



Informative OTIF Workshop

TSI CR Infrastructure



- 1. Scope and aspects of the CR INF TSI, Categories of Line**
2. Basic parameters characterising the infrastructure subsystem
3. Interoperability constituents
4. Implementing the infrastructure TSI
5. Specific Cases
6. Register of Infrastructure



Scope and principles of the CR INF TSI

- **Scope of Directive 2008/57/EC is the community railway system**
- **Geographical scope of the CR INF TSI is the TEN conventional rail system, not yet extended**
- **Extending the scope of the TSI to cover the whole railway system requires additional work**
- **The TSI sets requirements to be met by the Infrastructure subsystem related to 'Categories of Line' with respective 'Performance Parameters'**
- **The 'Categories of Line' determine specific levels of requirements for Basic Parameters**



For the purpose of Directive 2008/57/EC the CR TEN may be subdivided into the following categories (Annex I):

- lines intended for passenger services
- lines intended for mixed traffic (passenger and freight)
- lines specially designed or upgraded for freight services
- passenger hubs
- freight hubs, including intermodal terminals
- lines connecting the above mentioned elements



Categorisation for HS and CR TEN lines

High-speed lines only for passenger traffic

- Category of Line I – New lines for speeds of at least 250 km/h
- Category of Line II – Upgraded lines for speeds of the order of 200 km/h
- Category of Line III – New or upgraded lines with special features and adapted speed

Conventional rail lines for different types of traffic

- Type of Line IV – New core TEN line
- Type of Line V – Upgraded core TEN line
- Type of Line VI – New other TEN line
- Type of Line VII – Upgraded other TEN line



Categories of Line set out in the CR INF TSI

Performance parameters for Categories of Line

		gauge	axle load [t]	line speed [km/h]	train length [m]
Categories of Line	IV-P	GC	22,5	200	400
	IV-F	GC	25	140	750
	IV-M	GC	25	200	750
	V-P	GB	22,5	160	300
	V-F	GB	22,5	100	600
	V-M	GB	22,5	160	600
	VI-P	GB	22,5	140	300
	VI-F	GC	25	100	500
	VI-M	GC	25	140	500
	VII-P	GA	20	120	250
	VII-F	GA	20	100	500
	VII-M	GA	20	120	500

Type of Line

- (IV) New Core TEN Line
- (V) Upgraded Core TEN Line
- (VI) New Other TEN Line
- (VII) Upgraded Other TEN Line

