SLOVENSKI STANDARD
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**Železniške naprave - Profili - 5. del: Ozadje, razlaga in praktični primeri**

Railway applications - Gauges - Part 5: Background, explanation and worked examples

Bahnanwendungen - Begrenzungslinien - Hintergrund, Erläuterung und praktizierte Beispiele

Applications ferroviaires - Gabarits - Partie 5 : Contexte, explication et exemples



**Ta slovenski standard je istoveten z: FprCEN/TR 15273-5**



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# Railway applications - Gauges - Part 5: Background, explanation and worked examples

Applications ferroviaires - Gabarits - Partie 5 : Contexte, explication et exemples

Bahnanwendungen - Begrenzungslinien - Hintergrund, Erläuterung und praktizierte Beispiele

This draft Technical Report is submitted to CEN members for Vote. It has been drawn up by the Technical Committee CEN/TC 256.

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EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

**CEN-CENELEC Management Centre: Rue de la Science 23, B-1040 Brussels**



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# European foreword

This document (FprCEN/TR 15273-5:2018) has been prepared by Technical Committee CEN/TC 256 “Railway applications”, the secretariat of which is held by DIN.

This document is currently submitted to the Vote on TR.

This document is part of a series of standards that consists of the following parts:

— prEN 15273-1, *Generic explanations and methods of gauging*, which gives the general explanations of gauging and defines the sharing of the space between rolling stock and infrastructure;

— prEN 15273-2, *Rolling stock*, which gives the rules for dimensioning vehicles;

— prEN 15273-3, *Infrastructure*, which gives the rules for positioning the infrastructure;

— prEN 15273-4, *Catalogue of gauges and associated rules*, which includes a non-exhaustive list of reference profiles and parameters to be used by infrastructure and rolling stock; and

— FprCEN/TR 15273-5, *Background, explanation and worked examples* (present document).

# Introduction

The aim of this Technical Report is to define the rules for the calculation and verification of the dimensions of rolling stock and infrastructure from a gauging perspective.

This document gives gauging processes taking into account the relative movements between rolling stock and infrastructure and the necessary margins or clearances.

This part of the series prEN 15273 covers generic explanations and methods of gauging and is used in conjunction with the following parts:

— *Part 1: Generic explanations and methods of gauging*;

— *Part 2*: *Rolling stock*;

— *Part 3: Infrastructure gauges*;

— *Part 4: Catalogue of gauges and associated rules.*

# 1 Scope

This document presents the background of gauging methods, gives calculation examples for both rolling stock and infrastructure based on gauging methods from prEN 15273-2 and prEN 15273-3, and also demonstrates some relevant formulae.

# 2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

prEN 15273-1:2018, *Railway applications — Gauges — Part 1: Generic explanations and methods of gauging*

prEN 15273-2:2018, *Railway applications — Gauges — Part 2: Rolling stock*

prEN 15273-3:2018, *Railway applications — Gauges — Part 3: Infrastructure*

prEN 15273-4:2018, *Railway applications — Gauges — Part 4: Catalogue of gauges*

EN 50119, *Railway applications — Fixed installations — Electric traction overhead contact lines*

EN 50367, *Railway applications — Current collection systems — Technical criteria for the interaction between pantograph and overhead line (to achieve free access)*



# 3 Terms and definitions



For the purposes of this document, the symbols and abbreviations given in prEN 15273-1 apply.



ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at http://www.electropedia.org/
- ISO Online browsing platform: available at http://www.iso.org/obp

# 4 Symbols and abbreviations

For the purposes of this document, the terms and definitions given in prEN 15273-1 apply.

# 5 General

This document (FprCEN/TR 15273-5:2018) has been prepared by Technical Committee CEN/TC 256 “Railway applications” for better reading and understanding of the standard. All examples contained in this Technical Report are for guidance and are not contractual.

This document aims at defining the obstacles implementation, the tracks implementation and the sections for rolling stocks in order to ensure the service safety. These rolling stocks are designed according to the different types of existing or future configuration.

This document explains the general philosophy of the methods used and of the history of the evolution of the rules. Therefore, the reader should be able to adapt the philosophy or formulae to his specific cases.

# 6 Historical background

## 6.1 Why gauging?

The following photographs demonstrate the importance of gauging.

