2.1 SPECIFICHE TECNICHE D’INTEROPERABILITÀ

ERA
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8 settembre 2020
From national visions to European interoperability

YESTERDAY

International Agreements
(COTIF, AGC, AGTC,...)

+ International Rules
(UIC, RIV, RIC,...)

+ National Rules
(With or without mutual recognition)

TODAY

European Specifications

+ European Standards

+ National Rules
Background and legal framework
<table>
<thead>
<tr>
<th>Year</th>
<th>Development of the EC railway policy</th>
</tr>
</thead>
<tbody>
<tr>
<td>1996</td>
<td>• Directive 96/48: Interoperability of the trans-European (TEN) high-speed rail system</td>
</tr>
<tr>
<td>2007</td>
<td>• 3rd railway package: passenger rights better guaranteed, opening of the market for international railway services (from January 2010), European license for train drivers</td>
</tr>
</tbody>
</table>
| 2008 | • Interoperability Directive 2008/57/EC (covering the entire Union railway network)  
• Directive 2008/110/EC amending the Safety Directive (ECMs introduced) |
| 2016 | • 4th railway package (technical pillar): major revision of ERA regulation, Interoperability and Safety directives: new roles and responsibilities for ERA, single safety certificate and improved vehicle authorisation process |
Interoperability directives – Safety directives and ERA Regulation

- Directive 96/48: Interoperability of the trans-European (TEN) high-speed rail system
- Directive 2001/16: Interoperability of the trans-European (TEN) conventional rail system
- Interoperability Directive 2004/50 modifying 96/48 and 2001/16
- Safety Directive 2004/49/EC
- Regulation 881/2004 (European Railway Agency)
- Directive 2008/57/EC on the interoperability of the rail system within the Community (covering both HS and CR and extending the scope of the TSIs progressively to the whole rail system)

TSIs evolution*

- Decisions 2002 (HS)
- Decisions 2008 (HS)
- Decisions 2011 (CR)
- Decisions 2012 (HS)
- Regulations 2014 (TEN / off TEN)
- Regulation 2019
- New TSI package 2022

*e.g. INF/ENE TSIs
This Directive establishes the conditions to be met to achieve **interoperability** within the **Union rail system** in a manner compatible with Directive (EU) 2016/798 in order to define an **optimal level of technical harmonisation**, to make it possible to facilitate, improve and develop rail transport services within the Union and with third countries...
• (2) ‘interoperability’ means the ability of a rail system to allow the safe and uninterrupted movement of trains which accomplish the required levels of performance;

• (5) ‘subsystems’ means the structural or functional parts of the Union rail system, as set out in Annex II;

• (7) ‘interoperability constituents’ means any elementary component, group of components, subassembly or complete assembly of equipment incorporated or intended to be incorporated into a subsystem, upon which the interoperability of the rail system depends directly or indirectly, including both tangible objects and intangible objects;
• (9) ‘essential requirements’ means all the conditions set out in Annex III which must be met by the Union rail system, the subsystems, and the interoperability constituents, including interfaces;

• (11) ‘technical specification for interoperability’ (TSI) means a specification adopted in accordance with this Directive by which each subsystem or part of a subsystem is covered in order to meet the essential requirements and ensure the interoperability of the Union rail system;

• (12) ‘basic parameter’ means any regulatory, technical or operational condition which is critical to interoperability and is specified in the relevant TSIs;
Essential Requirements

- Safety
- Reliability and availability
- Health
- Environmental protection
- Technical compatibility
- Accessibility

Directive EU 2016/797
Annex III
For the purposes of this Directive, the system constituting the Union rail system may be broken down into the subsystems beside.
<table>
<thead>
<tr>
<th>Subsystems</th>
<th>Structural</th>
<th>Functional</th>
</tr>
</thead>
<tbody>
<tr>
<td>Infrastructure</td>
<td>INF TSI</td>
<td>OPE TSI</td>
</tr>
<tr>
<td>Energy</td>
<td>ENE TSI</td>
<td></td>
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<tr>
<td>Trackside CCS</td>
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<tr>
<td>On-board CCS</td>
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<tr>
<td>Rolling stock</td>
<td>LOC&amp;PAS TSI</td>
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<td></td>
<td>WAG TSI</td>
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<td></td>
<td>SRT TSI</td>
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<tr>
<td></td>
<td>PRM TSI</td>
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<tr>
<td></td>
<td>NOI TSI</td>
<td></td>
</tr>
</tbody>
</table>

TSIs chronology (Table 1 Structural TSIs, Table 2 Functional TSIs)
How to meet the essential requirements?

