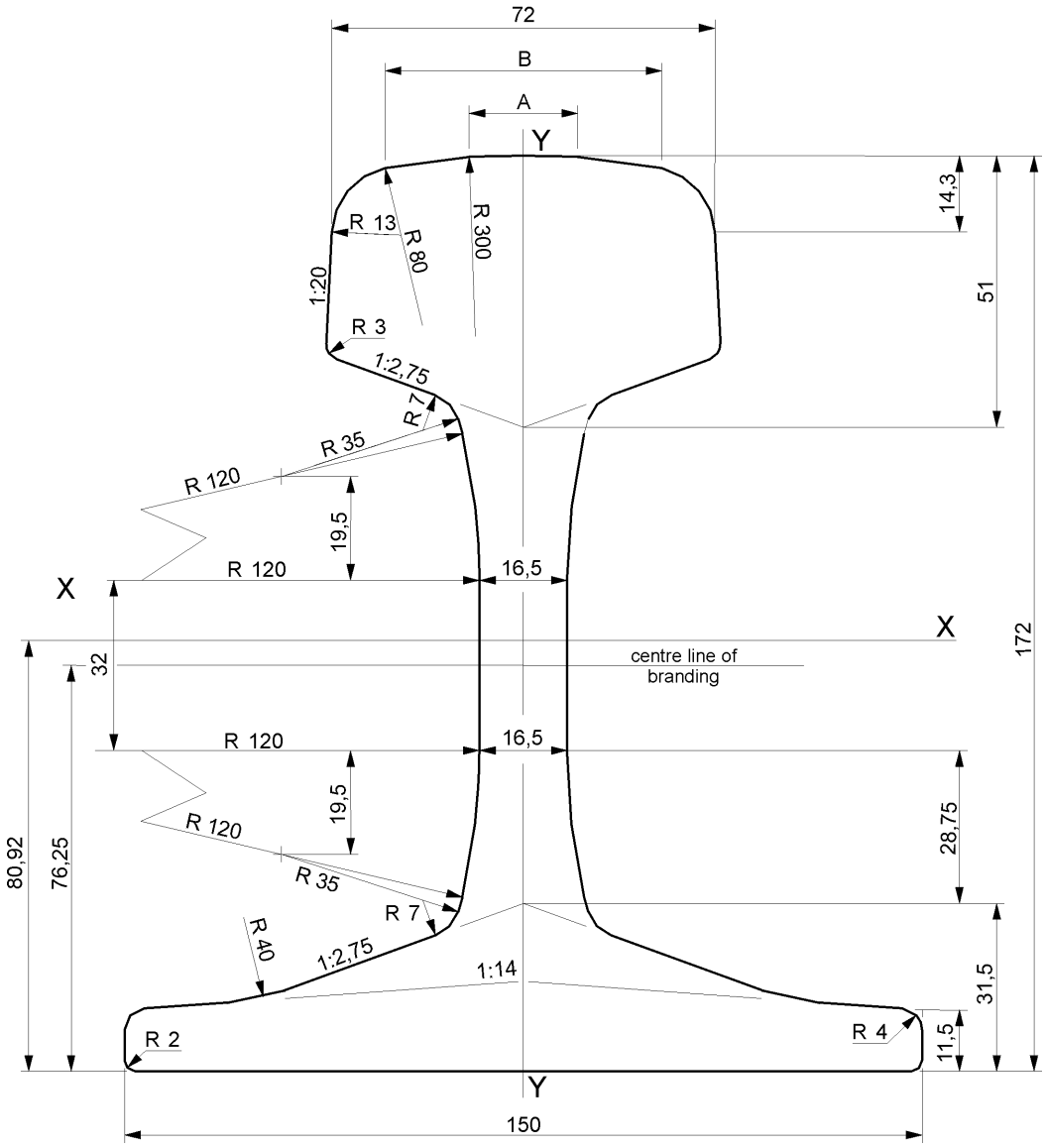
**Rail profile 54 E 3**




| | | |
|---|---|---|
| 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

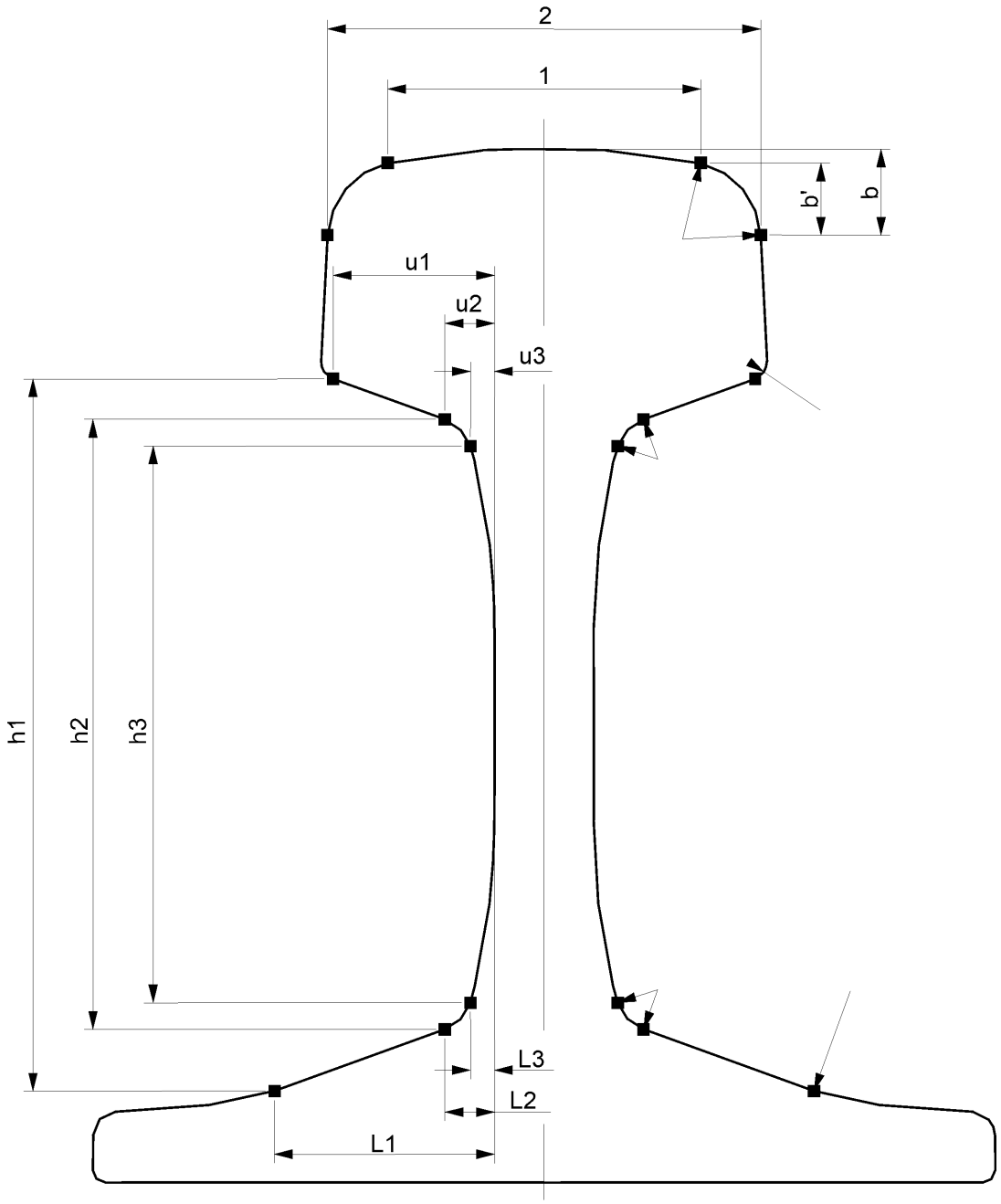
**Rail profile 56 E 1**




| | | |
|---|---|---|
| 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**




■ = Transition point 0,01 mm

**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 | Min elong | Centre line running surface |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | C | Si | Mn | P max | S | Cr | Al max | V max | N max | O | H | N/mm | % | hardness HBW |
| 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 |
| 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 | 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 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 | 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

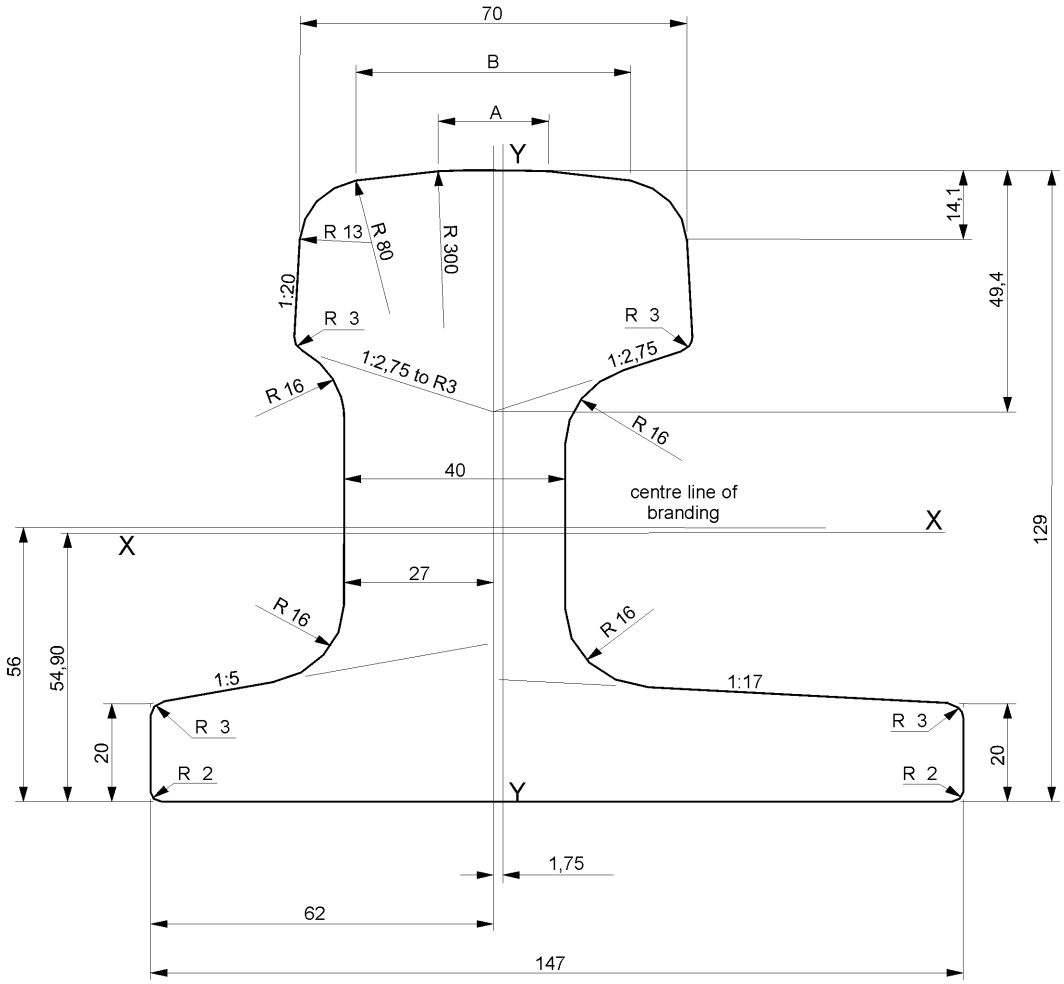
*Table 2(b)*

**Max residual elements**

| | 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*

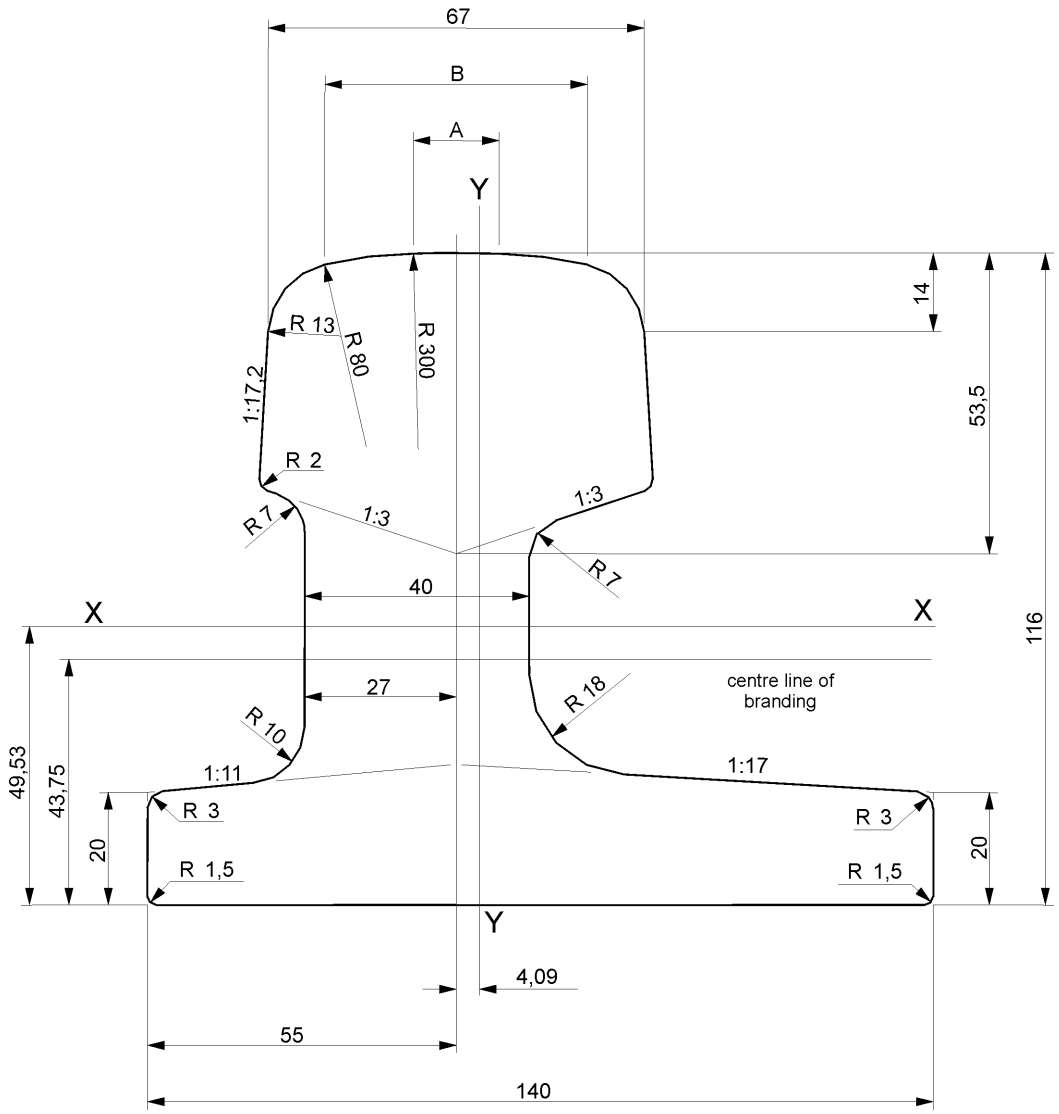
**CHECK RAILS USED IN CONJUNCTION WITH FLAT BOTTOM RAILWAY RAILS 46 KG/M AND ABOVE — RAIL PROFILES**




| | | |
|---|---|---|
| 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

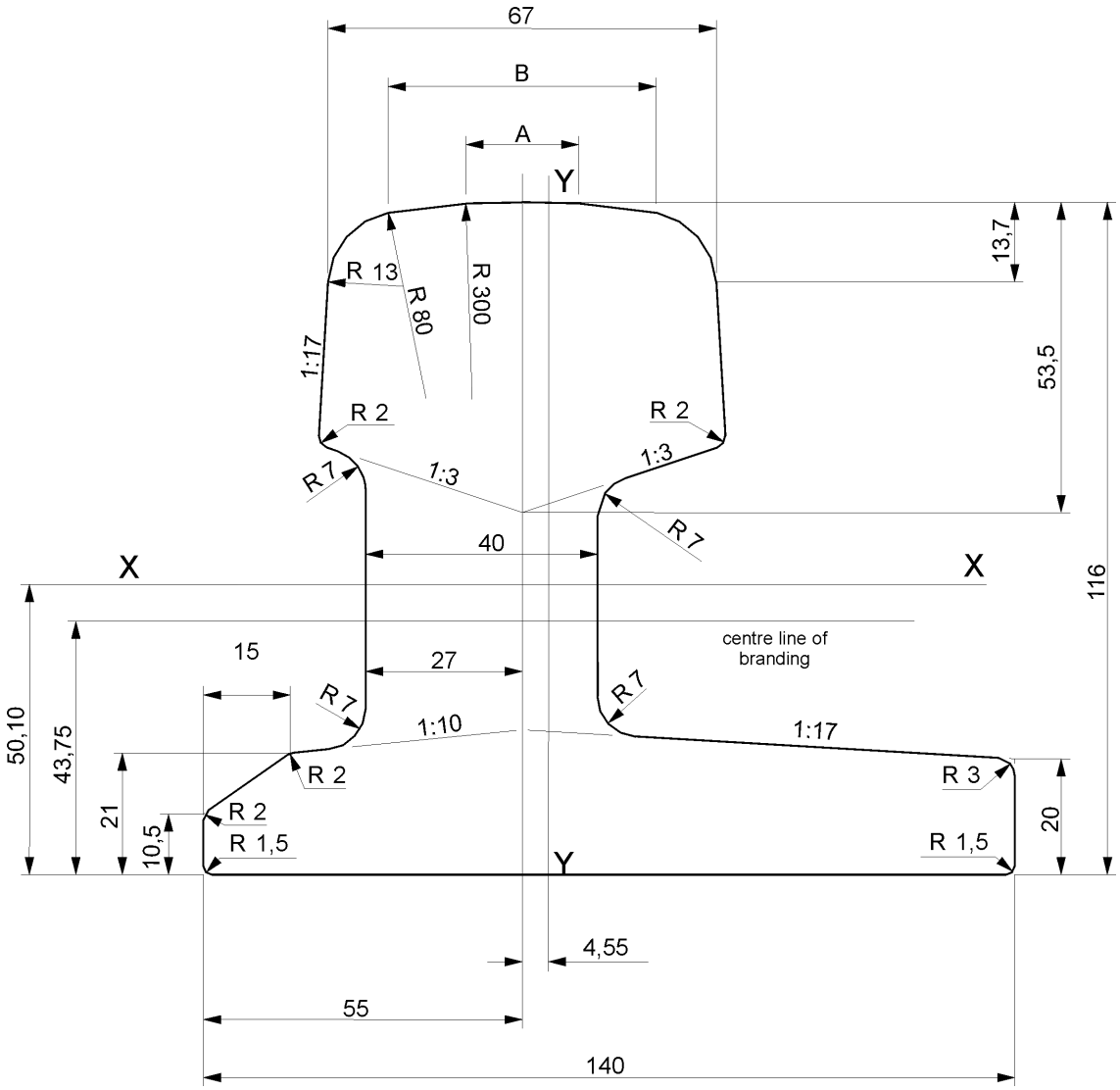
**Rail profile 54 E1 A1**




| | | |
|---|---|---|
| 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

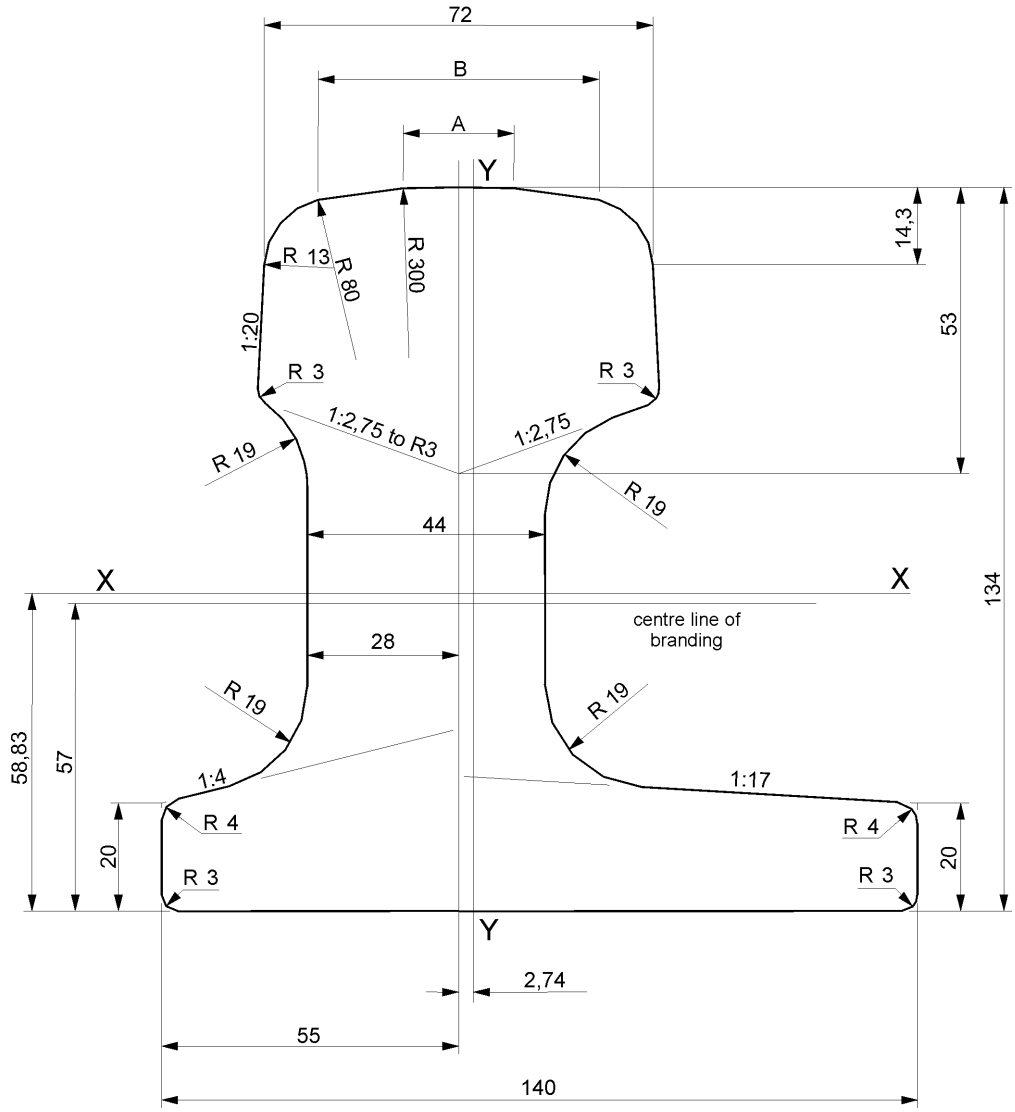
**Rail profile 49 E1 A1**




| | | |
|---|---|---|
| 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

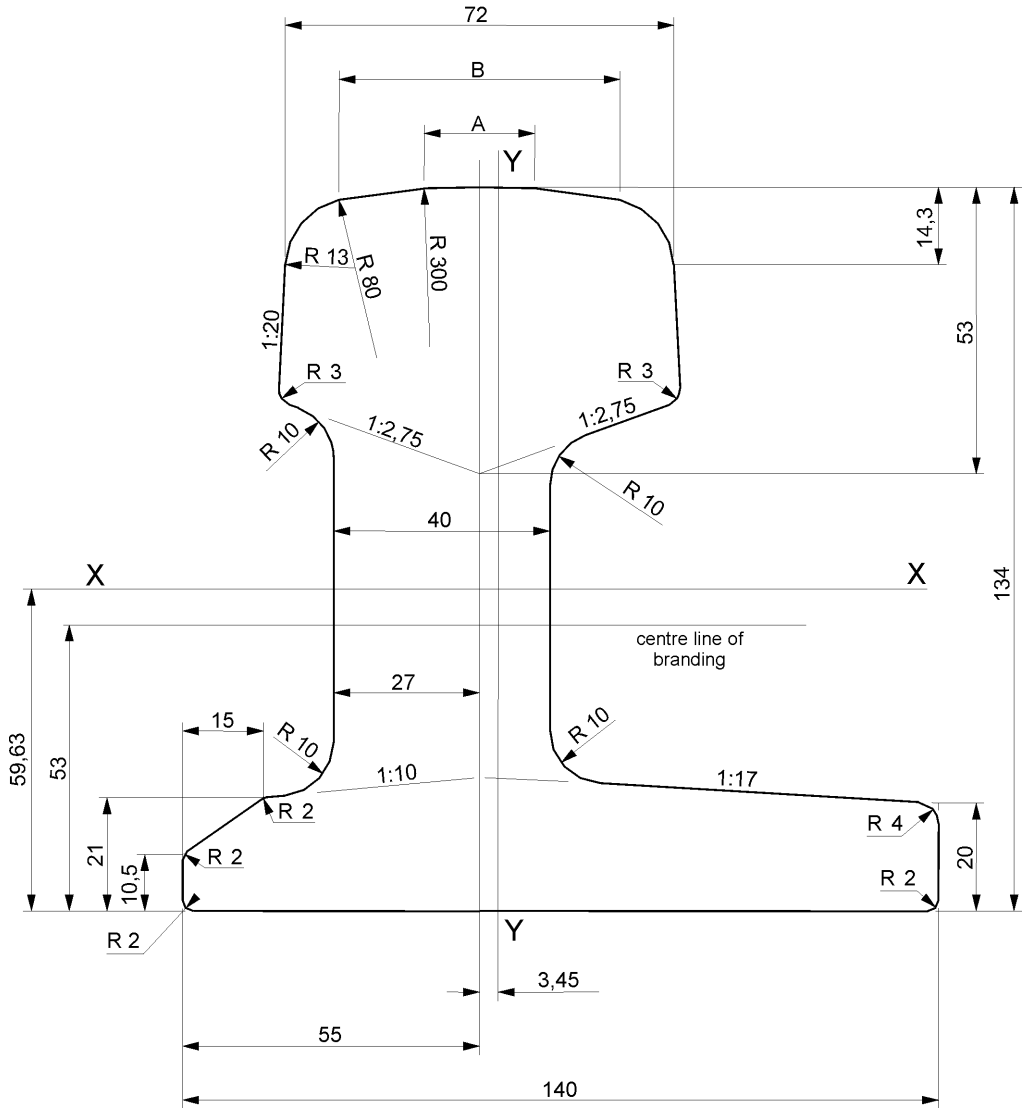
**Rail profile 49 E1 A2**




| | | |
|---|---|---|
| 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

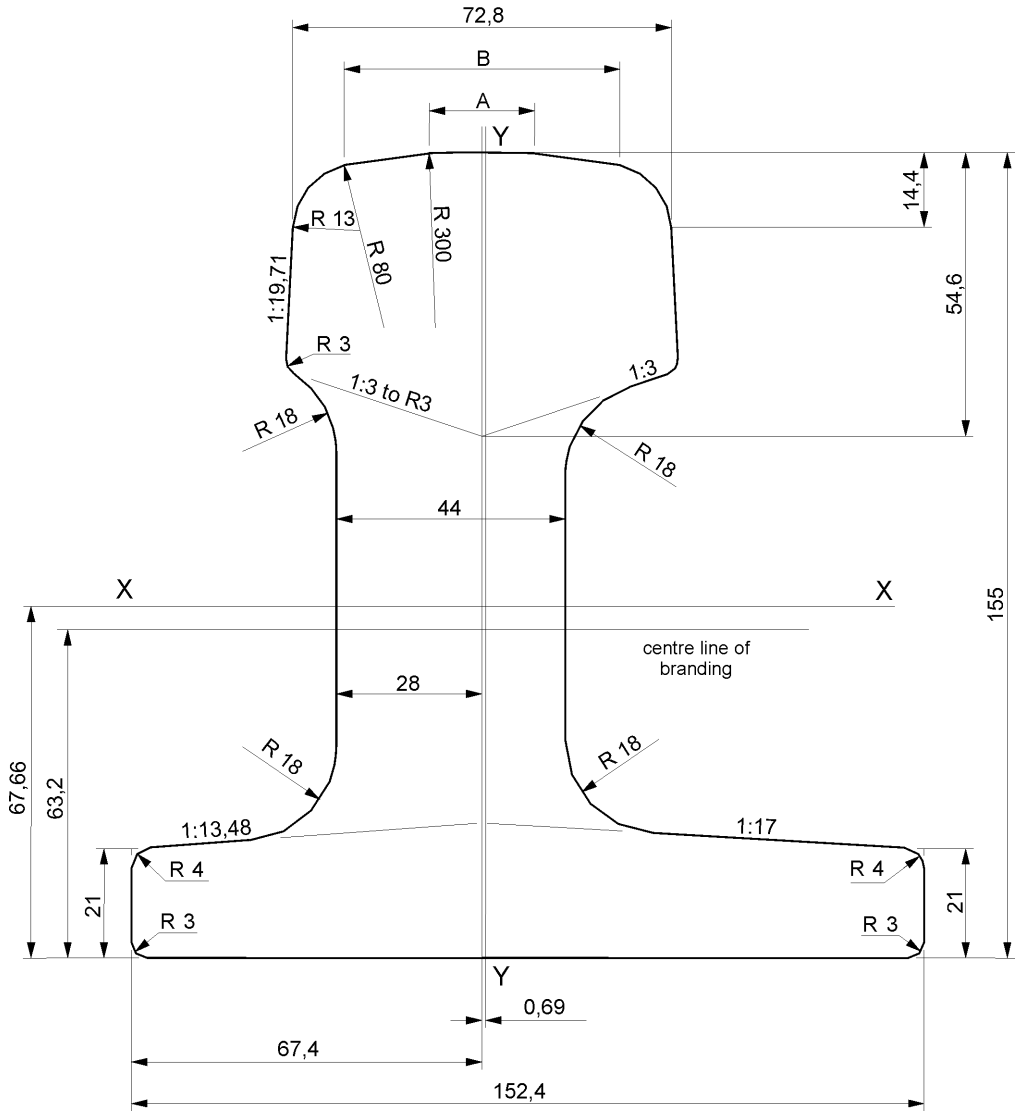
**Rail profile 60 E1 A1**




| | | |
|---|---|---|
| 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

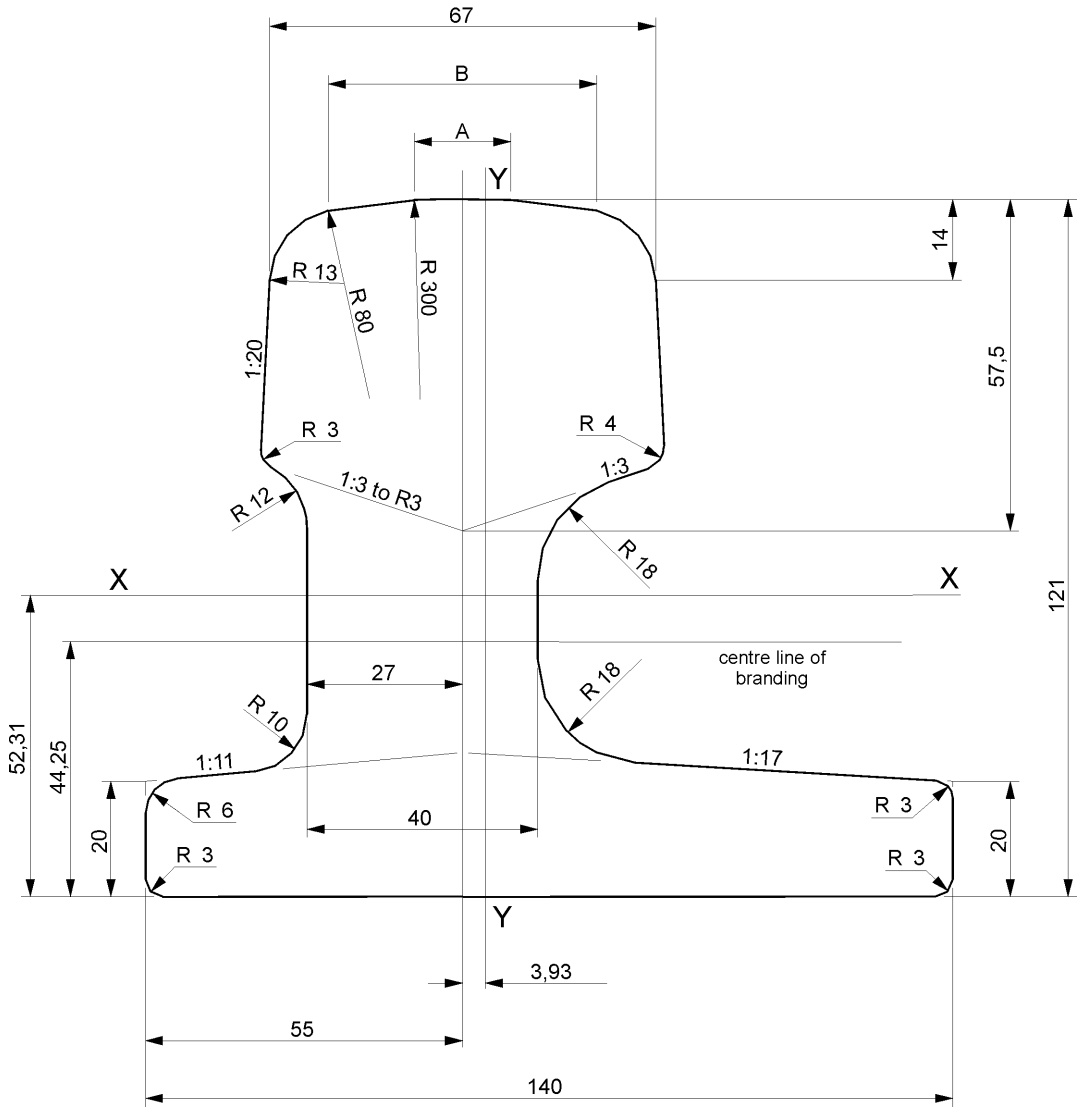
**Rail profile 60 E1 A2**




| | | |
|---|---|---|
| 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

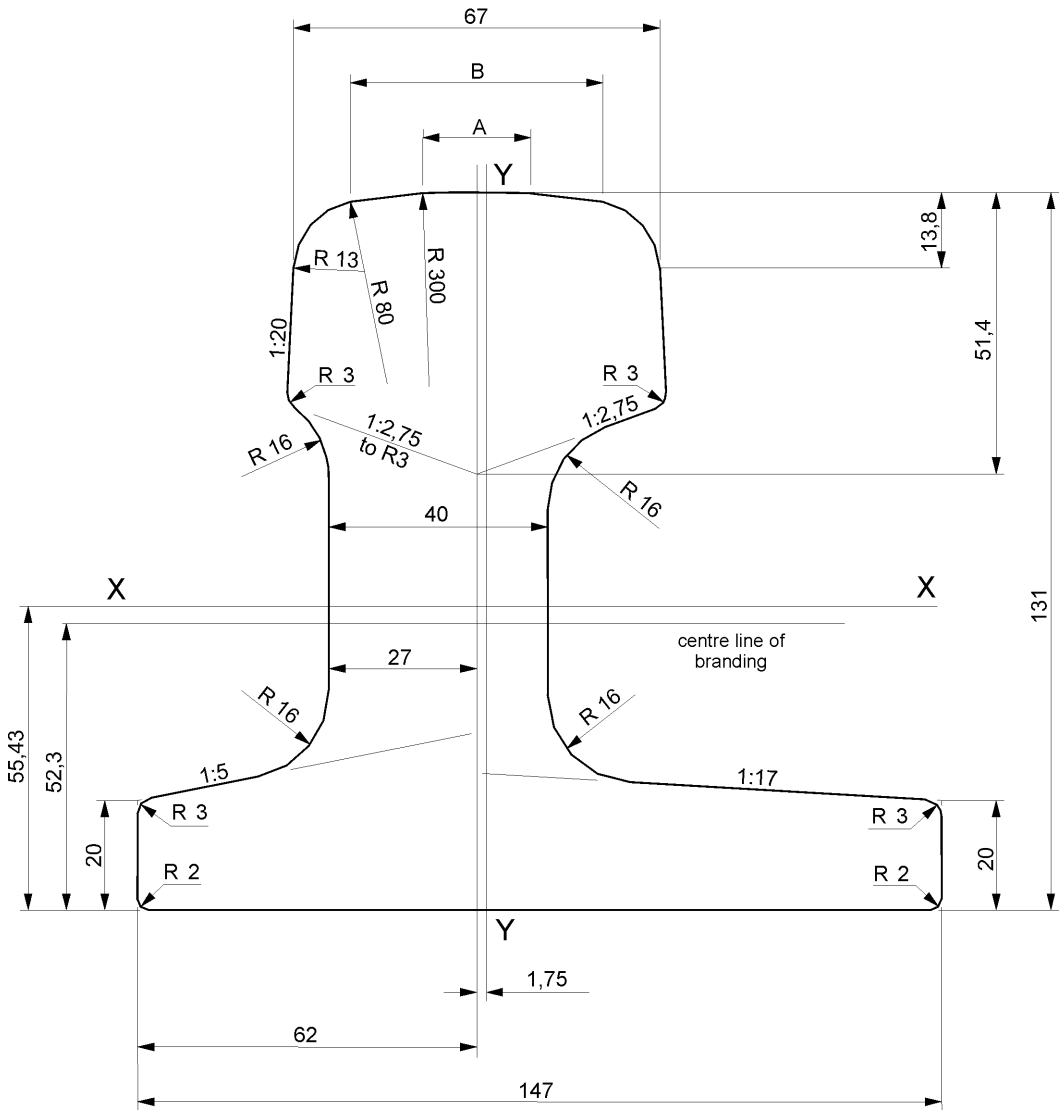
**Rail profile 60 E1 A3**




| | | |
|---|---|---|
| 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

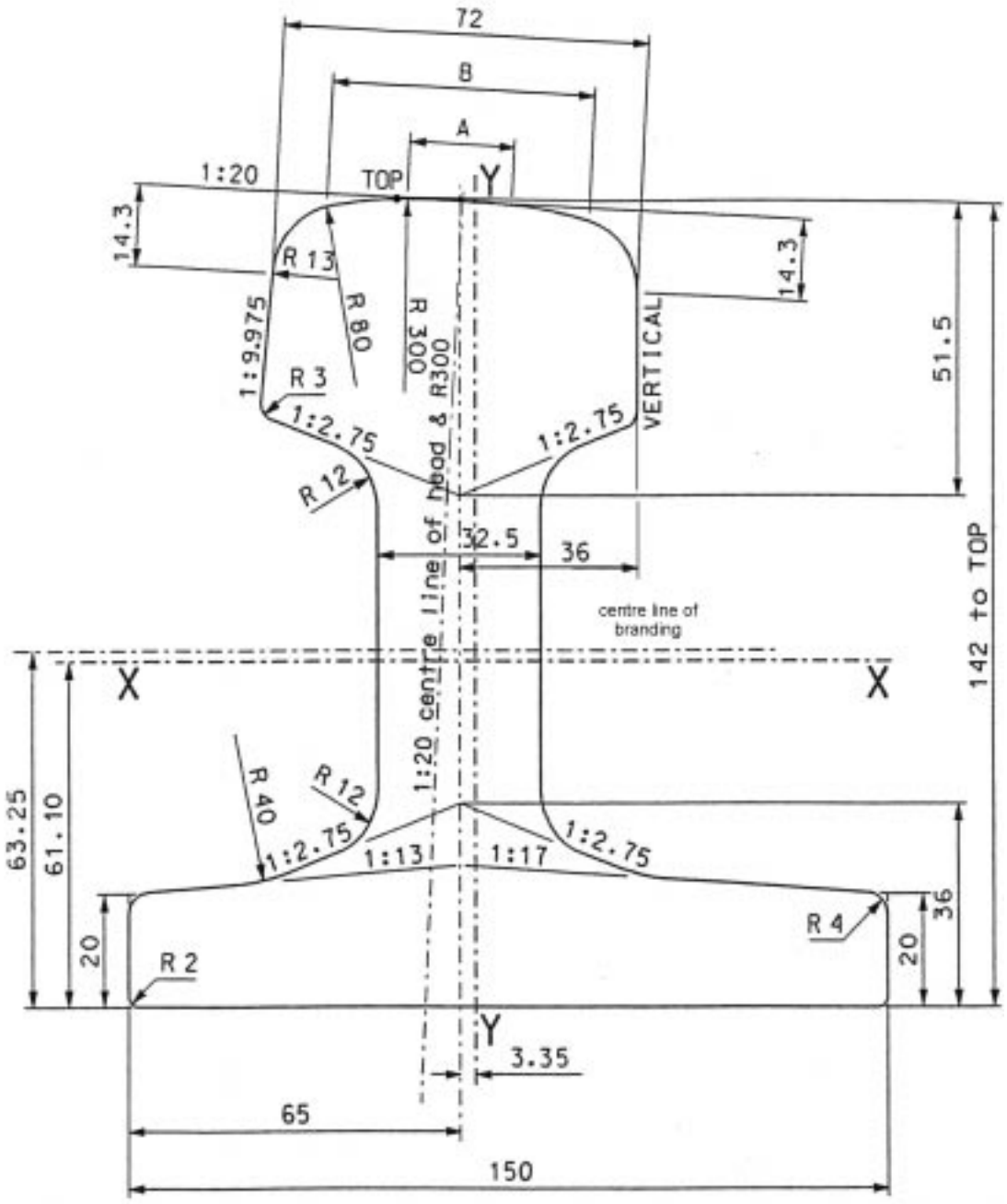
**Rail profile 54 E1 A2**




| | | |
|---|---|---|
| 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

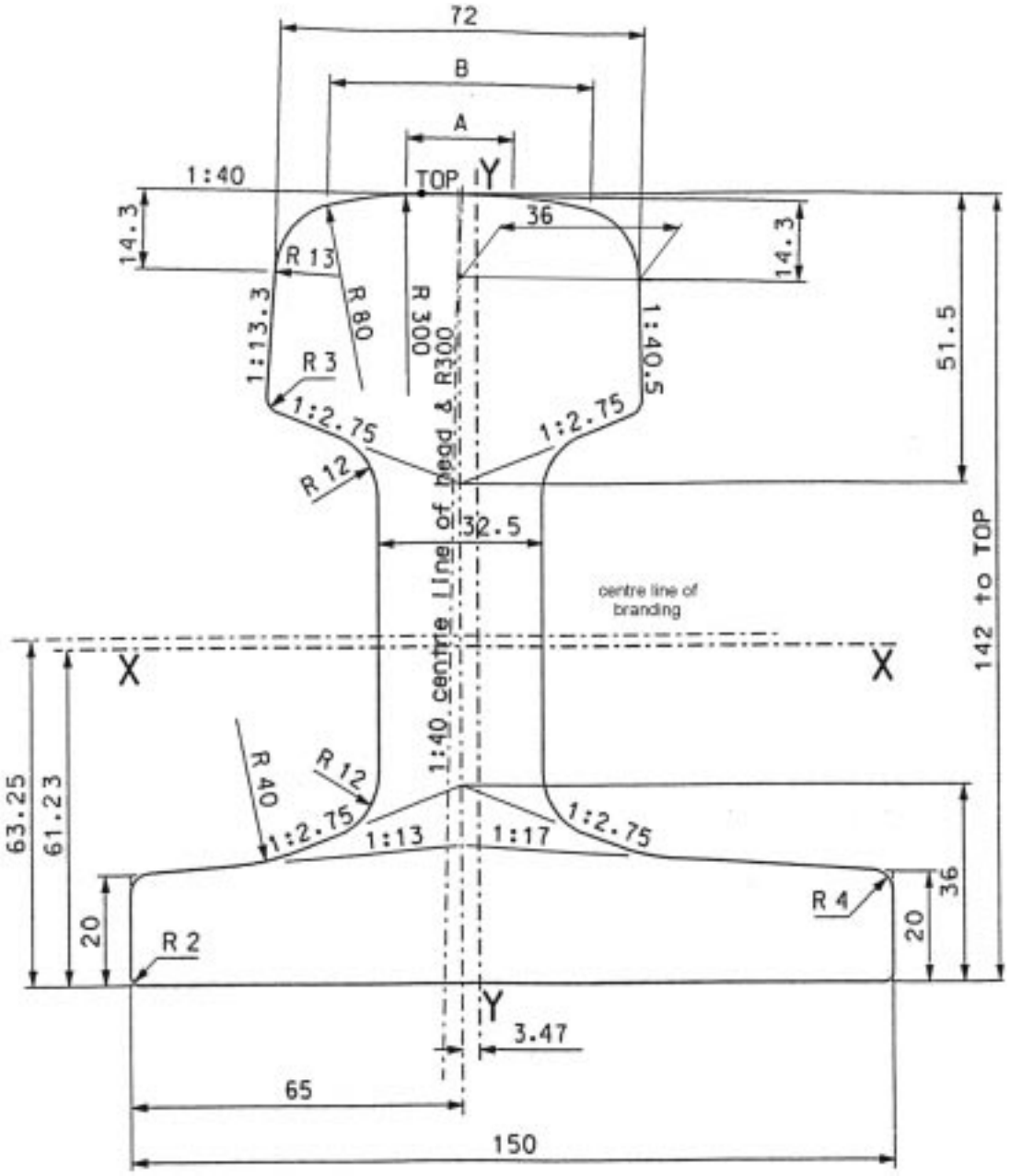
**Rail profile 54 E2 A1**




| | | |
|---|---|---|
| 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

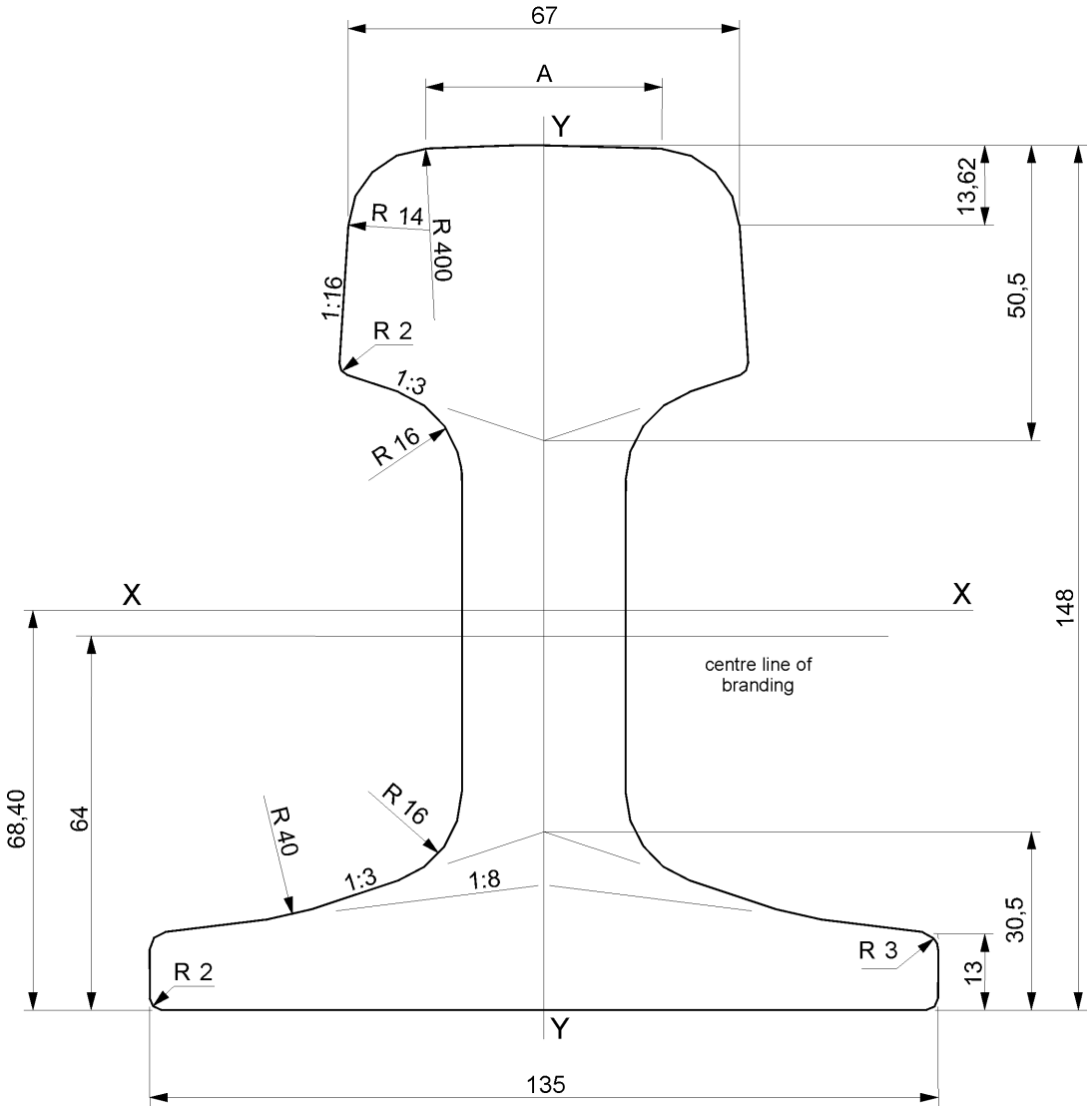
**Rail profile 60 E1 A4**




| | | |
|---|---|---|
| Cross-sectional area | 89,10 | $cm^2$ |
| Mass per metre | 69,94 | kg/m |
| Moment of inertia x-x axis | 2 034,9 | $cm^4$ |
| Section modulus-Head | 251,8 | $cm^3$ |
| Section modulus-Base | 332,5 | $cm^3$ |
| Moment of inertia y-y axis | 764,2 | $cm^4$ |
| Section modulus y-y axis left | 111,6 | $cm^3$ |
| Section modulus y-y axis right | 93,7 | $cm^3$ |

