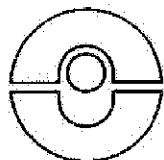


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2nd edition, 1.1.92

Technical specification  
for the approval of a  
procedure for arc welding  
on steels



International Union of Railways

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L'ETAT DU DOCUMENT**

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**Leaflets to be classified in volumes:**

- V - Transport stock
- VI - Traction
- VIII - Technical specifications

**Amendments**

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**Preliminary remarks:**

The double vertical line (||) in the margin indicates amendments introduced at the date shown at the foot of the page.

Enforcement of this leaflet is governed by the provisions contained under "Application" at the end of this document.

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### 1 - Purpose of the leaflet

This leaflet lays down methods and conditions for approval of a welding procedure (WP) based on a welding procedure description (WPD), together with the conditions for undertaking qualification tests and the validity limits of an accepted procedure.

The welding procedure description is compulsory.

When the welding procedure is compulsory, it shall require qualification through the welding test procedure described in this leaflet.

In the case of butt-welds, a welding qualification test is compulsory for all class B joints shown in drawings in line with the design specification.

For qualification of class C assemblies (1) and class B (1) fillet welded joints, the method of qualification of the welding procedure must be subject to agreement between the builder and the customer railway and qualification may be obtained using one of the following methods:

- from experience acquired;
- by reference to a standard procedure in a procedure description approved by the customer railway or by an approved body;
- by producing a prototype (or pre-production test);
- by a standardised welding procedure test.

(1) The examinations and checks on such assemblies may be carried out in accordance with Table 5.

Additional qualification testing (mock-ups or test assemblies) must be covered by an agreement between the builder and the customer railway.

A standardised welding procedure test shall be compulsory whenever the properties of the material in the weld metal and the heat-affected zone are critical for the structure.

The processes of qualification and monitoring during manufacture shall be covered by UIC Leaflet 897-13 (1).

### 2 - Scope

This leaflet shall apply to any welding or resurfacing operation (construction and repair) performed on welded structures of:

- railway rolling stock,
- lines or pipes and accessories for this rolling stock,
- machine welding of the components of this rolling stock,
- containers.

Resurfacing shall be covered by a welding procedure specified in advance and submitted to the railway for approval.

(1) Leaflet 897-13 "Technical specification for quality control on rolling stock assemblies made of steel" (to be published).

### 3 - Domain of qualification

#### 3.1 - General

The domain of qualification for which a procedure description is qualified shall cover all the following variables:

- the welding process,
- the type of welded joint,
- the base material and filler product,
- the dimensions of the test joint,
- the position in which welding is performed,
- the application technique,

The Examiner shall be the competent authority assigned to pronounce the qualification of a procedure description. He may belong to the railway or to an outside examining body approved by the railway.

The results of qualification tests shall be recorded in a document and certified by the examiner, on his sole responsibility.

This document must, as a matter of obligation, include not just the manufacturer's identification but also complete information about the procedure description, the tests and the results of the tests.

Documents prepared by the manufacturer shall be accepted only if they include the requisite information.

#### 3.2 - Welding processes

3.2.1- This leaflet shall apply to the classified (1) welding processes listed below (2).

Each welding process may be manual, semi-automatic or automatic, as the case may be:

- 11: arc welding with core wire (without shielding gas),
- 12: arc welding in flux in powder,
- 13: arc welding with core wire (with active shielding gas)
- 14: arc welding with refractory electrode (with active shielding gas),
- 15: plasma arc welding.

For other processes not mentioned above, a special qualification procedure shall be compiled.

Each of the welding processes may be qualified separately or in combination with other processes when a welding procedure entails several different welding operations. Similarly, one or more processes may be removed from a qualified welding procedure, provided that the thickness of the weld joint lies within the thickness validity range (see point 3.4.1) for the process(es) chosen.

(1) cf. ISO 857 standard

(2) cf. ISO 4063 standard

3.2.2 - Each test shall normally serve to approve a single process. It follows, therefore, that a change of process shall necessitate a new qualification test.

### 3.3. - Qualification Joints

3.3.1 - The qualification samples shall be butt welds (WD) on plates or pipes. The preparation of the edges and alignments must conform to the welding procedure description (WPD).

### 3.4 - Materials and filler products

#### 3.4.1 - Materials.

Rolled, forged and cast materials shall be covered.

The materials shall be classified in 9 groups.

Steels with the same metallurgical and welding properties shall be grouped together as shown in Table 1.

Table 1

Group	Type of steel
1 (2)	Steels: . with specified minimum yield strength $YS \leq 355$ N/mm <sup>2</sup> . or with tensile strength $TS \leq 520$ N/mm <sup>2</sup> . and a chemical composition on casting not exceeding in %: C                   0.24 % Si                  0.55 % Mn                 1.60 % Mo                 0.65 % P,S                0.045 % All others        0.8 % Any one other   0.3 %
2 (1) (2)	Standardised fine-grained steels with specified minimum yield strength $YS > 355$ N/mm <sup>2</sup>
3 (1)	Fine-grained steels, hardened and tempered, with specified minimum yield strength $YS > 500$ N/mm <sup>2</sup>
4 (1)	Steels with Cr max 0.6 %, Mo max 0.5 %, V max 0.25 %
5 (1)	Steels with Cr max 9 %, Mo max 1.2 %
6 (1)	Steels with Cr 12 %, Mo max 1 %, V max 0.5 %
7 (1)	Steels with Ni max 9 %
8 (1)	Stainless steels, ferritic or martensitic, with Cr 12 à 20 %
9	Stainless austenitic steels Cr - Ni
(1)	: For groups 4 to 8 the alloy content is calculated from the chemical analysis on casting.
(2)	: If qualification has not been carried out for the materials' limit values, it should be performed once again for these materials.