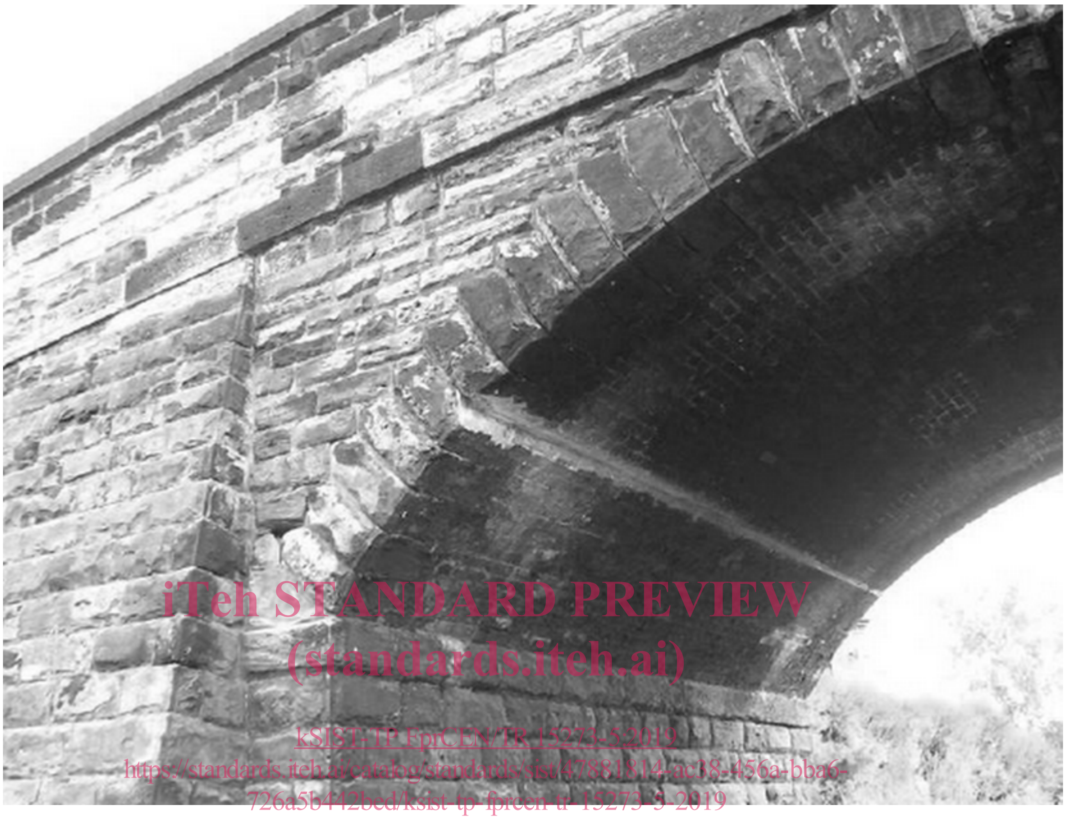




**Figure 1 — Container contact on the bridge**



**Figure 2 — Clearance between access doors and platform**



## 6.2 Defined gauges

The historical development of the rules of kinematic gauge is the subject of the UIC 505-5. As a summary, the needs of transport and of interoperability led the railways operators in 1913 to adopt a common gauge.

This gauge was defined as the UT (Technical Unit) and was a static gauge.

Until then, the rules practiced by the networks were not unified and pose interoperability problems. The UT static gauge consists of a reference contour and associated rules which allow infrastructure managers to set up barriers and responsibility for the design of rolling stock to define the vehicles allowing safe traffic next to the obstacles and next to cruisers trains.

Given the evolution of rolling stock: the lengthening of the wheelbase vehicles and bogies, the increase of the speeds and passenger comfort, etc., many parameters have therefore had an impact on the increase flexibility suspensions as well as clearance between carbody and bogie, UIC was requested in 1953 to develop a kinematic gauge. Thus was published in 1956 a first version of UIC 505, completed in 1957 by a table defining the lateral projections.

The basic principle of the method used at the time was the use of a reference profile that allowed to clearly separate the responsibilities of rolling stock and infrastructure, dividing the lateral movements so that they are taken into account a single time.

This breakdown leads to the standard values such was the case for cant that is shared between the rolling stock and infrastructure. Thus, the first 50 mm of cant or cant deficiency is covered by the rolling stock. The rest of the cant or the cant deficiency is taken into account by the infrastructure.