Indicative dimensions: A = 20,456 mm
B = 52,053 mm

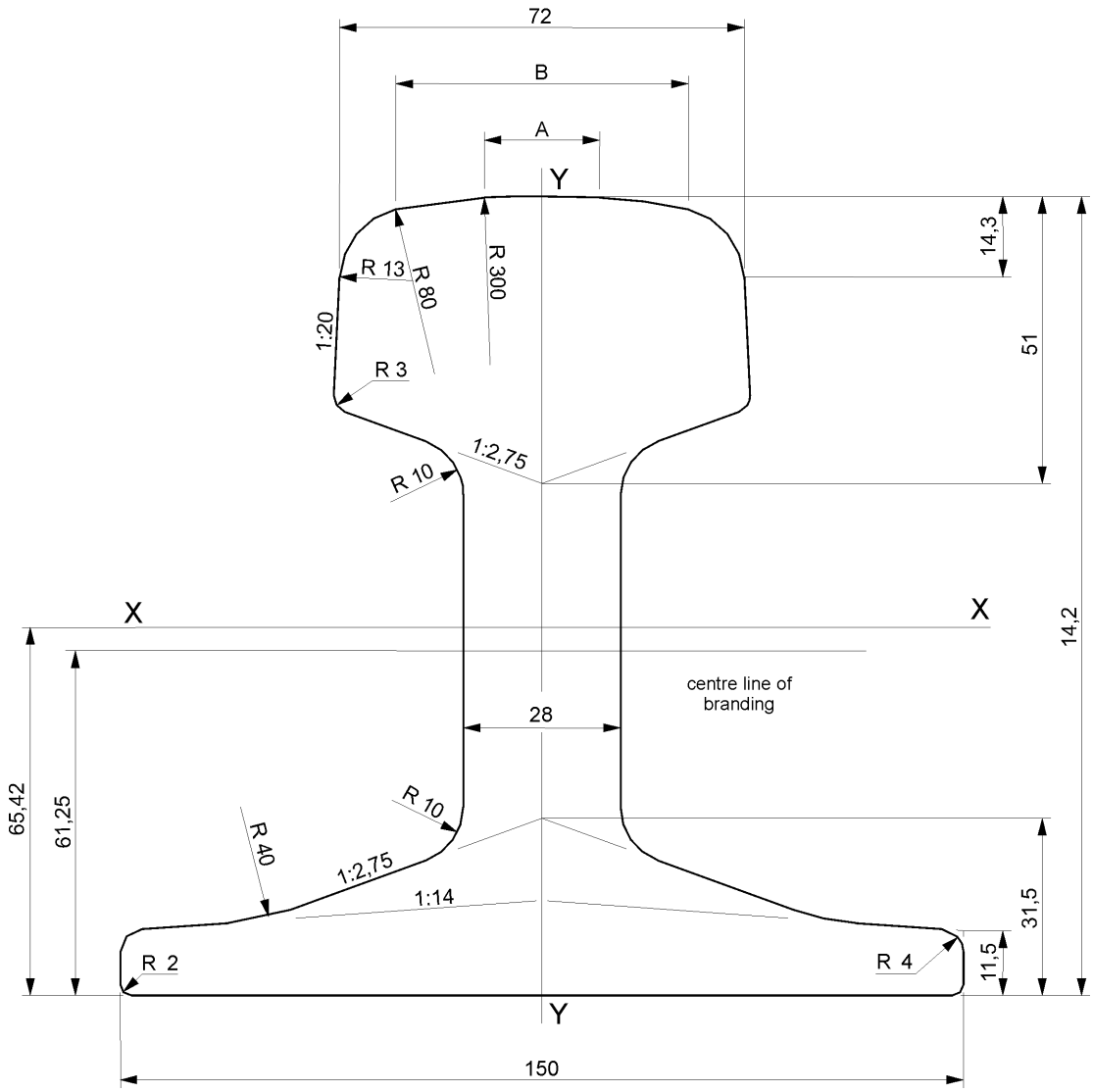
**Rail profile 60 E1 A5**




| | | |
|---|---|---|
| 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

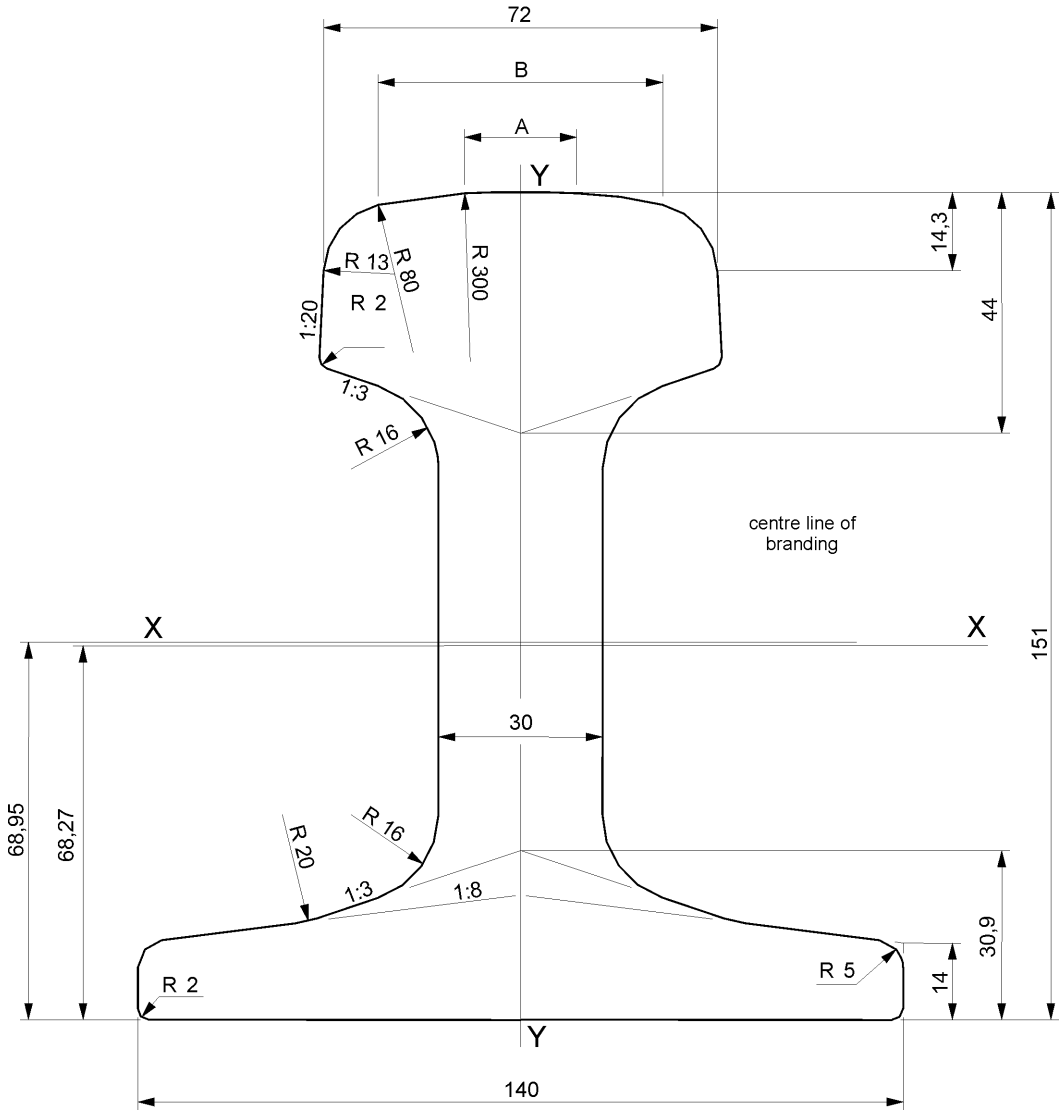
**Rail profile 50 E1 T1**




| | | |
|---|---|---|
| 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

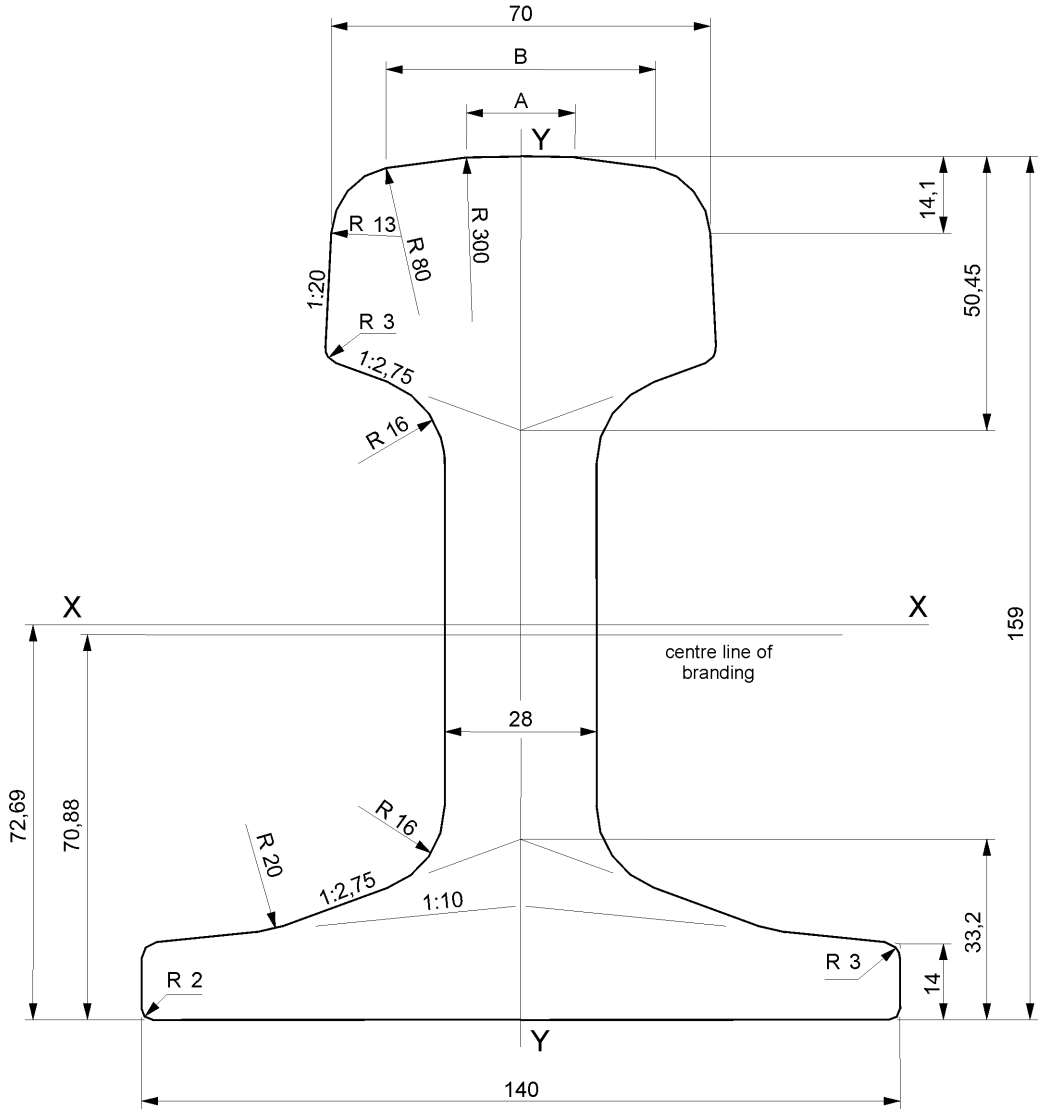
**Rail profile 60 E1 T1**




| | | |
|---|---|---|
| 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

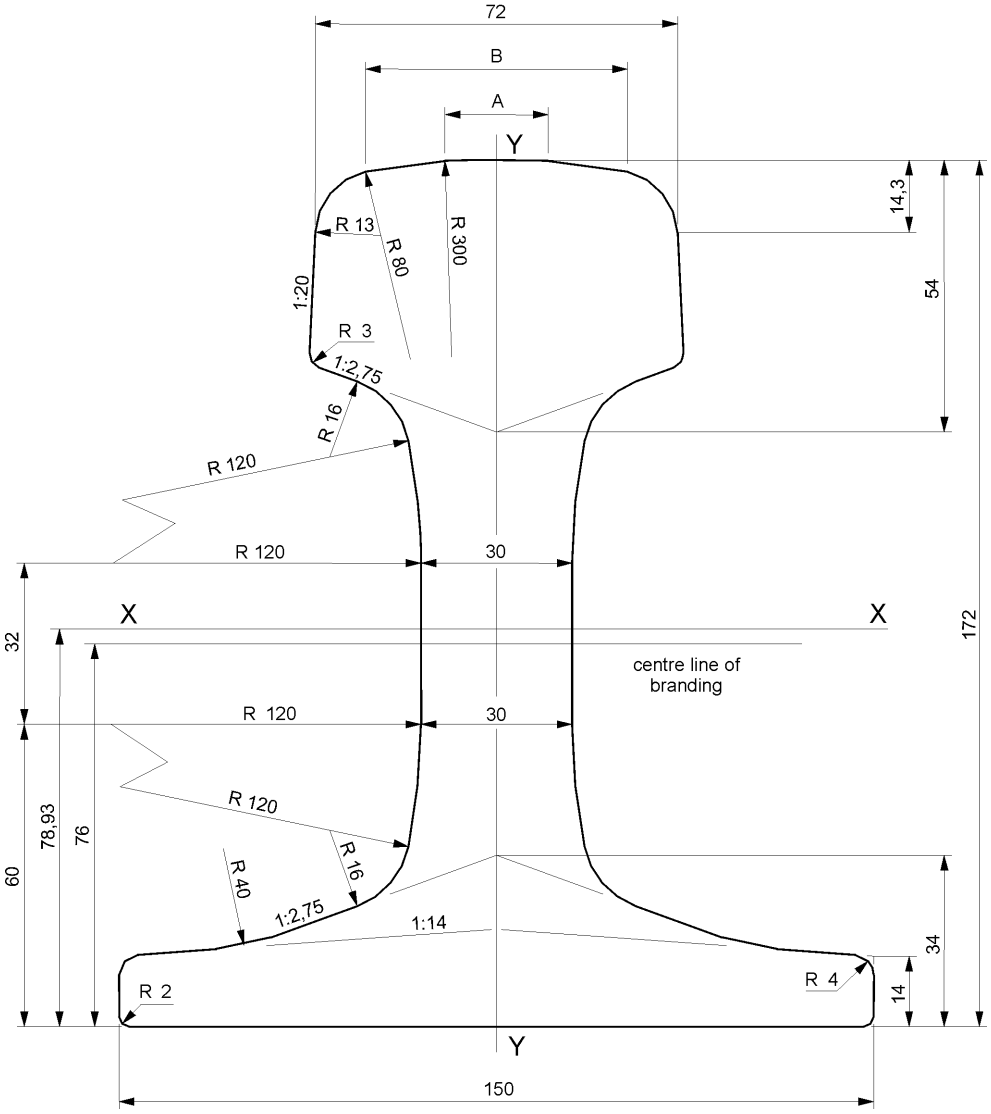
**Rail profile 50 E2 T1**




| | | |
|---|---|---|
| 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

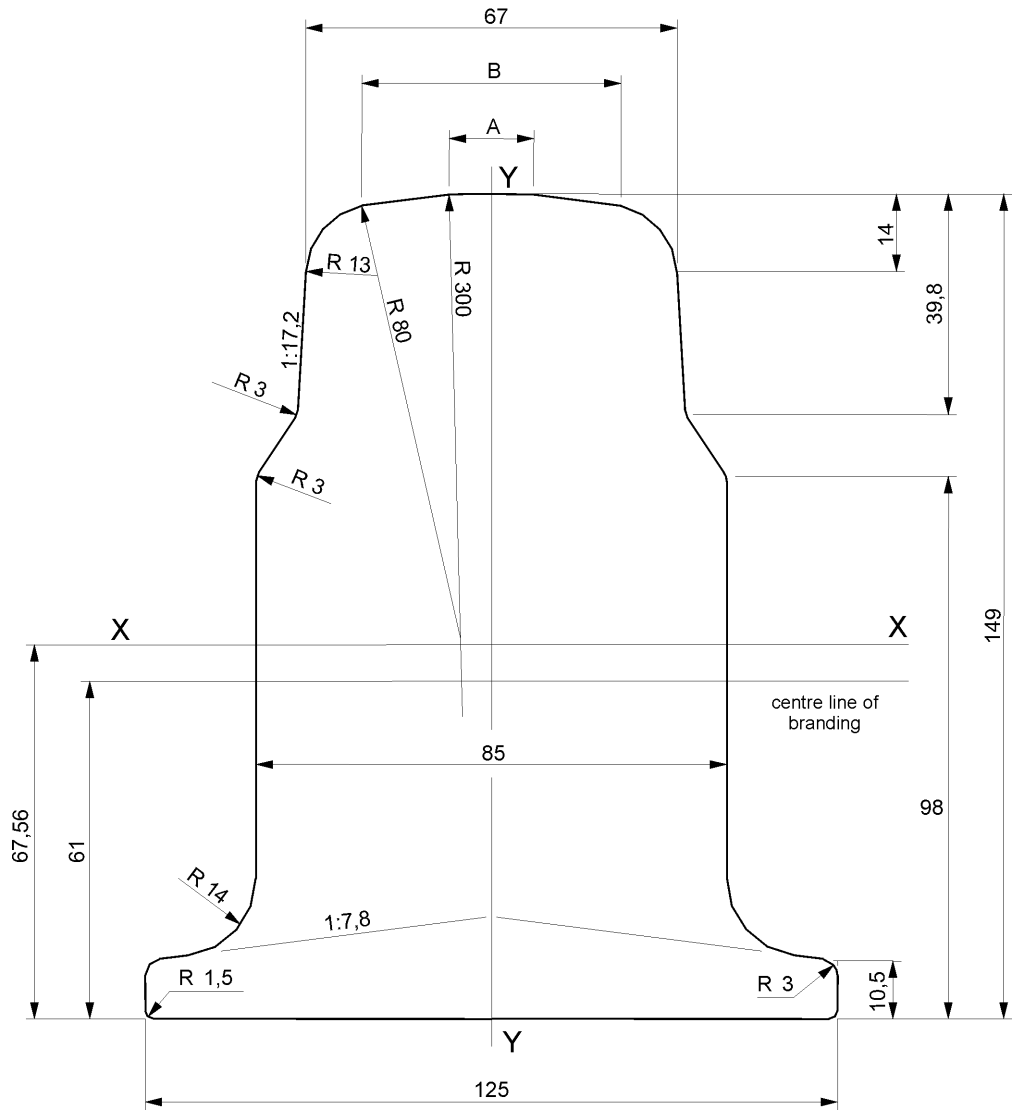
**Rail profile 54 E1 T1**




| | | |
|---|---|---|
| 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

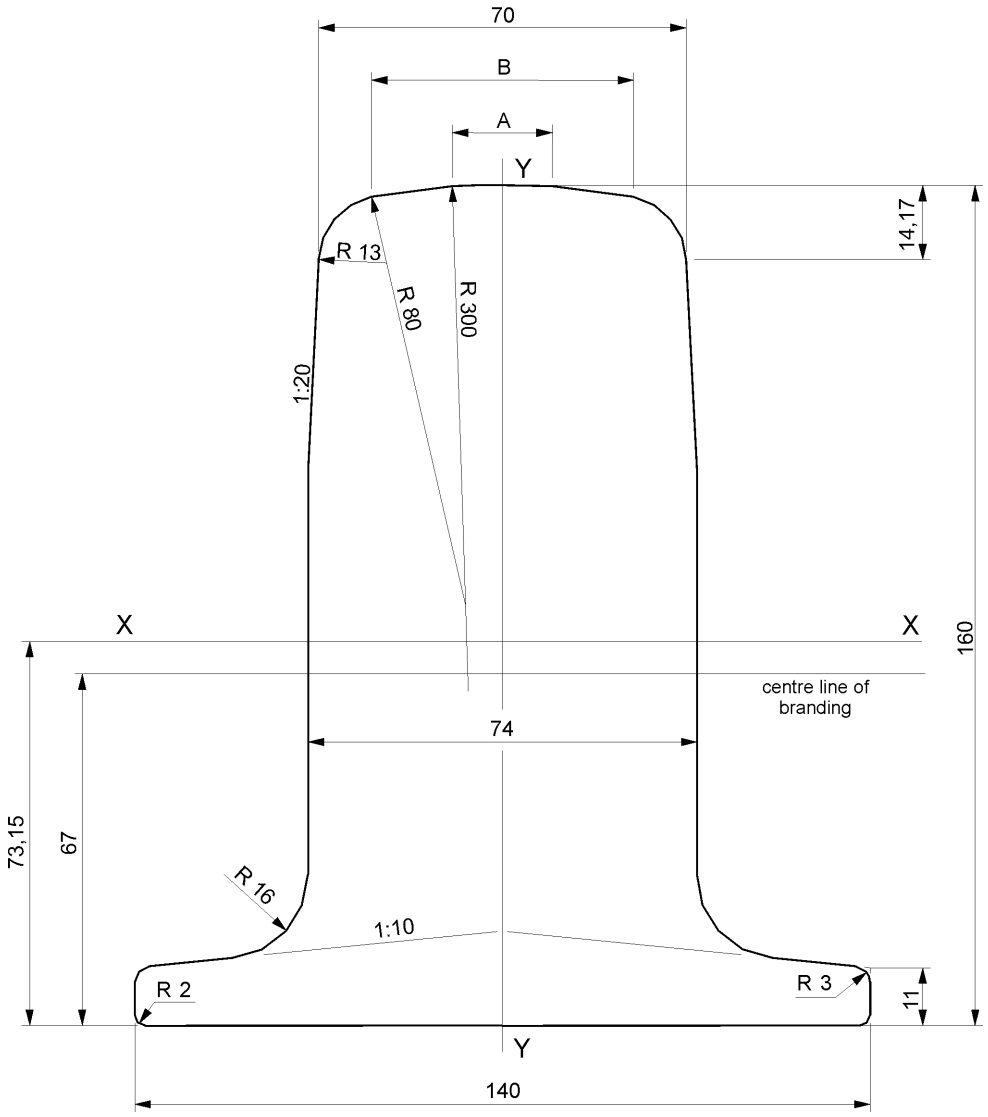
**Rail profile 60 E1 T2**




| | | |
|---|---|---|
| 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

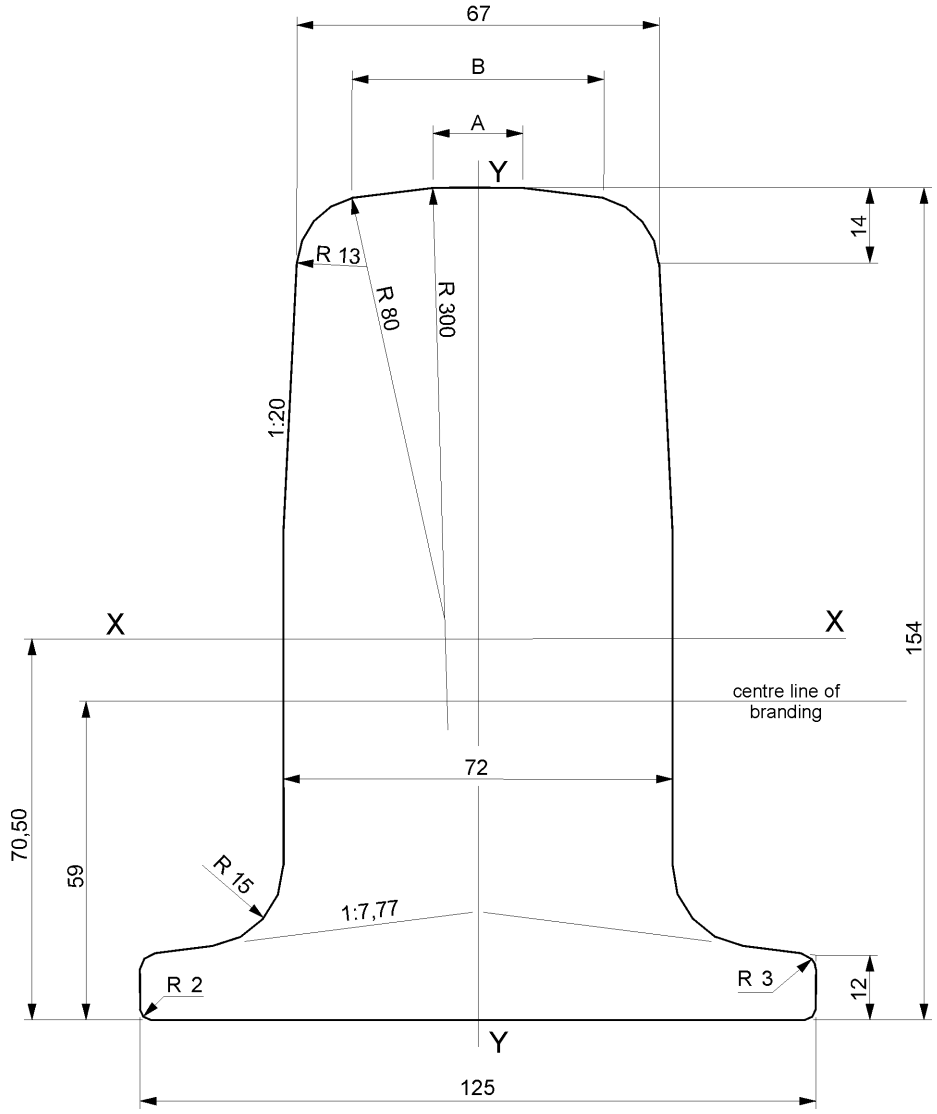
**Rail profile 49 E1 F1**




| | | |
|---|---|---|
| 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

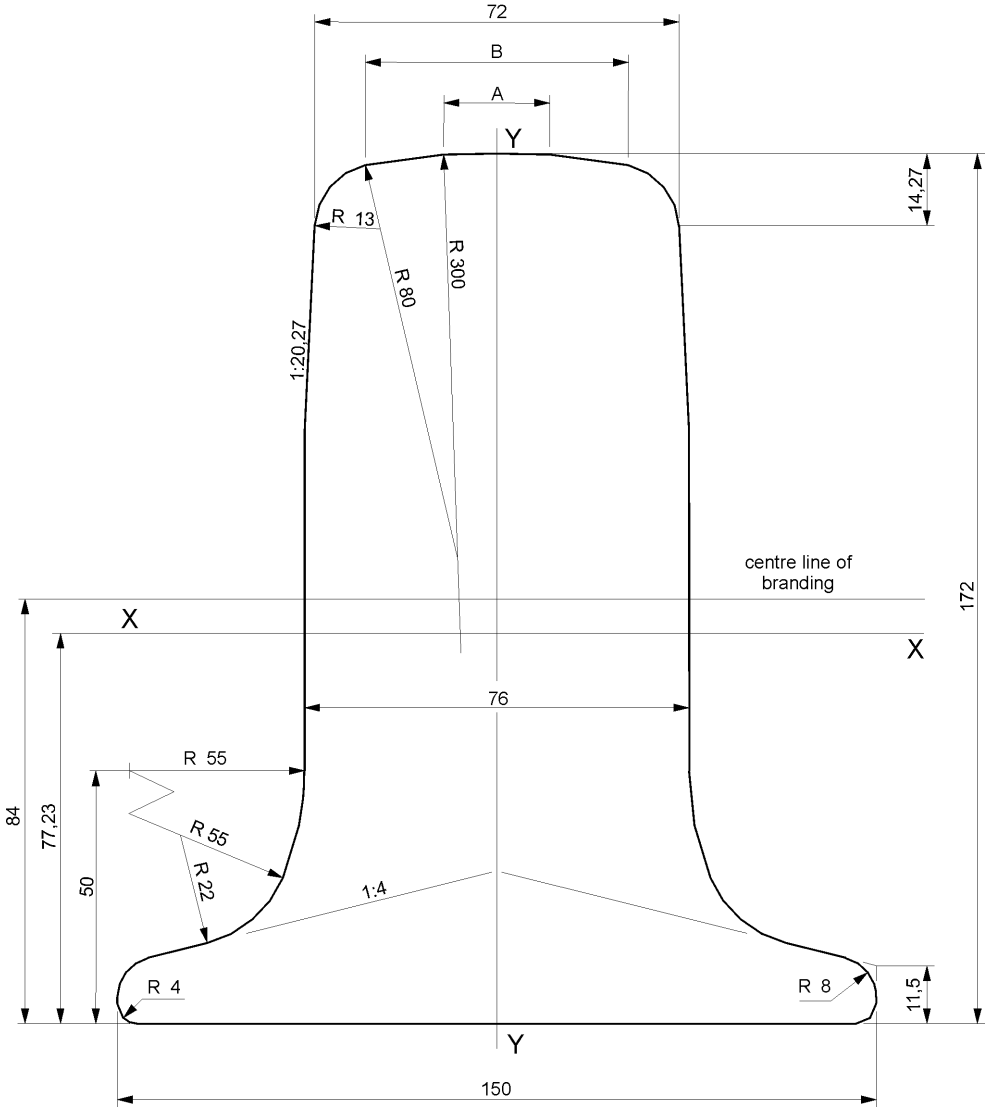
**Rail profile 54 E1 F1**




| | | |
|---|---|---|
| Cross-sectional area | 115,56 | $cm^2$ |
| Mass per metre | 90,72 | kg/m |
| Moment of inertia x-x axis | 2 389,0 | $cm^4$ |
| Section modulus-Head | 286,1 | $cm^3$ |
| Section modulus-Base | 338,9 | $cm^3$ |
| Moment of inertia y-y axis | 630,3 | $cm^4$ |
| Section modulus y-y-axis | 100,8 | $cm^3$ |

Indicative dimensions: A = 16,703 mm
B = 46,617 mm

**Rail profile 54 E3 F1**



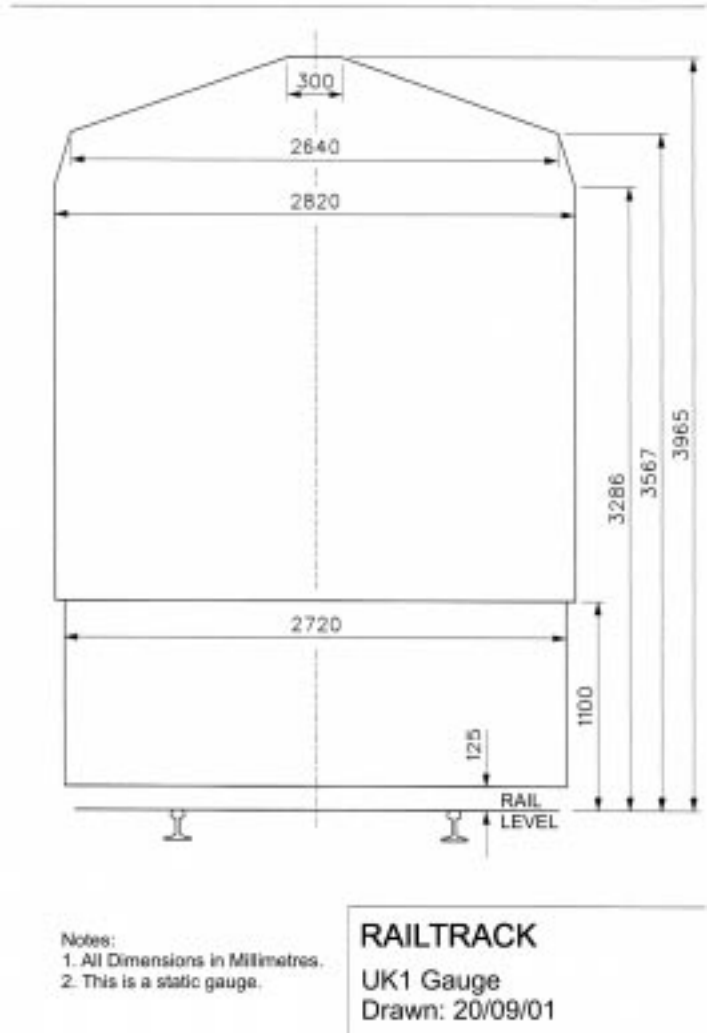

| | | |
|---|---|---|
| Cross-sectional area | 141,71 | $cm^2$ |
| Mass per metre | 111,24 | kg/m |
| Moment of inertia x-x axis | 3 737,3 | $cm^4$ |
| Section modulus-Head | 394,3 | $cm^3$ |
| Section modulus-Base | 483,9 | $cm^3$ |
| Moment of inertia y-y axis | 992,3 | $cm^4$ |
| Section modulus y-y-axis | 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.

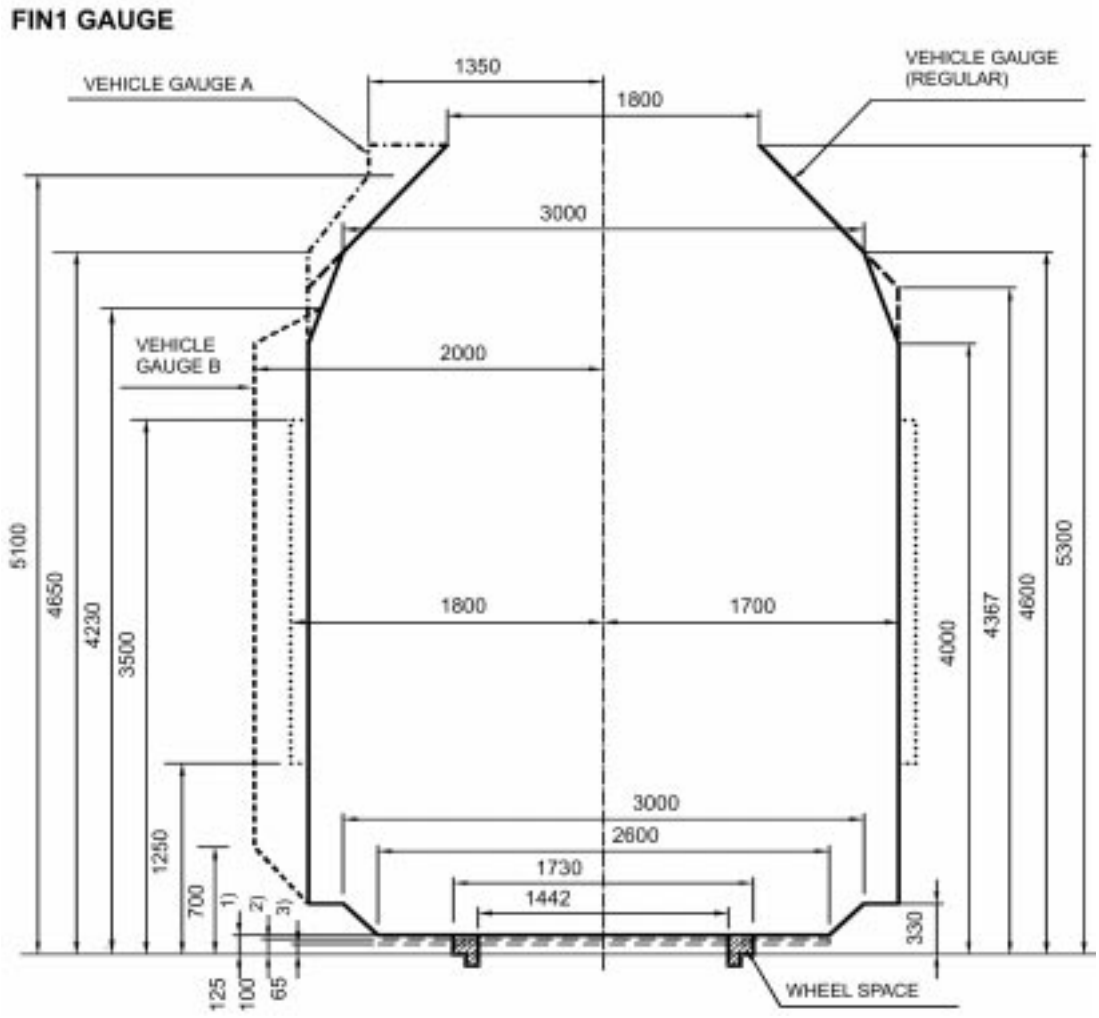
1. The diagram gives the basic dimensions for the UK1 gauge. (static on a straight level track).

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**




····· Marker lamps and rear mirrors.

– – – – Increase of vehicle gauge, which is valid on specified track sections.

–·–·– Increase of vehicle gauge (A), which is valid on specified track sections.

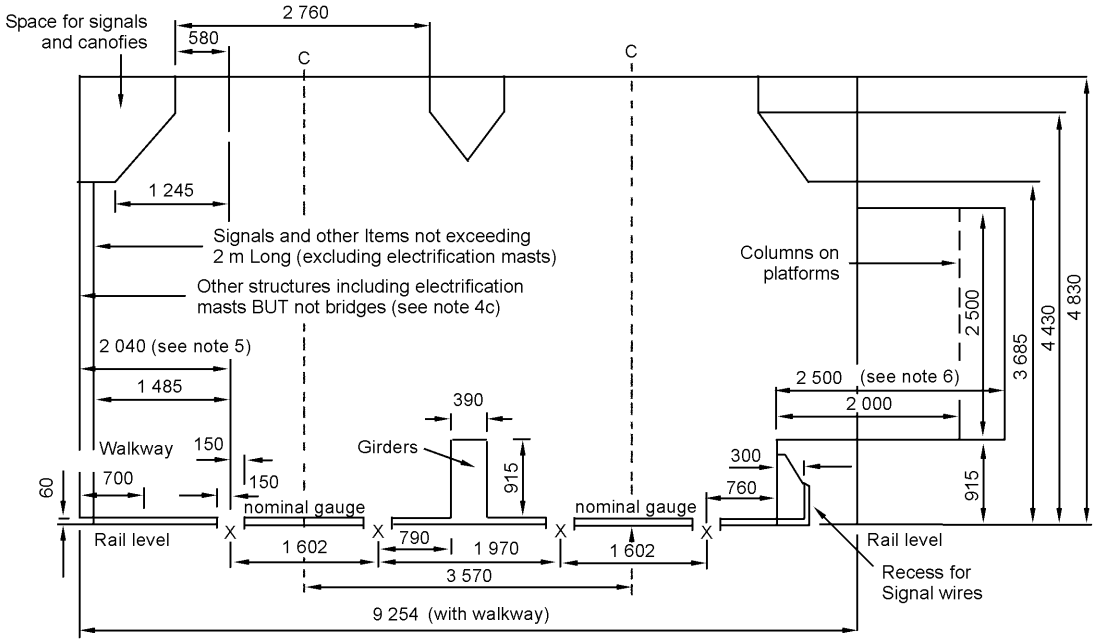
------- Increase of vehicle gauge (B). Gauge for tilting rolling stock, which is valid on specified track sections.

(1) Low contour for rolling stock, which is running over a hump and a rail brake.
(2) Low contour for rolling stock, which is not running over a hump nor a rail brake, exept for the bogie of tractive stock.
(3) Low contour for a bogie in tractive stock, which is not running over a hump nor a rail brake.

*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.

# COMMISSION DECISION

## of 30 May 2002

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

*(notified under document number C(2002) 1949)*

**(Text with EEA relevance)**

(2002/733/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 energy 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 and rolling stock 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 inform 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 inform 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 and a rolling stock register are published and updated each year. These registers will set out the main characteristics of the national infrastructure and rolling stock (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 'energy' 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 and rolling stock of the trans-European high-speed rail system as defined in Annex I to 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 relevant 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 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 6*

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 ENERGY SUBSYSTEM**

## 1. INTRODUCTION

### 1.1. Technical scope

This TSI concerns the energy 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 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 energy 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) of and with Annex I(1)(b) to 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) to 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. SUBSYSTEM DEFINITION/SCOPE

### 2.1. Scope

The energy subsystem of the trans-European high-speed rail system comprises all fixed installations that are required to supply, with respect to the essential requirements, the trains from high-voltage single-phase or three-phase networks.

The energy subsystem consists of:

— *substations*: they are connected on their primary side to the high-voltage grid with transformation of the high-voltage to a voltage and/or conversion to a power supply system suitable for the trains. On their secondary side substations are connected to the railway overhead contact lines,

— *sectioning points*: electrical equipment located at intermediate locations between substations to supply and parallel contact lines and provide protection, isolation, auxiliary supplies and compensation,

— *overhead contact lines*: the overhead contact lines distribute the energy to the trains running on the route and transmit it to the trains by means of pantographs. The overhead contact line is also equipped with manually or remotely controlled disconnectors which are required to isolate sections or groups of the overhead contact lines depending on the operational necessities. All types of feeder lines belong to the contact lines as well,

— *current return circuit*: the traction current utilises rails, which are connected directly or indirectly to earth, and return conductors, to flow back to the substations. Therefore, so far as this aspect is concerned, the current return circuit is part of the energy subsystem.

— *pantograph*: despite being installed on moving rolling stock the pantographs form an important device the proper function of which is directly linked to the overhead contact line. Therefore, it is considered to be part of the energy subsystem,

The following aspects of the energy subsystem are related to the interoperability of the trans-European high-speed rail system:

— electrification system,

— overhead contact lines and pantographs,

— interaction of pantographs and overhead line equipment,

— boundaries between high-speed lines, upgraded lines and connecting lines.

### 2.2. Definition of the subsystem

#### 2.2.1. *Electrification system*

As with any electrical device a traction unit is designed in order to operate correctly with a nominal voltage and a nominal frequency applied at its terminals that are the pantographs and wheels. Variations and limits of these parameters need to be defined to guarantee the anticipated performance of the train.

High-speed trains need a correspondingly high power. Therefore, in order to supply the trains with minimum losses it is necessary to increase the voltage of the supply system and decrease the current that gives rise to the resistive losses. The power supply system has to be designed such that every train will be supplied with the necessary power. Therefore, the power consumption of each train and the operating schedule are important aspects for performance.

Modern trains use regenerative braking sending back energy to the power supply to reduce the overall power consumption. Therefore, the power supply system has to accept regenerative braking as well.

In any electrical system short-circuits and other fault conditions may occur. The electrification system needs to be designed such that the subsystem control detects these faults immediately and triggers measures to remove the short-circuit current and isolate the defect part of the circuit. After such events the electrification system has to be able to restore supply to all installations as soon as possible to resume operations.

2.2.2. ***Overhead contact line and pantograph***

From the interoperability point of view, the geometry of the overhead contact line equipment and of the pantographs is an important aspect. So far as the geometrical interaction is concerned the height of the contact wire above the rails, the lateral displacement in still air and under wind pressure and the contact force have to be specified. For the pantograph the geometry of the collector head is also fundamental in order to guarantee correct interaction with the contact line whilst taking into account the possible sway of the vehicles.

2.2.3. ***Interaction of overhead line and pantograph***

At the high speeds envisaged for the trans-European high-speed rail system the interaction of the overhead contact line and the pantograph represents a very important aspect in establishing a reliable power transmission without undue disturbances to railway installations and of the environment. This interaction is mainly determined by:

— static and aerodynamic efforts depending on the nature of the contact strip of the pantograph and the design of the pantographs,

— the compatibility of the contact strip material with the contact wire regarding limitation of wear on those components,

— the dynamic behaviour and impacts on the current collection quality and the aim of a continuous, uninterrupted power supply without disturbances,

— the protection of the pantograph and overhead contact line equipment in case of a broken pantograph collector strip,

— the number of pantographs in service and the distance between them which have a fundamental impact on the collection quality since each pantograph can interfere with others on the same contact line.

2.2.4. ***Boundaries between high-speed lines and other lines***

High-speed lines have to be linked to upgraded lines or to connecting lines. The location of the boundaries between these types of line affects the power supply and contact line system and is, therefore, an aspect to be dealt with in the energy TSI.

2.3. **Links with other subsystems and within the subsystem**

2.3.1. ***Introduction***

The energy subsystem has many links with other subsystems of the trans-European high-speed rail system in order to achieve the envisaged performance of interoperability. These links are covered by the definition of interfaces and performance criteria.

2.3.2. ***Links concerning electrification system***

— Voltage and frequency and their permissible ranges interface with the rolling stock subsystem.

— The power installed on the lines and the specified power factor determine the performance of the interoperable high-speed rail system and interface with the rolling stock subsystem.

— Regenerative braking reduces energy consumption and interfaces with the rolling stock subsystem.

— Electrical fixed installations and on-board traction equipment need to be protected against short circuits by appropriate devices in substations. Tripping of circuit breakers in substations and on trains has to be coordinated; that is why electric protection interfaces with the rolling stock subsystem.

— Electric interference and harmonic emissions interface with the rolling stock and control-command and signalling subsystems.

2.3.3. ***Links concerning overhead contact line equipment and pantographs***

— In the case of high-speed lines the contact wire height needs special attention in order to avoid excessive wear of the contact wire. The contact wire height interfaces with the infrastructure and rolling stock subsystems.

— To pass boundaries of electrification systems without bridging differing systems the number and arrangement of pantographs on trains have to be stipulated. They interface with the rolling stock subsystem.

— The possible sway of vehicles and pantographs interfaces with the rolling stock and infrastructure subsystems.

2.3.4. ***Links concerning interaction of overhead line and pantograph***

— The quality of current collection depends on the number of pantographs in service and their spacing. The arrangement of pantographs interfaces with the rolling stock subsystem.

## 3. ESSENTIAL REQUIREMENTS

### 3.1. Compliance with essential requirements

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

### 3.2. Aspects of essential requirements

The essential requirements cover:

— safety,

— reliability and availability,

— health,

— environmental protection,

— technical compatibility.

According to Directive 96/48/EC the essential requirements may be generally applicable to the whole trans-European high-speed rail system or be specific to each subsystem and its constituents.

### 3.3. Specific aspects for the energy subsystem

3.3.1. ***Safety***

According to Annex III to Directive 96/48/EC essential requirements for the energy subsystem as far as safety is concerned 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 movement 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 normal or exceptional stress that has been specified during their period in service. The safety repercussion of any accidental failure 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 a fire.*

1.1.5. *Any devices intended to be handled by users must be so designed as not to impair their safety if used foreseeable in a manner not in accordance with the posted instructions.*

The aspects mentioned under 1.1.2 and 1.1.5 are not relevant in case of the energy subsystem.

In order to satisfy the essential requirements 1.1.1, 1.1.3 and 1.1.4 above, the energy subsystem shall be designed and constructed so that the requirements set out in points 4.2.2.2, 4.2.3.3, 4.3.1.2, 4.3.1.8, 4.3.2.1, 4.3.2.2 and 4.3.2.4 of Chapter 4 are met and the interoperability constituents used comply with the requirements set out in points 5.3.1.1, 5.3.2.1, 5.3.2.4 and 5.3.3.2 of Chapter 5. The essential requirements are met if compliance with the stipulations of Chapters 4 and 5 is verified.

The following essential requirements for safety according to Annex III to Directive 96/48/EC are especially of concern for the energy subsystem.

2.2.1. *Operation of the energy supply systems must not impair the safety either of high-speed trains or persons (users, operating staff, trackside dwellers and third parties).*

In order to satisfy the essential requirement 2.2.1 above, the Energy subsystem shall be designed and constructed so that the requirements set out in points 4.1.1, 4.2.2.2, 4.2.2.3, 4.2.2.7, 4.2.2.9, 4.3.1.2, 4.3.1.5, 4.3.1.7, 4.3.2.1, 4.3.2.2 and 4.3.2.4 of Chapter 4 are met and the interoperability constituents used comply with the requirements set out in point 5.3.1.1 of Chapter 5. The essential requirements are met if compliance with the stipulations of Chapters 4 and 5 is verified.

3.3.2. ***Reliability, availability and maintainability***

According to Annex III to Directive 96/48/EC, essential requirements for the energy subsystem as far as reliability, availability and maintainability are concerned are the following.

1.2. *The monitoring and maintenance of fixed or moveable 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.*

In order to satisfy the essential requirement 1.2, the energy subsystem shall be designed and constructed so that the requirements set out in points 4.3.1.9 and 4.3.2.6 of Chapter 4 are met. The essential requirements are met if compliance with the stipulations of Chapter 4 is verified.

3.3.3. ***Health***

According to Annex III to Directive 96/48/EC essential requirements for the energy subsystem as far as health is concerned are the following.

1.3.1. *Materials likely, by virtue of the way they are used, to constitute a health hazard to those having access to them must not be used in trains and railway infrastructures.*

1.3.2. *Those materials must be selected, deployed and used in such a way as to restrict the emission of harmful and dangerous fumes or gases, particular in the event of fire.*

In order to satisfy the essential requirements 1.3.1 and 1.3.2, the energy subsystem shall be designed and constructed so that the requirements set out in points 4.2.2.2, 4.2.3.2, 4.2.3.3, 4.3.1.2, 4.3.1.8, 4.3.1.10, 4.3.2.2 and 4.3.2.4 of Chapter 4 are met and the interoperability constituents used comply with the requirements set out in point 5.3.3.2 of Chapter 5. The essential requirements are met if compliance with the stipulations of Chapters 4 and 5 is verified.

3.3.4. ***Environmental protection***

According to Annex III to Directive 96/48/EC essential requirements for the energy subsystem as far as environmental protection is concerned 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 trains and infrastructure must prevent the emissions of fumes and gases which are harmful and dangerous to the environment, particularly in the event of fire.*

1.4.3. *The rolling stock and energy supply systems must be designed and manufactured in such a way as to be electromagnetically compatible with the installation equipment and public or private networks with which they might interfere.*

The aspects mentioned under 1.4.2 are not relevant in case of the energy subsystem.

In order to satisfy essential requirements 1.4.1 and 1.4.3, the energy subsystem shall be designed and constructed so that the requirements set out in points 4.2.3.2, 4.2.3.3 and 4.3.1.5 of Chapter 4 are met. The essential requirements are met if compliance with the stipulations of Chapter 4 is verified.

The following essential requirement for environmental protection according to Annex III to Directive 96/48/EC are especially of concern for the energy subsystem.

2.2.2. *The functioning of the energy supply systems must not interfere with the environment beyond specified limits.*

In order to satisfy essential requirement 2.2.2, the energy subsystem shall be designed and constructed so that the requirements set out in points 4.2.3.2 and 4.3.1.5 of Chapter 4 are met. The essential requirements are met if compliance with the stipulations of Chapter 4 is verified.

3.3.5. ***Technical compatibility***

According to Annex III to Directive 96/48/EC essential requirements for the energy subsystem as far as technical compatibility is concerned are the following.

1.5. *The technical characteristics of the infrastructures and fixed installations must be compatible which each other and with those of the trains on the trans-European high-speed rail system.*

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

In order to satisfy the essential requirement 1.5, the energy subsystem shall be designed and constructed so that the requirements set out in points 4.1.1, 4.1.2, 4.2.2.1, 4.2.2.3, 4.2.2.4, 4.2.2.5, 4.2.2.6, 4.2.2.7, 4.2.2.8, 4,2.2.9, 4.2.2.10, 4.2.2.11, 4.2.2.12, 4.3.1.1, 4.3.1.3, 4.3.1.4, 4.3.2.1, 4.3.2.3, 4.3.2.5 and 4.3.3 of Chapter 4 are met and the interoperability constituents used comply with the requirements set out in points 5.3.1.2, 5.3.1.3, 5.3.1.4, 5.3.1.5, 5.3.1.6, 5.3.1.8, 5.3.2.2, 5.3.2.3, 5.3.2.4, 5.3.2.5, 5.3.2.6, 5.3.2.7, 5.3.2.9, 5.3.3.1, 5.3.3.2, 5.3.3.3 and 5.3.3.4 of Chapter 5 are met. The essential requirements are met if compliance with the stipulations of Chapters 4 and 5 is verified.

The following essential requirements for technical compatibility according to Annex III to Directive 96/48/EC are especially of concern for the energy subsystem.

2.2.3. *The electrical supply systems used throughout the trans-European high-speed rail system must:*

— *enable trains to achieve the specified performance levels,*

— *be compatible with the collection devices fitted to the trains.*

In order to satisfy essential requirement 2.2.3, the energy subsystem shall be designed and constructed so that the requirements set out in points 4.1.1, 4.1.2.1, 4.1.2.2, 4.1.2.3, 4.3.1.1, 4.3.1.3, 4.3.2.1, 4.3.2.3 and 4.3.2.5 of Chapter 4 are met and the interoperability constituents used comply with the requirements set out in points 5.3.1.1, 5.3.1.2, 5.3.1.4, 5.3.2.1, 5.3.2.5, 5.3.3.1 and 5.3.3.5 of Chapter 5 are met. The essential requirements are met if compliance with the stipulations of Chapters 4 and 5 is verified.

3.4. **Verification of conformity**

Conformity of the energy subsystem and its constituents to the essential requirements shall be verified in accordance with the provisions of Directive 96/48/EC and the specifications presented in Chapter 6 and its related Annexes A to C to this TSI.

## 4. CHARACTERISATION OF THE SUBSYSTEM

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

### 4.1. Basic parameters of the Energy subsystem

#### 4.1.1. *Voltage and frequency*

Train services need standardisation of the voltage and frequency values as stipulated for interoperability. Table 4.1 lists the voltages and frequencies applicable depending on the line category.

*Table 4.1*

**Voltages and frequencies**

| Voltage and frequency | Line category | | |
|---|---|---|---|
| | Connecting lines | Upgraded lines | High-speed lines |
| AC 25 kV 50 Hz | X | X | X |
| AC 15 kV 16,7 Hz | X | X | (1) |
| DC 3 kV | X | X | (2) |
| DC 1,5 kV | X | X | — |

(1) In countries with networks currently electrified at AC 15 kV 16,7 Hz, this system can be used for new lines. The same system can also be applied in adjacent countries when it can be economically justified.
(2) The DC 3 kV supply may be used in Italy and Spain for existing lines and new line sections operated at 250 km/h when electrification with AC 25 kV 50 Hz would create a risk of disturbing ground and on-board signalling equipment on an existing line located near the new line.

The voltage at the terminals of the substation and at the pantograph shall comply with Annex N to this TSI. The frequency of the voltage shall comply with Annex N to this TSI. Voltage and frequencies will be defined in the register of infrastructure (Annex D to this TSI). For conformity assessment see Annex N4.

#### 4.1.2. *Overhead line and pantograph*

On future high-speed, upgraded and connecting lines there should be only one type of current collector head used for all trains running on these lines. To implement this approach, all future high-speed trains will use pantographs with a 1 600 mm pantograph collector head. All newly built AC high-speed overhead line equipment shall comply with points 4.1.2.1 and 4.1.2.3, respectively. This also concerns upgraded and connecting AC and DC lines.

##### 4.1.2.1. *Geometry of overhead contact line for AC systems*

The height of contact wire above the rails, the gradient of contact wire in relation to the track and the lateral deflection of the contact wire under the action of a cross wind all govern the interoperability of the high-speed network. The permissible data are given in Table 4.2.

*Table 4.2*

**Geometry of overhead contact lines for AC systems**

| No | Description | Connecting lines | Upgraded lines | High-speed lines |
|---|---|---|---|---|
| 1 | Nominal height of contact wire (mm) | Between 5 000 and 5 750 (1) (2) (3) | Between 5 000 and 5 500 (1) (3) | 5 080 or 5 300 (3) |
| 2 | Permissible contact wire gradient in relation to the track and variation of gradient | EN 50119, version 2001, point 5.2.8.2 | | No planned gradients acceptable |
| 3 | Permissible lateral deflection of the contact wire under action of cross wind (mm) (3) | ≤ 400 | | |

(1) For connecting lines with mixed freight and passenger traffic, for the operation of trailers with oversized gauge the contact wire height may be higher provided the pantograph is suited to collect the current with the specified quality and the development of the pantograph is sufficient as specified in point 5.3.2.5.
(2) At level crossings the contact wire height shall be designed according to national directives.
(3) The contact wire height and wind speed to be considered will be defined in the register of infrastructure defined in Annex D to this TSI.

The overhead contact line geometry shall comply with the requirements set in Annex H.3.1 to this TSI.

4.1.2.2. *Geometry of overhead contact line for DC systems*

The data determining the geometry of overhead contact line for DC systems within the trans-European interoperable rail network is stipulated in Table 4.3.

*Table 4.3*

**Geometry of overhead contact lines for DC systems**

| No | Description | Connecting lines | Upgraded lines |
|---|---|---|---|
| 1 | Nominal height of contact wire (mm) | Between 5 000 and 5 600 (1) (2) (3) (4) | Between 5 000 and 5 500 (3) (4) |
| 2 | Permissible contact wire gradient in relation to the track and variation of gradient | EN 50119, version 2001, point 5.2.8.2 | |
| 3 | Permissible lateral deflection of the contact wire under action of cross wind (mm) (4) | ≤ 400 | |

(1) For connecting lines with mixed freight and passenger traffic, for the operation of trailers with oversized gauge the contact wire height may be higher provided the pantograph is suited to collect the current with the specified quality and the development of the pantograph is sufficient as specified in point 5.3.2.5.
(2) At level crossings the contact wire height shall be designed according to national directives.
(3) For the lines in Italy referred to in note 2 to Table 4.1 the contact wire height is between 5 000 mm and 5 300 mm. The other values apply to other types of lines.
(4) The contact wire height and wind speed to be considered will be defined in the register of infrastructure defined in Annex D to this TSI.

The overhead contact line geometry shall comply with requirements set in Annex (J.3.1) to this TSI.

4.1.2.3. *Geometry of the pantograph collector head*

The width and the working range of the pantograph collector head, the width of the contact strips and the profile of the collector head are defined to achieve interoperability. Table 4.4 specifies data for both AC and DC systems. The profile of the pantograph collector head is depicted in figure 4.1.

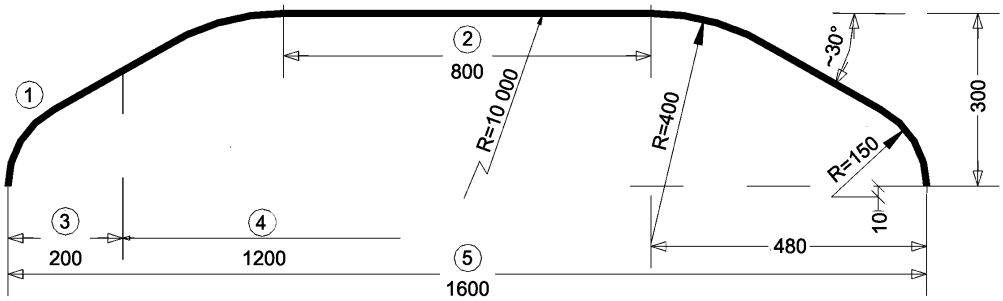
*Table 4.4*

**Geometry of pantograph collector head for AC and DC systems**

| No | Description | All line categories |
|---|---|---|
| 1 | Width of pantograph collector head (mm) | 1 600 |
| 2 | Profile of pantograph collector head | See figure 4.1 |
| 3 | Other requirements for AC systems | See Annex H(3)(2) to this TSI |
| 4 | Other requirements for DC systems | See Annex J(3)(2) to this TSI |

*Figure 4.1*

**Profile of pantograph collector head**




1 Horn made of insulating material
2 Minimum length of the contact strip
3 Projected length
4 Working range of the collector head
5 Width of the collector head

4.2. **Interfaces of the energy subsystem**

4.2.1. ***List of interfaces***

4.2.1.1. *Interfaces with Infrastructure*

— Gauges

— Protection against electric shock (earthing and bonding)

4.2.1.2. *Interfaces with Control-Command and Signalling*

— Harmonic currents, influence on signalling and internal telecommunications

— Control signals needed for phase and system separation sections

4.2.1.3. *Interfaces with Rolling Stock*

— Vehicle dynamic envelope

— Limitation of maximum power consumption

— Current at standstill

— Voltage and frequency

— Electrical protection coordination

— Arrangement of pantographs

— Running through phase separation sections

— Running through system separation sections

— Adjustment of pantograph contact force

4.2.1.4. *Common performance criteria with rolling stock*

— Power factor

— Regenerative braking

— Harmonic characteristics and related overvoltages on the overhead contact line

4.2.2. ***Characteristic data of interfaces***

4.2.2.1. *Gauges*

The infrastructure gauge shall take into account the space necessary for the passage of pantographs in contact with the overhead contact line equipment and for installation of the contact line equipment itself. The dimensions of tunnels and other structures shall be mutually compatible with the geometry of overhead line equipment and the dynamic envelope of the pantograph. (Annex (H.3.6) to this TSI specifies the dynamic envelope of the pantograph). The space necessary for installation of the contact line equipment shall be stipulated by the adjudicating entity. Conformity assessment shall be carried out within assessment of the Infrastructure subsystem.

4.2.2.2. *Earthing and bonding, protection against electric shock*

Infrastructure subsystem shall implement a general earthing system along the route to comply with the requirements for protection against electric shock specified in EN 50 122—1. Protection against electric shock during operation and in failure conditions is met by limiting touch voltages to acceptable limits as stipulated in EN 50 122-1, version 1997, point 7. Results of investigations carried out by the adjudicating entity and the corresponding specific provisions shall be provided to demonstrate the compliance with the requirements. Conformity assessment shall be carried out within the assessment of infrastructure subsystem.

4.2.2.3. *Harmonic currents, influence on signalling and internal telecommunications*

Harmonic currents generated by rolling stock affect the control-command and signalling subsystem through the energy subsystem. That is why this subject is dealt within the control-command and signalling subsystem. No conformity assessment is required by the energy subsystem.

4.2.2.4. *Vehicle dynamic envelope*

Overhead line equipment design shall comply with the dynamic envelope of the vehicles. The gauge to be adopted depends on the category of line defined in the register of infrastructure (Annex D to this TSI). Conformity assessment shall be carried out within the energy subsystem.

4.2.2.5. *Limitation of maximum power consumption*

The installed power on a high-speed line and upgraded or a connecting line determines the permissible power consumption of trains. Therefore, current limitation devices shall be installed on board as described in Annex O to this TSI. Assessment shall be carried out within assessment of the rolling stock subsystem. The register of infrastructure defined in Annex D to this TSI shall contain information on maximum power consumption.

4.2.2.6. *Limitation of current drawn by trains at standstill*

In case of DC 1,5 kV and 3,0 kV systems the current at standstill shall be limited to 300 A and 200 A, respectively, per pantograph. Assessment shall be carried out within assessment of the rolling stock subsystem.

4.2.2.7. *Voltage and frequency*

Trains shall be able to operate within the range of voltages and frequencies as given in point 4.1.1 and specified in Annex N to this TSI. Conformity assessment shall be carried out within assessment of the rolling stock subsystem.

4.2.2.8. *Electrical protection coordination*

Coordination between the electrical protection of substations and that of traction units is necessary to optimise the clearance of shortcircuits. (Annex E to this TSI gives the applicable requirements.) The register of infrastructure defined in Annex D to this TSI shall contain information on protection of substations.

Conformity assessment shall be carried out with the energy subsystem in so far as design and operation of substation is concerned and with the rolling stock subsystem in so far as equipment on traction units is concerned.

4.2.2.9. *Arrangement of pantographs*

The arrangement of pantographs on trains shall take care of the maximum train length. The maximum distance between pantographs is less than 400 m. In addition the spacing between three consecutive pantographs shall be more than 143 m. The acceptable number of pantographs and their spacing depend also on the dynamic performance. The pantographs shall not be linked electrically in case of AC power supply systems. Reference is made to Annex H (H.3.5) to this TSI.

Conformity assessment shall be carried out with the rolling stock subsystem.

4.2.2.10. *Running through phase separation sections*

Trains shall be able to move from one section to an adjacent one without bridging the two phases.

Adequate means shall be provided to allow a train that is stopped underneath the phase separation to be restarted. For design, reference is made to Annex H(H.3.3), to this TSI.

The register of infrastructure defined in Annex D to this TSI shall contain information on the design of phase separation sections.

Power consumption (traction and auxiliaries) of the train shall be brought to zero when entering the phase separation section. This shall be done automatically without the driver's intervention. Lowering of the pantographs is not necessary.

**Requirements for design of energy subsystem**

*For future lines* two types of designs of phase separation sections may be adopted:

— a phase separation design where all the pantographs of the longest interoperable trains are inside the neutral section. In this case there is no restriction for the arrangement and spacing of the pantographs on the trains. The length of the neutral section shall be at least 402 m. For detailed requirements see Annex H(H.3.3) to this TSI,

— a shorter phase separation with a restriction for pantograph arrangement on trains is shown in Annex H(H.3.3) to this TSI. The overall length of this separation is less than 142 m. Using this design necessitates that the distance between three consecutive pantographs in service is more than 143 m.

*For existing lines* various solutions might be adopted and based on the accepted arrangement of pantographs on the train, depending on the possibilities of route planning, required performance and investments acceptable to the adjudicating entity. If the design of existing phase separations does not permit the passage of interoperable high-speed trains, then the adjudicating entity shall provide adequate alternative procedures or designs.

Information on the design of phase separation sections shall be provided by the register of infrastructure as defined in Annex D to this TSI.

For design of phase separation section, conformity assessment shall be carried out within assessment of the energy subsystem.

**Requirements for control-command and rolling stock subsystems**

On high-speed lines, the control-command and signalling subsystem shall allow the rolling stock to operate automatically before and after phase separation sections. Equipment on traction units shall be triggered in due time in front of a phase separation section taking full account of the maximum permissible running speed. For conformity assessment functional tests shall be carried out jointly with rolling stock and control-command and signalling subsystems.

4.2.2.11. *Running through system separation sections*

*General*

Trains shall be able to move from one energy supply system to an adjacent one that uses a different energy supply without bridging the two systems. The necessary actions depend on the type of both supply systems as well as on the arrangement of pantographs on trains and the running speed.

There are two possibilities for the train to run through system separation sections:

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

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

A choice has to be made by the adjudicating entity and declared in the register of infrastructure defined in Annex D to this TSI.

**Requirements for the design of energy subsystem**

— *Pantographs raised*

If system separation sections are negotiated with pantographs raised to the contact wire the following conditions apply:

(1) the functional design of the system separation section is specified as follows:

— the geometry of different elements of the overhead contact line shall prevent pantographs short-circuiting or bridging both power systems with the arrangement of pantographs specified in point 4.2.2.9,

— for short neutral section, the mechanical behaviour of the pantograph overhead contact line system shall comply with the EN 50 119, version 2001, point 5.2, at maximum speed,

— provisions shall be taken in the energy subsystem to avoid bridging of both adjacent power supply systems when the opening of the on-board circuit breaker(s) fails,

— an example for arrangement of system separation section is given in figure H.4 of Annex H to this TSI;

(2) the height of the contact wires in both systems has to be the same, if the speed is more than 250 km/h. Details and tolerances are given in Annexes H and J to this TSI;

(3) on rolling stock, devices shall open automatically the circuit breaker before reaching the separation section and recognise automatically the voltage of the new power supply system at the pantograph in order to switch the corresponding circuits.

— *Pantographs lowered*

If the system separation sections are negotiated with pantographs down the following conditions apply:

(1) the design of the separation section between differing energy supply systems shall ensure that, in case of an unintentional pantograph at the contact line, bridging of the two power supply systems is avoided and switching off both supply sections is triggered immediately. Triggering of a short circuit ensures operation of insulated sections;

(2) this alternative choice has to be made if the conditions of operation with pantographs raised are not complied with;

(3) on high-speed lines with different heights of contact wire and on separation sections of existing lines not complying with the TSI requirements, pantographs shall be lowered when the energy supply system changes or when the running speed does not permit the installation of transition sections with acceptable gradients (see Annexes H and J to this TSI);

(4) at supply system separations which require a lowering of the pantograph, the pantograph shall be lowered without the driver's intervention, triggered by control signals.

For design of system separation sections conformity assessment shall be carried out within the energy subsystem.

**Requirements for control-command and rolling stock subsystems**

Before running through separation sections between different energy supply systems the traction units' main circuit breaker shall be opened without the driver's intervention, triggered by control signals. This shall be carried out in good time so that the traction unit electrical equipment for the terminating energy supply system fully shuts down before the new energy supply system is reached.