Type of Traffic

- (P) Passenger Traffic
- (F) Freight Traffic
- (M) Mixed Traffic

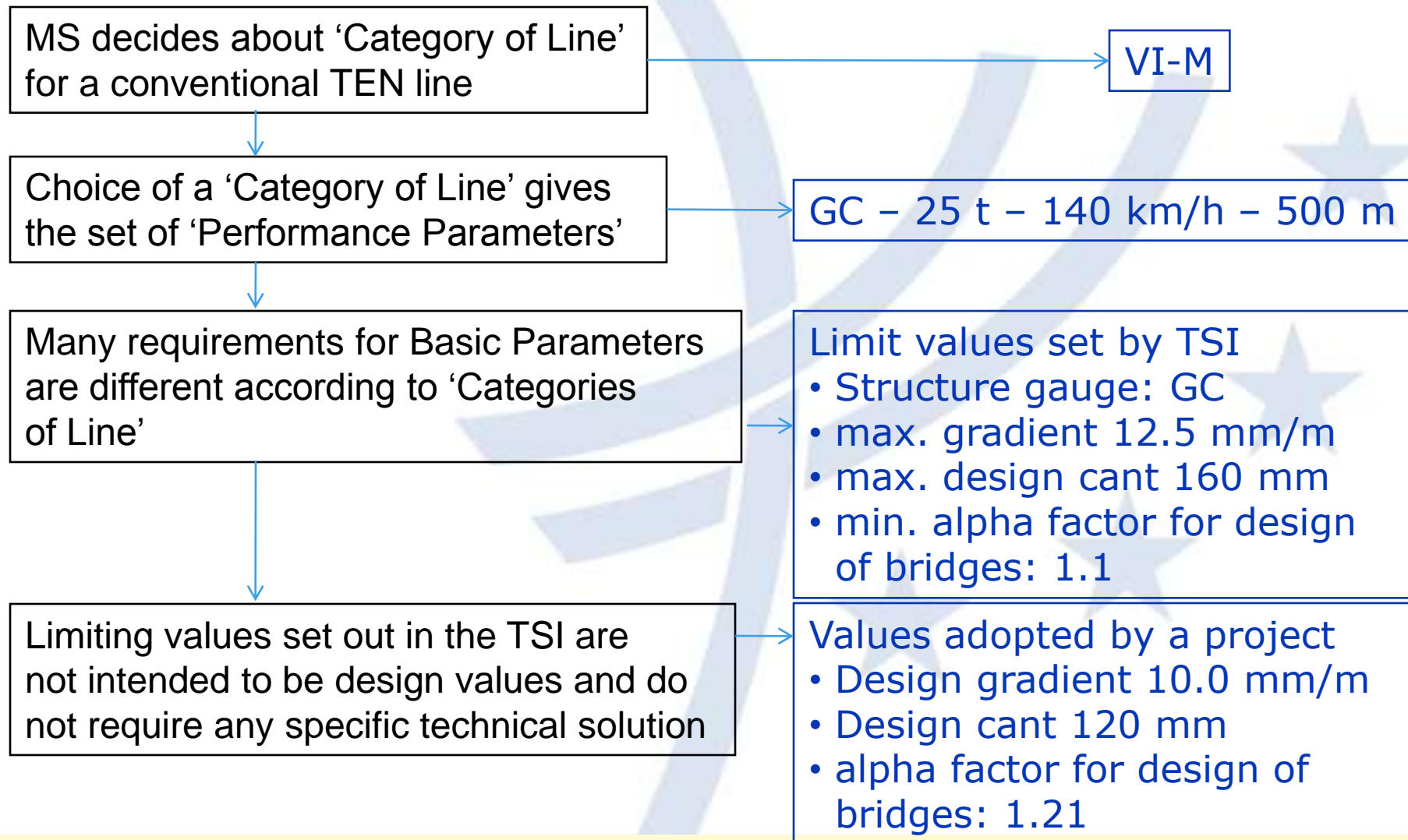


Principles for performance parameters

- It is permissible to design lines such that they will also accommodate larger gauges, higher axle loads, greater speeds and longer trains.
- It is permissible for a line or sections of a line to be designed for speeds and/or train length less than those specified in the TSI, where necessary to meet geographical, environmental or other constraints.
- Infrastructure designed to the minimum requirements of the TSI does not provide the capability to meet both maximum speed and maximum axle load in combination.



Example





Aspects covered

- **The CR INF TSI covers:**
 - the infrastructure structural subsystem
 - the part of the maintenance functional subsystem relating to the infrastructure subsystem (e.g. Washing machines)
- **The scope of the CR INF TSI therefore includes the following aspects:**
 - Line layout, track parameters, switches and crossings
 - Track and structure resistance to loads
 - Track geometrical quality
 - Platforms
 - Health, safety and environment, provisions for operation
 - Fixed installations for servicing trains



Aspects not covered

- **Interface in relation to the persons with reduced mobility TSI**
 - All requirements relating to the infrastructure subsystem for the access of persons with reduced mobility to the railway system are set out in the People with Reduced Mobility TSI.
- **Interface in relation to the safety in railway tunnels TSI**
 - All requirements relating to the infrastructure subsystem for safety in railway tunnels are set out in the Safety in Railway Tunnels TSI.
- **Inclusion of infrastructure into the scope of the noise TSI**
 - The scope of this TSI excludes noise mitigation, pending the proposal referred to in the technical specification for interoperability relating to the subsystem 'rolling stock — noise'.



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BPs – Line layout (1)

- **Structure gauge** (all Categories of Line)

The structure gauge shall be set on the basis of the gauge set out as performance parameters for Categories of Line.

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

- **Distance between track centres** (all Categories of Line)

The distance between track centres shall be set on the basis of the gauge.

Where appropriate the minimum distance between track centres shall also take into account aerodynamic effects. The rules for taking account of aerodynamic effects ... are an open point.



