

October 2007

ICS 45.060.01; 25.160.10

English Version

Railway applications - Welding of railway vehicles and
components - Part 4: Production requirements

Applications ferroviaires - Soudage des véhicules et des
composants ferroviaires - Partie 4: Exigences de
production

Bahnanwendungen - Schweißen von Schienenfahrzeugen
und -fahrzeugteilen - Teil 4: Fertigungsanforderungen

This European Standard was approved by CEN on 18 August 2007.

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. Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the CEN Management Centre or to any CEN member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CEN member into its own language and notified to the CEN Management Centre has the same status as the official versions.

CEN members are the national standards bodies of Austria, Belgium, Bulgaria, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland and United Kingdom.



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

Management Centre: rue de Stassart, 36 B-1050 Brussels

Contents

	Page
Foreword	3
Introduction	4
1 Scope	5
2 Normative references	5
3 Terms and definitions	6
4 Preparation before welding	6
4.1 Welding planning documents	6
4.2 Production weld tests	8
5 Requirements for welding	10
5.1 General	10
5.2 General requirements	10
5.3 Welding consumables	13
5.4 Parent metals	14
5.5 Welding processes	15
6 Special requirements for maintenance welding of railway vehicles	16
6.1 General rules for maintenance welding	16
6.2 Testing and documentation	16
Bibliography	17

Foreword

This document (EN 15085-4:2007) 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of an identical text or by endorsement, at the latest by April 2008, and conflicting national standards shall be withdrawn at the latest by April 2008.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.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland and the United Kingdom.

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 standard is aimed at defining the terms of enforcement applicable to European Standards, it should not be construed as a substitute to these standards.

This 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 describes the production requirements (i.e. preparation and execution) of the welding work.

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 287-1, *Qualification test of welders – Fusion welding – Part 1: Steels*

EN 1011 (all parts), *Welding – Recommendations for welding of metallic materials*

EN 10204:2004, *Metallic products – Types of inspection documents*

EN 13479, *Welding consumables – General product standard for filler metals and fluxes for fusion welding of metallic materials*

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

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

EN ISO 544, *Welding consumables - Technical delivery conditions for welding filler materials - Type of product, dimensions, tolerances and markings (ISO 544:2003)*

EN ISO 4063:2000, *Welding and allied processes - Nomenclature of processes and reference numbers (ISO 4063:1998)*

EN ISO 9013:2002, *Thermal cutting - Classification of thermal cuts - Geometrical product specification and quality tolerances (ISO 9013:2002)*

EN ISO 9606-2, *Qualification test of welders - Fusion welding - Part 2: Aluminium and aluminium alloys (ISO 9606-2:2004)*

EN ISO 9606-3, *Approval testing of welders - Fusion welding - Part 3: Copper and copper alloys (ISO 9606-3:1999)*

EN ISO 9606-4, *Approval testing of welders - Fusion welding - Part 4: Nickel and nickel alloys (ISO 9606-4:1999)*

EN ISO 9606-5, *Approval testing of welders - Fusion welding - Part 5: Titanium and titanium alloys, zirconium and zirconium alloys (ISO 9606-5:2000)*

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

CEN ISO/TR 15608:2005, *Welding - Guidelines for a metallic materials grouping system (ISO/TR 15608:2005)*

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

EN ISO 15610 *Specification and qualification of welding procedures for metallic materials - Qualification based on tested welding consumables (ISO 15610:2003)*

EN ISO 15611, *Specification and qualification of welding procedures for metallic materials - Qualification based on previous welding experience (ISO 15611:2003)*

EN ISO 15612 *Specification and qualification of welding procedures for metallic materials - Qualification by adoption of a standard welding procedure (ISO 15612:2004)*

EN ISO 15613, *Specification and qualification of welding procedures for metallic materials - Qualification based on pre-production welding test (ISO 15613:2004)*

EN ISO 15614 (all parts)¹⁾ *Specification and qualification of welding procedures for metallic materials – Welding procedure test*

