

Measures to ensure the technical compatibility of high-speed trains

Dispositions pour assurer la compatibilité technique des trains à grande vitesse

Bestimmungen zur Sicherung der technischen Verträglichkeit der Hochgeschwindigkeitszüge



UNION INTERNATIONALE DES CHEMINS DE FER
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IV - Operating

V - Transport stock

VI - Traction

VII - Way and Works

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Summary

This leaflet lists the rolling stock technical regulations that must be harmonised to ensure compatibility between high-speed trains on European infrastructure.

A high-speed train is understood to be any train suitable for running at speeds of 250 km/h or above.

The provisions of this leaflet apply to new high-speed trains.

1 - General

1.1 - Scope of application

This leaflet lists the rolling stock technical regulations that must be harmonised to ensure compatibility between high-speed trains on European infrastructure.

A high-speed train is understood to be any train suitable for running at speeds of 250 km/h or above.

The provisions of this leaflet apply to new high-speed trains.

1.2 - Terminology

1.2.1 - In this leaflet, the terms "high-speed train" and "high-speed stock" should be taken to cover both:

- an electric multiple unit trainset comprising intermediate vehicles between two end power cars (or one power car and a driving trailer),
- an electric multiple unit trainset with distributed traction power.

1.2.2 - The section set aside for conveying passengers may comprise:

- either individual vehicles each resting on two bogies (or sets of running gear),
- or a fixed-formation articulated set, where two adjacent vehicle body ends are borne by a single bogie (or set of running gear).

As such, in this and all other UIC leaflets concerned by this document, the term "coach" may be taken to refer to either of these two possibilities.

2 - Electrification systems

o 2.1 - Voltages, frequencies

The provisions of *UIC Leaflet 600* should be applied.

2.2 - Geometry of high-speed OHL

Reserved.

2.3 - Pantograph-OHL interaction

Reserved.

o 2.4 - Measures to be taken when passing from one power supply system to another

The provisions of *UIC Leaflet 611, point 4.3* should be applied.

o 2.5 - Emergency devices for raising pantographs

The provisions of *UIC Leaflet 611, point 3.5* should be applied.

o 2.6 - Power factor

The traction diagram should obtain a power factor that is approximately equal to 1 for single-phase alternative current and in any case be greater than 0,8, if the power drawn by the tractive unit at substation level is greater than half the nominal power of the tractive unit.

o 2.7 - Cut-out conditions for rolling stock circuit-breakers in relation to sub-stations

To guarantee proper discrimination between protections, in the event of a fault downline from the power car's circuit breaker, protection must be provided by the on-board circuit breaker rather than the sub-station breaker upline.

The cut-out power of the on-board breaker shall be higher than the maximum short-circuit power at sub-station level.

In a 25 kV system, the current breaking capacity of the on-board breaker shall be 12 kA.

In a 15 kV system, the current breaking capacity of the on-board breaker shall be (*reserved*).

o 2.8 - Conditions governing the use of high-speed trains on conventional or upgraded lines

2.8.1 - Power limitations

On certain conventional or upgraded lines wired with direct current or even single-phase current, the power intake from the sub-station needs to be limited.

This limitation may be effected either using a manual selector or by an automatic control device.

2.8.2 - Equipotential line

Where high-speed trains are equipped with an equipotential line making it possible to balance voltages under 1,5 kV or 3 kV d.c., the railways shall specify the conditions for opening or closing this line.

3 - Signalling systems - Track to train link

3.1 - Signalling and automatic stopping systems

Reserved.

o 3.2 - On-board signal recorder

High-speed trains shall be fitted with an on-board event recorder to give a record of driving events (speed, signals, status of certain equipment, etc.).

Reserved.

o 3.3 - Automatic vigilance device

The provisions of *UIC Leaflet 641* shall apply, together with those in *UIC Leaflet 651, point 4.3.2.6*.

o 3.4 - Indicator equipment

High-speed trains shall have a central module on the driver's desk giving the speed indication and essential cab signalling information.

In-cab repetition of lineside signals and other features specific to each railway should be incorporated into a side module positioned next to the central module.

The dimensions of the space to be set aside for these modules are set out in *UIC Leaflet 651, point 4.3.1.3*.

o 3.5 - Track-to-train service link

This shall be as specified in *UIC Leaflet 651, point 4.3.1.3*.

R 3.6 - Public telephone

High-speed vehicles may be fitted with a public telephone operating on national GSM networks for those railways which use the GSM standard.