The control-command and signalling subsystem shall provide the required signals to the traction units.

The traction units shall be designed so that they are able to receive line control signals to trigger the opening of the main circuit breaker and lower the pantographs if required without the driver's intervention. When pantographs are not lowered from the contact wire, only those electric circuits on the traction units which instantaneously conform to the energy supply system at the pantograph may remain connected.

The design and the operation of system separation sections shall be explained in the register of infrastructure defined in Annex D to this TSI.

Conformity assessment shall be carried out with functional tests jointly with control-command and rolling stock subsystems.

4.2.2.12. *Adjustment of pantograph contact force*

Rolling stock shall permit by internal controls adjustment of pantograph contact force to comply with the requirements specified in point 5.3.2.7. Conformity assessment shall be carried out within the rolling stock subsystem.

4.2.3. ***Regulatory and operational provisions***

4.2.3.1. *General regulatory conditions*

To guarantee the coherence of the trans-European high-speed rail system the following regulatory and operational provisions apply.

4.2.3.2. *Protection of the environment*

Protection of the environment is covered by Council Directive 85/337/EEC concerning the assessment of the effects of certain projects on the environment.

Specific requirements are not necessary for the energy subsystem of interoperable high-speed lines.

4.2.3.3. *Fire protection*

Fire protection is covered by Directive 89/106/EEC and its interpretative document concerning essential safety requirement No 2, 'Fire Safety'.

Specific requirements are not necessary for the Energy subsystem of interoperable high-speed lines.

4.2.3.4. *Exception in the case of execution of works*

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

Under some situations where works have been programmed in advance, it may not be possible to conform to these provisions whilst executing modifications to the Energy subsystem.

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

— the exceptions allowed shall be temporary and planned for a specific time period,

— railway undertakings operating on the line shall be given notice of these temporary exceptions, of their geographic situation, of their nature and of their particular signalling, by means of written notices describing the case being the type of specific signals used. A model of such notice shall be joined to the register of infrastructure defined in Annex D to this TSI of the line,

— any exception shall induce complementary safety measures, so as to ensure that the safety level requirement stays fulfilled. These complementary measures may in particular consist of:

  — particular survey provisions of the works concerned,

  — temporary speed restrictions on the line section as taken by the adjudicating entity.

4.2.3.5. *Register of infrastructure of European interoperable lines*

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

It allows:

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

— the railway undertakings providing, or considering the provision of, services on the line to be informed of its particular features when parameters or interoperability specifications are depending on a specific choice of the adjudicating entity,

— for the energy subsystem, indication for each homogeneous section of line and each particular equipment, of the general or particular specifications which have been adopted, which should be noted for the line operation. Their list is provided in Annex D to this TSI.

The adjudicating entity shall append this document to the EC declaration of verification of the energy subsystem as a part of the technical file described in Annex V to Directive 96/48/EC to be granted the authorisation for putting into service by the Member State.

## 4.3. Specified performance

### 4.3.1. *Performance of power supply system, substations and posts*

#### 4.3.1.1. *Installed power*

The performance to be achieved by the energy subsystem shall correspond to the relevant specified performance for each category of lines in the trans-European high-speed rail network system in respect of:

— the maximum line speed,

— the peak power at the pantographs and drawn by the trains,

— the minimum headway,

— the mean useful voltage.

The adjudicating entity shall declare the type of the line depending on its function with reference to Annex F to this TSI and in the register of infrastructure as defined in Annex D to this TSI. Electrification system design shall guarantee the ability of the power supply to achieve the specified performance. Therefore, point 4.2.2.5 gives a requirement on limitation of power consumption by rolling stock subsystem.

The calculated mean useful voltage at the pantograph shall comply with Annex L to this TSI.

#### 4.3.1.2. *Safety, earthing and bonding*

Safety of energy supply system, substations and posts shall be achieved by designing and testing these installations according to EN 50 122-1, version 1997, points 5, 7 and 9. Substations and posts shall be barred against unauthorised access.

#### 4.3.1.3. *Power factor*

The acceptable data for power factor is stipulated in Annex G to this TSI. On high-speed lines the minimum value is 0,95 under the conditions described in the abovementioned document. Conformity assessment to be carried out within assessment of the rolling stock subsystem.

#### 4.3.1.4. *Regenerative braking*

The AC energy supply systems shall be designed to permit the use of regenerative braking as a service brake able to exchange power seamlessly with other trains or with the primary network supplier. Reference is made to Annex K to this TSI.

Train equipment shall allow the use of other braking systems where regenerative braking is not possible.

The adjudicating entity can decide whether or not to accept regenerative braking on DC systems. The register of infrastructure as defined in Annex D to this TSI shall contain necessary information.

Conformity assessment for fixed installations shall be carried out as specified in Annex K(K.4) to this TSI.

For rolling stock conformity assessment shall be carried out as specified in the rolling stock TSI.

4.3.1.5. *External electromagnetic compatibility*

External electromagnetic compatibility is not a specific characteristic of the trans-European high-speed rail network. Energy supply installations shall comply with the standards EN 50 121-2 and EN 50 122 series to meet all requirements concerning electromagnetic compatibility. No conformity assessment is required within this TSI.

4.3.1.6. *Harmonic emissions towards the power utility*

Concerning harmonic emissions towards the power utility it is up to the adjudicating entity to comply with the national standards (or European standards when available) and with the requirements of the power utility. No conformity assessment is required within this TSI.

4.3.1.7. *Harmonic characteristics and related overvoltages on the overhead contact line*

To avoid unacceptable overvoltages on the overhead contact line caused by harmonics generated by motive power units the motive power units shall comply with Annex P to this TSI. The necessary requirements are defined in the rolling stock subsystem and conformity assessment shall be carried out with the rolling stock subsystem, as defined in Annex P.

4.3.1.8. *Protection against electric shock*

The energy supply system shall be integrated into the general earthing system along the line to comply with the requirements for protection against electric shock as specified in EN 50 122-1, version 1997, points 5, 7 and 9. Protection against electric shock during operation and in failure conditions is met by limiting touch voltages to acceptable limits as stipulated in EN 50 122-1, version 1997, points 7.2 and 7.3. For each installation a study shall be established to prove the protection against electric shock. The study may include tests.

4.3.1.9. *Maintenance plan*

A maintenance plan shall be drawn up by the adjudicating entity or his authorised representative to guarantee that the specified characteristics of the energy subsystem are upheld within the limits specified for them.

The maintenance plan shall contain at least the following elements:

— maintenance routines in substations and posts,

— recording of conditions, findings and experience gained,

— a set of safety limit values which would lead to a limitation of train speeds in order to comply with the specifications in point 4.1.1,

— an indication of the frequencies of checks and of the tolerances on measured values with for latter an indication of the rules of equivalence with the values of the standard quoted in subsection 4.3.1,

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

Maintenance procedures should not downgrade safety provisions such as continuity of return current circuit, limitation of overvoltages and detection of short circuits. It shall not reduce the global performance of the system and avoid de-energising of any part of the overhead contact line.

4.3.1.10. *Isolation of power supply in case of danger*

Equipment shall be installed and procedures implemented to initiate isolation of voltage from traction units and electrified lines through alarm devices allowing the power supply operator to carry out emergency actions. Conformity assessment shall be carried out by checking the transmission devices and instructions for procedures.

4.3.1.11. *Continuation of power supply in case of disturbances*

The power supply and the overhead contact line shall be designed to enable continuation of operation in case of disturbances. This can be achieved by sectioning contact lines into supply sections and installation of redundant equipment in substations. Conformity assessment shall be carried out by checking the circuit diagrams.

4.3.2. ***Performance of the overhead contact line***

4.3.2.1. *General*

The performance to be achieved by the overhead contact line shall correspond to the relevant performance as specified for each category of lines of the trans-European high-speed rail system in function of

— the maximum line speed, and

— the power demand of the trains at the pantographs.

The overhead contact line design shall guarantee the specified performance in accordance with the declaration made by the adjudicating entity in the frame of point 4.3.1.1.

4.3.2.2. *Safety, earthing and bonding*

The safety of the overhead contact line is achieved by designing these installations according to the European standards EN 50 119, version 2001, point 5.1.2 and EN 50 122-1, version 1997, points 5, 7 and 9. All live components shall be installed out of reach of users and any other persons.

4.3.2.3. *Requirements for dynamic behaviour and quality of current collection*

The design of the overhead line equipment shall comply with the requirements on the dynamic behaviour. The uplift under the design speed of the line shall comply with the stipulations in EN 50 119, version 2001, point 5.2.1.2 and on Tables 4.5 and 4.6 of this TSI.

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

The collection quality may be assessed by the mean value $F_m$ and the standard deviation $\sigma$ of measured or simulated contact forces or by counting of arcing. For AC systems the criteria are listed in Table 4.5 and for DC systems in Table 4.6.

The adjudicating entity shall decide to use interaction criterion item No 1 (contact force) or item No 2 (arcing) according to Table 4.5 or 4.6.

The interaction is considered to comply with the provisions in this TSI if

— item 1 or 2 of Table 4.5, and

— item 3 of Table 4.5,

are fulfilled.

Test results from a similar overhead contact line system may be used as a basis for conformity assessment.

For the qualification of the performance with more than one pantograph, it shall be taken into account the pantograph which will show the more critical values.

*Table 4.5*

**Interaction requirements, AC systems**

| No | Description | Connecting and upgraded lines | High-speed lines | |
|---|---|---|---|---|
| | | | Existing | New |
| 1 | Corrected mean force $F_m$ (N) [1] | See points 5.3.1.6 and 5.3.2.7 [2] | | See point 5.3.1.6 [2] |
| | Standard deviation at maximum speed $\sigma_{max}$ (N) | 0,3 $F_m$ | | |
| 2 | Percentage of arcing at maximum speed, NQ (%) | ≤ 0,14 | | |
| 3 | Necessary space for maximum uplift of steady arm under adverse aerodynamic conditions | See EN 50119, version 2001 point 5.2.1.2 | | $2 \cdot S_o$ [3] |

For definitions, values and tests see Annex Q

[1] $F_m$ is the dynamically corrected average value of the contact force obtained after statistical analysis of the results of contact force measurements or simulations.
[2] The dynamic correction shall be applied on the values given in points 5.3.1.6 and 5.3.2.7.
[3] $S_0$ is the calculated, simulated or measured uplift of contact wire at the steady arm generated in normal operating condition with one or several pantographs with a mean contact force $F_m$ at the maximum speed of the line, in accordance with EN 50 119 version 2001, point 5.2.1.2.

*Table 4.6*

**Interaction requirements, DC systems**

| No | Description | Connecting and upgraded lines [1] |
|---|---|---|
| 1 | Corrected mean force $F_m$ (N) [2] | See points 5.3.1.6 and 5.3.2.7 [3] |
| | Standard deviation at maximum speed $\sigma_{max}$ (N) | 0,3 $F_m$ |
| 2 | Percentage of arcing at maximum speed, NQ (%) | ≤ 0,20 |
| 3 | Necessary space for maximum uplift of steady arm under adverse aerodynamic conditions | See EN 50119, version 2001 point 5.2.1.2 [4] |

For definitions, values and tests see Annex Q

[1] For lines in Italy and Spain referred to note 2 to Table 4.1 the values specified for upgraded lines apply as well.
[2] $F_m$ is the dynamically corrected average value of the contact force obtained after statistical analysis of the results of contact force measurements or simulations.
[3] The dynamic correction shall be applied on the values given in points 5.3.1.6 and 5.3.2.7.
[4] The necessary space is determined by the calculated, simulated or measured uplift of contact wire at the steady arm generated in normal operating condition with one or several pantographs with a mean contact force $F_m$ at the maximum speed of the line.

4.3.2.4. *Protection against electric shock*

The overhead contact line shall be integrated into the general earthing system along the line to comply with the requirements for protection against electric shock as specified in EN 50 122-1, version 1997, points 5, 7 and 9. Protection against electric shock during operation and in failure conditions is met by limiting touch voltages to acceptable limits as stipulated in EN 50 122-1, version 1997, points 7.2 and 7.3. For each installation a study shall be established to prove the protection against electric shock.

4.3.2.5. *Static and mean aerodynamic contact force*

The nominal static force is specified by the adjudicating entity inside the following ranges:

— 70 N + 20 N/-10 N for AC supply systems,

— 110 N ± 10 N for DC 3 kV supply systems,

— 90 N ± 20 N for DC 1,5 kV supply systems.

In DC systems to improve the contact of carbon collector strips with the contact wire, a force more important, in general 140 N, can be required to avoid a hazardous heating of the contact wire when the train is at standstill with its auxiliaries working.

The value of total mean uplift force shall comply with the value of mean contact force $F_m$ required for a good quality of current collection (see point 4.3.2.3, 5.3.1.6 and 5.3.2.7).

Conformity assessment is carried out by assessing the interoperable constituent 'pantograph'.

4.3.2.6. *Maintenance plan*

A maintenance plan shall be drawn up by the adjudicating entity or his authorised representative to guarantee that the specified characteristics of the energy subsystem are upheld within the limits specified for them.

The maintenance plan shall contain at least the following elements:

— maintenance routines for overhead contact lines,

— recording of conditions, findings and experience gained,

— a set of safety limit values which would lead to a limitation of train speeds for the contact wire height and stagger according to points 4.1.2.2 and 4.1.2.3 of this TSI,

— an indication of the frequencies of checks and of the tolerances on measured values of the geometrical and dynamic data and of the means used to check them, with for latter an indication of the rules of equivalence with the values of the standard quoted in Subsection 4.3.2,

— the measures taken such as speed restriction and expected repair time when prescribed values are exceeded.

Maintenance procedures should not downgrade safety provisions such as continuity of return current circuit, limitation of overvoltages and detection of short circuits. It shall not reduce the global performance of the system.

4.3.3. ***Boundaries between high-speed lines and other lines***

It is up to the adjudicating entity to define, on a short route section, which connects a high-speed line with another line, the location where the requirements of the energy subsystem TSI for high-speed lines apply and their specified performances will be met.

## 5. INTEROPERABILITY CONSTITUENTS

### 5.1. General

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*'.

The interoperability constituents are covered by the relevant provisions of Directive 96/48/EC and are listed in section 5.2 of this TSI so far as the Energy subsystem is concerned.

5.2. **Definitions of interoperability constituents**

In case of the Energy subsystem the following constituents are defined:

— *overhead contact line*: an overhead contact line is a contact line placed above the upper limit of the vehicle gauge and supplying vehicles with electric energy through roof-mounted current collection equipment referred to as pantographs. In the case of high-speed rail systems overhead contact lines with catenary suspension are applied where the contact wire(s) is/are suspended from one or more longitudinal catenaries. The supporting components such as cantilevers, masts and foundations will not affect the interoperability and, therefore, are not covered by this TSI,

— *pantograph*: pantographs are devices for collecting currents from one or more contact wires formed by a hinged device designed to allow vertical movement of the pantograph head. The pantograph head carries the contact strips and their mountings. The end of the pantograph head is formed by a down-turned horn,

— *contact strips*: contact strips are the replaceable parts of the pantograph head which are in direct contact with the contact wire and as a consequence are prone to wear.

5.3. **Characterisation of constituents**

5.3.1. ***Overhead contact line***

5.3.1.1. *Overall design*

Design of overhead contact lines shall comply with EN 50 119, version 2001, points 5 and 6. Additional requirements, specially concerning high-speed lines are specified hereafter.

The overhead contact line shall meet the specified performance for the specific line especially so far as the maximum running speed and the current carrying capacity are concerned.

5.3.1.2. *Current capacity*

The current capacity depends on the ambient conditions which are maximum ambient temperature and minimum cross-wind speed defined for each specific line in the register of infrastructure defined in Annex D to this TSI as well as the permissible temperatures of the contact line elements and the duration of current action. The design of the overhead contact line shall take care of the limits for the maximum temperatures as specified in Annex B to EN 50 119, version 2001, taking account of the data given in EN 50 149, version 1999, point 4.5, Tables 3 and 4. An analysis shall prove that the contact line is able to comply with the specified requirements.

5.3.1.3. *Basic parameters*

The design of the overhead contact line shall comply with the basic parameters as specified in points 4.1.2.1 and 4.1.2.2.

5.3.1.4. *Wave propagation speed*

The speed of wave propagation on contact wires is a characteristic parameter for assessing the suitability of a contact line for a high-speed operation. This parameter depends on the specific mass and the stress of the contact wire. Maximum operation speed shall not be more than 70 % of the wave propagation speed. See also EN 50 119, version 2001, point 5.2.1.4.

5.3.1.5. *Elasticity and uniformity of elasticity*

Elasticity and the uniformity along the span are essential for a high-quality current collection and a reduction of wear and tear. The uniformity of elasticity can be assessed by the uniformity factor $u$

$$u = \frac{e_{max} - e_{min}}{e_{max} + e_{min}} \cdot 100(\%).$$

where:

$e_{max}$ maximum elasticity along a span,

$e_{min}$ minimum elasticity along a span.

In case of high-speed lines a parameter *u* as low as possible should be aimed at; Table 5.1 gives limit values for *u*, which are accepted for each type of overhead contact line.

*Table 5.1*

**Uniformity *u* of elasticity in %**

| Type of contact line | Running speed km/h | | |
|---|---|---|---|
| | 200 to 230 | 230 to 300 | Above 300 |
| Without stitch wire | < 40 | < 40 | < 25 |
| With stitch wire | < 20 | < 10 | < 10 |

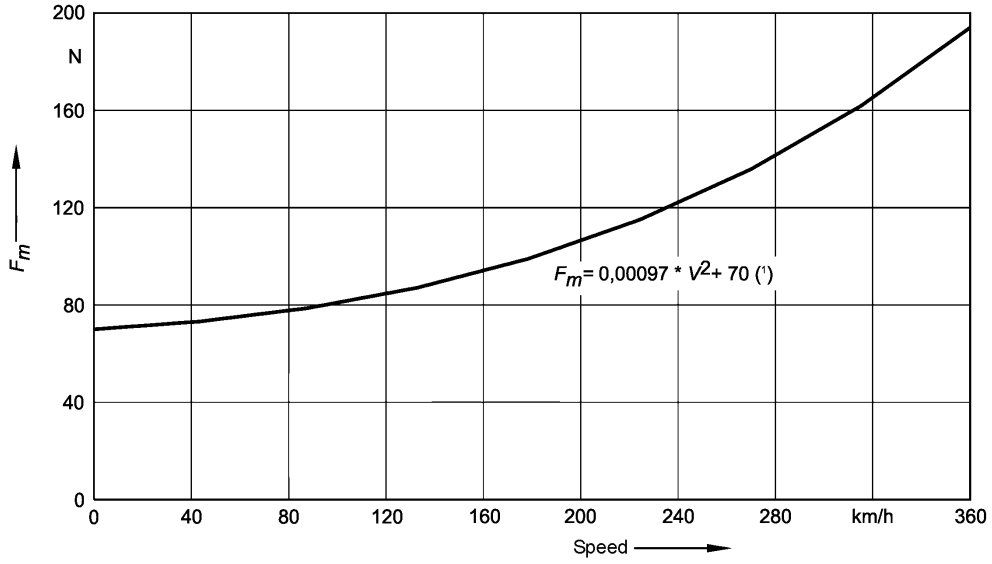
For high-speed lines the mid-span elasticity should be limited to values less than 0,5 mm/N. The contact line shall comply with EN 50 119, version 2001, point 5.2.1.3.

5.3.1.6. *Mean contact force*

This clause stipulates mean contact forces for which the contact line shall be designed.

*Figure 5.1*

**Target for mean contact force $F_m$ for AC systems depending on running speed**




(1) *V* in km/h

The mean contact force $F_m$ formed by the static and aerodynamic components of the contact force with dynamic correction which shall be applied on the contact wire is shown in figure 5.1 for AC systems as a function of running speed.

In this context $F_m$ represents a target value which should be achieved to ensure on one hand a current collection without undue arcing and which should not be exceeded on the other hand to limit wear and hazards to current collection strips.

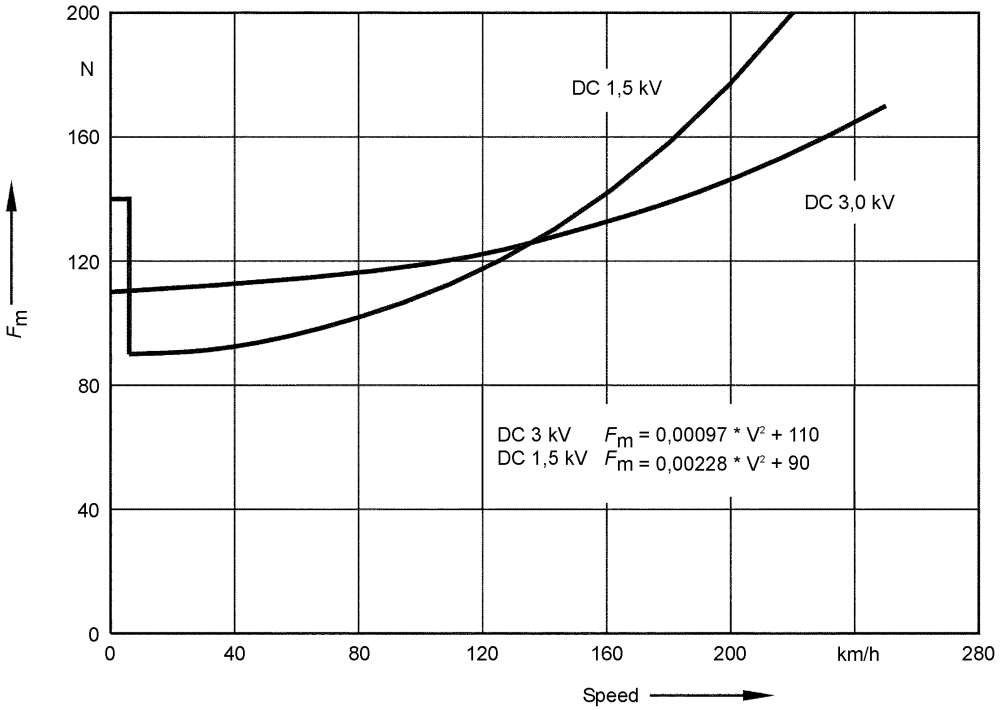
In case of trains with multiple pantographs simultaneously in operation the mean contact force $F_m$ for any pantograph shall be not higher than the value given by figure 5.1 since for each individual pantograph the current collection criteria shall be met.

Concerning DC systems, the mean contact force $F_m$ formed by the static and aerodynamic components of the contact force with dynamic correction which shall be applied for DC 1,5 kV and DC 3,0 kV systems is shown in fig. 5.2 as a function of running speed. For DC 1,5 kV lines the static contact force should be 140 N where necessary in respect of the current at standstill.

In case of trains with multiple pantographs simultaneously in operation the mean contact force $F_m$ for any pantograph shall be not higher than the value given by figure 5.2 since for each individual pantograph the current collection criteria shall be met.

*Figure 5.2*

**Target for mean contact force for $F_m$ for DC 1,5 kV and DC 3,0 kV lines depending on the running speed**




5.3.1.7. *Maintenance*

The manufacturer shall provide any necessary information to allow the adjudicating entity to draft a plan concerning maintenance taking into account especially the geometry of the overhead line, the wear of the contact wire, especially at critical points such as crossings, switches and overlaps.

5.3.1.8. *Current at standstill*

An acceptable level of current at standstill shall be acceptable for both the contact wire and pantograph collector strips to allow a proper feeding of the auxiliaries installed on board trains. For DC 1,5 kV systems a current of 300 A per pantograph shall be guaranteed, while for DC 3,0 kV systems a current of 200 A per pantograph shall be guaranteed. When testing the overhead contact line with the methodology specified in EN 50 206-1, version 1998, point 6.13, the contact wire temperature shall not exceed the limits given in Annex B to EN 50 119, version 2001.

5.3.2. ***Pantograph***

5.3.2.1. *Overall design*

The pantograph shall meet the specified performance as far as maximum running speed and current carrying capacity are concerned. So far as not specified hereafter EN 50 206 applies. The installation of pantograph on rolling stock is dealt with by the rolling stock subsystem.

5.3.2.2. *Basic parameters*

The design of the pantograph shall meet the basic parameters as specified in section 4.1.

5.3.2.3. *Current capacity*

The pantograph shall be designed for the specified current to be transmitted to the vehicles. The rated current shall be provided by the manufacturer. Attention shall be given especially to the specific data depending on the use on AC or DC systems. An analysis shall prove that the pantograph is able to carry the specified current.

5.3.2.4. *Design of insulation*

The pantographs shall be assembled on the roof of the vehicles insulated against earth. The design of insulation shall take care of the stresses by voltage. References for data to be verified are in Annex N to this TSI for system voltages and EN 50 124-1, version 1999, Table 2, for insulation coordination requirements. Insulators shall be tested according to EN 60 383.

5.3.2.5. *Working range of pantographs*

The pantographs shall be able to work under contact wire heights between 4 800 mm and 6 400 mm. For operation in the UK and Finland on upgraded or connecting lines, the height is different. See section 7.3.

5.3.2.6. *Static contact force*

Static force is the mean vertical contact force exerted upward by the collector head on the contact line and caused by the pantograph raising device, whilst the pantograph is raised and the vehicle is at standstill.

For AC systems the static force shall be adjustable between 40 N and 120 N.

In DC systems to improve the contact of collector strips with the contact wire, a higher force may be needed to avoid dangerous heating of the contact wire when the train is at standstill with its auxiliaries working. For DC systems the static force shall be adjustable between 50 and 150 N.

The pantographs and their mechanisms that provide the necessary contact forces shall ensure that the pantographs can be used on every type of interoperable overhead contact line. For details and assessment reference is made to EN 50 206-1, version 1998, point 6.3.1

5.3.2.7. *Mean contact force and interaction performance of the overhead line/pantograph system*

The mean contact force is the mean value of the forces due to static and aerodynamic actions. It is equal to the sum of static contact force (point 5.3.2.6) and the aerodynamic force caused by the airflow on the pantograph elements at the considered speed. The mean uplift force is a characteristic of the pantograph for given rolling stock and a given development of the pantograph. The mean contact force is measured at the collector head according to Annex Q(Q.4.2.2).

The value of mean contact force shall comply with the mean contact force F stipulated in point 5.3.1.6.

For existing, connecting, upgraded and high-speed AC lines which would not comply with the requirements stipulated in point 5.3.1.6, the pantograph shall be designed such that the running speed-dependent mean contact force $F_m$, in addition to the target curve according to figure 5.1, allows other adjustment curves C1 and C2.

These curves are defined in Annex Q(Q.4.1).

The manufacturer of the pantograph shall provide for the change between the three curves to be made on board taking the appropriate information e.g. use of 1 950 mm pantograph or information on the type of voltage on the overhead contact line. The register of infrastructure defined in Annex D to this TSI of existing lines shall indicate which curve shall be taken into account, i.e. the target curve or the alternative curves C1 or C2.

In case of trains with multiply pantographs simultaneously in operation, the contact force $F_m$ for any pantograph shall not be higher than the value given by the target curve of point 5.3.1.6 or one of the curves C1 or C2 since for each individual pantograph the current collection criteria shall be met.

Those requirements are specified in Annex Q.

Assessment shall be carried out according Annex Q.

5.3.2.8. *Automatic dropping device*

Pantographs shall be equipped with a device that drops the pantograph in case of a failure according to EN 50 206-1, version 1998, point 4.9.

5.3.2.9. *Current at standstill*

The current drawn by the trains at standstill shall be acceptable for both the contact wire and pantograph collector strips to allow proper feeding of the auxiliaries installed on board trains. For DC systems, in order to be in accordance with point 5.3.1.8, a current of 300 A per pantograph shall be guaranteed. A study shall prove that the pantograph is able to carry the specified current at standstill.

For conformity assessment reference is made to EN 50 206-1, version 1998, point 6.13 and Annex Q.

5.3.3. ***Contact strips***

5.3.3.1. *Basic parameters*

The contact strips of the pantographs shall comply with the basic parameters as given in section 4.1.

5.3.3.2. *Materials*

The material used for the pantograph contact strips shall be physically and electrically compatible with the contact wire material to avoid abrading the surface of the contact wires excessively, in order to keep wear of both wires and contact strips to a minimum. Plain carbon or carbon impregnated with additive material are accepted for use in interaction with contact wires made from copper or copper alloys. Therefore, this combination should preferably be used for the trans-European high-speed rail system.

Other material may be used in case of DC systems when multilaterally agreed upon. In this case the contact strips cannot be considered as interoperable. Reference is made to Annex M(M.2) to this TSI.

5.3.3.3. *Current capacity*

The material and cross-section of contact strips shall be selected in the light of the maximum current the contact strip is designed for. The rated current shall be noted on it by the manufacturer. Type tests shall demonstrate the conformity as specified in Annex M(M.4) to this TSI.

5.3.3.4. *Current at standstill*

An acceptable level of current at standstill shall be acceptable for both the contact wire and pantograph collector strips to allow for the proper supply of auxiliaries installed on-board trains. For DC systems, in order to be in accordance with point 5.3.1.8, a current of 300 A shall be guaranteed per pantograph. A study shall be carried out to prove the capacity of the collector strips. For conformity assessment reference is made to Annex M(M.3) to this TSI.

5.3.3.5. *Detection of contact strip breakage*

The contact strip shall be designed so that any failures of the contact strips will be detected and the lowering of the pantograph will be triggered. Reference is made to EN 50 206-1, version 1998, point 4.9.

## 6. ASSESSMENT OF CONFORMITY AND/OR SUITABILITY FOR USE

### 6.1. Interoperability constituents

#### 6.1.1. *Assessment procedures and modules*

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

If the adjudicating entity can demonstrate that tests or verification for previous applications remain valid for the new applications, then the notified body shall take them into account in the conformity assessment.

Assessment procedures for conformity of the interoperability constituents: overhead contact line, pantograph and contact strip as defined in Chapter 5 of this TSI, are indicated in Annex B, Tables B.1 to B.3 to this TSI.

As far as required by the modules specified in Annex A to this TSI, the assessment of conformity of an interoperability constituent shall be appraised by the 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 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 not required for interoperability constituents of the energy subsystem.

#### 6.1.2. *Application of modules*

For the assessment procedure of each interoperability constituent of the energy subsystem the manufacturer or his authorised representative established within the Community may choose either:

— the type-examination procedure (module B) indicated in Annex A(A.2) to this TSI for the design and development phase in combination with the conformity to type procedure (module C) indicated in Annex A(A.3) to this TSI for the production phase, or

— the full quality assurance with design examination procedure (module H2) indicated in Annex A(A.4) to this TSI for all phases.

These assessment procedures are defined in Annex A to this TSI.

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

The conformity assessment shall cover the phases and characteristics as indicated by X in the Tables B.1, B.2 and B.3 of Annex B to this TSI.

### 6.2. Energy subsystem.

#### 6.2.1. *Assessment procedures and 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 A to this TSI.

If the adjudicating entity can demonstrate that tests or verification for previous applications remain valid for the new applications, then the notified body shall take them into account in the conformity assessment

Assessment procedures for the EC verification of the energy subsystem are indicated in Annex C, Table C.1, to this TSI.

As far as specified in this TSI the EC verification of the energy subsystem shall take account of 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 Energy 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 Energy subsystem the adjudicating entity or its authorised representative established within the Community may choose either:

— the unit verification procedure (module SG) indicated in Annex A(A.5) to this TSI, or

— the full quality assurance with design examination procedure (module SH2) indicated in Annex A(A.6) to this TSI.

The module SH2 may be chosen only where all activities contributing to the subsystem project 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 Table C.1 of Annex C to this TSI.

## 7. IMPLEMENTATION OF THE ENERGY TSI

### 7.1. Application of this TSI to high-speed lines and rolling stock to put into service

As to the high-speed lines within the geographic scope of this TSI (see section 1.2) and to the rolling stock 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 section 7.3 hereafter.

### 7.2. Application of this TSI to high-speed lines and rolling stock already in service

In respect of infrastructure installations and rolling stock 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 energy.

While the TSI can be fully applied to new installations, implementation on existing lines may require modifications of existing installations. The modification necessary will depend on the extent of conformity of the existing installations. An implementation strategy can only be made individually for given lines or networks in the Member States of the Comunity. Section 7.3 indicates those items where implementation needs modification of existing installations. Table 7.1 summarises the characteristics to be implemented.

The contracting entity shall define the practical measures and the different phases which are necessary to allow placing into service with the required performances. These phases may include transition periods for placing into service with reduced performances.

*Table 7.1*

**Implementation of technical specifications for interoperability, energy subsystem**

| Characteristic to be implemented | Point |
|---|---|
| Voltage and frequency | 4.1.1 |
| Installed power, mean useful voltage | 4.3.1.1 |
| Harmonic currents | 4.2.2.3 |
| Electrical protection | 4.2.2.8 |
| External electromagnetic compatibility | 4.3.1.5 |
| Protection against electric shock | 4.3.1.8, 4.3.2.4 |
| Isolation of power supply | 4.3.1.10 |
| Continuation of power supply | 4.3.1.11 |
| Regenerative braking | 4.3.1.4 |
| Geometry of overhead contact line | 4.1.2.1, 4.1.2.2, 5.3.1.3 |
| Dynamic envelope | 4.2.2.4 |
| Phase separation sections | 4.2.2.10 |
| System separation sections | 4.2.2.11 |
| Current capacity | 5.3.1.2, 5.3.2.3, 5.3.3.3 |
| Wave propagation speed | 5.3.1.4 |
| Elasticity and its uniformity | 5.3.1.5 |
| Mean contact force | 5.3.1.6 |
| Safety, earthing and bonding | 4.3.1.2, 4.3.2.2 |
| Dynamic behaviour and current collection | 4.3.2.3 |
| Design of pantographs | 4.1.2.3 |
| Design of collector strips | 5.3.3 |
| Contact forces | 4.3.2.5 |

## 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 temporarily ('T' cases). As to temporarily 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 of the 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 Austrian network

Connecting lines

The investment of changing the overhead contact line on upgraded and connecting lines and in stations to meet the requirements of the 1 600 mm Euro pantograph is prohibitive. Trains traversing these lines will have to be provided with secondary 1 950 mm pantographs for medium-speed operation up to 230 km/h so that the overhead contact line on these parts of the trans-European network will not have to be prepared for the operation of the Euro pantograph. In these areas a maximum lateral deflection of contact wire of 550 mm under action of cross wind is permissible. Future studies concerning upgraded and connecting lines should take into account the Euro pantograph to demonstrate the relevance of the choices made.

Connecting and upgraded lines (P case)

Due to the acceptance of designing the overhead contact line for a 1 950 mm wide pantograph there is no need for adjustment.

Connecting lines (T1 case)

To comply with the requirements on mean useful voltage and installed power additional substations are necessary. Installation is planned until 2010.

7.3.2. **Particular features on the Belgian network (T1 case)**

Existing high-speed lines

On existing high-speed lines the phase separation sections are not compatible with the requirement of pantograph distance between three pantographs of more than 143 m. Between existing high-speed lines and upgraded lines there is no automatic control to trigger the opening of the main circuit breaker on the traction vehicles.

Both items have to be modified.

Connecting and upgraded lines

On some line sections, under bridges, the contact wire height does not meet the TSI minimum requirements and will have to be modified. Dates are open.

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

The investment of changing the overhead contact line on upgraded and connecting lines and in stations to meet the requirements of the 1 600 mm Euro pantograph is prohibitive. Trains traversing these lines will have to be provided with secondary 1 950 mm pantographs for medium-speed operation up to 230 km/h so that the overhead contact line on these parts of the trans-European network will not have to be prepared for the operation of the Euro pantograph. In these areas a maximum lateral deflection of contact wire of 550 mm under action of crosswind is permissible. Future studies concerning upgraded and connecting lines should take into account the Euro pantograph to demonstrate the relevance of the choices made.

7.3.4. **Particular features on the Spanish network (P case)**

The investment of changing the overhead contact line on upgraded and connecting lines and in stations to meet the requirements of the 1 600 mm Euro pantograph is prohibitive. Trains traversing these lines will have to be provided with secondary 1 950 mm pantographs for medium-speed operation up to 230 km/h so that the overhead contact line on these parts of the trans-European network will not have to be prepared for the operation of the Euro pantograph. In these areas a maximum lateral deflection of contact wire of 550 mm under action of crosswind is permissible. Future studies concerning upgraded and connecting lines should take into account the Euro pantograph to demonstrate the relevance of the choices made.

The nominal contact wire height can be 5,50 m on some sections of future high-speed lines in Spain; particularly in case of the future high-speed line between Barcelona and Perpignan. (It would concern also France between the Spanish border and Perpignan if this country asked for it.)

For the high-speed line Madrid-Seville, trains have to be equipped with a 1 950 mm pantograph.

7.3.5. **Particular features on the French network**

Existing high-speed lines (T2 case)

To provide for the criteria of current collection and dynamic behaviour on AC lines modification of overhead line equipment is necessary.

On existing high-speed lines the phase separation sections are not compatible with the pantograph arrangement between three pantographs of more than 143 m. Phase separation sections have to be modified.

On a specific high-speed line a modification of the overhead contact line is necessary to provide for the permissible uplift without uplift stops installed in the pantographs.

Upgraded and connecting lines

To provide for the criteria of current collection on DC lines modification of overhead line equipment is necessary. For DC lines the cross-section of contact wires is not sufficient to comply with the TSI requirements for current at standstill in stations or in areas where trains are pre-heated.

The existing DC line to Spain is operated with a 1 950 mm DC collector head. To operate this line with interoperable 1 600 mm Euro collector heads the overhead line has to be upgraded accordingly.

All categories of lines

The following applies for the pantographs:

— for AC systems a 1 600 mm Euro collector head is needed instead of 1 450 mm pan heads currently in use on TGVs,

— for DC systems a 1 600 mm Euro collector head is needed instead of 1 950 mm wide pan heads currently used on TGVs,

— for AC systems during an intermediate period, use of pantographs capable of operating with three targets curves (C1, C2 and target curve) for the mean contact force $F_m$ is necessary,

— for DC systems the use of pantographs capable of operating with two $F_m$ curves, one for 1,5 kV and another for 3 kV might be necessary.

The conversion has not yet been scheduled.

7.3.6. **Particular features on the British network**

New high-speed lines (T1 case)

On the planned Channel Tunnel railway line (CTRL) the phase separation sections may need adjusting to the specifications in the TSI. This amendment will be carried out with the introduction of full-service including freight trains.

Upgraded lines (P case)

On the east coast main line (ECML) some sections do not comply with the specifications for voltage and frequency, mean useful voltage and installed power. Implementation of the TSI is planned with the next major upgrade for the ECML.

On the ECML and the west coast main line (WCML) the geometry of overhead contact line and dynamic envelope are based on UK1 gauge and are treated as a special case. The variable contact wire height may be retained for speeds up to 225 km/h and the mean contact force will be adjusted to achieve the current collection requirements of EN 50 119, version 2001, point 5.2.1.

On the WCLM the existing type of phase separation sections will be retained.

7.3.7. **Particular features on the Italian network**

Existing high-speed lines (T1 case)

Geometry of overhead contact lines needs to be adjusted for height of contact wire on a length of 100 km double track line.

These modifications will be carried out until 2010.

Connecting and upgraded lines (T1 case)

Geometry of overhead contact lines needs to be adjusted concerning height of contact wire on parts of lines involved.

To comply with the requirements on mean useful voltage and installed power additional substations are necessary.

These modifications will be carried out until 2010.

7.3.8. **Particular features on the Irish and Northern Irish networks (P cases)**

On electrified lines of the Irish and Northern Irish networks, the IRL1 Irish standard structure gauge and the necessary clearances will define the nominal contact wire height.

7.3.9. **Particular features on the Swedish network (P case)**

The investment of changing the overhead contact line on upgraded and connecting lines and in stations to meet the requirements of the 1 600 mm Euro pantograph is prohibitive. Trains traversing these lines will have to be provided with secondary 1 950 mm pantographs for medium-speed operation up to 230 km/h so that the overhead contact line on these parts of the trans-European network will not have to be prepared for the operation of the Euro pantograph. In these areas a maximum lateral deflection of contact wire of 550 mm under action of crosswind is permissible. Future studies concerning upgraded and connecting lines should take into account the Euro pantograph to demonstrate the relevance of the choices made.

7.3.10. **Particular features on the Finnish network (P case)**

The normal height of the contact wire is 6 150 mm (minimum 5 600 mm, maximum 6 500 mm).

*ANNEX A*

**ASSESSMENT PROCEDURES (MODULES)**

— For conformity of interoperability constituents and

— For the EC verification of subsystems.

A.1. SCOPE

This annex covers the modules for the assessment procedures for the Conformity assessment of Interoperability Constituents and the EC verification of the Energy subsystem.

A.2. MODULE B (TYPE-EXAMINATION)

**Conformity assessment of interoperability constituents**

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, sub-assemblies, 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 (sub-assembly, 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 point 4.2, 4.3 and 4.4 to establish whether, where the appropriate European specification 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 point 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 modifications 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 will 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 established within the Community must keep with the technical documentation copies of the 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.

A.3. MODULE C (CONFORMITY TO TYPE)

**Conformity assessment of interoperability constituents**

1. This module describes that part of the procedure whereby the manufacturer or his authorised representative established within the Community 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 Directive 96/48/EC and of the TSI that apply to it.

2. The manufacturer must take all measures necessary to ensure that the manufacturing process ensures compliance of the manufactured interoperability constituents with the type as described in the EC type-examination certificate and with the requirements of Directive 96/48/EC and of the TSI that apply to them.

3. The manufacturer or his authorised representative established within the Community must draw up an 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 of 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,

   — 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 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.

   The certificates to be referred to are:

   — the type-examination certificate and its additions.

4. The manufacturer or his authorised representative established within the Community 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.

5. 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.

A.4. MODULE H2 (FULL QUALITY ASSURANCE WITH DESIGN EXAMINATION)

**Conformity assessment of interoperability constituents**

1. This module describes the procedure whereby a notified body carries out an examination of the design of an interoperability constituent and the manufacturer or his authorised representative established within the Community who satisfies the obligations of point 2 ensures and declares that the interoperability constituent concerned satisfies the requirements of Directive 96/48/EC and of 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 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 of Directive 96/48/EC will not be applied in full, the means that will be used to ensure that the requirements of the Directive 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 – 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 point 3.4, points 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 Directive 96/48/EC and of 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 of the Directive 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 modifications 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 that it has withdrawn or refused.

The other notified bodies will 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 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 of 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(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 TSIs 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 are:

— 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 established within the Community 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.

A.5. MODULE SG (UNIT VERIFICATION)

**EC verification of the energy 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 energy subsystem:

— complies with this TSI and any other applicable TSI, which demonstrates that the essential requirements of Directive 96/48/EC have been met,

— 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 TSI to be assessed.

It must include:

— a general description of the subsystem, overall design and structure,

— the register of infrastructure, including all indications as specified in the TSI,

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

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 and, 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 checking 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 of the technical file and must contain at least the information included in Annex V to 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 register of infrastructure, 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.

A.6. MODULE SH2 (FULL QUALITY ASSURANCE WITH DESIGN EXAMINATION)

**EC verification of the energy 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 energy subsystem:

— complies with this TSI and any other applicable TSI, which demonstrates that the essential requirements of Directive 96/48/EC have been met,

— complies with the other regulations deriving from the Treaty and may be put into service.

The notified body carries out the procedure, including a design examination of the subsystem under the condition that the adjudicating entity and the manufacturers involved satisfy the obligations of point 2.

2. For the subsystem, being 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 overall compliance of the subsystem with the requirements of Directive 96/48/EC and of the TSI. For other manufacturers (sub-suppliers) 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 sub-suppliers (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 of the Directive 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 overall design and subsystem quality, including in particular the subsystem integration management.

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, final 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 – December 2000, completed if necessary to take into consideration the specificity of the subsystem for which it is implemented.

For applicants, who are only involved in assembling and installation, the harmonised standard shall be EN ISO 9001 – 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 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 their 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 general, 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 point 3.4, points 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 established 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 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 energy subsystem 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.

6.3. The notified body must examine the application concerning the design examination and where the design meets the provisions of 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 quality system(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 for the main contractor 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 be ensured 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 under its responsibility and together with the other notified body(ies).

6.6. Where the subsystem meets the requirements of 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 of the technical file and must contain at least the information included in Annex V to 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, 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 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 points 4.4, and 4.5,

— the energy subsystem 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.

*ANNEX B*

## ASSESSMENT OF INTEROPERABILITY CONSTITUENTS

B.1. SCOPE

This Annex indicates the assessment of conformity of interoperability constituents (overhead contact line, pantograph and contact strip) of the energy subsystem.

B.2. CHARACTERISTICS

The characteristics of the interoperability constituents to be assessed in the different phases of design and production are marked by an X in Tables B.1 to B 3.

*Table B.1*

**Assessment of the interoperability constituent: overhead contact line**

| 1 | | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|
| Characteristics to be assessed | | Assessment in the following phase | | | | |
| | | Design and development phase | | | | Production phase |
| Characteristic | Point | Design review | Review of manufacturing process | Type test | In-service experience | (Series) |
| Geometry AC | 4.1.2.1 | X | n. a. | X | n. a. | X |
| Geometry DC | 4.1.2.2 | | | | | |
| Overall design | 5.3.1.1 | | | | | |
| Basic parameters | 5.3.1.3 | | | | | |
| Current capacity | 5.3.1.2 | X | n. a. | n. a. | n. a. | n. a. |
| Wave propagation speed | 5.3.1.4 | X | n. a. | n. a. | n. a. | n. a. |
| Elasticity and uniformity of elasticity | 5.3.1.5 | X | n. a. | X | n. a. | n. a. |
| Mean contact force | 5.3.1.6 | X | n. a. | X | n. a. | n. a. |
| Current at standstill | 5.3.1.8 | X | n. a. | X | n. a. | n. a. |
| Maintenance | 5.3.1.7 | n. a. | n. a. | n. a. | n. a. | X |

n. a.: not applicable.

*Table B.2*

**Assessment the interoperability constituents: pantograph**

| 1 | | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|
| Characteristics to be assessed | | Assessment in the following phase | | | | |
| | | Design and development phase | | | | Production phase |
| Characteristic | Point | Design review | Review of manufacturing process | Type test | In-service experience | (Series) |
| Overall design | 5.3.2.1 | X | n. a. | X | n. a. | X |
| Geometry of collector head | 4.1.2.3, 5.3.2.2 | X | n. a. | n. a. | n. a. | X |
| Current capacity | 5.3.2.3 | X | n. a. | n. a. | n. a. | X |
| Design of insulation | 5.3.2.4 | X | n. a. | X | n. a. | X |
| Working range | 5.3.2.5 | X | n. a. | n. a. | n. a. | X |
| Static contact force | 4.3.2.5, 5.3.2.6 | X | n. a. | X | n. a. | X |
| Mean contact force and interaction performance | 5.3.2.7 | X | n. a. | X | n. a. | X |
| Alternative contact force stipulations: | 5.3.2.7 | X | n. a. | X | n. a. | X |
| Automatic dropping devices | 5.3.2.8 | X | n. a. | X | n. a. | X |
| Current at standstill | 5.3.2.9 | X | n. a. | X | n. a. | n. a. |

*N.B.*: with 25 kV/95 kV 50 Hz 1 min and 250 kV peak, 1,2/50 μs.

n. a.: not applicable.

*Table B.3*

**Assessment of the interoperability constituents: contact strip**

| 1 | | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|
| Characteristics to be assessed | | Assessment in the following phase | | | | |
| | | Design and development phase | | | | Production phase |
| Characteristic | Point | Design review | Review of manufacturing process | Type test | In-service experience | (Series) |
| Basic parameter, length of contact strip | 5.3.3.1 | X | n. a. | n. a. | n. a. | X |
| Material | 5.3.3.2 | n. a. | n. a. | X | n. a. | X |
| Current capacity | 5.3.3.3 | n. a. | n. a. | X | n. a. | n. a. |
| Current at standstill | 5.3.3.4 | X | n. a. | n. a. | n. a. | n. a. |
| Detection of contact strip breakage | 5.3.3.5 | X | n. a. | n. a. | n. a. | X |

n. a.: not applicable.

*ANNEX C*

## ASSESSMENT OF THE ENERGY SUBSYSTEM

C.1. SCOPE

This Annex indicates the assessment of conformity of the energy subsystem.

C.2. CHARACTERISTICS AND MODULES

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

*Table C.1*

**Assessment of the energy subsystem**

| 1 | | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| Characteristics to be assessed | | Assessment in the following phase | | | |
| | | Design and development phase | Production phase | | |
| Characteristic | Point | Design review | Construction, assembling, mounting | Assembled, before putting into service | Validation under full operating conditions |
| Geometry of overhead contact line | 4.1.2.1, 4.1.2.2 | X | X | X | n. a. |
| Safety, earthing and bonding | 4.3.1.2, 4.3.2.2 | X | X | n. a. | n. a. |
| Gradient of contact wire | 4.1.2.1, 4.1.2.2 | X | n. a. | X | n. a. |
| Dynamic envelope | 4.2.2.4 | X | n. a. | n. a. | n. a. |
| Phase separation sections | 4.2.2.10 | X | n. a. | X | n. a. |
| System separation sections | 4.2.2.11 | X | n. a. | X | n. a. |
| Quality of current collection | 4.3.2.3 | X | n. a. | X | n. a. |
| Space for uplift | 4.3.2.3 | X | n. a. | X | n. a. |
| Voltage and frequencies | 4.1.1 | X | n. a. | n. a. | X |
| Mean useful value of the voltage on a supply area | 4.3.1.1 | X | n. a. | n. a. | X |
| Type of line (performance) | 4.3.1.1, 4.3.2.1 | X | n. a. | X | n. a. |
| Protection against electric shock | 4.3.1.8, 4.3.2.4 | X | X | X | n. a. |
| Electrical protection (coordination with rolling stock subsystem) | 4.2.2.8 | X | n. a. | X | n. a. |
| Regenerative braking | 4.3.1.4 | X | n. a. | n. a. | n. a. |
| Maintenance | 4.3.1.9, 4.3.2.6 | n. a. | n. a. | X | n. a. |
| Isolation of power supply in case of danger | 4.3.1.10 | X | n. a. | n. a. | n. a. |
| Continuation of power supply | 4.3.1.11 | X | n. a. | n. a. | X |

n. a.: not applicable.

*ANNEX D*

## REGISTER OF INFRASTRUCTURE, INFORMATION ON THE ENERGY SUBSYSTEM

D.1. SCOPE

This Annex covers the information concerning the energy subsystem to be included in the register of infrastructure for each homogeneous section of interoperable lines which has to be established according to point 4.2.3.5.

D.2. CHARACTERISTICS TO BE DESCRIBED

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

*Table D.1*

**Information to be given in the register of infrastructure by the adjudicating entity**

| Parameter, interoperability element | Point |
|---|---|
| Indication of voltage and frequency | 4.1.1 |
| Height of the contact wire for high-speed lines. Use of the 1 600 mm Eur collector head or of other collector head accepted on the line | 4.1.2.1, 4.1.2.2, 7.3 |
| Wind speed to be considered | 4.1.2.1, 4.1.2.2 |
| Maximum ambient temperature | 5.3.1.2 |
| Minimum crosswind | 5.3.1.2 |
| Adjustment of pantograph contact force | 5.3.2.7 |
| Phase separation sections: type of separation section used Information on operation | 4.2.2.10 |
| System separation sections: type of separation section used<br>Information on operation: tripping of circuit breaker, lowering of pantographs | 4.2.2.11 |
| Category of line: declaration of performance | 4.3.1.1 |
| Regenerative braking on DC electrification: acceptance or not | 4.3.1.4 |
| Harmonic characteristics: electrical data concerning the power supply | 4.3.1.7 |
| Power/current limitation on board required: yes or no | 4.2.2.5 |
| Electric protection coordination | 4.2.2.8 |
| Any other divergence from the TSI requirements | |

*ANNEX E*

## COORDINATION OF ELECTRICAL PROTECTION SUBSTATIONS/TRACTION UNITS

### E.1. GENERAL

Compatibility of protective systems between traction unit and substation shall be verified.

### E.2. PROTECTION TOWARD SHORT CIRCUITS

Every traction unit is equipped with a circuit breaker whose breaking capacity is higher or lower than the maximum short circuit current that may occur on the 'primary' of its electrical circuit, depending on the traction system.

*Table E.1*

**Maximum contact line — rail short circuit level**

| Power supply system | Substation generally connected in parallel | Maximum rail short circuit current that may occur |
|---|---|---|
| | Yes/No | kA |
| AC 25 000 V-50Hz | N | 15 ([1]) |
| AC 15 000 V-16,7 Hz | Y | 40 |
| DC 3 000 V | Y | 50 (prospective sustained) ([2]) |
| DC 1 500 V | Y | 75 (prospective sustained) ([2]) |
| DC 750 V | Y | 65 (prospective sustained) ([2]) |

([1]) The value of 12 kA was previously commonly accepted.
([2]) For definition see EN 50123-1

*Table E.2*

**Action on circuit breakers when internal fault within a traction unit occurs**

| Power supply system | When any internal defect fault occurs within the traction units: sequence of tripping of: | |
|---|---|---|
| | substation feeder circuit breaker | traction unit circuit breaker |
| AC 25 000 V-50 Hz | Immediate tripping ([1]) | Immediate tripping |
| AC 15 000 V-16,7 Hz | Immediate tripping ([1]) | *Primary side of the transformer:* tripping shall be staged<br>*secondary side of the transformer:* immediate tripping |
| DC | immediate tripping ([2]) | immediate tripping |

([1]) The tripping of the circuit breaker should be very rapid for high short circuits currents.
([2]) When the current of the short circuit is very high, the tripping of circuit breakers in the substations should be very rapid, and thereby prevents the traction unit circuit breaker clearing faults on it.

### E.3. AUTO-RECLOSING OF ONE OR MORE SUB-STATION CIRCUIT BREAKERS.

The auto reclosing systems (if any) for circuit breakers in the sub-station are liable to re-energise the line. In such a case, the sub-station circuit breakers may only be re-closed after the tripping of the circuit breakers on the traction units present in the zone supplied by the sub-station. The traction unit circuit breakers shall trip automatically as explained in point E 4 hereafter.

E.4. EFFECT OF LOSS OF LINE VOLTAGE AND RE-ENERGISATION ON THE TRACTION UNIT

The traction unit circuit breakers shall trip automatically within three seconds after loss of line voltage.

*Note 1:* see Annex N to this TSI.

On re-energisation, the traction unit circuit breaker shall not reclose within three seconds of the line being re-energised.

*Note 2:* the time delay on re-energisation allows for testing of the line for persistent short circuit.

E.5. DC ELECTRIFICATION SYSTEMS: TRANSIENT CURRENT DURING CLOSURE

This provision is only applicable to DC traction units fitted with an input filter.

When the circuit breaker of a traction unit is going to be closed, with the input filter (if fitted), the transient current should not cause the protection devices in the sub-stations to trip unnecessarily. The requisite information shall be obtained from the railways concerned when vehicle-mounted filters are being designed.

The di/dt differential of the transient current on closure of the traction unit circuit breaker shall have the following characteristics:

*Table E.3*

**di/dt when closure of traction unit circuit breaker**

| T | condition applicable to di/dt |
|---|---|
| 0 ms | di/dt < 60 A/ms |
| 20 ms | di/dt < 20 A/ms |

with a minimum overhead and sub-station inductance of 2 mH.

*ANNEX F*

**TYPE OF LINE**

F.1. SCOPE

This Annex covers both:

— lines generally equipped for speeds of 250 km/h and above, and

— lines upgraded for speeds of approximately 200 km/h.

F.2. OBJECTIVES

This Annex defines the type of line of a route as a function of the traffic in terms of speed and headway and the traction unit power at the pantograph.

F.3. DEFINITIONS

*Type of line*

Classification of lines as a function of the parameters described below.

*Maximum line speed*

Speed in km/h for which the line was approved for operation.

*Power of train at the pantograph*

Maximum continuous power in MW demanded by the train taking into account power for traction (from effort/speed curve), regeneration and auxiliaries.

*Minimum possible headway*

Interval in minutes at which trains can run in impaired scheduling conditions, as allowed by the signalling system.

F.4. DATA FOR TYPES OF LINES

F.4.1. **General**

Table F.1 provides information common to all electrification systems.

For high-speed lines the following is assumed: V ≥ 250 km/h; the electrification systems chosen are AC 25 kV 50 Hz and AC 15 kV 16,7 Hz.

For upgraded and connecting lines, Table F.1 covers all the electrification systems in use in Europe, regardless of line speed.

*Table F.1*

**Type of lines**

| Range of speed V | Minimum possible headway | Train power at the pantograph | Type of line | |
|---|---|---|---|---|
| km/h | Minutes | MW | | |
| V ≥ 300 | 3 | 20-25 or more | I | a |
| | 3 | 15-20 | | b |
| | 3 | 10-15 | | c |
| 250 ≤V< 300 | 2 | 20 | II | a |
| | 3 | 15-20 | | b |
| | 3 | 10-15 | | c |
| | 4 | 15-20 | | d |
| | 4 | 10-15 | | e |
| | 5 | 15-20 | | f |
| | 5 | 10-15 | | g |
| 200 ≤V< 250 | 2 | 15 | III | a |
| | 3 | 10-15 | | b |
| | 4 | 10-15 | | c |
| | 5 | 10-15 | | d |
| 160 ≤V< 200 | 2 | 6-10 | IV | a |
| | 2 | 10-15 | | b |
| | 2 | 15-25 | | c |
| | 3 | 6-10 | | d |
| | 3 | 10-15 | | e |
| | 4 | 6-10 | | f |
| | 4 | 10-15 | | g |
| | 5 | 6-10 | | h |
| | 5 | 10-15 | | i |
| 120-160 | 2 | ([1]) | V | a |
| | 3 | | | b |
| | 4 | | | c |
| | 5 | | | d |
| < 120 | 2 | ([1]) | VI | a |
| | 3 | | | b |
| | 4 | | | c |
| | 5 | | | d |

([1]) For lines with speed below 160 km/h the type of line shall only be defined simply in terms of line speed and headway due to the wide range of power of trains circulating on these lines.

*ANNEX G*

## POWER FACTOR OF A TRAIN

### G.1. SCOPE

This Annex applies to trains designed for interoperable traffic on lines of the trans-European high-speed rail system.

### G.2. GENERAL

The higher the power factor, the better is the power supply performance, therefore, the following rules apply. Capacitive or inductive power from a train can be utilised to change and improve the overhead line voltage.

### G.3. DEFINITION OF POWER FACTOR

The total power factor λ is defined by

$$\lambda = \alpha \cos \varphi$$

where: $\alpha$ = is the deformation factor and
$\varphi$ = the phase angle.

