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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)

(OJ L 245, 12.9.2002, p. 37)

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COMMISSION DECISION

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(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.

⁽¹⁾ OJ L 235, 17.9.1996, p. 6.

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- (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 ⁽¹⁾. 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 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

⁽¹⁾ OJ L 110, 20.4.2001, p. 1.

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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.

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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),

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- 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.

▼B*Article 5*

Commission Decisions 1999/569/EC ⁽¹⁾ and 2001/260/EC ⁽²⁾ 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

⁽¹⁾ OJ L 216, 14.8.1999, p. 23.

⁽²⁾ OJ L 93, 3.4.2001, p. 53.

▼B*ANNEX***TECHNICAL SPECIFICATION FOR INTEROPERABILITY RELATING
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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);

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- (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.

⁽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).

▼ B**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,

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 ⁽¹⁾.

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,

⁽¹⁾ 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.

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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,
- 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.

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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.

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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.

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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,

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- the automatic train protection function, comprising:
 - selecting the speed supervision mode,
 - defining and providing the intervention function,
 - setting the train characteristics,
- proving train integrity⁽¹⁾ (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,
- 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.

⁽¹⁾ Train integrity: the status of the completeness of the train according to operational rules.

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- 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.

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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.

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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;

▼ B

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;

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- (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.

▼B**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 stock 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.

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— 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 interfaces 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 (b) External STM (c) ERTMS/GSM-R on-board (d) *Safety information recorder (e) Euroloop (trackside) (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 (b) *ERTMS/GSM-R on-board (c) Safety information downloading tool (not being a control-command IC).	Operational recording of issue: 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

▼ **B**

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 (b) ERTMS/GSM-R trackside (c) *Safety information recorder	Rolling stock (see section 4.2 TSI control-command) and operational issues: — radio operational requirements, — drivers cab ergonomics, — operational rules, — operational language, — 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 (b) ERTMS/ETCS on-board (c) Safety information recorder (d) Odometry	(UNISIG grouping of on-board ICs)	(a) External STM (b) ERTMS/GSM-R on-board (c) Euroloop (trackside) (d) Eurobalise (trackside) (e) Safety information downloading tool	Rolling stock (see section 4.2 TSI control-command) and operational issues: — radio operational requirements, — driver's cab ergonomics, — operational rules, — operational language, — 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) (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 (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 (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 (b) Eurobalise (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 (b) Euroloop (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.

▼B**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.

▼ B

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 section 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.

▼ M2

▼ B

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).

▼ M2

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 without an additional subsystem declaration of verification.

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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.

▼B**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 ⁽¹⁾) 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.

⁽¹⁾ 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 (b) ERTMS/ETCS on-board		15

▼B

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	<p>1. Engineering rules</p> <p>2. Functional integration test</p> <p>Tests to confirm correct functional operation of inter-working of a new combination of interoperability constituents</p> <p>Tests in the real configuration</p> <p>The notified body shall verify that the integration test requirements (issued by the Member State) for Annex B systems have been met</p> <p>The test includes the ability of the down-loading tool to read and display the safety data recorded</p> <p>Includes absence of unsafe interaction between interoperability constituents (possibly due to national add-ons)</p> <p>3. The notified body shall insure the completeness of the safety approval process including safety case</p>	All those implemented	<p>Rolling stock</p> <p>All those implemented</p>	<p>34</p> <p>32</p> <p>+</p> <p>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.</p> <p>1, 2</p>

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 (b) ERTMS/ETCS trackside		0, 12c, 14a,
2	Train detection, including interference requirements from conducted interference	Trackside requirements: 1. lines with unknown detection/interference characteristics cannot receive a derogation, 2. they must be upgraded before they can be declared interoperable, 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 ERTMS/ETCS on-board		15

▼B

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	<p>1. Engineering rules</p> <p>2. Functional integration test</p> <p>Tests to confirm correct functional operation of interworking of a new combination of interoperability constituents</p> <p>Tests in the real configuration</p> <p>The notified body shall verify that the integration test requirements (issued by the Member State) for Annex B systems have been met</p> <p>Includes absence of unsafe interaction between interoperability constituents (possibly due to national add-ons)</p> <p>3. The notified body shall insure the completeness of the safety approval process including safety case.</p>	All those implemented	All those implemented	34 33 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 ⁽¹⁾, 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 ⁽²⁾ 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 necessary 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).