EN ISO 15620, *Welding - Friction welding of metallic materials (ISO 15620:2000)*

EN ISO 17652-1, *Welding - Test for shop primers in relation to welding and allied processes - Part 1: General requirements (ISO 17652-1:2003)*

EN ISO 17652-2, *Welding - Test for shop primers in relation to welding and allied processes - Part 2: Welding properties of shop primers (ISO 17652-2:2003)*

3 Terms and definitions

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

4 Preparation before welding

4.1 Welding planning documents

4.1.1 General

Welding planning documents shall be prepared by the manufacturers with the assistance of the recognised welding coordinator Level A for new and converted vehicles and maintenance of rail vehicles (see EN 15085-2). Type, scope and time of the submission and inspection should be agreed between customer and manufacturer.

Welding planning documents may include working plans, welding sequence plans, test planning documents and welding procedure specifications.

4.1.2 Working plans

For the production of railway vehicles it is necessary to have working plans for the following sub-assemblies:

- bogie (sub-assemblies, assembly);

1) For railway applications, only EN ISO 15614-1, EN ISO 15614-2, prEN ISO 15614-3, EN ISO 15614-4, EN ISO 15614-7, EN ISO 15614-11, EN ISO 15614-12 and EN ISO 15614-13 are relevant.

- underframe (with sub-assemblies);
- body (side wall, end wall, roof);
- further sub-assemblies with high safety and functional requirements (e.g. cardan shafts, brake cross members, motor housing, hollow shaft drive, drawbar coupling, bogie pivot pin, cross bearer).

4.1.3 Other welding planning documents

For more complicated assemblies welding sequence plans are necessary, e.g. for:

- bogies (bogie bolster, bogie centre plate including bogie pivot pin member, solebar, headstock, bogie pivot pin cross member, traction bar coupling, assembly of solebar and cross member);
- underframe (including cross member, solebar, headstock, bogie pivot pin cross member, traction bar coupling).

Standardised welding sequence plans (that applies for different types of vehicles) are also allowed.

Furthermore, other welding planning documents may be necessary (e.g. tacking sequence plans, repairing plans, test plans, documents for jigs and tools, remarks for protection of labour and health, plans for separating of damaged parts, special instructions for electronic parts). These details shall be determined by the responsible welding coordinator and/or the customer.

4.1.4 Welding procedure specification

For welds with welding performance classes CP A, CP B, CP C1, CP C2 and CP C3, welding procedure specifications according to EN ISO 15609-1 to EN ISO 15609-5, to EN ISO 14555 or to EN ISO 15620 are necessary. For weld performance class CP D this is only necessary if the customer demands it.

Dependent on the weld performance classes according to EN 15085-3, the following evidences are necessary for the welding procedure specification:

- Weld performance class CP A:
Evidence according to any of the following standards: EN ISO 15614²⁾ or EN ISO 15620; EN ISO 15613 only if a WPQR according to EN ISO 15614 exists; for materials with $R_{eh} > 500$ MPa or fully mechanised welding processes: EN ISO 15614. For the WPQR the acceptance criteria of weld performance class CP A (EN 15085-3:2007, Table 5 and Table 6) shall be fulfilled.
- Weld performance classes CP B, CP C1, CP C2:
Evidence according to any of the following standards: EN ISO 15613, EN ISO 14555, EN ISO 15620; if necessary for component or the material: EN ISO 15614.
- Weld performance class CP C3:
Evidence according to any of the following standards: EN ISO 15610, EN ISO 15611, EN ISO 15612, EN ISO 15613, EN ISO 14555, EN ISO 15620; if necessary for component or the material: EN ISO 15614.
- Weld performance class CP D:
According to the requirements of the customer.

In general, every WPS shall be covered by a WPQR, except for weld performance class CP D unless specified in the contract.

2) See footnote 1).