### G.4. INDUCTIVE POWER FACTOR

#### G.4.1. **Objective**

This point deals with inductive power factor and power consumption over the range of voltage between $U_{min1}$ and $U_{max1}$ defined in Annex N to this TSI.

#### G.4.2. **Requirements**

For each interoperable train running on an interoperable line the requirements specified in Table G.1 shall be met.

*Table G.1*

**Total power factor λ of a train**

| Power consumption of a train MW | Category of line | | |
|---|---|---|---|
| | High-speed | Upgraded | Connecting [3] |
| (a) P > 6 | ≥ 0,95 | ≥ 0,95 | ≥ 0,95 [1] |
| (b) 2 < P ≤ 6 | ≥ 0,93 | ≥ 0,93 | ≥ 0,93 [1] |
| (c) 0 ≤ P ≤ 2 | [2] | [2] | [2] |

[1] These values are recommended.

[2] In order to control the total power factor of the auxiliary load of a train during coasting phases, the overall average λ (traction and auxiliaries) defined by simulation and/or measurement shall be higher than 0,85 over a complete timetable journey.
The calculation of overall average λ for a train journey is taken from the active energy $W_P$ (MWh) and reactive energy $W_Q$ (MVArh) given by a computer simulation of a train journey or metered on an actual train

$$\lambda = 1/\sqrt{[1 + (W_Q/W_P)^2]}$$

[3] The adjudicating entity may impose conditions, e.g.: economic, operating, power limitation, for acceptance of trains having power factors below the target value.

For yards or depot, when a train is stationary, with traction power off, and the active power taken from the overhead line is greater than 10 kW per vehicle, the total power factor resulting from the train load shall not be less than 0,8, but with a target value of 0,9.

The values of conditions (a) and (b) shall be checked or measured with a feeding system not limiting the performances of the train.

G.5. CAPACITIVE POWER FACTOR

Within the range of voltage $U_{min1}$ to $U_{max1}$ defined in Annex N to this TSI, capacitive power factors are not limited. Within the range of voltage $U_{max1}$ to $U_{max2}$, a train shall not behave like a capacitor.

*ANNEX H*

**OVERHEAD LINE EQUIPMENT, GEOMETRICAL INTERACTION OF OVERHEAD LINES AND PANTOGRAPH, AC SYSTEMS**

H.1. SCOPE

This Annex covers:

— geometrical requirements for overhead contact lines,

— geometrical requirements for pantographs, and

— requirements for interaction of overhead contact lines and pantographs,

for lines of the trans-European high-speed rail system supplied by AC systems.

H.2. OBJECTIVES

This Annex supplements the basic parameters specified for lines supplied by AC systems. These requirements are necessary to guarantee safe running of the trains, a supply without interruption and undue disturbances, and to achieve an interaction without excessive wear and tear of contact wires and collector strips.

H.3. GEOMETRICAL REQUIREMENTS

H.3.1. **Overhead contact lines**

In Table H.1 the geometrical requirements are given together with tolerances.

*Table H.1*

**Geometry of overhead contact lines**

| No | Description | Connecting lines | Upgraded lines | High-speed lines |
|---|---|---|---|---|
| 1 | Height of contact wire | | | |
| 1.1 | Nominal height of contact wire (mm) | Between 5 000 and 5 750 ([1]) ([2]) ([3]) | Between 5 000 and 5 500 ([1]) ([3]) | 5 080 or 5 300 ([3]) |
| 1.2 | Tolerance (mm) | ± 30 | ± 30 | 0 + 20 |
| 1.3 | Limit values | 4 950 and 6 200 | 4 950 and 6 200 | — |
| 2 | Permissible contact wire gradient in relation to the track and permissible variation of gradient | See EN 50119, version 2001, point 5.2.8.2 | | No planned gradients acceptable |
| 3 | Permissible lateral deflection of the contact wire under action of cross wind (mm) ([3]) | ≤ 400 | | |

([1]) For connecting lines with mixed freight and passenger traffic of operation of trailers with oversized gauge the contact wire height may be higher provided the pantograph is suited to collect the current with the specified quality and the development of the pantograph is sufficient as specified in point 5.3.2.5.
([2]) At level crossings the contact wire height shall be designed according to national directives.
([3]) The contact wire height and wind speed to be considered will be defined in the register of infrastructure defined in Annex D to this TSI.

H.3.2. **Pantographs**

In Table H.2 the geometrical requirements for a pantograph suitable for the trans-European high-speed rail system are presented. Figure H.1 shows details of the pantograph collector head. Since the pantographs will be used on all lines of the interoperable system no distinction between line categories can be made.

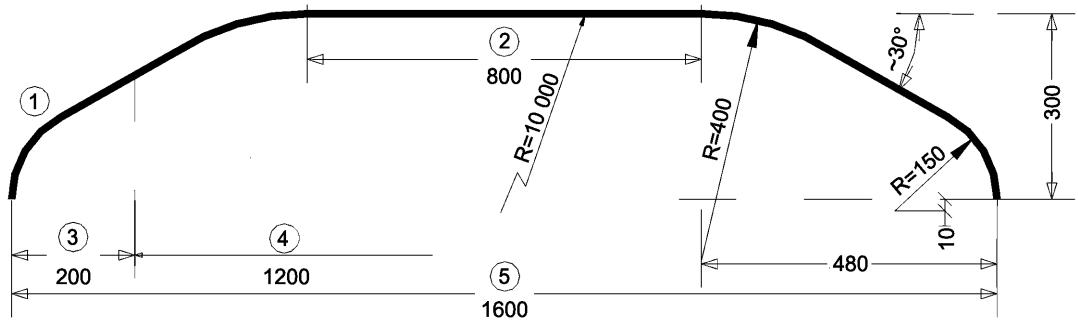
*Table H.2*

**Geometry of pantograph collector head**

| No | Description | All line categories |
|---|---|---|
| 1 | Width of pantograph collector head (mm) | 1 600 |
| 2 | Working range of pantograph collector head (mm) | 1 200 |
| 3 | Electrical width of pantograph collector head maximum (mm) | 650 |
| 4 | Length of contact strips (mm) | ≥ 800 |
| 5 | Profile of pantograph collector head | See figure H.1 |
| 6 | Device to detect defects in pantograph collector head | Necessary |

*Figure H.1*

**Profile of pantograph collector head**




1 Horn made of insulating material
2 Minimum length of the contact strip
3 Projected length
4 Working range of the collector head
5 Width of the collector head

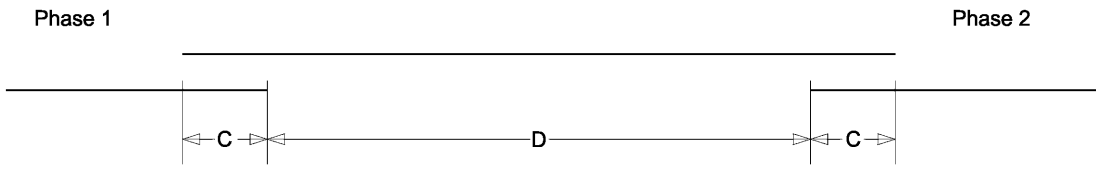
H.3.3. **Phase separation sections**

Two types of phase separation section are discussed.

In case of the arrangement according to figure H.2 the neutral section is longer than the distance between the farthest pantograph in operation on an interoperable train which is 400 m.

*Figure H.2*

**Arrangement of phase separation with long neutral section**



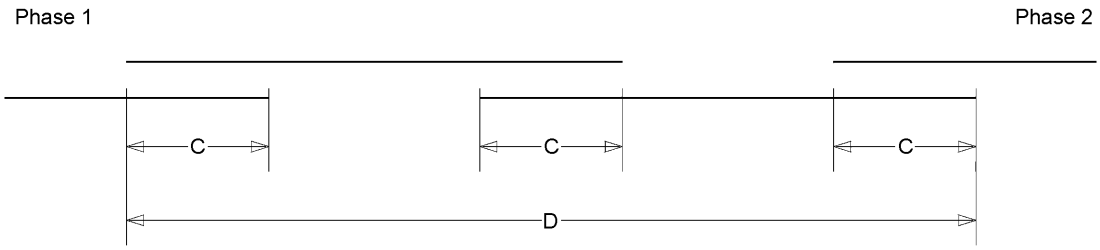

Length D > 402 m

Overlapping sections C: pantograph in contact with two contact wires.

In Figure H.3 the total separation section is shorter than the 143 m spacing between three consecutive pantographs.

*Figure H.3*

**Arrangement of phase separation with short neutral section**




Length D < 142 m

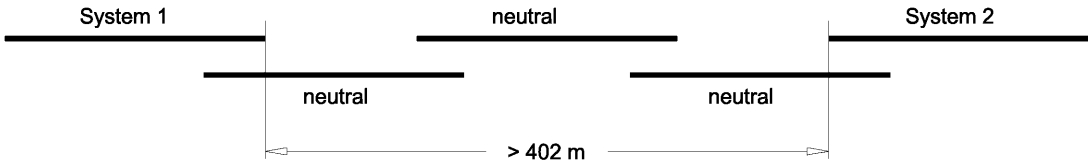
Overlapping sections C: pantograph in contact with two contact wires.

H.3.4. **Example of system separation section**

When system separation sections are negotiated with pantographs lifted the separation section consists of three neutral contact line sections insulated to each other. The total length shall be at least 402 m. Figure H.4 shows the design principle.

*Figure H.4*

**Arrangement of system separation section with long neutral section**

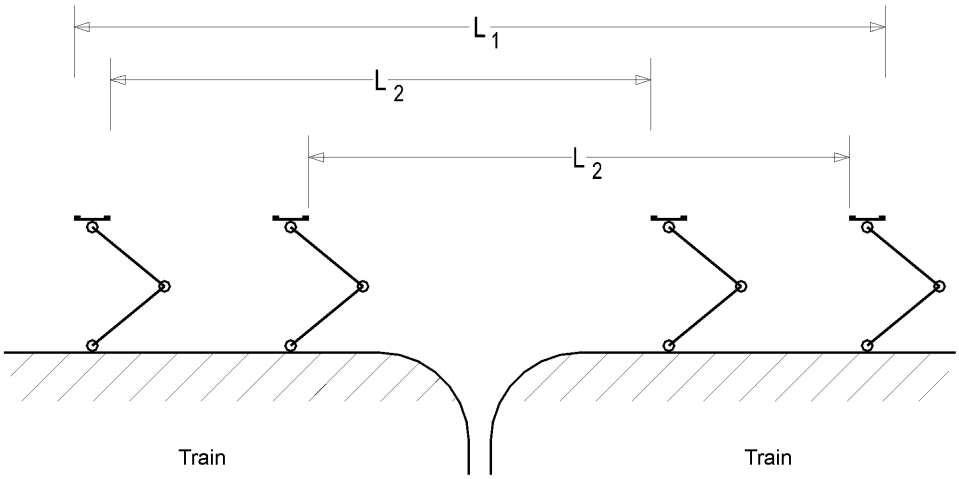



H.3.5. **Arrangement of pantograph on trains**

To negotiate the specified types of phase separations the maximum spacing of pantographs is 400 m, which is the maximum train length. In addition the spacing of three constructive pantographs must be more than 143 m. The pantograph between two others can be arranged anywhere. Between pantographs in service no electrical link may exist. Figure H.5 shows the pantograph arrangement.

*Figure H.5*

**Pantograph arrangement**




Length $L_1$ < 400 mm

Length $L_2$ > 143 m.

H.3.6. **Dynamic envelope for pantograph passage**

Figure H.6 shows the dimensions for the space necessary for passage of Euro pantographs on interoperable lines. In addition to this space the infrastructure shall take account of the space necessary for installation of the contact line itself and the necessary safety clearances. The space depends on the design of individual contact line and the corresponding voltage.

In figure H.6 the width $L_1$ refers to the contact wire height of 5,0 m while $L_2$ depends on the contact wire height as applicable for a specific line. S is the provision for uplift corresponding to two times $S_o$ according to Tables 4.5 and 4.6.

The value $L_2$ is

$L_2 = 0{,}74 + 0{,}04 \cdot H + 0{,}15 \cdot H \cdot C - 0{,}075 \cdot C + 2{,}5 / R$,

where the maximum track gauge is assumed to be 1,45 m The cant C, the radius R and the dimension H are measured in metres.

*Figure H.6*

**Dynamic envelope for passage of pantographs on interoperable lines**

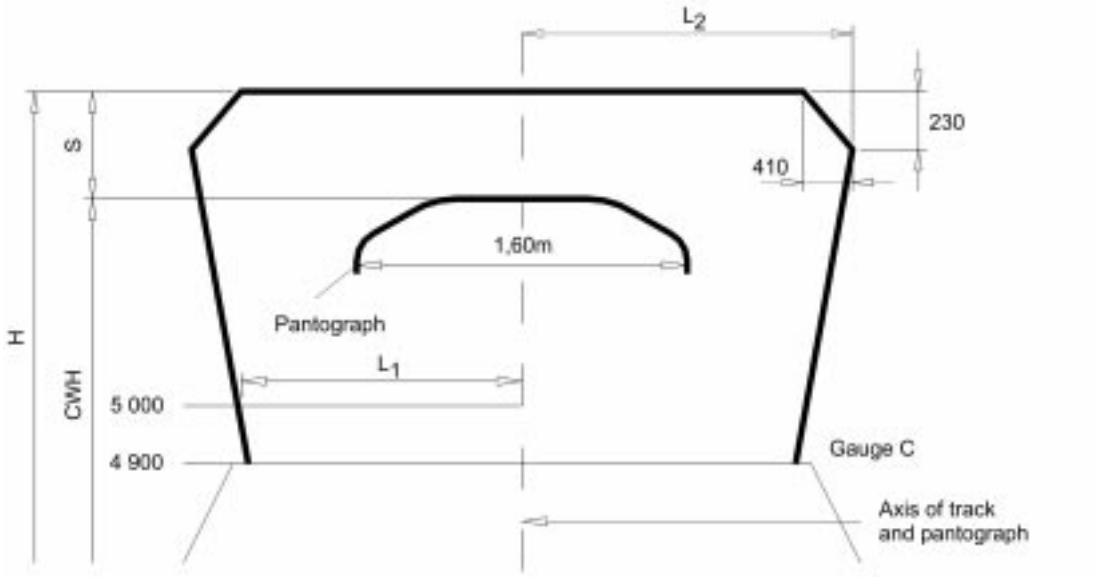



Table H.3 shows as an example the relations between track radius, cant and dimensions $L_1$ and $L_2$ for high-speed lines with a track radius of more than 3 000 m. The dimension H is the sum of the contact wire height CWH and the provision S for uplift.

*Table H.3*

**Dimensions for dynamic envelope for pantograph passage for high-speed lines (examples, track radius more than 3 000 m)**

| Cant C<br>m | Width $L_1$ at 5,00 m height<br>m | Width $L_2$ (see figure H.6)<br>m |
|---|---|---|
| 0,0 | 0,94 | 0,74 + 0,04 H |
| 0,066 | 0,99 | 0,74 + 0,05 H |
| 0,180 | 1,08 | 0,73 + 0,07 H |

*ANNEX J*

## OVERHEAD LINE EQUIPMENT, GEOMETRICAL INTERACTION OF OVERHEAD LINES AND PANTOGRAPHS, DC SYSTEMS

### J.1. SCOPE

This Annex covers:

— geometrical requirements for overhead contact lines,

— geometrical requirements for pantographs and

— requirements for interaction of overhead contact lines and pantographs,

for upgraded and connecting lines of the trans-European high-speed rail system supplied by DC systems.

### J.2. OBJECTIVES

This Annex supplements the basic parameters specified for lines supplied by DC systems. These requirements are necessary to guarantee the safe running of trains by an energy supply without interruption and undue disturbances and to achieve an interaction without excessive wear and tear of contact wires and collector strips.

### J.3. GEOMETRICAL REQUIREMENTS

#### J.3.1. **Overhead contact lines**

In Table J.1 the geometrical requirements are listed together with tolerances.

*Table J.1*

**Geometry of overhead contact lines**

| No | Description | Connecting lines | Upgraded lines |
|---|---|---|---|
| 1 | Height of contact wire | | |
| 1.1 | Standard height of contact wire (mm) | Between 5 000 and 5 600 ([1]) ([2]) ([3]) | Between 5 000 and 5 500 ([3]) ([4]) |
| 1.2 | Tolerance (mm) | 0 + 60 | 0 + 60 |
| 1.3 | Limit values (mm) | 4 950 and 6 200 ([5]) | 4 950 and 6 200 |
| 2 | Permissible contact wire gradient in relation to the track and variation of gradient | See EN 50119, version 2001, point 5.2.8.2 | |
| 3 | Permissible lateral deflection to the contact wire under action of cross wind (mm) | ≤ 400 | |

([1]) For connecting lines with mixed freight and passenger traffic of operation of trailers with oversized gauge the contact wire height may be higher provided the pantograph is suited to collect the current with the specified quality and the development of the pantograph is sufficient as specified in point 5.3.2.5.

([2]) At level crossings the contact wire height shall be designed according to national directives.

([3]) For the lines in Italy referred to in note 2 to Table 4.1 the contact wire height is between 5 000 mm and 5 300 mm. The other values apply to other types of lines.

([4]) The contact wire height and wind speed to be considered will be defined in the register of infrastructure defined in Annex D to this TSI.

([5]) For connecting lines in Spain: 4 600 mm and 6 200 mm.

J.3.2. **Pantographs**

In Table J.2 the geometrical requirements for a pantograph suitable for the trans-European high-speed rail system are presented. Figure J.1 shows details of the pantograph collector head. Since the pantographs will be used on connecting and upgraded lines of the interoperable system no distinction between line categories is made.

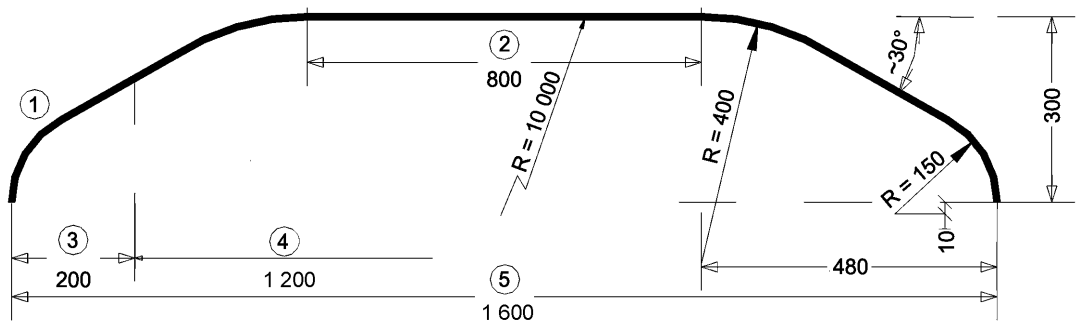
*Table J.2*

**Geometry of pantograph collector head**

| No | Description | All line categories |
|---|---|---|
| 1 | Width of pantograph collector head | |
| 1.1 | Unified collector head (mm) | 1 600 |
| 1.2 | Collector head during transition period (mm) | 1 450 and 1 950 |
| 2 | Working range of pantograph collector head (mm) | 1 200 |
| 3 | Length of contact strips (mm) | ≥ 800 |
| 4 | Profile of pantograph collector head | |
| 4.1 | Profile of unified collector head | See figure J.1 |
| 4.2 | Profile of transitional collector head | EN 50367 |
| 5 | Electrical link between pantograph | When such link exists, a means to interrupt this link shall be provided |
| 6 | Device to detect defects in pantograph collector head | Necessary |

*Figure J.1*

**Profile of current collector head**




1 Horn made of insulating material

2 Minimum length of the contact strip

3 Projected length

4 Working range of the collector head

5 Width of the collector head

J.3.3. **Dynamic envelope for pantograph passage**

The stipulations in DC are the same as in AC. Reference is made to Annex H, point H.3.6.

*ANNEX K*

**REGENERATIVE BRAKING**

K.1. SCOPE

This Annex applies to interoperable traffic on lines which power supply is an AC system. It gives the conditions for use of regenerative braking on power supply traction systems.

*Note:* In DC systems, by request of the railway undertaking, the adjudicating entity can decide upon the acceptance of regenerative braking.

K.2. ROLLING STOCK CONSIDERATIONS

Trains shall not continue to use their regenerative brake if:

— there is a loss of supply voltage or a contact line – rail/earth short circuit on the section fed by the substation,

— the contact line fails to absorb the energy,

— the line voltage is higher than $U_{max2}$. See Annex N to this TSI.

If feedback energy absorption by other consumers is not available, rolling stock shall revert to other brake systems.

K.3. ENERGY SUBSYSTEM CONSIDERATIONS

The energy subsystem has to be designed in such a way that regenerative braking can be used as a service brake.

The adjudicating entity shall ask the power supply authority to accept the feedback of braking energy into the supply network, when the energy cannot be absorbed by other railway consumers.

K.4. ASSESSMENT

The substation control and protection devices shall allow feed back for energy to the supplying net. The connecting diagrams shall allow the assessment.

*ANNEX L*

## VOLTAGE AT THE PANTOGRAPH (QUALITY INDEX OF POWER SUPPLY)

### L.1. SCOPE

The aim of a design study is to define the characteristics of fixed installations. These installations should allow the most severe conditions, as specified in the timetable to be satisfied through:

— the most dense operating period in the timetable, corresponding to peak traffic,

— the characteristics of the different types of train involved, taking account of the selected traction units.

This Annex covers both:

— high-speed lines designed for speeds of 250 km/h and above, and

— lines upgraded for speeds of approximately 200 km/h.

### L.2. OBJECTIVES

The objective is to give an indication of quality of fixed installations for electric traction. It is based on a mathematical study of voltage seen on an electrified route with trains running to the reference timetable.

The quality index $U_{\text{mean useful}}$ is calculated by simulation and can be verified by ad hoc measurements on a critical train.

*Note:* With the aim of guaranteeing the performance levels for all trains depending on type of line, the adjudicating entity should design his equipment in such a way that the mean useful voltage at the pantograph on each train in the supplied section is sufficiently high. This does not mean that trains will not, for very short periods, be subjected to extreme voltages as defined in Annex N to this TSI.

### L.3. DEFINITION OF MEAN USEFUL VOLTAGE

Mean useful voltage $U_{\text{mean useful}}$ is calculated by computer simulation of a geographic zone which takes account of all trains scheduled to pass through the zone in a given period of time corresponding to the peak traffic period in the timetable. This given period of time should be sufficient to take account of the highest load on each electrical section in the geographic zone.

Account shall be taken of the electrical characteristics of the power supply installation and each different type of train in the simulation.

The fundamental voltage at the pantograph of each train in the geographic zone is analysed at each simulation time step. For AC systems, the rms of the fundamental voltage is used. For DC systems, the average is used. This time step in the simulation shall be short enough to take into account all events in the timetable.

The voltage values from the simulation are used to study:

1. $U_{\text{mean useful}}$ of power supply zone

   This is the mean value of all voltages analysed in this simulation and gives an indication of the quality of the power supply for the entire zone.

   All trains in the geographic zone, over the peak traffic period considered, are included in this analysis whether they are in traction mode or not (stationary, traction, regeneration, coasting) at each simulation time step.

2. $U_{mean\ useful}$ of train

This is the mean value of all voltages in the same simulation as the geographic zone study but only analysing the voltages for one particular train at each time step where the train is taking traction load (not stationary, no regeneration, no coasting).

The mean value of these voltages gives a check on the performance of each train in the simulation and, as a result, identifies the governing train, the train whose ability to accelerate is most constrained by low voltage.

## L.4. VALUES RECOMMENDED FOR MEAN USEFUL VOLTAGE AT THE PANTOGRAPH

The minimum values for mean useful voltage $U_{mean\ useful}$ at the pantograph are given in Table L.1:

*Table L.1*

**Minimum mean useful voltage at pantograph (kV)**

| Electrification system | DC 1,5 kV | DC 3 kV | AC 15 kV | AC 25 kV |
|---|---|---|---|---|
| Zone | 1,30 | 2,80 | 14,2 | 22,5 |
| Train | 1,30 | 2,80 | 14,2 | 22,5 |

## L.5. RELATION BETWEEN MEAN USEFUL VOLTAGE $U_{mean\ useful}$ AND $U_{min1}$

The designing of the power supply shall be conducted in such a way that the simulations enabling mean useful voltage $U_{mean\ useful}$ at the pantograph to be computed, never generate instantaneous voltage values at the pantograph of any train lower than the limit $U_{min1}$ from Annex N to this TSI for traffic corresponding to the type of line concerned (see Annex F to this TSI).

## L.6. SELECTION CRITERIA DETERMINING THE VOLTAGE AT THE PANTOGRAPH FOR HIGH-SPEED TRAINS

The design of fixed installations for electric traction can be obtained by simulating the critical timetable taking into account the power drawn by each train in the simulation at each time interval. Over and above aspects of calibration of equipment (transformers, overhead lines, autotransformers for 2 × 25 kV and converters for DC) and compatibility with apparent performance tolerated at the high voltage connection points, the quality of the power supply constituents an important qualifying parameter for the supply scheme studied.

The characteristic curve of traction effort and speed for a traction unit changes as a function of the voltage at the pantograph. Determining the envelope of the characteristic traction effort and speed curve, under reduced voltage is achieved in relation to the nominal characteristic curve, by extrapolation over the speed range, with the proportionality coefficient being slightly lower than the voltage ratio of voltage at pantograph and nominal voltage ($U_{pantograph}/U_{nominal}$).

The voltage values obtained should allow the desired performance levels to be attained. For example, in order to study electrification with 25 kV, the selection of a voltage of at least 22,5 kV makes it possible, not to drop statistically below the minimum limit of 19 kV. Voltages below 19 kV are possible in periods of abnormal traffic with trains on closer headway in particular, or in the case of special situations that do not always appear in the simulations such as coincidence of flights of traffic in both directions.

The incidence of situations with impaired performance, both from the point of view of the power supply scheme and the operating graph, should be assessed taking into account permitted reductions in performance.

The selection of the correct mean useful voltage presents the following advantages.

— It allows the traction units to function close to their nominal voltage, hence optimising efficiency and performance.

— It ensures that the values of minimum voltage specified by the standards are respected.

— It reflects the fact that the fixed installations for electric traction have the correct performance and that, as a result, increased traffic volumes can be considered.

— It allows certain impaired traffic situations to be dealt with.

## L.7. CALCULATION OF MEAN USEFUL VOLTAGE AT THE PANTOGRAPH

The mean useful voltage $U_{\text{mean useful}}$ at the pantograph is defined as follows:

$$U_{\text{mean useful}} = \left(\sum_{j=1}^{n} \frac{1}{T_j} \int_0^{T_j} U_p \cdot |I_{pj}| dt\right) \Big/ \left(\sum_{j=1}^{n} \frac{1}{T_j} \int_0^{T_j} |I_{pj}| dt\right)$$

where:

$T_j$ = integration or study period on train number $j$,

$n$ = number of trains considered in the study.

For AC systems:

$U_{pj}$ = momentary rms voltage at power frequency at the pantograph of train number $j$,

$|I_{pj}|$ = module of momentary rms current at power frequency flowing through the pantograph of train number $j$.

For DC electrification:

$U_{pj}$ = momentary average DC voltage at the pantograph of train(s) number $j$,

$|I_{pj}|$ = module of momentary average DC current flowing through the pantograph of train number $j$.

This represents the relation between mean power calculated for the train (trains) during their traction sequences and the corresponding mean current.

An equivalent result is obtained with the following formula that is more suitable for some computer programs:

$$U_{\text{mean useful}} = \frac{1}{n} \sum_{i=1}^{n} \frac{1}{MN\Delta t} \sum_{j=1}^{N} \sum_{k=1}^{M} U_{j,k}(t) \cdot \Delta t$$

where:

$n$ = number of trains considered in the simulation,

$U_{j,k}$ = rms voltage of the power frequency voltage evaluated from the basic calculation step for AC electrification systems;

average voltage obtained on the basic calculation step for DC electrification systems,

$M$ = number of calculation steps in the integration period,

$N$ = number of integration periods in the simulation,

$\Delta t$ = time during which each step $M$ is simulated,

*Note:* $\Delta t$ has to be short enough to take account of all events in the timetable.

This expression for the voltage has the advantage that it reflects quite closely the quality of the power supply in the case of traffic simulations comprising a large number of trains on the railway under study.

The formula above is used to study:

A geographic part (i.e. the part of the network to be studied) in a given period of time, with account taken of all the trains passing through the part, whether they are in traction mode or not (stationary, traction, regenerating, coasting). The value of mean useful voltage $U_{\text{mean useful}}$ therefore is an indicator of the quality of the power supply for the entire part.

The mean useful voltage at the pantograph of each train among those within the studied part of line; only the traction periods of the train are taken into account. In this case *n* is equal to 1 in the formula above. This value is taken to check the performance of each train in the simulation and as a result identifies the governing train.

## L.8. QUALITY INDEX OF THE POWER SUPPLY

### L.8.1. $U_{\text{mean useful}}$ (zone)

| What | When | How | Acceptance condition |
|---|---|---|---|
| *Simulation* | | | |
| On a defined zone of the power supply system | After each simulation | Using the simulation results of the trains in the considered zone and calculation with definition in L.3 | The value is greater than the values given in the row 'Zone' of Table L.1 |

### L.8.2. $U_{\text{mean useful}}$ (train)

| What | When | How | Acceptance condition |
|---|---|---|---|
| *Simulation* | | | |
| For a defined train in the simulation timetable – mostly the dimensioning train | As a result of simulations | Using the simulation results of the train calculation with definition in point L.3 | The value is greater than the values given in the row 'each train' of Table L.1 (TSI lines or classical lines) |

### L.8.3. Relation between $U_{\text{mean useful}}$ and $U_{\text{min1}}$

| What | When | How | Acceptance condition |
|---|---|---|---|
| *Simulation* | | | |
| | After each simulation | Using the simulation results of each train considered in the zone test to be made only if $U_{\text{mean useful}}$ at the pantograph is higher than the values stipulated in L.5. | Check that the voltage at the pantograph of each train is never under $U_{\text{min1}}$ |

*ANNEX M*

## TEST AND VERIFICATION OF CONTACT STRIPS

### M.1. SCOPE

This Annex applies to tests and verification of collector strips to be used on pantographs for interoperable high-speed traffic.

### M.2. CONTACT STRIPS

#### M.2.1. **General**

The type of contact strip used shall be in accordance with following:

— current capacity,

— static force,

— contact strip material.

The material of the contact strips shall be acceptable to the adjudicating entity. Commonly used materials of contact strips are:

— plain carbon, if necessary impregnated with added material,

— copper-steel, copper alloy, copper,

— copper-clad carbon,

— sintered material.

For the use of other materials it is necessary to furnish proof that the characteristics are equal to or better than the characteristics of the recommended materials.

The operation with different contact strip material on the contact line network shall be based on an agreement between adjudicating entity and train operator.

*Note:* If mixed material for collector strips in the networks will be used, the wear of collector strips and contact wire could increase.

### M.3. CURRENT AT STANDSTILL

#### M.3.1. **Testing conditions**

The heating of the contact wire by the current at standstill shall be checked for DC systems. A check for the AC systems is not necessary because of the lower current at standstill.

The test shall be carried out with one pantograph equipped with a collector head containing two collector strips.

The two collector strips shall be tested on a plane surface according to a used condition.

The pantograph shall be mounted on a traction unit. Testing shall be performed in a protected environment (in a closed workshop) in order to avoid any influences from flows of air.

Testing shall be performed under one or two contact wires equipped with temperature sensors. The temperature sensors shall be located 2 mm from the contact surface.

M.3.2. **Testing procedure**

Testing shall be performed with a static contact force according to point 5.3.2.6.

The current conveyed by the pantograph shall be related to the maximum consumption of the rolling stock with the limits specified in point 5.3.3.4.

Each test shall last for 30 minutes unless the temperature displayed by one of the sensors reaches the maximum permissible value for the contact wires. This value shall be specified by the adjudicating entity. In this case the test shall be stopped.

Current intensity and temperature shall be continually recorded.

Testing shall be deemed to be satisfactory if the maximum temperature of the contact wires after 30 minutes is not higher than the limit value stipulated.

M.4. CURRENT AT ELECTRICAL LOAD

M.4.1. **Testing conditions**

The wear of the contact strips by the current at electrical load shall be checked for DC systems. A check for AC systems is not necessary because of the lower current at electrical load.

*Testing conditions*

The pantograph shall be mounted on a traction unit whose capacity permits at least the collection of maximum electric current.

The pantograph fitted with the test collector strips shall be set in such a manner during the on-track runs and before the measurements that the worst conditions for current transmission are fulfilled.

M.4.2. **Testing procedure**

The traction unit shall haul a train of the maximum allowed mass at a speed such that the maximum current is reached.

In each configuration the maximum current intensity during the relevant measurements shall be transferred for 30 minutes.

In order to ensure that the running performance of the collector strips is sufficiently representative, 10 measuring runs shall be performed in each configuration.

It is recommended that the collector strips be replaced in each case after a cycle of 10 runs.

After each cycle the condition of the collector strips shall be inspected and the extent of wear (mm/1 000 km) determined so that their running performance can be assessed.

Testing shall be deemed to be satisfactory when no defects are detected which can impair the running performance of the collector strips and when the extent of wear complies with the running performance indicated in the TSI Energy.

*ANNEX N*

## VOLTAGE AND FREQUENCY OF TRACTION SYSTEMS

### N.1. SCOPE

This Annex defines the voltage and frequency and their tolerances at the terminals of the substation and at the pantograph.

### N.2. VOLTAGE

The characteristics of the main voltage systems (overvoltages excluded) are detailed in Table N.1.

*Table N.1*

**Nominal voltages and their permissible limits in values and duration**

| Electrification system | Lowest non-permanent voltage | Lowest permanent voltage | Nominal voltage | Highest permanent voltage | Highest non-permanent voltage |
|---|---|---|---|---|---|
| | $U_{min2}$ (V) | $U_{min1}$ (V) | $U_n$ (V) | $U_{max1}$ (V) | $U_{max2}$ (V) |
| DC (mean values) | 400 (1) | 400 | 600 | 720 | 800 (2) |
| | 400 (1) | 500 | 750 | 900 | 1 000 (2) |
| | 1 000 (1) | 1 000 | 1 500 | 1 800 | 1 950 (2) |
| | 2 000 (1) | 2 000 | 3 000 | 3 600 | 3 900 (2) |
| AC (rms values) | 11 000 (1) | 12 000 | 15 000 | 17 250 | 18 000 (2) |
| | 17 500 (1) | 19 000 | 25 000 | 27 500 | 29 000 (2) |

(1) The duration of voltages between $U_{min1}$ and $U_{min2}$ shall not be longer than two minutes.
(2) The duration of voltages between $U_{max1}$ and $U_{max2}$ shall not be longer than five minutes.

— The voltage of the busbar at the substation with all line circuit breakers open shall be lower or equal than $U_{max1}$.

— Under normal operating conditions voltages shall stay within the range between $U_{min1}$ and $U_{max2}$.

Under abnormal operating conditions voltages in the range $U_{min1}$ to $U_{min2}$ are acceptable.

**Relation $U_{max1}/U_{max2}$**

Each occurrence of $U_{max2}$ shall be followed by a level below or equal to $U_{max1}$ for an unspecified period.

**Lowest operational voltage**

Under abnormal operating conditions, $U_{min2}$ is the lower limit of the overhead contact line voltage for which trains are intended to operate.

*Note:* Recommended values for undervoltage tripping:

The setting of undervoltage relays at fixed points or on board may be from 85 % to 95 % of $U_{min2}$.

N.3. FREQUENCY

The frequency of the 50 Hz electric traction system is imposed by the three-phase grid. Therefore, the values stated by EN 50 160 are applicable. The frequency of the 16,7 Hz electric traction system (except for synchronous-asynchronous converter) is not imposed by the three-phase grid.

Table N.2 gives the values applicable to both electric systems.

*Table N.2*

**Frequency on railway power system and their permissible limits**

| Duration | Nominal frequency of the system | Railway power system supplied by: | |
|---|---|---|---|
| | | an interconnected 3-phase grid | a non-interconnected 3-phase grid |
| 95 % of a week | 50 Hz | 50,50 Hz | 51,00 Hz |
| | | 49,50 Hz | 49,00 Hz |
| | 16,7 Hz | 16,83 Hz | n.a. |
| | | 16,50 Hz | n.a. |
| 100 % of a week | 50 Hz | 52,00 Hz | 57,50 Hz |
| | | 47,00 Hz | 42,50 Hz |
| | 16,7 Hz | 17,36 Hz | 17,00 Hz |
| | | 15,69 Hz | 16,17 Hz |

n.a.: not applicable.

*Note:* In practice, the variation of frequency is more closely controlled in Europe than stated above.

N.4. TEST METHODOLOGY

N.4.1. **Measurement of the voltage on the line**

N.4.1.1. *Rolling stock*

Rolling Stock shall be tested as described in EN 50 215: 1999 point 9.15

N.4.1.2. *Fixed installations*

| Where | When | How | Acceptance condition |
|---|---|---|---|
| *N.4.1.2.1 Substation bus bar, line circuit*<br>breakers open, normal operating conditions | At commissioning | — Voltage recorder for the fundamental frequency, or<br>— Digital data loggers with a frequency range greater than or equal to 2 kHz.<br>Averaging over 1 second<br>— Measurement period 1 minute | All voltage values are less than or equal to $U_{max1}$ |
| *N 4.1.2.2 If any voltage conditioning device is installed along the line*<br>Measure on either side of the device under no load and normal operating condition | At commissioning and operating | No load see above substation<br>When in operation see ad hoc measurement hereafter | No load see above substation<br>When in operation see ad hoc measurement hereafter |

| Where | When | How | Acceptance condition |
|---|---|---|---|
| N *4.1.2.3 Ad hoc measurement*<br>At the site, where problems are situated. | On response to problems. | — Voltage recorder devices for the fundamental frequency, or<br>— Digital data loggers with a frequency range greater than or equal to 2 kHz averaging over 1 second<br>— Measurement period minimum 1 hour maximum 1 week | — All voltage values are greater than or equal to $U_{min2}$<br>— All durations of voltages below $U_{min1}$ are less than or equal to the duration stated in point N.2 requirement 1.<br>— Average value of the voltage is between $U_{min1}$ and $U_{max1}$<br>— All durations of voltages above $U_{max1}$ are less than or equal to the duration stated in point N.2 requirement b.<br>— All voltage values are less than or equal to $U_{max2}$ |

N.4.2. **Measure of the frequency on the line**

| Where | When | How | Acceptance condition |
|---|---|---|---|
| *Continuous monitoring*<br>Only for networks, that are not imposed by the 3-phase grid.<br>Continuous in connection with the frequency closed loop control in the generating stations or in the network control centre | At commissioning and operating | — Digital data loggers with a frequency range | All frequency values are in the range of Table 2, last column. |

*ANNEX O*

## LIMITATION OF MAXIMUM POWER CONSUMPTION

### O.1. SCOPE

This Annex gives requirements for current and power limitation devices on board traction units.

### O.2. MAXIMUM TRAIN CURRENT

The maximum allowable train current is given in Table O.1: the levels apply both in traction and regeneration modes. Lower values for lines with weak power supplies shall be given in the register of infrastructure (see Annex D to this TSI).

*Table O.1*

**Maximum allowable train current (Amperes)**

| Power supply system | High-speed line | Upgraded line | Connecting line |
|---|---|---|---|
| DC 750 V | — | — | 6 800 |
| DC 1 500 V ([1]) | — | 5 000 | 5 000 |
| DC 3 000 V | 4 000 | 4 000 | 2 500 |
| AC 15 000 V 16,7 Hz | 1 700 | 1 000 | 900 |
| AC 25 000 V 50 Hz | 1 500 | 600 | 500 |

([1]) On special lines (e.g. freight in mountain area, suburban network), these values may be exceeded.

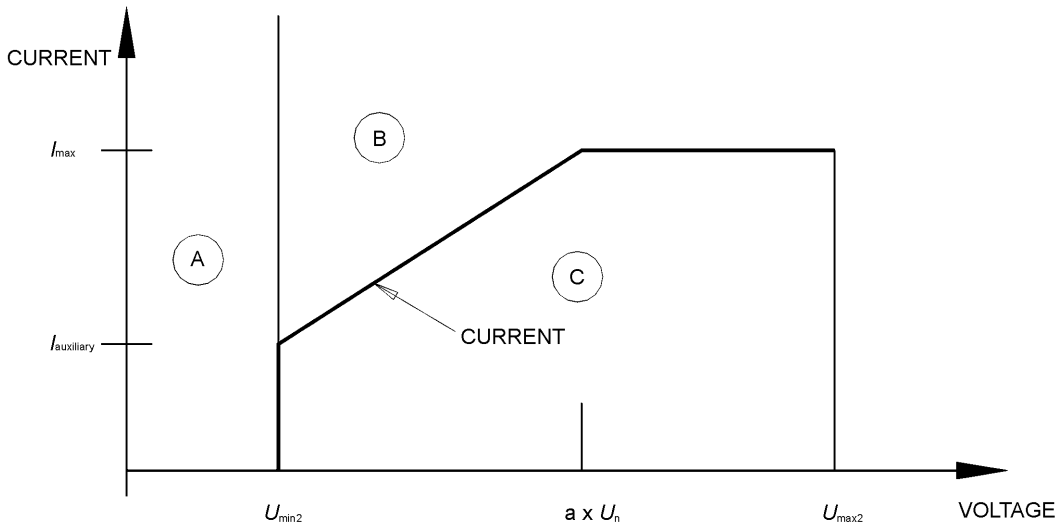
### O.3. AUTOMATIC REGULATION

Trains shall be equipped with an automatic device that adapts the level of the power consumption depending on overhead line voltage in steady state conditions. Figure O.1 gives current as a function of the overhead contact line voltage.

This figure does not apply in regenerative braking mode.

*Figure O.1*

**Maximum train current against voltage**




$I_{max}$= maximum current consumed by the train

A= no traction

B= current level exceeded

C= allowable current levels

a= factor given in Table O.2

*Table O.2*

**Values of factor a**

| Power supply system | AC 25 000 V 50 Hz | AC 15 000 V 16,7 Hz | DC 3 000 V | DC 1 500 V | DC 750 V |
|---|---|---|---|---|---|
| a | 0,9 | 0,95 | 0,9 | 0,9 | 0,8 |

O.4. POWER OR CURRENT LIMITATION DEVICE

In order to allow a powerful traction unit to operate everywhere (weak or well supplied lines), it is necessary to install on board a current or power selector which will limit the power demand of the train to the electrical capacity of the line. This is applicable only on upgraded and connecting lines of the trans-European high-speed network, and on all other lines of the conventional network.

The adjudicating entity has to declare on in the register of infrastructure the required limitation of each line.

This setting can be made manually by the driver or if the line is so equipped, it shall then be done automatically.

*ANNEX P*

## HARMONIC CHARACTERISTICS AND RELATED OVERVOLTAGES ON THE OVERHEAD CONTACT LINE

### P.1. SCOPE

This Annex defines the necessary requirements to avoid unacceptable overvoltages on the overhead contact line caused by harmonics generated by traction units.

### P.2. GENERAL

The harmonic characteristic of the power supply and the rolling stock in the railway system determines the overvoltages in the overhead contact lines. In order to achieve electrical system compatibility under steady state and dynamic conditions, those overvoltages must be limited below critical values in the relevant frequency range. With protection devices installed, overvoltages cause an interruption of normal operation and are critical more from the operation point of view than from safety aspects.

The following physical effects cause overvoltages:

**Overvoltages caused by system instability**

Modern railway vehicles with inverter propulsion and auxiliary systems as well as static-tie frequency converters are generally active devices which are capable of transferring energy from one frequency in the spectrum to another one. Their transfer behaviour is largely determined by the controllers as well as by the passive elements in the system.

Controllers have to be tuned in such a way that for all operating conditions stable behaviour results. In a non-stable system, physical values (as voltages or currents) either tend towards infinity and cause a protective shutdown in reality (valid for linear and non-linear systems) or continuously (steady state) oscillation on one or several frequencies (possible only in non-linear systems).

Stability questions always are related to feedback loops in a system, especially through one or several controllers of one or several electrical subsystems. There is no explicit excitation source, small disturbances are sufficient. This has to be distinguished from the other cases described below, where both an excitation source and a transmission/amplification path always exists.

Normally the potential oscillations caused by instabilities are in the frequency range of up to about 500 Hz (bandwidth of the relevant controllers). Low frequency oscillations (below and around supply frequency) strongly involve non-linear characteristics of modern vehicles, higher frequency instabilities can be linearised approximately.

**Overvoltages caused by harmonics**

Solid state inverters (both phase angle controlled and forced commutated ones) installed on rolling stock, or for power supply, produce current and voltage harmonics which can be represented by current or voltage sources in a simplified manner. Every type of converter generates a typical current or voltage spectrum. The converter, combined with passive elements such as transformers and filters, shows either a current source or voltage source behaviour including a typical internal impedance.

All power supply systems include resonance, due to the resonance of transmission lines and cables, some also due to passive filter components. This leads to an amplification of harmonics injected by converters into the power supply system. An amplification (or partial suppression) occurs both at the location of the converter (due to the line impedance seen from the converter) and between the converter's location and other locations in the network (transfer behaviour of the power supply itself).

An amplification of strong harmonics may lead to significant overvoltages, either at the vehicle's location or at a completely different location in the network.

The supply system (substations and overhead contact line) has resonance peaks due to its distributed parameters — inductance and capacitance per unit of length. These resonance peaks can cause huge resonant currents and voltages. More than 100 times could be the ratio between maximum and minimum current recorded along the overhead contact line at specific resonance frequencies. For four-quadrant converter vehicles the harmonic currents at the pantograph of a vehicle can be increased about three times due to a power supply net impedance unequal to zero.

Further technical phenomena, which have to be considered for the electrical systems compatibility between power supply and rolling stock, are:

— multiple zero-crossings,

— voltage spikes and sags, transients,

— variations of the phase of supply voltage,

— low frequency oscillations.

From conducted interference point of view following effects can be relevant:

— wheel slip/slide,

— auxiliary load,

— dynamic events,

— harmonics from the auxiliary converter,

— modulations produced from different converters.

## P.3. ACCEPTANCE PROCEDURE

Any new or rebuilt traction unit or infrastructure component (for example power supply equipment, static converter, high-voltage cable) will be integrated in an existing power supply network with traction units.

Compatibility between existing traction units and existing infrastructure, and future traction units and infrastructure components has to be checked towards the phenomena described in point P.2.

Involved bodies or parties are:

— the adjudicating entity,

— the train operator(s) of existing traffic,

— the purchaser/owner of the new traction unit(s) or infrastructure equipment,

— the manufacturer of the new traction unit(s) or infrastructure equipment.

A general specification for rolling stock or power supply, which avoids overvoltages in any situations, might be very conservative and impossible to fulfil. Therefore, a process as described in point P.6 should be applied to check compatibility (compatibility case).

## P.4. CHARACTERISATION OF THE TRACTION POWER SUPPLY FIXED INSTALLATIONS

To obtain complete and in-depth characterisation of the fixed installations for power supply is a huge effort. Furthermore, a general and simple characterisation for all types of fixed installations that is appropriate for the compatibility case (point P.6) can not be given.

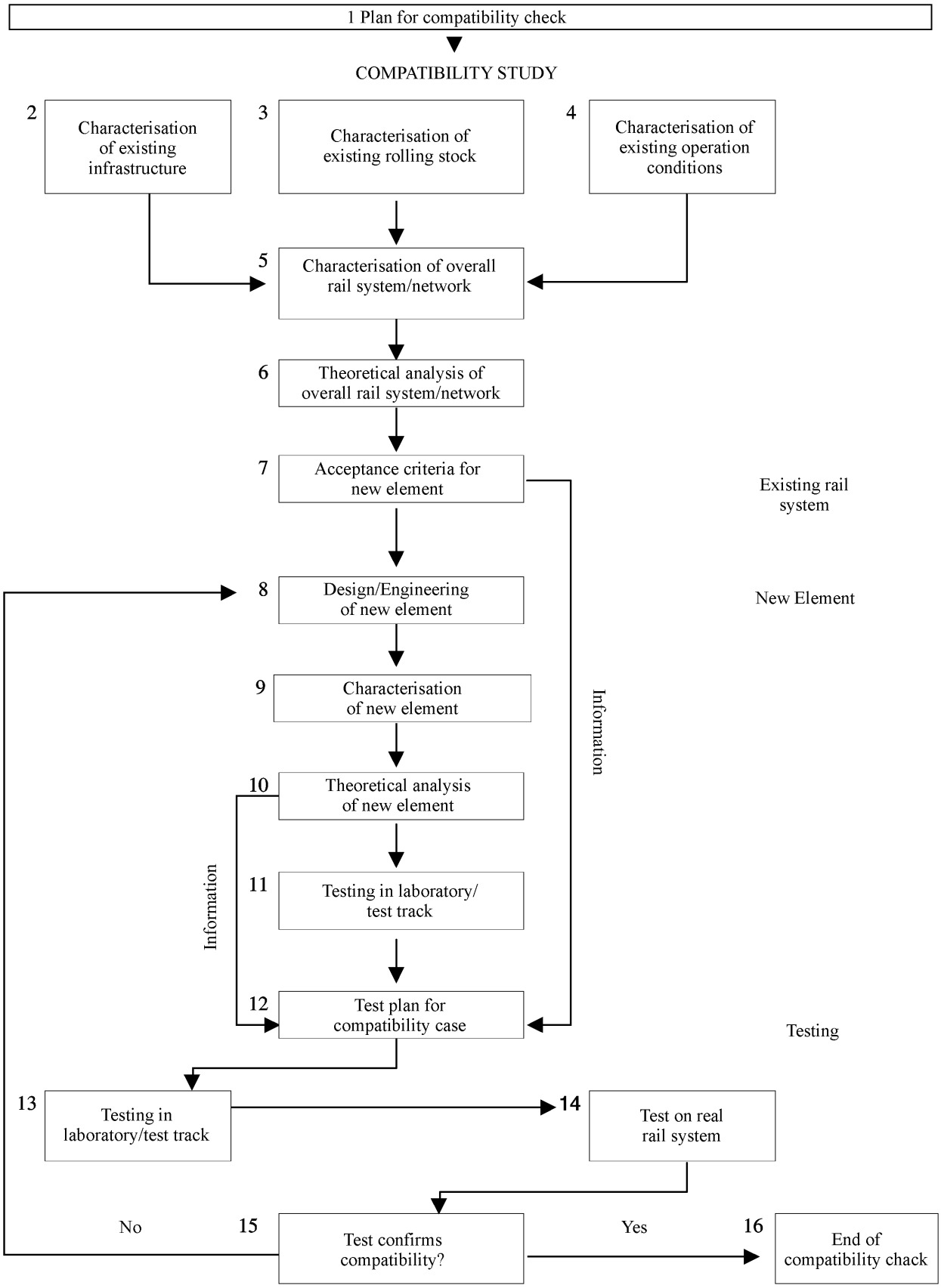
Values of systems shall be given by the adjudicating entity.

## P.5. CHARACTERISATION OF THE TRAINS

Values of vehicles shall be given by the operator(s) of existing traffic to the adjudicating entity.

*Figure P.1:*

**Procedure for introducing a new vehicle or new element**



P.6. COMPATIBILITY STUDY

The compatibility study (or compatibility case) is a process to demonstrate the compatibility of the new rolling stock or the new infrastructure component with the existing traction units and power supply network. As depicted in figure P.1 the first activity of the compatibility is the planning of the complete compatibility case. The flow chart is applicable for new rolling stock and also new infrastructure power supply components. It is a procedure for their introduction into an existing railway system.

The adjudicating entity is responsible for characterisation of infrastructure and overall network as described in points P.4 and P.5. It is also responsible for the definition of particular acceptance criteria for the vehicles or new infrastructure components as described in the steps 1 to 7 of Table P.1. The purchaser/owner of the new component (traction unit or power supply equipment) has to carry out a study to proof its compatibility. The particular acceptance criteria are necessary to guarantee compatibility to the complete system as described in point P.7

*Table P.1*

**Description of steps**

| No | Title | Description | Responsible |
|---|---|---|---|
| 1 | Plan for compatibility check | The plan for a specific compatibility check defines the scope of the analysis, and the precise tasks and responsibilities. The plan forms an agreement between all parties involved. | Organisation in charge of the compatibility check, normally supplier of new element |
| 2 | Characterisation of existing infrastructure | Characteristics of the existing infrastructure (mainly power supply system), information relevant with for the compatibility with. Information can be provided in the form of computer models. | Adjudicating entity |
| 3 | Characterisation of existing rolling stock | Characteristics of the vehicles already operating on the network, information relevant for the compatibility with the power supply. The characteristics can be provided in the form of computer models. | Operator/owner of rolling stock |
| 4 | Characterisation of existing operating conditions | Information about the operation of the existing system: number of trains in service, typical timetables, normal feeding arrangements, emergency feeding arrangements. | Operator of the railway system |
| 5 | Characterisation of overall rail system/network | This is the combination of the information from 2, 3 and 4. It may be necessary to define different scenarios. | Adjudicating entity |
| 6 | Theoretical analysis of overall system/network | Investigation of compatibility aspects for different scenarios. As a first step: confirm compatibility of the existing system. As a second step: test potential new elements (vehicles or power supply systems), check what characteristics they need to fulfil to maintain stability of the system. | Adjudicating entity |

| No | Title | Description | Responsible |
|---|---|---|---|
| 7 | Acceptance criteria for new element | The result from the theoretical investigations in 6 is the particular acceptance criteria for new vehicles or new elements of the power supply system (e.g. substation transformers, high voltage cables etc). The particular acceptance criteria must be understandable and measurable when designing and testing a new element. | Adjudicating entity |
| 8 | Design/Engineering of new element | Design of new vehicles or new elements of the power supply system, considering also the acceptance criteria defined in 7. | Supplier of the new element (vehicle or power supply equipment) |
| 9 | Characterisation of new element | The new element shall be characterised with respect to its compatibility with other vehicles and power supply elements. This characteristic after validation in step 15 shall allow an amendment of the characterisation of the existing railway as required in 2 and 3. | Supplier of the new element (vehicle or power supply equipment) |
| 10 | Theoretical analysis of new element | At an early stage of the design, it shall be checked in a theoretical analysis, e.g. using computer models, that the new element can meet the acceptance criteria. | Supplier of the new element (vehicle or power supply equipment) |
| 11 | Testing in laboratory/on test track | Once the first equipment (vehicle or power supply equipment) is built, it shall be tested in the laboratory or on a test track to verify that it meets the acceptance criteria as predicted by the theoretical analysis in 10. This set of tests is a type test of the new element. | Supplier of the new element (vehicle or power supply equipment) |
| 12 ([1]) | Test plan for compatibility case | A plan shall be made to define the tests necessary to confirm as far as possible and reasonable:<br>1. that the new element meets the acceptance criteria;<br>2. that the compatibility criteria of the standard are met and hence that the acceptance criteria are sufficient | Organisation responsible for the compatibility case |

| No | Title | Description | Responsible |
|---|---|---|---|
| 13 ([1]) | Testing in laboratory/on test track | As far as possible, tests will be performed in the laboratory and on test track. These tests shall officially demonstrate that the acceptance criteria are met. A failure to meet the acceptance criteria means redesign of the new equipment by the supplier. | Organisation responsible for the compatibility case |
| 14 ([1]) | Tests on real rail system | Tests on the real system shall give confidence that the acceptance criteria are sufficient to guarantee stability of the system after introduction of the new elements. If these tests show compatibility problems despite the compliance of the new equipment with the acceptance criteria, this means that the acceptance criteria were not sufficient. | Organisation responsible for the compatibility case |
| 15 | Tests confirm compatibility? | If both sets of tests are successful, then compatibility of the new element with the existing system has been demonstrated. This shall be documented in a compatibility report. | Organisation responsible for the compatibility case |
| 16 | End of compatibility check | With the successful completion of the compatibility case, the new elements (vehicles or power supply equipment) become ([2]) part of the existing railway system. The responsibility for its compatibility now lies with the operator of the railway system. | Operator of the railway system |

([1]) The test plan will define if both steps 13 and 14 or only one we have to be performed.
([2]) Seen from the compatibility point of view.

The result is a document describing the theoretical analysis and the proving tests to ensure that the vehicles and infrastructure are compatible in terms of conducted interference currents and stability.

## P.7. METHODOLOGY AND ACCEPTANCE CRITERIA

The compatibility case, which is described in point P.5, shall demonstrate that the existing rail system and the new element(s) are compatible.

The overall criterion for overvoltages and stability is that:

— no overvoltage higher than 30kV peak for 15kV - 16,7 Hz networks and 50kV peak for 25kV - 50 Hz networks will occur on the overhead contact line in any point of the power supply network with voltage $U$ defined in Annex N to this TSI below or equal to $U_{max2}$. This value is the peak value of the distorted voltage waveform.

These overall criteria can always be applied,

— since the overall acceptance criteria can only be applied to the complete rail system (existing rail system and new element(s)), it is beneficial to give design guidelines for the new elements which reduce the risk of failure in the compatibility study. For traction units the following guideline may be used:

The vehicle has to be passive (e.g. phase of input admittance between − 90° and + 90°) for all frequencies equal and higher than the first (lowest) resonance frequency of the existing rail system (existing infrastructure and existing rolling stock).

The distance between the highest active frequency of the vehicle (i.e. highest frequency with a phase of the input admittance below − 90° or above + 90°) and the lowest resonance frequency on of the existing rail system as described here above has to be larger than 20 % of the lowest resonance frequency.

*ANNEX Q*

## DYNAMIC INTERACTION BETWEEN PANTOGRAPH AND OVERHEAD CONTACT LINE

### Q.1. SCOPE

This Annex gives requirements and test method concerning the dynamic interaction between pantograph and overhead contact line.

### Q.2. DEFINITIONS

*Contact force:* the vertical force applied by the pantograph to the overhead contact line. The contact force is the sum of forces for all contact points of one pantograph.

*Static contact force:* The mean vertical force exerted upward by the collector head on the overhead contact line, and caused by the pantograph-raising device, whilst the pantograph is raised and the vehicle is at standstill.

*Mean force*: the statistical mean value of the contact force.

*Maximum force*: the maximum value of the contact force.

*Minimum force*: the minimum value of the contact force.

*Overhead contact line*: a contact line placed above (or beside) the upper limit of the vehicle gauge and supplying vehicles with electric energy through roof — mounted current collection equipment (IEC 50 811-33-*02*).

*Arcing*: the flow of current through an air gap between a contact strip and a contact wire usually indicated by the emission of intense light (pr EN 50 317).

*Percentage of arcing*: this is given by the following formula:

$$NQ = \frac{\sum t_{arc}}{t_{total}} \cdot 100$$

The result, given in %, is a characteristic for a given speed of the vehicle (prEN 50317).