1. Safety
2. Reliability and availability
3. Health
4. Environmental protection
5. Technical compatibility
6. Accessibility

Interoperability Directive
6 Essential Requirements

Mandatory Rules
TSIs + NTRs

Standards directly quoted in TSIs

Harmonised EN Standards

Other public standards and documents

Company standards

Mandatory
- Specified in TSIs / NTRs

Voluntary
- Applicant chooses own specifications
A **TSI** is a common (harmonized) technical standard specifying the elements of essential requirements* that need to be harmonized to achieve interoperability

- Safety, reliability and availability, health, environmental protection, technical compatibility, accessibility

**TSIs relate to**

+ structural subsystems (infrastructure, rolling stock, energy, CCS), or
+ functional subsystems (maintenance, traffic operation and management, telematics applications for passengers and freight services)

The TSI framework is supplemented by national rules (NRs)
Content and drafting of TSIs

Art. 4 and Art. 5 IoD
**Legal Basis**

- **Interoperability Directive (EU) 2016/797**
  - **Article 4** sets out the general content and some **general objectives** of the TSIs
  - Sets out the **specific objectives** applicable to all TSIs and to specific TSIs
  - Request to the Agency for TSI **recommendations** including **planning** (based on Delegated Decision (EU) 2017/1474)

- **Delegated Decision (EU) 2017/1474**

- **Commission’s request**
• Art 4.3 indicates aspects to be addressed by each TSI

• Art 4.4 requires to indicate the target system by each TSI

• Art 4.5 requires to retain the compatibility of existing rail system (Specific cases if needed)

• Art 4.6 refers to Open points

• Art 4.8 addresses references to European or international standards or specifications by TSI as mandatory
The scope of application
- Geographically, e.g. Union’s network
- Technically, e.g. locomotives and passenger rolling stock
- May exclude some types of subsystem

Functional and technical specifications
- To meet essential requirements as in Directive
- To describe interfaces with other subsystems
- May include references to standards

Interoperability constituents
- Checked independently from subsystem
- E.g. wheel, pantograph,
- If an IC is used, it must comply with TSI

Procedures to assess conformity
- Used by NoBos
- Generic assessment modules

Implementation strategy
- To minimise the economical impact
- Specific cases for Member States

Both requirements & assessment procedures are mandatory
**Digital rail**

The next revision must build on digitalisation and innovations and accompany the rail system transformation towards a significantly more efficient and cost-effective system, paving the way for automation and enhancing system capacity.

**Green freight**

In the 2011 White Paper on Transport, the EU set the objective to shift 30% of long-distance road freight to more energy-efficient transport modes such as rail or inland waterways by 2030 and 50% by 2050.

Despite the ambitious objectives set in the 2011 White Paper, the modal share of rail freight in all land transport has remained stagnant since the early 2000s at around 16–19% while the share of road freight remains very high (76%) (Eurostat).

Under the green freight objective, the 2022 revision must further remove barriers to freight and support uptake of more environmental friendly technologies.
Organisational structure of the CCM
• **TSI infrastructure** is an **Annex** to the Commission Regulation (EU) No 1299/2014 of 18 November 2014 on the technical specifications for interoperability relating to the ‘infrastructure’ subsystem of the rail system in the European Union.