NOTE For the validity of WPS and WPQR according to EN ISO 15614-1 and EN ISO 15614-2, see Introduction of EN ISO 15614-1:2004 and EN ISO 15614-2:2005.

4.2 Production weld tests

4.2.1 General

4.2.1.1 Aim and objective of production weld tests

If necessary, production weld tests shall be carried out.

The aim and objective of production weld tests is:

- to check and ensure that the design is satisfactory as specified in EN 15085-3;
- to prove the welding conditions;
- to demonstrate the skill of the welders;
- to demonstrate the quality of the weld.

One production weld test can be used for several tasks indicated above.

4.2.1.2 Realization and amount of testing of production weld test

The production weld test shall be carried out under the same manufacturing conditions as the real product. They shall be carried out under the supervision of the responsible welding coordinator and they shall be documented.

Production weld tests should be welded in accordance with EN ISO 15613. They may be welded separately as test plates, as sample sub-assemblies (mock-ups) or together with sub-assembly, for example, as an extension of the weld.

The production weld tests and the amount of testing should be listed in the test plan or specified by the welding coordinator. If no details for the testing of the production weld tests are defined in the test plan, EN ISO 15613 applies.

4.2.2 Production weld tests to check and ensure the design

Test specimens to demonstrate the weldability of the design shall be welded as a sample sub-assembly. They are necessary to demonstrate:

- practicability (design which is convenient for welding);
- selection of the material;
- possibility of testing;
- quality requirements;
- mechanical property data (e.g. strength, ductility).

4.2.3 Production weld tests to prove the welding conditions

For special welds where no proof is possible in accordance with EN ISO 15614, production weld tests are necessary for proving these welds to ensure the fusion of the weld. These can be, for example:

- welds without full penetration on butt and T joints;
- HV welds on T joints with single side access.

The production weld tests serve to demonstrate that the specified weld performance class has been achieved.

4.2.4 Production weld tests to demonstrate the skill of the welder

For welds which require a special skill in welding and are not specified in standards EN 287-1 or EN ISO 9606-2 to EN ISO 9606-5, production weld tests are necessary to qualify the welders. The testing of the production weld tests shall be carried out as specified in EN 287-1 or in EN ISO 9606-2 to EN ISO 9606-5. If the testing cannot be carried out according to these standards the responsible welding coordinator should specify the testing. EN 287-1 or EN ISO 9606-2 to EN ISO 9606-5 applies to the range and the duration of the validity and the prolongation.

Production weld tests for the qualification of welders (depending on their specific tasks) may be necessary:

- for HV or HY welds on T joints;
- for welds with several degrees of difficulty, e.g. three plate butt welds, plug welds, cross weld, complicated welds on extrusion profiles;
- for welds under complicated conditions, e.g. repairing;
- for poor accessibility;
- for materials with poor weldability;
- for pipe branches and pipe collars;
- for lap joints and corner welds in thin sheets ($t \leq 3$ mm);
- for especially high quality requirements, e.g. weld performance class CP A as specified in EN 15085-3;
- when taking on new welders or welding operators, e.g. staff on loan.

The production weld tests should be listed in the planning documents or specified by the welding coordinator.

4.2.5 Production weld tests to demonstrate the quality of the weld

The weld quality may be demonstrated with production weld tests. For example the following conditions should be considered (see EN 15085-3:2007, 4.7):

- to ensure the weld quality for inspection class CT 2, production weld tests are necessary if neither X-ray nor ultrasonic inspection is possible;
- kind of the production weld test and the frequency should be given in the test plan;
- production weld tests shall be taken from the assembly or from an extension of the work piece or from a similar work piece;
- production weld tests should be checked in accordance with EN ISO 15613. The tests shall be documented.

4.2.6 Production weld tests to check electron beam and laser beam welding

Before the start of the fabrication, production weld tests should be produced and assessed in accordance with EN ISO 15613. For a change of the design, of the material, in the way of fabrication or in the production other production weld tests could also be necessary, if the changes can influence the quality of the weld.