*Pantograph head*: pantograph equipment comprising the contact strips and their mountings

*Contact point*: point of mechanical contact between a contact strip and a contact wire

*Aerodynamic force*: additional vertical force applied to the pantograph as a result of air flow around the pantograph assembly

*Quasistatic force*: sum of static force and aerodynamic force at the particular speed

*Tension length*: distance from one termination point of the overhead contact line to the next (EN 50 119)

*Control section*: representative part of the total measuring length, over which the measuring conditions are controlled

*Pantograph current*: current that flows through the pantograph

Q.3. SYMBOLS AND ABBREVIATIONS

$\sigma_{max}$ maximum standard deviation of contact force

$F_m$ mean force

$F_{max}$ maximum force

$F_{min}$ minimum force

$NQ$ percentage of arcing

$d$ is the distance between arc sensor and light source (contact strip)

$y$ is the calibration distance between arc sensor and light source

$x$ is the power density of the smallest arc that can be detected

$F_{applied}$ is the force applied to pantograph head

$F_{measured}$ is the force measured

$n$ is the number of frequency steps

$f_1$ is the minimum frequency

$f_n$ is the maximum frequency

$f_i$ is the actual frequency

Q.4. INTERACTION PERFORMANCE

Q.4.1. **Mean contact force for intermediate period**

*Figure Q.1*

**Adjustment curve C1**

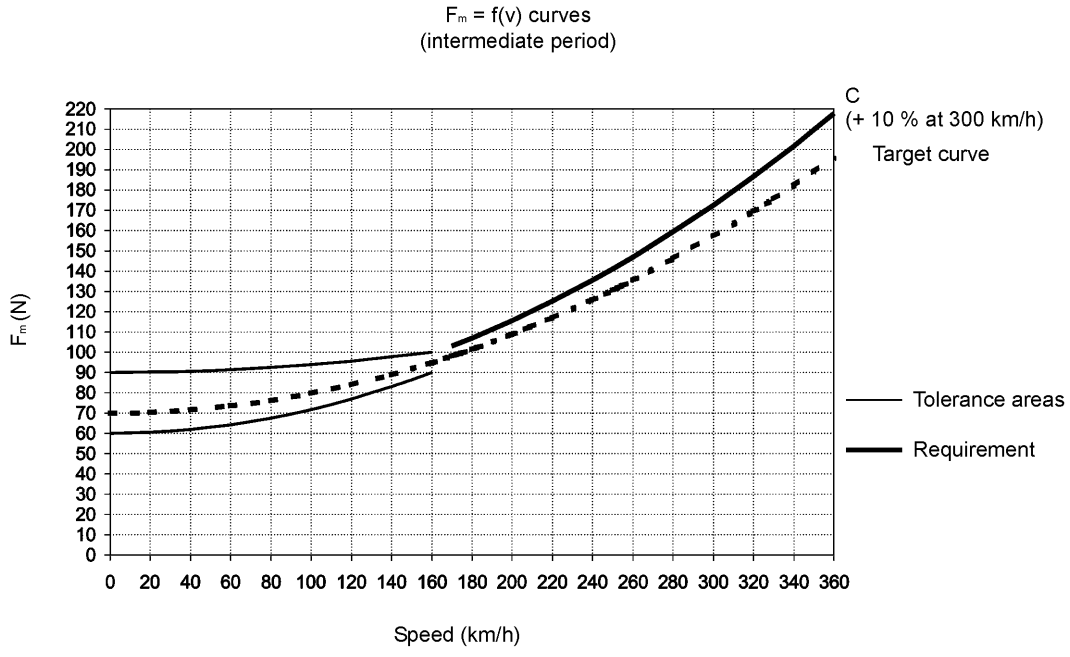
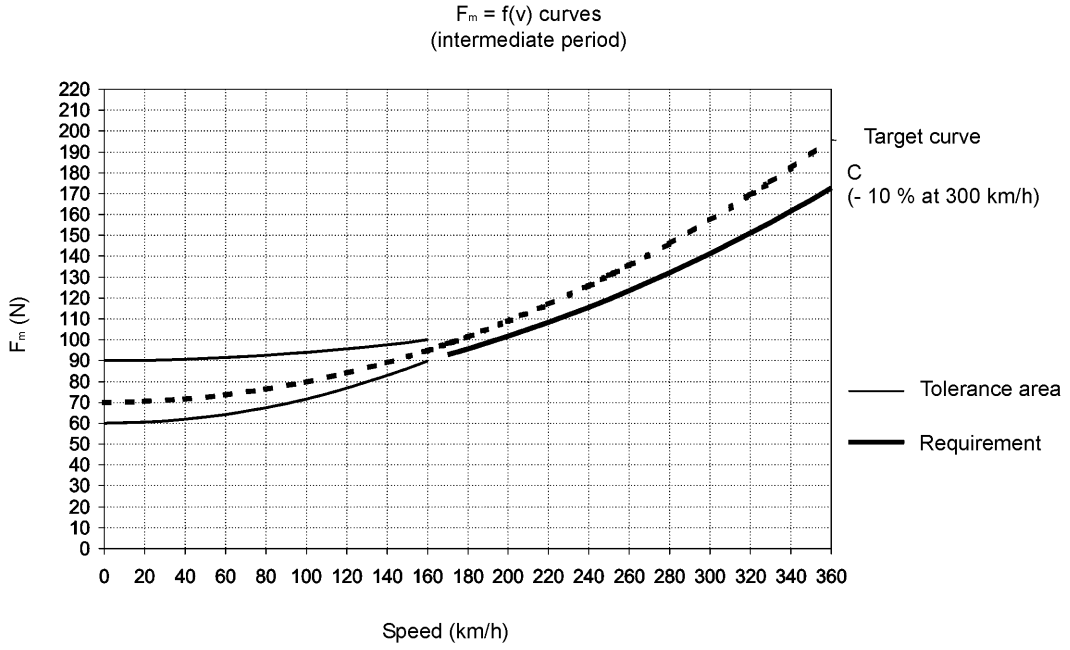


*Figure Q.2*

**Adjustment curve C2**




Q.4.2. **Requirements for output and validation of measurements of the dynamic interaction between pantograph and overhead contact line**

Q.4.2.1. **General**

The measurement of the interaction of the contact line and the pantograph is intended to prove the safety and the quality of the current collection system. Results of measurements of different current collection systems shall be comparable, to approve components for free access within Europe.

*Note:* Measured values are also required for validation of simulation programs and other measurement systems.

To check the performance capability of the current collection system at least the following data shall be measured:

— the contact force or percentage of arcing,

— the contact wire uplift at the support as the pantograph passes.

In addition to the measured values, the operating conditions (train speed, location, etc.) shall be recorded continuously and the environmental conditions (rain, ice, temperature, wind, tunnel, etc.) and test configuration (parameters and arrangement of pantographs, type of overhead contact system, etc.) during the measurement shall be recorded in the test report. This additional information shall ensure a repeatability of the measurement and a comparability of the results.

Q.4.2.2. **Measurements of contact force**

*General requirements*

The measurement of contact force shall be carried out on the pantograph with force sensors. The force sensors shall be located as near as possible to the contact points.

The measurement system shall measure forces in the vertical direction, without interference from forces in other directions.

The measurement deviation of the force sensors caused by the temperature shall be less than 10 N (for the sum of the force of all sensors) under all measuring conditions.

For pantographs with independent contact strips each contact strip shall be measured separately.

The measurement system shall be immune to electromagnetic interference.

The maximum error of the measurement system shall be less than 10 %.

*Influence of the measurement system*

The measurement system shall not have any effects on the measured force which could change the result by more than 5 %.

*Note:* The most important influence for distortion of the result by the measurement system are aerodynamic forces on the measurement equipment. This distortion can be checked by carrying out aerodynamic tests with and without the measurement system.

*Inertia correction*

The inertia forces due to the effect of the mass between the sensors and the contact point shall be corrected.

*Note:* This can be done by measurement of the acceleration to these components.

*Aerodynamic correction*

A correction shall be applied to allow for the influence of aerodynamic forces on the components between sensors and the contact points.

Aerodynamic tests shall be carried out to establish the aerodynamic corrections.

*Note:* The aerodynamic influence can be checked by a tethered test online.

Aerodynamic tests shall be carried out with nominally the same configuration (contact wire height, train configuration, measurement equipment, environmental conditions, etc.) as during the measurement of contact force.

*Note:* The aerodynamic test may be carried out during a line test.

*Calibration of the measurement system*

The measurement system shall be laboratory tested to check the accuracy of the measured force. This test shall be carried out for the complete pantograph fitted with the complete force measurement devices and any accelerometers, the data transfer system (telemetry, optical systems) and amplifiers.

The ratio between the applied and the measured forces (the transfer function of the pantograph and instrumentation) shall be determined by a dynamic excitation of the pantograph, at the pantograph head for a range of frequencies.

*Note:* If a sinusoidal force is used, an amplitude (peak to peak) of 30 % of the static force gives representative results.

The tests shall be carried out for the two cases:

— the force being applied centrally to the pantograph head,

— the force being applied 250 mm from the centre line of the pantograph head, if possible. Otherwise the point of force application shall be as close as possible to this value. If another value is used, it shall be noted in the test report.

The test shall be carried out with the pantograph head at the height of interest.

This test shall be carried out with the mean force equal to the static force. If the pantograph contact force increases with speed, the test shall also be carried out at the maximum quasistatic force.

Measurements of the applied force and the measured force shall be taken at frequencies up to 20 Hz in 0,5 Hz steps, with reduced intervals at resonant frequencies. The frequency steps near the resonant frequencies shall be specified.

*Note*: The transfer function is a continuous function with greater variations close to the resonant frequencies. The reduction of the frequency steps near the resonant frequencies is necessary.

The accuracy of the transfer function shall be calculated by using the following formula:

$$\left(1 - \frac{1}{(f_n - f_1)} \sum_{i=1}^{n-1} \left( (f_{i+1} - f_i) \left| 1 - \frac{F_{\text{measured}}}{F_{\text{applied}}} \right| \right) \right) \cdot 100\ \%$$

The transfer function of the pantograph force measurement system shall have an accuracy of greater than 80 % up to a frequency limit of 10 Hz without any correction. This accuracy is a mandatory requirement for the measurement system.

For the use for measurement of dynamic interaction between pantograph and overhead contact system the accuracy of the transfer function of the measurement systems shall be greater than 90 % up to a frequency limit of 20 Hz (in accordance with the general requirements). To achieve this a correction with filters can be made.

*Measurement parameters*

The sampling rate shall be greater than 200 Hz for time sampling or smaller than 0,40 m for distance sampling.

The contact force shall be low pass filtered with a cut-off frequency of 20 Hz.

The measuring range shall be at least:

— for AC-pantographs: from 0 N to 500 N,

— for DC-pantographs: from 0 N to 700 N.

*Measurement results*

Measurements taken within a control section shall be evaluated.

For calculating statistical values the control section should not be shorter than a tension length.

As a minimum the following statistic values shall be calculated for a control section:

— mean value ($F_m$),

— maximum value,

— minimum value,

— standard deviation ($\sigma$),

— histogram or probability curve of the contact force.

Q.4.2.3. **Measurements of displacement**

The measurement system shall not have any effects on the measured displacement which could change the result by more than 3 %.

*Uplift at the support*

The error of the measurement system shall be smaller than 5 mm.

*Vertical displacement of the contact point*

The vertical displacement of the contact point is measured relative to the base frame of the pantograph.

The accuracy of the measurement system shall be better than 10 mm.

*Measurement of other displacements in the overhead contact line*

The accuracy of the measurement system shall be better than 10 % of the amplitude of the measured value or less than or equal to 10 mm, which ever is gives a higher accuracy.

Q.4.2.4. **Measurement of arcing**

*General requirements*

For the detection of arcs the detector shall be sensitive to the wavelengths of light emitted by copper materials. For copper and copper alloyed contact wires a wavelength range shall be used, that includes the range 220 nm to 225 nm or 323 nm to 329 nm.

*Note:* These two wavelength ranges have substantial copper emissivity.

The measurement system shall be insensitive to visible light with wavelength greater than 330 nm.

The detector shall:

— be close enough to the pantograph to get a sufficiently high sensitivity,

— be close enough to the vehicle's longitudinal axis to get a sufficiently high sensitivity,

— be located behind the pantograph according to the travel direction of the vehicle,

— aim at the trailing contact strip according to the travel direction,

— be sensitive for a field of view over the whole working area of the pantograph head; the tolerance for this sensitivity shall be better than 10 %,

— have a response time to the beginning and ending of an arc of less than 100 μs,

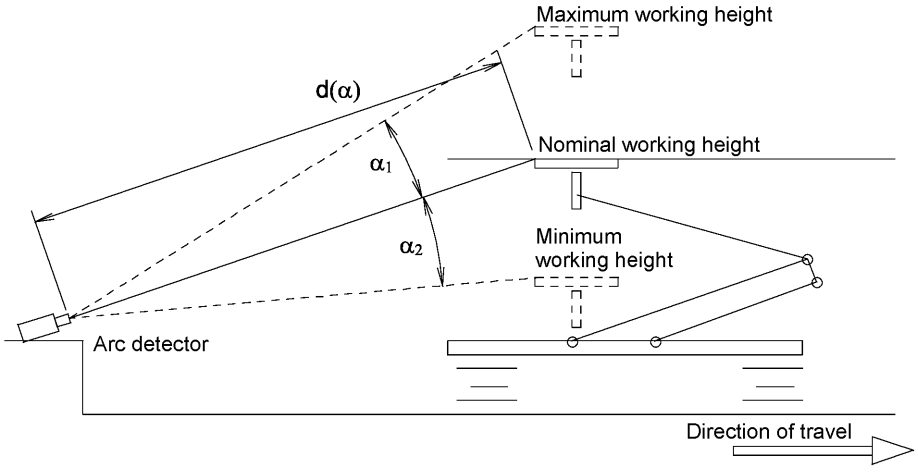
— have a detection threshold, depending on the minimum arc energy which shall be measured.

*Note:* The threshold values vary depending of the distance between measurement device and the place where the arcs occur.

Figure Q.3 gives an example of the side view of the location of a detector.

*Figure Q.3*

**Detector location**




*Calibration of the arc measurement system*

The considered detector shall be calibrated in power density in spectral range of interest.

This sensitivity curve represents the relationship between the response in volts of the detector, and the power density in $\mu W/cm^2$. This response is measured at the analogue output of the detector.

The power density of the smallest arc which is detected shall be defined.

*Note:* For example this value shall be at 5 m:

— 160 μW/cm$^2$ + 10 % under 25 kV overhead contact line,

— 12,5 μW/cm$^2$ + 10 % under 1,5 kV overhead contact line.

*Adjustment of the operating distance*

If the distance between the sensor and the light source differs in operation from the calibration distance (y), an adjustment of the detector shall be carried out.

This shall be carried out as follows:

— determine the power density of the smallest arc that can be detected at this distance in accordance the 1/d$^2$ law,

— use the calibration values to determine the signal corresponding to this power density level,

— consequently, the new value of power density threshold to be detected is a function of the new distance (d) owing to the relation

$$x \cdot d^2 / y^2$$

*Note:* An arc is considered to be a point source and consequently the power density is proportional to 1/d$^2$ (see figure Q.3).

*Values to be measured*

As a minimum the system shall measure:

— the duration of each arc,

— the train speed during the test,

— the pantograph current.

The location of the arc along the overhead contact line (kilometric position) should be recorded.

*Representation of values*

The representation of values shall be carried out for a control section.

For the output only arcs that were lasting longer than 1 ms shall be analysed.

When analysing the measurements, parts with a pantograph current below 30 % of the nominal current of the pantograph shall be disregarded.

As a minimum for the control section the following values shall be produced:

— train speed,

— the number of arcs,

— the sum of the duration of all arcs,

— the largest arc duration,

— the total time with a pantograph current greater than 30 % of the nominal current per train per pantograph,

— the total run time for the control section,

— the percentage of arcing.

*Note 1:* Another possible criterion is the number of arcs per km with a pantograph current greater than 30 % of the nominal current.

*Note 2:* The control section should not be shorter than 10 km and should be travelled at a constant speed with a tolerance of ± 2,5 km/h.

*Note 3:* To get representative results for the overhead contact line the total time with a pantograph current greater than 30 % of the nominal current should not be shorter than the time taken to travel over one tension length. This time should not be interrupted by sections with reduced currents and the speed should be constant.

# COMMISSION DECISION

## of 30 May 2002

## concerning the technical specification for interoperability relating to the operation 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) 1951)*

**(Text with EEA relevance)**

(2002/734/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 pursuant to 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 operation subsystem in accordance with Article 6(1) of the Directive. This mandate was 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) 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.

(9) 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.

(10) 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 and a rolling stock register are published and updated each year. These registers will set out the main characteristics of the national infrastructure and rolling stock (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 registers.

(11) 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:

[1] OJ L 235, 17.9.1996, p. 6.

— 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.

(12) 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 'operation' 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 and rolling stock of the trans-European high-speed rail system as defined in Annex I to Directive 96/48/EC, taking into account the conditions set out in Chapter 7 of the attached TSI.

*Article 2*

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

*Article 3*

This Decision is addressed to the Member States.

Done at Brussels, 30 May 2002.

*For the Commission*
Loyola DE PALACIO
*Vice-President*

*ANNEX*

# TECHNICAL SPECIFICATION FOR INTEROPERABILITY RELATING TO THE OPERATION SUBSYSTEM

## 1. INTRODUCTION

### 1.1. *TECHNICAL SCOPE*

This TSI concerns the 'operation' 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 operation 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) of and with Annex I(1)(b) to Directive 96/48/EC, this TSI:

(a) specifies the essential requirements for the 'operation' subsystem and its interfaces (Chapter 3);

(b) establishes the basic parameters described in Annex II(3) to 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. SUBSYSTEM DEFINITION AND SCOPE OF APPLICATION

The operation subsystem of the trans-European high-speed rail system comprises all the elements which allow the overall implementation and functionality of the system within the scope of railway operations, once the technical and functional elements of the other subsystems have been defined.

The operation of a railway system is governed by rules and regulations drawn up by the infrastructure managers that must also be implemented by the railway undertakings.

The initial start up of operation on a railway network requires qualified staff who apply the procedures defined in a manner consistent with the overall safety system of the network.

The following main functions relating to operating safety should be distinguished for operational implementation of the system:

— train driving,

— on-board staff,

— ground-based traffic management.

Besides these, there are organisations that handle the design and updating of the processes, the procedures and the necessary documentation.

For each of the above functions, personnel involved shall be identified and listed in the necessary documents.

The procedures shall be published in a regulatory document.

To achieve interoperability, the stated documentation shall be adapted to address the sole needs of interoperability, taking into account the human factors essential for dependable and efficient application of procedures.

The ideal solution would be to standardise or harmonise the operating rules of all the railways on the relevant routes.

However, even if this difficult ideal were achieved, it might actually defeat the overall 'safety coherence' of a network and thereby impede the safe running of other trains on the same routes, which would be contrary to the Directive.

Consequently, the requirement set out in essential requirement 2.7.1 of the Directive to align the network operating rules can apply only to harmonisation of the structure of the documents so that the driver, for instance, can follow the specific rules of each infrastructure manager along the route safely and effectively.

Conversely, any procedures directly relating to the operation of a new, common system implemented on the interoperable network must be standardised.

As far as qualification of the staff involved and in particular drivers, such qualification contributes substantially to maintaining a high level of safety and must therefore be organised in a uniform way in order to achieve the same level of safety on all the infrastructure networks which may be operated on.

Moreover, when carrying out these procedures, it is necessary for all the different members of staff to understand one another without any hesitation whatsoever, even in emergency situations; which makes it necessary to define the rules to be complied with in matters of communication and, in particular, the use of languages.

Operating safety also requires consistent checking of the system, through verifications and feedback of experience from the field.

The scope of application may be defined as the use of one or more routes as specified in the train service provided, by a designated set of rolling stock and specified members of staff.

The aspects of the operation subsystem which relate to the interoperability of the trans-European high-speed rail system may all be grouped under one of the following headings:

— procedures,

— documentation,

— qualification of personnel,

— communications,

— system monitoring.

'Infrastructure manager' means the body referred to in Article 3 and Article 7 of Directive 91/440/EEC and in Article 1 of Directive 2001/12/EC. The reallocation of tasks to bodies different from infrastructure managers is possible under Directive 2001/12/EC and the information concerning this reallocation must be mentioned in the network statement to be published by infrastructure managers in accordance with Directive 2001/14/EC.

## 3. **ESSENTIAL REQUIREMENTS**

### 3.1. *COMPLIANCE WITH THE ESSENTIAL REQUIREMENTS*

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

### 3.2. *ESSENTIAL REQUIREMENTS ASPECTS*

The essential requirements cover:

— safety,

— reliability and availability,

— health,

— environmental protection,

— technical compatibility.

According to Directive 96/48/EC, the essential requirements may be generally applicable to the whole trans-European high-speed rail system or be specific to each subsystem and its constituents.

### 3.3. *ASPECTS RELATING SPECIFICALLY TO THE OPERATION SUBSYSTEM*

In the case of the operation subsystem, the specific aspects, in addition to the considerations in Annex III to the Directive, are as follows.

#### 3.3.1. SAFETY

In accordance with Annex III to Directive 96/48/EC, the safety-related essential requirements that apply to the operation subsystem are the following:

***Essential requirement 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.'

This essential requirement is not relevant to the operation subsystem.

***Essential requirement 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.'

This essential requirement is not relevant to the operation subsystem.

***Essential requirement 1.1.3:***

'The components used must withstand any normal or exceptional stresses that have been specified during their period in service. The safety repercussions of any accidental failures must be limited by appropriate means.'

This essential requirement is not relevant to the operation subsystem.

***Essential requirement 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 a fire.'

This essential requirement is not relevant to the operation subsystem.

***Essential requirement 1.1.5:***

'Any devices intended to be handled by users must be so designed as not to impair their safety if used foreseeably in a manner not in accordance with the posted instructions.'

This essential requirement is not relevant to the operation subsystem.

However, the following safety-specific requirements do concern the operation subsystem:

***Essential requirement 2.7.1:***

'Alignment of the network operating rules and the qualifications of drivers and on-board staff must be such as to ensure safe international operation.

The operations and maintenance intervals, the training and qualifications of maintenance staff and the quality assurance system set up in the maintenance centres of the operators concerned must be such as to ensure a high level of safety.'

The first part of this essential requirement, (alignment of operating rules and personnel qualifications), is addressed by the following subsections of this specification, relating essentially to human factors:

— the unicity of procedures to be applied for identical situations directly linked to the operating of a new system: subsection 4.1.1,

— determining the scope of and harmonising the formatting of the documentation for drivers:

  — concerning procedures: subsection 4.1.2.1.1,

  — concerning timetables: subsection 4.1.2.1.3,

— the development of a 'procedures manual' for on-board staff: subsection 4.1.2.2,

— formalising and harmonising the description of the line and the installations on the route and formalising the process by which the documents used to inform the driver in advance are prepared and updated and the process by which the driver is advised in real time: subsection 4.1.2.1.2,

— formalising the safety messages, the methodology and the specification of the language to be used for different types of safety-related voice communications: section 4.1.4,

— formalising the process for checking out the system from the safety standpoint: section 4.1.10,

— formalising the process of verification of the composition of the crews: section 4.1.12.1,

— formalising the procedure to follow when running with a passenger overload: section 4.1.12.3.

Driver and train crew qualifications are assured by:

— formalisation and harmonisation of the organisation set up to qualify personnel from the standpoint of procedures and languages: section 4.1.3.1,

— formalisation of the process of route learning and maintenance of route knowledge: section 4.1.3.2,

— definition of a programme for special training for specific qualifications: section 4.1.3.3.

As concerns the training and qualification of maintenance personnel, requirements applicable to personnel responsible for maintaining the rolling stock are addressed by the rolling stock subsystems specification.

3.3.2. RELIABILITY AND AVAILABILITY

***Essential requirement 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.'

This essential requirement is not relevant to the operation subsystem.

***Essential requirement 2.7.2:***

'The operation and maintenance periods, the training and qualifications of the maintenance staff and the quality assurance system set up by the operators concerned in the maintenance centres must be such as to ensure a high level of system reliability and availability.'

The requirements applicable to personnel responsible for maintaining the rolling stock are addressed by the rolling stock subsystem specification.

3.3.3. HEALTH

***Essential requirement 1.3.1:***

'Materials likely, by virtue of the way they are used, to constitute a health hazard to those having access to them must not be used in trains and railway infrastructures.'

This essential requirement is not relevant to the operation subsystem.

***Essential requirement 1.3.2:***

'Those materials must be selected, deployed and used in such a way as to restrict the emission of harmful and dangerous fumes or gases, particularly in the event of fire.'

This essential requirement is not relevant to the operation subsystem.

3.3.4. ENVIRONMENTAL PROTECTION

***Essential requirement 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.'

This essential requirement is not relevant to the operation subsystem.

***Essential requirement 1.4.2:***

'The materials used in the trains and infrastructures must prevent the emission of fumes or gases which are harmful and dangerous to the environment, particularly in the event of fire.'

This essential requirement is not relevant to the operation subsystem.

***Essential requirement 1.4.3:***

'The rolling stock and energy-supply systems must be designed and manufactured in such a way as to be electromagnetically compatible with the installations, equipment and public or private networks with which they might interfere.'

This essential requirement is not relevant to the operation subsystem.

3.3.5. TECHNICAL COMPATIBILITY

***Essential requirement 1.5:***

'The technical characteristics of the infrastructures 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.'

This essential requirement is not relevant to the operation subsystem.

***Essential requirement 2.7.3:***

'The alignment of the operating rules of the networks and the qualifications of drivers, on-board staff and managers in charge of traffic must be such as to ensure operating efficiency on the trans-European high-speed rail system.'

This essential requirement is assured by:

— the unicity of procedures to be applied for identical situations directly linked to the operating of a new system: subsection 4.1.1,

— formalisation of the safety messages, of the methodology and specification of the language to be used for different types of safety-related voice communications: section 4.1.4,

— the provision of assistance to the driver in the event of an incident: section 4.1.5,

— informing the traffic managers about the operational status of the rolling stock: section 4.1.7,

— formalisation of the procedures and scenarios to be followed in the event of a major system degradation or incident: section 4.1.8,

— formalisation of the system compliance from the point of view of the quality of operation: section 4.1.11.

3.4. *VERIFICATION OF CONFORMITY*

The verification of conformity of the subsystem and its constituents with the essential requirements shall be made in accordance with the requirements laid down in Directive 96/48/EC.

## 4. CHARACTERISATION OF THE OPERATION SUBSYSTEM

The trans-European high-speed rail system to which Directive 96/48/EC applies and of which the operation subsystem is a part, is an integrated system whose coherence must be verified in particular with the basic parameters, the interfaces and performance, for the purpose of ensuring interoperability of the system in compliance with the essential requirements.

The basic parameters and applicable specifications for each interoperability element, characterising the operation subsystem, are shown below.

4.1. *PARAMETERS OF THE OPERATION SUBSYSTEM*

None of the 'basic parameters' listed in Annex II to Directive 96/48/EC is relevant to the operation subsystem.

The other parameters relevant to the subsystem are the following.

The operation subsystem must meet all the specified performances for each of the following line categories of the trans-European high-speed rail system that are relevant to it:

— lines specially constructed for high-speed,

— lines specially upgraded for high-speed,

— lines specially upgraded for high-speed which have special features.

In the case of the operation subsystem, certain other parameters as specified below must be met for operating interoperable high-speed trains, but they are not all specifically relevant to high-speed.

In the absence of a definition of the needs for all trains, at least the following safety-critical elements shall be specified.

4.1.1. PROCEDURES FOR OPERATING A NEW SYSTEM

The procedures to be used for identical situations linked directly to the operation of a new system intended to be used on the interoperable European network must be unique; for ERTMS/ETCS in particular, they shall comply with a European specification which shall be established.

4.1.2. DOCUMENTATION

4.1.2.1. ***Driver's documentation***

4.1.2.1.1. **Procedures**

All the necessary procedures for the driver shall be included in a document or a computer medium called the driver's rule book.

The driver's rule book shall state the requirements for the routes worked and the rolling stock used on those routes according to the situations of normal operation and degraded operation which the driver may meet.

Every driver's rule book shall be drafted following the standardised outline or format below:

A — Organisation of the service

B — Personal safety

C — Signalling and command and control

D — Running conditions of the rolling stock

E — Onboard systems

F — Running and driving of the train

G — Anomalies, incidents and accidents

Appendix 1 to driver's rule book: Manual of communication procedures

Appendix 2 to driver's rule book: Book of forms ('Livret formulaires').

The driver's rule book shall be written in the language of one of the States of the interoperable network chosen by the railway undertaking in liaison with the infrastructure managers of the networks that the service will be operated on, except for messages and forms ('formulaires') which shall remain in the language of the infrastructure managers (see subsection 4.1.4.1).

The driver's rule book shall be written by the railway undertaking and it shall include the information supplied by the infrastructure managers.

The process for preparing and updating the driver's rule book shall include the following steps:

— the infrastructure manager (IM) shall send the railway undertaking the delimited regulations in the IM's language,

— the railway undertaking shall draw up the initial or updated document in the IM's language,

— the infrastructure manager shall scrutinise the part of the document prepared by the railway undertaking relevant to the IM,

— the infrastructure manager shall grant authorisation to use those elements of the document which concern the IM,

— if the language chosen by the railway undertaking is not the one used by the infrastructure manager, the document shall be translated by a competent and acknowledged body, chosen by the infrastructure manager and the railway undertaking. The railway undertaking shall provide a certificate of compliance for the translation. The certificate will not include the section containing the messages and the forms (see point 4.1.4.1). Upon request, the railway undertaking and the infrastructure manager have the right to participate in the translation process.

4.1.2.1.2. **Description of the line and lineside equipment on lines worked over**

4.1.2.1.2.1. *Basic elements*

All the items necessary for operating the rolling stock concerned on the designated routes shall be set out in a document or computer medium called the 'route book'.

The route book shall include at least the following information:

— the general operating characteristics:

  — type of signalling and corresponding running regime (double track, two-way working, etc.),

  — type of power supply,

  — type of ground-train radio equipment,

— indication of rising and falling gradients:

  — gradient values and precise delimitation of areas with steep gradients,

— detailed line diagram:

  — names of stations on the line and key locations and their location,

  — permissible speed limits for each track and for the rolling stock concerned,

  — names of the organisation responsible for traffic management,

  — identification of the radio channels to be used,

  — schematic description of track layout.

The format of the route book shall be prepared in the same manner for all the infrastructures worked over by the trains of an individual railway undertaking.

The route book shall be written in the language of one of the Member States of the interoperable network chosen by the railway undertaking.

The route book shall be written by the railway undertaking using the information supplied by the infrastructure manager.

The process for preparing and updating the route book shall be defined by the railway undertaking. The infrastructure manager shall validate each element of the document for which it is responsible and which are within its language competencies.

4.1.2.1.2.2. *Modified elements*

Any elements modified either permanently or temporarily shall be advised to the railway undertaking by the infrastructure managers; these changes shall be grouped by the railway undertaking into a dedicated document or computer medium whose format shall be the same for all the infrastructures worked over by the trains of an individual railway undertaking.

The process whereby this document or computer medium is prepared shall be defined by the railway undertaking and validated by each infrastructure manager for each element for which it is responsible and which are within its language competencies.

4.1.2.1.2.3. *Informing the driver in real time*

The procedure for advising drivers in real time about all modifications to safety arrangements on the route shall be defined by the infrastructure managers concerned (the process shall be unique where ERTMS/ETCS is in use).

4.1.2.1.3. **Rolling stock**

All the information about running of the rolling stock in both normal and degraded situations that must be known by the driver shall be compiled into a document or in a computer medium called the 'driver's rolling stock book'.

The driver's rolling stock book shall be prepared by the railway undertaking.

4.1.2.1.4. **Timetables**

The information necessary for the normal running of the train shall be taken up in a single document or computer medium called the 'timetable sheet' ('fiche train') that shall be given to the driver and that shall include at least the following items:

— the stopping points and other timing points,

— the arrival/departure/passing times at each of those points.

The timetable sheet shall be prepared by the railway undertaking concerned as a compilation of the timing information supplied by the infrastructure manager(s) concerned.

The process by which it is prepared shall be formalised by the railway undertaking and validated by each infrastructure manager concerned for each element of the document for which it is responsible and which are within its language competencies.

4.1.2.2. ***Documentation for on-board staff***

All the procedures necessary for on-board staff shall be grouped into a document or computer medium called the 'on-board crew's rule book'.

The on-board crew's rule book shall be prepared by the railway undertaking and shall include the information supplied by the infrastructure managers.

The infrastructure managers may request, concerning the part relevant to them, that this document be drawn up and updated in accordance with the same process as the one used for the driver's rule book (subsection 4.1.2.1.1).

All the items necessary for using the rolling stock which must be known to the on-board staff concerning both normal and degraded situations shall be collected into a document or computer medium called the 'on-board staff's rolling stock book'.

The on-board staff's rolling stock book shall be written by the railway undertaking.

4.1.3. QUALIFICATION OF DRIVERS AND TRAIN STAFF OF THE RAILWAY UNDERTAKING HAVING SAFETY-RELATED DUTIES

4.1.3.1. ***Basic qualification, procedures and languages***

For drivers and train staff having safety duties the railway undertaking shall apply the qualification process consisting of the following phases and elements.

A. Personnel selection:

— evaluation of personnel's experience and their professional and physical qualities,

— evaluation of their competence in use of the foreign language(s) in their vocational field or their aptitude to learn it (them).

B. Initial vocational training:

— training requirements specification,

— training programme resources,

— qualification of instructors.

C. Initial certification:

— drawing up of the requirements for the certification programme,

— licensing of certifiers,

— delivery of a certificate of qualification.

D. Maintenance of the qualification level and monitoring personnel:

— career monitoring scheme,

— health monitoring scheme.

E. Maintenance of the qualification level and refresher training:

— principles of assessment of training needs,

— principles of training implementation,

— principles of training evaluation.

F. Maintenance of the qualification level and maintenance of continued certification:

— principles of continued certification,

— formalisation of continued certification procedures.

The qualification process is defined taking into account the rules which apply on the concerned infrastructures. The document describing the detail of the process is sent to each concerned infrastructure manager.

4.1.3.2. ***Route knowledge***

The railway undertaking shall define the process whereby knowledge of the routes the service operates on is acquired and maintained, based on the rules laid down by the infrastructure managers.

4.1.3.3. ***Special qualifications***

In certain cases, included in the register of infrastructure, such as a tunnel containing particular equipment, the railway undertaking shall draw up a special training and maintenance of knowledge programme for all of the train staff who might become involved in safety procedures, based on the rules set down by the infrastructure managers concerned.

4.1.4. SAFETY-RELATED COMMUNICATIONS BETWEEN PERSONNEL

4.1.4.1. ***Nature and format of messages and safety-related communications methodology***

Principles to be applied by railway undertakings and infrastructure managers concerning:

— the nature and format of the messages,

— the communications methodology,

are defined in Annex A to the present TSI.

Operational items prepared so as to facilitate the applications of these principles, are defined in documents for use by drivers and traffic management staff.

For the drivers, there are Annexes to the driver's rule book:

— Annex 1: Manual of communication procedures,

— Annex 2: Book of forms ('livret formulaires')

4.1.4.2. ***Language used between the ground and the train***

The language used shall be that used on the infrastructure concerned; it shall be decided by the infrastructure manager.

The level of knowledge for safety purposes shall be as follows:

— Driving function (driver)

Ability to send and understand the messages specified in Annex A to the present TSI.

The content of these messages shall be laid down by the infrastructure manager.

— Train accompaniment function (on-board staff)

Ability to send information describing the train and its operational status as far as the staff is concerned and useful measures for dealing with particular situations involving passengers.

The content of these messages shall be laid down by the infrastructure manager.

4.1.4.3. ***Language used between on-board staff and between on-board Staff and the driver***

The language used shall be that used on one of the territories of the interoperable network. It shall be chosen by the railway undertaking.

4.1.4.4. ***Language used between on-board staff and passengers***

In situations related to passenger safety and health, the language used between the train staff and passengers shall be that used on one of the territories of the interoperable network; it shall be chosen by the railway undertaking by agreement with the infrastructure managers.

Moreover, the infrastructure managers may set down particular rules for specific cases (for running through long tunnels for example) or to comply with the regulations of individual Member States.

4.1.5. AID TO DRIVERS IN THE EVENT OF AN INCIDENT OR OF A MAJOR ROLLING STOCK MALFUNCTION

The railway undertaking shall keep available, during all the time that the train is running, an expert who can be contacted directly by the driver, in real time, in the event of an incident or of major malfunctioning of the rolling stock.

4.1.6. INVESTIGATION OR INQUIRY FOLLOWING AN ACCIDENT OR INCIDENT

The railway undertaking shall specify, by agreement with the infrastructure manager, the persons to be contacted.

The infrastructure manager, by agreement with the railway undertaking, shall prescribe the time scales against which the investigation or inquiry into an accident or incident shall commence.

As far as conservation, extraction and reading of the required safety-related event recordings, the railway undertaking must establish, in agreement with the infrastructure manager, a procedure in order that these actions may be undertaken.

4.1.7. INFORMING THE INFRASTRUCTURE MANAGER OF THE TRAIN'S OPERATIONAL STATUS

A procedure shall be defined between the infrastructure manager and the railway undertaking so that any anomaly affecting the rolling stock having possible repercussions on the train's running (prior to departure and en route) will be reported to the organisation responsible for traffic management.

4.1.8. SCENARIOS AND PROCEDURES TO DEAL WITH MAJOR INCIDENTS

Scenarios and procedures shall be specified by the infrastructure managers in coordination with the railway undertaking for the following incidents:

— Accident:

  — rescuing people,

— Rolling stock failures:

  — evacuating passengers,

  — rescuing failed stock,

— Infrastructure failures:

  — driving conditions for a re-routed train.

The railway undertakings and the infrastructure managers shall take account of these scenarios and procedures in the rule books and in their personnel training specifications.

Furthermore, and in order for the infrastructure managers to be able to pre-establish the measures to be taken according to the rules and regulations, depending on the nature of the incidents, the tailway undertaking shall supply them, at their request, the list of specific malfunctions of the rolling stock which may have substantial traffic implications.

4.1.9. RUNNING UNDER PARTICULAR CONDITIONS (TEST TRAINS AND FAILED TRAINS)

The particular conditions for the running of trains for rolling stock under test and the movement of recovered, failed stock shall be defined by the railway undertakings and scrutinised for endorsement by the Infrastructure Managers concerned.

4.1.10. MONITORING THE SYSTEM FROM THE SAFETY POINT OF VIEW

4.1.10.1. ***Checking compliance with the specifications***

Compliance with the interoperability specifications shall be checked, in particular, through audits.

The infrastructure managers shall:

— carry out, as a minimum, yearly audits of their network, covering:

  — implementation of the specifications by the railway undertakings,

  — the effectiveness of the monitoring system set up by the railway undertaking,

— inform the railway undertakings of the findings of those audits carried out on their network.

The railway undertakings shall:

— make audits at least once a year of the interoperable high-speed service that concerns them,

— communicate the findings of the audits to the infrastructure managers concerned.

4.1.10.2. ***Feedback of experience***

The infrastructure managers shall:

— set up a process for feedback of field information on the operational performance of the interoperable high-speed system,

— advise the railway undertakings concerned about incidents and accidents having occurred on their territory,

— communicate to the railway undertakings, when one of their staff is concerned, the analyses and conclusions of the investigation or inquiry.

The railway undertakings shall:

— set up a process for feedback of field information on the operational performance of the interoperable high-speed system,

— periodically and if needed inform the infrastructure managers about the results of the feedback and areas where corrective actions are expected.

4.1.11. MONITORING QUALITY OF OPERATION

Events which have significantly disrupted operations shall be analysed as soon as possible, jointly by the railway undertaking and the infrastructure manager concerned.

Any recurring event shall be analysed jointly by the railway undertaking and the infrastructure managers concerned at least once a year.

These processes shall be defined by the railway undertaking in agreement with the infrastructure managers.

4.1.12. ON-BOARD SERVICE

4.1.12.1. ***Crewing***

The minimum number of persons on board and their qualification shall be in accordance with the train staffing rules of each of the infrastructures worked over.

A procedure shall be drawn up by the railway undertaking in agreement with the infrastructure manager to define the checks to be made before the train departs.

4.1.12.2. ***Number of passengers on-board the train***

When a railway undertaking uses high-speed rolling stock that cannot run at its nominal speed because of a substantial passenger overload, it shall take the necessary measures to ensure that normally such an overload situation never occurs.

In the exceptional cases where the situation does occur, the railway undertaking shall advise the infrastructure manager of the conditions under which the movement can be made.

For certain cases included in the register of infrastructure, such as a tunnel for which the infrastructure manager has provided an evacuation scenario whereby passengers shall have to walk down the train, the infrastructure manager together with the railway undertaking shall fix the maximum number of passengers allowed on the train.

Furthermore, in the case just mentioned and for the same reasons, no baggage shall be permitted in the aisles or doorways.

4.2. *INTERFACES WITH THE OPERATION SUBSYSTEM*

None

4.3. *SPECIFIED PERFORMANCE*

None

## 5. INTEROPERABILITY CONSTITUENTS

5.1. Within the meaning of 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.'

5.2. The interoperability constituents are covered by the relevant provisions of Directive 96/48/EC.

5.3. Some interoperability constituents are addressed by specifications setting out performance requirements for them. The assessment of their conformity and/or fitness for use shall be made, as a rule, via the interfaces of the interoperability constituents. Design or descriptive characteristics shall be relied on only by exception.

The operation subsystem does not have any interoperability constituents.

## 6. ASSESSMENT OF CONFORMITY AND/OR FITNESS FOR USE

6.1. *INTEROPERABILITY CONSTITUENTS*

The operations TSI contains no interoperability constituents.

6.2. *OPERATIONS SUBSYSTEM*

6.2.1. ASSESSMENT PROCEDURES AND MODULES APPLICABLE

Conformity assessment of the parameters in question involves verifying the following points for each parameter, on the route(s) to be worked over and the rolling stock to be used:

— prior to entry into service: the characteristics of all defined documents, procedures, processes or special provisions,

— during operation: the implementation and control of all defined elements associated with the quality monitoring system.

The types of module to be applied for conformity assessment are as follows.

— Prior to start up of service

  — For design parameters of concern to the infrastructure manager, the type A module shall be used.

  — For design parameters of concern to the railway undertaking, the type A module shall be used in conjunction with the additional provision A1 as follows:

    'a notified body chosen by the railway undertaking shall conduct a verification of the characteristics of design parameter elements of concern to it prior to start up of service'.

This module is referred to as AE and is described in point 6.2.2.

— During operation

  For the parameter elements relating to the quality monitoring system, a type D module shall be used in conjunction with the provision D1 as follows:

  'a notified body, or a notified institution chosen by the infrastructure manager and the railway companies, shall, every two years, assess the elements of the parameters relating to the quality monitoring system processes (application of the quality monitoring system, identified as SQ in Table 6.2.2) that concern the railway undertaking and/or the infrastructure manager. The choice of the notified body is made according to a procedure laid down by the Member State concerned and from among the notified bodies with the essential skills, and in agreement with the authority appointed by the Member State concerned to issue the safety certificates.'

  This module shall be referred to as DE and is described in point 6.2.2.

6.2.2. APPLICATION OF MODULES

The table below:

— lists the parameters to be assessed and the elements to be verified for each parameter and identifies the quality monitoring system elements to be assessed (marked SQ),

— gives a TSI reference for the various parameters and indicates which modules should be used.

This table is the basis for applying the modules.

| Parameters to be assessed | Elements to be verified for each parameter | TSI reference | Modules to be applied | |
|---|---|---|---|---|
| | | | RU | IM |
| Procedure for operating a new system | Application for this system of the instructions set out in the European specification established for the system | 4.1.1. | | A |
| Documentation | | | | |
| Driver's rule book | Existence | 4.1.2.1.1 | AE | A |
| | Structure | | AE | |
| | Language of text | | AE | |
| | Drafting and updating process, including the choice of a competent and acknowledged body and conformity certification of the translation | | AE | |
| Route book | Existence | 4.1.2.1.2.1 | AE | |
| | Minimum content | | AE | |
| | Mode of presentation by railway undertaking | | AE | |
| | Language of text | | AE | |
| | Drafting and updating process | | AE | A |
| Document or computer file of amended elements | Existence | 4.1.2.1.2.2 | AE | |
| | Mode of presentation by railway undertaking | | AE | |
| | Drafting and updating process | | AE | A |
| Procedure for informing the driver in real time | Existence | 4.1.2.1.2.3 | AE | A |
| Driver's rolling stock book | Existence | 4.1.2.1.3 | AE | |
| Timetable sheet | Existence | 4.1.2.1.4 | AE | |
| | Minimum content | | AE | |
| | Mode of presentation by railway undertaking | | AE | |
| | Language of text | | AE | |
| | Drafting process | | AE | A |

| Parameters to be assessed | Elements to be verified for each parameter | TSI reference | Modules to be applied | |
|---|---|---|---|---|
| | | | RU | IM |
| On-board crew's rule book | Existence of these documents | 4.1.2.2 | AE | |
| | Drafting and updating process as appropriate | | AE | A |
| On-board staff's rolling stock book | Existence | | AE | |
| Qualification of drivers and on-board staff | | | | |
| Process for general qualifications of drivers and on-board staff | Existence | 4.1.3.1 | AE | |
| | Structure | | AE | |
| | Submission by the RU to each IM of the document describing the processes | | AE | |
| Process for acquisition and maintenance of route knowledge | Existence | 4.1.3.2 | AE | A |
| Process for training and maintaining knowledge for specific qualifications | Existence of a specific programme | 4.1.3.3 | AE | A |
| Safety-critical communications | | | | |
| Operational elements for ground-to-mobile communications appearing in the documents:<br>— to be used by the driver (appendices to the rule book)<br>— manual of communications procedures<br>— book of forms<br>— to be used by staff responsible for traffic management | Application of the principles set out in Appendix A | 4.1.4.1 | AE | A |
| Language used between track and train | Definition | 4.1.4.2 | AE | |
| Language used between on-board staff and driver | Definition | 4.1.4.3 | AE | |

| Parameters to be assessed | Elements to be verified for each parameter | TSI reference | Modules to be applied | |
|---|---|---|---|---|
| | | | RU | IM |
| Language(s) used between on-board staff and passengers | Definition | 4.1.4.4 | AE | A |
| Measures to assist drivers | Existence | 4.1.5 | AE | |
| Measures for investigation and inquiry purposes and to access and read recorded safety data | Existence | 4.1.6 | AE | A |
| Procedure to inform the infrastructure manager of the train's operational status | Existence | 4.1.7 | AE | A |
| Scenarios and procedures to deal with major incidents | Existence | 4.1.8 | AE | A |
| | Inclusion in rule books and training specifications | | AE | A |
| | List of malfunctions | | AE | A |
| Measures concerning running conditions for rolling stock undergoing testing and return of failed rolling stock | Definition | 4.1.9 | AE | A |
| | Inclusion in audit programmes | | | |
| System verification from safety standpoint | | | | |
| Audit process | Existence | 4.1.10.1 | AE | A |
| | Application of process in operation (SQ) | | DE | DE |
| Feedback | Existence | 4.1.10.2 | AE | A |
| | Application of process in operation (SQ) | | DE | DE |
| System verification from operating quality standpoint | Existence | 4.1.11 | AE | A |
| | Application of process in operation (SQ) | | DE | DE |
| On-board service | | | | |
| Provisions governing the composition of train crews | Definition of minimum number of staff on board and their qualifications | 4.1.12.1 | AE | A |

| Parameters to be assessed | Elements to be verified for each parameter | TSI reference | Modules to be applied | |
|---|---|---|---|---|
| | | | RU | IM |
| Procedure to check the number of staff on board prior to train departure | Existence | | AE | A |
| Provisions concerning the train load factor | Existence<br>Verification as part of audit | 4.1.12.2 | AE | |
| Provisions concerning the maximum number of passengers where evacuation scenarios exist | Existence | | AE | A |
| Provisions concerning baggage | Existence | | AE | |

(SQ) Elements concerning the quality monitoring system to be verified during operation.

The arrangements for implementing the modules are as follows.

***Module A***

The producer (infrastructure manager) shall, for the elements of parameters of concern to him:

(a) draw up the operating documentation for the interoperable system in question:

— documentation on the rolling stock used and the route being worked over,

— documentation on each parameter: document, name of the process, procedure or special provisions,

— list of European specifications to be applied,

and shall archive this material, keeping it available for inspection by national authorities for a period of at least 10 years;

(b) verify, for each parameter and design element of the parameters indicated in the above list, that the characteristics defined in the TSI are complied with;

(c) draw up a declaration of conformity including the list of parameters and elements to be verified (from the previous table) and, for each of them, an indication of compliance. This declaration shall be archived with the operating documentation.

***Module AE***

The producer (railway undertaking) shall, for the elements of concern to him:

(a) draw up the operating documentation for the interoperable system in question:

— documentation on the rolling stock used and the route being worked,

— documentation on each parameter: document, wording of the process, procedure or special provisions,

— list of European specifications to be applied,

and shall archive this material, keeping it available for inspection by the national authorities for a period of at least 10 years;

(b) select a notified body and request verification, for each parameter and design parameter element indicated in the above list, that the characteristics defined in the TSI are complied with along the whole of the route being worked over.

The notified body shall:

(c) verify, for each parameter and design parameter element indicated in the above list, that the characteristics defined in the TSI are complied with;

(d) notify the producer that requested the verifications of the results obtained.

The producer shall:

(e) draw up a declaration of conformity including a list of the parameters and elements to be verified, taken from the above table, and for each of them, an indication of conformity. This declaration shall be archived with the operating documentation.

***Module DE***

The producers (railway undertaking and infrastructure manager, each for the part of concern to it) shall:

(a) draw up the operating documentation for the interoperable system in question:

— documentation on the rolling stock used and the route being worked,

— documentation on the organisation, responsibilities and powers in relation to quality monitoring system,

— documentation on each parameter relating to the operating quality monitoring system:

— name of processes,

— result of audits,

— elements concerning feedback,

— elements concerning overall quality monitoring system,

and shall archive this material, keeping it available for inspection by national authorities for a period of at least 10 years;

(b) select a notified body or a notified institution every two years and request that it conduct an assessment of the elements of parameters relating to the quality monitoring system (application of the quality monitoring processes identified as SQ in the table above) which concerns them.

The notified body or the notified institution:

(c) shall conduct an assessment of the monitoring processes of concern to the producers (railway undertaking and/or infrastructure manager) and draw up a report for each, indicating in particular whether:

— the producers have implemented the processes as planned,

— the producers control the processes;

(d) gives the result of this assessment and the related report to the producers who requested the report.

The producers (railway undertaking and infrastructure manager, for the part of concern to each):

(e) shall establish a compliance declaration indicating the results of this assessment and the related report and keep this declaration with the operating documentation.

## 7. IMPLEMENTING THE OPERATION TSI

The operation of the train service on the relevant part of the trans-European high speed rail system must conform with the Operation TSI:

— when new or upgraded interoperable infrastructure is put into service in accordance with Article 14 of Directive 96/48/EC,

— or, when a new cross-border service is put into service,

— or, in the case of existing infrastructure referred to in point 1.2 of the present TSI, step by step and, if possible, by 2005.

However, in the case of an infrastructure where existing trains are running and are not subject to Directive 96/48/EC, the operating rules resulting from the application of this TSI can be adapted to the local situation in view of preserving the compatibility of the existing rail system and its current safety level. Such exceptions must be mentioned in the infrastructure register.

*ANNEX A*

**SAFETY-RELATED COMMUNICATIONS BETWEEN PERSONNEL INVOLVED IN THE SUBSYSTEM**

**NATURE AND STRUCTURE OF THE MESSAGES**

**COMMUNICATION METHODOLOGY**

**INTRODUCTION**

The purpose of this document is to set out the rules for safety-related ground-to-mobile and mobile-to-ground communications applicable to information transmitted or exchanged for safety critical situations on the interoperable network and in particular to:

— define the nature and structure of the safety-related messages,

— define the methodology for voice transmission of those messages.

This appendix is to serve as the basis:

— to enable the infrastructure manager to draw up the messages and books of forms (*formulaires*). These elements shall, be addressed to the railway undertakings at the same time as the delimited rules and regulations are made available,

— for the infrastructure managers and the railway undertaking to draw up the documents for the operators (books of forms: *livret formulaires*), instructions for the personnel responsible for traffic management and Appendix 1 to the driver's rule book 'Manual of communication procedures'.

1. *NATURE AND STRUCTURE OF THE SAFETY-RELATED MESSAGES*

1.1. NATURE

The safety-related messages shall be defined in a formal manner by each infrastructure manager according to four types:

— top priority emergency messages,

— procedural messages,

— additional messages,

— information messages with a variable content.

The rules concerning the transmission of these messages are given under section 2 – 'Communication methodology'.

1.1.1. **Top priority emergency messages**

The top priority emergency safety messages are intended to give urgent operational instructions.

To avoid any risk of misunderstanding, the message is always repeated.

Classified according to need, the main messages which can be sent are indicated hereafter: in addition, other top priority emergency messages may, if necessary, be defined by the infrastructure manager.

The top priority emergency messages may be followed by procedural messages (see subsection 1.1.2).

All essential top priority emergency messages are indicated in Appendix 1 'Manual of communications procedures' to the rule book for drivers and in the documents of instructions for use by the personnel responsible for traffic management.

1.1.1.1. *Messages sent either by the ground or the driver*

— Need to stop all trains:

| |
|---|
| **Emergency stop all trains** |
| **Emergency stop all trains** |

Information on location or area are, if necessary, specified in the message.

In addition, this message is to be quickly complemented, if possible, by the reason, the location of the emergency and the train's identification:

| |
|---|
| **Obstruction** |
| **or fire** |
| **or** ..... **(other reason)** |
| **on line** ..... **(name)** **at** ..... **(m.ch)** |
| **Driver of train** ..... **(number)** |

— Need to stop a particular train:

| |
|---|
| **Train** ..... **(number)** **on** ..... **(name)** **line(s)** |
| **Emergency stop at** ..... **(m.ch)** |
| **Train** ..... **(number)** **on** ..... **(name)** **line(s)** |
| **Emergency stop at** ..... **(m.ch)** |

— Need for radio silence:

| |
|---|
| **Radio silence** |
| **Radio silence** |

1.1.1.2. *Messages issued by the driver*

— Need to cut the traction power supply:

| |
|---|
| **Emergency current isolation** |
| **Emergency current isolation** |

This message is to be quickly complemented, if possible, by the reason, the location of the emergency and the train's identification:

| |
|---|
| **At** ..... **(m.ch)** |
| **on** ..... **(name)** **line** |
| **between** ..... **(station)** **and** ..... **(station)** |
| **Reason** ..... |
| **Driver of train** ..... **(number)** |

1.1.2. **Procedure messages**

1.1.2.1. *Nature of the messages*

Procedural messages are used to send operational instructions associated with situations represented in the driver's rule book.

They comprise the text of the message itself, corresponding to a situation, and a number identifying the message.

If the message requires the recipient to report back, the text of the report is also given.

These messages use predetermined wording prescribed by the infrastructure managers in their own language and they are presented in the form of pre-printed paper forms.

1.1.2.2. *Procedure forms*

Procedure Forms are the formalised medium for procedural messages.

Their purpose is to:

— provide a common working document used in real-time by the ground staff responsible for traffic management and by the drivers,

— enable traceability of communications.

These forms are identified by a unique code word or number relating to the procedure.

They are drawn up by each infrastructure manager in his own language.

1.1.2.3. *Book of forms (livret formulaires)*

The whole set of forms must be collected into books (books of forms) in paper form:

— a book of forms intended for the driver which groups all the forms that might be used by the different infrastructure managers anywhere on the route travelled. The book of forms shall constitute Appendix 2 to the driver's rule book,

— a book of forms intended for personnel responsible for traffic management, allowing them to put into practice all the procedures used within their territory.

The book of forms are in two parts.

The first part comprises the following items.

— a reminder about the utilisation of the book of forms,

— an index of ground-originated procedure forms,

— an index of driver-originated procedure forms,

— the list of situations cross-referencing to which procedure form is to be used,

— a glossary giving the situations to which each procedure form applies,

— the code for spelling out messages (phonetic alphabet etc.).

The second part contains the procedure forms themselves.

Several model forms are included in the book of forms and page dividers shall be used.

The railway undertaking may include explanatory text relevant to each form and the situations covered, in the drivers' book of forms.

1.1.3. **Additional messages**

Additional messages are information messages used by the driver to inform the personnel in charge of traffic management or used by the personnel in charge of traffic management to advise the driver of certain predictable situations related to train running or to the technical condition of the train or the infrastructure.

The necessary additional messages are identified by the infrastructure managers and are included in Appendix 1 'Manual of communications procedures' of the driver's rule book and in the documents of instructions for use by personnel in charge of traffic management.

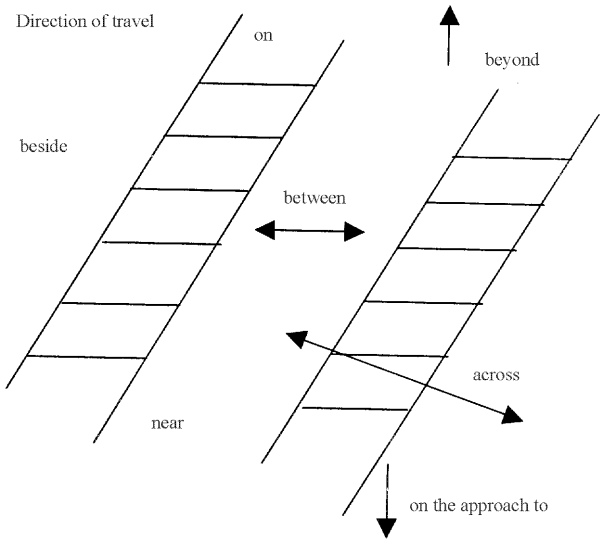
1.1.4. **Information messages with a variable, content**

These messages shall be used, in some situations, by the driver to advise personnel in charge of traffic management on the ground about circumstances which are of a rare nature and for which predetermined messages are not provided.

To make it easier to describe the situations and construct the information messages, a message model, a glossary of railway terminology, a descriptive diagram of the rolling stock being employed and a descriptive statement of the infrastructure equipment (track, traction supply, etc.) shall be drawn up.

