

Note

This leaflet forms part of a set, which also includes :

— Leaflets of sub-section 89 (nos. 897-1 to 897-13) : Welding.

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1 - Subject

This leaflet specifies the tests to be performed, and the requirements to be met, by a welder or welding machine operator (1) in order to demonstrate his ability to produce pre-defined welded joints by a given process and conforming with the required quality criteria.

2 - Scope of application

This leaflet applies to any welding operation (fabrication and repair) except for build-up welds carried out by welders working on welded constructions of :

- Railway rolling stock,
- Ducts or pipe work and ancillary equipment of these vehicles,
- Welded component sections of these vehicles,
- Containers.

3 - Scope of approval

3.0 - General

The scope of approval, permitting a welder or welding machine operator to work to a given degree of skill (B or C) (2), covers all of the following functions :

- the welding procedure,
- the type of joint,
- the parent metal and filler metal,
- the dimension of the test joint,
- the welding position.

(1) Except robot operators.

(2) Skill grade C is required only exceptionally.

The degrees of skill are defined in Appendix 4.

Unless stated otherwise in the specification, where a different class may be stipulated, the degree of skill demand by the design is determined by mutual agreement between the Railway and the manufacturer.

Being the competent authority, the examiner is authorised to issue the approval of a welder or machine operator. He may be a representative of the Railway or of an outside inspection body approved by the Railway.

The results of the approval examination must be embodied in a document and certified by the examiner under his sole responsibility.

This document must contain, apart from the personal data on the welder or operator, all information pertaining to the tests and the examination results.

The document prepared by a manufacturer is accepted as far as it contains the requested information.

In the tests for the approval examination, the welder or operator shall be assessed for suitable practical skill, ability to apply a welding process, the knowledge of safety regulations and equipment. No provision is made for a theoretical examination. It is a matter for the examiner to satisfy himself in advance that the welder or operator has acquired his skill by adequate training.

Within the provisions of Point 6.3 "Renewal conditions" it is permissible to waive a new approval test.

3.1 - Welding processes

3.1.1 - This leaflet applies to the coded (1) welding processes enumerated below (2).

Depending on the conditions, each welding process can be carried out manually, semi-automatically or automatically :

- (111) arc welding with coated electrode,
- (114) arc welding with cored welding wire (without gas shield),
- (12) submerged arc welding,
- (131) MIG welding,
- (135) MAG welding,
- (136) arc welding with cored welding wire (with active gas shield),
- (141) TIG welding,
- (15) plasma arc welding,
- (311) oxy-acetylene welding.

Special test programmes must be established for the other welding processes not listed above.

3.1.2 - Each approval normally covers only one welding process. A change of process requires a new approval test. However, a welder or an operator may be approved for more than one process by a single test or by two separate tests to cover the case of a welded connection, where more than one process is used.

3.2 - Types of welded assemblies

3.2.1 - The test pieces to be made are fillet welds (FW) and butt welds (BW) on sheets and tubes.

The preparation of the pieces depends on their thickness, the welding process and technical factors.

(1) According to standard ISO 857.

(2) According to standard ISO 4063.

3.2.2 - The work, for which the welder or operators is approved, is set out in Table 1 in relation to the type of welded joint.

A welder or operator approved for a welded joint type A is also approved for the other types of joint listed in Table 1.

Table 1 - Butt welds

Weld joint for the approval examination			Approval range					
			Butt welds					
			On plate				On tubes	
			on one side		on both sides		on one side	
			Backing		Gouging		Backing	
			with	w/o	with	w/o	with	w/o
Butt weld on plate	weld on one side	with backing	A	-	x	-	(1)	-
		w/o backing	x	A	x	x	(1)	(1)
	weld on both sides	with gouging	x	-	A	-	(1)	-
		w/o gouging	x	-	x	A	(1)	-
Butt weld on tube	weld on one side	with backing	x	-	x	-	A	-
		w/o backing	x	x	x	x	x	A

(1) See article b)

The following guiding criteria shall be employed :

- a) The welding approval for butt welding of tubes also covers butt welding on plate, except joints of thin plate $t = 1$ mm.
- b) The welding approval for butt welding of plate in all welding positions also covers butt welding of tubes with an outer diameter D_e exceeding 500 mm.
The approval for butt welding of flat bar steel with a flat weld (PA) or horizontal weld (PC) also covers butt welding of tubes with an outer diameter D_e of at least 150 mm or a similar weld position in accordance with Table 6.
- d) Welding on one side without backing also covers welding on one side with backing as well as welds on both sides with or without back gouging.
- e) Welding on plate or tubes with backing also covers welds on both sides, but not welds without backing.
In the case of production work, where fillet welds predominate, it is recommended to submit the welder or operator to approval for this process.
- f) Welding on both sides without back gouging also covers welds on one side with backing and welds made on both sides with back gouging.
- g) Approval for butt welding a tube without backing also covers a tube branch connection in the same position and with the same range of thickness and diameter.