3.4.2 - Qualification according to base materials

3.4.2.1 - Base materials belonging to the same group

A welding procedure qualification test carried out on one of the steels of the group shall be valid for steels with a lower degree of alloy, for the steels with intentionally incorporated additional elements, or for steels with a lower specified yield strength in the same group, provided that the filler metals used for this test can also be used for the other steels in that group. Group 2 covers Group 1.

3.4.2.2 - Base materials not belonging to the same group

A separate welding procedure qualification test must be carried out for each steel or combination of steels not belonging to the grouping system. A steel which may belong to two groups shall be classified in the group with the lower level properties.

Welds used between two different types of joint shall require the welding of specific samples. These samples shall not, however, be necessary if the provisions laid down in Table 2 are met.

3.4.2.3 - Extent of validity for other combinations of materials

Combinations of materials not covered by Table 2 may be accepted on condition that specific samples are welded. These samples shall be produced using the welding procedure laid down, the designated base materials and the filler metal concerned. The quality of execution and fusion shall be noted.

Table 2

Qualification of existing welding procedure for following mixed groups or joints	Range of validity
2	2 welded to 1
3	3 welded to 1 3 welded to 2
8 welded to 2	8 welded to 1 8 welded to 2
8 welded to 3	8 welded to 1 8 welded to 2 8 welded to 3
9 welded to 2 or 9 welded to 3	9 welded to 1 9 welded to 2 9 welded to 3

3.4.3 - Filler products

Only those filler products approved by the railways may be used (1).

A qualification remains valid for all filler products of the same classification as those used in testing, except when impact strength tests are required.

(1) laid down by Leaflets 897-1, 897-4, 897-6 and 897-8 for the welding of steels in Group 1.

For group 11 welding processes:

The qualification of the diameter remains valid when using an electrode with a diameter immediately larger or smaller than the standard diameter, for each pass, with the exception of the root pass executed on a joint welded on one side only.

For group 12 welding processes:

The qualification given is limited to the system of wire used in the welding procedure qualification test (single or multiple-wire systems).

The qualification given for the combination of wire or powder is valid for the class used for the welding procedure qualification test.

For group 13 welding processes:

The qualification given for the combination of shielding gas and wire is valid for the type of gas (nominal composition) used in the welding procedure qualification test.

The qualification given is limited to the wire system used for the welding procedure qualification test (single or multiple-wire system).

For group 14 welding processes:

The qualification given for the shielding gas is valid for the type of gas (nominal composition) used in the welding procedure qualification test.

For group 15 welding processes:

The qualification given is valid for the type of plasma gas and the shielding gas (nominal composition) used in the welding procedure qualification test.

3.5 - Dimensions of test joints (plates or pipes)

3.5.1 - Thickness of test joints.

The thickness of the qualification welded joint shall be that which is closest to the thicknesses encountered in construction.

The qualification of a welding procedure on a thickness "t" shall be valid for the thicknesses of the domain of validity given in Table 3.

Table 3

Thickness "t" of the welded joint (1) mm	Domain of validity (2) mm
$t < 3$	from 1 to 3 mm (3)
$3 \leq t \leq 12$	from 3 mm to 2 t (3)
$t \geq 12$	20 mm and above

(1) Thickness "t" shall mean the following:  
a) For a butt weld:  
for joints between different thicknesses, "t" shall be the thickness of the thickest material.  
b) For a fillet weld:  
for joints between different thicknesses, "t" shall be the thickness of the thickest material.  
For each domain of validity of thickness given above, the qualification of a fillet weld having a throat "a" gives qualification for the range of validity of throat thicknesses from "0.75 a" to "1.5 a", except for tests carried out with a throat thickness greater or equal to 10 mm which give qualification for all throats having thicknesses greater than or equal to 10 mm.  
c) For a weld on pipe:  
the thickness "t" shall be the thickness of the smaller pipe.  
(2) If tests are carried out on thicknesses less than 12 mm (lower limit for impact strength tests), the qualification is only valid up to 12 mm in the absence of an impact strength test.  
(3) If qualification on a thickness "t" is in a single pass, the corresponding domain of validity is from 0.9 to 1.1 t.

3.5.2 - Diameters of the pipes of the test joint

The qualification domain of validity for the outside diameter of the tube is shown in Table 4.

Table 4

Outside diameter "OD" of the test piece (1)	Domain of validity (3)
OD < 25 mm 2)	from OD to 2 OD
25 ≤ OD < 150 mm 2)	from 0,5 OD to 2 OD
OD ≥ 150 mm	from 0,5 OD to all larger diameters.

(1) For sections of hollow monocylindrical bodies, OD shall be the smallest dimension.  
(2) The diameter of the pipe shall be that which exists in construction and design of brake pipes.  
(3) A welding procedure qualification test carried out on a pipe inclined at angle  $\alpha$  qualifies all pipe inclination angles greater than or equal to  $\alpha$  and less than or equal to 90°.

3.6 - Welding positions

The qualification test shall be carried out using welding positions and angles encountered in production.

The angle  $\alpha$  used shall be the smallest angle used in construction.

A qualification (pipe or plate) obtained in one position remains valid in all welding positions (pipe or plate) when no impact strength or hardness requirement is specified.

A qualification for all positions is obtained when a resilience and/or hardness test is specified, if the resilience test specimens are taken in the positions where the welding energy is highest, and the hardness test specimens in the positions where the welding energy is lowest.

3.7 - Application technique

3.7.1 - Type of current

The qualification shall be granted only for the type of current (d.c., a.c. or pulsed) and the polarity used for the welding procedure qualification test.

When no resilience test is required, this clause may be waived for processes 11, 12, 13, 14 and 15 of ISO/DIS standard 4063 provided that both types of current are specified in the operating manual for the electrode.