• The Regulation (EU) No 1299/2014 has been amended by Commission Implementing Regulation (EU) 2019/776 of 16 May 2019

• A consolidated version is available in the [link](#)
• Section 1: Technical and Geographical scope.
• Section 2: indicates its intended scope (e.g. SRT and PRM excluded).
• Section 3: lays down essential requirements for the infrastructure and part of the maintenance subsystems.
• Section 4: establishes the functional and technical specifications to be met by the infrastructure and part of the maintenance subsystems and its interfaces vis-à-vis other subsystems.
• Section 5: specifies the interoperability constituents.
• Section 6: states which procedures are to be used in order to assess the conformity of the interoperability constituents or the EC verification of the subsystem.
• Section 7: indicates the strategy for implementing this TSI and the Specific Cases.
The INF TSI concerns the **infrastructure subsystem** and **part of the maintenance subsystem** of the Union rail system defined respectively in points **2.1 and 2.8 of Annex II to Directive (EU) 2016/79:**

2.1. Infrastructure
The track, points, level crossings, engineering structures (bridges, **tunnels***, etc.), rail-related elements of stations (including entrances, platforms, zones of access, service venues, toilets and information systems, as well as their **accessibility features for persons with disabilities and persons with reduced mobility**), safety and protective equipment.

2.8. Maintenance
The procedures, associated equipment, logistics centres for maintenance work and reserves providing the mandatory corrective and preventive maintenance to ensure the interoperability of the Union rail system and guarantee the performance required.

The technical scope is further defined in **Article 2(1), 2(5) and 2(6) of the Regulation (EU) 1299/2014:**

2 (1): The TSI shall apply to all **new, upgraded or renewed ‘infrastructure’** of the rail system in the European Union as defined in point 2.1 of Annex II to Directive (EU) 2016/797 of the European Parliament and of the Council.

2 (5): The TSI shall apply to networks with the following **nominal track gauges:**
  1 435 mm, 1 520 mm, 1 524 mm, 1 600 mm and 1 668 mm.

2 (6): **Metric gauge** is excluded from the technical scope of this TSI

* Covered by TSI SRT
** Covered by TSI PRM
The geographical scope of this TSI is defined in Article 2(4) of the Regulation (EU) No 1299/2014:

The TSI shall apply to the network of the Union rail system as described in Annex I of Directive (EU) 2016/797 with the exclusion of cases referred to in Article 1(3) and (4) of Directive (EU) 2016/797

3. This Directive shall not apply to:

(a) metros;

(b) trams and light rail vehicles, and infrastructure used exclusively by those vehicles;

(c) networks that are functionally separate from the rest of the Union rail system and intended only for the operation of local, urban or suburban passenger services, as well as undertakings operating solely on those networks.

4. Member States may exclude from the scope of the measures implementing this Directive:
### Chapter 3 - Essential requirements

#### Table 1

<table>
<thead>
<tr>
<th>TL point</th>
<th>Title of TL point</th>
<th>Safety</th>
<th>Reliability</th>
<th>Availability</th>
<th>Health</th>
<th>Environmental protection</th>
<th>Technical compatibility</th>
<th>Accessibility</th>
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<tr>
<td>4.2.3.1</td>
<td>Structure gauge</td>
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<td>Distance between track centre</td>
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<td>Minimum gradient</td>
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<td>Minimum radius of horizontal curve</td>
<td>1.1.3</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>4.2.3.5</td>
<td>Minimum radius of vertical curve</td>
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<td>1.5</td>
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<td>4.2.4.2</td>
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<td>1.1.1</td>
<td>2.1.1</td>
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<td></td>
<td></td>
<td>1.5</td>
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<td>4.2.12.4</td>
<td>Water retention</td>
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<td>1.2</td>
<td></td>
<td>1.3.1</td>
<td></td>
<td></td>
<td>1.5</td>
</tr>
<tr>
<td>4.2.12.5</td>
<td>Refuelling</td>
<td>1.1.5</td>
<td>1.2</td>
<td></td>
<td>1.3.1</td>
<td></td>
<td></td>
<td>1.5</td>
</tr>
<tr>
<td>4.2.12.6</td>
<td>Electric supply</td>
<td>1.1.5</td>
<td>1.2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1.5</td>
</tr>
<tr>
<td>4.4</td>
<td>Operating rules</td>
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<td>1.2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.5</td>
<td>Maintenance rules</td>
<td></td>
<td>1.2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>4.6</td>
<td>Professional qualifications</td>
<td>1.1.5</td>
<td>1.2</td>
<td></td>
<td></td>
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<tr>
<td>4.7</td>
<td>Health and safety conditions</td>
<td>1.1.5</td>
<td>1.2</td>
<td>1.3</td>
<td>1.4.1</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

