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Bahnanwendungen - Schweißen von Schienenfahrzeugen und -fahrzeugteilen - Teil 5: Prüfung und Dokumentation

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EUROPEAN COMMITTEE FOR STANDARDIZATION
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Management Centre: rue de Stassart, 36 B-1050 Brussels

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Foreword

This document (EN 15085-5:2007) 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of an identical text or by endorsement, at the latest by April 2008, and conflicting national standards shall be withdrawn at the latest by April 2008.

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: Quality requirements and certification of welding manufacturer
- Part 3: Design requirements
- Part 4: Production requirements
- Part 5: Inspection, testing and documentation

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

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

1 Scope

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

This part of the series specifies:

- inspections and testing to be executed on the welds;
- destructive as well as non-destructive tests to be performed;
- necessary documentation to issue to declare the conformity of the products.

2 Normative references

The following referenced documents are indispensable for the application 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 473, *Non destructive testing — Qualification and certification of NDT personnel — General principles*

EN 10204, *Metallic products — Types of inspection documents*

EN 12062, *Non-destructive examination of welds — General rules for metallic materials*

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 15085-3:2007, *Railway applications — Welding of railway vehicles and components — Part 3: Design requirements*

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

EN ISO 3834 (all parts), *Quality requirements for fusion welding of metallic materials*

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 10042, *Welding — Arc-welded joints in aluminium and its alloys — Quality levels for imperfections (ISO 10042:2005)*

EN ISO 14731:2006, *Welding coordination — Tasks and responsibilities (ISO 14731:2006)*

EN ISO 15609 (all parts), *Specification and qualification of welding procedures for metallic materials — Welding procedure specification*

EN ISO/IEC 17050-1, *Conformity assessment — Supplier's declaration of conformity — Part 1: General requirements (ISO/IEC 17050-1:2004)*

EN ISO/IEC 17050-2, *Conformity assessment — Supplier's declaration of conformity — Part 2: Supporting documentation (ISO/IEC 17050-2:2004)*

3 Terms and definitions

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

4 Inspection and testing of welded joints

4.1 General

The relationship between essential welding related tasks and the manufacturing phases to be performed by the responsible welding coordinator or his deputies are given in Table A.1.

4.2 Inspection and testing before welding

Additional to Table A.1 the responsible welding coordinator is responsible for the following tasks:

- planning of back gouging and sealing run;
- provision of additional welding-related information for incorporation in the drawings.

As evidence that the checks listed in Table A.1 and above have been carried out, the outcome shall be recorded.

In order to carry out the above-mentioned tasks, the coordinator may seek support of other company departments. Details of responsibilities for the tasks have to be defined as applied to the organization of the welding manufacturer.

The task of the welder or welding operator, before beginning any type of welding activity, is to check the following items:

- that the welding machine is validated and efficient;
- availability of the work instructions;
- conditions of the edges and the correct tacking of the items to be welded (conditions of cleanliness and assembly of the pieces in accordance with the design and/or the WPS);
- identification of the items to be welded;
- compliance of the welding consumables with the WPS.

4.3 Inspection and testing during welding

The welders or welding operators performing the job have to check and ensure the following:

- adequate cleaning and shape of the joints during the intermediate passes;
- compliance with the prescribed values of the pre-heating and/or interpass temperatures;
- compliance with the WPS and/or work instructions;
- compliance with the sequence of operations if prescribed in specific operating instructions (e.g. the welding sequence plan).

The process steps and phases in which it is necessary for the welding activity to be supervised by the responsible welding coordinator or his deputy shall be explained by welding planning documents (see EN 15085-4:2007, 4.1).

If the welding sequence plan or test plan requires the check of a weld during production, welding shall be continued only after the weld has been checked.

4.4 Inspection and testing after welding

4.4.1 Checks by the welder or welding operator

After welding, the welder or welding operator shall carry out the following checks:

- that the weld is complete;
- that the weld is cleaned;
- that the profile and dimensions of the weld conform to the drawing.