1.1.4.1. *Model structure for messages*

These variable-field messages shall be structured on the following basic model:

| Stage in the communication flow | Message element |
|---|---|
| Reason for passing the information | ☐ for information<br>☐ for action |
| Observation | ☐ There is<br>☐ I saw<br>☐ I had<br>☐ I hit |
| Position<br>— along the line<br><br>— in respect to my train | ☐ at ..... (station name)<br>☐ ..... (characteristic point)<br>☐ at milepost/kilometre point ..... (number)<br>☐ power car ..... (number)<br>☐ trailer car ..... (number) |
| Nature<br>— object<br>— person | ☐ ..... (see glossary) |
| State<br>— static<br><br><br>— moving | ☐ standing on<br>☐ lying on<br>☐ fallen on<br>☐ walking<br>☐ running<br>☐ towards |
| Location with respect to the tracks |  |

These messages may be followed by a request for instructions.

The elements of the messages are provided in both the language chosen by the railway undertaking and in those of the concerned infrastructure managers.

1.1.4.2. *Glossary of railway terminology*

The glossary of railway terminology shall be produced by the railway undertaking for each network traversed. It shall supply the terms in regular use in the language chosen by the railway undertaking and in those of the infrastructure managers whose infrastructure is worked over.

It shall be composed of two parts:

— a listing of terms by subject matter,

— a listing of the terms in alphabetical order.

1.1.4.3. *Descriptive diagram of the rolling stock*

The descriptive diagram of the rolling stock used shall be prepared by the railway undertaking and shall list the names of the various components that may be the subject of communications with the different infrastructure managers concerned. It shall provide the common names for the standard terms in the language chosen by the railway undertaking and in those of the infrastructure managers whose infrastructure is worked over.

1.1.4.4. *Descriptive statement of the characteristics of the infrastructure equipment (track, traction supply, etc.)*

The descriptive statement of the characteristics of the infrastructure equipment (track, traction supply, etc.) on the route worked over shall be drawn up by the railway undertaking, showing the names of the various components that may be the subject of communications with the infrastructure managers concerned. It shall provide the common names for the standard terms in the language chosen by the railway undertaking and in the ones of the infrastructure managers whose infrastructure is worked over.

## 2. *COMMUNICATIONS METHODOLOGY*

2.1. ELEMENTS AND RULES OF THE METHODOLOGY

2.1.1. **Glossary of terms used in the procedures**

2.1.1.1. *Speech transmission procedure*

Term transferring the opportunity to speak to the opposite party:

**over**

2.1.1.2. *Message receiving procedure*

— upon receiving a direct message

Term confirming that the sent message has been received:

**received**

Term used to have the message repeated in the event of poor reception or misunderstanding

**say again (+ speak slowly)**

— upon reception of a message that has been read back

Terms used to ascertain whether a read-back message exactly matches the sent message:

**correct**

or not:

**error (+ I say again)**

2.1.1.3. *Communications breaking procedure*

— if the message has ended:

**out**

— if break is temporary but does not break the connection

Term used to keep the other party waiting:

**wait**

— if break is temporary but the connection is broken

Term used to tell the other party that the communication is going to be broken but will be resumed later on:

**I call again**

2.1.1.4. *Message cancelling procedure*

Term used to cancel the procedure underway:

**cancel procedure** .....

If the message is then to subsequently be resumed, the procedure shall be repeated from the start.

2.1.2. **Rules to be applied in the event of error or misunderstanding**

To permit the correction of possible errors during communication, the following rules shall be applied:

2.1.2.1. *Errors*

— error during transmission

When a transmission error is discovered by the sender himself, the sender must request cancellation by sending the following procedure message:

**error (+ prepare new form ...)**

or

**error + I say again**

and then send the initial message again

— error during read back

When the sender discovers an error whilst the message is being read back to him, the sender shall send the following procedure messages:

**error + I say again**

and send the initial message again.

2.1.2.2. *Misunderstanding*

If one of the parties misunderstands a message he must ask the other party to repeat the message by using the following text:

**say again (+ speak slowly)**

2.1.3. **Word, number, time, distance, speed and date spelling code**

To aid in understanding and expressing messages in different situations, each term must be pronounced slowly and correctly by spelling out the words and figures likely to be misunderstood. The following spelling rules shall apply.

2.1.3.1. *Spelling out of words and letter groups*

The international phonetic alphabet shall be used.

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| A | Alpha | F | Foxtrot | K | Kilo | P | Papa | U | Uniforme | Z | Zulu |
| B | Bravo | G | Golf | L | Lima | Q | Quebec | V | Victor | | |
| C | Charlie | H | Hotel | M | Mike | R | Romeo | W | Whisky | | |
| D | Delta | I | India | N | November | S | Sierra | X | X-ray | | |
| E | Echo | J | Juliet | O | Oscar | T | Tango | Y | Yankee | | |

Examples: points A B = points alpha bravo; signal number KX 835 = signal Kilo X-Ray eight three five.

The railway undertaking may add further indications about pronunciation as it deems necessary.

2.1.3.2. *Expression of numbers*

Numbers shall be spoken digit by digit.

| | | | |
|---|---|---|---|
| 0 | zero | 5 | five |
| 1 | one | 6 | six |
| 2 | two | 7 | seven |
| 3 | three | 8 | eight |
| 4 | four | 9 | nine |

Example: train **2183** = train two one eight three.

Decimals shall be expressed by the word point.

Example: **12.50** = one two point five zero.

2.1.3.3. *Expression of time*

The time shall be given in local time, in plain language.

Example: **10:52 hours** = ten fifty-two.

If necessary, the time shall be spelled out digit by digit (one zero five two hours).

2.1.3.4. *Expression of distances and speeds*

Distances shall be expressed in kilometres and speeds in kilometres per hour. Miles may be used if that unit is used on the infrastructure concerned.

2.1.3.5. *Expression of dates*

Dates shall be expressed in the usual manner.

Example: **10 December.**

2.2. COMMUNICATIONS STRUCTURE

The voice transmission of safety-related messages shall in principle comprise two 2 phases as follows:

— identification and request for instructions,

— transmission of the message itself and termination of the transmission.

The first phase may be cut back or entirely omitted for top priority safety messages.

2.2.1. **Rules for identification and requests for instruction**

To enable the parties to identify one another, define the operational situation and transmit procedural instructions, the following rules shall apply:

2.2.1.1. *Identification*

Every communication other than top priority safety messages must begin with identification messages even after an interruption during transmission.

The following messages shall be used for this purpose by the different parties.

— by the personnel responsible for traffic management:

train . . . . . .

. . . . . (number)

this is . . . . . signals

. . . . . (name)

— by the driver:

. . . . . signals

. . . . . (name)

this is train . . . . . .

. . . . . (number)

NB:

The identification may be followed by an additional information message giving the person responsible for traffic management enough details of the situation to determine precisely the procedure that the driver may subsequently be required to follow.

2.2.1.2. *Request for instructions*

Every application of a procedure must be preceded by a request for instructions. The following terms shall be used to request instructions:

**prepare procedure** . . . . . .

2.2.2. **Rules for message transmission procedures**

2.2.2.1. *Top priority safety messages*

Due to their urgent and imperative nature, these messages:

— may be sent or received while running,

— may omit the identification part,

— shall be repeated,

— shall, as soon as possible, be followed by further information.

2.2.2.2. *Procedural message*

In order to reliably send (at a standstill) the procedural messages contained in the book of forms (livret formulaires), the following rules shall be followed.

2.2.2.2.1. Message sending

The form may be completed prior to transmitting the message so that the full text of the message can be sent in one single transmission.

2.2.2.2.2. Message receiving

The receiver of the message must fill in the form given in the book of forms based upon the information given by the sender.

2.2.2.2.3. Read back

All the predetermined railway messages in the book of forms shall be required to be read back. The read back shall include the message shown in the grey field on the forms, the report back section and any additional or complementary information.

2.2.2.2.4. Acknowledgement of correct read back

Every read-back message shall be followed by an acknowledgement of conformity or non-conformity given by the sender of the message:

**correct**

or

**error + I say again**

and resending of the initial message.

2.2.2.2.5. Acknowledgement

Every message received shall be acknowledged positively or negatively as follows:

**received**

or

**negative, say again (+ speak slowly)**

2.2.2.2.6. Traceability and verification

A unique identification or authorisation number shall accompany all messages initiated from the ground:

— if the message concerns an action for which the driver requires a specific authorisation (e.g. passing a signal at danger, etc.):

**authorisation** .....

..... **(number)**

— in all other cases (e.g. proceeding with caution, etc.):

**message** .....

..... **(number)**

2.2.2.2.7. Reporting back

Every message comprising a request to 'report back' shall be followed by a 'report'.

2.2.2.3. *Additional messages*

Additional messages

— shall be preceded by the identification procedure,

— shall be short and precise (limited wherever possible to information to be communicated and where it applies),

— shall be read back and followed by an acknowledgement of correct read back, or not,

— may be followed by a request for instructions or a request for further information.

2.2.2.4. *Information messages with a variable content not predetermined*

Information messages with a variable content shall be:

— preceded by the identification procedure,

— prepared before sending,

— read back and followed by an acknowledgement of correct read back, or not.

# COMMISSION DECISION

## of 30 May 2002

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

*(notified under document number C(2002) 1952)*

**(Text with EEA relevance)**

(2002/735/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 rolling stock 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 and rolling stock 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 in 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

[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).

96/48/EC, it is necessary, during the transition period between the publication of this Decision and the 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 a rolling stock register is published and updated each year. This register will set out the main characteristics of the national rolling stock (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 'rolling stock' 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 rolling stock of the trans-European high-speed rail system as defined in Annex I to 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 relevant 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 Commission recommendation 2001/290/EC ([3]) on the basic parameters of the trans-European high-speed rail system have no longer 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 6*

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 rolling stock subsystem**

## 1. INTRODUCTION

### 1.1. TECHNICAL SCOPE

This TSI concerns the rolling stock 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.

This TSI is applicable to trains running at a speed of at least 250 km/h on the lines specially built for high speed and at a speed of the order of 200 km/h on existing lines which have been or are to be specially upgraded. As far as trains running on upgraded lines at a speed of the order of 200 km/h and on other conventional lines are concerned, Article 2 of the present TSI Decision is applicable as long as this case is not covered in the TSI revision process.

More information about the rolling stock 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 European Parliament and Council Decision No 1692/96/EC 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 2);

(b) establishes the basic parameters described in Annex II(3) to 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. SUBSYSTEM DEFINITION/SCOPE

### 2.1. SUBSYSTEM DESCRIPTION

'The characteristics of the rolling stock must be such as to allow it to travel on any line on which it is expected to operate. (Council Directive 96/48/EC, Annex III, essential requirement 2.4.3)'.

Trains that meet the technical requirements stated in this TSI are able to serve the lines mentioned in Annex I(1)b to Directive 96/48/EC.

The rolling stock subsystem does not include the control-command, operation or power supply subsystems since these subsystems are specified in their own TSIs.

In addition, rolling stock does not include the train staff (driver and other on-board train crew).

The rolling stock shall fulfil the following functions:

— carry and protect the passengers and train crew

— accelerate, maintain speed, brake and stop

— keep the train driver informed, provide a view ahead, and allow proper control

— support and guide the train on the track

— signal the presence of the train to others

— function safely even in the event of incidents

— respect the environment.

### 2.2. ROLLING STOCK FUNCTIONS WITHIN THE SCOPE OF THIS TSI

#### 2.2.1. **Carry and protect passengers and train staff**

Trains shall ensure the required level of safety for passengers and train crew during access to and egress from the trains, and during their journey. Trains shall also be sensitive to the special needs of persons of reduced mobility.

#### 2.2.2. **Accelerate, maintain speed, brake and stop**

The performance defined in the TSI will allow vehicles to fit into the timetable slots on the sections or stretches of the trans-European high-speed network for which the rolling stock is designed.

#### 2.2.3. **Keep train driver informed, provide a view ahead, and allow control of the train**

The driver shall be provided with a clear view of the line ahead. All instruments and controls relating to train operation and the control-command subsystem shall be clearly marked, work in real-time, and be unambiguous for the driver.

#### 2.2.4. **Support and guide the train on the track**

The different needs of this subsystem are defined by standards for the wheels that comprise the interface with the rail in the infrastructure subsystem.

The contact geometry is such that the stability of the train with all its equipment in good working order is ensured at the highest operating speed specified for the trainset. This aspect allows the interface with the many parameters within the infrastructure subsystem such as the track gauge, cant deficiency and equivalent conicity, to be defined.

2.2.5. **Signal its presence to others**

Trains are provided with equipment which enables them to indicate their presence in an audible, visual and/or electronic form acceptable to all parts of the interoperable network and its traffic management systems.

2.2.6. **Function safely even in the event of incidents**

Trains are provided with safety devices to fulfil their functions in the event of possible incidents, reducing the effects of such incidents, and allowing their elimination whenever possible.

2.2.7. **Respect of the environment**

The materials selected for use on rolling stock shall minimise the emission of harmful and dangerous fumes or gases during use of the trains. The limits set for exterior noise and electromagnetic interference shall result in minimal environmental impact.

2.3. FUNCTIONS OUTSIDE THE SCOPE OF THIS TSI

2.3.1. **Ability to operate on available traction supply systems**

As national railways are equipped with various electrification systems, electric trains shall be able to use the available voltage and frequency, and have the correct pantograph to handle the catenary geometry.

These requirements for traction supply are defined in the energy subsystem TSI.

Pantograph: despite being installed on rolling stock, the pantographs are considered to be a part of the Energy subsystem as an important device the proper current-collection function of which is directly linked to the characteristics of the overhead line. The interface characteristics of the pantographs are specified and described in the energy TSI.

2.3.2. **Onboard control command equipment**

The interfaces and characteristics of the on-board ERTMS signalling equipment and the radio system are entirely specified and described in the control-command TSI.

2.3.3. **Maintainability during service on the network**

Major maintenance work that allows the required reliability and availability targets to be met are the responsibility of the railway undertaking that operates the vehicles. The specific technical needs for undertaking tasks appropriate to interoperability in facilities on the interoperable network that do not belong to the rolling stock operator are specified in the maintenance TSI.

3. **ESSENTIAL REQUIREMENTS**

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

3.2. The essential requirements relate to:

— safety,

— reliability and availability,

— health,

— environmental protection,

— technical compatibility.

According to Directive 96/48/EC, the essential requirements can be generally applied to the whole trans-European high-speed rail system or be specific to particular aspects of each subsystem and its constituents.

3.3. In the case of the rolling stock subsystem, the specific aspects, in addition to the considerations contained in Annex III to the Directive, are as follows:

3.3.1. **Safety**

*Essential requirement 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'.

This safety requirement is of universal application; as specified in Chapter 1, Section 1.3, this document is limited to the definition of those conditions relating to interoperability. In this regard, this essential requirement is satisfied when all the basic criteria that define the rolling stock in Chapter 4 of this TSI are met.

*Essential requirement 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'.

In order to satisfy this requirement, the wheel profiles, the allowable profile wear and the components affecting running stability shall be specified in Section 4.2.10 in such a way as to be completely compatible with the track criteria defined in the infrastructure subsystem.

Bearing in mind the importance of maintaining these parameters to guarantee safe operation, it is necessary to make arrangements to monitor these parameters on a continuous or periodic basis to prevent their deterioration over time.

*Essential requirement 1.1.3:*

'The components used must withstand any normal or exceptional stresses that have been specified during their period in service. The safety repercussions of any accidental failures must be limited by appropriate means'.

The components concerned in respect of each requirement correspond to the constituents and elements for which the characteristics are given in this TSI, together with their monitoring devices. The main characteristics for this requirement are:

— the static resistance of the vehicle structures,

— wheel-wear criteria as defined by the choice of material,

— the hot-box detection,

— the environmental conditions for which the rolling stock equipment is specified,

— the windscreen characteristics.

The relevant characteristics to validate in respect of this TSI are defined in Sections 4.1.7, 4.2.10, 4.3.12 and 4.3.19.

In addition, some characteristics are given in order to meet this requirement in the context of their interface with the infrastructure subsystem:

— maximum track forces,

— heat transmitted to the rail,

— effects of crosswinds.

The relevant characteristics to validate in respect of this TSI are defined in Sections 4.1.1, 4.2.15 and 4.2.14.

*Essential requirement 1.1.4:*

'The design of fixed installation and rolling stock and the choice of the materials used must be aimed at limiting the generation, propagation and effects of fire and smoke fumes in the event of a fire.'

This requirement is met by Section 4.3.11 which covers fire protection.

The relevant characteristics to validate in respect of this TSI are defined in Section 4.3.11.

*Essential requirement 1.1.5:*

'Any devices intended to be handled by users must be so designed as not to impair their safety if used foreseeably in a manner not in accordance with the posted instructions.'

The present design of trains already takes these risks into account. There is no need to define any specific characteristics purely for interoperability.

*Essential requirement 2.4.1 Section 1:*

'The rolling stock structures and those of the links between vehicles must be designed in such a way as to protect the passenger and driving compartments in the event of collision or derailment.'

In order to meet this requirement, the vehicle structures are designed with passive safety provisions. The basic principle envisages the possibility of a collision with an obstacle such as a heavy lorry on a level crossing or a rock fall, where the compartments that contain the passengers and driver are subject to minimal deformation. Collision energy shall be absorbed in unoccupied crumple zones designed for such eventualities, which limit deceleration forces and prevent overriding of the vehicle bodies.

The relevant characteristics to validate in respect of this TSI are defined in Section 4.1.7.

*Essential requirement 2.4.1 Section 2:*

'The electrical equipment must not impair the safety and functioning of the control and command and signalling installations.'

This requirement is met by the criteria defined in the control command TSI, in the paragraph dealing with the electromagnetic compatibility of the rolling stock and the signalling system.

The constraints to operation over existing infrastructure are dealt with on a case-by-case basis. It is imperative to respect the limits defined for existing installations. To find out the different infrastructure characteristics, refer to the 'Register of infrastructure' in which the information is given on a line by line basis.

The relevant characteristics to validate in respect of this TSI are defined in Section 4.1.9.

*Essential requirement 2.4.1 Section 3:*

'The braking techniques and the stresses exerted must be compatible with the design of the tracks, engineering structures and signalling systems'.

For the present TSI, this requirement is dealt with by two basic parameters.

— the braking performances defined in Section 4.1.5,

— the maximum longitudinal force, defined in Section 4.1.1c, to be applied to the track without exceeding the maximum acceptable longitudinal force on the infrastructure.

Furthermore, the particular case of brake systems independent of wheel rail adhesion that use electromagnetic effects in the rail (eddy current brakes) rather than wheel/rail adhesion is tackled separately in Section 4.2.15 in order to evaluate the consequences of thermal effects in the rails.

*Essential requirement 2.4.1 Section 4:*

'Steps must be taken to prevent access to electrically-live constituents in order not to endanger the safety of persons'.

To satisfy this requirement, the rolling stock may also be manufactured using European standards relating to protection against electric shock.

The relevant characteristics to validate in respect of this TSI are defined in Section 4.3.17.

*Essential requirement 2.4.1 Section 5:*

'In the event of danger, devices must enable passengers to inform the driver and accompanying staff to contact him.'

This requirement concerns the indications given to passengers relating to the passenger alarm signal. The various functions of the public address system and of the intercom between the driver and the train crew are intended to respond to this requirement.

The relevant characteristics to validate in respect of this TSI are defined in Section 4.2.12.

*Essential requirement 2.4.1 Section 6:*

'The access door must incorporate an opening and closing system which guarantees passenger safety.'

This requirement is dealt with in the functional specification of the door control, and by constraints concerning the possibility of door unlocking.

The relevant characteristics to validate in respect of this TSI are defined in Section 4.2.6.

*Essential requirement 2.4.1 Section 7:*

'Emergency exits must be provided and indicated.'

The number of emergency exits, their distribution, their operation and their sign posting are defined in the present TSI in order to meet the evacuation requirement.

The relevant characteristics to validate in respect of this TSI are defined in Sections 4.2.7 and 4.2.8.

*Essential requirement 2.4.1 Section 8:*

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

The provisions relating to fire and fume protection, the trainset design with a driver's cab at each end, emergency alarms which allow the driver to chose his stopping point, emergency lighting, the public address system and the other items defined in this TSI work together to improve safety in tunnels.

The additional stipulations of this requirement are gathered together in a specific paragraph. They are only envisaged for rolling stock that is regularly used through very long tunnels having specific demands listed in the 'infrastructure register'.

The relevant characteristics to validate in respect of this TSI are defined in Sections 4.3.14 and 4.2.12.

*Essential requirement 2.4.1 Section 9:*

'An emergency lighting system having a sufficient intensity and duration is an absolute requirement on board trains.'

This requirement is covered by the definition of the main functions of the emergency lighting system.

The relevant characteristics to validate in respect of this TSI are defined in Section 4.3.15.

*Essential requirement 2.4.1 Section 10:*

'Trains must be equipped with a public address system which provides a means of communication to the public from on-board staff and ground control.'

This requirement is covered by the definition of the main functions of the public address system.

The relevant characteristics to validate in respect of this TSI are defined in Section 4.3.16.

3.3.2. **Reliability and availability**

*Essential requirement 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.'

*Essential requirement 2.4.2:*

'The design of the vital equipment and the running, traction and braking equipment and also the control and command system must, in a specific degraded situation, be such as to enable the train to continue without adverse consequences for the equipment remaining in service.'

Meeting the performances specified in Sections 4.1.5, 4.2.1, 4.2.9, 4.3.1 and 4.3.3 allows these two requirements to be met.

3.3.3. **Health requirements**

*Essential requirement 1.3.1:*

'Materials likely, by virtue of the way they are used, to constitute a health hazard to those having access to them must not be used in trains and railway infrastructures.'

This requirement, which is not specific to the railway field, is covered by compliance with the appropriate European or national legislation.

*Essential requirement 1.3.2:*

'Those materials must be selected, deployed and used in such a way as to restrict the emission of harmful and dangerous fumes or gases, particularly in the event of fire.'

As already defined in Section 3.3.1, dealing with essential requirement 1.1.4, this requirement is dealt with in Section 4.3.11, which deals with fire protection.

The relevant characteristics to validate in respect of this TSI are defined in Section 4.3.11.

3.3.4. **Protection of the environment**

*Essential requirement 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.'

As concerns rolling stock, this requirement is covered by boundary characteristics relating to outside noise, electromagnetic interference as well as light pollution.

The relevant characteristics to validate in respect of this TSI are defined in Sections 4.1.8; 4.1.9; 4.2.20.

*Essential requirement 1.4.2:*

'The materials used in the trains must prevent the emission of fumes or gases which are harmful and dangerous to the environment, particularly in the event of fire.'

This requirement, which is not specific to the railway field, is covered by compliance with the appropriate European or national legislation.

*Essential requirement 1.4.3:*

'The rolling stock and energy-supply systems must be designed and manufactured in such a way as to be electromagnetically compatible with the installations, equipment and public or private networks with which they might interfere.'

This essential requirement is covered by the basic parameter 'Boundary characteristics linked to outside electromagnetic interference'.

The relevant characteristics to validate in respect of this TSI are defined in Section 4.1.9.

3.3.5. **Technical compatibility**

*Essential requirement 1.5:*

'The technical characteristics of the infrastructures 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.'

This general requirement concerns the rolling stock fundamental criteria that correspond to the characteristics defined in Chapter 4 of this TSI.

Some temporary solutions are envisaged. They will be evoked in particular cases to allow proper operation on existing lines or will ultimately appear in the form of special characteristics within the 'infrastructure register'.

*Essential requirement 2.4.3 Section 1:*

'The electrical equipment must be compatible with the operation of the control and command and signalling installations.'

Defining the electrical boundary characteristics, the limits of electromagnetic interference and the interface with the control command subsystem ensures this compatibility.

The relevant characteristics to validate in respect of this TSI are defined in Sections 4.1.6, 4.1.9 and 4.2.4.

*Essential requirement 2.4.3 Section 2:*

'The characteristics of the current-collection devices must be such as to enable trains to travel under the energy supply systems for the trans-European high-speed rail system.'

This compatibility is ensured by the definition of the interface interfaces with the electrification system as specified in the TSI energy subsystem.

The relevant characteristics to validate in respect of this TSI are defined in Section 4.2.3.

*Essential requirement 2.4.3 Section 3:*

'The characteristics of the rolling stock must be such as to allow it to travel on any line on which it is expected to operate.'

This essential requirement is covered by values of the basic parameters, characteristics of the subsystem interfaces and additionally by the specified rolling stock performance.

The relevant characteristics to validate in respect of this TSI are defined in Sections 4.1, 4.2 and 4.3.

3.4. **Verification**

Conformity of the rolling stock subsystem and its constituents to the essential requirements is checked in accordance with the provisions envisaged in Directive 96/48/EC as well as in this TSI.

## 4. CHARACTERISTICS OF THE SUBSYSTEM

The Trans-European high-speed rail system (to which Directive 96/48/EC applies and of which the subsystem is a part) is an integrated system. It requires the basic parameters, interfaces and performance to be verified in particular so as to ensure that the system is interoperable and that the essential requirements are met.

With regard to technical interoperability, the rolling stock subsystem has the following characteristics:

— basic parameters

— interfaces with other subsystems

— specified performance

The common characteristics of rolling stock are defined in Section 4 of the present TSI. Particular characteristics are listed in the register of rolling stock (see Annex I to the present TSI).

### 4.1. BASIC PARAMETERS OF THE ROLLING STOCK SUBSYSTEM

The basic parameters for the Rolling Stock subsystem are those listed in Annex II of Directive 96/48/EC:

— maximum track forces (BP4)

— axle load (BP10)

— maximum train length (BP11)

— vehicle loading gauge (BP12)

— minimum braking characteristics (BP13)

— electrical boundary characteristics for rolling stock (BP14)

— mechanical boundary characteristics for rolling stock (BP15)

— exterior noise limits (BP17)

— electromagnetic interference limits (BP19)

— interior noise limits (BP20)

— air conditioning limits (BP21)

— requirements for the transport of mobility impaired people (BP22).

Additional basic parameters:

— maximum pressure variations in tunnels (BP23)

— maximum gradients (BP25).

#### 4.1.1. **Maximum track forces (BP4)**

In addition to basic parameter BP10 that deals with the static axle load, the characteristics that allow the maximum track forces to be defined are:

— the dynamic load applied to the rail by the wheel,

— the transverse forces exerted on the track by the train.

(a) Dynamic load

The maximum vertical load to be exerted by the wheels on the rail (dynamic load of wheel Q) is defined as follows:

— for rolling stock designed to operate on specially constructed high-speed lines at speeds equal to or greater than 250 km/h, the following values apply:

| V (km/h) | Q (kN) |
|---|---|
| V = 250 | 180 |
| 250 < V ≤ 300 | 170 |
| V > 300 | 160 |

— for 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.

(b) Transverse track forces

Interoperable rolling stock shall comply with the Prud'homme criteria for the maximum transverse force ΣY defined as follows:

— total dynamic maximal transverse effort exercised by an axle on the track:

$$(\Sigma Y)_{max} = 10 + \frac{P}{3} \text{ kN},$$

P being the static load on the axle in kN. This result of this formula defines the limit of adhesion between the track tie and the ballast under the influence of transverse dynamic efforts,

— quotient of the transverse and vertical efforts of a wheel:

$$(Y/Q)_{lim} = 0,8,$$

Y and Q expressing respectively transverse dynamic effort and vertical effort exercised by a wheel on the rail. This limit characterizes the risk of a wheel climb on the rail.

(c) Longitudinal track forces

Longitudinal forces exerted on the track by the rolling stock shall always be less than those corresponding to an acceleration or a deceleration of 2,5 $m/s^2$.

4.1.2. **Axle load (BP10)**

The mass on the rail shall be minimised in order to reduce the forces exerted on the track by the train.

This paragraph specifies the static axle load for interoperable rolling stock; note that the dynamic load from train movement is specified in basic parameter 4 (Section 4.1.1).

The limiting values for the static axle loads specified for interoperable trains are set out in the infrastructure TSI.

The track forces are based on the limits set by the increased track stresses resulting from excessive axle loads.

These different aspects are closely linked with the infrastructure subsystem in which the quality of the track is specified.

Note that a limit to the mass will also have the effect of reducing the installed power required and the energy consumption.

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

— for rolling stock designed to operate on specially constructed high-speed lines at speeds equal to or greater than 250 km/h:

$P_o$ < or = 17 t/axle where V > 250 km/h,

$P_o$ < or = 18 t/axle where V = 250 km/h,

where V = maximum service speed

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

— for 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 %.

4.1.3. **Maximum train length (BP11)**

High-speed trains suitable for running on the interoperable network shall be made up of fixed-consist trainsets (indivisible in service), able to run either singly (single unit) or coupled together (units in multiple).

The maximum length of the trains thus formed shall not exceed 400 m. A tolerance of 1 % is permissible in order to improve aerodynamic penetration of the front and rear of the train.

To allow them to operate in the terminal stations on the network, the maximum length of the trains shall be compatible with the length of platforms on high-speed and conventional lines that they are intended to serve on the trans-European network.

4.1.4. **Vehicle loading gauge (BP12)**

Interoperable rolling stock shall comply with the dynamic reference contour of one of the following vehicle gauges UIC 505-1, GA, GB or GC as defined in Annex G to this TSI.

The choice of rolling stock gauge shall be made based on the routes over which the rolling stock is required to operate. The information required is defined in the infrastructure register.

4.1.5. **Minimum braking characteristics (BP13)**

(a) High-speed trains incorporate a speed control system with different deceleration levels. The prescribed performance levels defining the minimum braking power for trains suitable for working on all high-speed lines are given in the two following tables. Meeting these performance levels and the safe operation of the braking system, for new systems, shall be fully demonstrated.

(b) It is important to note that the values in Tables 4.1.5c and 4.1.5d are those appropriate for rolling stock and they shall not be interpreted as being the parameter values for defining the braking curves required by the control-command sub-system. These require the essential safety margins for rail operations in all conditions to be taken into account. These margins shall be specified, for the lines concerned, in liaison with the control-command subsystem.

(c) Performances: the interoperable trainsets shall be able to achieve, over the range of speeds shown, the average decelerations listed hereafter.

Table 4.1.5c

| Braking mode | $t_e$ (s) | Minimum deceleration under set braking conditions ($m/s^2$) | | | |
|---|---|---|---|---|---|
| | | 330 to 300 (km/h) | 300 to 230 (km/h) | 230 to 170 (km/h) | 170 to 0 (km/h) |
| Case A — emergency braking with certain equipment isolated | 3 | 0,85 | 0,9 | 1,05 | 1,2 |
| Case B — emergency braking with certain equipment isolated and unfavourable climatic conditions | 3 | 0,65 | 0,7 | 0,8 | 0,9 |

$t_e$(s) = Equivalent time of application.

*Note:* Emergency braking applications in Case A and Case B shall be performed under the following conditions:

Case A

— level track and normal train load (number of seats × 80 kg)

— dynamic brake of a motor traction module isolated.

Case B

In addition to the conditions in Case A, the following shall be added:

— one pneumatic brake distributor is isolated;

— reduced wheel-rail adhesion;

— friction coefficient between pad and disc reduced by humidity.

*Note 1:* On existing infrastructures, infrastructure managers may define further requirements because of the different signalling and control systems on their part of interoperable networks, (infrastructure register), e.g. additional braking systems or reduced service speeds for given braking distances.

*Note 2:* Normal service braking conditions are defined in Section 4.3.7.

(d) Stopping distances: the stopping distance 'S' calculated as a function of the minimum decelerations defined above can be defined by using the formula:

$$S = V_0 \times t_e + \frac{V_o^2 - V_1^2}{2ab_1} + \frac{V_1^2 - V_2^2}{2ab_2} + \ldots + \frac{V_n^2}{2ab_n}$$

where: $V_0$ = initial speed (measured in m/s)

$V_1 \ldots V_n$ = speed given in Table 4.1.5c (measured in m/s)

$ab_1 \ldots ab_n$ = specified deceleration over the speed band under consideration (measured in $m/s^2$)

$t_e$ = equivalent time of application (measured in s)

For example, the stopping distances to be met from specific initial speeds are given in Table 4.1.5d:

Table 4.1.5d

| Braking mode | $t_e$ (s) | Stopping distances must not exceed | | | |
|---|---|---|---|---|---|
| | | 330—0 (km/h) | 300—0 (km/h) | 250—0 (km/h) | 200—0 (km/h) |
| Case A — emergency braking with certain equipment isolated | 3 | 4 530 | 3 650 | 2 430 | 1 500 |
| Case B — emergency braking with certain equipment isolated and unfavourable climatic conditions | 3 | 5 840 | 4 690 | 3 130 | 1 940 |

(e) Supplementary conditions:

For cases A and B, when emergency braking is considered:

— the contribution of electric dynamic brakes can only be included in the calculation of the performances defined above if their operation is independent of the presence of voltage in the catenary,

— the contribution of brakes independent of adhesion and based on retardation caused by the generation of eddy current in the rails can be included in the emergency braking performances, under the conditions defined in Section 4.2.15,

— in this case, the condition that an independent eddy current brake module shall be isolated shall be added to the conditions stated in Cases A and B of Tables 4.1.5c and 4.1.5d,

— electromagnetic track brakes independent of wheel/rail adhesion shall be available for emergency applications on all lines.

4.1.6. **Electrical boundary characteristics for rolling stock (BP14)**

The electrical characteristics of the rolling stock which interface with the fixed infrastructure can be considered under the following headings:

— the voltage and frequency variations in the electrical supply,

— the maximum power that can be drawn from the catenary,

— the power factor of the alternating current supply,

— the short over voltages generated by the operation of rolling stock,

— the electromagnetic interference, see Section 4.1.9,

— the other functional interfaces quoted in Section 4.2.3.

4.1.6.1. *Voltage and frequency of the electricity supply*

4.1.6.1.1. Energy supply

These boundary characteristics are defined in the energy TSI, Section 4.1.1 within which is defined, amongst other things, the voltage range to be supplied by the fixed installations.

4.1.6.1.2. Energy recuperation

The general conditions for the return of energy to the catenary from regenerative braking are specified in Section 4.3.6 and in Annex K to the energy TSI.

Rolling stock equipped with a regenerative braking system able to return energy to the catenary shall not, under any circumstances, cause the voltage to exceed the limits given in the Annex previously mentioned.

4.1.6.2. *Maximum power that can be drawn from the catenary*

The rolling stock shall be specified so that the maximum power demand on the catenary shall always be less than the value defined in Section 4.2.2.5 of the energy TSI.

The maximum current that can be drawn from the catenary during a stop of long duration is defined in Section 4.2.2.6 of the energy TSI.

4.1.6.3. *Power factor*

The power factor $\lambda$ (defined by $\lambda = \alpha \cos\varphi$) of the rolling stock shall in all normal operating conditions remain above the values specified in Section 4.3.1.3 of the energy TSI,

4.1.6.4. *Harmonic characteristics and related over-voltages on the OHL*

The characteristics that prevent the generation of unacceptable over-voltages in the catenary are defined in Section 4.2.2.7 of the energy TSI.

4.1.7. **Mechanical boundary characteristics for rolling stock (BP15)**

The static and dynamic strength of vehicle bodies shall ensure the safety required for passengers and train crew. In particular, it should cope in the event of a collision with objects from outside of the rail system, such as heavy lorries or rock falls.

The construction standards used for this purpose shall ensure what is called passive safety. They do not compensate for a possible lack of active safety in the railway network but shall complement personal safety in unforeseen events that are beyond the control of the railway system.

The mechanical boundary limits defined for rolling stock to ensure that this requirement is met are defined below:

(a) static resistance of vehicle structures, and

(b) passive safety (crashworthiness).

(a) Static resistance of vehicle bodyshells

(a1) Vertical static resistance:

The bodyshell of each vehicle shall be able to withstand, without permanent deformation, the vertical static proof loads Fz in the following configurations:

— jacking of the complete body of the vehicle in running order (VRO), without the running gear, by its four jacking points,

— lifting of one end of the body, VRO,

— exceptional vertical load:

the greater of the two values of $Fz = 1{,}3\ (m_1 + (m_{21} \text{ or } m_{22})) \times g$ (N) where

$m_1$ = weight of the car body, VRO, with tanks assumed to be half full,

$m_{21}$ = number of seats (excluding tip-ups) × 2 × 80 kg,

$m_{22}$ = number of seats (excluding tip-ups) × 80 kg + area of corridors and vestibules ($m^2$) × 4 × 80 kg.

(a2) Longitudinal static resistance:

The bodyshell of each vehicle shall be able to withstand a static longitudinal, compressive loading, at the level of the coupler attachments, of at least 1 500 kN without residual deformation.

*Note:* If this value is lower than the longitudinal resistance specified by the passive safety criteria, then the passive safety criteria value shall be applied.

(b) Passive safety (crashworthiness)

See Annex A for a detailed explanation of these characteristics.

In the event of a frontal impact, the mechanical structure of vehicles shall:

— resist over-riding,

— limit deceleration,

— protect the areas occupied by passengers and the driver as far as possible,

— absorb the energy collision.

Three collision scenarios are proposed; corresponding respectively to:

— a front end impact between two trainsets,

— a front end impact with a vehicle fitted with side buffers,

— an impact with a lorry on a level crossing.

Main specifications to be met:

— limited deformation to the driver and passenger areas from a static resistance with the ability to withstand a mean crush load of 1 500 kN,

— dissipation of 6 MJ of crash energy of which at least 4,5 MJ shall be in the front part of the first vehicle,

— all the vehicles in the trainset shall have a consistent level of crashworthiness

— a maximum average deceleration in passenger and drivers cab areas to 5 g,

— the vehicle ends shall be fitted with devices preventing over-riding.

The problems, principles, scenarios as well as the specifications to be met for crashworthiness are described in more detail in Annex A.

Assessment shall be made during the design phase and the integration of components and subassemblies; it shall include the assessment of material properties by crash tests on mock-ups or prototypes. Crush tests can be used as an alternative to assess conformity if the results can be accurately correlated with those of crash tests. Validation of technical solutions related to the present paragraph shall be made according to EN 12663 standard.

Trains must withstand the mechanical loads due to pressure variations in tunnels.

4.1.8. **Boundary characteristics linked to exterior noise (BP17)**

(a) Stationary noise levels:

Noise levels in stations or on stabling tracks shall not exceed 65 dB(A) measured continuously or 70 dB(A) intermittently.

The following conditions apply to these values: measured over 30 seconds, in open country at 7,5 m from the axis of the track at a height between 1,2 and 3,5 m.

(b) Noise levels in high-speed service:

The noise level generated by a trainset in service shall not exceed a value of 87 dB(A) at a speed of 250 km/h, 91 dB(A) at a speed of 300 km/h and 92 dB(A) at a speed of 320 km/h (linear interpolation for other maximum speeds) [1].

Measurements are carried out in accordance with the constant speed test in prEN ISO 3095 — January 2001, with the following additional conditions:

— the passage of a train is measured in open country at 25 m from the axis of the track at a height of 3,5 m,

— at constant speed with traction power operating,

— minimal possible operational configuration for normal service,

[1] Taking into account that the measurement conditions and the description of the reference track were still under discussion at the time of the adoption of the present TSI, a margin of 1 dB(A) on the limit values is tolerated. This section will be revised when adopting the next generation TSI.

— a track type is used with design parameters ensuring minimum sound radiation from the track. These include: monoblock concrete sleepers in ballast and railpads with a static pad stiffness of at least 500 kN/mm at 60 kN preload. It is also permitted to use an acoustically equivalent track design, if available and proven. In that case, the track radiation must be shown to be equivalent to that of the track type mentioned, in accordance with prEN ISO 3095 — January 2001, Annex B: railhead roughness level $L_{rough}$ (one-third-octave-band) averaged over a width of 20 mm should be

$$L_{rough} \leq \left[4 - 6\log\left(\frac{\lambda_0}{\lambda}\right)\right] dB$$

with $\lambda_0$ = 1 m and the wavelength $\lambda$ between 0,2 and 0,005 m (rail roughness measurements according to ISO 3095, Annex C).

In areas particularly sensitive to noise, the level of noise perceived on the passing of a train can be reduced by the installation of sound attenuating measures placed along the track.

All noise measurements shall be made according to prEN ISO 3095 — January 2001.

4.1.9. **Boundary Characteristics linked to exterior electromagnetic interference (BP19)**

For electric trains, the supply of electricity from the distribution substation to the trains generates interference of high or low intensity by conduction (through the catenary and rail) and by electromagnetic radiation. In addition, any on-board electrical equipment is capable of causing interference.

4.1.9.1. *Interference generated on the signalling system and the telecommunications network*

The rolling stock shall meet specifications not to interfere with track circuits, axle counters, and the telecommunications network. The items to be taken into account are listed in the infrastructure register for reference purposes.

Compatibility between the rolling stock and the characteristics of the detection system shall be demonstrated using the acceptance procedures in EN 50238 standard.

4.1.9.2. *not used*

4.1.9.3. *Radio frequency interference*

The rolling stock shall meet the requirements of the EN 50121-3-1 standard by not generating interference affecting lineside and adjacent installations on a line declared to be interoperable.

4.1.9.4. *Electromagnetic immunity*

In order to avoid interference to the proper operation of rolling stock due to electromagnetic interference, the requirements of the following standards shall be met:

— EN 50121-3-1 for the total rolling stock subsystem,

— EN 50121-3-2 for the different kinds of on-board equipment susceptible to interference.

4.1.10. **Boundary characteristics linked to interior noise (BP20)**

The interior noise level of passenger vehicles is not considered to be an interoperability constituent. However, the noise level within the driver's cab is an important issue and in this case a permissible equivalent continuous sound pressure level of 84 dB(A) shall not be exceeded over 30 minutes. The measuring methods are defined in Chapter 6 of this TSI. The values recommended for new vehicle designs are indicated in Chapter 7.

4.1.11. **Boundary characteristics linked to air conditioning (BP21)**

— Driving cab:

The ventilation of the driving cab shall be such as to ensure that carbon monoxide and dioxide levels remain under the level set by European health and safety legislation.

4.1.12. **Characteristics linked to the carriage of persons of reduced mobility (BP22)**

The railway company has to take the necessary measures to guarantee the access of persons of reduced mobility to the operated vehicles. The horizontal and vertical surfaces required for the fixed installations are specified in the infrastructure TSI.

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 in all parts of the network. It will therefore be necessary to use technical and operational solutions to overcome this problem for disabled passengers. There are several solutions available that 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:

  — platform lift

  — partially raised platform (i.e. section of all platforms at 750 mm),

— operational solutions:

  — portable ramp deployed by operating staff

  — mobile lift deployed by operating staff.

Access to trains for those with reduced mobility shall be possible. Since 'disabled passengers' includes wheelchair users (WCU), provisions for wheelchair users shall be designed to accommodate a 'wheelchair' conforming to the dimensions specified in ISO 7193. High-speed trains should be specifically equipped to meet their needs with an adapted toilet, space for at least one wheelchair, and gangways and doors of sufficient width.

These measures shall be put in place during upgrading or new building as disabled access measures are incorporated into harmonised national legislation.

4.1.13. **Maximum pressure variations in tunnels (BP23)**

The design of the interoperable trainsets shall be such that the maximum pressure variation defined in the infrastructure TSI (10 kPa) is never exceeded, even in the event that the pressure sealing of vehicles (when so equipped) fails.

Thus one can define the pressure characteristics of the trainset by a unique envelope curve in order to provide the three pressure variations P0, P1 and P2, which are specified in Annex B.

For reference purposes, the following values are used:

— $\Delta P0 <$ or = 1 800 Pa,

— $\Delta P1 <$ oder = 3 200 Pa,

— $\Delta P1 - 0{,}8\Delta P0 <$ oder = $\Delta P2$.

These values are given by:

— a ratio between the train and tunnel cross-sections of 0,18,

— a service speed of 250 km/h

4.1.14. **Maximum gradients (BP24)**

The rolling stock will be able to start, operate and stop on the maximum gradients on all the lines for which it is designed and over which it is likely to operate.

This is of particular relevance to the performance requirements specified in Chapter 4.3.

The maximum gradients of each line are defined in the infrastructure register.

4.2. ROLLING STOCK SUBSYSTEM INTERFACES

As far as technical compatibility is concerned, these are the interfaces of the rolling stock subsystem with the other subsystems:

— the design of the fixed formation trainset

— driver vigilance device

— the electrification system

— on-board train control equipment

— platform height

— the door controls

— emergency exits

— emergency couplers

— wheel/rail contact

— hot-box detection

— alarm signal

— pressure wave effects

— effect of crosswinds

— brakes independent of adhesion

— flange lubrication

— coefficient of flexibility.

The interfaces are defined in the following list in order to ensure the development of a consistent trans-European network.

4.2.1. **Design of the fixed formation trainset**

The trainsets shall be able to run on the European network and provide seamless travel for passengers. In this respect, they shall comply with the technical requirements stated in this TSI.

The trains concerned shall be self-propelled fixed formation trainsets, capable of bi-directional operation and achievement of the performance stated elsewhere. They shall provide a driver's cab at each end to aid reversals at terminal stations and in the event of a tunnel evacuation.

The following are permissible:

— conventional or articulated fixed consist trainsets,

— trainsets with or without tilt systems,

— single or double deck trainsets.

To allow train passenger capacity to meet changing traffic needs it is permissible to couple trainsets of the same type to run in multiple. Such a train formed from two or more trainsets shall meet the specification in this document. It is not a requirement that trains of different manufacturers' designs or from other networks shall operate coupled together.

4.2.2. **Driver's vigilance device**

Any lack of driver vigilance shall be detected within a given time and shall lead, in the absence of driver reaction, to an automatic emergency brake application on the train.

4.2.3. **Electrification system**

For electrically powered interoperable trainsets, the principal interface elements between the rolling stock and the energy subsystem are defined in the energy TSI.

They are as follows:

— the maximum power that can be drawn from the catenary (Section 4.1.6.2 of this document) defined in Section 4.2.2.5 of the energy TSI,

— the maximum current that can be drawn at standstill is defined in Section 4.2.2.6 of the energy TSI,

— the voltage and the frequency of the traction supply (see Section 4.1.6.1.1) defined in Section 4.2.2.7 of the energy TSI,

— over-voltages generated on the overhead line by harmonics (see Section 4.1.6.4) defined in Section 4.3.1.7 of the energy TSI,

— electrical protection measures defined in Section 4.2.2.8 of the energy TSI,

— the distribution of the pantographs defined in Section 4.2.2.9 of the energy TSI,

— running through phase separation sections defined in Section 4.2.2.10 of the energy TSI,

— running through system separation sections defined in Section 4.2.2.11 of the energy TSI,

— adjustment of the pantograph contact defined in Section 4.2.2.12 of the energy TSI,

— power factor (see Section 4.1.6.3) defined in Section 4.3.1.3 of the energy TSI,

— regenerative braking (see Section 4.1.6.1.2) defined in Section 4.3.1.4 of the energy TSI.

The interaction between the pantographs and the catenary is of particular importance since their joint operation will ensure an uninterrupted power supply for traction and, if required, regenerative braking. These requirements shall also be observed by all combinations of trains, single trainsets as well as trainsets that are coupled in multiple. The constraints imposed by the distribution of pantographs and the quality of current collection are defined in Section 4.3.2.3 of the energy TSI.

4.2.4. **Control-command system onboard the trains**

To conform Directive 96/48/EC, and finally move towards a unified system, interoperable trainsets shall be compatible with the ERTMS system (Commission Decision 2001/260/EC). Compatibility with existing systems will be achieved using adaptive modules installed on the trainsets. In practical terms it would be impossible to install all the modules required on board a train set. The choice of modules shall be based on the routes for which the trainset is intended.

The interface characteristics between the rolling stock and the control command subsystem are included in Section 4.2.1.2 of the TSI for that subsystem, and are notably:

— the minimum braking characteristics for the train covered in Section 4.1.5 of the present document,

— compatibility between the ground-based train detection systems and the rolling stock, dealt with Section 4.1.9.1 of the present document,

— compatibility between the detectors fixed under vehicles and the dynamic clearances of those vehicles,

— the environmental conditions for the on-board equipment are dealt with in Section 4.3.12 of the present document,

— electromagnetic compatibility with on-board control command equipment are dealt with in Section 4.1.9.4 of the present document,

— train data concerning braking, train integrity and train length,

— electromagnetic compatibility with the ground-based systems covered in Section 4.1.9.3 of the present document.

In addition, the following functions are directly linked with parameters defined by the control-command subsystem.

— operation in degraded mode conditions

— monitoring to ensure that the train speed is at all times less than or at most equal to the maximum permitted speed in the operating environment.

Information about the characteristics of these interfaces is given in Tables 5.1 A, 5.1 B and 6.1 in the control-command TSI. In addition, reference to European standards and specifications to be used as part of the assessment procedure for conformity are indicated, for each characteristic, in Annex A to the control-command TSI.

4.2.5. **Passenger step**

The passenger step for access to vehicles shall be optimised for the two platform heights of 550 mm and 760 mm that exist on the network, unless the trainset can only operate over a part of the network with a single platform height.

4.2.6. **Passenger access door**

(a) Terminology used:

— a 'closed door' is a door held closed by the door closing mechanism only,

— a 'locked door' is a door held closed by a mechanical door locking device,

— a 'door locked out of service' is immobilised in a closed position by a mechanical device activated by a member of the train crew.

(b) Door operation: The passenger access doors shall be designed to operate in such a way that their opening and closing does not require any significant effort on the part of the passengers.

(c) Door closing: The control and command system shall allow the train crew (driver or conductor) to close and lock the doors before the train departs.

When the locking control is under staff control, and activated from a door, this door can remain open when the other doors close, but it must then be possible for staff to close and lock it subsequently. In addition, a closing and locking order of this door shall occur automatically before the train reaches 5 km/h.

The doors shall be kept closed and locked until the train crew releases them.

In the event of loss of power to the door controls, the doors shall be kept locked by the locking mechanism.

(d) Information available to the train crew:

An appropriate device shall indicate that all the doors apart from a door under local control are closed and locked.

Appropriate indication will be provided to the train crew of any fault in the door closing operation. A 'door locked out of service' shall not be taken into account.

(e) Locking a door out of service: A manual device shall be provided to enable the train crew to lock a door out of service. This action shall be possible from both inside and outside the train.

After the door is locked out of service it shall no longer be taken into account by the door controls or the onboard monitoring systems.

(f) Door opening release: The train crew shall be provided with controls that allow the doors to be released separately on each side, to allow them to be opened by passengers when the train is stopped.

This opening control shall be accessible from both the outside and the inside of the vehicle.

Each door shall be provided with an individual opening device, accessible to passengers, to allow that door to be opened for emergency reasons, at speeds below 10 km/h. This device shall have no effect on 'a door locked out of service'.

(g) Door dimensions shall allow the complete evacuation of passengers in normal operation within three minutes.

4.2.7. **Passengers' emergency exits**

(A) Arrangement: the vehicles shall have a minimum number of emergency exits on each side of the vehicle, and shall conform to the following rules:

— the distance between each passenger seat and an emergency exit shall always be less than 16 m,

— there shall be at least two emergency exits in each vehicle accommodating 40 passengers or less and more than two in each vehicle accommodating more than 40 passengers,

— the dimensions through the emergency exits shall be at least 700 mm × 550 mm.

(B) Operation: if doors cannot be opened, it is permissible to use the following as emergency exits:

— the windows, by ejection of the window or glazing or by breaking the glass,

— compartment doors, by rapid removal of the door or breaking the glass,

— access doors, by ejecting them or breaking the glass.

Trains must allow evacuation in a limited time. The dimension of doors and corridors must allow a free flow of passengers to the access doors and promote an even distribution of passengers over the doors.

(C) Signage: emergency exits shall be clearly identified to passengers and rescue teams by means of suitable signs.

(D) Evacuation via the doors: the interoperable high-speed trains shall be equipped with emergency devices allowing the evacuation of passengers via the access doors away from stations (emergency steps or ladders).

4.2.8. **Driver's cab emergency exits**

In an emergency, evacuation from the driver's cab (or access to the interior of the train by the emergency services) shall normally be by means of the access doors specified in Section 4.3.18a.

Where the doors do not give direct external access, each driver's cab shall be provided with an appropriate means of evacuation or at least one of the side windows shall have sufficient dimensions to allow for the release of trapped persons after the glass is removed or broken.

4.2.9. **Coupling arrangements to rescue trainsets**

High-speed trainsets shall:

(a) be equipped at each end of the trainset with a type of coupler meeting the requirements of Annex K. This provision enables the rescue of a trainset in the event of a breakdown by another interoperable trainset, without the need to use an intermediate coupler adapter;

(b) be able to be rescued by motive power units with standard UIC buff and draw components. To this extent, a special coupling equipment (emergency coupler) can be used. The emergency coupler shall be able to be installed by two people in 15 minutes.

4.2.10. **Wheel/rail contact**

(a) Description of the interface with the infrastructure:

wheel/rail contact has an influence on:

— vehicle running stability,

— the vehicle ride behaviour,

— noise emitted into the environment.

Concerning the first point, the contact geometry shall be such that the stability of running gear is ensured at the highest running speeds.

In relation to the other points, account shall also be taken both of conventional formations (ballast and sleepers), and of ballast-less track which has different characteristics.

The required criteria shall also be complied with for vehicles and equipment with the wear that can be expected to occur on a high-speed network.

This aspect interfaces closely with many parameters within the infrastructure subsystem such as the track gauge, cant deficiency and equivalent conicity.

The different needs of this aspect are translated for this subsystem by the definition of standards for the wheels and axles that comprise the interface points.

The definition of this interface with the infrastructure subsystem allows the ride stability of the rolling stock to be guaranteed in all circumstances and limits of wear of the running gear.

(b) Specification of ride stability criteria:

vehicle ride stability, which is essential for vehicle running safety, depends on the design characteristics of vehicles and more specifically on the wheel-rail contact parameters.

The following characteristics relate to the equivalent conicity defined by the infrastructure subsystem.

Three infrastructure-related parameters determine this:

— the profile of the rail head (e.g. UIC 60, etc.)

— rail inclination (e.g. 1/40, 1/20, etc.)

— track gauge (e.g. 1 435 mm, etc.).

The geometric characteristics of the wheelset (tread profile, gauge of active surfaces, etc.) combined with the three previous parameters generally determines the ride stability to be maintained in the new or worn condition within the range of extreme tolerances permitted for each of these parameters.

(c) Characteristics of the interface elements:

to be accepted for working on the interoperable network, rolling stock shall comply with the criteria on equivalent conicity defined in the infrastructure subsystem, and therefore shall:

(c1) be fitted with axles fitted with: wheels having a profile in conformity with one of the following:

— S 1002,

— GV 1/40,

distance between internal wheel faces measured at 60 mm below the top of the flange:

— 1 357 to 1 363 mm for wheel diameter = or > 840 mm,

— 1 359 to 1 363 mm for wheel diameter < 840 mm,

distance between active faces of the wheel:

— 1 410 to 1 426 mm for wheel diameter = or > 840 mm,

— 1 415 to 1 426 mm for wheel diameter < 840 mm;

(c2) be subject to acceptance tests in accordance with the provisions in Chapter 6 of the present TSI;

(c3) to guarantee ride stability under all conditions and protect against failures, have mandatory procedures for periodic checking of the integrity of that equipment by ensuring ride stability (axles, suspension linkages, dampers, etc.);

(c4) be fitted with an approved device for continuous detection of running gear instability, which shall only be active at speeds in excess of 220 km/h (i.e. in high-speed operation). This device shall advise the driver to reduce speed in the event of instability.

(d) Wear criteria characteristics:

to achieve a proper match between the choice of materials for the rail (as defined in the Infrastructure TSI) and the wheels, the wheels shall use materials defined as follows:

— for the entire zone of wheel rims wear, the values of Brinell hardness (HB) of the material have to be equal or superior (for every measure) to 245,

— if the thickness of the zone of wear is superior to 35 mm, the value of 245 HB has to be obtained until a depth of 35 mm under the bearing surface,

— the value of hardness in the connection between the wheel centre and the wheel rim should be lower at least by 10 points than the measured one on the verge of the range of wear.

(e) Electrical resistance of wheelsets:

to ensure the operation of track circuits, the electrical resistance of each wheelset measured:

— from tyre to tyre,

— in tare condition,

— with a voltage of between 1,8 and 2 volts,

shall be less than:

— 0,01 ohm when new,

— 0,1 ohm after overhaul of the wheelset.

In the case of independent wheels (left and right parallel wheels that rotate independently), it is necessary to electrically connect the pair of wheels to comply with the abovementioned values.

4.2.11. **Hot-box detection** [1]

Axle box temperature rise shall be detected on high-speed trains.

This monitoring equipment shall be able to detect a temperature rise over time to allow abnormal temperature rises in an axle box to be detected. It shall be able to reliably transmit warning and alarm messages that, if necessary, are graduated in order to initiate a speed reduction or a train-stop depending on the extent of the temperature rise.

To prevent confusion when a hot box warning is given, the hotbox detection system has to be located entirely on board.

In addition, it has to be taken into account that axle box temperature-monitoring equipment is nevertheless installed on the ground to monitor trains not yet equipped with such train-borne systems or other types of trains running on the line.

Train-borne equipment shall not interfere with trackside axle box temperature-monitoring equipment installed on the routes concerned.

[1] This item will be included in the list of interoperability constituents in a future version of this TSI.

Infrastructure managers shall ensure the compatibility between the operation of interoperable trainsets and trackside axle box temperature monitoring equipment, according to the conditions set out in Section 7.2.6.2 of infrastructure TSI.

4.2.12. **Emergency alarm**

Passenger areas on high-speed trains shall be fitted with emergency signal devices conforming to the following provisions:

— emergency handle to activate the continuous brake must be installed in coaches where they can be easily seen and reached by passengers without having to pass through an interior door. The emergency handle must be clearly indicated by easily understood logos and instructions enabling passengers to use it without difficulty.

The emergency handle must have a clearly visible seal prior to passenger use.

The alarm once activated shall not be capable of being disengaged by passengers. If a device is provided to indicate that the alarm has been activated it should be marked as indicated in Annex Q to this TSI.

Operation of the emergency signal shall be indicated next to the device used.

Activating the alarm shall:

— initiate braking,

— cause a visual (flashing light) and acoustic (buzzer/klaxon) alarm to be triggered in the driver's cab,

— transmit a message (acoustic or visual signal) to the train crew working among the passengers,

— transmit an acknowledgement, recognisable by the person who triggered the signal (acoustic signal in the vehicle, braking application, etc.).

In all cases, the arrangements installed in the rolling stock (automatic brake application, in particular) shall allow the driver to intervene in the braking process so as to be able to choose the stopping point of the train, or start again immediately if the train has stopped. For this purpose, activation of one or more other alarms shall have no further effect, whilst the train-crew has not re-armed the first.

Lastly a connection between cab and train shall enable the driver, at his or her initiative, to investigate the reasons why the emergency signal was triggered.

4.2.13. **Slipstream effects**

The behaviour of a train with respect to slipstream effects on persons outside the train is characterised by the trackside forces created on passage of the trainset.

