

**Welding of railway vehicles and
components
-Part 4- execution regulations**

6700-4

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Welding of railway vehicles and components – Part 4: Rules of execution (carry out) regulations
Soudage des véhicules ferroviaires et des pièces – Partie 4: Règles d'exécution

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Introduction

This standard is developed by the standard committee rail vehicles (FSF).

Welding is an important process for the manufacture of rail vehicles and -parts. In this norm series the required regulation for the special process of "welding" are laid down. Basis of this regulations are the basic welding technological norms with consideration for the particular requirement on rail vehicles.

- Part 1 Basic conceptions and basic rules
- Part 2 Requirements for the qualification of the welding plant.
- Part 3 Design requirements
- Part 5 Quality requirements
- Part 6 Material, filler metal, welding process, welding documents

1 Area of application

This norm defines the rules of execution for welding of metallic materials for the manufacture and maintenance of rail vehicles and parts except pressure containers.

2 Normative instructions

This norm contains commitments through dated or undated instructions from other publications. These normative instructions are cited in the relative places in the text and the publications are quoted afterwards. With dated instructions later modification or reworking of this norm belong to it only if they have been included through modification or reworking. With undated instructions the last edition of the relevant publication is valid..

- DIN 6700-1 Welding of railway vehicles and components, Part 1: Basic terms, basic rules
- DIN 6700-2 Welding of railway vehicles and components, Part 2: Qualification of manufacturer of welded rolling stock materials – Quality assurance
- DIN 6700-3 Welding of railway vehicles and components, Part 3: Design rules
- DIN 6700-4 Welding of railway vehicles and components, Part 4: Rules of execution (execution regulations)
- DIN 6700-5 Welding of railway vehicles and components, Part 5: Quality requirements
- DIN 6700-6 Welding of railway vehicles and components, Part 6: Qualification of manufacturer of welded rolling stock materials – Materials, filler materials, welding processes
- DIN EN 287-1 Approval testing of welders – Fusion welding – Part 1: Steels (it contains changing A1:1997); German edition EN 287-1:1992+A1:1997.
- DIN EN 287-2 Approval testing of welders - Part 2: Aluminium and Aluminium alloys (it contains changing A1:1997); German edition EN 287-2:1992+A1:1997.
- DIN EN 288-2 Specification and approval of welding procedures for metallic materials
Part 2: Welding procedure specification for arc welding (it contains changing A1:1997); German edition EN 288-2:1992+A1:1997.
- DIN EN 288-8 Specification and approval of welding procedures for metallic materials
Part 8: Approval by a pre-production welding test
- DIN EN 1418 Welding personnel – Approval testing of welding operators for fusion welding and resistance weld setters for fully mechanised and automatic welding of metallic materials; German edition EN 1418:1997.

3 Concepts

For the use of this standard the concepts quoted in DIN 6700-1 are valid.

4 General rules of execution

4.1 The welding seam preparation must be carried out according to the drawing or for other works documents.

If for dynamic loaded parts the cut or the weld preparation is made by autogenous or plasma cutting, the surface quality must have quality I according to DIN EN ISO 9013.

4.2 The surfaces of the welding area must be free of damp or dirt like rust, scale, slag, oil or paintbits. When welding in several positions the surface of the previous position has to be arranged in such a way, that the faultless welding of the next position (layer) is possible. Dirt, Slag, notches etc. must be removed.

4.3 According to the type of filler metals the filler metal must undergo a re-drying process according to instructions by manufacturer prior to welding. Only suitable tested fillers must be used, see part 5.1 of DIN 6700-6. The instructions by manufacturer shall be considered for the preparation of the pWPS according to DIN EN 288-2.

4.4 The welding joints must be visible and accessible to the welder, see part 4.2 for DIN 6700 - 3.

4.5 The welders shall have valid test according to DIN EN 287 ff. for the welding process, the weld type, the material, the dimension (sheet thickness) and the welding position, in whose the welder should weld. Irregularities shall be notified to the welding coordinator before welding, e.g. improper and dirty weld preparation, incorrect or unsuitable filler metal or welding machines.

4.6 One must strive to weld in normal position (PA- or PB). In a predicamentary welding situation for instance in assembly or repair, suitable measures will have to be taken (for instance fillers and welding procedure) the welders must be used according to their qualification.

