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Železniške naprave - Varjenje železniških vozil in elementov - 3. del: Zahteve za projektiranje

Railway applications - Welding of railway vehicles and components - Part 3: Design requirements

Bahnanwendungen - Schweißen von Schienenfahrzeugen und -fahrzeugteilen - Teil 3: Konstruktionsvorgaben

Applications ferroviaires - Soudage des véhicules et des composants ferroviaires - Partie 3 : Exigences de conception

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Railway applications - Welding of railway vehicles and components - Part 3: Design requirements

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

If this draft becomes a European Standard, CEN members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration.

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prEN 15085-3:2021 (E)**European foreword**

This document (prEN 15085-3:2021) 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 Enquiry.

This document will supersede EN 15085-3:2007.

This series of European Standards EN 15085 "Railway applications — Welding of railway vehicles and components" consists of the following parts:

- *Part 1: General*
- *Part 2: Requirements of the organisation of welding manufacturer*
- *Part 3: Design requirements*
- *Part 4: Production requirements*
- *Part 5: Inspection, testing and documentation*
- *Part 6: Maintenance.*

iTeh STANDARD PREVIEW

This document has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association, and supports essential requirements of EU Directive(s).

For relationship with EU Directive(s), see informative Annex ZA, which is an integral part of this document.

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Introduction

Welding is a special process in the manufacture of railway vehicles and their parts. The required provisions for this process are laid down in the standards series EN ISO 3834. The basis of these provisions is the basic technical welding standards in respect of the special requirements for the construction of railway vehicles.

This European Standard is aimed at defining the terms of enforcement applicable to European Standards; it is not construed as a substitute to these standards.

This document can also be used by internal and external parties, including accredited certification bodies, to assess the organisation's ability to meet customer, regulatory and the organisation's own requirements.

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prEN 15085-3:2021 (E)**1 Scope**

This series of documents applies to welding of metallic materials in the manufacture and maintenance of railway vehicles and their components.

This document specifies design and classification rules applicable to the manufacture and maintenance of railway vehicles and their parts. Upon agreement with the customer, drawings issued prior to this document may be subject to the provisions of this European Standard.

This document does not define parameters for the dimensioning (refer to other standards e.g. on fatigue testing).

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.

EN 1011-2, *Welding — Recommendations for welding of metallic materials — Part 2: Arc welding of ferritic steels*

EN 1708-2, *Welding — Basic weld joint details in steel — Part 2: Non internal pressurized components*

EN 12663-1, *Railway applications - Structural requirements of railway vehicle bodies - Part 1: Locomotives and passenger rolling stock (and alternative method for freight wagons)*

EN 12663-2, *Railway applications - Structural requirements of railway vehicle bodies - Part 2: Freight wagons*

EN 13749, *Railway applications — Wheelsets and bogies — Methods of specifying structural requirements of bogie frames*

EN 15085-1:2007, *Railway applications — Welding of railway vehicles and components — Part 1: General*

EN 15085-2:2007, *Railway applications — Welding of railway vehicles and components — Part 2: Quality requirements and certification of welding manufacturer*

EN 15085-4:2007, *Railway applications — Welding of railway vehicles and components — Part 4: Production requirements*

EN 15085-5:2007, *Railway applications — Welding of railway vehicles and components — Part 5: Inspection, testing and documentation*

EN 15827, *Railway applications - Requirements for bogies and running gears*

EN ISO 2553, *Welding and allied processes - Symbolic representation on drawings - Welded joints (ISO 2553)*

EN ISO 3452-1, *Non-destructive testing - Penetrant testing - Part 1: General principles (ISO 3452-1)*

EN ISO 4063, *Welding and allied processes — Nomenclature of processes and reference numbers (ISO 4063:1998)*

EN ISO 5817, *Welding — Fusion-welded joints in steel, nickel, titanium and their alloys (beam welding excluded) — Quality levels for imperfections (ISO 5817:2003)*

EN ISO 6520-1, *Welding and allied processes — Classification of geometric imperfections in metallic materials — Part 1: Fusion welding (ISO 6520-1:2007)*

EN ISO 6520-2, *Welding and allied processes — Classification of geometric imperfections in metallic materials — Part 2: Welding with pressure (ISO 6520-2:2001)*

EN ISO 10042, *Welding — Arc-welded joints in aluminium and its alloys — Quality levels for imperfections (ISO 10042)*

