

Welding of Railway Vehicles and Parts

Part 6: Materials, Filler Metals, Welding Processes,
Welding Technological Documents

DIN

6700-6

ICS:...

Deskriptoren: Schweißen, Schienenfahrzeug, Schienenfahrzeugteil, Werkstoff, Schweißzusatz, Schweißverfahren

Welding of railway vehicles and parts - Part 6: - Materials, filler metals, welding processes, outlines

Soudage des véhicules ferroviaires et des pièces - Partie 6: - Matériaux, métaux d'apport, procédés de soudage, documents pour la conception

Contents

	Page
Preface	1
1. Area of application	2
1. Normative instructions	2
2. Concepts	4
3. Materials	4
4. Filler metals for welding	4
5. Welding processes	4
6. Drawings and welding technological planning documents	4
Appendix A (normative) Certificate for filler metals (form), Labelling of filler metals, Classification of filler metals to base materials	6
Appendix B (normative) Welding procedures released for application	12
Appendix C (informative) Materials with proven welding suitability	13
Appendix D (informative) Literature	16

Preface

This standard was worked out by the Normenausschuß Schienenfahrzeuge (Standards Committee for Rail vehicles, FSF).

Welding is a fundamental process for the manufacture of rail vehicles and vehicle parts. In the standards of series DIN 6700 the required instructions for the special process "welding" are being met. Bases of these commitments are the welding technological basic standards in consideration of the special requirements for the construction of rail vehicles.

DIN 6700 "Welding of rail vehicles and -parts" consists of:

- Part 1: Basic concepts and basic rules,
- Part 2: Requirements for the qualification of welding plant,
- Part 3: Construction standards,
- Part 4: Execution rules for welding joints,
- Part 5: Quality requirements for welding joints,
- Part 6: Materials, filler metals, welding processes, welding technological documents.

Continued page 2 to 17

Normenausschuß Schienenfahrzeuge (FSF) im DIN Deutsches Institut für Normung e. V.
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1 Area of Application

This standard states the instructions for materials, welding filler materials, welding procedures and welding technological planning documents for welding of metallic materials on rail vehicles and parts.

2 Normative Instructions

This standard contains through dated and undated instructions procedures from other publications. These normative instructions are cited in particular places in the text and the publications are given following the text. For dated instructions later alterations or re-working only belong to this publication of the standard in case they have been included by way of alteration or re-working. For undated instructions the last edition of the respective publications is valid.

DIN 1628 Welded circular tubes of non alloyed steels for special requirements; technical delivery conditions

DIN 1681 Cast steel for general use; technical delivery conditions

DIN 1725-2 Aluminium alloys; casting alloys; sand casting, chilled work, diecasting

DIN 1732-1 Filler metals for aluminium and aluminium alloys - composition, use and technical delivery conditions

DIN 1733-1 Filler metals for copper and copper alloys - composition, use and technical delivery conditions

DIN 1910-1 Welding - conceptions, details of procedures

DIN 5512-1 Materials for rail vehicles - Steel Part 1: Non alloyed and weatherproof structural steels, hot rolled; selection standard

DIN 5512-2 Materials for rail vehicles - Steel Part 2: Non alloyed steels for cold rolled flat products ≤ 3 mm thickness; selection standard

DIN 5512-3 Materials for rail vehicles - Steel Part 3: Flush products of stainless steel; selection standard

DIN 5513 Materials for rail vehicles - Aluminium and aluminium alloys

DIN 6700-1 Welding of rail vehicles and -parts - Part 1: basic concepts, basic rules

DIN 6700-2 Welding of rail vehicles and -parts - Part 2: Qualification of welding plants, quality assurance

E DIN 6700-3 Welding of rail vehicles and -parts - Part 3: Construction instructions

E DIN 6700-4 Welding of rail vehicles and -parts - Part 4: Manufacture rules

E DIN 6700-5 Welding of rail vehicles and -parts - Part 5: Quality requirements

DIN 17175 Seamless tubes of steel with high temperature strength; Technical delivery conditions

DIN 17182 Cast steel with improved weldability and ductility for general use

DIN 17445 Cast stainless steel; Technical delivery conditions

DIN EN 288-3 Requirements and acceptance of welding procedures for metallic materials - Part 3: Welding procedure tests for arc welding of steel; German version of EN 288-3: 1992

DIN EN 288-4 Requirements and acceptance of welding procedures for metallic materials - Part 4: Welding procedure tests for arc welding of aluminium and aluminium alloys; German version of EN 288-4: 1992

DIN EN 499 Filler metals - Covered electrodes for manual arc welding of non alloyed and fine-grained steel - Classification; German version of EN 499: 1994

DIN EN 573-3 Aluminium and aluminium alloys - Chemical composition and kind of semifinished products - Part 3: Chemical composition; German version of EN 573-3: 1994

DIN EN 757 Filler metals - Covered electrodes for manual arc welding of high strength steel - Classification; German version of EN 757: 1997

DIN EN 1561 Foundry practice; Lamellar graphite cast iron; German version of EN 1561: 1997

DIN EN 1562 Foundry practice; Malleable cast iron; German version of EN 1561: 1997