4.7 When welding outside (in the open) the welding places must be protected from the weather influences.

4.8 To protect overlap joints and other areas no longer accessible from corrosion on must add sealings admittable by the customer prior to welding, this should be started in drawings or other work documents.

4.9 The recirculation of the welding current (workpiece clamp) has to be fitted immediately by the welding place in such a way that a faultless electrical contact exists with minimal resistance and full cable connection.

When welding rail vehicles the workpiece clamp must be fitted at the vehicle near the welding place. Because of danger to stores through current penetration the fitting of workpiece clamps to rail is not allowed. The vehicles electronic as well as the batteries must be unclamped prior to start of welding.

4.10 If parts have to be moved prior to completion of welding (turned or transported) then they must be able stand up (resist) these stresses without plastic deformation.

4.11 If it states in the drawing that the roof position must be welded by welded through counterwelds (▽), then slag's and faulty places must be removed prior to the welding of the counterposition (backingposition). The same also goes for seams welded on booth sides with full cross-section cut (for instance DV-DHV-seams) see EDIN 6700-5 table 3. If backwelding is not to be applied for not complete crosssection connection (for instance HY-Y seams) for reasons of corrosion, a preparation prior to welding of backposition is not required.

4.12 With seams of fullcross section connection a faultless welding through must be activated by welding from one side by qualified welders and suitable means (welding procedure, filler metal, preparation of seams, width of gap, weld pool support) see 7.1.1.

4.13 Manufacturing coating (FB) may only be welded over when it has the agreement of the customer.

4.14 If necessary the temperature of the welding area must be determined dependend on the material and part to be welded. When taking the prewarming temperature must also be adhered to. Preheat intermediate position temperatures must be kept with their limits during welding and must be controlled. When the workpiece temperature is below 5°C a pre-heating is necessary. Thereby the whole welding area (4x sheet thickness max 100 mm, both side next to seam) must be heated to the relevant pre-heat temperature prior welding, see 5.1.2 and 5.4.4.

4.15 Welding seam sequence, -seam build up and direction must be chosen in such a way that:

- one can weld tension and distortion free,
- the welding seam quality is obtained,
- the required mechanical-technological quality is reached.

If the welding technical documents contain instruction for welding sequence these must be followed (see chapter 7 of DIN 6700-6).

4.16 If tacking places become wholly or partly a part of the welded joint, then the same requirement apply to them as to the joint as far as the choice of fillers and the qualification of the welders is concerned. Tacking places, that do not become part of the welding joint have to be carried out in such a way respectively, that they can be completely melted away, at the finishing process of the welding

seam (for instance by appropriate welding procedure, welding of a backposition with previous preparation including tacking place). Only crackfree tack welds can be overwelded.

Outside of the welding area tack welds are only allowed without removing (e.g. remaining weld pool support or assembly auxiliaries), if they are been planned by the designer.

4.17 Ignition places and grind notches on the workpiece surface are not admissible. If grind notches occur they shall removed in a bleeding way. If ignition places occur they shall be removed and checked to be crackfree. If rated wall thickness is over 5 % weakened, ground of ignition places will have to be rewelded, smoothed out and checked for cracks.

4.18 The use of the anti-tacking means for better removal of welding spatter on surface, which receive after welding a coat of paint is only permissible, if the user has furnished proof of sufficient painttacking and welding seam quality with the Anti-tacking media that has been used.

4.19 Welding bath fuses may only stay on the part, if they are shown in the drawings see E DIN 6700-5, Table 3

4.20 If the welding on and removal of assembly auxiliaries or welding on parts is required, this must be done by applying the conditions necessary for welding of the materials. The material may not be damaged through welding on or separating. Seambits must be removed by grinding see E DIN 6700-5, table 3.

4.21 Starting- and run out sheets must be supplied to DIN 6700-5, table 2.

4.22 If the drawing states the working-off of the top and or-roof position of bultwelds (even surfaces), then the top - or roof position must be worked out an even surface in direction of stress by way of mechanical work procedure. After the treatment penetration notches, craters or other surface fault may only remain according to the quality requirements.