4.2.7 Production weld tests to check resistance spot, roll seam and projection welds

With resistance spot, resistance seam and projection welding, production weld tests shall be produced according to EN 15085-3:2007, Table F.2. Simplified weld production tests shall be done before the daily start of the fabrication and shall be recorded in a log book. Normal weld production tests shall be done to prove the quality in the production at regular intervals depending on weld volume, weld equipment and weld performance class.

4.2.8 Production weld tests to check flash butt welding

For flash butt welds at the beginning of a new production run or when changing the manufacturing conditions (e.g. materials etc.) it is necessary to demonstrate by production weld tests according to EN ISO 15614-13 and testing with a notch bending test, a fracture surface assessment or a non-destructive testing that the mechanical and technical quality values of the weld are in accordance with the specification.

4.2.9 Production weld tests to check stud welding

For stud welding, simplified production tests according to EN ISO 14555 shall be done before starting production or when changing the manufacturing conditions and shall be recorded in a log book.

5 Requirements for welding

5.1 General

Listed below are the technical requirements for the welding of railway vehicles and their components. In addition the recommendations of series of standards EN 1011 should be observed for welding.

5.2 General requirements

5.2.1 Weld preparation

- 1) The weld preparation shall be done as specified on the drawing or in other work documents. The requirements specified in EN 15085-3 should be observed.
- 2) The cut surfaces of dynamically loaded components shall meet the requirements of cut quality 33 according to EN ISO 9013:2002. The cut surface of sheared cuts or stamped jogs shall be free of notches and cracks. If necessary, these imperfections shall be ground out.
- 3) Run-on and run-off plates shall be used according to EN 15085-3:2007, 7.3.11. For $t \geq 8$ mm they shall have the same joint preparation as the actual weld. The run-on and run-off plates shall be made so as to enable the welding to be started or stopped beyond its necessary length. The parts to be assembled and the plates, which are "integrated" into the design or implanted as small plates on the parts to be welded, are homogenous. The preparation of these plates shall be the same as that used on the joints to be made. The plates shall either be fixed by mechanical or magnetic means and can be welded. After having completed the joint, the plates can either be mechanically removed or cut using a blowpipe or plasma. A longitudinal grinding shall be made after the removal of the plates. Any rupture caused by shock is prohibited.
- 4) If welding of temporary attachments is necessary this shall be agreed with the design department.

- 5) The surfaces in the weld shall be free from damp and contamination such as dirt, rust, scale, slag, oil and paint. For multi-run welding the surface of the previous run shall be prepared so that a satisfactory welding of the next run is possible. Dirt, slag and unacceptable imperfections shall be removed.
- 6) For corrosion protection on overlap joints and other areas that are no longer accessible after welding, the application of shop primer paint or coating is acceptable if the following conditions are met:
 - using these primers or coatings is acceptable to the customer, if customer approval is required;
 - the requirement is included in the design;
 - the WPQR has been qualified with the primer being applied;
 - the requirements of EN ISO 17652-1 and EN ISO 17652-2 are met.
- 7) The weld joints shall be visible and accessibility should be optimized for the welder (see 4.2.4).
- 8) Before welding, any irregularities shall be advised to the welding coordinator, e.g. incorrect weld preparation, faulty or unsuitable filler metals or unsuitable welding machines.