DIN EN 1563 Foundry practice; Nodular graphite cast iron; German version of EN 1561: 1997

DIN EN 1600 Filler metals - Covered electrodes for manual arc welding of stainless and heat-resisting steel - Classification; German version of EN 1600: 1997

DIN EN 10025 Hot rolled products of non alloyed structural steel - Technical delivery conditions (contains alterations A1: 1993), German version of EN 10025: 1990

DIN EN 10083 Tempering steel; Technical delivery conditions; German version of EN 10083: 1991

DIN EN 10088-2 Stainless steel - Part 2: Technical delivery conditions for steel metal and strip for general use; German version of EN 10088-2: 1995

DIN EN 10088-3 Stainless steel - Part 3: Technical delivery conditions for semifinished products, rods, wire rods and profile for general use; German version of EN 10088-3: 1995

DIN EN 10113-2 Hot rolled products of welding suitable fine-grained steel - Part 2: Technical delivery conditions for normalized/ normalized rolled steel; German version of EN 10113-2: 1993

DIN EN 10155 Weatherproof structural steel; Technical delivery conditions; German version of EN 10155: 1993

DIN EN 10130 Cold rolled flush products of soft steel for cold shaping - Technical delivery conditions; German version of EN 10130: 1991

DIN EN 10137-1 Plates and sheet bars of structural steel with elevated yield strength in quenched and tempered or precipitation-hardened condition - Part1: General delivery conditions; German version of EN 10137-1: 1995

DIN EN 10204 Metallic products; Kinds of test certificates; German version of EN 10204: 1995

DIN EN 22553 Welding and soldering seams - Symbol representation in drawings (ISO 2553: 1992); German version of EN 22553: 1994

DIN 24063 Welding, braze, solder and open joint brazing of metals - List of procedures and process numbers for drawing representation (ISO 4063: 1990); German version of EN 24063: 1992

DIN EN 29692 Manual arc welding, shielded metal arc welding and oxy-acetylene welding; Weld edge preparation for steel; German Version of EN 29692: 1996

E DIN EN 1652 Copper and copper alloys

E DIN EN 1653 Copper and copper alloys

E DIN EN 1654 Copper and copper alloys

DIN EN ISO 13920 Welding; General positional tolerances for welded constructions - Length and angular dimension, shape and position; German version of EN ISO 13920: 1996

E DIN EN ISO 9606-3 Approval testing of welders; Fusion welding; Part 3: Copper and copper alloys; German version of prEN ISO 9606-3: 1998

EURONORM 113 Weldable fine-grained steel - General quality instruction

3 Concepts

For this standard the concepts shown in DIN 6700-1 are valid.

4 Materials

4.1 General

The metallic materials are to be selected to the respective DIN EN standards and to this standard.

4.2 Materials with proven welding suitability

For welding construction in rail vehicle production only materials with proven welding suitability can be used. The welding suitability counts as proven, when the materials correspond to the material standards and are described in these as welding suitable, or are included in Appendix C.

Appendix C contains an informative list of materials with proven welding suitability for the validity area of this standard.

The materials are detailed corresponding to the material groups to DIN EN 288-3, DIN EN 288-4 respectively E DIN EN ISO 9606-3.

For a material without welding suitability the proof can be established by

- a) Welding procedure test to DIN EN 288-3 resp. DIN EN 288-4 or
- b) Suitability test of filler materials on the material.

4.3 Materials with highly stressed parts

For rail vehicles and -parts with high static or dynamic stress or high safety factor, these are parts of class C 1 and C 2 to DIN 6700-2 (e.g. bogies, base frames, vehicle body, universal joint shafts, tension and abutting equipment, brake cross beams, tension and pressure rod) only materials may be used, which have been established respectively agreed, for which the bearable tensions for the dynamic stress for the material and the welding joint are at disposal.

4.4 Material certificates

For the supply of metallic materials, the required material certificates to DIN EN 10204 have to be agreed by contract. For parts of classes C 1 and C 2 to DIN 6700-2 a certificate 3.1.B to DIN EN 10204 is required. Deviations from this requirement, and the kind of material certification for all other parts are to be agreed by contract.

5 Filler metals for welding

5.1 Qualification of filler metals

For filler metals (except shielding gases), which are used for applications to DIN 6700, the compliance to the relevant standards (DIN or DIN EN standards) or technical rules (e.g. Technische Lieferbedingungen der DB AG - Technical Terms of Delivery of the DB AG) is to be proven. The proof of compliance shall be given by the certificate of a certification authority (e.g. DB AG) according to Appendix A.1.

Basis of the certification are

- a) an initial qualification test (type examination to module B according to the official journal of the EC 93/465/EEG dated 22.07.1993) by an authorized inspection authority and
- b) an external surveillance at the manufacturer by an authorized surveillance authority. As a proof of the stable quality the external surveillance shall be performed at least annually by the surveillance authority, and is documented towards the certification authority by a surveillance report.

As proof of conformity the delivery shall be labelled by the supplier (manufacturer) according to Appendix A.2.