If the drawings shows notch free grinding, then the welding seam must be ground in direction of stress. If nothing else is given $R_a < 50$ m is valid

4.23 If resistance welding, studwelding and other welding procedures the corresponding norms, rules and DIN 6700 are to be followed.

4.24 If corrective after welding are necessary during manufacture one needs to proceed as with original welding work of greater extent (for instance exchange of parts, non conformity of first execution, repair of larger seam length series mistakes) must be agreed with customer.

4.25 Prior to removal of cracks the exact run (course) of the crack is to determine eventually drill off crack end and work out cracks. The welding over of crack is not permissible.

4.26 When adjusting flame following basic rules apply:

- Straightening with the flame is only to be done, if it is permissible for the particular material respect the part and does not lead to a reduction of strength.
- When carrying out the straightening procedure the technical rules apply. - The required area of temperature must be checked by suitable measurements/thermopins, Measuring instruments. If requested from customer the temperature check is to be documented.

4.27 Cold straightening is only admissible if straightening process does not lead to damage on part or in welding area.

5 Material conditions Welding rules

5.1 Additional rules for non alloyed steel and cast steel

5.1.1 To avoid cracks the steel must pre heated for welding with carbon content $C > 0,24$ % mass portion. With a multi-run (multi layer) weld the temperature between to single layers must also be kept to. In consideration of effects of further alloy elements (for instance Mo, Cr, Mn, Cu, Ni and V) as far as hardness tendency is concerned one must check, if it is necessary to pre-heat even with less C content.

The carbon equivalent of the groups 1.1, 1.2 and 2 of DIN 6700-6 can be found out as follows:

$$CEV\% + \% C + \frac{\% Mn}{6} + \frac{\% Cu + \% Ni}{15} + \frac{\% Cr + \% Mo + \% V}{5} \quad \text{in Prozent.}$$

For the altitude of pre-heat temperature with steel in dependency of metal thickness and CEV the following reference values apply of table 1.

Table 1: Pre-heat temperatures

CEV (%)	Metal thickness (mm)	Pre-heat temperatures (°C)
> 0,30 - 0,45 *)	t < 25	No one
	t ≥ 25	100 - 200
> 0,45 - 0,60	t ≥ 50	150 - 250
> 0,60 - 0,75	exception t > 50	

*) With cast steel one needs to pre-heat already with CEV > 35, take notice of norms, for instance DIN 17182, and for instructions of manufacturer.

Next to the material thickness and CEV for the altitude of the required pre-heat and interim temperature one must also take into consideration the we form of welding thrust, the welding construction, the distance (length) energy, the welding position and other circumstances which could influence the speed of cooling off. Technical rules for instance ZTU - diagrams (graphics) and the DSV Sheet 1703 must be adhered to.

5.1.2 At the thermit cutting and welding of normalised thermomechanical treated and waterquenched fine grained steel the guide lines for the fabrication of weldable fine grained steel and/or the instructions of the steel manufacturer must be adhered to.

5.1.3 For fine grained steel compared with their cooling time $t_{8/5}$ it shall be also considered the hydrogen content in the welding material in order to avoid hydrogen inlcuded cracks when applying heat.

5.1.4 For arc welding of steels the hardness values shall be observed in the heat influence zone according to DIN EN 288-3.

5.1.5 For cast steel compared a hardness value of the base material is allowed 50 % higher according to DIN 6700-6, appendix C.

5.2 Additional execution rules for alloyed steel

5.2.1 Scale layers and tempering colours which develop during welding or heat treatment present an interruption of the passive material surface.

They can be removed mechanically by for instance:

- grinding with suitable grinding discs,
- brushing with stainless steelbrushes,
- shot blasting with iron free shot blasting means

or chemically to instructions of pickling media manufacture for instance:

- pickling bath
- pickling pastes.

5.3 Additional execution rules for welding of unalloyed and alloyed steel

5.3.1 The selection of filler metals for alloyed materials shall be done with the help of the Schaeffler-Diagramms. The welding material mixed with the basic material shall have a structure with a chemical composition which is not endangered either by brittleness or high temperature cracks.

5.4 Additional execution rules for aluminium and aluminium alloys

5.4.1 When fusion welding aluminium and aluminium alloy is preferred the controlled atmosphere welding under inert gases (for instance MIG, WIG) is to be used. Arc welding with rod electrode and gas welding are not permissible.