BPs – Line layout (2)

- **Maximum gradients**

- New lines for passenger traffic

- Gradients as steep as 35 mm/m are permitted for main tracks at the design phase provided ...

- New lines for mixed and freight traffic

- Maximum gradients as steep as 12.5 mm/m are permitted for main tracks at the design phase

- Upgraded lines

- No values ... determined by the original construction of the line ...

- All Categories of Line

- Gradients of stabling tracks intended for parking rolling stock shall not be more than 2.5 mm/m unless ...



BPs – Line layout (3)

- **Minimum radius of horizontal curve** (all Categories of Line)

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

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

Reverse curves ... with radii in the range from 150 m up to 300 m shall be designed in accordance to EN 13803-2:2006 section 8.4 to prevent buffer locking.

- **Minimum radius of vertical curve** (all Categories of Line)

The radius of vertical curves ... shall be at least 600 m on a crest or 900 m in a hollow.

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



BPs – Track parameters (1)

- **Nominal track gauge** (all Categories of Line)

European standard nominal track gauge shall be 1435 mm.

- **Cant**

all Categories of Line – design limit adjacent to platforms 110 mm

Passenger traffic – design limit 180 mm

Freight and mixed traffic – design limit 160 mm

- **Rate of change of cant (as a function of time)**

(all Categories of Line)

The maximum rate of change of cant through a transition shall be 70 mm/s ...



BPs – Track parameters (2)

- **Cant deficiency** (all Categories of Line)

Plain track and through route of S+C

For trains which are not fitted with cant deficiency compensation systems ... cant deficiency shall not exceed

- 130 mm for freight wagons
- 150 mm for locomotives of passenger coaches

Diverging track of switches

- 120 mm for ... turnout speeds of $30 \text{ km/h} \leq V \leq 70 \text{ km/h}$
- 105 mm for ... turnout speeds of $70 \text{ km/h} < V \leq 170 \text{ km/h}$
- 85 mm for ... turnout speeds of $170 \text{ km/h} < V \leq 200 \text{ km/h}$



BPs – Track parameters (3)

- **Equivalent conicity** (all Categories of Line)

Design values

Design values of track gauge, rail head profile and rail inclination for plain line shall be selected to ensure that the equivalent conicity limit of 0.25 ($60 \text{ km/h} < V \leq 200 \text{ km/h}$) is not exceeded, when modelled wheelsets passing over the designed track conditions.

Requirements for controlling equivalent conicity in service

Open point

- pending closure of the open point the value of 1430 mm ($60 \text{ km/h} < V \leq 200 \text{ km/h}$) set out for mean track gauge shall be respected



BPs – Track parameters (4)

- **Railhead profile for plain line** (all Categories of Line)

... geometrical dimensions ...

- **Rail inclination** (all Categories of Line)

The rail shall be inclined towards the centre of the track.

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

- **Track stiffness** (all Categories of Line)

Open point

- **Electrical insulation of rails** (all Categories of Line)

... the design value of minimum electrical resistance shall be 3 Ω km in wet conditions.



BPs – Switches and crossings (1)

- **Means of locking**
- **In service geometry of switches and crossings**
 - The technical characteristics of switches and crossings for the track gauge of 1435 mm shall comply with the following in-service limits:
 - Maximum value of free wheel passage in switches: 1380 mm
 - Minimum value of fixed nose protection for common crossings: 1392 mm
 - Maximum value of free wheel passage at crossing nose: 1356 mm
 - Maximum value of free wheel passage at check rail/wing rail entry: 1380 mm
 - Minimum flangeway width: 38 mm
 - Minimum flangeway depth: 40 mm
 - Maximum excess height of check rail: 70 mm



BPs – Track resistance (1)

- **Vertical loads** (all Categories of Line)

The track ... shall be designed to withstand at least ... axle load, max. dynamic wheel force, max. quasi-static wheel force

- **Longitudinal track resistance** (all Categories of Line)

The track ... shall be designed to withstand at least ... forces arising from braking (deceleration) ... from temperature changes in the rail (use of braking systems independent of wheel-rail adhesion condition)

- **Lateral track resistance** (all Categories of Line)

The track ... shall be designed to withstand at least ... maximum total dynamic lateral force, quasi static guiding force



BPs – Structures resistance (1)

- **Resistance of new bridges to traffic loads** (all Categories of Line)

Structures shall be designed to support vertical loads in accordance with load model 71, defined in EN 1991-2:2003 (in addition load model SW/0 for continuous bridges).