The same goes for the flexibility coefficient (For example, for the gauge G1 its value is 0,4) except that its reference value this time is limited by the infrastructure. If this value is exceeded by the designers of the rolling stock, it is to their responsibility to adapt the vehicle's exterior dimensions to respect the space cleared by the infrastructure.

Thus were developed the UIC 505 (all parts) for various type of rolling stock and for infrastructure.

In 1991, the 5th and 7th UIC Commissions decided to group the first three leaflets under the name UIC 505-1 and maintain UIC 505-4 and UIC 505-5.

Subsequently, the implementation of European Standards development led to renew these calculation methods while

— optimizing, for example using generic formulas in the calculation of the lateral reductions,

— adapting,

  — because they were such striking passage reduction formulas on marshalling humps for special wagons,

  — creating rules for the area of wheels and live parts on the roof.



Rolling stock sized following UIC 505-1 and UIC 506 is compatible with the requirements of EN 15273 for kinematic gauges below:



— G1, GI1, GI2 and G2 for UIC 505-1;

— GA, GB, GB1, GB2, GC and GI3 for UIC 506.

## 6.3 Absolute and comparative process

The historical development of the absolute and comparative gauging process originated in the rail network of Great Britain (GB). Early trains and infrastructure built were small; it was only once their popularity was established that larger rolling stock was produced. Fortunately, the difference in size between structures built and the limiting structure gauge meant that larger trains could be easily accommodated. Today's railway is very different in GB; a requirement for larger, high-capacity trains, containerised freight (in 9'6" high boxes) presents quite a different problem to small goods wagons. The combination of cross-sectional area, shape, length and speed all place a space requirement on today's railway that could not be dreamed about in Victorian times, although GB continues to use much of the same infrastructure. Historically not only were many structures built bigger than required, but the space allowed between trains and structures was large also. This space is known as clearance. Clearance is provided to accommodate movement of the train as it travels and to provide a safety margin to accommodate track maintenance, unknown situations, tolerances, etc. and sometimes to provide safe walking routes.

As GB has built progressively larger trains, they have reduced the clearance originally provided. Tracks have been moved to accommodate the often conflicting demands of wide passenger trains and tall freight container trains (which don't fit neatly through arched bridges and tunnels).

The simplest form originally used by GB was using static gauges. Following nationalisation, standard gauges for locomotives (L1), carriages (C1) and wagons (W1 to W5) were introduced in 1950, these being gauges that would fit virtually anywhere on the national railway network. The W6 gauge, larger than W5 and quickly replaced with W6a once issues regarding clearances to third rail electrified track were identified, was added later. The W6a gauge is now the most widely used wagon gauge on the modern GB railway network. W6a however does not guarantee route compatibility with the entire British railway network (‘go-anywhere’), and assumes wagon type suspension parameters which makes it unsuitable for use in building other types of rolling stock such as passenger vehicles. Whilst GB retains the use of static gauges in some circumstances, their use has been superseded by more sophisticated analysis to make better use of space.

Following extensive research the 1970-80s, a methodology was established by British Rail Mechanical and Electrical Engineering Department for the calculation of vehicle sways and drops named Design Guide 501 or “BASS 501”. This hand-calculated technique enabled the calculation of simple vehicle body sways from speed and cant deficiency or excess from which the dynamic space required could be calculated and compared to structures along a route.

Since then, increasingly sophisticated computer modelling systems were developed, together with more accurate tools for measuring the actual size of infrastructure. The systems and processes were adopted by the GB Rail Industry as the absolute and comparative process which allowed the understanding of how much trains move and how much safety margin to provide, to make more effective use of the existing Victorian built infrastructure.



It is through the use of these systems and processes and that tilting trains, large containerised freight trains and modern commuter rolling stock can be run in GB – this would not have been possible using traditional processes without vast expenditure in providing additional (and arguably unnecessary) space to accommodate them. Avoiding these large capital expenditures is traded off against a need to tightly control infrastructure position and maintain a high level of asset knowledge.



The absolute and comparative gauging process cover a series of techniques that ensure that sufficient space exists around a moving train (clearance) to provide safe operation. The complex, computer modelling processes used in the absolute dynamic gauging process provide the greatest level of 'fit' between trains and structures (and passing other trains).