5.2 Selection of filler metals

5.2.1 For parts of steels (except stainless steels) the decisive criteria are the minimum requirements for the all weld metal. The codes for the minimum requirements are given in the respective DIN- or DIN EN standards for filler metals. The minimum requirements for the all weld metal for selected steels used in the manufacture of rail vehicle are given in table A.1.

5.2.2 For welding joints of different steel sorts the minimum requirement for the steel sort of lower grade is decisive for the all weld metal. The metallurgical characteristics and welding conditions for the higher graded steel sort must however be taken into account (e.g. special filler metals for high strength steel, pre-heating temperature).

5.2.3 For the welding of stainless steel with each other and with other steel the filler metals of the respective DIN- or DIN EN- standards have to be selected. The table A.2 contains a classification of filler metals to DIN EN 1600 for selected steels in the manufacture of rail vehicles.

5.2.4 For the welding of aluminium and aluminium alloys the filler metals for arc welding under inert shielding gas are admissible (e.g. welding processes 141 and 131). The tables A.3 and A.4 contain a classification of filler metals to DIN 1732-1 for selected aluminium alloys in the manufacture of rail vehicles.

5.2.5 For welding of copper and copper alloys the filler metals to DIN 1733 are to be selected preferably.

6 Welding processes

For welding work on rail vehicles only welding processes may be used which

- a) are given in detail in Appendix B and
- b) are qualified for the welding plant to DIN 6700-2.

For the approval of processes not mentioned in Appendix B welding procedure tests to DIN EN 288-3 respectively DIN EN 288-4 are required.

7 Drawings and welding technological planning documents

For all welding constructions, drawings with parts lists have to be produced. The classification of welded parts to table 1 of DIN 6700-2 has to be given. Additionally to the constructive instructions (amongst other accuracy to E DIN 6700-3) the following welding technology statements must be available.

7.1 Welding technological required statements in the drawings

The weld joints must bear the following statements in the drawing:

7.1.1 Fusion welding joints:

- Weld edge preparation (seam form) to E DIN 6700-3 and DIN EN 29692,
- Dimension (e.g. thickness of seam, seam symbol, length of seam) to DIN EN 22553.
- Welding quality class to E DIN 6700-5.

7.1.2 Resistance welding joints:

- Dimension (e.g. diameter, seam symbol, number of spots, spot distance resp. seam length) to DIN EN 22553.
- Welding quality class to E DIN 6700-5.
- Surface quality class to E DIN 6700-5.

7.2 Supplementary statements

If special requirements are put to individual welding seams these must be specified in the drawing.

This could be

- specially stated welding processes,
- special test instructions (e.g. test plan, test protocol, position of welder control stamp),
- special working instructions (e.g. heat treatment, machining, notch free grinding),
- degree of accuracy to DIN EN 13920.

The supplementary instruction can be given in the seam symbol, in the **fork with relevant sign** or additionally in the drawing.

7.3 Welding technological required statements in the parts lists

As far as it is not stated in the drawing, the following instructions are necessary in the parts lists for individual welding joints:

7.3.1 Fusion weld joints

- Dimension (e.g. seam sort, seam thickness, entire seam length),
- Weld seam quality group to E DIN 6700-5,
- Base material and instructions for filler metals to para. 5,
- If necessary, instructions for the welding process.

7.3.2 Resistance weld joints

- Base material
- Seam sort (e.g. spot seam, roller seam joint) with dimension (e.g. diameter respectively width, number respectively length),
- Weld seam quality class to E DIN 6700-5.

7.4 Welding technological documents for planning

7.4.1 General

When manufacturing from new, at reconstruction and if necessary at the maintenance of rail vehicles, the manufacturer has to provide welding technological documents for parts of high stress with high or normal safety requirements with the co-operation of the recognized welding supervisor to DIN 6700-1 grade 1. The kind and extent of the documents and the point of time of their submission respectively inspection are to be agreed between manufacturer and client.

For the manufacture of rail vehicles the following is required:

7.4.2 Welding plans for manufacture groups

- Bogies (base groups, assembly),
- Base frames (with base groups),
- **Construction / build up** (side wall, front wall, roof),
- Further parts with enhanced requirements for safety and function (e.g. universal joist shafts, brake cross beams, engine housing, hollow shaft drive, tension rod steering, fulcrum pin brace).

7.4.3 Other welding technological planning documents

In case it is required in the order, welding sequence plans, tacking and test plans could become necessary.

Therefore welding sequence plans could be required for:

- bogies (rocker, cross girders including fulcrum pin fitting, length joist, head piece, fulcrum pin brace, tension steering, assembly of length joist, cross girder and head piece).
- base frames (including cross girder, length joist, head joist, fulcrum pin brace, tension rod steering).

For that also standardized welding plans (valid for different rail vehicle manufacture) are admissible.