3.7 - Alarm devices (radio alarm, flashing headlights, etc.)

Reserved.

4 - Trainset design

4.1 - General running conditions

4.1.1 - Rolling stock gauge

- 4.1.1.1 - Single-deck high speed trains must comply with the UIC gauge in *UIC Leaflet 505-1*.
- 4.1.1.2 - Tilting high speed trains shall meet the gauge given in *UIC Leaflet 505-1, Appendix F* (Reserved for the calculation of pantograph clearance).
- R 4.1.1.3 - Double-deck high speed trains may comply with the GB gauge of *UIC Leaflet 506*, according to the terms of bi- or multi-lateral agreements.

○ 4.1.2 - Negotiation of curves

4.1.2.1 - Single curves

- For fixed formation trainsets:
 - The provisions of *UIC Leaflet 645, point 1* shall apply.
- For trainsets which do not have a fixed formation:
 - The power cars shall meet the requirements of *UIC Leaflet 645, point 2*.
 - The coaches shall meet the requirements of *UIC Leaflet 567, point 1.2.1*.

4.1.2.2 - S curves

High speed trains shall be able to run in S curves as specified in *UIC Leaflet 527-1*.

4.2 - Indications, markings and technical data on the trainset exterior

4.2.1 - Two cases can be considered:

- Fixed formation trainsets:
It is accepted that the provisions below only apply to end vehicles.
When the provision is obligatory for all the vehicles concerned in the trainset, the text is preceded by a dot •.
- Trainsets which do not have a fixed formation:
 - a. The power cars shall meet the requirements of *UIC Leaflet 640*.
 - b. The provisions below apply to all the other vehicles concerned in the trainset.

4.2.2 - The nature and dimensions of the inscriptions and markings for staff instructions to be applied directly on the vehicle are specified in [Appendix A - page 39](#).

[Appendix B - page 40](#) specifies the location of the external inscriptions.

- **4.2.2.1** - • The inscriptions and markings must always be visible.

- **4.2.2.2** - • It is forbidden to give any different meaning to the inscriptions and markings.
 - **4.2.2.3** - The owning railway is left free to apply additional information.
 - This additional information shall always be placed at a reasonable distance away from the locations provided for the inscriptions and markings specified in point **4.2.3**.
 - **4.2.2.4** - • The inscriptions and markings specified in point **4.2.3** shall appear in the form of pictograms, if need be, with Latin characters and Arabic figures.
- 4.2.3** - The inscriptions and marks below, defined in point **4.2.2**, shall be applied in a very prominent manner on the vehicles:
- **4.2.3.1** - The sign of the railway to which the vehicle (or the trainset) belongs, in letters, with in addition, if appropriate, its emblem or logo.
 - **4.2.3.2** - • The identification marking of the vehicle.
 - R **4.2.3.3** - One of the following STI (Technical Specifications for Interoperability) signs, in accordance with *UIC Leaflet 580, Appendix 16*:
 - The sign 000/STI, in accordance with *UIC Leaflet 580, Appendix 16, Figure 1* to indicate that the coach (or the trainset)
 - a. meets the requirements of the TSI,
 - b. can run at the maximum speed indicated in the box on the left of the STI sign.
 - The sign 000/STI, in accordance with *UIC Leaflet 580, Appendix 16, Figure 2*, to indicate that the coach (or the trainset)
 - a. meets the TSI requirements,
 - b. can run at the maximum speed indicated in the box on the left of the STI sign,
 - c. meets the special TSI requirements of the railways on which the vehicle is authorised to run, and of which the initials (in accordance with the *RIC, Appendix I* (see *Bibliography - page 48*)) are indicated in the box on the right of the STI sign. A vehicle which on certain lines does not meet the special conditions of a railway required in the TSIs, shall carry in the box of the STI the sign * placed close to the symbol of this railway in accordance with *UIC Leaflet 580, Appendix 16, Figure 2*.
- The STI sign can be applied to the coaches (or the trainsets) if they satisfy all the other conditions required for the signs to be applied.
- **4.2.3.4** - For fixed formation high-speed trainsets, the total tare of the trainset including 100% of the total water supplies carried.
- For trainsets which do not have a fixed formation, the tare of each vehicle including 100% of the total water supplies carried and the total mass in tonnes, with:
- for the coaches, the number of seats, as specified in *UIC Leaflet 580, Appendix 9, Figure 4a or 4b*,

- for the baggage vans, the load limit, as specified in *UIC Leaflet 580, Appendix 9, Figure 4c*
- for coaches with a baggage compartment, the number of seats and the load limit in accordance with *UIC Leaflet 580, Appendix 9, Figure 4d*.