4.4.2 Self-inspection by the welder or welding operator

If a self-inspection system is used, the personnel entrusted with the self-inspection shall be suitably trained and instructed with respect to visual examinations and the requirements of EN 15085-3:2007, Clause 5, by the responsible welding coordinator or his nominee (deputy, or personnel certified to Level 2 according to EN 473).

The inspections carried out by the welder or welding operator shall then be clearly defined (acceptance criteria, dimensioning etc.) and recorded in accordance with Table 1. Recording documents shall be signed by the welder or welding operator who carries out the inspection and have to be enclosed with the other inspection documents. A copy of the personal signatures with names in clear, printed text will be held for all personnel who sign inspection documents. Alternatively, traceability can be achieved by an electronic system.

4.4.3 Conformity control of welds

After welding, the NDT (Non-Destructive Testing) is carried out by certified personnel (except VT; see Table 1).

Table 1 defines the type and frequency of the testing to be carried out during series production. This is based on the relationship between the weld performance class of the welded joint assigned by the design engineer and the resulting inspection class (see EN 15085-3).

Testing at the beginning of production: shall be according to the inspection class, 100 % testing of all welds on each initial item of the series if testing is required in Table 1.

Testing during series production: the tests described in Table 1 shall be carried out on products manufactured during series production in accordance with the frequencies indicated therein and as per the weld performance class indicated on the drawing by the design engineer.

In the case of detecting unacceptable defects during the tests indicated in Table 1, the procedure for management of non-conformance shall be applied, with the extension of the testing as indicated in Clause 7.

Table 1 — Tests which have to be performed during production

Inspection class	Volumetric tests RT or UT	Surface tests MT or PT	Visual examination VT
CT 1	100 % ^a	100 %	100 %
CT 2	10 % ^{a b}	10 % ^b	100 %
CT 3	Not required	Not required	100 %
CT 4	Not required	Not required	100 %

The percentages expressed refer to the total length to be examined for one given weld. Thus:

- 100 % means: request for testing of the entire length of the weld and on all the pieces built;
- 10 % means: testing of 10 % of the entire length of the weld on all the pieces built or 100 % testing on 1 of every 10 items built

The test methods indicated in Table 1 shall be the minimum capable of ensuring compliance of the welded joints. Additional tests depending on the material, the design or customer requirements may be necessary.

All NDT (RT, UT, MT or PT) shall be performed by personnel certified according to EN 473 and shall be documented.

For inspection classes CT 1 and CT 2, the visual examination shall be performed by personnel certified according to EN 473 and shall be documented.

For inspection class CT 3, the visual examination shall be performed as a minimum by personnel qualified by the manufacturer and should be documented.

For inspection CT 4, the visual examination shall be performed as a minimum by welders who are trained in visual examination and documentation is not required.

a Volumetric tests applicable only for butt welds and T-welds with full penetration.

b Where volumetric testing is not feasible for welds of the weld performance class CP B in medium safety category or CP C1, 100 % surface testing is required. When five consecutive items are acceptable, surface testing may be reduced to 25 %. A production weld test according to EN 15085-4 for every welder or operator of a robot who carries out this weld before the start of the production is necessary. The production weld test is valid for six months and may be prolonged by the responsible welding coordinator if the welder or operator is still in the production (for information on weld performance classes, see EN 15085-3:2007, Table 2).

In the case of fully mechanised or automatic welding procedures with process monitoring for weld performance class CP B and CP C1 the extent of testing can be reduced in agreement with the responsible welding coordinator. If required, the agreement of the customer shall be obtained.

NOTE Independent of the weld performance class, water tightness tests can be carried out if required.

5 Test planning and test criteria

5.1 Test planning

For each welded assembly and subassembly, according to the test plan, the current status of inspection and testing required for compliance with the quality requirements according to EN 15085-3:2007, Clause 5, shall always be identifiable.

During the production planning, the test method, time schedule and amount of testing (depending on the inspection class, the weld shape and the material) shall be defined in a test plan. For simple welded structures, the test plan may be part of the working plan. For particularly complex or important structures it is recommended that a test instruction is produced that describes explicitly all the various phases.