DB - Kennblatt für Schweißzusätze und Schweißhilfsstoffe im Schienenfahrzeugbau nach DIN 6700-6 <i>DB-Certificate for Filler Metals and Auxiliary Welding Materials</i> <i>used for Rail Vehicles to DIN 6700-6</i>	
Hersteller / Manufacturer of Filler Metal:	
Schweißzusatz / Filler Metal: Markenbezeichnung / Trade Name: Normbezeichnung / Classification to Standard:	DB - Kennblatt - Nr. / DB Certificate No.: Geltungsdauer / Valid until:
Geltungsbereich aufgrund der nach TL 918 490 durchgeführten Eignungsprüfung / Area of validity, based on the approval tests acc. to TL 918 490: Werkstoffe / Base metals: Schweißverfahren / Welding Process: Schutzgase / Shielding Gases: Schweißpositionen / Welding Positions: Stromart und Polung / Current and Polarity: Durchmesserbereich / Diameter Range: Bemerkungen, Schweißbedingungen / Remarks, Welding Conditions:	
..... (Ort, Datum) (Location, Date)	 (Zertifizierungsstelle) (Certification Authority)

A.2: Labelling of Filler Metals and of Auxiliary Welding Materials

On the smallest package unit (label) of the filler metals and of auxiliary welding materials following designations shall be printed:

- company (manufacturer, supplier),
- trade name,
- standard and classification,
- size of filler metal (diameter, length, grain size),
- weight or number of rods,
- heat no. or production lot no.,
- Ü-mark (Ü-Zeichen) and certificate no. of the certification authority

The Ü-mark shall consist of the capital letter "Ü" and shall contain following informations:

- company name and manufacturing site. The manufacturing site is given by a code number. The code number is issued by the certification authority. It consists of a three-digit number for the company and a two-digit sequential number for the manufacturing site. Only the certification authority and the surveillance authority are informed about the manufacturing site belonging to the code number.
- short name of the standard
- signet of the certification authority.

The figure below shows the example of an Ü-mark of company "Firma Muster", followed by the code number, for a covered electrode according to DIN EN 499, with the signet of the certification authority Deutsche Bahn AG, Minden.

The size of the Ü-mark is not fixed, the informations within the Ü-mark must be legible.

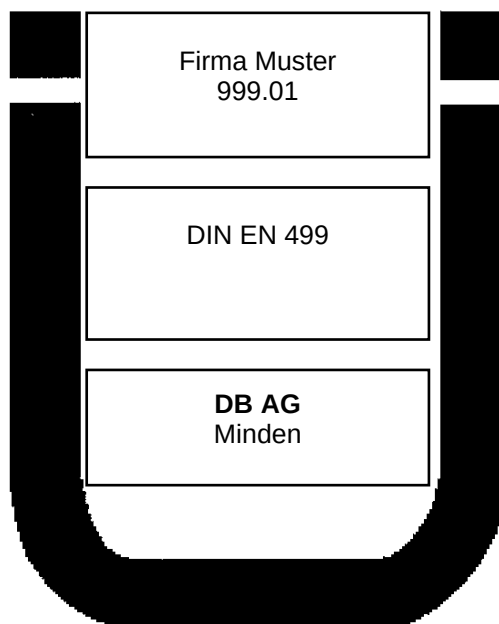


Figure A.1: Ü-mark

Table A.1: Classification of minimum requirements of all weld metal to DIN EN 499 respectively DIN EN 757 for selected steels (except stainless steels)

Base materials ¹⁾	Minimum requirements for all weld metal ^{1) 2)}
S235J DIN EN 10 025 (St 37 DIN 17 100, St 1203 DIN 1623)	35A DIN EN 499 (4320 DIN 1913)
S355J2G3 DIN EN 10 025 (St 52 DIN 17 100)	350 (35A) ³⁾ DIN EN 499 (4330 (43 20) ³⁾ DIN 1913)
E295 to E360 DIN EN 10 025 (St 50, St 60, St 70 DIN 17 100) ⁴⁾	420 DIN EN 499 (5130 DIN 1913)
S275N to S 355N DIN EN 10 113 (StE 255-StE 355 DIN 17 102)	350 (35A) ³⁾ DIN EN 499 (4332 (4322) ³⁾ DIN 1913)
S380N DIN EN 10 113 (StE 380 DIN 17 102)	380 DIN EN 499 (Y 3832 DIN 8529)
S420N DIN EN 10 113 (StE 420 DIN 17 102)	420 DIN EN 499 (Y 4232 DIN 8529)
S460N DIN EN 10 113, S460Q DIN EN 10 137 (StE 460 DIN 17 102)	460 DIN EN 499 (Y 4632 DIN 8529)
S500Q DIN EN 10 137 (StE 500 DIN 17 102)	500 DIN EN 499 (Y 5032 DIN 8529)
S550Q DIN EN 10 137 (FeE 550 Euronorm 113)	550 DIN EN 757 (Y 5542 DIN 8529)
S620Q DIN EN 10 137 (FeE 620 Euronorm 113)	620 DIN EN 757 (Y 6242 DIN 8529)
S690Q DIN EN 10 137 (FeE 690 Euronorm 113)	690 DIN EN 757 (Y 6942 DIN 8529)
1) In parenthesis material designations and codes to DIN-standards formerly valid are given. 2) Besides the named DIN EN-standards for rod electrodes all other DIN EN-standards for filler metals are valid depending on the welding processes. 3) By use of rod electrodes class 3 (R3, R(C)3) to DIN 1913; only to be applied for root and thin metal welding (metal thickness ≤ 3 mm) in butt weld seams. 4) For these base metals basic filler metals are to be preferred.	