EN ISO 10675-2, *Non-destructive testing of welds - Acceptance levels for radiographic testing - Part 2: Aluminium and its alloys (ISO 10675-2)*

EN ISO 13919-1, *Welding — Electrons and laser beam welded joints — Guidance on quality levels for imperfections — Part 1: Steel (ISO 13919-1:1996)*

EN ISO 13919-2, *Welding — Electron and laser beam welded joints — Guidance on quality levels for imperfections — Part 2: Aluminium and its weldable alloys (ISO 13919-2:2001)*

EN ISO 14555, *Welding — Arc stud welding of metallic materials (ISO 14555:2006)*

EN ISO 15614-1, *Specification and qualification of welding procedures for metallic materials — Welding procedure test — Part 1: Arc and gas welding of steels and arc welding of nickel and nickel alloys (ISO 15614-1:2004)*

EN ISO 15614-12, *Specification and qualification of welding procedures for metallic materials — Welding procedure test — Part 12: Spot, seam and projection welding (ISO 15614-12:2004)*

EN ISO 17636-1, *Non-destructive testing of welds - Radiographic testing - Part 1: X- and gamma-ray techniques with film (ISO 17636-1)*

EN ISO 17637, *Non-destructive testing of welds - Visual testing of fusion-welded joints (ISO 17637)*

EN ISO 17653, *Destructive tests on welds in metallic materials — Torsion test of resistance spot welds (ISO 17653:2012)*

EN ISO 23277, *Non-destructive testing of welds - Penetrant testing - Acceptance levels (ISO 23277)*

EN ISO 25239-5:2020, *Friction stir welding - Aluminium - Part 5: Quality and inspection requirements (ISO 25239-5:2020)*

ISO 10447, *Resistance welding — Peel and chisel testing of resistance spot, projection and seam welds*

CEN ISO/TR 15608, *Welding — Guidelines for a metallic materials grouping system (ISO/TR 15608:2013)*

prEN 15085-3:2021 (E)**3 Terms and definitions**

For the purposes of this document, the terms and definitions given in EN 15085-1:2007 apply.

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

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

3.1 stress factor
ratio of the calculated fatigue stress to the admissible fatigue stress of the joint type, adjusted by the appropriate safety factor

3.2 admissible fatigue stress
maximum stress applicable to materials to which a specific coefficient to the assembly to be welded is applied

4 Design requirements**4.1 General**

Regarding welded joints forming an integral part of items of rolling stock, except for specific provisions laid down within the framework of the project or in the product specification, design and requirements shall be defined as follows.

A stress assessment shall be done for new designs. For existing designs not according to EN 15085, the requirements of EN 15085-6 shall apply.

The relation between safety category, stress category and weld performance as described in table 2 shall be respected in the drawing and the associated technical documentation.

If the strength assessment procedure already considers the weld performance class (regarding the quality levels for imperfections and the weld inspection class), and the safety category according to the definition given in EN 15085-3, then Table 1 and Table 2 don't need to be applied.

NOTE prEN 17149-3 provides such a procedure.

Irrespective of the method of assessment, for welded joints with high safety category the weld performance classes allowed in EN 15085-3 (CP A, CP B1, CP C1) shall be chosen.

CP D is only allowed for low safety category.

4.2 Dimensioning of welded joints

For dimensioning and preparation of different types of welded joints see annexes B and C.

4.3 Stress categories and stress factors

The stress category is determined by the stress factor according to Table 1. The stress factor is the ratio of the calculated fatigue stress to the admissible fatigue stress of the welded joint type.

The fatigue strength value can be obtained from calculation standard or fatigue tests on representative joint samples. The statistical evaluation of the fatigue tests shall be done according to an appropriate standard.

European standards for structural requirements of railway vehicles, e.g. EN°12663 (series), EN°13749, EN°15827, shall be applied.

Table 1 — Stress categories

Stress category	Stress factor
	Fatigue strength values from calculation standard or Fatigue test values for representative joint sample
High	$\geq 0,9$
Medium	$0,75 \leq S < 0,9$
Low	$\leq 0,75$

4.4 Safety categories

The safety category defines the consequences of failure of the single welded joint with respect to the effects on persons, facilities and the environment.