3.7.2 - Welding energy

The range of validity for the welding energy shall be ± 15 % of the specified energy.

When different welding energies are used for multi-run welds, a range of validity must be specified for each weld pass.

When a particular requirement is stipulated in order to test the resilience or the hardness of the testpiece, the welding energy may be increased by 15 % only above that used during the welding procedure qualification test.



### 3.7.3 - Preheating and inter-pass temperature

The lower limit of the range of validity shall be the nominal preheat temperature applied at the start of the welding procedure qualification test.

The upper limit of the range of validity shall be the nominal inter-pass temperature reached during the welding procedure qualification test.

### 3.7.4 - Post-welding heat treatment

Adding or removing post-welding heat treatment shall not be permitted.

The range of validity shall be the range of temperature used during the welding procedure qualification test.

Heating rates, cooling rates and holding time must be in accordance with the specified thermal cycle.

## 4 - Welding Procedure Qualification

### 4.1 - General

The qualification welded joints shall be made by welders approved in accordance with Leaflet 897-11.

A welding procedure that has been successfully conducted in accordance with a welding procedure description shall be qualified within the meaning of this leaflet for all welding operations in actual production.

As a general rule, certification tests also qualify the welding procedure(s) and the filler products used in the welding procedure tests and the production of a prototype.

Tests on specimens or actual parts may be performed during construction, as part of the statistical quality control programme based on destructive tests.

### 4.2 - Welded joints

#### 4.2.1 - Number of welded joints

The inspector shall be the competent authority in judging whether or not the samples are representative.

When the shape and the dimensions of the samples are not sufficiently representative of the welded joint to be tested, specific specimens must be prepared to simulate the required joint in all its characteristics (dimensions, clamping, heating cycle, etc.) under the same conditions as those to be used in production. The number of welded joints to be made shall be determined by the variables to be considered, these being listed in chapter 3.

Additional specimens, or specimens larger than normal, may be prepared to cater for the possible need for retesting (see paragraph 6.3).

The direction of rolling shall be indicated on the samples.

#### 4.2.2 - Shapes and minimum dimensions of the test joints

Each test joint shall be made up of 2 or more welded parts.

Figures 1, 2, 3 and 4 in Appendix 1 give a schematic representation, valid for all positions, of the types of simple joints to be produced.

Specific conditions of service or construction may make the additional tests stipulated in Chapter 5 necessary, in order to gain further information without having to produce new specimens.

If the additional tests are carried out, the dimensions of the specimens must be increased accordingly.

#### 4.2.3 - Execution of the test joints

The welding of the specimens must be carried out according to the proposed welding procedure description and under the same general conditions as in production. The welding positions and the limiting values for angles of inclination and rotation must conform to the specifications of ISO standard 6947 and Article 3.5.

The welding and the testing of the specimens must be supervised by the inspector, by his representative or by an external examining body approved by the railway.

### 5 - Examination of test joints and acceptance criteria

#### 5.1 - Examination of welded joints

Should the construction plant not have facilities for checking qualification tests for welding procedure descriptions, this may be done in a laboratory approved by the railway.

The specification and its accompanying documents shall indicate the nature, location and dimensions of the marks to be made on each test joint and specimen. All qualification test joints shall be stamped with the inspector's identifying mark.

#### 5.2 - Examination during assembly

The examination shall be designed to check the different parameters contained in the welding procedure descriptions.

#### 5.3 - Examination following assembly

After completion of the weld, and following heat treatment where specified in the procedure, the test joints shall undergo the examinations and tests stipulated in Table 5.

Table 5

Test method	Butt welds plates and pipes			Fillet welds plates and pipes Welds on pipes		
	Thickness "t"			Pipe diameter "OD"		
	< 3	3 ≤ t ≤ 12	≥ 12	< 25	25 ≤ OD ≤ 150	> 150
Visual	1	1	1	1	1	1
Calibration	1	1	1	1	1	1
Radiographic (1) or ultrasonic		1	1 (2)	1 (8)	1 (8)	1 (8)
Penetrant (3) or magnetic particle		1	1	1	1	1
Bending (4)		4	4			
Tensile strength		2 (9)	2			
Impact strength (5)		6 (9)	6			
Hardness (6)	1 (10)	1	1	1	1	1
Macroscopic (7)	3 (10)	3 (7)	3 (7)	3	3	3

(1) The radiographic examination shall be carried out in accordance with the particular requirements of the railway.  
 (2) The ultrasonic examination may replace the radiographic examination.  
 (3) Penetrant examination only for non-magnetic materials.  
 (4) There shall be 2 face and 2 root bend tests.  
 The two face and two root bend tests may be replaced by 4 "side" bend specimens for t > 20 mm.  
 (5) A series of 3 specimens in the deposited metal and a series of 3 in the thermally-affected zone (TAZ). To be performed only on parent metals with a specified impact strength or when stipulated by the application standard.  
 (6) Not to be performed on metals with tensile strength TS < 420 N/mm<sup>2</sup> (YS < 275 N/mm<sup>2</sup>) for group 9 steels.  
 (7) The samples must be taken from the beginning and the end of the bead and on a restart, if required.  
 (8) Only for welds on pipes.  
 Ultrasonic examination only for ferritic steels and for t ≥ 10 mm.  
 (9) The minimum thickness shall be determined by the customer railway.  
 (10) To be carried out if stipulated in the specification.

For qualification by production of a prototype (or pre-production test), examinations must be performed, insofar as is possible, in accordance with these stipulations, which may if necessary be supplemented or replaced by special tests appropriate to the nature of the welded joint.

5.3.1 - Number and sampling of specimens

*Specimen for visual examination and calibration.*

The specimen shall consist of the welded joint itself.