5.2 Test criteria

5.2.1 Weld performance classes

According to the weld performance class indicated in the engineering documentation (e.g. on the drawing), the quality levels for imperfections of EN ISO 5817 for steel and EN ISO 10042 for aluminium and aluminium alloys as defined in EN 15085-3:2007, Clause 5, shall be fulfilled. For resistance spot welding, EN 15085-3:2007, Annex F, applies.

5.2.2 Examination and acceptance levels

EN 12062 refers to examination and acceptance levels depending on the quality level of the non-destructive test method used and shall be applied.

NOTE CP A is not completely covered by the acceptance levels of EN 12062 (see EN 15085-3:2007, Clause 5).

In specific cases if it is necessary to verify in detail the extent and the type of an imperfection, e.g. to verify its fitness for operation, it may be necessary to apply other non-destructive test methods that are not covered by EN 12062.

If specified in the contract, the specific methods used in these cases shall be agreed between customer and manufacturer.

6 Documentation

In order to be related to the individual subassemblies, appropriate test documents shall be marked with the product identification data (type, job order, drawing and its revision, serial number or progressive manufacturing number or IT identification number). These documents shall also be identified and have a revision system enabling the applicable version to be managed.

If prescribed by the test plan, these documents shall be completed and signed by the personnel carrying out the job.

In this way this documentation shall be capable of demonstrating and documenting the progress of the production activities during the manufacturing of the individual products.

These shall therefore be considered as quality reports according to EN ISO 3834 and as such, they shall be filed and retained by the manufacturer according to the methods indicated in the appropriate clause of the series of standards EN ISO 3834, together with any other documentation referred to therein.

Signatures shall be traceable to the individual, e.g. by additional printed names.

7 Non-conformance and corrective actions

7.1 General

This clause describes how to deal with non-conformance found on the welded joints, i.e. deviations that are observed on the welded product with respect to the design requirements.

In general it is necessary to ensure that the non-conforming items are not used in production until after the analysis and the resolving of non-conformance, and that after repairs the products comply with the required characteristics.

Furthermore, all necessary steps shall be taken to ensure that the causes of the non-conformance are quickly detected and eliminated in order to prevent any repetition.

Weld finishing carried out for eliminating any superficial imperfection is not considered as a repair operation. The eliminating of internal imperfections is also not considered as a repair operation, as long as the original WPS or another WPS which results in the required weld quality is used.

However, if in the welding coordinator's opinion the necessary repairs require the issuing of a new, specific WPS as it is not possible to follow the usual operations prescribed initially in the production cycle, he shall analyze the problems of the case in question to establish the most appropriate operating methods and activate the internal non-conformance process.

7.2 Management of non-conformance

7.2.1 General

The use of un-repairable product has to be prevented.

For all repairs by welding not covered by the scope of the original WPQR (or another WPQR which enables the same weld quality to be achieved) or not in accordance with the design, a report of non-conformance is necessary.

The repair having effect on:

- function of the product,
- inter-changeability of the work piece,
- sequence of the production and
- maintenance of the work piece

has to be approved by the design department and if necessary, agreed by the customer.

The WPS used for the repair shall be according to the appropriate part of EN ISO 15609.

As a rule, the personnel assigned to the identification of the non-conforming material are based in the internal quality control departments of the company. However, it is necessary for all the corporate personnel to collaborate in the identification and reporting of product and/or process non-conformance.

The management of the non-conformance is referred to the assigned company department, according to the instructions in the manufacturer's quality manual; in all cases the resolution of the non-conformance on the welded products requires the involvement of the responsible welding coordinator.

The responsible welding coordinator may call on the co-operation of other company departments/offices (e.g. design) if he requires a more specific competence for analyzing or assessing the non-conformance.

If required in the contract, the manufacturer shall inform the customer of all non-conformances and wait for approval.

7.2.2 Resolving of non-conformance (repairs)

Items detected as nonconforming shall be identified and if possible, should be isolated in a specific area in order to prevent their use in production until resolution of the non-conformance.