The load models shall be multiplied by the factor alpha (α) depending on Categories of Line.

- **Equivalent vertical loading for new earthworks and earth pressure effects** (all Categories of Line)

similar to bridges

- **Resistance of new structures over or adjacent to tracks** (all Categories of Line)

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



BPs – Structures resistance (2)

- **Resistance of existing bridges and earthworks to traffic loads**
upgraded Lines

Bridges and earthworks shall be brought to a specified level of interoperability according to the Category of Line.

The capability requirements for structures are defined by a combined quantity comprising of the Line Category set out in EN 15528:2008 (or if relevant Locomotive Class) and a corresponding maximum speed.

Example (Annex E of the TSI):

Category of Line V-F

- Freight wagons – D4-100

- Locomotives and power heads - $L4_{22.5}-100$, $L6_{19}$ $L6_{20}$ $L6_{21}$ $L6_{22}-100$



BPs – Track geometrical quality (1)

- **Track twist** (all Categories of Line)

... difference between two cross levels taken at a defined distance apart, usually expressed as a gradient ...

The track twist limit is a function of the measurement base applied (l) according to the formula: $\text{Limit twist} = (20/l + 3)$ with a maximum value of 7 mm/m.

- **Variation of track gauge** (all Categories of Line)

Minimum and maximum track gauge depending on the speed.

- **In service cant**

Lines for passenger traffic +/- 20 mm with a maximum of 190 mm

Lines for freight/mixed traffic +/- 20 mm with a max. of 170 mm



BPs – Platforms (1)

- **Usable length** (all Categories of Line)

The platform length shall be sufficient to accommodate the longest interoperable train intended to stop at the platform in normal service. When determining the length of trains intended to stop at the platform, consideration shall be given to both the current service requirements ...

- **Further BPs related to platforms are set out in the PRM TSI**



BPs – Health, safety and environment (1)

- **Maximum pressure variations in tunnels** (all Categories of Line)
The maximum pressure variation in tunnels and underground structures along the outside of any train complying with the HS and CR rolling stock TSIs intended to run in the specific tunnel at speeds of greater than 190 km/h shall not exceed 10 kPa ...
- **Noise and vibration limits and mitigation measures**
open point
- **Protection against electric shock** (all Categories of Line)
... Ensured by provisions of ENE TSI ...
- **Safety in railway tunnels** (all Categories of Line)
set out in SRT TSI
- **Effects of cross winds** (all Categories of Line)
open point



BPs – Fixed installations for servicing trains

(1)

- **Toilet discharge** (all Categories of Line)

Fixed toilets discharge installation shall be compatible with the characteristics of the retention toilet system specified in RST ...

- **Train external cleaning facilities**

... it shall be able to clean the outer sides of single or double-deck trains

...

- **Water restocking** (all Categories of Line)

... shall be compatible with the characteristics of the water system specified in RST ...

- **Refuelling** (all Categories of Line)

... shall be compatible with the characteristics of the fuel system specified in RST ...

- **Electrical shore supply** (all Categories of Line)

open point



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ICs of the infrastructure subsystem

- **Selection of Interoperability Constituents**

The requirements ... are based on a traditional design of ballasted track with Vignole (flat-bottom) rail on concrete or wooden sleepers and fastening providing resistance to longitudinal slip by bearing on the rail foot.

- **List of ICs**

- rail
- rail fastening
- track sleepers

Rails, fastenings and sleepers used for short length of track for specific purposes, for example in switches and crossings, at expansion devices, ... are not considered to be interoperability constituents.