⁽¹⁾ Class A: see section 2.

⁽²⁾ Class B: see section 2.

▼ B

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.

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.

▼ M2

7.2.1.4. *Registers*

The data to be provided for the registers provided for in Articles 34 and 35 of Directive 2008/57/EC of the European Parliament and of the Council ⁽¹⁾ are those indicated in Commission Implementing Decision 2011/633/EU of 15 September 2011 on the common specifications of the register of railway infrastructure ⁽²⁾ and Commission Implementing Decision 2011/665/EU of 4 October 2011 on the European register of authorised types of railway vehicles ⁽³⁾.

⁽¹⁾ OJ L 191, 18.7.2008, p. 1.

⁽²⁾ OJ L 256, 1.10.2011, p. 1.

⁽³⁾ OJ L 264, 8.10.2011, p. 32.

▼B**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,

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,

▼B

- 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.

▼ B**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.

▼ M2**▼ B****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.

▼ B

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.

▼ M2**▼ B**

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

All specifications referred to in this table are mandatory unless they are clearly marked as informative.

GLOBAL REQUIREMENTS

IndexNo	Control-commandTSI paragraph reference ⁽¹⁾	Subject ⁽²⁾	Scope ⁽³⁾	European specifications defining basic parameters	Other European specifications
0a.	4.1.1	ETCS FRS		UIC ETCS FRS Version 4.29 EEIG 99E5362 Version 2.00	
0b.	4.1.1	GSM-R FRS		EIRENE FRS Version 6.0	
1	3.2.1	Safety assurance.	Informative documentation: EN 50128 March 2001		EN50126 September 1999 EN50129 February 2003
2		RAMS			
2a.	3.2.1 4.1.1	Safety requirements	Informative documentation UNISIG SUBSET -077-V222 UNISIG SUBSET -078-V222 UNISIG SUBSET -079-V222 (2parts) UNISIG SUBSET -080-V222 (2 parts) UNISIG SUBSET -081-V222 (2 parts) UNISIG SUBSET -088-V222 (6 parts)	UNISIG SUBSET -091-V222	EN50129 February 2003
2b.	3.2.2e	Reliability-availability-requirements.	ERTMS/96s1266- (RAM chapter) to be used as input information. 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.	Reserved	EN 29000 and EN 29001

IndexNo	Control-commandTSI paragraph reference ⁽¹⁾	Subject ⁽²⁾	Scope ⁽³⁾	European specifications defining basic parameters	Other European specifications
3	3.2.5.1.1 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. Informative documentation: EEIG 97S0665- Version 5, EN50125-3 October 2003	Reserved	EN 50125-1 September 1999 and EN 50155 August 2001
4	3.2.5.1.2	Electromagnetic compatibility:			
4a.	3.2.5.1.2 4.2.1.2d	Electromagnetic compatibility	ERTMS/97s0665- to be used as input document. For the purpose of EMC, frequency bands for intentional transmission (Eurobalise, Euroloop, and GSM-R) are excluded from the specifications indicated in this index. Specific requirements for the Eurobalise air-gap are indicated in index 12a. Specific requirements for the Euroloop air-gap are indicated in index 12b. Specific requirements for GSM-R air-gap are indicated in index 12c.	Reserved	For on-board equipment: EN 50121-3-2, September 2000, Tables 4 and 6 in Clause 7. Clauses 4, 5, and 6 are applicable for testing procedures. EN 50121-3-2, September 2000, Tables 7, 8, and 9 in Clause 8. Clauses 4, 5, and 6 are applicable for testing procedures. For track-side equipment: EN 50121-4, September 2000, Clause 5. EN 50121-4, September 2000, Clause 6
4b	3.2.5.1.2b 4.2.1.2f	The immunity characteristics of train detection systems.	To ensure that train detection systems are not perturbed by traction current. Input for European specification is contained in the report to TSI CC.	Reserved	(reserved)

⁽¹⁾ The references of this column are only valid in the case of the TSI CCS-HS.