In the case in which it is possible to repair the non-conforming product, the manufacturer shall carry out the repairs by following specific procedures that shall be available in the work areas.

The re-testing of the repaired item shall be carried out by the same test method used previously. At the discretion of the welding coordinator, other additional test methods may be applied.

7.2.3 Corrective actions

In the event of recurrent non-conformance or of non-conforming products that could affect safety, the company shall take all steps necessary for ensuring that the causes are detected and corrected.

7.2.4 Documentation

The non-conformance report shall contain a description of the anomaly, the cause, the actions decided upon for its resolution and any corrective actions undertaken.

For each test carried out after repair or rework, with the aim of ascertaining the compliance of the product, it is necessary to issue a report (e.g. non-destructive test report, dimensional check etc.) that shall be annexed to the relative non-conformance report.

7.3 Additional tests

7.3.1 General

When non-acceptable imperfections are found during the tests indicated in Table 1, the procedure indicated below shall be followed.

7.3.2 Start/restart of production

The type of test indicated in Table 1 shall be applied over 100 % of the length of the weld with the non-acceptable imperfections and also on the products welded after this first weld until such time as no more non-acceptable imperfections are found.

The presence of non-acceptable imperfections during the initial phase of production shall be the subject of detailed examination with the aim of establishing any technical/practical deficiencies and activating the corrective actions necessary for restoring the process.

7.3.3 Series production

The weld with the non-acceptable imperfections shall be retested with the same test methods as used for the first test, on 100 % of the length of the two items immediately prior to and after (if already produced) the non-conforming item.

If even one of these two items turns out to have non-acceptable imperfections the tests shall be extended using identical methods, to the two preceding and two subsequent units, subunits or assemblies until ascertaining the absence of non-acceptable imperfections.

If even one single item of these four should turn out to be unacceptably defective the production shall be stopped until the causes of the non-acceptable imperfections are clearly identified. The test shall be extended to the entire relevant production batch.

8 Sub-contractors

If the manufacturer orders welded components from its sub-contractors, it is necessary that these sub-contractors are in compliance with the requirements of this series of standards in order to assure the required quality level for the product.

In particular, the sub-contractors shall be certified to the appropriate certification level according to EN 15085-2 relating the ordered products.

The manufacturer, who is responsible for the products delivered to the final customer, shall verify, with periodic auditing visits, that the sub-supplier is able to ensure the requested quality performances on the

products and to manage the process in accordance with the contractual prescriptions. The extent and the frequency of the auditing visits shall be agreed depending on the product.

For products of certification level CL 1 and CL 2 according to EN 15085-2:2007, the manufacturer's responsible welding coordinator or his nominee will execute these audits at the beginning of production, i.e. on the first welded structure carried out by the sub-contractor (first article inspection). Further auditing visits are at the discretion of the responsible welding coordinator.

In the case of sub-contracting products of certification level CL 1 according to EN 15085-2:2007, before the beginning of manufacturing activities, the manufacturer shall inform the customer about all welding works ordered to external sites and about the sub-contractors involved. In the case of sub-contracting of certification level CL 2 or CL 3 only if agreed between customer and manufacturer.

The documentation of the auditing visits shall be available in order to give evidence to the customer, if requested.

9 Declaration of conformity

The manufacturer of railway products shall draw up and issue a declaration of conformity certifying compliance with the specified contractual requirements, the design, and the required technical specifications. The guidelines for drawing up this declaration of conformity shall be as indicated in EN ISO/IEC 17050-1 and EN ISO/IEC 17050-2.

The type of test certificate according to EN 10204 shall be agreed between customer and manufacturer.

10 Traceability

In accordance with EN ISO 3834, the traceability is not required unless specified in the contract. Nevertheless, for railway applications, the material traceability should be made at least until the cutting operation including off-cuts to prevent dangerous material exchange in the production phase.