*Specimen for radiographic examination.*

The specimen shall consist of the welded joint itself, and the radiographic examination shall be performed along the whole length of the weld bead, following visual examination and calibration of the latter.

*Specimens for tensile testing*

The specimens for these tests shall be taken as shown in figure 1 of Appendix 1 and figures 5 and 6 of Appendix 2.

Cutting shall be done by cold tool or torch. If the latter is used, traces of the cutting and thermally-affected areas should be removed.

*Specimens for impact strength test.*

The area reserved for taking specimens is shown in figure 1 of Appendix 1 and figure 5 of Appendix 2.

Cutting shall be done by cold tool or torch. If the latter is used, traces of the cutting and thermally-affected areas should be removed.

The Charpy type specimen, with V-notch perpendicular to the surface of the welded joint shall be taken in the skin 1 or 2 mm below the said surface as shown in figure 7.

The notch shall be 1 or 2 mm from the fusion line in the thermally-affected zone, as shown in figure 7.

When the thickness exceeds 50 mm, a series of three specimens shall be taken in the area near the weld root.

Three specimens must be taken at each specified position.

*Specimens for bending test on butt welds.*

The specimens to be tested shall be taken as shown in figure 1 of Appendix 1 and figure 5 of Appendix 2 of this specification.

Cutting shall be done by cold tool or torch.

If the latter is used, traces of the cutting and the thermally-affected zone should be removed.

*Specimens for macroscopic examination and hardness testing*

The specimens for macroscopic examination shall be taken as shown in figures 1, 3 and 4 of Appendix 1 and figure 5 of Appendix 2.

5.3.2 - Preparation of specimens

*Impact strength test specimens.*

The dimensions of the Charpy test specimens with V notches must comply with ISO 148.

*Transverse tensile test specimens.*

The specimens for transverse tensile tests on welded joints shall be prepared in accordance with ISO/DIS 4136.

The tensile test specimens for pipes of outside diameter greater than 50 mm must comply with figure 6 of Appendix 2. The weld thickness allowance must be removed from both sides so that the thickness of the specimen is equal to that of the pipe.

The tensile test specimens for pipes of outside diameter less than or equal to 50 mm must comply with either figure 6 of Appendix 2 or figure 8 of Appendix 3.

The weld thickness allowance should be left as welded when the whole diametrical section of the pipe is used.

In addition, the specimens shall undergo the following preparation:

*Specimens for radiographic examination.*

The penetration flange should be removed whilst leaving the parent metal intact.

*Specimens for bending test (Figure 9 of Appendix 3)*

The dimensions of the bending test specimens for butt welds and fillet welds must comply with the indications given.

The weld thickness allowance and the penetration flange shall be removed, leaving the parent metal intact. Drilled edges shall be rounded to a radius approximately equal to a tenth of the thickness of the assembled parts.

*Specimens for macroscopic examinations and hardness testing.*

The dimensions of the specimens for butt welds and fillet welds must comply with the indications given in Appendix 1.

The specimens must be polished and etched with a reagent on one side.

**5.3.3 - Execution of examinations and tests.**

*Calibration.*

Calibration shall be carried out using a suitable template.

*Radiographic examination.*

The radiographic examination of the weld bead shall be performed taking into account the indications given in accordance with the class B method of ISO standard 1106/1 (butt welds on plates), ISO standard 1106/2, and ISO standard 1106/3 (butt welds on pipes) depending on the material and the construction requirements.

The image quality number shall be that used for the radiographic examination of the welds that the qualified welder will have to make, and shall be noted in the particular specification.

*Ultrasonic examination.*

The ultrasonic examination of the weld bead shall be carried out according to the procedure approved jointly by the builder and the railway.

*Bending tests.*

- Butt welds.

The bending test shall be conducted in accordance with the indications in ISO standards 5173 and 5177.

The specimens shall be bent as shown in figure 4 of Appendix 1, on a cylinder whose diameter shall be 4 times the thickness of the specimen; the diameter of the rolls shall be 4 times the thickness of the specimen.

The bending angle must be at least 120°. The side bend test and/or the face and root bend tests for butt welds shall be conducted according to standard (ISO 5173 or ISO 5177).

During the test, the specimens must not show defects in any direction that exceed 3 mm in length.

*Macroscopic examination*

The specification and its accompanying documents must state the quality of the finish. In the absence of any indication, the reagent used shall have the following composition:

- for steels in groups 1, 2 and 3:

- 3 g ammoniacal copper chloride
- 25 cc distilled water
- 50 cc hydrochloric acid (d = 1.19)
- 15 g ferric chloride.

- for steels in groups 4 and 5

Reserved

- for steels in groups 6, 7, 8 and 9

Reserved

The macroscopic examination must cover a width of about 10 mm of unaffected parent metal.

*Tensile test*

The tensile test shall be conducted according to ISO/DIS 4136. The tensile strength of the specimen must not normally be less than the minimum value specified for the parent metal.

*Impact strength test*

The test temperature and the energy absorbed must comply with the requirements laid down at the design stage of the structure in question, whilst respecting the provisions of the application standard.

*Hardness test*

The hardness test shall be performed in accordance with ISO standard 6507/1.

The Vickers HV 10 method shall be used. Imprints shall be made in the weld metal, the thermally-affected zone and the parent metal, with the aim of measuring and recording all minimum and maximum values of the welded joint. This shall normally include transverse imprints which shall be at most 2 mm below the surface.

There shall be a minimum of three individual imprints for each of the areas measured, namely the weld metal, the thermally-affected zone and both parent metals. The first imprint in the thermally-affected zone shall be made as close as possible to the fusion line.