The safety categories are differentiated as follows:

- Low:** Failure of the welded joint does not lead to any direct impairment of the overall function. Consequential events with personal injuries are unlikely.
- Medium:** Failure of the welded joint leads to an impairment of the overall function or can lead to consequential events with personal injuries.
- High:** Failure of the welded joint leads to consequential events with personal injuries and breakdown of the overall function.

For a more detailed explanation of the safety category, also Annex G should be considered.

4.5 Weld performance classes

Weld performance classes shall be defined in the design phase depending on the safety category and the stress category. The responsible welding coordinator should be consulted with respect to practicability, feasibility and testing.

Welded joints of railway vehicles are divided into seven weld performance classes (see Table 2).

Table 2 — Weld performance classes

Stress categories	Safety categories		
	High	Medium	Low
High	CP A ^a	CP B2 ^c	CP C2
Medium	CP B1 ^b	CP C2	CP C3
Low	CP C1 ^d	CP C3	CP D

^a For new manufacturing the combination of high safety category and high stress category, which leads to weld performance class CP A, is forbidden. For application in maintenance see EN 15085-6

^b Weld performance class CP B1:
CP B1 is only applicable for welds with full penetration and full accessibility for inspection in production and maintenance.

^c Weld performance class CP B2:
CP B2 is also-applicable for welds without the possibility for a volumetric test; e. g. welds with partial penetration or fillet welds are possible; in this case a special remark “medium safety category/increase of surface test is required” shall be indicated on the drawing or technical documentation linked to the drawing

^d Weld performance class CP C1: CP C1 is also valid for welds without the possibility for volumetric testing; e. g. welds with partial penetration or fillet welds are possible

The inspection of all welded joints shall be carried out according to EN 15085-5:2007, table 1 as minimum.

For welded joints with weld performance class CP B1, CP B2 and CP C1, which can be inspected during production but cannot be inspected and repaired in maintenance one of the following actions shall be carried out:

- The weld shall be allocated to the next higher inspection class (CT°1) according to Table 3;
- redesign the welded joint:
 - in order to reduce the stress category;
 - in order to allow access for inspection and repair in maintenance.

If it is not possible to fulfil the requirements of a weld performance class, the designer shall reduce the stress category or change the design, see Annex D.

Post-welding improvement is one of the possible ways of increasing the admissible fatigue stresses of an assembly and may consequently lead to a downscaling of the weld performance class.

Weld performance classes shall be shown on drawings or in other documents, e.g. parts lists.

In case of higher weld inspection class than that defined in table 3 it shall be shown on drawings or in other documents, e.g. parts lists.

4.6 Weld inspection classes

The inspection class applicable to each welded joint is defined depending on the weld performance class defined formerly, see Table 3.

These inspection classes are used to identify the various types and minimum levels of inspections on the welded joints in accordance to EN 15085-5:2007, Table 1.

Table 3 — Correspondence between weld performance classes and inspection classes

Stress category	Safety category	Weld performance class	Quality levels for imperfections EN ISO 5817 EN ISO 10042 EN 13919-1 EN 13919-2	Inspection class Minimum requirements	Volumetric tests RT or UT Min.	Surface tests MT or PT Min.	Visual examination VT Min.
High	High	CP A	B ^a	CT 1	100%	100 %	100 %
High	Medium	CP B2	B ^a	CT 2	10 %	10 %	100 %
High	Low	CP C2	C ^a	CT 3	Not required	Not required	100 %
Medium	High	CP B1	B ^a	CT 2	10%	10 %	100 %
Medium	Medium	CP C2	C ^a	CT 3	Not required	Not required	100 %
Medium	Low	CP C3	C ^a	CT 4	Not required	Not required	100 %
Low	High	CP C1	C ^a	CT 2	10 %	10 %	100 %
Low	Medium	CP C3	C ^a	CT 4	Not required	Not required	100 %
Low	Low	CP D	D ^a	CT 4	Not required	Not required	100 %

^a For detail see Table 4 to 6

5 Quality levels for imperfections

5.1 General

The definition and classification of weld imperfections in accordance with EN ISO 6520-1 and EN ISO 6520-2, are applicable.

5.2 Quality levels for imperfections

NOTE The quality levels for imperfections related to the weld performance class are described below.

5.2.1 Quality levels for imperfections for fusion welded joints (beam welding excluded)

The quality levels for imperfection for fusion welding of steel and aluminium are listed in Table 4 in accordance to EN ISO 5817 and EN ISO 10042.