⁽²⁾ This is the subject addressed in the paragraph referenced in the TSI.

⁽³⁾ This is a description of the intent of the standard required to support the TSI.

CONTROL COMMAND FUNCTIONS

IndexNo	Control-commandTSI 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.	Informative documentation: UNISIG SUBSET-050-V200, UNISIG SUBSET-076-0-V222 UNISIG SUBSET -076-2-V221 UNISIG SUBSET -076-3-V221 UNISIG SUBSET -076-4-1-V100 UNISIG SUBSET -076-4-2-V100 UNISIG SUBSET -076-5-3-V220 UNISIG SUBSET -076-5-4-V221 UNISIG SUBSET -076-6-1-V100 UNISIG SUBSET -076-6-4-V100 UNISIG SUBSET -076-6-5-V100	UNISIG SUBSET-026- V222 UNISIG SUBSET-043-V200 UNISIG SUBSET-046-V200 UNISIG SUBSET-047-V200 UNISIG SUBSET-054-V200 UNISIG SUBSET-055- V222 UNISIG SUBSET -076-5-1-V221 UNISIG SUBSET -076-5-2-V221 UNISIG SUBSET -076-6-3-V100 UNISIG SUBSET -076-7-V100 UNISIG SUBSET -094-0-V100	
5b.	4.1.1	Degraded operation	The system requirements in response to failures. ERTMS/97E832 to be used as input for European specification	UNISIG SUBSET-026- V222	

IndexNo	Control-commandTSI paragraph reference	Subject ⁽¹⁾	Scope ⁽²⁾	European specifications defining basic parameters	Other European specifications
6	4.1.1 4.1.2.2	STM management.	<p>The functional and physical requirements on the STM interface to the Class A system.</p> <p>KER compatibility is to be addressed.</p> <p>Informative documentation: UNISIG SUBSET-059-V200</p>	<p>UNISIG SUBSET-035-V211</p> <p>UNISIG SUBSET-026- V222</p> <p>UNISIG SUBSET-056-V220</p> <p>UNISIG SUBSET-057-V220</p> <p>UNISIG SUBSET-058-V211</p>	
7	4.1.1	MMI driver interface functional requirements.	<p>The functional specification for communication between the driver and the onboard 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.</p> <p>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.</p> <p>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.</p>	<p>UNISIG SUBSET-033-V200</p> <p>UNISIG SUBSET-026- V222</p> <p>UNISIG SUBSET-035-V211</p>	

▼ **M1**

IndexNo	Control-commandTSI paragraph reference	Subject ⁽¹⁾	Scope ⁽²⁾	European specifications defining basic parameters	Other European specifications
8	4.1.1	Odometry requirements	<p>The functional requirements of the odometry sub-system 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.</p> <p>Note relation with index 6, STM</p>	UNISIG SUBSET-041-V200	
9	4.1.1	Requirements for the onboard recording of operational data	<p>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.</p>	<p>UNISIG SUBSET-026- V222</p> <p>UNISIG SUBSET-027-V200</p>	
10	4.1.1	Vigilance (dead man's) system requirements.	<p>The definition of a vigilance function so that the train can operate acceptably on the European networks.</p> <p>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.</p>	Reserved	

▼ **M1**

IndexNo	Control-commandTSI paragraph reference	Subject ⁽¹⁾	Scope ⁽²⁾	European specifications defining basic parameters	Other European specifications
			<p>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 inter-dependent 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.</p> <p>UIC 641 is to be the basis for European Specification.</p>		
11	4.1.1 4.2.1.2e	Radio.	The definition of the radio system for voice and data communication to and from the trains.	<p>EIRENE SRS</p> <p>Version 14</p> <p>Test requirements (to be added in the next version of this TSI)</p>	

⁽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

IndexNo	Control-commandTSI 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 4.1.2.1	Balise	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-V221 UNISIG SUBSET-085-V212	ETSI EN 300330-1, V1.3.1 (June 2001), up to and including Sub-clause 7.2 ⁽³⁾ .
12b.	3.2.5.1.2 4.1.2.1	Loop	Informative documentation: UNISIG SUBSET-050-V200	UNISIG SUBSET-043-V200 UNISIG SUBSET-044-V200 UNISIG SUBSET-045-V200 Test requirements (to be added in the next version of this TSI)	
12c.	3.2.5.1.2 4.1.2.1	Radio		EIRENE SRS Version14	

⁽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-V221.