The results of the hardness test must satisfy the following provisions:

- The Vickers hardness measured under the weld bead, for group 1 steels, must be less than 350 HV 10.
- For steels in groups 2, 3 and 4, it must be less than 380 HV 10. For steels in groups 5 and 6 and for steels with yield strength  $YS > 885 \text{ N/mm}^2$ , a special value shall be determined by agreement between the parties concerned.

**6 - Conclusion of examinations and validity of qualification**

**6.1 - Qualification**

A procedure which meets all the stipulated requirement shall qualify the WPD.

In the case of results being unsatisfactory, the WPD can not be approved.

The existence of values recorded which exceed the permitted limiting values and of defects which exceed the permitted limits under Appendix 4 class B shall result in non-qualification of the welding procedure (qualification by testing).

**6.2 - Validity**

A welding procedure carried out in accordance with the provisions of this leaflet and meeting all the stipulated requirements shall qualify concurrently:

- the welding process:

Qualification is valid only for the process(es) used during the qualification test.

- the welding of any material or combination of materials provided that the tests give a reasonable approximation of the actual conditions of welding production.

A welding procedure description which has been used for the construction of the prototype shall qualify similar welded joints.

A WPD shall be qualified if the range of validity defined for each variable is included in that authorised by the standard procedure approved by the competent authority.

**6.3 - Retest**

When a specimen does not satisfy one of the provisions of the visual examination or of the non-destructive tests specified in paragraph 6.1, another specimen must be welded and put through the same tests. If it fails to meet the corresponding provisions, the welding procedure shall be considered not to comply, as it stands, with the provisions of this leaflet.

When one of these specimens does not satisfy the provisions of paragraph 6.1 as a result of a local defect, another specimen shall be taken for each defective specimen, either on the same sample (if sufficient material is available) or on another sample, which must then undergo the same test a further time.

If none of these additional specimens satisfies the provisions, the welding procedure shall be considered not to comply, as it stands, with the provisions of this leaflet.