In the case of a tube branch connection the approved diameter range is governed by the diameter of the branch pipe.

In certain cases, an approval test for tube branch connection is essential.

3.3 - Parent metals and filler metals

3.3.1 - Parent metals — Types of filler metals

Considered are rolled, forged and cast materials.

The materials are classified in 5 groups.

This classification shall be used only for determining the type of filler metal, which alone is regarded as a variable.

The type of metal deposited is considered in order to be able to classify the filler metals in the same groups as the parent materials.

Table 2, which shows these groups, shall also be applied to the filler metals.

Group 01

Low carbon non-alloy steels (carbon-manganese steels) and/or low alloy steels generally require no pre-heating or control of welding energy.

This group also includes fine grained steels with a yield strength R_{eH} of less than 355 MPa.

Group 02

Creep resistant chromium-molybdenum (CrMo) steels and/or chromium/molybdenum/vanadium (CrMoV) steels generally require pre-heating and/or control of welding energy or even thermal treatment after welding.

Group 03

Fine grained normalised and tempered structural steels and thermo-mechanically treated steels with a yield limit ReH above 355 MPa. Also nickel alloy steels for similar welding work with a nickel content of 2 % to 4 % by weight, which generally require pre-heating and/or control of welding energy.

Group 04

Ferritic or martensitic steels with a chromium content of at least 12 %, which generally require pre-heating and/or control of welding energy.

Group 11

Stainless austenitic-ferritic steels and stainless austenitic chromium-nickel alloy steels (CrNi), which are welded with or without control of welding energy.

3.3.2 - Approval related to the parent material**Table 2**

A welded or machine operator approved for a given material group A is also approved for the other material group(s) listed in Table 2.

Groups of materials used for approval	Range of validity of the approval				
	Group 01	Group 02	Group 03	Group 04	Group 11
Group 01	A				
Group 02	x	A			
Group 03	x	x	A		
Group 04 (1)	x	x		A	
Group 11 (1)					A

Welding of any material in a group means the approval of the welder or operator for welding any other material of the same group, provided the filler material used during the test can be used for the other steels of this group.

However, in the case of mixed joints (different steel grades to be joined) the materials group or filler material with the highest steel grade is considered.

3.3.3 - Filler materials

Only filler materials approved (2) by the purchasing Railway may be used for welding.

(1) Each stainless steel family of groups 04 and 11 requires separate approval.

(2) Specified in UIC Leaflets 897-1, 897-4, 897-6 and 897-8 for welding steels of group 01.

3.3.3.1 - Approval related to electrode types

The different types of coated electrodes are specified in ISO 2560 depending on their essential characteristics.

For further details on coated electrodes reference should be made to standards ISO 2560, ISO 3580 and 3581 depending on the steel. Unless stated otherwise in the specification, a welder or operator approved for a given electrode coating E will also be approved for the other coating types X in Table 3, with the same welding position.

Table 3

Covered electrodes for manual electric arc welding	Approval range of welders				
	A; AR; O	R; RR	B	C	S
A; AR; O	E				
R; RR	X	E			
B	X	X	E		
C				E	
S (1)					E

(1) S only means approval for the specific type of coated electrode used in the test.

3.3.3.2 - Types of flux

- Flux in powder form : this does not act as a main variable.
- Gaseous shroud : in point 3.1 "Welding processes" a distinction is made between active gas and inert gas, which affect the processes and, therefore, the testing.

Therefore, in view of the different possible combinations within a class, a separate test is to be made for each gas or flux or gas mixture.

3.3.3.3 - Diameter of filler metal or electrode

Only in cases where the electrode or wire is used to carry out the penetration pass on joints without a backing root weld is the diameter of the filler, wire or electrode considered to be a variable. In this case any increase of diameter requires a further test.