INTERFACES ONBOARD BETWEEN CONTROL-COMMAND INTEROPERABILITY CONSTITUENTS

IndexNo	Control-commandTSI paragraph reference	Subject ⁽¹⁾	Scope ⁽²⁾	European specifications defining basic parameters	Other European specifications
13		Onboard 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	ERTMS/ETCS Euroradio		UNISIG SUBSET-026- V222 UNISIG SUBSET-034-V200 UNISIG SUBSET-047-V200 UNISIG SUBSET-037-V225 UNISIG SUBSET-093-V226 UNISIG-SUBSET-048-V200 UNISIG SUBSET-092-1-V225 UNISIG SUBSET-092-2-V225	
13b.	4.1.2.2	GSM-R	Informative documentation: O-2475 V1.0	A11T6001.12	
13c.	4.1.2.2	Train data interface for analysis of operational data recorded onboard	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 parties interested.	UNISIG SUBSET-027-V200	
13d.	4.1.2.2	Odometry interfaces.	ERTMS/97e267 is to be the basis for a European specification A Specification will not be available in the first step.	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.

INTERFACES AT THE TRACKSIDE BETWEEN CONTROL-COMMAND INTEROPERABILITY CONSTITUENTS

IndexNo	Control-commandTSI 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/ETCS Euroradio.		UNISIG SUBSET-049-V200 UNISIG SUBSET-026- V222 UNISIG SUBSET-037-V225 UNISIG SUBSET-092-1-V225 UNISIG SUBSET-092-2-V225 UNISIG SUBSET-093-V226	
14b.	4.1.2.3	GSM-R	Informative documentation: O-2475 V1.0	A11T6001.12	
14c.	4.1.2.3	Eurobalise and LEU.		UNISIG SUBSET-036-V221 UNISIG SUBSET-085-V212	
14d.	4.1.2.3	Euroloop and LEU.		UNISIG SUBSET-045-V200	
14e.	4.1.2.3	ERTMS/ETCS and ERTMS/ ETCS (RBC-RBC-handover).		UNISIG SUBSET-039-V200	
15	4.2.4	Key management		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

IndexNo	Control-commandTSI 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. To be completed, e.g., to take into account inductivity in case of axleless wheelsets and minimum axleload.	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.

DATA INTERFACES BETWEEN CONTROL-COMMAND AND ROLLING-STOCK

IndexNo	Control-commandTSI 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⁾ dsfds

⁽²⁾ dsfsd

CONTROL-COMMAND PERFORMANCE

IndexNo	Control-commandTSI paragraph reference	Subject ⁽¹⁾	Scope ⁽²⁾	European specifications defining basic parameters	Other European specifications
18	4.1.1 4.3	Performance Required.	Annexes I and IV of 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

IndexNo	Control-commandTSI paragraph reference	Subject ⁽¹⁾	Scope ⁽²⁾	European specifications defining basic parameters	Other European specifications
32 ⁽³⁾	6.2	Onboard assembly integration requirements	<p>This shall be sufficient to ensure that the onboard assembly will operate correctly with the trackside assemblies (sub-system-verification considering the options as indicated in the register of rolling stock).</p> <p>Practical running tests have to be performed after the installation of onboard control-command equipment.</p> <p>Special attention shall be given to electromagnetic compatibility between CC and rolling stock.</p>	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 onboard assemblies (sub-system-verification considering the options as indicated in the register of infrastructure).	UNISIG SUBSET (reserved)	
34	Table 6.1 Table 6.2	Installation requirements	The engineering rules that apply when installing the control-command assembly onboard 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 number 19 through 31 are intentionally deleted.

▼ B*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.

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Railway undertakings needing to install one or more of these systems on their trains shall refer to the appropriate Member State.

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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
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13. TVM
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▼B

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

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- 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

▼B*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.