Table A.2: Classification of filler metals to DIN EN 1600 for selected stainless steel to DIN 5512-3 respectively DIN EN 10088

Base metal B	Base metal A				
	1.4301 (X5CrNi1810 DIN 5512-3) (X4CrNi18-10 DIN EN 10088)	1.4401 (X5CrNiMo 17122 DIN 5512-3) (X4CrNiMo 17-12-2 DIN EN 10088)	1.4541 (X6CrNiTi1810 DIN 5512-3) (X6CrNiTi18-10 DIN EN 10088)	1.4571(X6CrNi MoTi17122 DIN 5512-3) (X6CrNiMoTi 17-12-2 DIN EN 10088)	1.4003 (X2Cr11 DIN 5512-3) (X2CrNi12 DIN EN 10088) 1.4512 (X6CrTi12 DIN 5512-3) (X2CrTi12 DIN EN 10088) 1.4589 (X5CrNiMoTi152 DIN 5512-3)
non- and low alloyed steel	1.4370 (X15CrNiMn188) 18 8 Mn (1.4370) DIN EN 1600				
1.4003 (X2Cr11DIN 5512-3) (X2CrNi12 DIN 10088) 1.4512 (X6CrTi12 DIN 5512-3) (X2CrTi12 DIN EN 10088) 1.4589 (X5CrNiMoTi152 DIN 5512-3)	1.4316 (X2CrNi199) ¹⁾ 19 9 (1.4316) DIN EN 1600				
1.4571 (X6CrNiMoTi17122 DIN 5512-3) (X6CrNiMoTi 17-12-2 DIN EN 10088)	1.4576 (X5CrNiMoNb1912) 19 12 3 Nb (1.4576) DIN EN 1600				
1.4541 (X6CrNiTi1810 DIN 5512-3) (X6CrNiTi18-10 DIN EN 10088)	1.4551 (X5CrNiNb199) 19 9 Nb (1.4551) DIN EN 1600				
1.4401 (X5CrNiMo17122 DIN 5512-3) (X4CrNiMo17-12-2 DIN EN 10088)	1.4430 (X2CrNiMo1912) 19 12 (1.4430) DIN EN 1600				
1.4301 (X5CrNi1810 DIN 5512-3) (X4CrNi18-10 DIN EN 10088) 1.4318 (X2CrNiN187 DIN 5512-3) (X2CrNiN18-7 DIN EN 10088)	1.4316 (X2CrNi199) 19 9 (1.4316) DIN EN 1600				
1) for 1.4003 and 1.4589 alternatively: 1.4370					

Alternatively to determinations in the drawings and part lists referring to table A.2 other filler metals can be used if their suitability is approved for the respective base material (see also notes in the respective DIN- and DIN EN-standards).

Table A.3: Classification of filler metals to DIN 1732-1 for selected aluminium and aluminium alloys to DIN 5513

Base material B to DIN 5513	Base material A to DIN 5513						
	AlSi- and AlSiMg-casting alloy with Si ≤ 7 %	AlSi- and AlSiMg-casting alloy with Si > 7 %	Al99,8 Al99,5	AlMg2Mn0,8 AlMg3 AlMg5	AlMg4,5Mn	AlMgSi0,5Mn AlMgSi0,5 AlMgSi0,7 AlMgSi1	AlZn4,5Mg1
	AlZn4,5Mg1	SG-AlSi5	SG-AlSi5	SG-AlMg5 SG-AlMg4,5Mn ¹⁾	SG-AlMg5 SG-AlMg4,5Mn ¹⁾	SG-AlMg5 SG-AlMg4,5Mn ¹⁾	SG-AlMg5 SG-AlMg4,5Mn ¹⁾
	AlMgSi0,5Mn AlMgSi0,5 AlMgSi0,7 AlMgSi1			SG-AlMg5 SG-AlMg4,5Mn ¹⁾ SG-AlSi5 ^{2) 3)}		SG-AlMg5 SG-AlMg4,5Mn ¹⁾ SG-AlSi5 ^{2) 3)}	
	AlMg4,5Mn			SG-AlMg5 SG-AlMg4,5Mn ¹⁾	SG- AlMg4,5Mn ¹⁾		
	AlMg2Mn0,8 AlMg3 AlMg5						
	Al99,8 Al99,5			SG-Al99,5Ti			
	AlSi- and AlSiMg-casting alloy with Si > 7 %	SG-AlSi5 ³⁾ SG-AlSi12 ³⁾	SG-AlSi5 ³⁾ SG-AlSi12 ³⁾				
AlSi- and AlSiMg-casting alloy with Si ≤ 7 %	SG-AlSi5 ³⁾						
1) Alternatively: SG - AlMg4,5MnZr. 2) SG-AlSi5 will only be used for the repair of parts which have already been welded at the new manufacture with that component. The use of it for the application at a new manufacture has to be agreed between customer and manufacturer. 3) For parts which will not be painted the different colour of the weld seam must to be taken into consideration.							