Comparative gauging provides for the certification of compatibility by a process of demonstrating that new rolling stock can be operated in 'the shadow' of rolling stock which already has certification on the routes that new rolling stock is to be operated on. In absolute gauging, the actual space required to run a vehicle along a route is compared with the actual size of structures and the position of adjacent tracks along that route.

In practice, both can only be done through computer simulation, where the dynamic swept envelopes of candidate and comparator vehicles are compared over the range of speeds and cant deficiencies / excesses that would be experienced on the route, where the route data is kept up to date by the infrastructure manager.

# 7 Technical background

## 7.1 Defined gauges

### 7.1.1 Rolling stock

#### 7.1.1.1 How to operate to make a gauge calculation for rolling stock defined kinematic gauge?

Before beginning a gauge calculation it is necessary to collect, reference contour and associated rules (see prEN 15273-4) as well as product-related data:

— the vehicle data: type of configuration conventional or non- conventional, the pivot centre distance “a”, the length of the carbody, variation law of lateral clearance between the carbody and bogies “$w$” depending on the curve radius;

— characteristics bogies (motor or trailing bogie) and their suspensions ( flexibility coefficient s, downward displacements $Aff$, distance between suspension springs $b_1$ or $b_2$) wheelbase axle $p$, wheel wear $Usr$ and $d$;

— associated rules (see prEN 15273-4);

— data on conditions of operation and maintenance.

prEN 15273-1:2018, 5.2 gives further explanations and links between the different parts of this standard.



#### 7.1.1.2 Main steps to perform a gauge calculation

The generic procedure can be summarized as:



a) know and assimilate standard(s) to respect any pertinent requirements;

b) know and understand the rolling stock configuration;

c) determine the position of the bumps stops between carbody and bogie, check the free movement of the bogies without interference with the carbody in very small radius curve (think comfort of the passengers);

d) determine clearances $w$ in the cross-section of the bogie pivot (may depend on the curve radius);

e) determine the lateral reductions;

f) determine the vertical reductions depending on the suspension characteristics and connections;

g) determine the maximum construction gauge in the relevant cross-section;

h) complete this calculation by taking into account the particular components: implantation of the pantographs, sensor location, antenna, reducing gaps in access steps...;

i) write all results in the calculation file in order to get the homologation;

j) the calculated values may change according to the updating of the project: a new calculation should be performed.

#### 7.1.1.3 Train configuration

When developing new configurations such as an articulated vehicle with an offset articulation or other solution, it is necessary to apply the philosophy stated in the standard to implement secure calculations as practiced throughout modelling.

The aim of the calculations is to search for a given configuration for maximum space offer travellers comfort and for freight vehicles better cargo capacity.

To take into account all criteria and architectural organization of the train (switching module) it is necessary to design vehicles that make up the train according to the gauge rules. Caution is necessary to adapt the formulae of this standard according to the chosen configuration as in the current version of this standard are only treated the two bogies on conventional vehicles and articulated vehicles (see prEN 15273-2:2018, A.1.3) for example for tilting trains and vehicles installation and track maintenance.

Figure 3 and Figure 4 show different classical configurations.

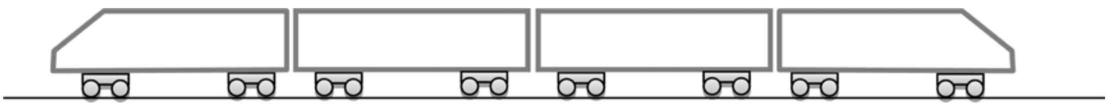


**Figure 3 — Example of conventional vehicles with 2 bogies**

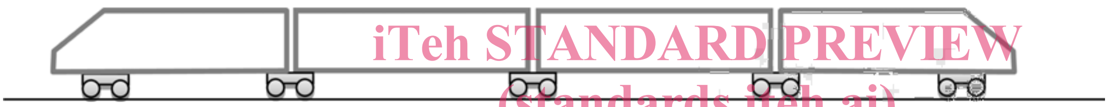
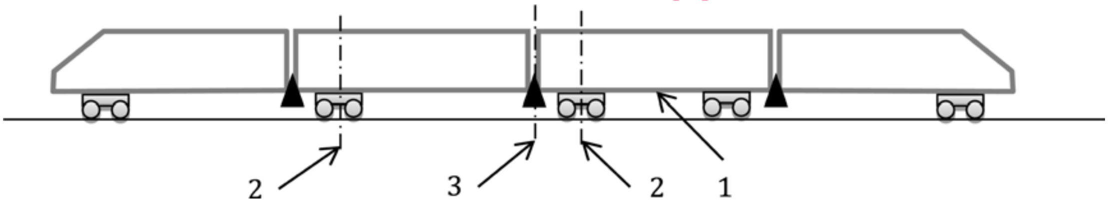