- **4.2.3.5** - For air brakes, the signs and inscriptions of *UIC Leaflet 580, Appendix 10* and *UIC Leaflet 545, Appendices 2, 7 and 8*, as well as the braked weight and the inscriptions specified in *UIC Leaflet 545, Appendix 3*.
- **4.2.3.6** - • For vehicles fitted with disc brakes, the instructions for checking the operation of the brake, as specified in *UIC Leaflet 541-3, point 1*.
- R **4.2.3.7** - The date of the last overhaul and the abbreviation of the workshop which did it using a sign from *UIC Leaflet 580, Appendix 11, Figures 1 or 2*.
- R **4.2.3.8** - For the electrical power supply, the inscriptions of *UIC Leaflet 552, Plates I and V*.
- **4.2.3.9** - On all junction boxes and plug rests of the train line, as well as on vehicles fitted with footsteps or seats with a height of more than 2000 mm above the top of the rails or ladders for which the end exceeds this dimension, close to these items, the warning signs in *UIC Leaflet 580, Appendix 12*.
- **4.2.3.10** - • For marking the filling and discharge devices for water tanks and their pipework, the signs defined in *UIC Leaflet 563, point 2*.
- **4.2.3.11** - • For marking the repeating devices for alarm signals when they are enclosed in external casings, the signs in *UIC Leaflet 545, Appendix 4*.
- R **4.2.3.12** - For pressure tight vehicles, a "(p)", in accordance with the *RIC code, plate 11, Figure 4*.
- **4.2.3.13** - • For coaches with sealed toilets, the sign in *UIC Leaflet 563, Appendix 18* to indicate the discharge nozzles.
- R **4.2.3.14** - For non-pressure tight vehicles which have sealed toilets, a "(wc)", in accordance with the *RIC code, Plate 11, Figure 5*.
- **4.2.3.15** - • The support points for lifting and re-railing are marked by the signs specified in the Figures of *UIC Leaflet 581, Appendix 1*.

4.3 - Masses

○ 4.3.1 - Maximum mass per axle - m(e)

The maximum static mass per axle shall be 17 tonnes.

In the case of powered axles, exceptions can be granted depending on the running speed, up to the following limits:

for $V \geq 260$ km/h, $m(e) \leq 17$ t/axle,

for $220 \leq V < 260$ km/h, $m(e) \leq 18$ t/axle.

o 4.3.2 - Distribution of masses

Masses must be distributed such that the following conditions are met:

o 4.3.2.1 - Power cars

1. The average mass of the power cars calculated using a statistically representative sample of the order, increased by the value of the standard deviation, shall remain less than M in the following equation:

$M = n(e) \cdot m(e)$, where

$n(e)$: number of axles on the power car

$m(e)$: maximum permissible axle-load

2. The mass of each axle on the power car shall not deviate by more than $\pm 1,5\%$ from the average mass of the axles of that power car. This is strictly applicable to power cars where the mass m is greater than (M - 0,2 tonne).

For power cars in which the mass m is less than (M - 0,2 tonne), it is permissible to deviate by +2% from the average mass of the axles of that power car.

3. No axle on any power car may exceed the upper limit of $m(e)$ by more than 2%.

o 4.3.2.2 - All vehicles

When empty and in running order, the difference in load between one rail and the other shall not exceed 600 kg on the bogie of the whole trainset where the imbalance is most severe.

4.4 - Emergency assistance for trains

o 4.4.1 - Objectives

It must be possible for a high speed train to:

- be assisted by and assist a vehicle fitted with conventional buffing and draw gear as defined by the UIC rules,
- be assisted by and assist a vehicle fitted with another type of coupler meeting the provisions of the *standard EN XXXXX (to be drafted)* which defines the geometry and locking characteristics for mechanical coupling between two vehicles not equipped with the UIC coupler.

If any additional devices (emergency coupler) are necessary in order to meet the above provisions, their characteristics and performance must conform to the requirements of *standard EN YYYYY (to be drafted)*.

NB : In the absence of applicable standards, these provisions shall apply on a provisional basis. They concern the definition of an emergency coupler that is compatible with an assisting vehicle fitted with a UIC coupler.

4.4.2 - General

- o 4.4.2.1 - In order for assistance to be provided for high-speed trains, it must be possible to fit them with an emergency coupler enabling the trainset to be coupled to a locomotive fitted with a draw hook.