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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

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— 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

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- 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. Ebrake 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

▼B*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

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- 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/Punktformige 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 it 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

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- 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

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- 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 \pm 0,4 kHz (FSK)
 - 1 200 bit/sec
 - 83,5 steps per telegram

▼ B

- Data transmission from trains:
 - 56 kHz \pm 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.

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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.

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- 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 \pm 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

▼B**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 \pm 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

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- 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 inter-operable.

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,*

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- 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,
- immediately 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 Méditerranée) 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.

▼B*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,

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- 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.

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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 $v_{\text{actual}} < v_{\text{target}}$
 - vigilance check every 200 m in case of $v_{\text{actual}} > v_{\text{target}}$
 - 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

▼B**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

▼ B

- 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)

▼ B

- 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

INDEX:

1. UIC Radio Chapter 1 to 4
2. UIC Radio Chapter 1 to 4 and 6
3. UIC Radio Chapter 1 to 4 and 6 and 7
 - Introduction to UK Systems
4. BR 1845
5. BR 1609
6. FS ETACS and GSM

▼ M2

These systems are currently in use in Member States.

▼ B**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.

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- 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 μ V at > 20 dB signal-to-noise ratio (mobile)
 - > 2 μ V (lineside)
- Radiating power:
 - 6 W mobile
 - 6 W lineside
- Antenna characteristics:
 - $\lambda/4$ 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

▼B**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:
 - $\lambda/4$ 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

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- 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

▼B**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:
 - $\lambda/4$ 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

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- 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: 2280 Hz
 - listening: 1960 Hz
 - pilot: 2800 Hz
 - warning: 1520 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

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- 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.

▼B**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 μ V at > 20 dB signal to noise ratio (mobile)— < 2 μ V (lineside)

— Radiating power:

— 10 W mobile

— 10 W lineside

— Antenna characteristics:

— $\lambda/4$ 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

▼B

- 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)

▼B

— 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

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- Sensitivity:
 - < 0,6 μ V at 12 dB signal-to-noise ratio (mobile)
 - < 0,3 μ V at 12 dB signal-to-noise ratio (lineside)
- Radiating power:
 - > 25 W mobile
 - > 25 W lineside
- Antenna characteristics:
 - $\lambda/4$ 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

▼B

- 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

▼B**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:

— $\lambda/4$ 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

▼B

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

▼ B

Antenna characteristics:

- $\lambda/4$ 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 1 200 b/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