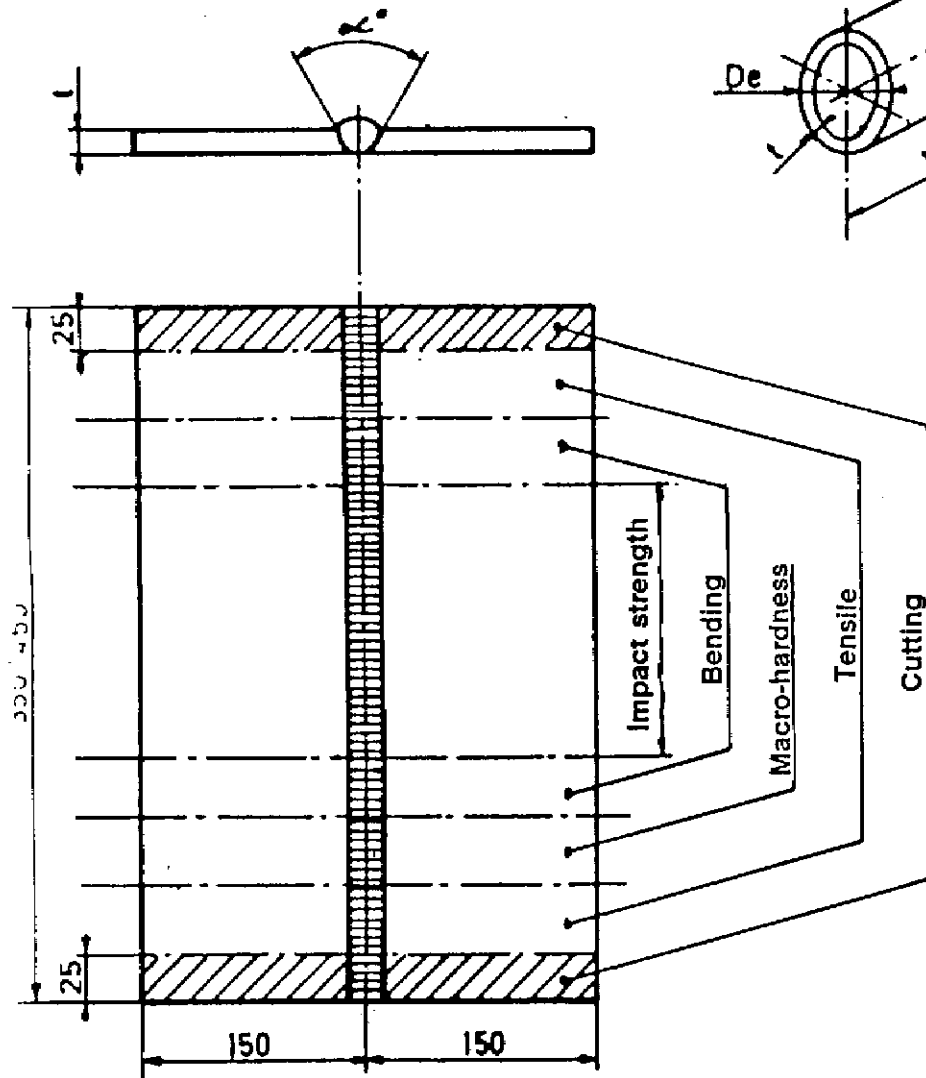


fig. 1

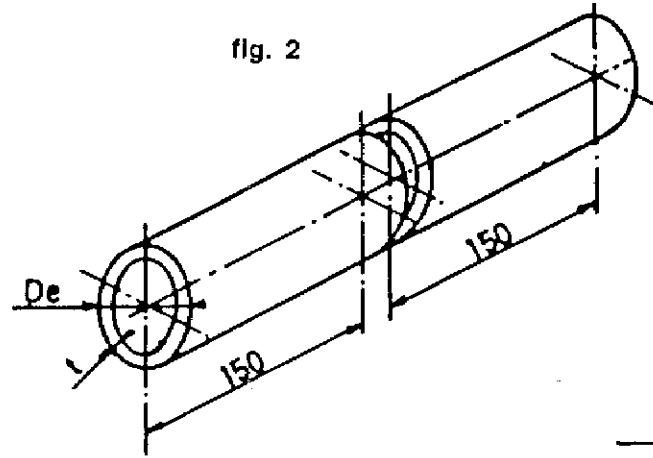


fig. 2

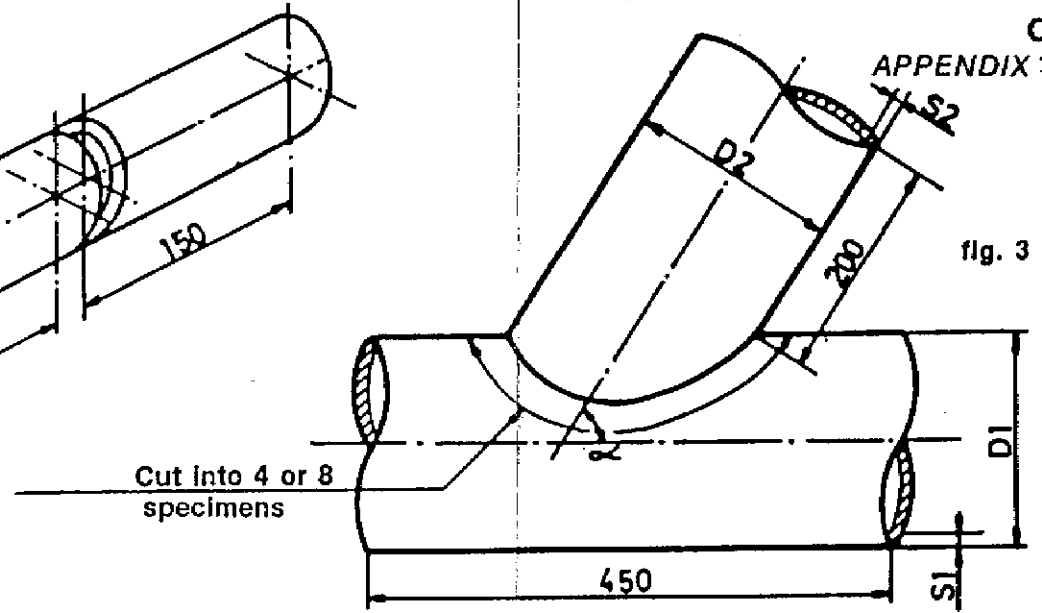


fig. 3

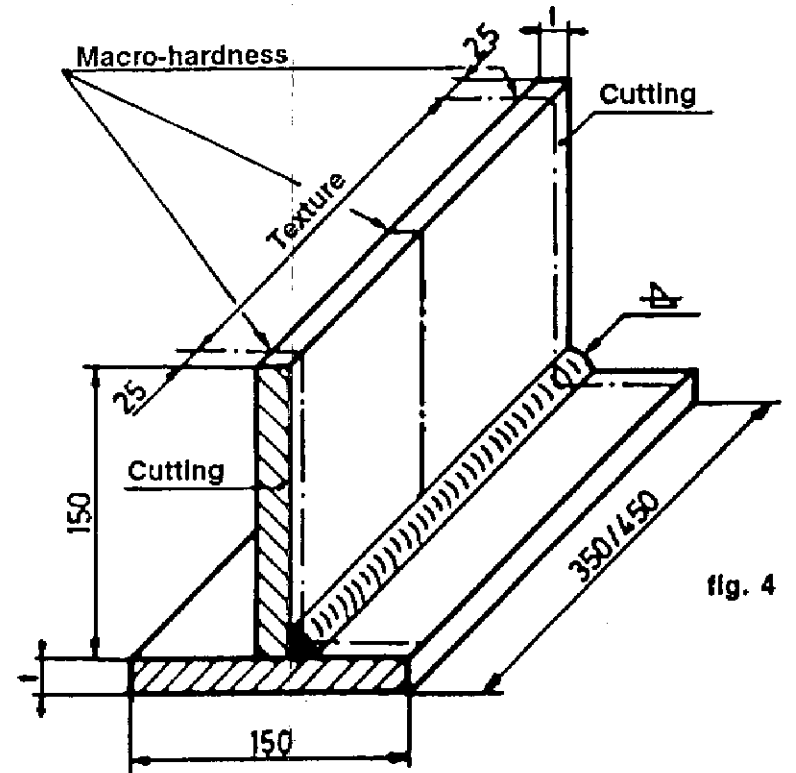


fig. 4



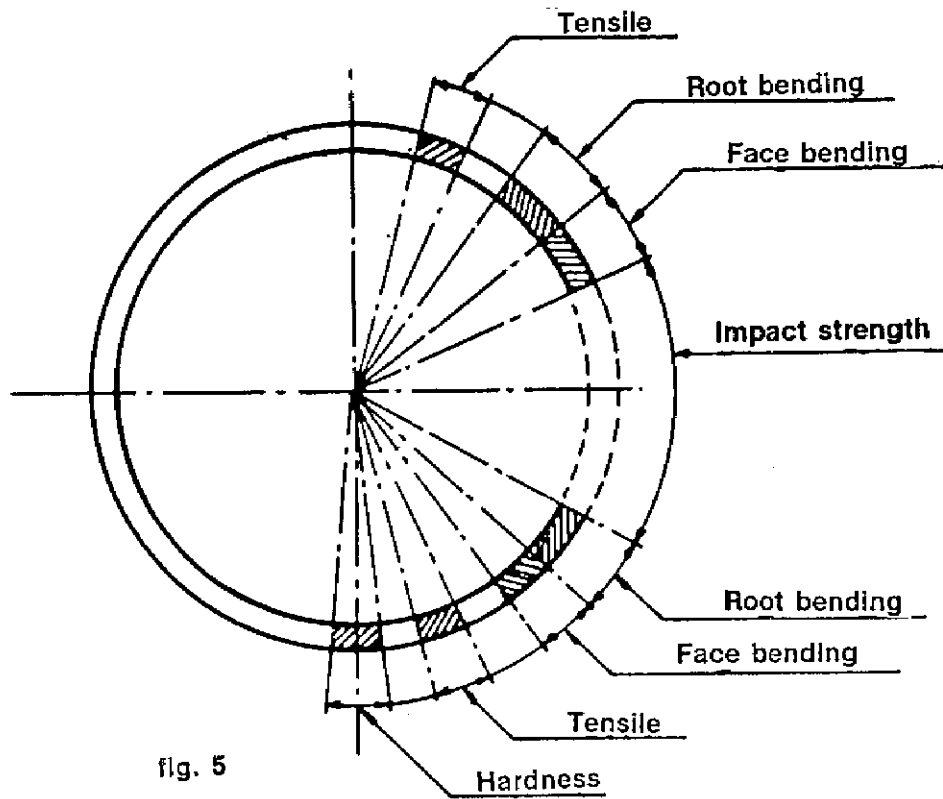


fig. 5

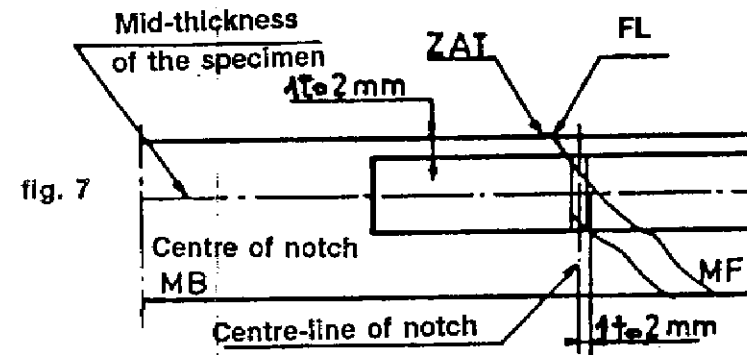