Table A.4: Classification of filler metals to DIN 1732-1 for selected aluminium and aluminium alloys to DIN EN 573-3

Base material B to DIN EN 573	Base material A to DIN EN 573						
	AlCu- casting alloy with Cu > 2 %	AlSi- and AlSiMg- casting alloy with Si > 5 %	AW-Al 99,0 (AW-1200); AW-Al 99,5 (AW-1050A); AW-Al 99,8(A) (AW-1080A); AW-Al 99,98 (AW- 1098)	AW-AlMg3 (AW-5754); AW-AlMg2Mn0,8 (AW-5049); AW-AlMg2,5 (AW-5052) AW-AlMg5 (AW-5019)	AW-Mg4,5Mn0,7 (AW-5083)	AW-AlMgSi (AW-6060); AW-AlSiMg(A) (AW-6005A); AW-AlSi1Mg (AW-6082);	AW-AlZn4,5Mg1 (AW-7020)
AW-AlZn4,5Mg1 (AW-7020)			R-AlMg5Mn (R5556A) R-AlMg4,5Mn 0,7(A) (R5183) R-AlMg4,5MnZr (R5087)	R-AlMg5Mn (R5556A) R-AlMg4,5Mn 0,7(A) (R5183) R-AlMg4,5MnZr (R5087)	R-AlMg5Mn (R5556A) R-AlMg4,5Mn 0,7(A) (R5183) R-AlMg4,5MnZr (R5087)	R-AlMg5Mn (R5556A) R-AlMg4,5Mn 0,7(A) (R5183) R-AlMg4,5MnZr (R5087)	R-AlMg5Mn (R5556A) R-AlMg4,5Mn 0,7(A) (R5183) R-AlMg4,5MnZr (R5087)
AW-AlMgSi (AW-6060); AW-AlSiMg(A) (AW-6005A); AW-AlSi1Mg (AW-6082)			R-AlMg5Mn (R5556A) R-AlMg4,5Mn 0,7(A) (R5183) R-AlMg4,5MnZr (R5087) R-AlSi5(A) (R4043A)			R-AlMg5Mn (R5556A) R-AlMg4,5Mn 0,7(A) (R5183) R-AlMg4,5MnZr (R5087) R-AlSi5(A) (R4043A)	
AW-Mg4,5Mn0,7 (AW-5083)	R-AlSi5(A) (R4043A)	R-AlSi5(A) (R4043A)	R-AlMg5Mn (R5556A) R-AlMg4,5Mn 0,7(A) (R5183)		R-AlMg4,5Mn 0,7(A) (R5183) R-AlMg4,5MnZr (R5087)		
AW-AlMg3 (AW-5754); AW-AlMg2Mn0,8 (AW-5049); AW-AlMg2,5 (AW-5052) AW-AlMg5 (AW-5019)			R-AlMg4,5MnZr (R5087)				
AW-Al 99,0 (AW-1200); AW-Al 99,5 (AW-1050A); AW-Al99,8(A) (AW-1080A); AW-Al 99,98 (AW- 1098)			R-Al99,5Ti (R1450)				
AlSi- and AlSiMg- casting alloys with Si > 5 %	R-AlSi5(A) ¹⁾ (R4043A) R-AlSi12 ²⁾ (R4047A)	R-AlSi5(A) ¹⁾ (R4043A) R-AlSi12 ²⁾ (R4047A)					
AlCu-casting alloys with Cu > 2 %	R-AlSi5(A) ¹⁾ (R4043A)						

1) R-AlSi5 will only be used for the repair of parts which have already been welded at the new manufacture with that component. The use of it for the application at a new manufacture has to be agreed between customer and manufacturer.

1) For parts which will not be painted the different colour of the weld seam must to be taken into consideration.

Appendix B (normative)

Welding procedures released for application

Table B.1:

Description	Short identification to DIN EN 24063	Short identification to DIN 1910	Released for	
			Steel	Al and Al-Alloys
Oxy-acetylene welding	311	G	X	
Manual arc welding	111	E	X	
Active-gas metal-arc welding - with solid wire - with flux cored wire	135 136	MAG (MAGM, MAGC)	X	
Inert-gas metal-arc welding - with solid wire - with flux cored wire	131 137	MIG	X	X (131 only)
Tungsten inert-gas welding	141	WIG	X	X
Metal-arc welding with flux cored wire without shielding gas	114	MF	X	
Active-gas metal-arc spot welding	(135)	MSG-fusion spot welding	X	
Plasma arc welding	15	WPL	X	X
Elektro gas welding	73	MSGG	X	
Submerged arc welding	12	UP	X	
Gravity welding	112	SK	X	
Resistance spot welding	21	RP	X 1) 2)	X 1)
Roller seam welding	22	RR	X	X
Projection welding	23	RB	X	X
Foil butt seam welding	225	RFS	X	
Flash-butt welding	24	RA	X	X
Friction welding	42	FR	X	X
Stud welding with – stroke ignition – point ignition – coil ignition	78	BH BS BR	X	X
High frequency welding	./.	HF	X	X
Laser beam welding	751	LA	X	X
Electron-beam welding	76	EB	X	X
1) Double spot welding electrodes which work simultaneously at the same time need special authorization of the customer and of the recognized authority. 2) The combination of S355J2G3 DIN EN 10 025 with steel of group 8 to appendix C (1.4003), (1.4512), (1.4589) has to be avoided (risk of increased hardness).				