5.4.2 Parts to be welded must be cleaned prior to welding mechanically and or with suitable cleansing materials to remove fat, dust and coating. When welding several layers each layer must be cleaned prior to welding next layer or position.

5.4.3 In the manufacture of welding seam joint by grinding or grinding off seams or tackings only grinding wheel admissible for aluminium must be used.

5.4.4 Generally one should do without pre-heating to avoid bonding faults and pores (voids) on dependence of the workpiece measurements and the welding procedure a preheating could however be necessary. The pre-heat temperature should usually not be higher than 150°C. At several layers (multi positioned) welding interim temperature must no exceed 200°C.

To determine the pre-heat and interim temperatures one needs to take into consideration the specific characteristic of aluminium alloy corresponding with the instructions of the manufacturer.

5.4.5 For hot straining with flame the DVS Sheet 1614 or the instruction of manufacture shall be considered.

6. Supplementary rules for welding for maintenance of rail vehicles

For the maintenance of rail vehicles the Technical Rules Vehicle Maintenance (TRF), the special editions and rules of the employers, the operator-railways or the safety regularity authority shall be taken into account.

7. Test prior to production start, test specimens

7.1 For arc welding

For arc welding test specimens are necessary for:

- to check and ensure that the design is satisfactory as specified in DIN 6700-3
- to guarantee the weld process
- to demonstrate the qualification of the welders
- to demonstrate the quality of the weld seam

Test specimen shall be carried out in the welding plants under the supervision of the recognised welding coordinator (SAP) and must be documented. Test specimens establish the welding process and the qualification of the welder.

7.1.1 To guarantee the welding process

Test specimens to guarantee the welding process are necessary in the case of an existing WPS:

- as proof of stated seam thickness,
- for only one side accessible HV-seams at a T-joint,
- in the case of irregularities in the production,
- for taking up a new production, if the lack of experience or the degree of difficulty require this.

7.1.2 To demonstrate the qualification of the welders

For welds which need a special dexterity for welding and which are not tested according to DIN EN 287 test specimens are necessary to demonstrate the qualification of the welder. The examination of the test specimen take place according to DIN EN 287. The result of the test specimen should be conducted and administered like a special test. For the duration and the prolongation DIN EN 287 is valid.

To demonstrate the qualification of the welder, the operator or the fitter test specimens are necessary inter alia:

- for HV- and HY-seams at the T-joint,
- at welding joints with several grades of difficulty (three metal thrust, hole welding),
- for bad accessibility,
- for material with a partial weldability,

- for tube (pipe) branching and tubesocket,
- for overlap thrust and corner seam in the area of thin metal $t < 3$ mm,
- for special high quality requirement, e.g. SGK 1,
- for the use of new welding machines or installations,
- for changing the filler metal or auxiliary substances,
- for the use of new materials
- for the deployment of new welders or operators (is also valid for hire personal).

7.1.3 Test specimens shall be carried out according to DIN EN 288-8. They can be welded as a separate test piece or together with a part as a continuation of a welding seam.

7.1.4 If test specimens are carried out by welders according to DIN EN 287-1 or DIN EN 287-2, then these can be recognised as a prolongation of the validity of the welders test, if the extent of the test specimen includes all of the welders test. The same is valid for the operator of fully mechanised welding equipment and welding robot.

7.1.5 To demonstrate the quality of the weld seam test specimens shall be specified in the test planning or defined by the recognised welding coordinator.

7.1 For other welding processes

7.2.1 At the flush butt seam welding if there is a modification one needs to check over through test specimen, whether the mechanic-technological quality values of the welding joint are according to conditions laid down, see chapter 6.2.3 of DIN 6700-5.

7.2.2 At resistance shot welding, roller seam weld and projection welding test specimen shall be carried out daily prior to start of work and or prior to beginning production according to chapter 6.2.3 of DIN 6700-5. The test must be carried out under these conditions for the started protection against corrosion.

7.2.3 When stud welding test specimens shall be carried out is there in a modification to production conditions and it must be tested through an impact bending test., see chapter 6.2.1 of DIN 6700-5.