5.2.2 Execution of the welding

- 1) Weld build up, weld direction and weld sequence shall be chosen so that the welding produces minimized residual stresses and distortion, so that the weld quality and the required mechanical properties are achieved.
- 2) At the end of gussets or stiffeners, the weld shall run around them. See also EN 15085-3:2007, 7.3.9.
- 3) If possible the welding should be done in position PA or PB. If possible rotating equipment should be used.
- 4) The welding shop shall be protected against the effects of detrimental weather when welding (e.g. against wind, rain, snow and draughts in the shop).
- 5) The welding current return line (work piece clamp) shall be attached directly to the component to be welded so that there is a satisfactory electrical contact with low resistance. It is recommended to attach the welding current return line as near as possible to the welding area.
- 6) When welding on rail vehicles the welding current return line shall be attached to the vehicle in vicinity of the place where the welding will be done. Because of the danger of damaging bearings by current flowing through them attaching the welding current return line to the rails is forbidden.
- 7) If necessary, before the beginning of the welding work the batteries should be bonded out and the vehicle electronics should be protected, e.g. by removing or electrically disconnecting them.
- 8) The necessary rules to prevent fire shall be considered.
- 9) If components have to be moved before the welding is complete (rotated or transported) they shall be able to accept the loads without plastic deformation.
- 10) If necessary the preheat and interpass temperature of the weld area should be specified depending on the material, the thickness and the component to be welded. Information about the required temperatures is given in EN 1011-2 and EN 1011-4, guidance on measurement is given in EN ISO 13916. Preheat and interpass temperature shall be maintained during tacking and welding within the limits specified and checked.
- 11) If the temperature of the work piece is below 5 °C, preheating is necessary in any case.

- 12) If tack welds are incorporated in the final weld, they are subject to the same requirements as the weld.
- 13) If tack welds should not remain in the final weld they shall be carried out in such a way or machined so far that they are correctly melted during welding.
- 14) If welds of the weld performance classes CP A, CP B or CP C1 with full penetration and sealing run (↙) are specified by the design, before welding the first run on the second side the root shall be removed by grinding or machining. Otherwise the applied procedure shall be qualified by a procedure qualification test in accordance with EN ISO 15613 or EN ISO 15614 or by a production weld test.
- 15) Tack welds outside the weld area (e.g. on the remaining root backing) are only permissible if they are provided as part of the design. They are subject to the same requirements as the weld.

5.2.3 Weld quality

- 1) Stray arcing on the surface of the work piece is not allowed. If it occurs, stray arcing shall be ground out. For weld performance classes CP A, CP B or CP C1 a surface test shall be carried out (surface test covers all surface breaking defects including cracks).
- 2) The permission of spatters depends on the material used and on the case of application and shall be agreed by the customer and the manufacturer.
- 3) Permanent backing is only allowed if it is specified on the drawing.
- 4) For adding temporary attachments the agreement of the designer is necessary. For welding and removing these attachments see EN 1011-1.
- 5) After removing notches caused by finishing work (e.g. grinding notches, ledges) the remaining wall thickness shall be at least 95 % of the nominal wall thickness. If the nominal wall thickness is weakened more than 5 % a repair operation is necessary (grinding out, welding, grinding, crack detection). Deviations shall be agreed with the customer.
- 6) If for reasons of design, the drawing specifies the machining or grinding of the excess weld metal the remaining undercuts, craters or other surface defects may only remain if they shall meet the quality requirements.
- 7) If the drawings specify notch free grinding for strength reasons, the weld should be ground in the direction of loading.
- 8) For repair welds only qualified procedures, suitable for the weld performance class shall be used.
- 9) If there is systematic damage or deviations from the drawing the agreement of the customer shall be obtained. Before repairing the reason of the damage or deviations shall be determined.
- 10) Welding over cracks is not permissible.
- 11) Before the repair of cracks by welding the exact location of the crack shall be established. If necessary, the end of the crack should be drilled out and then the crack should be machined out and re-welded. A surface test shall be carried out before and after welding.
- 12) For flame straightening the following principles shall be noted:
 - Flame straightening may only be used when it is permissible for the respective material or the component and does not lead to a reduction of strength. Deviations shall be agreed with the customer.

- When the straightening process is carried out the special technical recommendation should be observed.
- The maximum temperature shall not be exceeded and shall be monitored by suitable measuring equipment for high-strength materials and aluminium. Melting is not permitted.

5.3 Welding consumables

5.3.1 Choice of welding consumables

For unalloyed and low-alloy steels

For parts made of unalloyed or low-alloy steels minimum weld-metal specifications apply. The properties of the welded joint shall be equivalent to the minimum properties specified for the parent material and to EN standards for classification of welding consumables respectively.