Two emergency couplers shall be provided on each high-speed train. These couplers shall be placed either in the end vehicles or in the two vehicles adjacent to the end.

- **4.4.2.2** - The space set aside for stowing the emergency coupler shall be designed so that the coupler is readily accessible, even on service tracks.

The emergency coupler shall be accessible from both sides of the trainset, or from one side only but in such a way that the couplers are diagonally opposed at each end of the trainset.

- **4.4.2.3** - It shall be compact and of lightweight design so that two people can carry it and fit it within 10 minutes. The maximum mass of each of its component parts must be less than 50 kg.

- **4.4.2.4** - A simple grip system shall be provided for handling and assembly.

- R **4.4.2.5** - It is recommended that handles be fitted to facilitate handling.

- **4.4.3 - Fitting**

4.4.3.1 - It shall be possible to fit the emergency coupler manually onto the UIC hook on the rescue vehicle.

4.4.3.2 - At the moment of engagement, the emergency coupler shall be able to engage mechanically with the service coupler of the high-speed train to be rescued under all load conditions.

4.4.3.3 - The emergency coupler must permit coupling on straight track and on curves with a minimum radius of 150 m.

4.4.3.4 - It must be possible to connect the main brake and air supply pipes of the rescue vehicle and the high-speed train one to the other respectively.

- **4.4.4 - Mechanical stresses**

4.4.4.1 - The maximum engagement speed must be less than or equal to 2 km/h. The emergency coupler shall be able to withstand engagement at this speed at least.

4.4.4.2 - The emergency coupler must be able to accommodate tensile and compressive forces of at least 400 kN. For forces of this size, the yield strength of the materials used shall not be exceeded.

4.4.4.3 - It shall be possible using the emergency coupler to start the train from a halt on the maximum permissible gradient for this type of vehicle, when the high-speed train is being hauled or propelled.

4.4.4.4 - The draw hook on the rescue vehicle is not designed to accommodate propelling forces. The emergency coupler must therefore be designed in such a way that the compressive forces are conducted to a zone of greater resistance (headstock, buffers, etc.) on the rescue vehicle.

- **4.4.5 - Running conditions**

4.4.5.1 - It shall be possible to negotiate curves of 125 m minimum radius.

4.4.5.2 - A minimum speed of 60 km/h should be guaranteed when the high-speed train is being hauled and 30 km/h when it is being propelled.

4.4.5.3 - When the rescue operation involves propelling the high-speed train, an audio link shall be set up between the rescue vehicle and the driving cab of the high-speed train.

4.5 - Strength and safety of vehicle bodies

o 4.5.1 - Static strength of vehicle bodies

High-speed trains must conform to the requirements of draft *standard EN 12663* (see Bibliography - page 48), category P-I.

However, if it is not possible to split the train consist in normal service, the requirements of category P-II may be adhered to, provided compatibility with the provisions of point 4.5.3 - page 11 is guaranteed.

These provisions are subject to possible review following the standardisation work on crashworthiness in TC256/WG2.

The maximum payload shall be equal to one of the two following values:

$m_2 = \text{number of seats (not including folding seats)} \times 2 \times 80 \text{ kg}$

or

$m_2 = \text{number of seats (not including folding seats)} \times 80 \text{ kg} + \text{surface area of the aisle and vestibule areas (m}^2\text{)} \times 4 \times 80 \text{ kg}$

o 4.5.2 - Component parts in coaches

The provisions of *UIC Leaflet 566*, points 2.1.1.2, 4.2.1, 4.2.1.1, 4.2.1.2, 4.2.1.3 and 4.2.1.6 shall apply.

4.5.3 - Crashworthiness of vehicle bodies

4.5.3.1 - Reference accidents

NB : Any request to amend this text should be lodged with the Rolling Stock TSI (Technical Specifications for Interoperability) working group.

Three reference accidents are to be considered:

- Scenario 1
Collision between two identical high-speed trainsets at a relative speed of 36 km/h.
- Scenario 2
Collision between a high-speed trainset and a railway vehicle fitted with side buffers at a relative speed of 36 km/h. The railway vehicle shall be a four-axle freight wagon weighing 80 t, as specified in *UIC Leaflet 571-2*.
- Scenario 3
Collision at a level crossing and a relative speed of 110 km/h with a road vehicle weighing 15 t represented by a rigid mass with a vertical impact surface area equivalent to the front-end surface area of a railway vehicle.