EN ISO 5817:2014, Annex C, is not applicable in the production and maintenance of railway vehicles and components.

Table 4 — Quality levels for imperfections for steel and aluminium related to weld performance classes

Imperfection No. according to EN ISO 6520-1	Weld performance classes			
	CP A	CP B1 / CP B2	CP C1 / CP C2 / CP C3	CP D
	Level of Imperfections according to EN ISO 5817 and EN ISO 10042			
Group 100	B	B	C	D
Group 200	B	B	C	D
Group 300	B	B	C	D
Group 400	B	B	C	D
5011, 5012, 5013, 502, 504, 506, 509, 511, 510, 515, 516, 517	Not permitted	B	C	D
5071, 5072, 601	B	B	C	D
503, 5213, 512 ^a , 617	Not applicable	B	C	D
505 and Multiple Imperfections	B	These imperfections are not assessed		
5214 [steel]	Not applicable	B	C	D
5214 [aluminium]	Not applicable	refer to geometrical dimension defined into design documentation (e.g. avoid interference during assembly)		
602, 610 [steel]	B	B	C	D
602 [aluminium]	Acceptance depends on application, e.g. material, corrosion protection			
610 [aluminium]	Not applicable			

^a 512: Excessive asymmetry of fillet weld (unequal leg length) is not assessed if the fillet weld is an addition on a HY-weld or HV-weld at T-joint (see Annex B, No. 10c and 11c). The throat thickness of these fillet welds depends on the shorter leg length.

5.2.2 Quality levels for imperfections for beam welded joints

Quality levels for imperfections shall be according to EN ISO 13919-1 and EN ISO 13919-2 and are given in Table 5 and Table 6.

Table 5 — Quality levels for imperfections for laser and electron beam welding for steel related to the weld performance class

Imperfections according to EN ISO 13919-1	Weld performance classes			
	CP A	CP B1 / CP B2	CP C1 / CP C2 / CP C3	CP D
1 to 4, 6, 7, 18	B	B	C	D
5, 8, 10 to 16	Not permitted	B	C	D
9, 17	Not applicable	B	C	D

Table 6 — Quality levels for imperfections for laser and electron beam welding for aluminium and its alloys related to the weld performance class

Imperfections according to EN ISO 13919-2	Weld performance classes			
	CP A	CP B1 / CP B2	CP C1 / CP C2 / CP C3	CP D
1 to 5, 7, 8, 20	B	B	C	D
6, 9, 11 to 18	Not permitted	B	C	D
10, 19	Not applicable	B	C	D

5.2.3 Quality levels for imperfection for friction stir welding

The visual inspection shall be done according to EN ISO 17637.

The assessment criteria of all weld performance classes for destructive and non-destructive testing shall be in accordance with EN ISO 25239-5:2020, Table A.1. Cracks, wormholes and lack of fusion are unacceptable.

Penetrant Testing:

The assessment shall be in accordance with EN ISO 3452-1 with the acceptance levels according to EN ISO 23277 group 2x

Radiographic Testing:

The radiation tests shall be carried out in accordance with EN ISO 17636-1, class B. The acceptance level 1 according to EN ISO 10675-2 shall be fulfilled.

5.2.4 Quality levels for imperfections for stud welding related to the weld performance class

Stud welded joints are permitted for weld performance classes CP C3 and CP D only. The requirements according to EN ISO 14555 shall be fulfilled.

5.2.5 Quality requirements for resistance spot welding, projection welding and resistance seam welding related to the weld performance class

The quality requirements for resistance spot welding, projection welding and resistance seam welding are defined in Table F.2. For the surface quality, Table F.3 applies.

Resistance spot welding, projection welding and resistance seam welding is forbidden for weld performance classes CP A, CP B1 and CP B2.

5.2.6 Defining quality requirements for other welding processes

The quality requirements for other welding processes shall be defined before starting the production.

6 Choice of parent metals and welding consumables

6.1 Choice of parent metals

The parent metals should meet the requirements of material groups according to CEN ISO/TR 15608 (CEN°ISO/TR°20172) and shall have proven weldability. The weldability according to CEN°ISO/TR 581 is considered proven if the materials correspond with the appropriate EN standards and are identified as weldable by them.

For a parent metal without proven weldability it shall be demonstrated, by means of Welding Procedure Qualification Record (according to EN ISO 15614), that the characteristics of the joints achieved by using