The sensor used is a dummy with the following characteristics:

A cylinder constituting a test body subjected to the slipstream effect with the following geometrical characteristics:

— cylinder frontal area: $0{,}36 m^2 \pm 0{,}05 m^2$,

— cylinder height: 0,92 m ± 0,10 m,

— height of the pressure centre (cylinder centre) in relation to the base of the bearing device: 1,10 m ± 0,15 m,

— a device maintaining the cylinder in its measuring position at garage distance $d_G$,

— a measurement system.

Definitions:

Ve: test speed in km/h.

$V_{max}$: the anticipated operating maximum speed in km/h.

$TT_{max}$: maximal effort module for the whole trainset.

IT: trail index in N.

$d_G$: garage distance, or distance separating the outside model face (the closest to the rail) of the outside rail face.

It can be defined:

$$NM = \frac{TT_{max}}{Ve^2}$$

Then comes:

$$\begin{cases} IT = \left(\overline{NM} + 2 \cdot \sigma_{NM}\right) \cdot V_{max}^2 \\ \overline{NM} : \text{Sample mean of NM} \\ \sigma_{NM} : \text{Standard deviation of NM} \end{cases}$$

The reference values of the drag effect IT are defined as follows:

The interoperable trainsets have to respect:

— at the speed of 300 km/h,

— or in the maximal speed of the trainset if it is lower than 300 km/h,

IT value:

$$IT < \text{or} = 185 \text{ Nat a distance } d_g \text{ of } 2 \text{ m}$$

4.2.14. **Effect of cross-winds**

This item is still an open question (further studies underway). The transitional situation is described in the infrastructure TSI, Section 4.3.3.23.

4.2.15. **Eddy current brakes**

This paragraph deals with the Infrastructure subsystem interfaces relating to the use of eddy current track brakes.

As specified in the infrastructure TSI, the use of this type of brake, independent of adhesion, on the lines (to be built, upgraded or connecting) of the interoperable network is permissible as follows:

— for emergency braking on all lines except some specific connecting lines listed in the infrastructure register,

— for Full or normal service braking over the major part of the network. Use of this type of brake is permissible, line-by-line, as given in the infrastructure register.

The interoperable trainsets equipped with this type of brake shall meet the following specifications:

— brakes independent of wheel rail adhesion can be used from the maximum operating speed down to 50 km/h: (Vmax ≥ V ≥ 50 km/h),

— the maximum average deceleration shall be less than 2,5 $m/s^2$ (this value, which is an interface with the longitudinal resistance of the track, shall be met with all brakes in use).

— in the worst case, that is to say with the trainsets working in multiple to their maximum permitted train length, the maximum longitudinal braking force applied to the track by a train shall not exceed:

  — 360 kN in emergency braking

  — 180 kN (provisional value) for full service braking to meet the speed limits set by the signalling system

  — 100 kN (provisional value) for braking on steep gradients or where speed limits are automatically applied.

This is with the understanding that the safe operation of this type of brake can be proven and in particular the absence of risk relating to common mode failures. It is permissible to include the contribution of brakes independent of adhesion in the braking performances defined in Section 4.1.5 of the present TSI, for operation on lines where their use is permitted for full and normal service braking.

4.2.16. **Flange lubrication**

To protect the rails and wheels against excessive wear, particularly in curves, the interoperable trainset shall be equipped with flange lubrication. This shall be installed and monitored according to the following provisions:

lubrication must be assured in the curves with radius lower or equal to 1 200 m;

after such a lubrication:

— a continuous film of lubricant is present on the active zone of the rail shoulder,

— the bearing surface wheel/rail is not polluted, so as to not degrade braking performance.

Flange lubrication shall ensure the protection of all axles of the trainset.

4.2.17. **Suspension coefficient**

This parameter influences the dynamic loading gauge of a vehicle. The suspension coefficient of vehicles equipped with pantographs shall be less than 0,25.

4.2.18. **Minimum curve radius**

This parameter is an interface with the infrastructure subsystem in that the minimum curvatures to be taken into account are defined partly by the high-speed tracks (based on the cant deficiency) and partly by the existing network.

4.2.19. **Maintenance**

(a) Maintenance plan

In order to guarantee that the performance of each of the characteristics in this TSI is maintained, the existence and application of a rolling stock maintenance plan shall be required.

The maintenance plan shall be set up by the owner of the rolling stock or his agent in order to guarantee maintenance of the characteristics specified in the rolling stock subsystem.

As a minimum the maintenance plan shall contain the following elements:

— a set of inspections to be carried out with, if necessary, statements of the allowable limits (values outside which the train can no longer safely operate),

— a set of equipment replacement schedules to be carried out on the basis of wear or period of use,

— statements of the periodicity of these checks and how they are controlled,

— provisions for the training and qualification of maintenance personnel,

— standards relating to the provisions, checks and values called for above,

— arrangements of the means of implementing these checks,

— methods to ensure traceability of maintenance work on the rolling stock.

The existence of the maintenance plan including the above elements will be verified by the notified body, but the operator is responsible for values and periodicities indicated in the maintenance plan.

(b) Maintenance work

The majority of the maintenance work shall be the responsibility of the railway undertaking that operates the vehicle. In-service maintenance and minor repairs necessary to ensure a safe return journey shall be able to be carried out on parts of the network distant from the vehicles' home base, including whilst stabled on a foreign network. The main tasks concerned are required between the legs of a return journey:

— filling and emptying (water, WC, sand, etc.),

— cleaning of the vehicle.

Also minor repairs and unplanned maintenance.

To facilitate these operations, interoperable trainsets shall be capable of being stabled, with no crew onboard, with auxiliary power supply maintained for lighting, air conditioning, refrigerated cabinets, etc.

The various requirements applicable to interoperability for undertaking these tasks are specified in the maintenance TSI.

The functional interfaces between the maintenance subsystem and the rolling stock subsystem are as follows:

— external cleaning of trainsets (Section 4.2.2.2.1 of the maintenance TSI)

— the system for emptying retention toilets (Section 4.2.2.2.2 of the maintenance TSI)

— interior cleaning of trainsets (Section 4.2.2.2.3 of the maintenance TSI)

— arrangements for replenishing water and sand (Sections 4.2.2.2.4 and 5 of the maintenance TSI)

— stabling arrangements (Section 4.2.2.2.6 of the maintenance TSI).

The constituents that interface between the maintenance and rolling stock subsystems are:

— the connectors for toilet emptying (Section 5.3.1 of the maintenance TSI)

— the power sockets for interior cleaning of the trainsets (Section 5.3.3 of the maintenance TSI)

— the connectors for water replenishment (Section 5.3.5 of the maintenance TSI)

4.2.20. **External lights and horn**

(a) Front and rear lights

As specified in Section 4.2.1, it is permissible for trains to be made up of one or more trainsets. The lights described below shall only appear at the front and rear ends of the complete train formation.

The external lights of driving cabs located at intermediate points within the train shall be kept switched off.

The trainsets shall be fitted with:

— three fixed white indicator lamps at the front of the train in the direction of travel, two in a horizontal line on the lower part and a third placed centrally above,

— two red indicator lamps at the rear of the train in a horizontal line.

In addition to their traditional role as the front and rear indicator lamps, it shall be possible in emergency to use the lamps in specific ways and arrangements.

The dimensions, fitting, positioning, visibility, intensity, operation, etc., of the lamps shall be as specified in Annex H to this TSI.

(b) Horns

The trainsets shall be fitted with horns with two distinct tones.

4.2.21. **Lifting/rescue procedures**

A procedure shall be established for managers of the infrastructures regularly operated over by the trainsets which describes the method as well as the means of recovering a trainset in difficulties.

4.3. SPECIFIED PERFORMANCE

To verify the rolling stock subsystem, performance criteria for the trans-European high-speed network shall be met for the specific requirements of each of the following line categories:

— kines specifically built for high speed,

— lines specifically upgraded for high speed,

— lines specially upgraded for high speed but with special characteristics.

For the rolling stock subsystem these requirements are:

4.3.1. **Minimum performance requirements**

In order to run on the interoperable network and under conditions allowing trains to slot smoothly into the overall traffic pattern, all high-speed rolling stock shall be required to guarantee minimum traction and braking performance levels. The trains shall have sufficient standby and backup capacity to ensure that these performance levels are maintained or only slightly downgraded in case of breakdown in systems or modules contributing to these processes (traction chain from pantograph to axles, mechanical/electrical braking equipment). These margins and redundancies are defined in detail in the characteristics contained in Sections 4.3.2 to 4.3.6, 4.3.9, 4.3.11, 4.3.15 and 4.3.16.

In the event of the failure of rolling stock equipment or functions, or passenger overload, the rolling stock operator shall, in full knowledge of the consequences, have defined the acceptable limits and operating conditions associated with each degraded mode. For this purpose, the various degraded modes that can be experienced in service shall be described and indexed in a special document.

Performance levels demanded on the other lines and feeder lines that do not form part of the interoperable network as such, but allow access to terminal installations (stations, train stabling tracks,), shall be defined in bi-or multilateral agreements between operators and infrastructure managers depending on the service levels planned.

4.3.2. **Maximum service speed of trainsets**

Interoperable trains shall have, in conformity with Article 5(3) of and Annex I to Directive 96/48/EC, a maximum service speed of:

— at least 250 km/h in the case of rolling stock designed for lines specially built for high speed,

— the order of 200 km/h in the case of rolling stock designed for existing lines which have been or are to be specially upgraded.

The maximum service speed is the nominal speed trains are expected to run in daily operation on appropriate sections.

In both cases, it shall be possible for interoperable rolling stock to be worked at their maximum speed (if allowed by the infrastructure) with sufficient acceleration margins (as specified in the following paragraphs).

4.3.3. **Traction performance requirements**

In order to guarantee proper compatibility with other train operations, the mean minimum accelerations calculated over time on a level track shall be:

— 0 to 40 km/h: 48 $cm/s^2$

— 0 to 120 km/h: 32 $cm/s^2$

— 0 to 160 km/h: 17 $cm/s^2$

At the maximum service speed and on level track, the residual acceleration shall be at least 5 $cm/s^2$.

For reasons of availability, traffic flow, and safe clearance of tunnels, three conditions shall be met by the trainsets:

— performance shall be achieved with the mean supply voltage available at the pantograph as specified in energy TSI Section 4.3.1.1, Annex L,

— a failed traction module shall not deprive the trainset of more than 25 % of its rated output,

— failure of a traction supply element shall allow at least 50 % of the traction modules to continue in operation.

Under these conditions it shall be possible for a trainset under normal load (number of seats × 80 kg) with a traction module out-of-service to start on the maximum gradient it is likely to meet with a residual acceleration in the vicinity of 5 $cm/s^2$. It shall be possible for this starting regime to be maintained for 10 minutes, and for the speed to reach 60 km/h.

4.3.4. **Traction adhesion requirements**

To ensure a high availability of traction, the utilisation of adhesion shall not exceed the values given below:

— at start-up and at very low speed: 25 %

— at 100 km/h: 25 %

— at 200 km/h: 17,5 %

— at 300 km/h: 10 %.

In order to make the best of the adhesion available, interoperable rolling stock shall be equipped with an anti-slip system.

4.3.5. **Brake adhesion demand limits**

For speeds between 50 and 200 km/h, the maximum adhesion coefficient demand during braking shall be no more than 0,15. For speeds above 200 km/h, the adhesion coefficient demand declines linearly to 0,10 at 350 km/h.

A train in full service condition and a normal passenger load shall be used to verify these values.

4.3.6. **Brake system requirements**

In addition to the needs listed in Sections 4.1.5 and 4.3.5, the braking system of interoperable trainsets shall be designed in such a way that attainment of the safety objectives set by Directive 96/48/EC can be demonstrated. In particular that they do not introduce any degradation in this area, either for the rolling stock subsystem or the total rail system.

This demand is implicitly satisfied by interoperable trainsets using UIC braking systems. For other braking systems, a demonstration must establish that it is possible to achieve a level of operation at least as safe as that achieved in the prescribed standard.

Furthermore, and whatever is envisaged for construction, the brake system must meet the following requirements:

for the complete train:

— use of the emergency brake, for whatever reason, shall automatically cut all traction power, without the facility to reapply traction power while the emergency brake is applied,

— the emergency brake shall be capable of being applied at all times with the driver in his normal driving position,

— vehicles shall be fitted with wheel-slide devices to control the sliding of wheels in the event of reduced adhesion between wheel and rail,

— vehicles shall be equipped with a wheel-monitoring system to advise the driver that an axle has seized. The wheel-monitoring system shall be independent of the wheel-slide system in all its functions.

Electric braking:

— it shall only be permissible to take account of the electric brake in the brake performance if its operation is independent of the presence of voltage in the catenary,

— where the electrical installations (the sub-stations) permit, the return of electrical energy generated in braking is permissible, but this shall not cause the voltage to exceed the limits defined in Annex P to this TSI,

— in addition, in the event that the supply to the catenary is lost, it shall not prohibit the line voltage dropping to 0 V.

In addition, interoperable trainsets shall be provided with:

— indicators of brake failure,

— a means of brake isolation,

— a system of (brake) fault diagnostics.

4.3.7. **Service braking performance**

In addition to the specifications required in Section 4.1.5 'minimum braking characteristics', the trainsets shall comply with the average decelerations in service defined below:

Table 4.3.7

| Braking mode | $t_e$ (s) | Minimum deceleration under set braking conditions ($m/s^2$) | | | |
|---|---|---|---|---|---|
| | | 330 to 300 (km/h) | 300 to 230 (km/h) | 230 to 170 (km/h) | 170 to 0 (km/h) |
| Normal service braking | 2 | 0,35 | 0,35 | 0,6 | 0,6 |

$t_e$(s) = equivalent time of application.

These decelerations shall be achieved by a train on level track, in the configurations defined in Section 4.1.5, case A and B.

4.3.8. **Protection of an immobilised train**

It shall be possible for the train to be kept stationary for an indefinite period on the maximum gradient on the line concerned. When the parking brake alone is not sufficient, it shall be supplemented by extra on-board facilities.

4.3.9. **Brake performance on steep gradients**

(reserved)

4.3.10. **Detection of derailments**

Derailment detection systems shall be installed on new builds of trainsets, when they are available and homologated.

4.3.11. **Protection against fire and toxic fumes**

(a) The trainsets shall be able to continue to operate for 15 minutes at a speed of at least 80 km/h with a fire declared to be on board. A fire in an area that is open to natural ventilation must not allow transmission to other areas of the train within 15 minutes.

(b) Passengers and train crew shall be protected against fire hazards. A fire resistance of at least 15 minutes shall be provided between:

— high power electrical equipment and passengers and staff areas,

— two vehicles of the trainset

(c) For thermal engines, the fire barriers between the driver's cab, passenger and staff areas, thermal engines and fuel tanks, shall have a fire resistance of at least 30 minutes.

(d) The high voltage electrical equipment compartments and those parts of the train not directly visible to the train crew or passengers which are likely to be the source of a fire shall be equipped with a system of fire detection, parts of the train to be so equipped shall be defined as the result of a global assessment of fire risks.

(e) In order to prevent fire, materials with low flammability must be used and electrical installations must meet appropriate European specifications.

(f) In case of fire in closed areas in the train, material on board shall not produce fumes that could jeopardise passenger and crew who are evacuating.

(g) In order to enable train crew and passengers to fight a fire, adequate and sufficient fire extinguishers must be provided on board.

(h) External signs shall indicate the location of emergency exits and the position of the devices to unlock the doors

4.3.12. **Environmental conditions for rolling stock**

The rolling stock, as well as the on-board equipment, shall be able to be put into service and operate normally in the conditions specified in the EN 50125-1 standard and function in climatic zones for which the equipment is designed and in which it is likely to run.

The different environmental conditions likely to be experienced on the lines worked are specified in the infrastructure register.

4.3.13. **Monitoring and diagnostic concepts**

The functions and equipment specified in this TSI and repeated below, shall be monitored because they present an important risk to safety in the event of a failure or operating fault:

— failure of the driver vigilance device (Section 4.2.2)

— control-command sub-system information (Section 4.2.4)

— door operation (Section 4.2.6)

— running gear instability detection (Section 4.2.10)

— on-board hot-box detection system (Section 4.2.11)

— activation of the passenger alarm (Section 4.2.12)

— fault in the brake system (Section 4.3.6)

— derailment detection (Section 4.3.10)

— fire detection (Section 4.3.11).

This monitoring shall be continuous, or at a suitable frequency to ensure reliable detection of failure in good time. The system shall also be linked to the on-board data recorder to allow the necessary traceability.

Indication to the driver shall be made of such detection, and shall require acknowledgement by the driver. Automatic action shall be required where a fault can have grave consequences for safety.

4.3.14. **Particular specification for long tunnels**

The characteristics described in this paragraph shall only be applicable to interoperable trainsets called on to traverse long tunnels in normal service. The information to identify the lines where such tunnels are located is to be found in the infrastructure register.

(a) Passenger and train crew areas as well as drivers' cabs equipped with air conditioning:

The train crew shall be able to close external air vents to prevent the inhalation of fumes in the event of a fire in close proximity to the train. At the same time, the ducting for the air recirculation shall be designed so as not to distribute fumes to the whole train in the event of an internal fire located in a passenger saloon.

(b) Public address system:

In order to remain available in the event of an incident, the public address system shall be designed in such a manner that it will continue to operate the majority of its loud speakers in the event of a failure in one of its transmission elements.

4.3.15. **Emergency lighting system**

To provide protection and safety on board in the event of all types of emergency, including fire, the interoperable trainsets shall be equipped with an emergency lighting system. This system shall provide a suitable lighting level in the passenger and in the service areas, for a minimum operating time:

— operating time of three hours after catenary supply has failed,

— lighting level of at least 5 lux at floor level.

These applicable values are defined in Annex N to this TSI. The testing methods are indicated in Chapter 6.

4.3.16. **Public address system**

Trains shall be equipped with a means of communication:

— for the train crew and ground control to address the passengers in a train,

— for the train crew and ground control to communicate between one another, using the track to train link,

— for internal communication between the train crew, especially between the driver and staff in the passenger saloons.

The equipment shall be able remain on standby and function independent of the catenary supply for at least three hours.

The public address system shall be designed so as to operate 50 % of its loudspeakers in the event of a failure of one of the transmission elements.

Apart from the emergency alarm (see Section 4.2.12) no specific provisions are prescribed for passengers to contact train crew or ground control.

4.3.17. **Protection against electric shock**

Electrically live components shall be designed such that conscious and unconscious contact with train staff and passengers is prevented, in normal operation and in case of equipment failure.

Earth bonding of the coach body shall be provided in case of failures in the high-voltage train equipment or of breakage of the contact wire.

Rolling stock shall comply with EN 50153, and for earthing, with the provisions of Annex O to the present TSI.

4.3.18. **Driver's cab**

(a) Access and egress:

The cab shall be accessible from both sides of the train from the platform and ground level.

It is permissible for this access to be either directly from the exterior or through an adjoining compartment (either an equipment room or an area occupied by passengers) at the rear of the cab.

The train crew shall be able to prevent the cab being accessed by non-authorised persons.

(b) External visibility

Vision ahead: The driver shall be able to see fixed signals set to the left or right of the track when the trainset is on a level and straight track in the following conditions:

— a high level signal set at a distance of 2,5 m from the track centre, with a height up to 6,3 m at a distance at least 10 m ahead of the coupler,

— a ground signal set at a distance of 1,75 m from the track centre at a distance of at least 15 m ahead of the coupler.

Side vision: The driver shall be provided with a window or opening panel at each side of the cab allowing him to view his train while it is standing at the platform or speak with platform staff if necessary.

(c) Seats:

The main seat available to the driver shall be designed in such a way that it allows him to undertake all normal driving functions in a seated position.

In addition, a second seat shall be provided giving a forward view for possible accompanying crew.

(d) Interior layout:

Freedom of movement of personnel in the cab interior shall not be inhibited by projections. The floor of the cab shall not be uneven.

4.3.19. **Wind screen and front of the train**

The drivers cab windscreens shall:

(A) be of an optical quality in accordance with the following characteristics: The types of safety glass used for the front windows, and any heated windows (windows heated to prevent frost) of drivers' cabs must not alter the colour of signals and their quality must be such (generally laminated glass) that the glass, when pierced or starred, remains in position and affords staff protection and sufficient visibility to enable the train to continue its journey;

(B) be equipped with cleaning, de-icing and de-misting facilities;

(C) Be able to resist impacts from projectiles: the front windows must be sufficiently strong to obviate any risk of their being pierced by solid projectiles such as large ice blocks, birds, large pieces of ore falling from freight trains, or bottles, cans, etc. thrown from passing trains.

Conformity will be validated by the test indicated in Section 6.3.

The front end of the train shall be capable of resisting the same impact as the window in order to protect persons travelling in the front vehicle.

4.3.20. **Passenger information signs**

All passenger signs closely connected with safety shall be capable of being instantly understood by the majority of passengers. For this purpose, they shall use the unified sign formats given in standard ISO 7001.

4.3.21. **Toilets available to passengers and train crew**

Sealed retention toilets shall be installed onboard. Flushing is permissible with either clean water or by re-circulation techniques. They shall have tanks able to operate in normal service for three days without emptying.

## 5. INTEROPERABILITY CONSTITUENTS

5.1. According to Article 2(d) of Directive 96/48/EC the interoperability constituents are

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

5.2. The interoperability constituents are subject to the relevant provisions of the Directive 96/48/EC and are listed in Annex to the present TSI.

5.3. These interoperability constituents are subject to performance specifications Assessment of conformity and/or the range of their application is principally carried out by means of the interfaces of the interoperability constituent — recourse to conceptual or descriptive characteristics being exceptional.

5.4. For the purposes of this TSI the following are declared to be 'interoperability constituents':

— the couplers at the ends of the trainsets (Section 4.2.9)

— the wheels (Section 4.2.10)

— the constituents that interface with the maintenance subsystem (Section 4.2.19)

— lights and warning devices at the ends of the trainset (Section 4.2.20)

— driver's cab windscreens (Section 4.3.19).

The characteristics to be respected by interoperable high-speed rolling stock are given in the relevant paragraphs of Chapters 4.2 and 4.3 indicated above.

## 6. ASSESSMENT OF CONFORMITY AND/OR SUITABILITY FOR USE

### 6.1. INTEROPERABILITY CONSTITUENTS OF ROLLING STOCK

#### 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 F to this TSI.

The phases for the application of the conformity and suitability for use assessment procedures for the interoperability constituents: end couplers, wheels, constituents that interface with the maintenance subsystem, lighting and warning devices at the vehicle ends, driver's cab windscreen as defined in Chapter 5 of this TSI are indicated in Annex D, Table 1 to this TSI.

As far as required by the modules specified in Annex F 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.

#### 6.1.2. Application of modules

6.1.2.1. *Assessment of conformity*

For the assessment procedure of interoperability constituents that interface with the maintenance subsystem within the rolling stock subsystem, the manufacturer or his authorised representative established within the Community shall apply the internal control of production procedure (module A) indicated in Annex F of this TSI for all phases.

For the assessment procedure of interoperability constituents such as end couplers, wheels, lighting and warning devices at the vehicle ends, driver's cab windscreens within the rolling stock subsystem, the manufacturer or his authorised representative established within the Community may choose:

— the type-examination procedure (module B) indicated in Annex F to this TSI for the design and development phase in combination with:

  either the production quality assurance procedure (module D) indicated in Annex F of this TSI for the production phase,

  or the product verification procedure (module F) indicated in Annex F to this TSI,

or alternatively

— the full quality assurance with design examination procedure (module H2) indicated in Annex F to this TSI for all phases.

6.1.2.2. *Assessment of suitability for use*

For the assessment procedure of interoperability constituent such as end couplers, wheels, constituents that interface with the maintenance subsystem, lighting and warning devices at the vehicle ends, driver's cab windscreen within the rolling stock subsystem, the manufacturer or his authorised representative established within the Community shall apply the type validation of in service experience procedure (module V) indicated in Annex F to this TSI.

6.1.2.3. *Definition of assessment procedures*

The assessment procedures are defined in Annex F to this TSI.

Module D may only be chosen where the manufacturer operates a quality system for production, final product inspection and testing, approved and surveyed by a notified body.

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

The conformity and suitability for use assessment shall cover the phases and characteristics as indicated by X in the Table 1 of Annex D to this TSI.

6.2. ROLLING STOCK 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 F to this TSI.

If the adjudicating entity can demonstrate that tests or verifications for previous applications remain valid in the new application, then the notified bodies shall take them into account in the conformity assessment.

Assessment procedures for the EC verification of the rolling stock subsystem, list of specifications and descriptions of the testing procedures are indicated in Annex E, Table 2 to this TSI.

As far as specified in this TSI the EC verification of the rolling stock subsystem shall take account of 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 rolling stock 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 rolling stock subsystem the adjudicating entity or its authorised representative established within the Community may choose either:

— the type-examination procedure (module SB) indicated in Annex F to this TSI for the design and development phase in combination with:

  either the production quality assurance procedure (module SD) indicated in Annex F to this TSI,

  or the product verification procedure (module SF) indicated in Annex F to this TSI for the production phase,

or alternatively

— the full quality assurance with design examination procedure (module SH2) indicated in Annex F to this TSI for all phases.

The SH2 module may be chosen only where all activities contributing to the rolling stock subsystem project 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 SD module may be chosen only where all activities contributing to the rolling stock subsystem project to be verified (manufacturing, assembling, installation) are subject to a quality system for production, final product inspection and testing, approved and surveyed by a notified body.

If these two above conditions are not fulfilled, the SB module in combination with the SF module is to be applied.

The assessment shall cover the phases and characteristics as indicated in Table 2, of Annex E to this TSI.

6.3. SPECIFIC TEST METHODS

6.3.1. **Limit characteristics related to internal noises — measuring methods**

Measurements shall be effected under the following conditions:

— the doors and windows must be closed,

— the track must be in good running order, and track characteristics must be specified by the owner-railway,

— the hauled loads must be equal to at least twothirds of the maximum permissible value.

The maximum speed must be maintained for at least 90 % of the measurement time.

The measurement time may be subdivided into several short periods in order to comply with the abovementioned conditions.

The measurement shall be made level with the driver's ear (in the seated position), in the centre of the horizontal surface stretching from the front windowpanes to the rear wall of cabs.

6.3.2. **Method to test the front window of the cab for sufficient resistance to projectiles**

A cylindrical projectile shall be fired at the front window, the projectile shall have a hemispheric tip and have a total mass of 1 kg and be constructed as shown in Annex J. If the projectile sustains permanent damage after impact, it must be replaced.

For the test, the front window shall be fixed in a frame of the same construction as that mounted on the vehicle.

The temperature of the window during the tests must be between −15 °C and 35 °C. The projectile is assumed to impact at right angles to the window or alternatively the test window can be mounted at the same angle to the track as it is mounted in the vehicle.

The projectile's impact velocity shall be determined by:

$$Vp = Vmax + 160 \text{ km/h}$$

Vp = velocity of the projectile in km/h on impact

Vmax = maximum velocity of the trainset in km/h

The test result shall be deemed satisfactory if:

— the projectile does not break through the front window,

— the window remains in its frame.

## 7. IMPLEMENTATION OF THE ROLLING STOCK TSI

### 7.1. APPLICATION OF THIS TSI — PRINCIPLES

#### 7.1.1. **New rolling stock**

As to the new rolling stock which will be put into service after the entry into force of this TSI, Chapters 2 to 6 are entirely applicable, except possible specific provisions of Section 7.3 hereafter.

In addition, information included in the infrastructure register shall be taken into account, as explained in Section 7.2 hereafter.

#### 7.1.2. **Rolling stock being upgraded**

In respect of rolling stock already in operation, this TSI applies to existing high-speed trains or conventional rolling stock to be upgraded 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.

In the majority of cases, the application of this TSI on existing rolling stock will demand important modifications, which will mainly be undertaken at the time that the trainsets undergo major refurbishment or overhauls.

### 7.2. COMPATIBILITY OF ROLLING STOCK WITH OTHER SUBSYSTEMS

The implementation of the rolling stock TSI has to comply with the requirement of full compatibility between the rolling stock and the fixed installations, including energy and control-command. This principle applies to the interoperable network covered by the TSIs, whereby it has to be taken into account that the rolling stock may have to be prepared to circulate also on existing national networks.

Following this, the implementation methods and phases concerning rolling stock depend on the following conditions:

— the progress of implementation of the infrastructure, energy and control-command TSIs,

— the rolling stock operational schemes (rosters) which may cover existing national networks.

The tools to ensure the compatibility requirement as well as to take into account the abovementioned conditions are: infrastructure register (trans-European network high-speed (TEN HS)), respectively set up for a specific line or route, represent a compilation of the following characteristics (basic parameters, interfaces, performances):

— characteristics on which TSIs allow alternative values,

— characteristics on which TSIs contain specific cases,

— characteristics on which the specifications given in the TSIs are provisionally not met, e.g. before full implementation of the TSIs, or due to temporary maintenance works,

— characteristics which are based on regional conditions.

Registers of rolling stock (TEN HS) (See Annex I: characteristics required to appear in the Register of Rolling Stock), respectively set up for a specific type of trainsets or if needed for one specific train, representing a description of the train characteristics (basic parameters, interfaces, performances) which are needed to assess the ability of the train to run on all or on a part of the lines of the trans-European rail transport network.

The implementation of the rolling stock TSI must take into account the infrastructure register of those lines on which the rolling stock will be operated.

The register of rolling stock must contain all the corresponding rolling stock specifications to describe the requirement for putting into service of the trains for operation on the lines on which they will be operated.

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 temporarily ('T' cases). As to temporarily cases, it is recommended that the target system is reached either by 2010 ('T1' cases), an objective set in European Parliament and Council Decision No 1692/96/EC of 23 July 1996 on Community guidelines for the development of the trans-European transport network, or by 2020 ('T2' cases).

7.3.1. **Vehicle loading gauge (Section 4.1.4)**

— Specific case for lines in Britain:

Trains designed for interoperable running on upgraded lines in Britain shall comply with 'UK1' gauge as defined in Annex C to this TSI.

— Specific case for trains running on Irish and Northern Irish networks:

The loading gauge of trains designed for interoperable running on lines of the Irish and Northern Irish networks shall be compatible with the Irish standard structure gauge.

7.3.2. **Boundary characteristics linked to exterior noise (Section 4.1.8)**

It is allowable to apply Section 4.1.8 of this TSI (excluding the footnote) with the limit values referred to in the table below, for a transitional period of 24 months starting from the date of entry into force of this TSI, in the case of:

— options to purchase additional vehicles in contracts already signed at the date of entry into force of this TSI, or

— rolling stock being contracted during the transitional period based one existing design platforms.

| V<br>km/h | Noise level<br>dB(A) |
|---|---|
| 250 | 90 |
| 300 | 93 |
| 320 | 94 |

Rolling stock already in operation and requiring a new authorisation for placing into service or already contracted at the date of entry into force of this TSI shall be allowed to run with the maximum abovementioned limit values.

7.3.3. **Maximum pressure variations in tunnels (Section 4.1.13)**

To take account of the numerous tunnels with a cross-section of 54 $m^2$ which are traversed at 250 km/h, and those with a cross-section of 82,5 $m^2$ and traversed at 300 km/h, Interoperable trainsets operating on the Italian network shall conform to the following envelope curve:

— $\Delta P0 < \text{or} = 1\,600$ Pa,

— $\Delta P1 < \text{or} = 3\,000$ Pa,

— $\Delta P1 - 0{,}8\Delta P0 < \text{or} = \Delta P2$.

These values are given by:

— a ratio between the train and tunnel cross-sections of 0,18,

— a service speed of 250 km/h,

If a trainset does not fulfil the values specified above, the operation rules for this train shall be determined by applying the published rules of the infrastructure manager.

7.3.4. **Passenger step (Section 4.2.5)**

— Specific case for British lines:

The passenger step for those trainsets intended to serve the British network shall be optimised for the 915 mm platform height on that system in accordance with Section 4.2.5.

— Specific case for the lines of the Netherlands network:

The passenger step for those trainsets intended to serve the Netherlands network shall be optimised for the 840 mm platform height on that system in accordance with Section 4.2.5.

— Specific case for trains running on Irish and Northern Irish networks:

The passenger step of trains designed for interoperable running on lines of the Irish and Northern Irish networks shall be optimised for the design platform height set down for these lines in the TSI for the infrastructure system.

7.3.5. **Wheel-rail contact (wheel profiles) (Section 4.2.10)**

— Specific case for trainsets operating frequently on British lines:

It is permissible for trainsets that frequently operate on the British network to be fitted with wheels with the EP8 profile when the following conditions are met:

— the maximum service speed of the trainsets so equipped shall be less than or equal to 250 km/h,

— a report is made available which contains:

— a demonstration of the stable running of this profile on interoperable tracks,

— a calculation of the different critical speeds on interoperable tracks taking into account the range of wear experienced in service,

— a report of service trials on interoperable tracks to confirm these results.

— Specific case for trains running on Irish and Northern Irish networks:

Wheel sets of trains designed for interoperable running on lines of the Irish and Northern Irish networks shall be compatible with the track gauge of 1 602 mm.

7.3.6. **Protection against fire and toxic fumes**

Prior to the publication of the relevant European specifications, the conformity with the requirements of Section 4.3.11 shall be deemed to be satisfied by the verification of conformity to the applicable national regulation of a Member State.

7.4. RECOMMENDATIONS

7.4.1. **Boundary Characteristics linked to interior noise (BP20)**

Noise levels in the driver's compartments must be kept as low as possible, by limiting noise at source through appropriate measures (acoustic insulation, sound absorption).

The $L_{eq}$ equivalent continuous noise level measured over 30 minutes must not exceed 78 dB(A) in the drivers' cabs of motive power units running at speeds of 160 km/h.

When higher speeds are involved, every effort should be made to achieve the same value specified above.

| | |
|---|---|
| Values for speed = 300 km/h | |
| open track | ≤ 78 dB (A) recommended level<br>≤ 75 dB (A) target level |
| in tunnel regardless of the superstructure | ≤ 83 dB (A) recommended level<br>≤ 80 dB (A) target level |
| while stationary, with auxiliary equipment running and the windows closed | ≤ 68 dB (A). |

7.4.2. **Boundary characteristics linked to exterior noise (BP17)**

It is recommended that in the case of rolling stock to be ordered after 1 January 2005 or to be put into service after 1 January 2008, Section 4.1.8 of this TSI is applied with a reduction of 2 dB(A) at a speed of 250 km/h and 3 dB at speeds of 300 km/h and 320 km/h. In the case of 350 km/h, a reduction of 3 dB(A) should be striven towards.

This recommendation will serve as a basis for revising Section 4.1.8. in the context of the TSI revision process.

7.4.3. **Characteristics linked to the carriage of persons of reduced mobility (BP22)**

In addition to the provisions of Section 4.1.12, rolling stock have to take into account, as appropriate, the results of the COST 335 Action.

*ANNEX A*

**PASSIVE SAFETY — CRASHWORTHINESS**

Detailed description of the passive safety provisions covered in Section 4.1.7b of this document.

(b1) **Reminder of the problem at issue**

Collision is a risk of train operation that may be analysed depending on the nature of the different obstacles encountered. In the case of a railway obstacle (another train or rail vehicle), such an eventuality should normally be under the control of the railway system, signalling system, the operational rules, the automatic control mechanisms and the brakes which should be designed to reduce the probability of such an event to as close to zero as possible.

However, obstructions from outside the rail system such as road vehicles or lumps of rock may accidentally occur in the path of a train.

In the event of such a collision, an energy absorbing system allows the controlled deformation of parts specially designed for this purpose.

Improvements to rolling stock passive safety (to limit damage in the event of a collision) are not designed to compensate for any shortcomings in the active safety (collision avoidance) of the railway system but to supplement it in order to take account of events outside the railway system's control.

(b2) **Basic principles**

The guiding principles of this improvement are:

— to avoid overriding in the event of a collision between the two vehicles involved or between two vehicles behind one another in the same trainset,

— to limit the degree of deceleration in areas of the train reserved for passengers and the crew,

— to ensure minimal penetration of areas of the train reserved for passengers and the crew,

— to ensure the controlled deformation of the leading vehicle and the rest of the train by introducing elements that can absorb the energy generated by a collision elements and/or crumple zones.

(b3) **Reference accident**

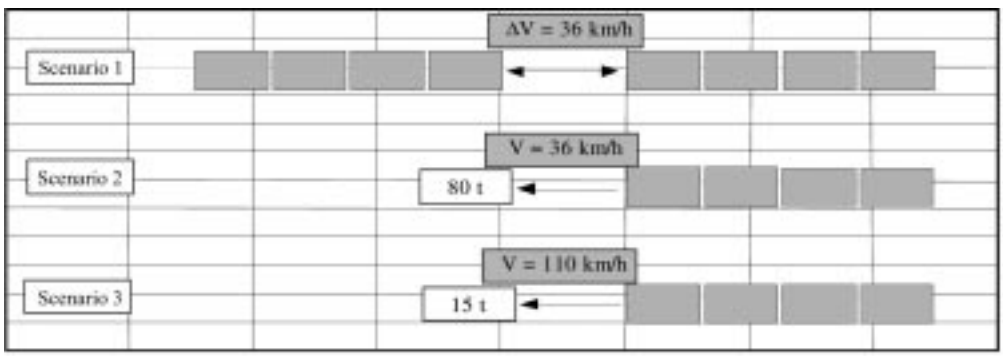
Three reference accidents are considered:

— *Scenario 1*

Collision between two identical high speed trainsets at a relative speed of 36 km/h

— *Scenario 2*

Collision between a high-speed trainset and a railway vehicle equipped with side buffers at a speed of 36 km/h. The railway vehicle is a four-axle freight wagon UIC 571-2 with an 80 tonne mass.



— *Scenario 3*

Collision at a speed of 110 km/h at a level crossing with a 15 tonne lorry represented by a rigid mass presenting a vertical surface for impact.

(b4) **Specifications**

— For Scenario 1 the driver's cab and the passenger saloons should not present plastic deformations which could affect the occupants' safety.

For Scenarios 2 and 3 the driver's cab may deform but the passengers saloons should not present plastic deformations which could affect the occupants' safety. The rear of the cab shall be fitted with a rigid survival cell for the driver with a length of at least 0,75 m. Access to the staff or passenger compartment located behind the cab shall be kept free at all times. Drivers' cabs at the ends of vehicles must have at least a door or a gangway allowing easy access for staff in an emergency to a longitudinal corridor leading to the opposite end. If a door is provided, it must open outwards from the driver's cab and must be as airtight as possible.

However, it must be possible to open the door just by pushing or in some other simple and quick manner. If there is any risk of obstruction (baggage, passengers), the door must be of the swing-type (opening outwards and inwards) or of the sliding type.

The exit must be easily accessible, not only to the driver, but also to the second man.

Accordingly the seat(s) must not be a major obstacle to reaching the exit.

It must be possible to exit from the driver's cab safely and without difficulty over a distance of at least 2 m. The exit should measure at least 1 800 mm in height, at least 500 mm in width, and the free door space should measure a minimum of 1 700 mm × 430 mm.

— 6 MJ of crash energy shall be dissipated, of which at least 75 % shall be in the front part of the first vehicle of the trainset and the remainder distributed over all the intercar links down the train,

— crashworthiness shall be increased in passenger saloons located in the leading vehicle and in the driver's survival cell. These sections shall be designed with a static load limit of at least 1 500 KN above the mean crush force of the crumple zones for the three collision scenarios considered,

— the crashworthiness of the leading vehicles should be consistent with that of the other vehicles in the trainset. The forces experienced in the crumple zones should not result in mean accelerations exceeding 5g in the passenger areas in the leading vehicle or in the driver's survival cell,

— anti-climbing devices shall be fitted between the vehicles comprising the train set.

*ANNEX B*

**MAXIMUM PRESSURE VARIATIONS IN TUNNELS**

A significant number of tunnels (both twin and single track) exist on the certain stretches of the high-speed network that can be passed through at maximum line speed.

When a train enters a tunnel, pressure waves are created in the tunnel that rebound from the tunnel ends. For health reasons, the effects of pressure waves experienced by passengers and train staff shall be limited.

The extent of the phenomenon depends on a number of parameters, of which the following are specific to the rolling stock:

— the ratio between the train and tunnel cross-sections,

— the shape of the nose of the train,

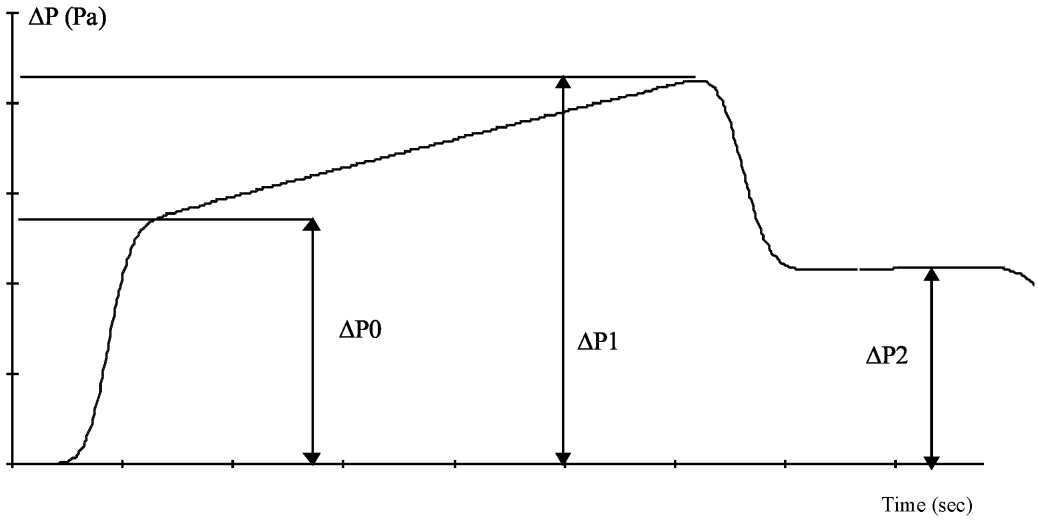
— the coefficient of friction between the train and the air flow in the tunnel,

— the length of the trainset,

— the shape of the train end.

The aerodynamic characteristics of a trainset vis-à-vis the generation of pressure waves in a tunnel can be created from the pressure variation in the tunnel at the time of the train's total entry into the tunnel.

The train can be defined by an envelope curve signature unique to that provided by the three pressure variations P0, P1 and P2. An example of these values can be found on the curve below.




Pressure variation at a point within the tunnel.

Envelope curve unique to the trainset.

Take these values at 250 km/h

— ΔP0 < or = 1 800 Pa,

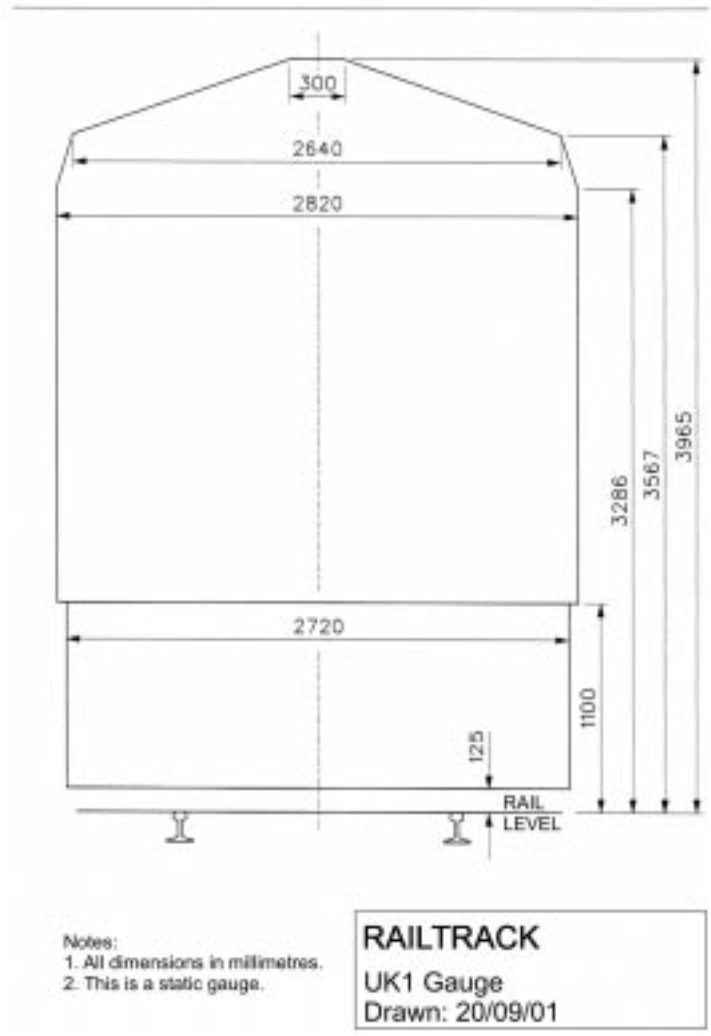
— ΔP1 < or = 3 200 Pa ,

— ΔP1 − 0,8ΔP0 < or = ΔP2.

These values are given by a blocking ratio between the train and tunnel cross-sections of 0,18.

*ANNEX C*

**MAXIMUM PROFILE FOR UK1 GAUGE**




**Definition of UK1 gauge**

The approach in the UK is to maximise the vehicle gauge while ensuring that the swept envelope of the vehicle is within the structure gauge at each point along the routes.

As a result the UK 1 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 D*

**ASSESSMENT OF INTEROPERABILITY CONSTITUENTS**

1. **Scope**

This Annex indicates the assessment of conformity and suitability for use for interoperability constituents within the rolling stock subsystem.

2. **Characteristics**

The characteristics of the interoperability constituents to be assessed in the different phases of design and production are marked by an 'X' in Table 1.

*Table 1*

Assessment of interoperability constituents of the rolling stock subsystem.

| 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 manu- factur- ing process | Type test | In service experience | (Series) |
| 4.2.9.a. | End coupler | X | n.a. | X | X | X |
| 4.2.9.b. | Emergency coupler | X | n.a. | X | X | X |
| 4.2.10.c. | Wheel profile | X | n.a. | n.a. | n.a. | X |
| 4.2.10.d. | Wheel material | X | X | X | X | X |
| 4.2.19. | In service maintenance: | | | | | |
| | Coupling for emptying retention toilets (TSI maintenance Section 5.3.1 and Annex IV) | X | n.a. | n.a. | n.a. | X |
| | Internal power sockets (TSI maintenance Section 5.3.3) | X | n.a. | n.a. | n.a. | X |
| | Connections for water replenishment (TSI maintenance Section 5.3.5 and Annex V) | X | n.a. | n.a. | n.a. | X |
| 4.2.20. | External lights and horn | X | n.a. | n.a. | n.a. | X |
| 4.3.19. | Windscreen | | | | | |
| | optical quality | X | n.a. | X | n.a. | X |
| | ability to resist impacts | X | n.a. | X | n.a. | X |

*ANNEX E*

**ASSESSMENT OF THE ROLLING STOCK SUBSYSTEM**

1. **Scope**

This Annex indicates the assessment of conformity of the rolling stock subsystem

2. **Characteristics and modules**

The subsystem characteristics to be assessed in the different phases of design, installation and operation are marked by an 'X' in Table 2. This table also lists the European specifications (standards) and the references of other documents giving details of assessment procedures.

*Table 2*

Assessment of the rolling stock subsystem

| 1 | | 2 | 3 | 4 |
|---|---|---|---|---|
| Characteristics to be assessed | | Assessment in the following phase | | |
| | | Design and development phase | | Production phase |
| | | Design review | Type test | Serial production quality |
| 4.1.1. | Maximum track forces | | | |
| 4.1.1.a. | Dynamic vertical load | n.a. | X | n.a. |
| 4.1.1.b. | Transversal track forces | n.a. | X | n.a. |
| 4.1.1.c. | Longitudinal track forces ([1]) | X | X | n.a. |
| 4.1.2. | Static axle load | n.a. | X | X |
| 4.1.3. | Maximum train length | X | n.a. | n.a. |
| 4.1.4. | Vehicle kinematic gauge (*) | X | X | n.a. |
| 4.1.5. | Minimum braking characteristics | | | |
| | Safe operation ([2]) | X | X | n.a. |
| | Minimum deceleration | X | X | X |
| | Maximum braking distance | X | X | X |
| 4.1.6. | Electrical boundary characteristics | | | |
| 4.1.6.1. | Voltage and frequency variations in the electrical supply (**) | X | X | n.a. |
| 4.1.6.2. | Maximum power demand (**) | X | X | n.a. |
| 4.1.6.3. | Power factor (**) | X | X | n.a. |
| 4.1.6.4. | Short over-voltages generated | X | n.a. | n.a. |
| 4.1.7.a. | Static resistance (vertical/longitudinal) | n.a. | X | n.a. |
| 4.1.7.b. | Crash worthiness | X | n.a. | n.a. |

| 1 | | 2 | 3 | 4 |
|---|---|---|---|---|
| Characteristics to be assessed | | Assessment in the following phase | | |
| | | Design and development phase | | Production phase |
| | | Design review | Type test | Serial production quality |
| 4.1.8. | Boundary characteristics outside noise | n.a. | X | n.a. |
| 4.1.9.1. | Interference to signalling system (**) | X | X | n.a. |
| 4.1.9.2. | Not used | X | X | n.a. |
| 4.1.9.3. | Radio frequency interference (**) | X | X | n.a. |
| 4.1.9.4. | Electromagnetic immunity (**) | X | X | n.a. |
| 4.1.10. | Boundary characteristics linked to inside noise in drivers cab | n.a. | X | n.a. |
| 4.1.11. | Boundary characteristics linked to air conditioning | n.a. | X | n.a. |
| 4.1.12. | Characteristics linked to carriage of persons of reduced mobility | X | n.a. | n.a. |
| 4.1.13. | Maximum pressure variations in tunnels | X | n.a. | n.a. |
| 4.1.14. | Starting, operating, stopping in maximum gradients (*) | n.a. | X | n.a. |
| 4.2. | Rolling stock subsystem interfaces | | | |
| 4.2.1. | Design of train configuration | X | n.a. | n.a. |
| 4.2.2. | Driver vigilance device | n.a. | n.a. | X |
| 4.2.3. | Electrification system: | | | |
| | Maximum power drawn from catenary (energy TSI Section 4.2.2.5) | X | X | n.a. |
| | Maximum power drawn at standstill (energy TSI Section 4.2.2.6) (**) | X | X | n.a. |
| | Voltage and frequency of supply (energy TSI Section 4.2.2.7) | X | X | n.a. |
| | Over-voltages caused by harmonics (energy TSI Section 4.2.2.8) | X | X | n.a. |
| | Electrical protection measures (energy TSI Section 4.2.2.8) | X | n.a. | n.a. |
| | Distribution of pantographs (energy TSI Section 4.2.2.9, Annex H) | X | n.a. | n.a. |
| | Running through phase separations (energy TSI Section 4.2.2.10, Annex H) | n.a. | X | n.a. |

| 1 | | 2 | 3 | 4 |
|---|---|---|---|---|
| Characteristics to be assessed | | Assessment in the following phase | | |
| | | Design and development phase | | Production phase |
| | | Design review | Type test | Serial production quality |
| | Running through system separations (energy TSI Section 4.2.2.11) | n.a. | X | n.a. |
| | Pantograph contact forces (energy TSI Section 5.3.2.7) | n.a. | X | X |
| | Power factor (**) | X | X | n.a. |
| | Regenerative braking (energy TSI Section 4.3.1.4, Annex K) | X | X | n.a. |
| 4.2.4. | On board train control equipment | | | |
| | Braking performances (verification in Section 4.1.5) | | | |
| | Electromagnetic compatibility (verification in Section 4.1.9) | | | |
| | Dynamic clearances of vehicles | X | X | n.a. |
| | Train data transmission (braking, integrity, length) | n.a. | X | n.a. |
| 4.2.5. | Passenger step | X | n.a. | n.a. |
| 4.2.6. | Doors and door controls | X | n.a. | X |
| 4.2.7. | Passenger emergency exits | n.a. | X | n.a. |
| 4.2.8. | Drivers' cab emergency | n.a. | X | n.a. |
| 4.2.9.a. | End couplers | | | |
| 4.2.9.b. | Emergency couplers | | | |
| 4.2.10. | Wheel/rail contact/ride stability | | | |
| 4.2.10.c1. | Wheel profile | | | |
| 4.2.10.c2. | Acceptance tests | n.a. | X | n.a. |
| 4.2.10.c3. | Periodic checking procedures ([3]) | X | n.a. | n.a. |
| 4.2.10.c4. | Detection device for running gear instability | X | X | n.a. |
| 4.2.10.d. | Wheel materials | | | |
| 4.2.10.e. | Electrical resistance (**) | X | X | n.a. |

| 1 | | 2 | 3 | 4 |
|---|---|---|---|---|
| Characteristics to be assessed | | Assessment in the following phase | | |
| | | Design and development phase | | Production phase |
| | | Design review | Type test | Serial production quality |
| 4.2.11. | Hotbox detection: | | | |
| | validation of the system | X | X | X |
| | interface with existing trackside systems | X | n.a. | n.a. |
| 4.2.12. | Emergency alarm | n.a. | X | X |
| 4.2.13. | Slipstream | n.a. | X | n.a. |
| 4.2.14. | Effects of crosswinds ([4]) | X | n.a. | n.a. |
| 4.2.15. | Eddy current brakes | | | |
| | Maximum deceleration ([5]) | n.a. | X | n.a. |
| | Maximum longitudinal track forces (Section 4.2.15) | X | n.a. | n.a. |
| | Safety of failures modes (Section 4.2.15) | X | n.a. | n.a. |
| 4.2.16. | Flange lubrication | n.a. | X | n.a. |
| 4.2.17. | Suspension coefficient (*) | n.a. | X | n.a. |
| 4.2.18. | Clearance in minimum curve radius (*) | n.a. | X | n.a. |
| 4.2.19. | In service maintenance: | | | |
| 4.2.19.a. | Maintenance plan | The existence of the maintenance plan including the elements defined in Section 4.2.19.a will be verified by the notified body. | | |
| 4.2.19.b. | Maintenance work: | | | |
| | External cleaning (Maintenance TSI Section 4.2.2.2.1) | X | n.a. | n.a. |
| | Toilet emptying: technology of trainset toilets to allow them to be emptied at three-day intervals (Maintenance TSI Section 4.2.2.2.2) | X | n.a. | n.a. |
| | Power supply for internal cleaning: power, voltage; availability of electrical sockets; spacing of sockets (Maintenance TSI Section 4.2.2.2.3) | X | n.a. | n.a. |

| 1 | | 2 | 3 | 4 |
|---|---|---|---|---|
| Characteristics to be assessed | | Assessment in the following phase | | |
| | | Design and development phase | | Production phase |
| | | Design review | Type test | Serial production quality |
| | Replenishment of water and sand<br>(Maintenance TSI Section 4.2.2.2.4 and 5) | X | n.a. | n.a. |
| | Trainsets standby: Stationary noise level (Maintenance TSI Section 4.2.2.2.6) see Section 4.1.8 of this TSI<br>Capability of being stabled with no crew aboard and with auxiliary power supply sustained (Maintenance TSI Section 4.2.2.2.6) | X | n.a. | n.a. |
| | Parking brake (Section 4.3.8) | | | |
| 4.2.20. | External lights and horn | | X | |
| 4.2.21. | Lifting/rescue procedures | Verification carried out independently of the rolling stock assessment<br>Existence of a procedure for recovering a trainset in difficulties | | |
| 4.3. | Specified performance | | | |
| 4.3.1. | Minimum performances in degraded modes (*) | n.a. | X | n.a. |
| 4.3.1. | Description of degraded modes in special document | X | n.a. | n.a. |
| 4.3.2. | Service speed (*) (**) | X | X | n.a. |
| 4.3.3. | Traction performance requirements (normal and degraded modes) | n.a. | X | X |
| 4.3.4. | Traction adhesion requirements | X | n.a. | n.a. |
| 4.3.4. | Validation of the anti-slip system | n.a. | X | n.a. |
| 4.3.5. | Brake adhesion limits | X | n.a. | n.a. |
| 4.3.6. | Brake system requirements | | | |
| | conformity assessment of control system | X | X | X |
| | safety assessment of new control systems ([6]) | X | n.a. | n.a. |
| | wheel-slide device | n.a. | X | n.a. |
| | detection of seized up axle | n.a. | X | n.a. |
| | taking the electric brake into account in the performances | X | n.a. | n.a. |
| | regenerative braking characteristics | n.a. | X | n.a. |

| 1 | | 2 | 3 | 4 |
|---|---|---|---|---|
| Characteristics to be assessed | | Assessment in the following phase | | |
| | | Design and development phase | | Production phase |
| | | Design review | Type test | Serial production quality |
| | indicators of brake and means of brake isolation | X | n.a. | n.a. |
| | brake fault diagnostics | X | n.a. | n.a. |
| 4.3.7. | Service braking performance | n.a. | X | n.a. |
| 4.3.8. | Devices for immobilisation of train | n.a. | X | n.a. |
| 4.3.9. | Brake performance on gradients | X | n.a. | n.a. |
| 4.3.10. | Detection of derailment ([7]) | n.a. | X | n.a. |
| 4.3.11.a, b, c, d, e, f, g. | Fire and fumes protection | X | X | n.a. |
| 4.3.11.a. | Ability to operate for 15 minutes with a declared fire on board | X | n.a. | n.a. |
| 4.3.12. | Environmental conditions (*) | X | n.a. | n.a. |
| 4.3.13. | Monitoring and diagnostic concepts | X | X | n.a. |
| 4.3.14. | Special provisions for tunnels | X | n.a. | n.a. |
| 4.3.15. | Emergency lighting | n.a. | X | n.a. |
| 4.3.16. | Public address system | n.a. | X | n.a. |
| 4.3.17. | Protection against electrical shocks | X | X | n.a. |
| 4.3.18. | Driver's cab | | | |
| | (a) access and egress | X | n.a. | n.a. |
| | (b) external visibility | X | n.a. | n.a. |
| | (c) and (d) seats and interior layout | X | n.a. | n.a. |
| 4.3.19. | Windscreen characteristics | | | |
| | optical quality | | | |
| | ability to resist impacts | | | |
| 4.3.20. | Passenger information signs | n.a. | n.a. | X |
| 4.3.21. | Toilets available to passengers and train crew | X | n.a. | n.a. |

| 1 | | 2 | 3 | 4 |
|---|---|---|---|---|
| Characteristics to be assessed | | Assessment in the following phase | | |
| | | Design and development phase | | Production phase |
| | | Design review | Type test | Serial production quality |
| 7.3. | Specific cases | | | |
| 7.3.1. | Vehicle loading gauge (Great Britain) | | | |
| 7.3.2. | Boundary characteristics linked to outside noise (existing designs) | | | |
| 7.3.3. | Maximum pressure variations in tunnels (Italian network) | | | |
| 7.3.4. | Passenger step (British and Netherlands lines) | | | |
| 7.3.5. | Wheel rail contact (British lines) | | | |

(*) Data according to the infrastructure register of rolling stock.
(**) Type test only if necessary.
([1]) Verification during assessment of the braking characteristics.
([2]) Only for new systems.
([3]) Creation of maintenance documents.
([4]) Under evaluation (simulations and calculations).
([5]) Less than 2,5 $m/s^2$, all brakes in use.
([6]) Only for new technology.
([7]) Functional verification.