3.4 - Dimensions of the test welds (plates or pipes)

3.4.1 - Thickness of test joints

Unless otherwise indicated in the specification, the approval test shall be carried out with a material thickness "t" (plate or, in the case of tubes, wall thickness) as shown in Table 4.

Table 4

Thickness "t" of test joint in mm	Approval range mm
t = 1	from 1 to 3 t (1)
t = 5	from 3 mm to 2 t
t = 12	from 5 mm and over

(1) For oxy-acetylene welding the maximum material thickness is limited to 2 t.

3.4.2 - Diameters of tubes and branch connections for the test joints

Unless otherwise indicated in the specification, the approval test shall be carried out with a diameter, D_e as shown in Table 5.

Table 5

External diameter "De" (1) of test joint	Range of approval
De less than < 25 mm (2)	from De to 2 De
De = 100 mm (25 ≤ De < 150 mm) (2)	from 0.5 De to 2 De
De = 200 mm (De ≥ 150 mm)	from 0.5 De and all greater diameters

(1) In the case of mono-cylindrical hollow cross-sections De is the smallest diameter.
(2) The tube diameter is the one used for brake pipes in the design.

3.5 - Welding positions

The test piece must be made in the positional and angular conditions encountered in production.

The angles of inclination and rotation to be adhered to during the tests are specified in the standard ISO DIS 6947.

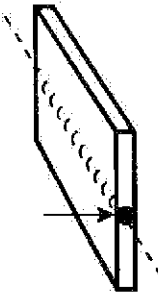
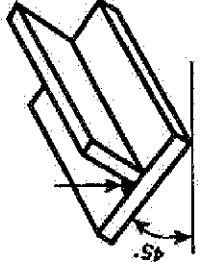
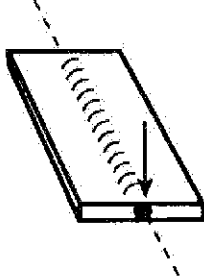
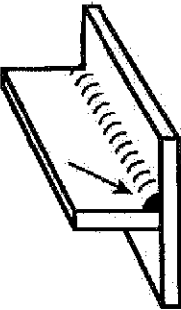
The elements of the test joint are fixed, while welding is in progress, except when a rotating tube is welded.

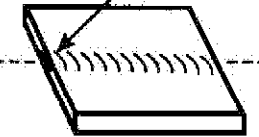

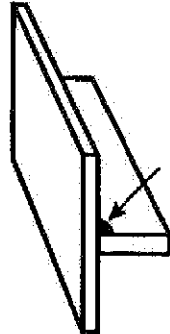
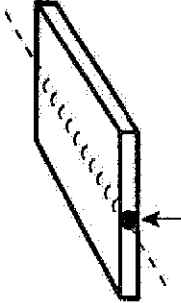
3.5.1 - Butt and fillet welds on plates

The welding positions are specified in Fig. 1.

Welding positions on plates

Fig. 1

BUTT WELDS	FILLET WELDS
<p>Flat weld : the plates are in a horizontal plane, the filler metal is brought in from above.</p>  <p style="text-align: right;">PA</p>	<p>Fillet weld in H.V. positions: the plates are arranged so that the weld runs horizontally while the throat is vertical.</p>  <p style="text-align: right;">PA</p>
<p>Horizontal vertical weld : the plates stand in a vertical plane, the weld runs horizontally.</p>  <p style="text-align: right;">PC</p>	<p>Flat weld: one plate lies horizontally, the other is vertical. The weld between two plates is made in a horizontal plane.</p>  <p style="text-align: right;">PB</p>