Appendix C (informative)

Materials with proven welding suitability

Table C.1: Group assignment to DIN EN 288-3 - Steel

Group assignment to DIN EN 288-3 No.:	Description:	Designation to	
		DIN - Standards	DIN EN - Standards
1.1	C-Mn-steel with $Re \leq 355 \text{ N/mm}^2$ within the analysis limits: C $\leq 0,24 \%$, Si $\leq 0,55 \%$ Mn $\leq 1,6 \%$, Mo $\leq 0,65 \%$ P $\leq 0,045\%$, S $\leq 0,045\%$ others altogether $\leq 0,8 \%$ others individually $\leq 0,3 \%$	St 37-2 to St 52-3 DIN 17 100; StE 255 to StE 355 DIN 17 102; St 12 to St 14 DIN 1623-1; St 37.4 to St 52.4 DIN 1628; GS 38 to GS 52 DIN 1681; GS16 Mn5, GS20Mn5 DIN 17 182; HI to 15 Mo 3 DIN 17 155; St 35.8 to 19 Mn 5 DIN 17 175; C 22 DIN 17 200	S235JR to S355J2G3 DIN EN 10025; S275N to S355N DIN EN 10113; DC01 to DC04 DIN EN 10130; C22 DIN EN 10 083; P235GH to 16Mo3 DIN EN 10028
1.2	C-Mn-steel with $Re \leq 355 \text{ N/mm}^2$ within the analysis limits:: C $> 0,24 \%$, Si $\leq 0,55 \%$ Mn $\leq 1,6 \%$, Mo $\leq 0,65 \%$ P $\leq 0,045\%$, S $\leq 0,045\%$ others altogether $\leq 0,8 \%$ others individually $\leq 0,3 \%$	St 50 to St 70 DIN 17 100; C25 to C 60 DIN 17 200 WTSt 37-2 to WTSt 52-3 to SEW 087	E295 to E360 DIN EN 10025; C25 to C60 DIN EN 10083 S235JOW to S355J2G1W DIN EN 10155
1.3	Mn - high-carbon steel / group 1	./.	X120Mn12
1.4	Cast iron	GG 10 - GG 35 DIN 1691 GTW-35-04 to GTW-45-07 DIN 1692 GTS-35-10 to GTS-70-02 DIN 1692 GGG 40 - GGG 70 DIN 1693	GJL-100 to GJL-500 DIN EN 1561 GJMW-350-4 to GJMW-450-7 DIN EN 1562 GJMB-350-10 to GJMB-800-1 DIN EN 1562 GJS-400-15U to GJS-700-2U DIN EN 1563
2	Fine-grained steel with $Re > 355 \text{ N/mm}^2$ to $Re \leq 500 \text{ N/mm}^2$	StE 380 to StE 460 DIN 17 102; FeE 500 V Euronorm 113	S420N to S460N DIN EN 10113; S460Q to S500Q DIN EN 10137
3	Quenched and tempered fine-grained steel with $Re > 500 \text{ N/mm}^2$	FeE550V to FeE690V Euronorm 113	S550Q to S690Q DIN EN 10137

(continued)

Table C.1: Group assignment to DIN EN 288-3 - Steel (concluded)

Group assignment to DIN EN 288-3 No.:	Description:	Designation to	
		DIN - Standards	DIN EN - Standards
4	Steel with $\text{Cr} \leq 0,6 \%$, $\text{Mo} \leq 0,5\%$, $\text{V} \leq 0,25\%$	./.	./.
5	Steel with $\text{Cr} \leq 9 \%$, $\text{Mo} \leq 1,2\%$	e.g. 13 CrMo 44 DIN 17 155	e.g. 14CrMo4-5 DIN EN 10028
6	Steel with $\text{Cr} \leq 12 \%$, $\text{Mo} \leq 1\%$, $\text{V} \leq 0,5\%$	X-20 CrMoV 121 DIN 17 175; GS-17 CrMo 55 DIN 17 245	./.
7	Steel with $\text{Ni} \leq 9 \%$	./.	./.
8	Ferritic or martensitic stainless steel with $\text{Cr} = 12 \% - 20 \%$	X 6 CrTi 12 (1.4512); X 2 Cr 11 (1.4003); X 5 CrNiMoTi 15 2 (1.4589) DIN 5512-3	X2CrTi12 (1.4512); X2CrNi12 (1.4003) DIN EN 10088
9	Austenitic stainless steel as well as the corresponding steel casting sorts	X 5 CrNi 18 10 (1.4301); X 6 CrNiTi 18 10 (1.4541); X 5 CrNiMo 17 12 2 (1.4401); X 6 CrNiMoTi 17 12 2 (1.4571) DIN 5512-3 and the corresponding steel casting sorts to DIN 17 445	X5CrNi18-7 (1.4301); X6CrNiTi18-10 (1.4541); X5CrNiMo17-12-2 (1.4401); X6CrNiMoTi17-12-2 (1.4571) DIN EN 10088 and the corresponding steel casting sorts