Slide 25
• 4.1. Introduction

• 4.2. Functional and technical specifications of infrastructure subsystem

• 4.3. Functional and technical specification of the interfaces

• 4.4. Operating rules

• 4.5. Maintenance rules

• 4.6. Professional qualifications

• 4.7. Health and safety conditions
(2) The limiting values set out in this TSI are not intended to be imposed as usual design values. However the design values must be within the limits set out in this TSI.

(3) The functional and technical specifications of the infrastructure and part of the maintenance subsystems and their interfaces, as described in points 4.2 and 4.3, do not impose the use of specific technologies or technical solutions, except where this is strictly necessary for the interoperability of the Union rail system.

(4) Innovative solutions for interoperability which do not fulfil the requirements specified in this TSI and/or which are not assessable as stated in this TSI require new specifications and/or new assessment methods. In order to allow technological innovation, these specifications and assessment methods shall be developed by the process for innovative solutions described in Article 10.

(5) Where reference is made to EN standards, any variations called, unless otherwise specified in this TSI ‘national deviations’ in the EN do not apply
### Chapter 4.2 – TSI Category of lines

#### Table 2
Performance parameters for passenger traffic

<table>
<thead>
<tr>
<th>Traffic code</th>
<th>Gauge</th>
<th>Axle load [t]</th>
<th>Line speed [km/h]</th>
<th>Usable length of platform [m]</th>
</tr>
</thead>
<tbody>
<tr>
<td>P1</td>
<td>GC</td>
<td>17 (*)</td>
<td>250-350</td>
<td>400</td>
</tr>
<tr>
<td>P2</td>
<td>GB</td>
<td>20 (*)</td>
<td>200-250</td>
<td>200-400</td>
</tr>
<tr>
<td>P3</td>
<td>DE3</td>
<td>22,5 (**)</td>
<td>120-200</td>
<td>200-400</td>
</tr>
<tr>
<td>P4</td>
<td>GB</td>
<td>22,5 (**)</td>
<td>120-200</td>
<td>200-400</td>
</tr>
<tr>
<td>P5</td>
<td>GA</td>
<td>20 (**)</td>
<td>80-120</td>
<td>50-200</td>
</tr>
<tr>
<td>P6</td>
<td>G1</td>
<td>12 (**)</td>
<td>n.a.</td>
<td>n.a.</td>
</tr>
<tr>
<td>P1520</td>
<td>S</td>
<td>22,5 (**)</td>
<td>80-160</td>
<td>35-400</td>
</tr>
<tr>
<td>P1600</td>
<td>IRL1</td>
<td>22,5 (**)</td>
<td>80-160</td>
<td>75-240</td>
</tr>
</tbody>
</table>

#### Table 3
Performance parameters for freight traffic

<table>
<thead>
<tr>
<th>Traffic code</th>
<th>Gauge</th>
<th>Axle load [t]</th>
<th>Line speed [km/h]</th>
<th>Train length [m]</th>
</tr>
</thead>
<tbody>
<tr>
<td>F1</td>
<td>GC</td>
<td>22,5 (*)</td>
<td>100-120</td>
<td>740-1050</td>
</tr>
<tr>
<td>F2</td>
<td>GB</td>
<td>22,5 (*)</td>
<td>100-120</td>
<td>600-1050</td>
</tr>
<tr>
<td>F3</td>
<td>GA</td>
<td>20 (*)</td>
<td>60-100</td>
<td>500-1050</td>
</tr>
<tr>
<td>F4</td>
<td>G1</td>
<td>18 (*)</td>
<td>n.a.</td>
<td>n.a.</td>
</tr>
<tr>
<td>F1520</td>
<td>S</td>
<td>25 (*)</td>
<td>50-120</td>
<td>1050</td>
</tr>
<tr>
<td>F1600</td>
<td>IRL1</td>
<td>22,5 (*)</td>
<td>50-100</td>
<td>150-450</td>
</tr>
</tbody>
</table>
If a new line is intended to be operated by passenger trains with speed of 250 km/h, local commuter trains with speed of 120 km/h and heavy freight trains in the night. What is the best combination of traffic codes?