*ANNEX F*

## PROCEDURES FOR ASSESSMENT OF CONFORMITY AND SUITABILITY FOR USE

### 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 discharges 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 prepare 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 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 shall be written in the same language as the technical file and include 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 the signatory having received authority 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 in the Community market.

7. If in addition 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.

MODULE B (TYPE-EXAMINATION)

**Conformity assessment of interoperability constituents**

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.

The manufacturer, or his authorised representative established within the Community, must lodge the application for the type-examination with a notified body of his choice.

2. 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, sub-assemblies, 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 specifications with relevant clauses),

— descriptions of the solutions adopted to meet the requirements of the TSI in cases 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 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 Specifications 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 Specifications 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 specifications, 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 typeexamination 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 typeexamination 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 modifications 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 will 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 established within the Community must keep with the technical documentation copies of the 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.

MODULE D (PRODUCTION QUALITY ASSURANCE)

**Conformity assessment of interoperability constituents**

1. This module describes the procedure whereby the manufacturer or his authorised representative established within the Community 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. 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 — 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 established within the Community, 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 reassessment 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 that it has withdrawn or refused.

3.6. The other notified bodies will 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 the second paragraph of 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 of 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 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 are:

— 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 established within the Community 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.

MODULE F (PRODUCT VERIFICATION)

**Conformity assessment of interoperability constituents**

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, 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 Directive 96/48/EC and of 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 EC type-examination certificate and with the requirements of Directive 96/48/EC and 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 Directive 96/48/EC and of 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 Directive 96/48/EC and of the TSI that apply to them.

4.2. The notified body must draw up a written certificate of conformity for the approved products 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 specifications referred to in Article 10, or equivalent tests, shall be carried out to ensure their conformity with the requirements of Directive 96/48/EC and of 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 established within the Community 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 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 of 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 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 are:

— the EC type-examination certificate and its additions,

— the certificate of conformity as mentioned under point 4 or 5.

7. The manufacturer or his authorised representative established within the Community 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.

MODULE H2 (FULL QUALITY ASSURANCE WITH DESIGN EXAMINATION)

**Conformity assessment of interoperability constituents**

1. This module describes the procedure whereby a notified body carries out an examination of the design of an interoperability constituent and the manufacturer or his authorised representative established within the Community who satisfies the obligations of point 2 ensures and declares that the interoperability constituent concerned satisfies the requirements of Directive 96/48/EC and of 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 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 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 — 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 reassessment 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 unscheduled 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 point 3.4, points 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 Directive 96/48/EC and of 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 modifications 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 will 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 of 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(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 the signatory having received power to engage the manufacturer or his authorised representative established within the Community.

The certificates to be referred to are:

— 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 established within the Community, 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.

MODULE V (EC TYPE-VALIDATION BY 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 Directive 96/48/EC and of the TSI that apply to it for suitability for use, to be demonstrated by type validation by in service experience.

2. The application for the type-validation by 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 by 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 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 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 specifications 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 about the programme and the location where the inspections and necessary tests will be carried out and about 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 Directive 96/48/EC and 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 certificate, 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 the suitability for use certificate 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 modifications 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 suitability for use certificates it has withdrawn or refused.

10. The other notified bodies will receive copies of the suitability for use certificates 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 established within the Community 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 (bodies) 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 specifications,

— identification of the signatory having received power to engage the manufacturer or his authorised representative established within the Community.

13. The manufacturer or his authorised representative established within the Community 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.

MODULE SB (EC TYPE-EXAMINATION)

**EC verification of rolling stock subsystem**

1. This module describes part of 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 a type of a rolling stock subsystem, representative for the production envisaged,

   — complies with this TSI and any other applicable TSI, which demonstrates that the essential requirements of Directive 96/48/EC have been met,

   — complies with the other regulations deriving from the Treaty.

2. The adjudicating entity or its authorised representative established within the Community must lodge an application for EC verification (through type-examination) 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, as described in point 3.

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

   A type may cover several versions of the subsystem 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 so required for specific test or examination methods and specified in the TSI or in the European specifications referred to in Article 10, also a specimen or specimens of a subassembly or assembly or a specimen of the subsystem in a preassembled condition has to be delivered.

   The technical documentation must enable the design, manufacture, installation and operation of the subsystem to be understood, and shall enable conformity with the provisions of Directive 96/48/EC and of the TSI to be assessed. It must, as far as relevant for such assessment, cover the design, manufacture and operation of the subsystem.

   It must include:

   — a general description of the subsystem, overall design and structure,

   — the register of rolling stock, including all indications as specified in the TSI

   — conceptual design and manufacturing drawings and schemes of components, subassemblies, assemblies, circuits, etc.,

   — descriptions and explanations necessary for the understanding of said drawings and schemes and the operation of the product,

   — 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,

   — technical documentation as regards the manufacturing and the assembling of the subsystem,

   — a list of manufacturers, involved in the subsystem's design, manufacturing, assembling and installation,

   — conditions for use and maintenance of the subsystem (restrictions of running time or distance, wear limits, etc.),

— a list of the European specifications referred to in Article 10 or in the technical design specification,

— results of design calculations made, examinations carried out, etc.,

— test reports.

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

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 subsystem at the completion of the design process,

4.3. if type tests are requested in the TSI, verify that the specimen(s) of the subsystem or of assemblies or subassemblies of the subsystem, required for carrying out type tests, 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 specifications concerned,

4.4. identify the elements which have been designed in accordance with the relevant provisions of the TSI and the European specifications referred to in Article 10, as well as the elements which have been designed without applying the relevant provisions of those European specifications,

4.5. perform or have performed the appropriate examinations and necessary tests in accordance with points 4.2. and 4.3. to establish whether, where the appropriate European specifications referred to in the TSI have not been applied, the solutions adopted meet the requirements of the TSI,

4.6. perform or have performed the appropriate examinations and necessary tests in accordance with points 4.2. and 4.3 to establish whether, where the relevant European specifications have been chosen, these have actually been applied,

4.7. agree with the applicant the location where the examinations and necessary tests will be carried out.

5. Where the type meets the provisions of Directive 96/48 /EC and 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 adjudicating entity and the manufacturer(s), 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 adjudicating entity or its authorised representative established within the Community is denied a 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 subsystem which must receive additional approval where such changes may affect the conformity with the requirements of Directive 96/48/EC and of the TSI or the prescribed conditions for use of the subsystem. 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 modifications 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 EC type-examination certificates it has withdrawn or refused.

9. The other notified bodies will 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 adjudicating entity or its authorised representative established within the Community must keep with the technical documentation copies of type-examination certificates and their additions throughout the service life of the subsystem, it must be sent to any other Member State who so requests.

MODULE SD (PRODUCTION QUALITY ASSURANCE)

**EC verification of rolling stock 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 a rolling stock subsystem, for which an EC type-examination certificate has already been issued by a notified body,

— complies with this TSI and any other applicable TSI, which demonstrates that the essential requirements of Directive 96/48/EC have been met,

— complies with the other regulations deriving from the Treaty and may be put into service.

The notified body carries out the procedure, under the condition that the adjudicating entity and the manufacturers involved satisfy the obligations of point 2.

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

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 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 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,

— the technical documentation of the approved type and a copy of the type-examination certificate, issued after the completion of the type-examination procedure of module SB.

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 overall compliance of the subsystem with the type as described in the type-examination certificate and overall compliance of the subsystem with the requirements of the TSI. For other manufacturers (subsuppliers) the quality system has to ensure compliance of their relevant contribution to the subsystem with the type as described in the type-examination certificate and 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.,

and for the main contractor:

— responsibilities and powers of the management with regard to overall subsystem quality, including in particular the subsystem integration management.

The examinations, tests and checking shall cover all of the following stages:

— structure of subsystem, including, in particular, civil-engineering activities, constituent assembly, final 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 — 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 reassessment 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 as referred to under point 3.1 must have permanent access for inspection purposes to the locations of building sites, production workshops, locations of assembling and installation, storage areas and, where appropriate, prefabrication or testing facilities and, more general, 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 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 must 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 (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 and may carry out or cause to be carried out tests, in order to check the proper functioning of the quality system where necessary. It must provide the applicant(s) with an inspection report and also, if an audit has been carried out, with an audit report, and, if a test has been carried out with a test 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 point 3.4, points 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 production quality assurance), including coordination of the surveillance of the quality systems as under point 6.5., with a notified body of its choice. The adjudicating entity or his authorised representative within the Community must inform the manufacturers involved of this choice and of the application.

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

It must include:

— the technical documentation regarding the approved type, including the type-examination certificate, as issued after completion of the procedure defined in module SB,

and, if not included in this documentation,

— 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.

— the register of rolling stock, 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 manufacturers 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.

6.3. The notified body must examine the application concerning the validity of the typeexamination and the typeexamination certificate.

6.4. The notified body must then examine if the approval and surveillance of the quality system(s) of the applicant(s) as mentioned in the last subparagraph of point 3.2 sufficiently and properly cover all stages of the subsystem.

If the conformity of the subsystem with the type as described in the EC type-examination certificate and the compliance of the subsystem with the requirements of Directive 96/48/EC and 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,

— if overall responsibilities and powers of the management for the compliance of the whole entire subsystem for the main contractor 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 be ensured 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 under its responsibility and together with the other notified body(ies).

6.6. Where the subsystem meets the requirements of the TSI, the notified body must then, based on the type-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 of the technical file and must contain at least the information included in Annex V to 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, 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 the conditions and limits for use,

— all elements relating to the instructions concerning servicing, constant or routine monitoring, adjustment and maintenance,

— the type-examination certificate for the subsystem and the accompanying technical documentation,

— certificate of EC verification of the notified body as mentioned under point 6.5, 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 points 4.4 and 4.5 and in particular:

— the register of rolling stock, 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.

MODULE SF (PRODUCT VERIFICATION)

**EC verification of a rolling stock 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 a rolling stock subsystem, for which an EC type-examination certificate has already been issued by a notified body,

— complies with this TSI and any other applicable TSI, which demonstrates that the essential requirements of Directive 96/48/EC have been met,

— 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 product 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. Within that part of the procedure the adjudicating entity or his authorised representative established within the Community checks and attests that the subsystem concerned is in conformity with the type as described in the EC type-examination certificate and satisfies the requirements of Directive 96/48/EC and of the TSI that apply to them.

4. The adjudicating entity must take all measures necessary in order that the manufacturing process (including assembling and integration of interoperability constituents) ensures conformity of the subsystem with the type as described in the EC type-examination certificate and with the requirements that apply to them.

5. The technical documentation must enable the design, manufacture, installation and operation of the subsystem to be understood, and shall enable conformity with the type as described in the type-examination certificate and the requirements of the Directive and the TSI to be assessed.

It must include:

— the type-examination certificate and its accompanying documents and additions, and, as far as not included in the documents accompanying the EC type-examination certificate,

— a general description of the subsystem, overall design and structure,

— the register of rolling stock, including all indications as specified in the TSI,

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

6. The notified body must carry out the appropriate examinations and tests in order to check the conformity of the subsystem with the type as described in the EC type-examination certificate and with the requirements of the TSI by examination and testing of every subsystem, manufactured as a serial product, as specified under point 4.

7. *Verification by examination and testing of every subsystem (as a serial product)*

7.1. The notified body must carry out the tests, examinations and verifications, to ensure conformity of the subsystem as serial products 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:

— structure of subsystem, including constituent assembly and overall adjustments,

— final testing of the subsystem,

— and, whenever specified in the TSI, the validation under full operational conditions.

7.2. All subsystems (as serial products) must be individually examined and appropriate tests and verifications as set out in the TSI and in the relevant European specifications (or equivalent tests) shall be carried out in order to verify their conformity with the type as described in the type-examination certificate and the requirements of the TSI that apply to them.

8. The notified body may agree with the adjudicating entity the locations where the tests will be carried out and may agree that final testing of the subsystem and, whenever required in the TSI, tests or validation under full operating conditions, are carried out by the adjudicating entity under direct supervision and attendance of the notified body.

9. The notified body must have permanent access for testing and verification purposes to 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.

10. Where the subsystem meets the requirements of the Directive 96/48/EC and of the TSI, the notified body must then, based on the tests, verifications and checking carried out on all serial products as indicated in point 7 and required in the TSI and in the European specifications referred to in Article 10, 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 of the technical file and must contain at least the information included in Annex V to Directive 96/48/EC.

11. 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,

— the register of rolling stock, including all indications as specified in the TSI,

— 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 of use,

— all elements relating to the instructions concerning servicing, constant or routine monitoring, adjustment and maintenance,

— EC type-examination certificate and accompanying technical documentation,

— certificate of EC verification of the notified body as mentioned under point 10, 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.

12. 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.

13. 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.

MODULE SH2 (FULL QUALITY ASSURANCE WITH DESIGN EXAMINATION)

**EC verification of rolling stock 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 a rolling stock subsystem

— complies with this TSI and any other applicable TSI, which demonstrates that the essential requirements of Directive 96/48/EC have been met,

— complies with the other regulations deriving from the Treaty and may be put into service.

The notified body carries out the procedure, including a design examination of the subsystem under the condition, that the adjudicating entity and the manufacturers involved satisfies 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.

Where 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 overall compliance of the subsystem with the requirements of the Directive 96/48/EC and of 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 the TSI 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 overall design and subsystem quality, including in particular the subsystem integration management.

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, final 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 — 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 29002, 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 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 their 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 reassessment 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 general, 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 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 unscheduled 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 point 3.4, points 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 established 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 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 register of rolling stock, 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.

6.3. The notified body must examine the application concerning the design examination and where the design meets the provisions of 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 quality system(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 for the main contractor 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 be ensured 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 under its responsibility and together with the other notified body(ies).

6.6. Where the subsystem meets the requirements 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 to Directive 96/48/EC.

6.7. The notified body shall be responsible for compiling the technical file 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:

— 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 points 4.4 and 4.5,

— the register of rolling stock, 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.

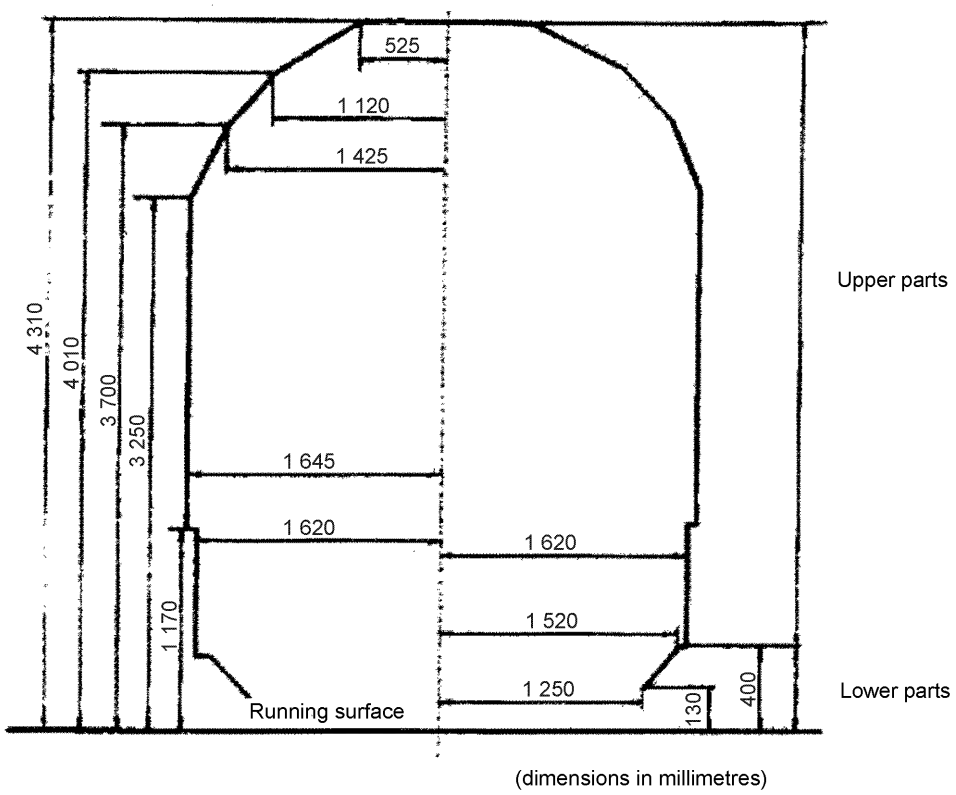
8. The adjudicating entity or its authorised representative within the Community must keep a copy of the records throughout the service life of the subsystem; it must be sent to any other Member State who so requests.

*ANNEX G*

**GAUGE**

505-1

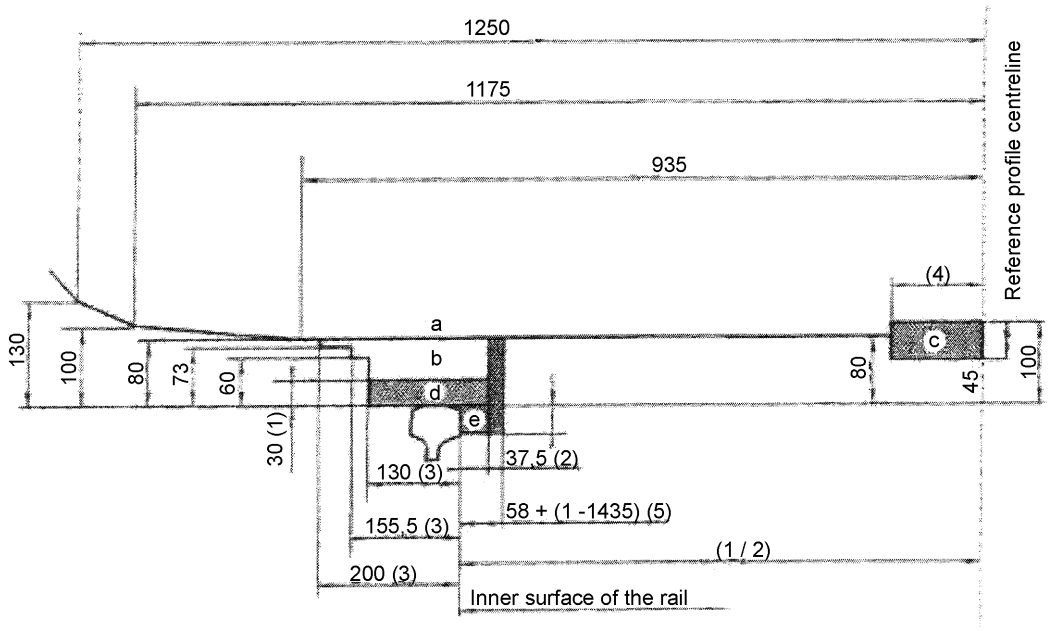
PART COMMON TO ALL VEHICLES



505-1

**Part below 130 mm on vehicles which must not pass over shunting humps or negotiate rail brakes and other activated shunting and stopping devices**

Certain gauge restrictions must be observed at right angles to the axles when vehicles are placed on an under-floor lathe for wheel reprofiling.




(Dimensions in millimetres)

(a) zone for equipment awqay from wheels

(b) zone for equipment in immeditate proximity of wheels

(c) zone for contact ramp brushes

(d) zone for wheels and other parts coming into contact with the rails

(e) zone occupied exclusively by the wheels

(1) Limit for parts located outside the axle ends (guard irons, sanders, etc.) not to be exceeded for running over detonators. This limit may however be disregarded for parts located between the wheels, provided these parts remain within the wheel track.

(2) Maximum theoretical width of the flange profile in the case of check-rails

(3) Effective limit position of the outside surface of the wheel and of the parts associated with this wheel

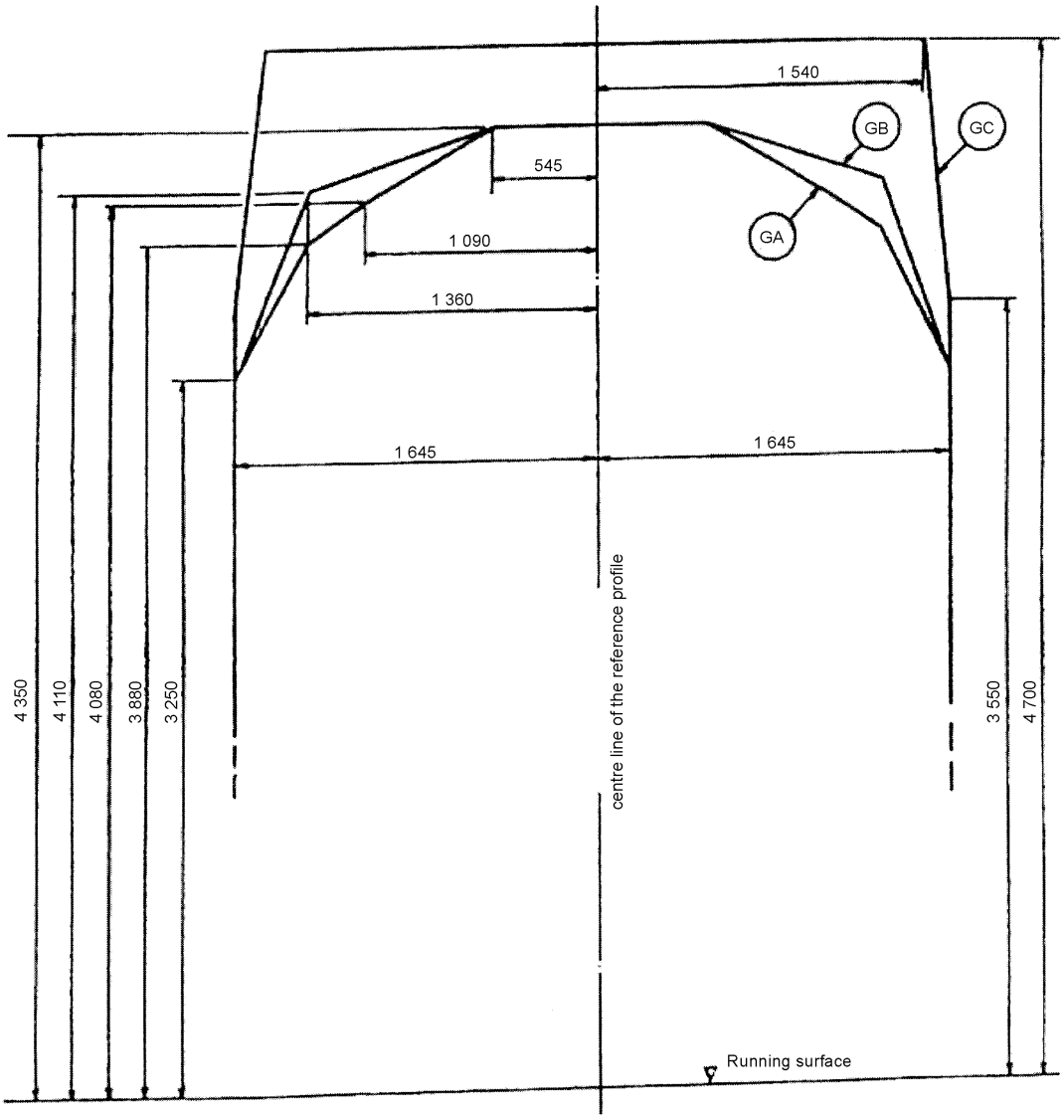
(4) When the vehicle is in any position whatsoever on a curve of radius R = 250 m (minimum radius for contact rampo installation) and a track width of 1 465 mm, no part of the vehicle likely to descend to less than 100 mm from the running surface, except for the contact brush, should be less than 125 mm from the track centre.

For parts located inside the bogles, this dimension is 150 mm.

(5) Effective limit position of the internal surface of the wheel when the axle is against the opposite rail. This dimension varies with gauge widening.

GA, GB AND GC, KINEMATIC GAUGES

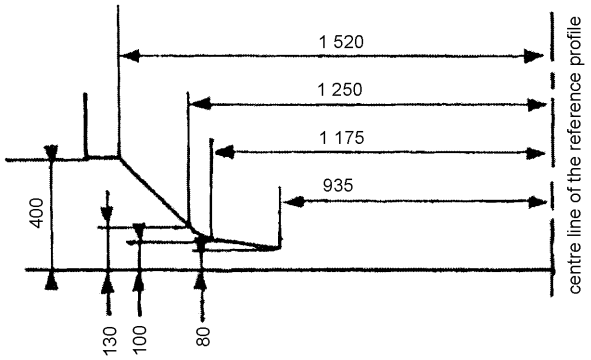
**Reference profiles**



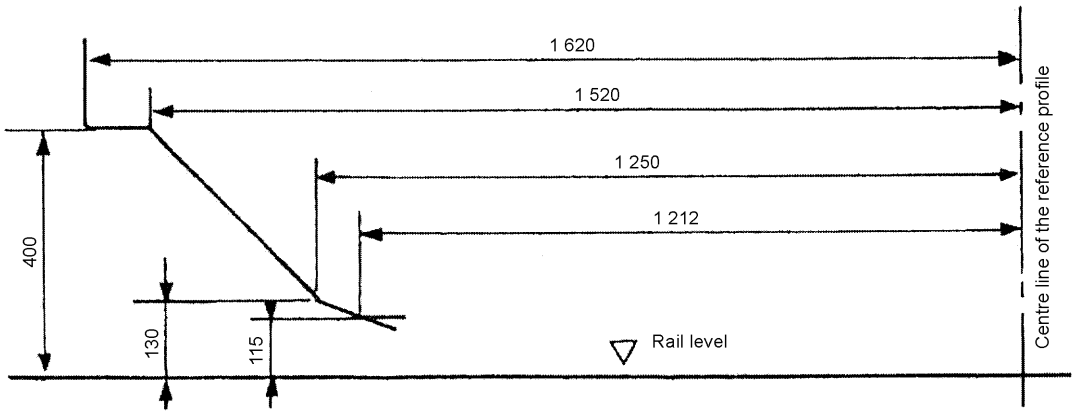

*N.B.*: Up to a height of 3 250 mm, the reference profile of GA, GB and GC gauges is identical.

LOWER PARTS

A. **Lines over which powered units used on international services run**



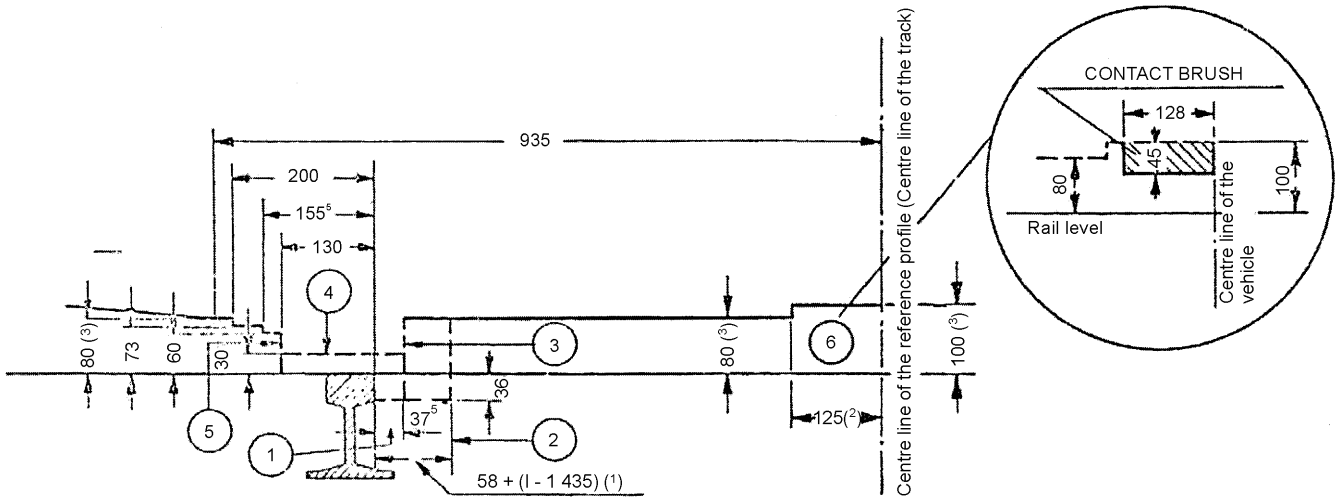

B. **Lines over which coaches, vans and wagons used on inernational services run (with the exception of powered units used on international services)**




*Note:* On inclined connections with a radius R ≥ 500 m, the vertical measurements shown in diagrams A and B above mut be reduced by $\frac{50\,000}{R}$ mm. (R in m. If 625 ≥ R ≥ 500 m, the measurement 80 in diagram A is cancelled.

KINEMATIV GAUGE FOR THE LOWER PARTS IN THE AREA OF THE RAIL, THE AREA TAKEN UP BY TRACK BRAKES AND THE AREA OF THE CENTRE LINE OF THE TRACK

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) fo 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.

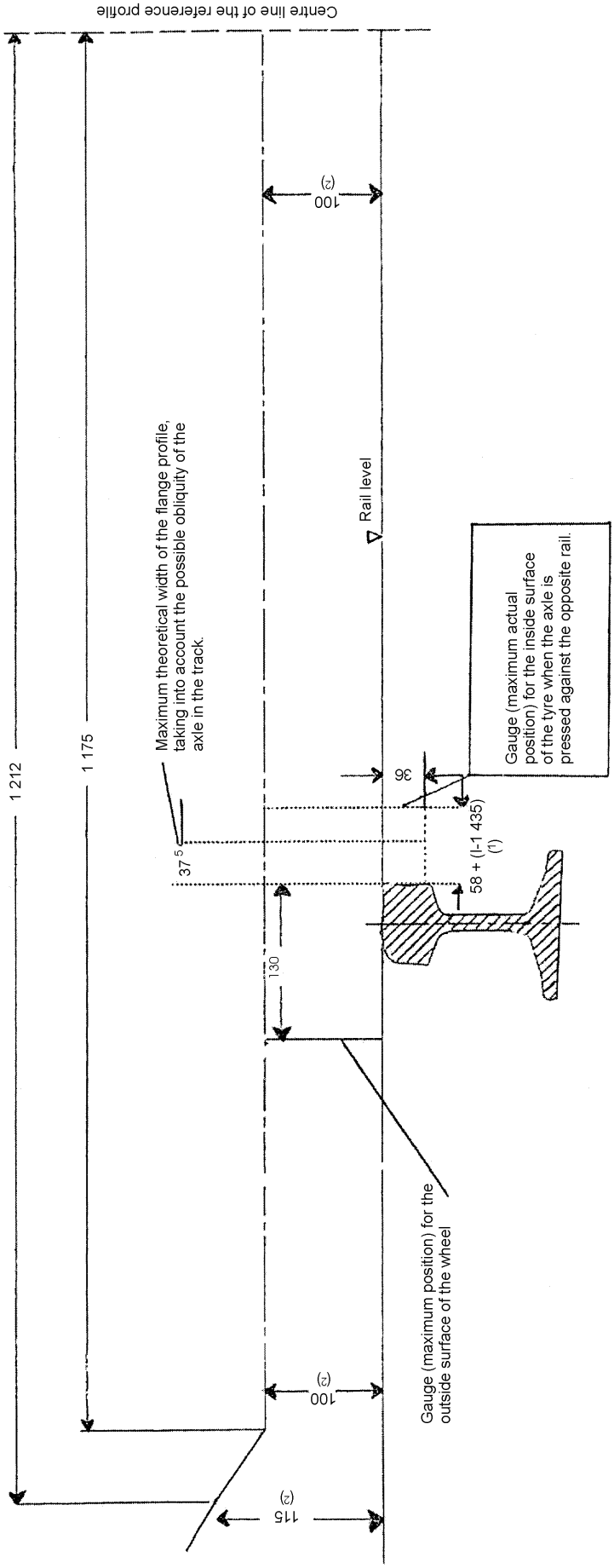
(1) l = width of track.

(2) Irrespective of radius R ≥ 250 m and width of track l ≤ 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 ≥ R ≥ 500 m.

KINEMATIC GAUGE FOR THE LOWER PARTS

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 ≥ 500 m, this dimension must be reduced by $\frac{50\,000}{R}$ mm.

*ANNEX H*

## FRONT AND REAR LAMPS

### Tail lamps

Two indicator lamps shall be provided at each end of the trainset, arranged on the horizontal axis at the same height above the railhead, symmetrical to the centre line, and at least 1 300 mm apart.

It is recommended that the indicator lamps be mounted level between 1 600 mm and 2 000 mm above the railhead. As a general rule each lamp shall provide a source of red light at least 170 mm in diameter.

Should available space be limited then a horizontal width down to 110 mm may be permitted, as long as the technical performance of the lamp is not compromised.

A single switch shall be provided to allow both tail lamps at the extremity of the train to be extinguished simultaneously. It is permitted to provide a means of changing the colour aspect of the lamps.

The optical system of the tail lamps shall be designed to provide a red light intensity of:

— at least 15 candelas in the direction of travel,

— at least 7,5 candelas at an angle of 15° to the horizontal and 5° to the vertical in the direction of travel.

### Fixed indicator lamps

Two electric fixed indicator lamps shall be provided at each end of interoperable trainsets mounted level on the same horizontal axis between 1 600 mm and 2 000 mm above the railhead.

The distance between the two indicator lamps shall be as great as possible, without falling below 1 300 mm; in exceptional cases this distance can be brought down to 1 000 mm for rolling stock with tapered nose cones.

In addition, interoperable trainsets must be built to accept at each extremity a third fixed electric indicator lamp situated on the centre line above the windscreen.

The lower two fixed lamps shall contain a device to provide either a white or a red aspect, except when the lamps contain superimposed optical elements.

It is recommended that the switch to change the colour aspect be situated inside the vehicle. In addition, it is recommended that separate controls for the electrical signals be provided with lamps able to accept colour screens (yellow or green).

Lamps can be equipped with an electrical commutation device to allow them to act as headlights.

### Headlight controls

Headlamps on rolling stock designed for high speed operation shall be provided with the following functions:

— off,

— dimmed sidelight,

— full sidelight,

— dimmed headlight,

— full-beam headlight.

Measured along the centre line, the luminosity of each lamp in each set of lamps shall correspond to the values indicated in the table below:

Luminous intensity in cd (candela) (charged battery)

| Sets position | Dimmed side-light | Full sidelight | Dimmed headlight [a] | Full-beam headlight |
|---|---|---|---|---|
| Lower headlights | 100 | 300/700 | 12 000/16 000 | 50 000/70 000 |
| Front lights | 50 | 150/350 | 12 000/16 000 | 12 000/16 000 |

[a] The upper limit of the beam ist at a downward angle of 5° 30' to the orizontal centre line.

*ANNEX I*

**REGISTER OF ROLLING STOCK**

CHARACTERISTICS REQUIRED TO APPEAR IN THE REGISTER OF ROLLING STOCK

*Indicative list*

Type designation:

Railway operator (owner):

State:

National serial No:

National train No (*):

Manufacturer

Date of putting into operation:

Date of declaration of conformity:

Notified body

Train configuration

graphic scheme

Number and location of axles: motorized, non-motorised

…….

| Item | Train characteristic | Compliance with TSI |
|---|---|---|
| Mechanical characteristics | | |
| Vehicle gauge | | |
| Train length | | |
| Gauge of wheelsets | | |
| Maximum axle load | | |
| Possible platform heights | | |
| Particular equipment for long tunnels | | |
| Equipment for access of disabled persons installed | | |
| Fire proofing equipment | | |
| Electrical supply characteristics | | |
| Voltage | | |
| Frequency | | |
| Pantographs: | | |
| Number and types installed | | |
| Mean contact force | | |
| Working range (Height) | | |

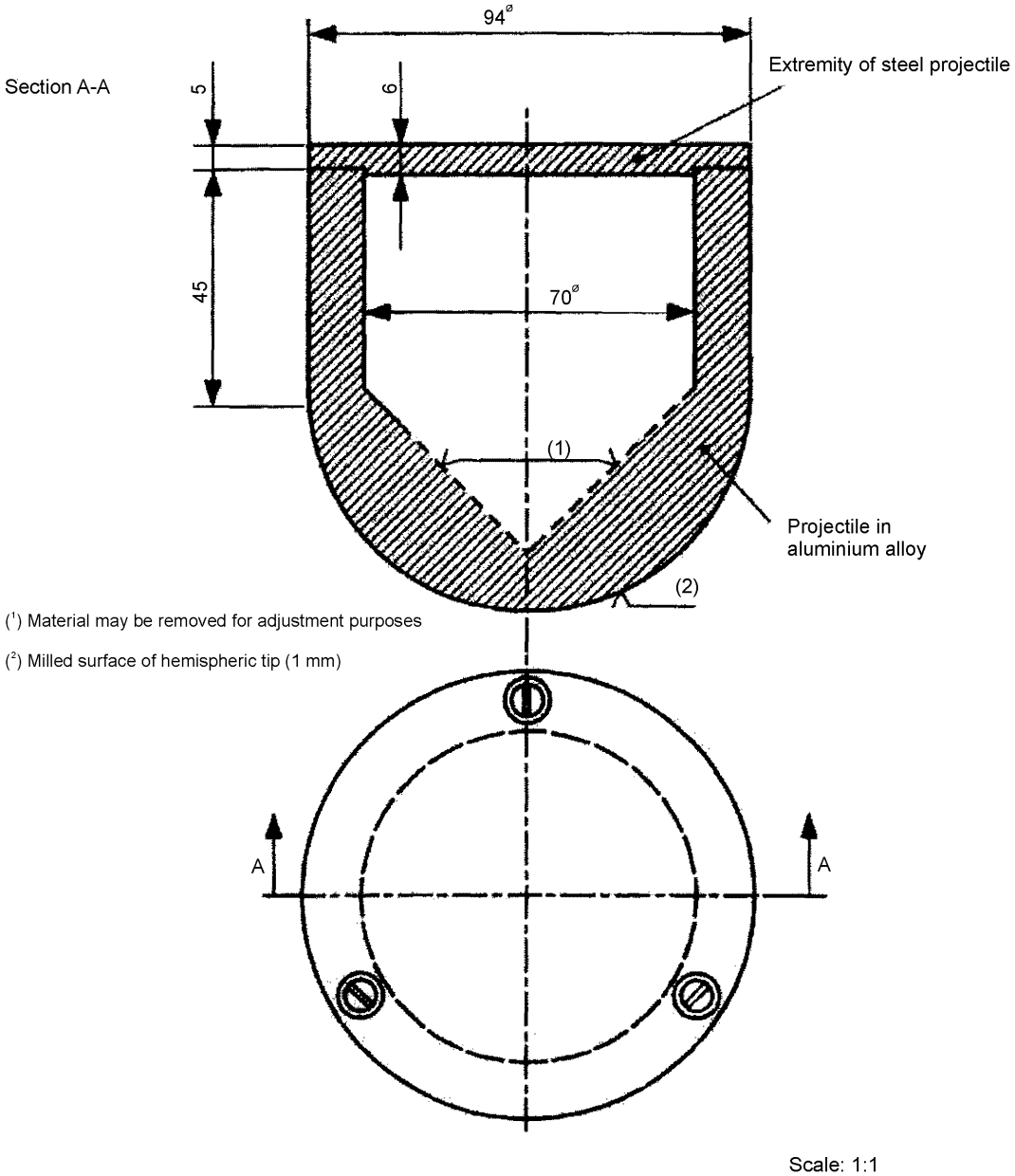
(*) If this register of rolling stock (TEN HS) covers only one train.

| Item | Train characteristic | Compliance with TSI |
|---|---|---|
| Power/current limitation device on board available | | |
| Maximum current at standstill | | |
| Traction and braking characteristics | | |
| Maximum service speed | | |
| Maximum gradients to be operated with maximum service speed | | |
| Brake performances (guaranteed performance) | | |
| Eddy-current brake installed | | |
| Control/command characteristics | | |
| ERTMS/ETCS | | |
| Level of application | | |
| Optional functions installed | | |
| ERTMS/GSMR radio | | |
| Optional functions | | |
| For ERTMS/ETCS level 1 with infill-function: technical implementation installed | | |
| Class B train protection, control and warning system installed | | |
| Class B radio system installed | | |
| EMC emissions | | |
| Environmental characteristics | | |
| Climatic resistance: | | |
| Temperature maximum/minimum | | |
| Humidity maximum | | |
| Outside noise level at maximum service speed | | |

*ANNEX J*

**PROJECTILE TO TEST THE FRONT WINDOW OF THE CAB**

Diagram of projectile (mass: 1 000 g)




(1) Material may be removed for adjustment purposes

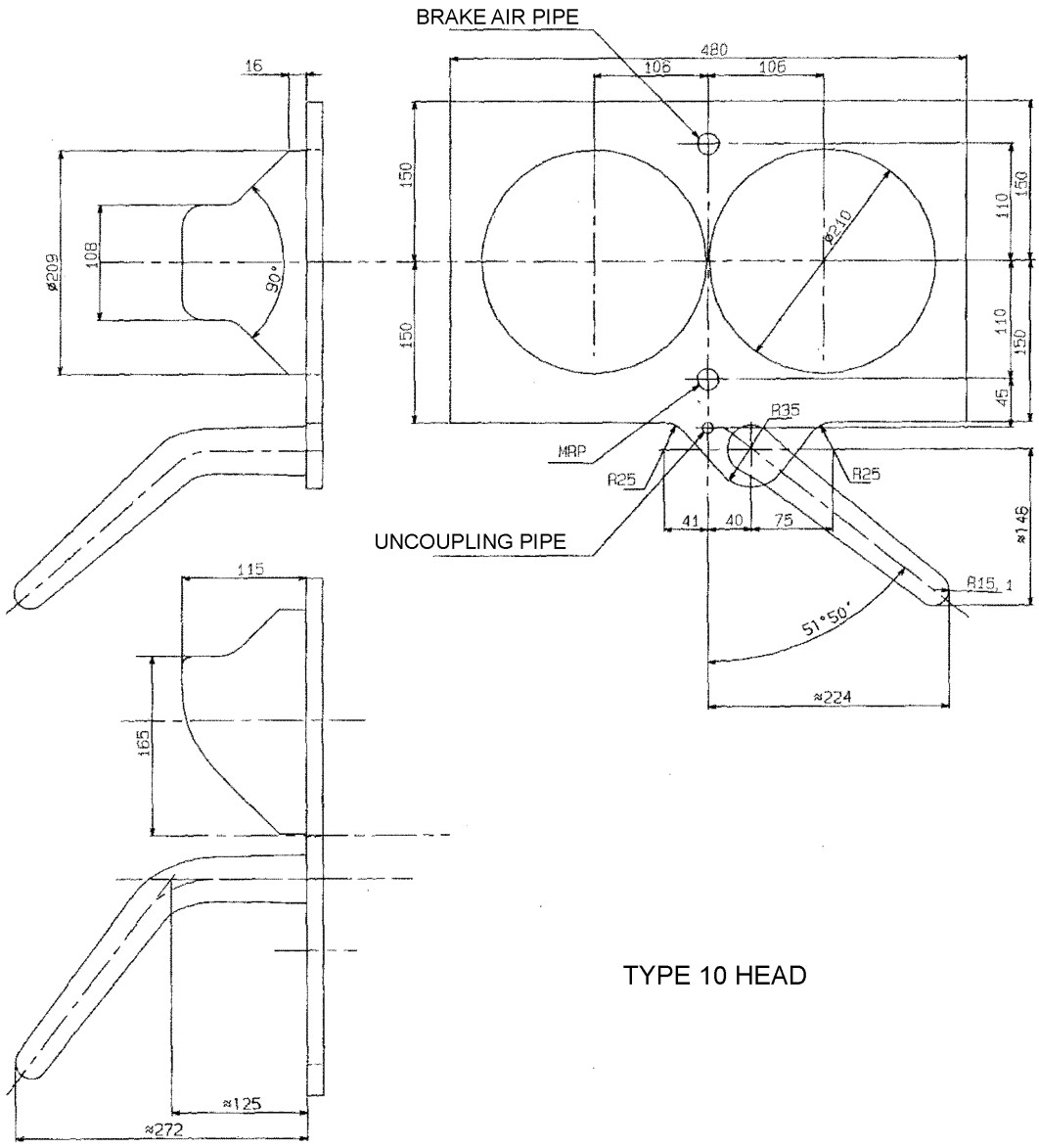
(2) Milled surface of hemispheric tip (1 mm)

Scale: 1:1

*ANNEX K*

**COUPLER**

K.1 Schematic of the coupler




The horizontal axle of the coupler shall be placed at a height of 1 025 mm above the running surface.

K.2 Operating conditions

(reserved)

*ANNEX L*

## ASPECTS NOT SPECIFIC TO HIGH SPEED AND FOR WHICH NOTIFICATION OF NATIONAL RULES IS REQUIRED

### Geometrical and mechanical compatibility with the railway infrastructure

Respect of the gauge (particularities related to tilting bodies and to exceptional transports)

Insertion of the rolling stock in curves and sinuous layouts

Insertion in longitudinal profile

Running over track twists

Running over switches and crossings

Cowcatcher/obstacles-plough

### Body, bogie, axles

Bogies: design, fabrication and approval — steel grade used — resistance — vibrations dampening, critical twisting resonance (traction unit)

Mounted axles: design, fabrication and approval — defaults of bearing table admitted in operation

Equipment attached to vehicle bodies, bogie frames and axleboxes

Reliability and resistance of hydraulic systems (if any)

Resistance to fatigue loads

Missile protection — resistance to impacts related to natural events or to acts of malevolence

Design and construction of the tanks of tank wagons

Suitability for gravity shunting: couplers, passing over shunting bumps, resistance to shunting shocks

Marking — identification of rail vehicles

### Braking

Compressed-air brake: characteristics (including automatic immobilisation in case of coupling rupture)

Other brake types

Elements composing the braking system

Use of the air of the brake system (*inter alia*, tap of the mechanic, emergency braking command, CG vent to the atmosphere, automatic mechanism of play take-up)

Capacity of production and storage of compressed air — residual performance of self-propelled trains (exceptional use): energy supply to the braking equipment of another train and start in a slope

Sandboxes operation in case of emergency braking or jamming detection

Automatic mechanism of play take-up

### Traction/energy

Autonomy of self propelled equipment

Operation of level crossings (restriction to the traction performances)

Electrical protection of the train: circuit breaker location, damages downstream from the circuit breaker of the train

Command of the pantographs, backup mechanism for raising the pantograph in the absence of air in the main tank

Safeguarding the catenary: escape at high temperature

Characteristics/performances of steam locomotives and internal combustion engines

Insulation characteristics

Main transformer

Characteristics of earthing and current return circuits

Traction unit: cooling, regulation

Traction systems behaviour under minimum and maximum voltage conditions on the network and when entering a section with earthed catenary

Battery charging

Electrical components thermal characteristics

**Control-command (interfaces with signalling)**

Distance between consecutive axles

Mechanism of aid for shunting

Sandboxes throughput

Presence of metal parts (other than wheel flanges) in the area of sensitivity of electronic pedals

Inhibition of traction by braking

Ergonomy of the command, control and emergency mechanisms

Characteristics and performance of security mechanisms for components susceptible to separation

Equipment for single driver operation — command of the passengers' access doors

Remote control

Bus of a vehicle and bus of the train (command of the train)

Semi-automation or automation of system transition

Software (systems controlled by software) (EN 50128)

Safety systems

Diagnostic mechanisms/transmission of the data

Diagnostic system failure

Head or tail lights failure

**Safety and health of persons**

Prevention of explosions

No internal or external sharp edges, slipping prevention, indication of steps in the train

Emission of gasses other than carbon monoxide and dioxide ([1])

([1]) Health issues that are not railway specific but need specification. Take account of system failure and/or loss of power supply. The TSIs do not discuss air-conditioning, heating and ventilation for passengers.

Stability problems related to train accelerations ($m/s^2$) and jolts ($m/s^3$) — physical damage due to vibrations

Visibility of the train and sound signalling devices

*25KV Transformers*

Audible warning sound before closing doors, presence of windows on all doors

Instruction to passengers for a safety-conscious behaviour

Evacuation and emergency message: information on train position for the driver

Indication on evacuation procedures and use of emergency exits in adequate languages

Exits of each compartment to two platforms

Ensure that the opening of the doors is possible in emergencies

Food preparation and storage ([1])

Electromagnetic compatibility with pacemakers ([1])

Flashing lights ([1])

Respiratory problems or intoxication due to bad quality of air ([1])

Health damages due to radiant heat, hot air, extreme high or low temperature conditions ([1])

**Environment**

Exhaust gases of thermic engines

Use of prohibited or restricted materials and products (asbestos, PCB, CFC, etc.)

*Operation*

Vehicle and route acceptance

Certification processes for non destructive testing

Post incident and accident testing of vehicles and train protection systems

Vehicle recovery

([1]) Health issues that are not railway specific but need specification. Take account of system failure and/or loss of power supply. The TSIs do not discuss air-conditioning, heating and ventilation for passengers.

*ANNEX M*

**(p.m.)**

*ANNEX N*

## EMERGENCY LIGHTING REQUIREMENTS

### N.1. General points

Emergency lighting has to allow for the continued occupation or evacuation of a vehicle in complete safety.

The emergency lighting system shall provide the minimum number of lights to allow passengers to move around inside vehicles and to evacuate them while being able to identify the presence of obstacles.

Reduced visibility caused by, for example, the presence of smoke, should be taken into account.

Emergency lighting shall be activated automatically if required and its automatic settings shall not be accessible to passengers.

### N.2. Electrical supply

The emergency lighting system shall be fed from the vehicle battery by at least one dedicated wiring circuit. If the vehicle is not equipped with its own battery and if it can be uncoupled in normal service, the emergency lighting system must be provided with its own source of supply.

### N.3. Illumination levels

The minimum average illumination level of the emergency lighting has to be ≥ 5 lux and this value must be measured at floor level and along the central axis of the gangway.

The minimum value at the evacuation thresholds has to be ≥ 30 lux.

The minimum value for the evacuation signs has to be ≥ 50 lux.

All the values must be measured according to methods indicated in Chapter 6 of this present TSI.

### N.4. Uniformity of illumination

The mean lighting level for the sustained lighting measured according to the requirements of Chapter 6 of this present TSI must be between 0,2 and 10.

### N.5. Limitation of the dazzle phenomena

To minimise the effect of dazzle, the intensity of the illumination of the emergency lamps shall not exceed 400 cd/m $^2$ in the generally visible zone (up to 60° over the horizontal plane of the lamp).

### N.6. Performance on ignition

The performance on ignition of the sustained lighting has to reach 50 % of the required illumination levels within five seconds and 100 % of the illumination level required in the 15 seconds.

### N.7. Operating duration

Except where otherwise agreed between the user and the manufacturer, the emergency lighting shall continue to operate for:

— at least one hour on railway vehicles intended for the public transport systems,

— at least three hours other railway vehicles.

After the failure of the electric supply in the vehicle, e.g. the battery charging system.

Note: the specified durations apply to a battery completely charged under conditions agreed between the buyer and the manufacturer.

N.8. **Layout of the emergency lighting**

The emergency lights must be arranged as follows:

— at least in every autonomous zone, e.g. compartments, toilet, driver's cab, kitchen,

— next to doors and steps, in particular at emergency exits,

— in the zones where obstacles can be present, e.g. presence of luggage in the side aisles, the hallways,

— in the neighbourhood of breaks or changes of direction in the central aisles or the side aisles,

— at every change in floor level.

*ANNEX O*

**EARTH PROTECTION OF THE VEHICLES' METAL PARTS**

0.1. EARTHING PRINCIPLES

All the metal parts of the vehicle:

— likely to be touched by persons, or possibly by animals, and at risk of becoming a source of excessive contact voltages, as the result of a fault in the vehicles electrical installation or because of parts of the catenary becoming detached, or

— an accident risk as a result of the arcing of switch-gear subjected to high currents in the presence of dangerous materials,

shall be set at the same potential as the rail through connections offering the lowest possible resistance.

0.2. EARTHING OF THE VEHICLE BODYSHELL

Electric resistance between metal parts and the rail for a two-axle vehicle shall be less than or equal to 0,05 Ohm. This value is measured with a constant sustained current of 50 amps and a voltage equal or lower than 50 volts.

0.3. EARTHING OF THE VEHICLE PARTS

The metal parts in the roof must be bonded to all conductive elements inside the vehicle, where they might be accessible, and must be bonded to the body of the vehicle in a safe way.

0.4. EARTHING OF ELECTRIC INSTALLATIONS

All the electrical installations and are connected to the main power circuit, and have metal parts which are likely to be touched and are not switched under power must have their metal components bonded with the mass of the vehicle in a safe way.

All the metal parts of a vehicle (other than those covered in the previous point) which are susceptible to be touched and, although not switched under power, risk being switched accidentally, shall be bonded in a safe way if the nominal voltage of the part concerned is greater than:

— 50 V direct current

— 24 V alternating current

— 24 V between phases for three phase current where the neutral is not bonded and

— 42 V between phases for three phase current when the neutral is bonded.

The cross-section of earthing bond is a function of current to be conducted; it must be sized so as to guarantee the safe functioning of the circuit breakers if tripped.

0.5. ANTENNAE

Antennae fitted outside vehicles have to fulfil the following conditions:

— the conductive parts of the antenna must be fully protected from catenary voltages by a protective device immune to impacts,

— the antenna system has to provide be provided with a single point earth connection (antenna with static earthing),

— an antenna fitted outside the vehicle that does not respond to the previous conditions must be isolated, by means of high voltage capacitors connected to other over-voltage devices, connected to the inside of the vehicle.

*ANNEX P*

## LINE VOLTAGE

The characteristics of the main traction voltage systems (with the exception of over-voltages) are described in detail in the following table:

**Nominal voltages and their acceptable limits in value and in duration.**

| Electrification system | Lowest non-permanent voltage | Lowest permanent voltage | Nominal voltage | Highest permanent voltage | Highest non-permanent voltage |
|---|---|---|---|---|---|
| | $U_{min2}$ (V) | $U_{min1}$ (V) | $U_n$ (V) | $U_{max1}$ (V) | $U_{max2}$ (V) |
| DC (mean values) | 400 (1) | 400 | 600 | 720 | 800 (2) |
| | 400 (1) | 500 | 750 | 900 | 1 000 (2) |
| | 1 000 (1) | 1 000 | 1 500 | 1 800 | 1 950 (2) |
| | 2 000 (1) | 2 000 | 3 000 | 3 600 | 3 900 (2) |
| AC (effective values) | 11 000 (1) | 12 000 | 15 000 | 17 250 | 18 000 (2) |
| | 17 500 (1) | 19 000 | 25 000 | 27 500 | 29 000 (2) |

(1) The duration of voltages between $U_{min1}$ and $U_{min2}$ shall not exceed two minutes.
(2) The duration of voltages between $U_{max1}$ and $U_{max2}$ shall not exceed five minutes.

— The voltage of the collection bar in the substation including the line circuit breakers shall not exceed $U_{max1}$,

— voltages, in normal operating conditions, have to stay in the range between $U_{min1}$ and $U_{max2}$,

— when operating conditions are interrupted, voltages in the range $U_{min1}$ to $U_{min2}$ are acceptable.

### Relationship $U_{max1}/U_{max2}$

Every occurrence of $U_{max2}$ must be followed by a level not exceeding $U_{max1}$ for an indefinite duration.

### Lowest tension of service

When the operating conditions are interrupted, $U_{max2}$ will be the lower voltage limit for the air breakers when trainsets can run.

*Note:* Values recommended for under-voltage tripping.

The under-voltage breakers with fixed or adjustable trips can be adjusted for values between 85 % and 95 % of $U_{min2}$.

*ANNEX Q*

**SIGNS INDICATING THE CASKET WHICH CONTAINS THE EQUIPMENT OF ALARM DEVICE REMINDER**

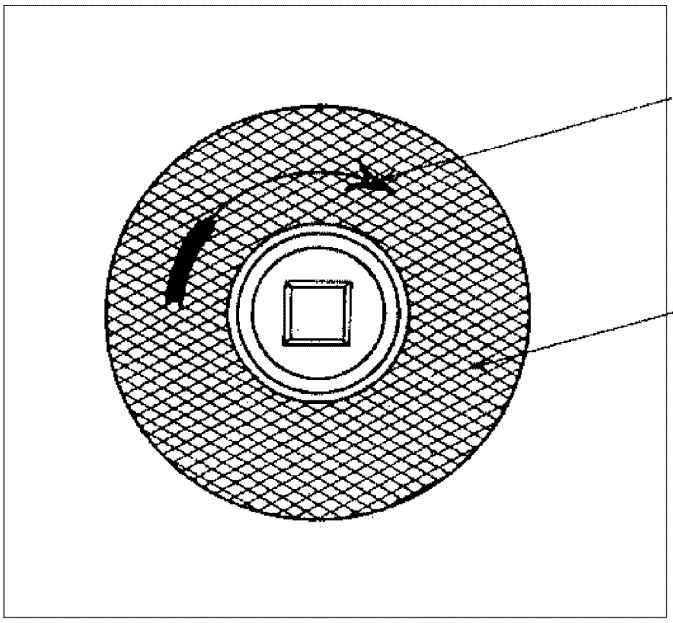



Figure 1

The return maneuver is done directly with the square key.

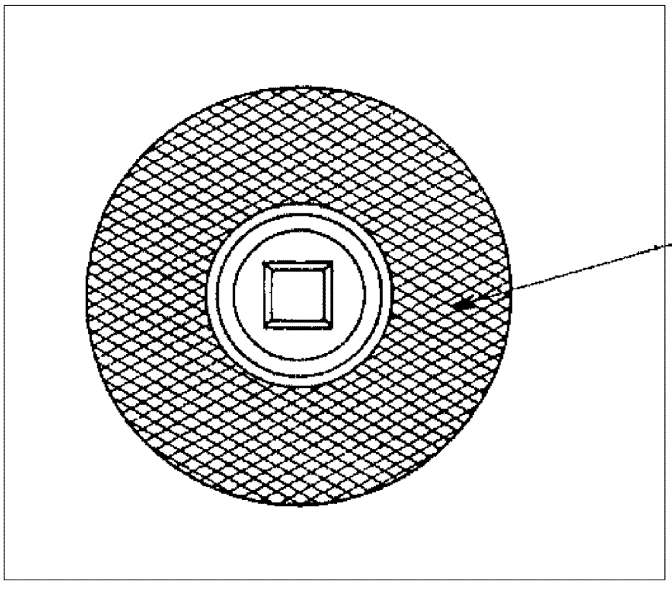



Figure 2

The return maneuver requires the opening of the casket.