BS EN 15085-3:2022+A1:2023

BSI Standards Publication

Railway applications — Welding of railway vehicles and components

Part 3: Design requirements

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National foreword

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A list of organizations represented on this committee can be obtained on request to its committee manager.

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European foreword

This document (EN 15085-3:2022+A1:2023) has been prepared by Technical Committee CEN/TC 256 “Railway applications”, the secretariat of which is held by DIN.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by October 2023, and conflicting national standards shall be withdrawn at the latest by October 2023.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN shall not be held responsible for identifying any or all such patent rights.

This document includes Amendment 1 approved by CEN on 1 February 2023.

This document supersedes [A1⟩ EN 15085-3:2022 ⟨A1].

The start and finish of text introduced or altered by amendment is indicated in the text by tags [A1⟩ ⟨A1].

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 organization of welding manufacturer*

— *Part 3: Design requirements*

— *Part 4: Production requirements*

— *Part 5: Inspection, testing and documentation*

— *Part 6: Maintenance*

EN 15085-3:2022 includes the following changes with respect to EN 15085-3:2007.

— The weld performance class CP B has been divided into CP B1 and CP B2 (see Table 2);

— Terms and definitions have been updated;

— The following annexes have been reworked accordingly;

  — Annex H has been deleted and part of its content has been integrated into the main text (see 6.2 and 7.1);

  — Annex ZA has been added.

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

For relationship with EU Directive(s) / Regulation(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 with respect to the special requirements for the construction of railway vehicles.

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

It describes the control for the welding process for railway vehicles and their components for new manufacture and maintenance.

With respect to the railway environment, this series of standards defines the quality requirements for the welding manufacturer to undertake new building and repair work.

Components, parts and subassemblies are assigned a classification level, based on their safety relevance.

According to these levels, qualifications for welding personnel of the manufacturer are specified.

This series provides an essential link between the weld performance class defined during design, the quality of the weld, and the demonstration of the required quality by inspection.

This series of standards does not deal with product qualification.

NOTE This series of standard can also be used by internal and external parties, including certification bodies, to assess the organization's ability to meet customer, regulatory and the organization's own requirements.

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1 Scope

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

This document specifies applicable design and classification rules.

This document does not specify parameters for the dimensioning.

NOTE Requirements for structures can be found in other standards (e.g. EN 12663).

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 1011-2:2001, *Welding - Recommendations for welding of metallic materials - Part 2: Arc welding of ferritic steels*

EN 12663-1:2010+A1:2014, *Railway applications - Structural requirements of railway vehicle bodies - Part 1: Locomotives and passenger rolling stock (and alternative method for freight wagons)*

EN 12663-2:2010, *Railway applications - Structural requirements of railway vehicle bodies - Part 2: Freight wagons*

EN 13749:2021, *Railway applications - Wheelsets and bogies - Method of specifying the structural requirements of bogie frames*

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

EN 15085-2:2020, *Railway applications - Welding of railway vehicles and components - Part 2: Requirements for welding manufacturer*

EN 15085-4:—,[2] Railway applications — Welding of railway vehicles and components — Part 4: Production requirements

EN 15085-5:—,[3] Railway applications — Welding of railway vehicles and components — Part 5: Inspection, testing and documentation

EN 15085-6:—,[4] *Railway applications — Welding of railway vehicles and components — Part 6:* Maintenance welding requirements

EN 15827:2011, *Railway applications - Requirements for bogies and running gears*

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[4] Under preparation. Stage at the time of publication: FprEN 15085-6:2021

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EN ISO 2553:2019, *Welding and allied processes - Symbolic representation on drawings - Welded joints (ISO 2553:2019, Corrected version 2021-09)*

EN ISO 3452-1:2021, *Non-destructive testing - Penetrant testing - Part 1: General principles (ISO 3452-1:2021)*

EN ISO 4063:2010, *Welding and allied processes - Nomenclature of processes and reference numbers (ISO 4063:2009, Corrected version 2010-03-01)*