- **Railhead profile**
 - shall fulfil ... 4.2.5.6 “Railhead profile for plain line”
 - shall allow ... 4.2.5.5.1 for “Design values for equivalent conicity”
- **Moment of inertia of the rail cross section**
 - is relevant to ... 4.2.7 “Track resistance to applied loads”
 - The calculated value ... about the principal horizontal axis through the centre of gravity shall be at least 1600 cm^4 .
- **Rail hardness**
 - is relevant to ... 4.2.5.6 “Railhead profile for plain line”
 - shall be at least 200 HBW measured at the crown of the rail head



The rail fastening system

- is relevant to ... Section 4.2.7.2 for “Longitudinal track resistance” , section 4.2.7.3 “Lateral track resistance”, section 4.2.7.1 for “Track resistance to vertical loads” and section 4.2.5.9 for “Electrical insulation of rails”
- shall comply in laboratory test conditions with the following requirements:
 - ❑ the longitudinal force required to cause the rail to begin to slip ... shall be at least 7kN
 - ❑ the rail fastening shall resist application of 3 000 000 cycles of the typical load applied in a sharp curve, such that the performance of the fastening in terms of clamping force and longitudinal restraint is not degraded by more than 20% and vertical stiffness is not degraded by more than 25% ...
 - ❑ where the rail fastenings are intended to provide electrical insulation of the rails, the electrical insulation measured from rail to rail on a single sleeper in wet conditions shall be at least 5 k Ω



Track sleepers

- Track sleepers shall be designed such that when they are used with a specified rail and rail fastening system they will have properties that are consistent with the requirements of 4.2.5.1 for “Nominal track gauge”, section 4.2.5.5.2 for “Requirements for controlling equivalent conicity in service (table 5: minimum values of mean track gauge)”, section 4.2.5.7 for “Rail inclination” and section 4.2.7 for “Track resistance to applied loads”



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Application of the CR INF TSI

- **The Member State shall define which lines of the conventional TEN as given by Decision 1692/96/EC as amended by Decision 884/2004/EC are to be categorised as core TEN lines or other TEN lines based on the classification given in chapter 4.2.1.**
- **The Member State shall specify for TEN lines those elements of the infrastructure subsystem, which are required for interoperable services (e.g. tracks, sidings, stations, marshalling yards) and therefore need to comply with this TSI. In specifying these elements the Member State shall consider the coherence of the system as a whole.**



New CR lines

- For the purpose of this TSI a “New line” means a line that creates an economically exploitable route where none currently exists.
- New Core TEN lines (type IV) shall satisfy the requirements of Category of Line IV-P, IV-F or IV-M.
- New Other TEN lines (type VI) shall satisfy the requirements of Category of Line VI-P, VI-F or VI-M. It is also permissible for the line to satisfy the requirements of Category of Line IV-P, IV-F or IV-M respectively.



- **Upgrading of a line**

- when at least the performance parameters axle load and gauge as defined in section 4.2.2 are met
- an existing Core TEN line shall be in accordance with the requirements of Category of Line V-P, V-F and V-M. (An upgrade to the requirements of Type of Line IV is permissible)
- an existing Other TEN lines shall be in accordance with the requirements of category of line VII-P, VII-F or VII-M. (An upgrade to the requirements of Type of Line VI is permissible.)



- **Renewal of a line**

- A project undertaken to systematically replace elements of a subsystem on a route basis. Renewal differs from a substitution in the framework of maintenance ... in that it gives the opportunity to achieve a TSI compliant route. A renewal is effectively the same case as upgrading, but without a change in performance parameters.
- The project plan should state the stages of project at which EC verification will be sought to be coordinated with the Member State.



- **Substitution in the framework of maintenance**
 - Maintenance replacements should be, as far as is reasonably practicable, undertaken in accordance with the requirements of this TSI. The objective should be ... contribute the development of an interoperable line. In order to get a valuable part of the infrastructure subsystem for a progressive process towards interoperability, a group of basic parameters should always be adapted together.
- **Existing lines that are not subject to a renewal or upgrading project**
 - The IM may ... on a voluntary basis complete the Register of Infrastructure in accordance with Annex D of this TSI to show the level of compliance with the basic parameters of this TSI.