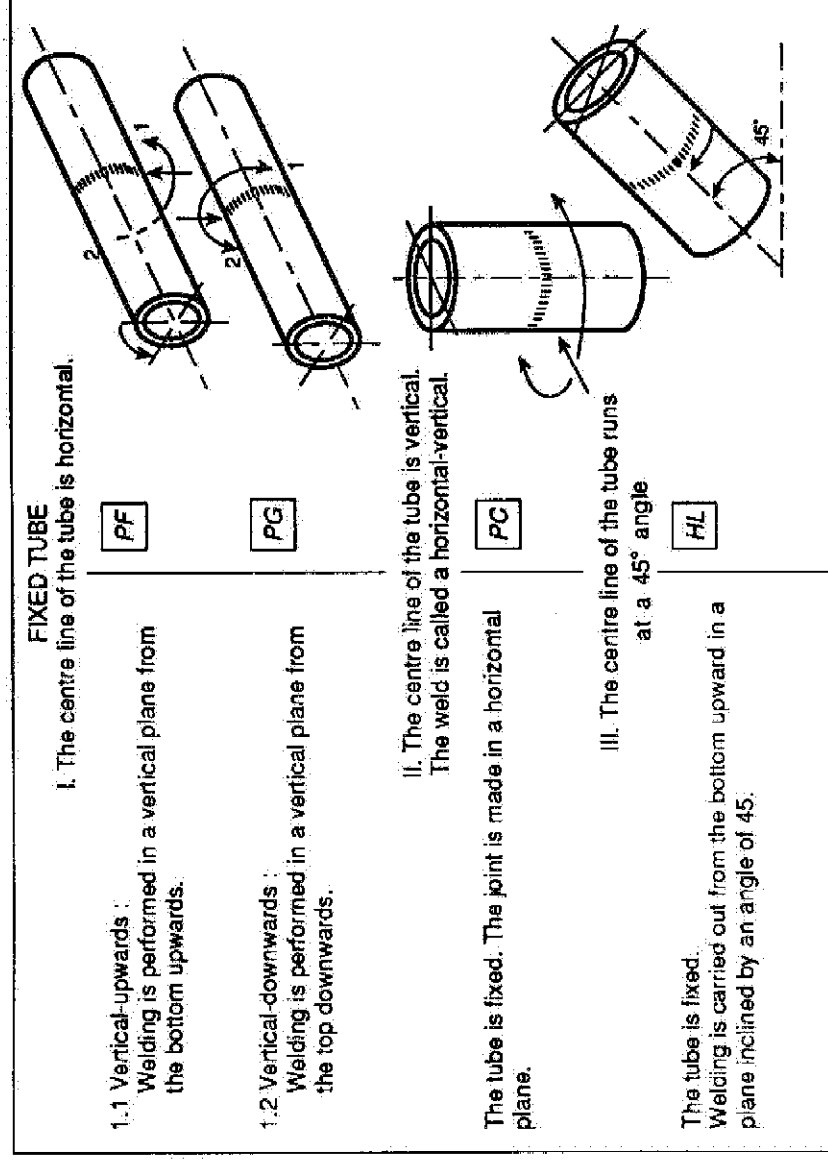
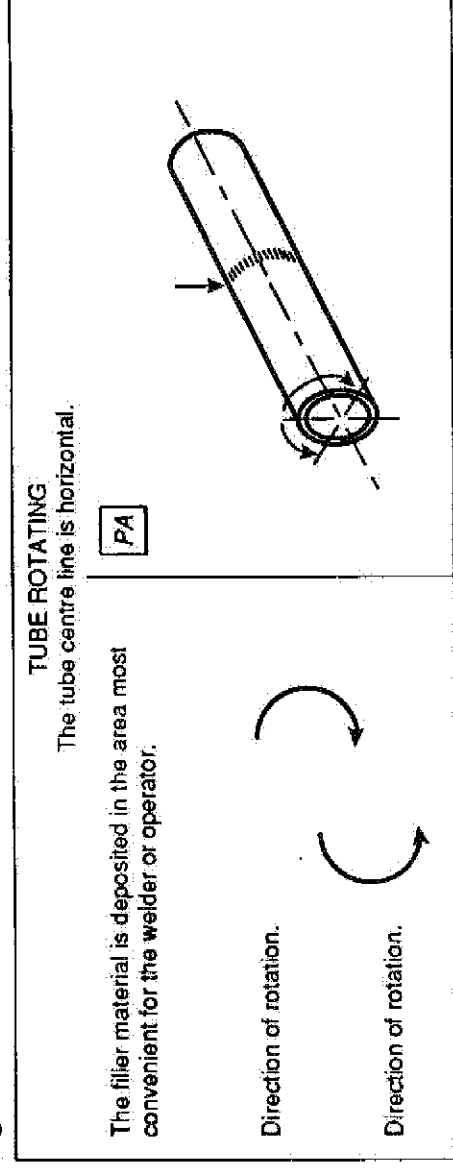
BUTT WELDS	FILLET WELDS
<p>Vertical weld : the plates and the axis of the weld are in a vertical plane.</p>  <p style="text-align: right;">PF</p>	<p>Vertical weld : the plates and the axis of the weld are vertical.</p>  <p style="text-align: right;">PF</p>
<p>Vertical-upwards weld : the filler metal is deposited from the bottom towards the top.</p> <p style="text-align: right;">PG</p> <p>Vertical-downwards weld : the filler metal is deposited from the top towards the bottom.</p> <p style="text-align: right;">PG</p>	<p>Overhead weld : one plate is horizontal, the other vertical, the weld bead is deposited from below in a horizontal plane.</p>  <p style="text-align: right;">PD</p>
<p>Overhead weld : the plates are in a horizontal plane, the filler metal is deposited from below.</p>  <p style="text-align: right;">PE</p>	<p>Overhead weld : the plates and the axis of the weld are vertical.</p> <p style="text-align: right;">PG</p>