EN ISO 5817:2014, *Welding - Fusion-welded joints in steel, nickel, titanium and their alloys (beam welding excluded) - Quality levels for imperfections (ISO 5817:2014)*

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

EN ISO 6520-2:2013, *Welding and allied processes - Classification of geometric imperfections in metallic materials - Part 2: Welding with pressure (ISO 6520-2:2013)*

EN ISO 10042:2018, *Welding - Arc-welded joints in aluminium and its alloys - Quality levels for imperfections (ISO 10042:2018)*

EN ISO 10675-2:2021, Non-destructive testing of welds — Acceptance levels for radiographic testing — Part 2: Aluminium and its alloys (ISO 10675-2:2021)

EN ISO 13919-1:2019, *Electron and laser-beam welded joints - Requirements and recommendations on quality levels for imperfections - Part 1: Steel, nickel, titanium and their alloys (ISO 13919-1:2019)*

EN ISO 13919-2:2021, *Electron and laser-beam welded joints - Requirements and recommendations on quality levels for imperfections - Part 2: Aluminium, magnesium and their alloys and pure copper (ISO 13919-2:2021)*

EN ISO 13920:1996, *Welding - General tolerances for welded constructions - Dimensions for lengths and angles - Shape and position (ISO 13920:1996)*

EN ISO 14555:2017, *Welding - Arc stud welding of metallic materials (ISO 14555:2017)*

EN ISO 15614-1:2017,[5] *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 15614-1:2017)*

EN ISO 15614-12:2021, *Specification and qualification of welding procedures for metallic materials - Welding procedure test - Part 12: Spot, seam and projection welding (ISO 15614-12:2021)*

EN ISO 17636-1:2022, Non-destructive testing of welds — Radiographic testing — Part 1: X- and gamma-ray techniques with film (ISO 17636-1:2022)

EN ISO 17637:2016, *Non-destructive testing of welds - Visual testing of fusion-welded joints (ISO 17637:2016)*

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[5] Document impacted by A1:2019.

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

EN ISO 17663:2009, *Welding - Quality requirements for heat treatment in connection with welding and allied processes (ISO 17663:2009)*

EN ISO 23277:2015, *Non-destructive testing of welds - Penetrant testing - Acceptance levels (ISO 23277:2015)*

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

EN ISO 10447:2015, *Resistance welding - Testing of welds - Peel and chisel testing of resistance spot and projection welds (ISO 10447:2015)*

3 Terms and definitions

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

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

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at https://www.electropedia.org/

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

3.2
admissible fatigue stress
maximum fatigue stress applicable to the welded joint according to the applicable standard / specification

4 Design requirements

4.1 General

All welded joints produced under the scope of the EN 15085 series shall be designed according to the requirements of this document unless more stringent product / project specific requirements are defined.

A stress assessment shall be done for new designs. For existing designs not according to EN 15085, the requirements of EN 15085-6:-[4] shall apply.

Results of the stress assessment shall be used in combination with the safety category to define the weld performance class (CP) according to Table 2. The weld performance class for each weld shall be identified on the manufacturing drawing or associated technical documentation.

If the strength assessment procedure already considers the weld performance class (i.e. the quality levels for imperfections and the weld inspection class), and the safety category according to the definition given in this document, then Table 1 and 2 do not need to be applied.

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NOTE EN 17149-3:-[5] provides such a procedure.

Irrespective of the method of assessment, for welded joints with high safety category the weld performance classes according to this document (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, (see 3.1).

The fatigue strength value can be obtained by calculation according to the appropriate standard / guideline or fatigue tests on representative joint samples.

The statistical evaluation of the fatigue tests shall be done according to an appropriate standard. The verification of strength should be carried out using only one coherent system for calculation.

European standards for structural requirements of railway vehicles, e.g. EN 12663-1:2010+A1:2014, EN 12663-2:2010, EN 13749:2021, EN 15827:2011, shall be applied.