Then, the TSI category of line for this case would simply be P2-P5-F1

The line shall then have to be designed in order to fulfil the envelope of performance parameters for this category:
- Gauge: GC (from F1)
- Axle load: 22.5 t (from F1)
- Line speed: 200 - 250 km/h (from P2)
- Usable length of platform: 200 – 400 m (from P2)
- Train length: 740 – 1050 m (from F1)
Chapter 4.2 - Functional and technical specifications of subsystem

The Basic Parameters, characterising the infrastructure subsystem, are grouped according to the following aspects:

- Line Layout
- Track Parameters
- Switches & Crossing
- Track resistance to applied loads
- Structure resistance to traffic loads
- Immediate action limits on track geometry defects
- Platforms
- Health, safety and environment
- Provision for operation
- Fixed installations for servicing trains
Basic parameters 1/2

Line layout
- Structure gauge (4.2.3.1)
- Distance between track centres (4.2.3.2)
- Maximum gradients (4.2.3.3)
- Minimum radius of horizontal curve (4.2.3.4)
- Minimum radius of vertical curve (4.2.3.5)

Track parameters
- Nominal track gauge (4.2.4.1)
- Cant (4.2.4.2)
- Cant deficiency (4.2.4.3)
- Abrupt change of cant deficiency (4.2.4.4)
- Equivalent conicity (4.2.4.5)
- Railhead profile for plain line (4.2.4.6)
- Rail inclination (4.2.4.7)

Switches and crossings
- Design geometry of switches and crossings (4.2.5.1)
- Use of swing nose crossings (4.2.5.2)
- Lateral track resistance (4.2.6.3)

Track resistance to applied loads
- Track resistance to vertical loads (4.2.6.1)
- Longitudinal track resistance (4.2.6.2)
- Lateral track resistance (4.2.6.3)

Structures resistance to traffic loads
- Resistance of new bridges to traffic loads (4.2.7.1)
- Equivalent vertical resistance to traffic loads and new structures (4.2.7.2)
- Resistance of new structures over or adjacent to tracks (4.2.7.3)
- Resistance of existing bridges and earthworks to traffic loads (4.2.7.4)
Immediate action limits on track geometry defects

IAL for alignment (4.2.8.1)

IAL for longitudinal level (4.2.8.2)

IAL for track twist (4.2.8.3)

IAL of track gauge as isolated defect (4.2.8.4)

IAL for cant (4.2.8.5)

IAL for switches and crossings (4.2.8.6)

Platform

Usable length of platforms (4.2.9.1)

Platform height (4.2.9.2)

Platform offset (4.2.9.3)

Track layout alongside platforms (4.2.9.4)

Health, safety and environment

Maximum pressure variation in tunnels (4.2.10.1)

Effect of crosswinds (4.2.10.2)

Aerodynamic effect on ballasted track (4.2.10.3)

Provision for operation

Location markers (4.2.11.1)

Equivalent conicity in service (4.2.11.2)

Fixed installations for servicing trains

Toilet discharge (4.2.12.2)

Train external cleaning facilities (4.2.12.3)

Water restocking (4.2.12.4)

Refuelling (4.2.12.5)

Electric shore supply (4.2.12.6)
• Interfaces with the **rolling stock subsystem** (LOC&PAS TSI and WAG TSI)

• Interfaces with the **energy subsystem** (ENE TSI)