**Figure 4 — Example of articulated trainset with standard and Jakobs bogies**



Figure 5 and Figure 6 show different hybrid configurations for which formulas should be adapted.



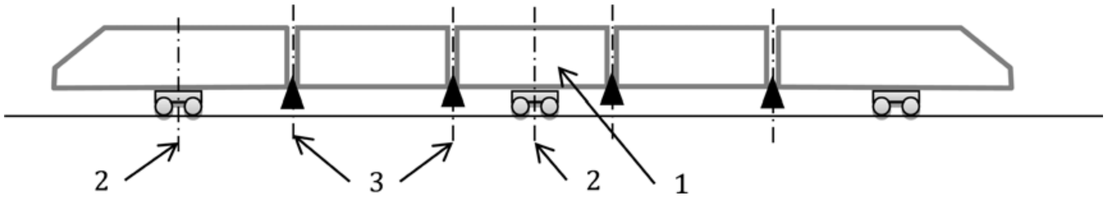

**Key**

1 key vehicle

2 bogie pivot

3 articulation between cars

**Figure 5 — Example of configuration with offset articulation**




**Key**

1 key vehicle

2 bogie pivot

3 articulation between cars

**Figure 6 — Example of configuration with suspended carbody**

An example of development of formulas is proposed in 8.2.10 of this document for the same conditions as conventional vehicles: straight line and constant radius.

It is necessary to check these configurations for other conditions such as s-curves, switches and crossings in order to be sure that these vehicles do not infringe the infrastructure gauge. Two specific cases should be checked:

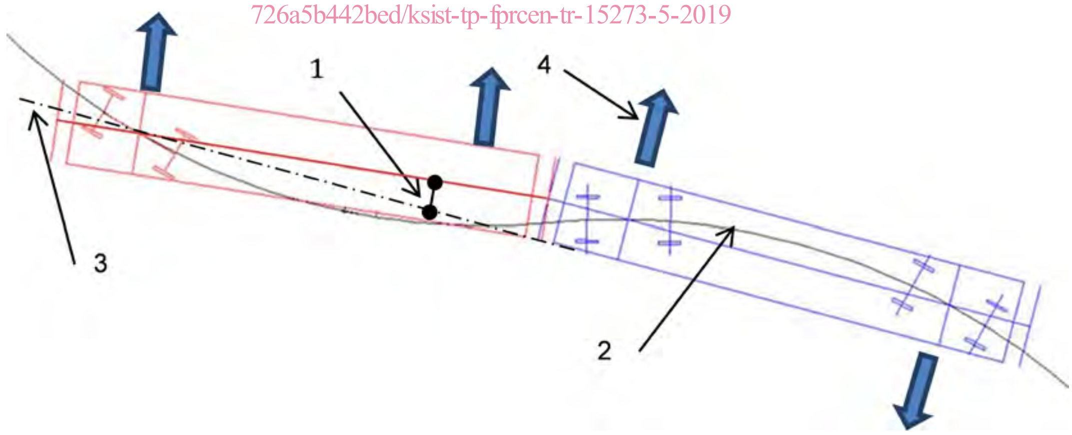
a) *S*-curve of 190 m radius without an intermediate straight section;

b) *S*-curve of 150 m radius with an intermediate straight section of 6 m.



The figure below shows the difference in the geometric overthrow with respect a conventional vehicle when considering train configuration corresponding to Figure 5 in an *s*-curve without intermediate straight track.






**Key**

1 additional geometric overthrow
2 S-curve without an intermediate straight section corresponding to the case n°1
3 conventional vehicle centreline
4 direction of the additional lateral displacements of the carbody

**Figure 7 — Example of configuration with offset articulation in a *s*-curve**