Appendix A (normative)

Supplementary regulations for welding for the maintenance of rail vehicles and components

A.1 General

The regulations of DIN 6700 and the supplementary regulations of this appendix have to be adhered to at the welding technological maintenance of rail vehicles and their components.

Welding plants which carry out the welding technological maintenance must have a corresponding qualification to DIN 6700-2.

Prior to starting the welding technological maintenance on rail vehicles and components the extent has to be determined with the employer of the railways (work acceptance) Which welding technological maintenance measures which show a modification of manufacture (for instance reconstruction, redevelopment of accident vehicles (ambulances) the permission of the railway employer is necessary. This measure must be documented.

Before welding for the maintenance the material and the weldability shall be known. For it the basis are the drawings and the piece lists. For unknown material and for rimmed steel (e.g. rolled steel made before 1960) the weldability shall be established by a test.

Welding technological maintenance measures on part (for instance long carriers (joist, girder) bogie frames, spring (loaded) pedestals) which require a test of running (traverse) safety, may only be carried out in vehicle workshops, which are in possession of an appropriate permission of the employing railway or the appropriate supervisory office. Excepted from this are maintenance measures which solely serve the running (travel) ability purposes of a viaduct.

On welded parts welding technological maintenance measure can be carried out without restriction, if they are carried out according to the new manufacture drawing. Repeatedly occurring cracks of fractures (serial damage, no obvious, force damage) on the same parts which require a welding technological maintenance (repair) are to be reported to the relevant safety regularity authority.

When the repair measures are carried out by metal guninjectors (instead of surface fusion welding) it is necessary to obtain the agreement of the operator.

A.2 Restricted welding work with repair

On the following parts welding technological repair measures are only permissible by agreement of the operator:

- wheel bodies (elements) (surface fusion welding (deposition welding) of hubbores),
- wheel tyres and whole wheels (wheel flanks surface-fusion welding with inspection and supervision by an office recognised by the safety regularity authority),
- car wheel transmissions (surface fusion welding of centre borings),
- car wheel steering wheels (not permissible on quench and tempered car wheel steering),
- car wheel housing (casing, chambers) (repair welding on wearing parts and centre rings),
- coupling (clutch) stirrups (frames) (surface fusion welding only on freight/railway) wagons),
- swans like neck (goose neck) carriers/only surface fusion welding),
- buffer middle coupling inclusive power driving parts,
- pull and push installations,
- drive parts (drive hollowshafts, brake hollowshafts, hollow shafts housings, drive- and wobbler pivots (stud-spigot) crankshafts, propeller shafts),
- welding technological repair of parts, which are manufactured with other joining methods (for instance riveting, gluing screwing),
- on following parts of tramcars: universal joints, drawbars wobbler head housing, spring pedestals, main braking levers.

Further restrictions as far as vehicles and vehicle components are concerned must be determined by the operator or if required by the relevant safety regularity authority.

A.3 Illegal repair or maintenance welding

For the following component repair or maintenance welding is illegal:

- cast friction discs, brake (friction) catch loop, clampstrips, tension strips of aircontainers, braking block sole (base bottom),
- springs, spring links with connecting piece for link suspension attachment,
- shell sockets,
- main studs and coupling loops of trams.

Further prohibitions with regard to vehicles and their parts are determined by the operator.

A.4 Works instructions and guidelines of the operator

At the welding technological repair of rail vehicles and parts the work instructions or guidelines of the operator for welding technological repair must be adhered to.

The main points of emphasis of the work instruction and guidelines are:

- Evidence of release (relief) of the loaded (strained) part at the repair,
- Evidence of sufficient accessibility of parts at the repair,
- Evidence of welding technological repair of parts with cavity conservation or of foamed out parts.
- Standards for the welding technological repair of parts
 - a) with high static/dynamic stress and high security requirements,
 - b) materials from which a high strength decrease can be expected (for instance aluminium, aluminium alloys, high teniasteel, TM steel),
 - c) which require a pre- or postheat treatment (for instance pre heating, tension anneal).
- Standards for welding technological repair of parts of unknown material, rimmed steel (e.g. rolled steel profiles made before 1960) unknown welding procedure/fillers at time of manufacture,
- Statements for the restricted welding work to section 2.