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Requests for Specific cases

- **15 MS representing the majority of the 1435 mm track gauge networks did not require any Specific Case.**
- **Estonia, Latvia and Lithuania for 1520 mm track gauge lines asked for Specific Cases as open points.**
- **Due to different track gauges, 6 MS needed Specific Cases concerning: Nominal track gauge, Structure gauge, Distance between track centres, In service geometry of switches and crossings, Equivalent conicity**
- **UK (Great Britain) is the only 1435 mm network requesting Specific Cases. The network does not conform to European structure gauges.**



Specific cases - conclusions

- **Almost all Specific Cases concern wide or narrow track gauge networks. There is not an economically reasonable migration path to adapt these networks to European track gauge.**
- **The Specific Cases for the 1435 mm track gauge network of UK (Great Britain) are justified because there is no economic migration possible to adapt to the gauges GA, GB or GC.**
- **The analysis and assessment of Specific Cases confirm the suitability of the TSI for the CR networks. Parameters in the final draft CR INF TSI are well calibrated to represent an optimal level of technical harmonisation of railway infrastructure in EU.**



SC – example Portugal, P-cases for all CoL (1)

- **Structure gauge (4.2.4.1)**
 - The Structure gauge shall be set on the basis of the reference contours CPb, CPb+ or CPc.
 - Calculations of the structure gauge shall be done using the kinematic method in accordance with the requirements of prEN 15273-3:2009 Annex D section D.4.3.
 - For the three rail track system, the Structure gauge shall be set on the basis of the CPb+ reference contour, centred on the track gauge 1668 mm.
- **Nominal track gauge (4.2.5.1)**
 - The nominal track gauge shall be 1668 mm, 1435 mm or both if the line is equipped with the three rail track system.



SC – example Portugal, P-cases for all CoL (2)

- **Design values for equivalent conicity (4.2.5.5.1)**
 - For the nominal track gauge of 1668 mm the following wheelsets shall be modelled passing over the designed track conditions (simulated by calculation according to EN 15302:2008):
 - S 1002 as defined in EN 13715:2006 Annex C with SR = 1653 mm
 - ...
- **Requirements for controlling equivalent conicity in service (4.2.5.5.2)**
 - pending closure of the open point the value of 1663 mm ($60 \text{ km/h} < V \leq 200 \text{ km/h}$) set out for mean track gauge shall be respected.



SC – example Portugal, P-cases for all CoL

(3)

- **In service geometry of switches and crossings (4.2.6.2)**
 - The technical characteristics of switches and crossings for the nominal track gauge of 1668 mm shall comply with the following in-service:
 - Maximum value of free wheel passage in switches: 1613 mm
 - Minimum value of fixed nose protection for common crossings: 1624 mm
 - Maximum value of free wheel passage at crossing nose: 1589 mm
 - Maximum value of free wheel passage at check rail/wing rail entry: 1613 mm



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Purpose of Register of Infrastructure

- **Application of RINF (expectations of the railway sector)**
 - Check of technical compatibility of rolling stock designated to be put into service for a specific area of infrastructure – both infrastructure and rolling stock registers will facilitate the process
 - Monitoring the progress of interoperability in Europe
 - Provide strategic information for Rolling Stock manufacturers, Railway Undertakings and whole railway sector about technical level of European infrastructure – for development of new products and services
 - RINF may be also used as an initial indicator for cross acceptance of vehicles, especially of existing vehicles which have not been EC verified



Geographical

Community rail system, taking into account possible exclusions, however RINF may include lines excluded by MS when they are connected to Community rail system (limited data)

Technical

Features laid down under applicable TSIs have been currently selected for the TEN only – technical scope is not consistent with geographical scope. The non-TEN lines might require additional information or other values for items.

Items for RINF are set out in HS and CR TSIs for subsystems (INF, ENE, CCS, OPE), in combined TSIs (PRM, SRT) and also in HS RST and WAG TSIs.



Structure of RINF specification

Introduction: Background to the assignment, Summary

Abbreviations and references: Abbreviations, Reference documents

Legal framework: Register of Infrastructure and related legislation,

Network statement and related legislation, Comparison

Purpose and scope: Purpose (Requirements from the Directive, Application of RINF), Geographical scope, Technical scope

Information indicated in TSIs: General information structure, Main features of the INF subsystem, Main features of the ENE subsystem, Main features of the CCS subsystem

Format of the register

Management of the register

Instructions for use

Implementation



Questions?