Annex A (normative)

Inspection and testing of welded joints

Table A.1 — Relationship between essential welding related tasks and the manufacturing phases to be performed

Essential welding related tasks		Manufacturing phases				
Related clause from EN ISO 14731:2006, Annex B	Essential welding related tasks to be considered when appropriate	Contract analysis phase	Design phase	Work preparation phase	Production phase	Post-production phase
B.1 Review of requirements	— product standard to be used, together with any supplementary requirements.	X				
B.2 Technical review	— parent material(s) specification and welded joints properties; — joint location with relation to the design requirements; — requirements for weld performance class; — location, accessibility and sequence of welds, including accessibility for inspection and non-destructive testing; — other welding requirements, e.g. batch testing of consumables, ferrite content of weld metal, ageing, hydrogen content, permanent backing, use of peening, surface finish, weld profile; — dimensions and detail of joint preparation and completed weld.		X X X X X	X		
B.3 Sub-contracting	With regard to sub-contracting, the suitability of any sub-contractor for welding fabrication shall be ensured.	X	X	X		
B.4 Welding personnel	With regard to welding personnel, the qualification of welders and welding operators shall be carried out (including training, instruction, performance and assessment).	X	X	X		
B.5 Equipment	The suitability of welding and associated equipment shall be ensured.	X	X	X		
B.6 Production planning	— reference to the appropriate procedure specifications for welding; — allocation of qualified personnel.		X	X X		
B.7 Qualification of the welding	— method and range of qualification with regard to the qualification of the welding procedures; — performance and assessment of welding		X			

Essential welding related tasks		Manufacturing phases				
Related clause from EN ISO 14731:2006, Annex B	Essential welding related tasks to be considered when appropriate	Contract analysis phase	Design phase	Work preparation phase	Production phase	Post-production phase
procedure s	procedure qualification.		X	X		
B.8 Welding procedure specifications	With regard to welding procedure specifications, the range of qualification shall be determined.		X	X		
B.9 Work instructions	With regard to work instructions, the issuing and use of work instructions shall be determined.			X		
B.10 Welding consumables	— compatibility; — delivery conditions; — any supplementary requirements in the welding consumables purchasing specifications, including the types of welding consumable inspection document; — storage and handling of welding consumables.		X X X	X X		
B.11 Materials	— any supplementary requirements in the material purchasing specifications, including the types of inspection document for the material; — storage and handling of the parent material.	X	X		X X	
B.12 Inspections and testing before welding	— suitability and validity of welder's and welding operator's qualification certificates; — suitability and validity of the welding procedure specification; — identity of the parent material and welding consumables; — joint preparation, fit-up, jigging and tacking; — any special requirements in the welding procedure specification (e.g. prevention of distortion); — suitability of working conditions for welding, including the environment; — planning, performance and assessment of mock-ups.	X	X X X X X	X X X X	X X X X	
B.13 Inspections and testing during welding	— essential welding parameters; — preheating/interpass temperature; — cleaning and shape of runs and layers of weld metal; — back gouging;			X	X X X	

Essential welding related tasks		Manufacturing phases				
Related clause from EN ISO 14731:2006, Annex B	Essential welding related tasks to be considered when appropriate	Contract analysis phase	Design phase	Work preparation phase	Production phase	Post-production phase
	— welding sequence; — correct use and handling of welding consumables.				X X	
B.14 and B.15 Inspections and testing after welding	— use of visual inspection; — use of non-destructive testing; — use of destructive testing; — results and records of post-operations (e.g. post-weld heat treatment, ageing).				X X X	X X X
B.16 Non-conformance and corrective actions	With regard to non-conformance and corrective actions, the necessary measures and actions (e.g. weld repairs, re-assessment of repaired welds, corrective actions) shall be determined.				X	X
B.17 Calibration and validation of measuring, inspection and testing equipment	The necessary methods and actions shall be determined.				X	X
B.18 Identification and traceability	The applicable actions shall be determined for welding details.	X	X	X	X	X
B.19 Quality records	Preparation and release of necessary welding records and documents shall be carried out.	X	X	X	X	X