Table C.2: Classification to DIN EN 288-4 - Aluminium and Aluminium alloys

Groups to DIN EN 288-4 No.:	Description:	Designation to	
		DIN 1725-1 (wrought alloys) DIN 1725-2 (casting alloys)	DIN EN 573
21	Pure aluminium with $\leq 1\%$ impurities or alloying constituent	Al99,98 Al99,8 Al99,5 Al99	EN AW-Al 99,98 (EN AW- 1098) EN AW-Al 99,8(A) (EN AW-1080A) EN AW-Al 99,5 (EN AW-1050A) EN AW-Al 99,0 (EN AW-1200)
22.3	Non-precipitation hardening AlMg-Alloys with $1,5\% < \text{Mg} \leq 3,5\%$	AlMg2,7 AlMg2Mn0,8 AlMg3	EN AW-AlMg2Mn0,8 (EN AW-5049) EN AW-AlMg2,5 (EN AW-5052) EN AW-AlMg3 (EN AW-5754)
22.4	Non-precipitation hardening AlMg-Alloys with $\text{Mg} > 3,5\%$	AlMg4,5Mn AlMg5	EN AW-Mg4,5Mn0,7 (EN AW-5083) EN AW-AlMg5 (EN AW-5019)
23.1	Precipitation hardening AlMgSi- Alloys	AlMgSi0,5 AlMgSi0,5Mn AlMgSi0,7 AlMgSi1	EN AW-AlMgSi (EN AW-6060); EN AW-AlSiMg(A) (EN AW-6005A); EN AW-AlSi1MgMn (EN AW-6082);
23.2	Precipitation hardening AlZnMg-Alloys	AlZn4,5Mg1	EN AW-AlZn4,5Mg1 (EN AW-7020)
24.1	Non-precipitation hardening AlSi-casting alloys with $\text{Cu} \leq 1\%$ and $5\% < \text{Si} \leq 15\%$	G-, GK-AlSi12	EN AC-AlSi12 (EN AC-44200)
24.2	Precipitation hardening AlSiMg-casting alloys with $\text{Cu} \leq 1\%$, $5\% < \text{Si} \leq 15\%$ and $0,01\% < \text{Mg} \leq 0,80\%$	G-, GK-AlSi7Mg wa G-, GK-AlSi9Mg wa G-, GK-AlSi10Mg wa	EN AC-AlSi7Mg (EN AC-42000) EN AC-AlSi9Mg (EN AC-43300) EN AC-AlSi10Mg (EN AC-43400)
26	Precipitation hardening AlCu-casting alloys with $2\% < \text{Cu} \leq 6\%$	G-, GK-AlCu4Ti wa	EN AC-AlCu4Ti (EN AC-21100)

Table C.3: Classification to E DIN EN ISO 9606-3 - Copper and Copper Alloys

Groups to E DIN EN ISO 9606-3 No.:	Description	Designation to E DIN EN 1652, E DIN EN 1653, E DIN EN 1654
31	Pure copper	Cu-ETP (CW004A) Cu-FRTP (CW006A) Cu-OF (CW008A) Cu-DLP (CW023A) Cu-DHP (CW024A)
32	Copper-zinc alloys	CuZn5 (CW500L) to CuZn40 (CW509L) CuZn20Al2As (CW702R) CuZn23Al2Co (CW703R) CuZn38AlFeNiPbSn (CW715R) CuZn38Sn1As (CW717R) CuZn39Sn1 (CW719R)
33	Copper-tin alloys	CuSn4 (CW450K) to CuSn8 (CW453K) CuSn3Zn9 (CW454K)
34	Copper-nickel alloys	CuNi25 (CW350H) CuNi9Sn2 (CW351H) CuNi10Fe1Mn (CW352H) CuNi30Mn1Fe (CW354H)
35	Copper-aluminium alloys	CuAl8Fe3 (CW303G) CuAl9Ni3Fe2 (CW304G) CuAl10Ni5Fe4 (CW307G)
36	Copper-nickel-zinc alloys	CuNi10Zn27 (CW401J) to CuNi18Zn27 (CW410J)

Appendix D (informative)

Literature

DVS 1610

General guidelines for planning of welding technological manufacture in rail vehicle construction ¹⁾

FSF-Zeichnungsrichtlinie (-Guideline for drawings)

Preparation of drawings and mikrofilming for rail vehicles ²⁾

TL 918 490

Technical delivery conditions; Requirements for filler metals used for weld joints and weld cladding of metallic materials at railway construction ³⁾

¹⁾ obtainable through: DVS - Verlag GmbH, Postfach 10 19 65, D-40010 Düsseldorf

²⁾ obtainable through: TGB - Technisches Gemeinschaftsbüro GmbH, Panoramaweg 1, D-34131 Kassel

³⁾ obtainable through: DB AG, AHS, Druck und Logistik, Stuttgarter Straße 61a, D-76137 Karlsruhe