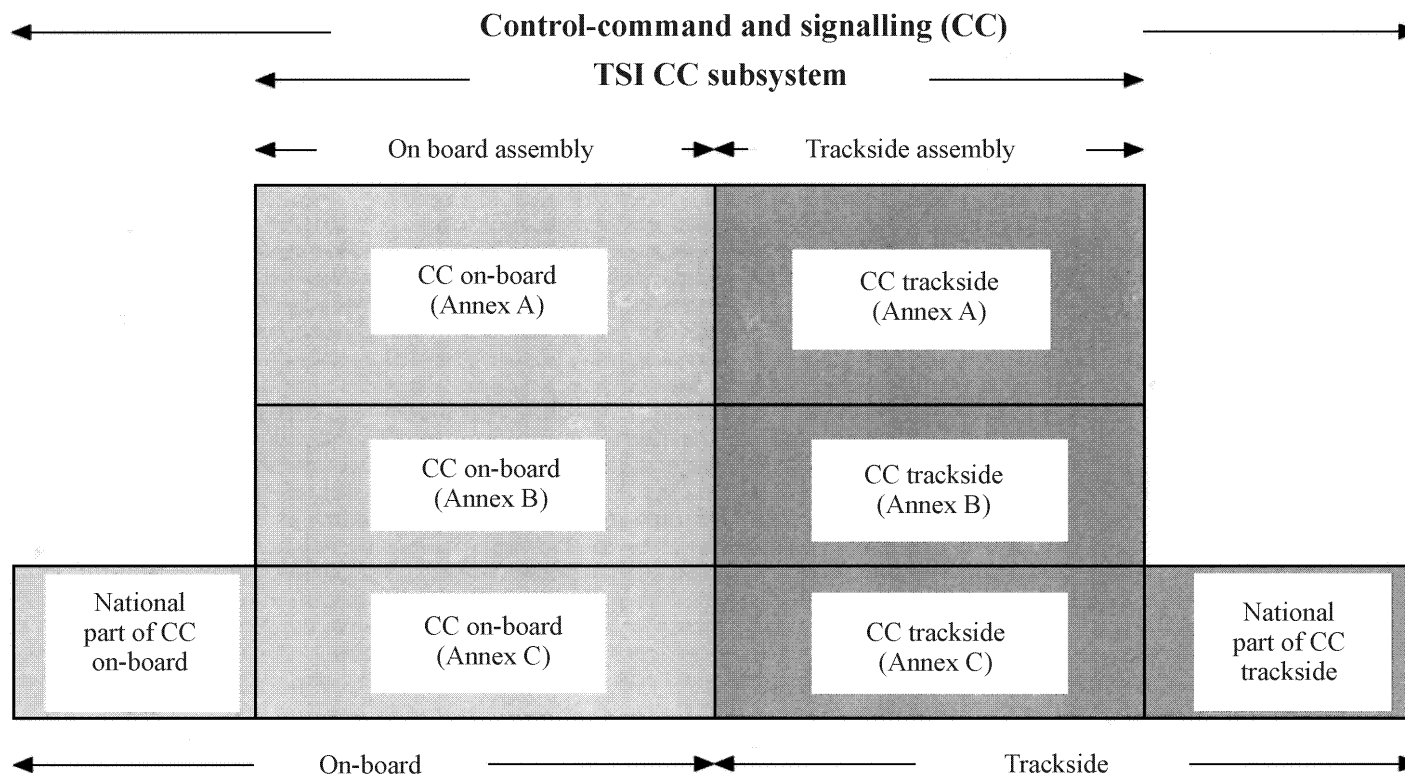
Responsible Member State: Portugal

▼ M2

ANNEX D

TSI CC (high-speed rail system) — Figure 1

This figure shows the principle only



▼B*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),

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- 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 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.

(*) This clause is not applicable to the European specifications that are used to define basic parameters. These are indicated in Annex A.

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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.

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.

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- 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.

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- 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),

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- 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

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- 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.
 - 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),

(*) This clause is not applicable to the European specifications that are used to define basic parameters. These are indicated in Annex A.

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- 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.

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.

⁽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.

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- 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.

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.

(*) This clause is not applicable to the European specifications that are used to define basic parameters. These are indicated in Annex A.

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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.

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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.

(*) This clause is not applicable to the European specifications that are used to define basic parameters. These are indicated in Annex A.

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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.

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.

(*) This module applies to both on-board and trackside control-command assemblies.

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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,

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- the European register of authorised types of vehicle, including all information as specified in the TSI,

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- 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,

(*) This clause is not applicable to the European specifications that are used to define basic parameters. These are indicated in Annex A.

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- 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.

(*) This clause is not applicable to the European specifications that are used to define basic parameters. These are indicated in Annex A.

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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 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.

(*) This module applies to both on-board and trackside control-command assemblies.

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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,

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- 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.

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- 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.

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- 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.

▼ M2

- the Register of Infrastructure, including all information as specified in the TSI,

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- 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.

(*) This clause is not applicable to the European specifications that are used to define basic parameters. These are indicated in Annex A.

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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.

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:

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- the Register of Infrastructure, including all information as specified in the TSI.

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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.

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,

(*) This module applies to both on-board and trackside control-command assemblies.

▼ M2

- the Register of Infrastructure, including all information as specified in the TSI,

▼ B

- 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.

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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,

▼ M2

- the Register of Infrastructure, including all information as specified in the TSI,

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- 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.

▼B**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.

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,

(*) This module applies to the trackside control-command assembly.

(**) This clause is not applicable to the European specifications that are used to define basic parameters. These are indicated in Annex A.

▼B

- 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,
 - 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.

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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 ⁽¹⁾ (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.

⁽¹⁾ 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.

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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).

(*) This clause is not applicable to the European specifications that are used to define basic parameters. These are indicated in Annex A.

▼ B

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 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.

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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,

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- 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.

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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,

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- 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,

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- the Register of Infrastructure, including all information as specified in the TSI.

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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.