Table 1 — Stress categories

Stress category	Stress factor (S)
High	≥ 0,9
Medium	0,75 ≤ S < 0,9
Low	≤ 0,75

4.4 Safety categories

The safety category defines the consequences of failure of a single welded joint with respect to its effect 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, Annex G should also 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. A welding coordinator should be consulted with respect to practicability and testing of the welded joints.

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

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Table 2 — Weld performance classes

Stress categories	Safety categories		
	High	**Medium**	**Low**
High	CP A [a]	CP B2 [b]	CP C2
Medium	CP B1 [a]	CP C2	CP C3
Low	CP C1 [b]	CP C3	CP D

a Weld performance classes CP A and CP B1: CP A and CP B1 are only applicable for welds with full penetration and full accessibility for inspection in production and maintenance.

b Weld performance classes CP B2 and CP C1: CP B2 and CP C1 are also applicable for welds where volumetric NDT is not possible. Where this is the case, see EN 15085-5:-[3], Table 1, footnote b. This should be noted on the related weld inspection documentation with a note "increase of surface test is required".

For new manufacturing, the combination of high safety category and high stress category, which leads to weld performance class CP A, shall be avoided. For application in maintenance see EN 15085-6:-[4].

The inspection of all welded joints shall be performed according to EN 15085-5:-[3], Table 1 as a minimum.

When the weld performance class assessment leads to CP B1, CP B2 or CP C1, and the weld is inaccessible for inspection or repair during maintenance, one of the following actions shall be performed:

— Increase the weld inspection class to CT 1.

— change the design:

  — to reduce the stress category;

  — 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.

Different post weld treatment methods to increase the fatigue strength are possible. These methods can lead to a downgrading of the stress category.

4.6 Weld inspection classes

The weld inspection class is determined based on the weld performance class.

The correlation between the weld performance class, weld inspection class and inspection requirements is defined in Table 3. Details of weld inspection are further defined in EN 15085-5:- [3], Table 1.

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Table 3 — Correlation between weld performance classes and weld inspection classes

Stress category	Safety category	Weld performance class	Quality levels for imperfections EN ISO 5817:2014 EN ISO 10042:2018 EN ISO 13919-1:2019 EN ISO 13919-2:2021	Weld inspection class Minimum requirements	Volumetric tests min.	Surface tests min.	Visual examination 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							

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.

5 Quality levels for imperfections

5.1 General

The definition and classification of weld imperfections in accordance with EN ISO 6520-1:2007 and EN ISO 6520-2:2013, are applicable.

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

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

The quality levels for imperfection for fusion welding of steel and aluminium alloys are listed in Table 4 in accordance to EN ISO 5817:2014 and EN ISO 10042:2018.

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

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

Imperfection No. according to EN ISO 6520-1:2007	Weld performance classes			
	CP A	CP B1 / CP B2	CP C1 / CP C2 / CP C3	CP D
	Level of Imperfections according to EN ISO 5817:2014 and EN ISO 10042:2018			
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.

5.3 Quality levels for imperfections for beam welded joints

5.3.1 General

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

Quality levels for imperfections shall be according to EN ISO 13919-1:2019 and EN ISO 13919-2:2021 and are given in Table 5 and Table 6.

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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 13919-1:2019	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 13919-2:2021	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

5.3.2 Quality levels for imperfection for friction stir welding

The visual inspection shall be carried out according to EN ISO 17637:2016.

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, worm-holes and lack of fusion are not permitted.

Penetrant Testing:

The assessment shall be in accordance with EN ISO 3452-1:2021 with the acceptance levels according to EN ISO 23277:2015 group 2x.

Radiographic Testing:

Radiographic testing shall be carried out in accordance with EN ISO 17636-1:2022, class B. The acceptance level 1 according to EN ISO 10675-2:2021 shall be fulfilled.

5.3.3 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 14555:2017 shall be fulfilled.

5.3.4 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 not permitted for weld performance classes CP A, CP B1 and CP B2.

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