For welding of different grades of steel, the minimum weld-metal specifications for the lower rated grade of steel apply. However, the metallurgical properties and welding conditions for the higher rated steel grade shall still be taken into consideration.

For stainless steels

For similar and dissimilar welds of stainless steels the welding consumables shall be selected so that the mechanical properties of the weld meet the requirements.

For aluminium and aluminium alloys

Welding consumables shall be selected in accordance with EN 1011-4.

Additional information on the drawing or parts lists shall be taken into account, see EN 15085-3:2007, Annex H.

5.3.2 Conformity of welding consumables

All welding consumables shall conform to the requirements given in EN 13479 and the appropriate European classification standards.

The range of validity of the certificate shall be in accordance with the planned welding process, material, welding position and welding current type. The certificate is issued on the basis of qualification test according to EN 13479. If required by the customer, conformity shall be demonstrated by a certificate according to EN 14532-1 (steel) or EN 14532-3 (aluminium alloys) issued by certification body.

The delivered welding consumables shall be declared in accordance to EN ISO 544, including a certificate according to EN 10204. The level of certificate shall be agreed between manufacturer and customer.

The producer or supplier of the delivered welding consumables shall declare conformity by applying the CE marking according to EN 13479 on a label indicating also the certification body and the certificate number.

5.3.3 Storage and handling

The recommendations given by the producer of welding consumables for storage and handling shall be considered (see EN 1011-1:1998, 8.2).

5.4 Parent metals

5.4.1 Choice of parent metals

See EN 15085-3:2007, 6.1.

5.4.2 Conformity of parent metals

The parent metals shall meet the requirements of the welding planning documents.

The conformity of the parent metals shall be documented in a material certificate according to EN 10204:2004. The material certificate 3.1 according to EN 10204:2004 is necessary for components with welds of certification level CL 1 or CL 2.

5.4.3 Additional rules for welding carbon and fine grain structural steels

For welding of carbon and fine grain structural steels the preheating temperature and the cooling rate shall be determined according to EN 1011-2.

For thermal cutting and welding of fine grain structural steels the guidelines and the instructions of the steel manufacturers shall be followed.

With arc welding of carbon, fine grain structural and cast steels the maximum hardness values in the heat affected zone shall be in accordance with EN ISO 15614-1.

5.4.4 Additional rules for welding of cast irons

For welding of cast irons, the recommendations of EN 1011-8 shall be followed.

5.4.5 Additional rules for welding stainless steels

Additional to the recommendations given in EN 1011-3 the following rules apply:

The layers of scale and temper colours produced by welding or by heat treatment of steels, material groups 7, 8 or 10 according to CEN ISO/TR 15608:2005, produce a break in the passive material surface which can be overcome by removing the temper colours and by passivating. The following methods can be used:

- grinding with suitable grinding discs;
- brushing with stainless steel brushes;
- blasting with iron free blasting grit;
- chemicals, as specified by the manufacturer of the etching material.

5.4.6 Additional rules for welding carbon or fine grain structural steels with stainless steels

The filler metal shall be chosen using the Schaeffler diagram. The chemical composition of the weld metal shall lie within a range which is not at risk of embrittlement or hot crack formation.

5.4.7 Additional rules for welding aluminium and aluminium alloys

Additional to the recommendations given in EN 1011-4 the following rules apply:

Welding processes manual metal arc welding (111 according to EN ISO 4063:2000) and gas welding (3 according to EN ISO 4063:2000) are not permitted.

Only grinding discs and appropriate tools which are suitable for aluminium shall be used.

5.5 Welding processes

Table 1 contains the welding processes for use, provided that the requirements of 4.1.4 are fulfilled.

Other welding processes shall be agreed with the customer.