fig. 7

PM = parent metal  
WM = weld metal  
FL = fusion line  
TAZ = thermally-affected zone.

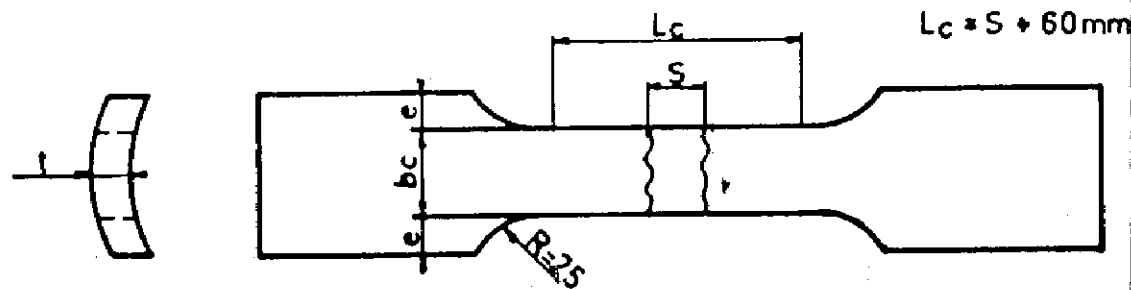


fig. 6

For  $D < 50 \text{ mm}$ :  $bc = 1 + \frac{D}{10}$  }  
 For  $D \geq 50 \text{ mm}$ :  $bc = 1 + \frac{D}{20}$  } with  $bc = 35 \text{ mm max.}$