  4.3.2. **Interfaces with the energy subsystem**

<table>
<thead>
<tr>
<th>Interface</th>
<th>Reference Infrastructure TSI</th>
<th>Reference Energy TSI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gauge</td>
<td>4.2.3.1 Structure gauge</td>
<td>4.2.10 Pantographs gauge</td>
</tr>
</tbody>
</table>

• Interfaces with the **control command and signaling subsystem** (CCS TSI)

• Interfaces with the **operation and traffic management subsystem** (OPE TSI)
Chapter 5 - Interoperability constituents

(7) ‘interoperability constituents’ means any elementary component, group of components, subassembly or complete assembly of equipment incorporated or intended to be incorporated into a subsystem, upon which the interoperability of the rail system depends directly or indirectly, including both tangible objects and intangible objects;
Chapter 6 – Assessment of conformity of IC and EC verification of the subsystems

Modules (Decision 2010/713/EU) and particular assessment procedures are identified for:

- **Interoperability Constituents:**

  - **Infrastructure subsystems:**
  
  6.2.2. Application of modules
  
  For the EC verification procedure of the infrastructure subsystem, the applicant may choose either:
  
  (a) Module 5G: EC verification based on unit verification, or
  
  (b) Module 5H: EC verification based on full quality management system plus design examination.
• Application of TSI to **new railway lines** vs **existing railway lines**

• National Implementation plan (to be developed by MSs)

• Specific cases:
  (a) ‘P’ cases: permanent cases;
  (b) ‘T’ cases: temporary cases, where it is recommended that the target system is reached by 2020
‘P’ (permanent) cases

- 7.7.10.1. Platform offset (4.2.9.3)
- 7.7.10.2. Equivalent conicity (4.2.4.5)
- 7.7.10.3. Equivalent conicity in service (4.2.11.2)
Appendix A — Assessment of interoperability constituents
Appendix B — Assessment of the infrastructure subsystem
Appendix C — Technical characteristics of track design and switches and crossings design
Appendix D — Conditions of use of track design and switches and crossings design
Appendix E — Capability requirements for structures according to traffic code
Appendix F — Capability requirements for structures according to traffic code in the United Kingdom of Great Britain and Northern Ireland
Appendix G — Speed conversion to miles per hour for Ireland and the United Kingdom of Great Britain and Northern Ireland
Appendix H — Structure gauge for the 1 520 mm track gauge system
Appendix I — Reverse curves with radii in the range from 150 m up to 300 m
Appendix J — Safety assurance over fixed obtuse crossings
Appendix K — Basis of minimum requirements for structures for passenger coaches and multiple units
Appendix M — Specific case on the Estonian network
Appendix N — Specific cases of the Hellenic network
Appendix O — Specific case on the Ireland and United Kingdom of Northern Ireland networks
Appendix P — Structure gauge for the lower parts for the 1 668 mm track gauge on the Spanish network
Appendix Q — National technical rules for UK-GB Specific Cases
Appendix R — List of open points
Appendix S — Glossary
Appendix T — List of referenced standards
Appendix R

List of open points

(1) Immediate action limits for isolated defects in alignment for speeds of more than 300 km/h (4.2.8.1).

(2) Immediate action limits for isolated defects in longitudinal level for speeds of more than 300 km/h (4.2.8.2).

(3) The minimum allowed value of distance between track centres for the uniform structure gauge IRL3 is an open point (7.7.18.2).

(4) EN Line Category — Associated Speed [km/h] for Traffic codes P1 (multiple units), P2 (multiple units), P3a (multiple units), P4a (multiple units), P1520 (all vehicles), P1600 (all vehicles), F1520 (all vehicles) and F1600 (all vehicles) in Appendix E, Tables 38 and 39.

(5) Route Availability Number — Associated Speed [miles/h] for Traffic codes P1 (multiple units), P2 (multiple units), P3a (multiple units), P4a (multiple units), P1600 (all vehicles) and F1600 (all vehicles) in Appendix F, Tables 40 and 41.

(6) Rules and drawings related to gauges IRL1, IRL2 and IRL3 are an open point (Appendix O).

(7) The requirements for mitigating the risk for ballast pick up for speed greater than 250 km/h.
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