Table 1 — Welding processes for use

Process	Ref.-No. as specified in EN ISO 4063:2000	Approved for:	
		Steels	Al and Al-alloys
Gas welding	3	X	—
Submerged arc welding	12	X	—
Plasma arc welding	15	X	X
Resistance spot welding	21	X	X
Resistance seam welding	22	X	X
Projection welding	23	X	X
Flash welding	24	X	X
Friction welding	42	X	X
Electron beam welding	51	X	X
Laser beam welding	52	X	X
Electrogas welding	73	X	—
Stud welding with	78	X	X
Manual metal arc welding	111	X	—
Gravity arc welding with covered electrode	112	X	—
Self-shielded tubular-cored arc welding	114	X	—
Metal inert gas welding	131	X	X
Metal active gas welding	135	X	—
Metal-protection gas melt spot welding	(131) (135)	X X	X —
Tubular cored metal arc welding with active gas	136	X	—
Tubular cored metal arc welding with inert gas	137	X	—
Tungsten inert gas welding	141	X	X
Foil butt-seam welding	225	X	—
High frequency resistance welding	291	X	X
Drawn arc stud welding with ceramic ferrule or shielding gas	783	X	X
Short-cycle drawn arc stud welding	784	X	X
Capacitor discharge drawn arc stud welding	785	X	X

Process	Ref.-No. as specified in EN ISO 4063:2000	Approved for:	
		Steels	Al and Al-alloys
Friction stir welding (FSW)		–	X
Laser-Hybrid-Welding		X	X

6 Special requirements for maintenance welding of railway vehicles

6.1 General rules for maintenance welding

Maintenance welding includes repair welding but not refurbishment or revamping.

If no other requirements are given by the railway operator or the national safety authority the following requirements shall be fulfilled.

The railway operator is responsible for maintenance of his vehicles.

For maintenance welding of railway vehicles all necessary information about the vehicle such as documentation of vehicle manufacturer (drawings, operation manuals, manufacturer requirements) as well as special guidelines and working instructions of the railway operator should be available. The railway operator shall be informed when, as a result of maintenance welding, consistency with the drawing is not maintained. The railway operator shall decide on the further actions.

When cracks and breakage (no obvious acts of violence) occur repeatedly on identical components (serial damage), the vehicle manufacturer shall be informed. The vehicle manufacturer and the railway operator shall decide on the further actions.

Welding of materials with heat input or temperature restrictions (e.g. heat affected zone of heat treatable aluminium alloys) and tempered components requires specific processing agreed by the railway operator or his representative.

6.2 Testing and documentation

If the design is in accordance with EN 15085-3, as a minimum, testing and documentation shall be performed according to the requirements of EN 15085-3.

If the weld performance class is not defined at all or not according to EN 15085-3, testing and documentation have to be determined at least according to Table 4 of EN 15085-3:2007.

If the stress level of the weld is unknown the highest possible weld performance class related to the safety category of the weld shall be used, see Table 4 of EN 15085-3:2007.

Additional to Table 4 of EN 15085-3:2007 the following applies:

For repair welding of single defects testing shall be 100 % for welds of weld performance class CP C1 and CP B.

For all welds a 100 % visual examination shall be performed.

All NDT tests shall be recorded.

A welding report has to be produced by the responsible welding coordinator or his nominee.

Bibliography

- [1] EN ISO 3834 (all parts), *Quality requirements for fusion welding of metallic materials*
- [2] EN 15085-2, *Railway applications – Welding of railway vehicles and components – Part 2: Quality requirements and certification of welding manufacturer*
- [3] EN 14532-1, *Welding consumables – Test methods and quality requirements – Part 1: Primary methods and conformity assessment of consumables for steel, nickel and nickel alloys*
- [4] EN 14532-2, *Welding consumables – Test methods and quality requirements – Part 2: Supplementary methods and conformity assessment of consumables for steel, nickel and nickel alloys*
- [5] EN ISO 13916, *Welding - Guidance on the measurement of preheating temperature, interpass temperature and preheat maintenance temperature (ISO 13916:1996)*