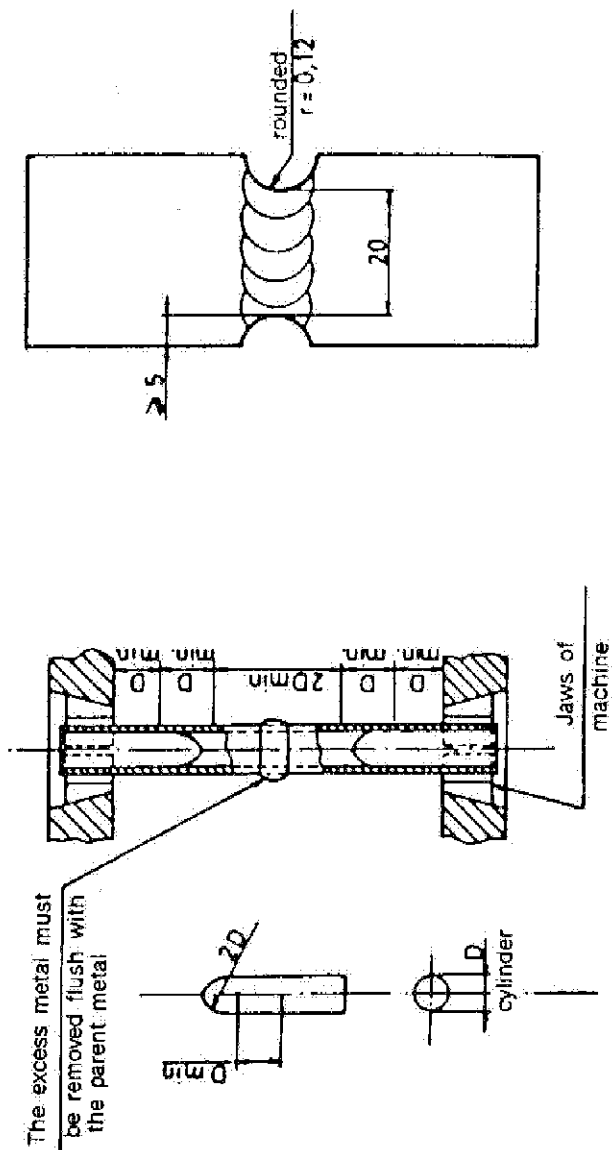


fig. 8

fig. 9

Limits for types of defects

Defect	Types of defect	ISO 6520	Comments	Limits: Upper requirement B 1)
1	Cracks	100		not permitted
2	Crater cracks	104		not permitted
3	Uniformly distributed spheroidal-gas-pores	2011 2012 2014 2017	Projection in a plane parallel to the surface of the welded joint over the whole length of the weld affected. An assessment must be made on each of the areas exhibiting pores.	The pores must not exceed 1 % of the projected surface. The size of a cavity must not exceed 2 mm.
4	Clustered porosity	2013	Projection on a plane parallel to the surface of the welded joint. The area containing pores must be limited, since systematic defects are not permitted.	The pores must not exceed 4 % of the projected surface. The size of the cavity must not exceed 2 mm.

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Defect	Types of defect	ISO 6520	Comments	Limits: Upper requirement B 1)
4	Clustered porosity	2013	The possibility that other defects may be masked must be taken into consideration. The area of pores in the cluster shall be calculated as a % of the area of an envelope enclosing all the welds or of a circle of diameter $s$ (where $s$ is the nominal diameter of the weld), whichever is larger.	The total must not exceed 2 % of the projected surface.
5	Elongated pores, tubular pores	2015 2016 2024		Continuous defects are not permitted. The height and width of local defects must not exceed 2 mm.  The length must be less than the thickness of the weld.
5 (a)	Crater shrink hole			Not permitted.

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6	Solid inclusions	300 301	Defect limits for no. 5 apply	Defects not permitted
7	Lack of fusion	401		Defects not permitted
8	Lack of penetration	402	Applies to weld penetration in butt, fillet and T joints. If it is specified that the thickness of the weld is to be less than the thickness of the plate, the height of the defect shall be equal to the difference between the nominal thickness and actual thickness of the weld. If for this type of weld it is held that the true thicknesses should not exceed the prescribed values, then additional requirements may be stipulated.	Defects not permitted

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Defect	Types of defect	ISO 6520	Comments	Limits: Upper requirement B 1)
9	Root gap		Gap at the root of butt welds executed from one side. Treated as an alignment defect.	The height of the gap must not exceed limits stipulated for the lack of penetration (defect no. 8). See also no. 18.
10	Penetration notches	5011 5012 5013		Defects not permitted.
11	Weld overfill on butt weld	502		The height of the thickness allowance must in no case exceed 1 mm + 5 % of the width of the thickness allowance, to a maximum of 2 mm.
12	Excessive convexity at weld	503	Height to be measured from true throat.	In no case must the height exceed 1 mm + 10 % of the true throat (1 mm + 5 % of the bead width), to a maximum of 2 mm.

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13	Fillet weld with throat less than nominal value.			No error is permitted.
14	Fillet weld with throat greater than nominal value.			The error must not exceed the limits stipulated for excessive convexity (defect no. 12).
15	Excess penetration			Penetration must be continuous. The height of penetration must not exceed 3 mm and in no case 1 mm + 30 % of the width of penetration. For pipes with $d \leq 25$ mm, the height of the penetration flange must be $\leq 1.5$ mm.

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Defect	Types of defect	ISO 6520	Comments	Limits: Upper requirement B 1)
15	Excess penetration			In the case of welding with an inert gas: For steels of groups 2 and fluxing is not permitted. For steels of group 11 surface oxidation Traces are not permitted
16	Protrusion	5041		Not permitted
17	Overspill	506		Not permitted
18	Alignment defect	507	The stated limits refer to errors with respect to the correct position. What is understood by correct position is dependent on circumstances. In the absence of indications to the contrary, plates are regarded as correctly aligned when the axes at mid-thickness coincide.	Defect not permitted

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Defect	Types of defect	ISO 6520	Comments	Limits: Upper requirement B 1)
19	Angular deformation	508	Alignment defects measured on the surface can be larger or smaller, according to variation in thickness of the plate, the pipe diameter and the wall thickness.	$< 1/20$ or $3^\circ$
20	Sag	509 5091 5092 5093 5094		The amount of sag must not exceed these limits stipulated by: - excess penetration (defect no. 15) - lack of thickness (defects no. 13 and 21)
21	Lack of thickness. Butt welds	511	The values correspond to a smooth and rounded recessed profile. For sharp-edged defects, refer to the value given for undercuts (no. 10)	Defect not permitted

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Defect	Types of defect	ISO 6520	Comments	Limits: Upper requirement B 1)
22	Symmetry defect in fillet weld	512	It is presumed that an asymmetric fillet weld has not been expressly requested.	The difference between the lengths of the sides must not exceed 10 % of the throat
23	Gas cavity at the root	515		Same limits as for defect 8 (lack of penetration) If the edges are melted, the limits given for defect 10 may be used as an alternative.
24	Poor restart	517		Defect not permitted
25	Arc burn	601		Defect not permitted

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26	Spotters	602		Some splashes permitted
27	Poor fit and lack of penetration, fillet welds		Gap between the parts and lack of penetration.	Defect not permitted

1) Degree of aptitude according to ISO DIS 5817

## **Application**

From 1 January 1992.

All UIC Railways.

## **Record references**

*Headings under which this question has been dealt with:*

- *Question 5/SA/FIC* - Revision of leaflets.  
Approval of new Leaflet 897-12.

(Traction and Rolling Stock Committee, Stockholm, June 1991).

- Finalisation of Leaflet 897-12.

(Paris, November 1991).