3.5.2 - Butt welds and fillet welds on tubes

The welding positions are specified in Figs. 2a, 2b and 2c.

Positions for welding on tubes

Fig. 2a

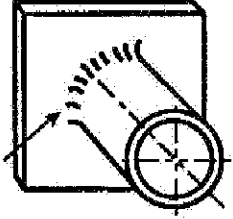
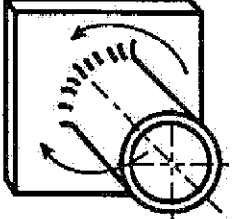


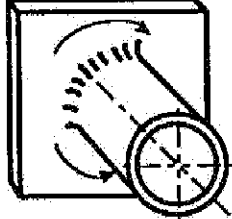
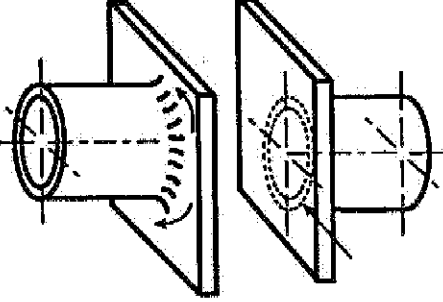
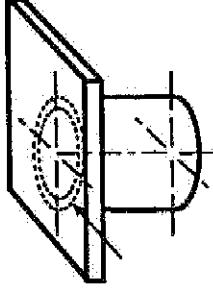
ii. The centre line of the tube is vertical. The weld is called a horizontal-vertical.

iii. The centre line of the tube runs at a 45° angle

Welding of a tube branch connection on a plate. Angle joints.

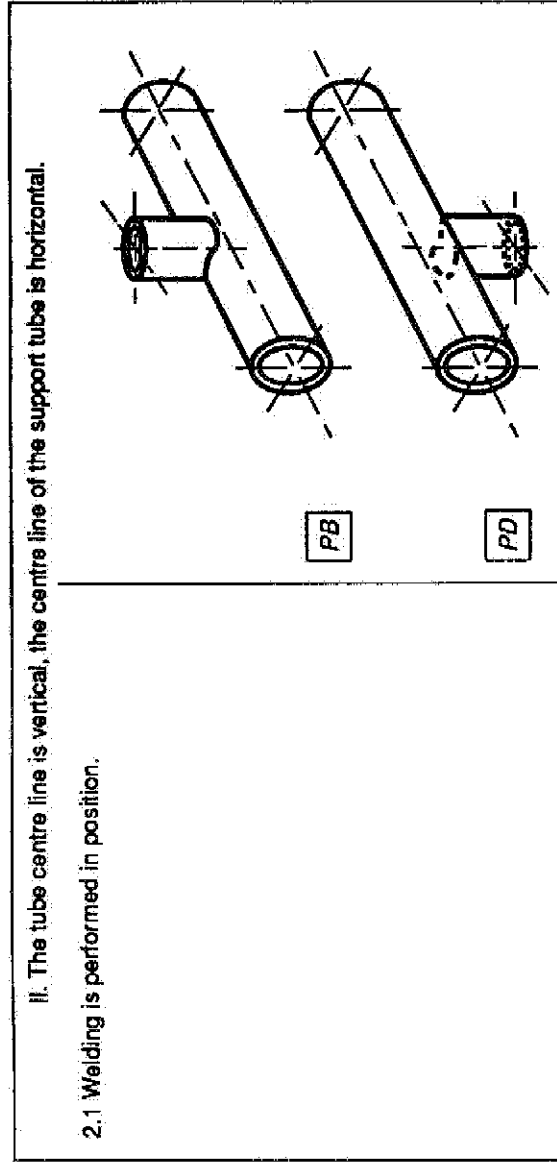
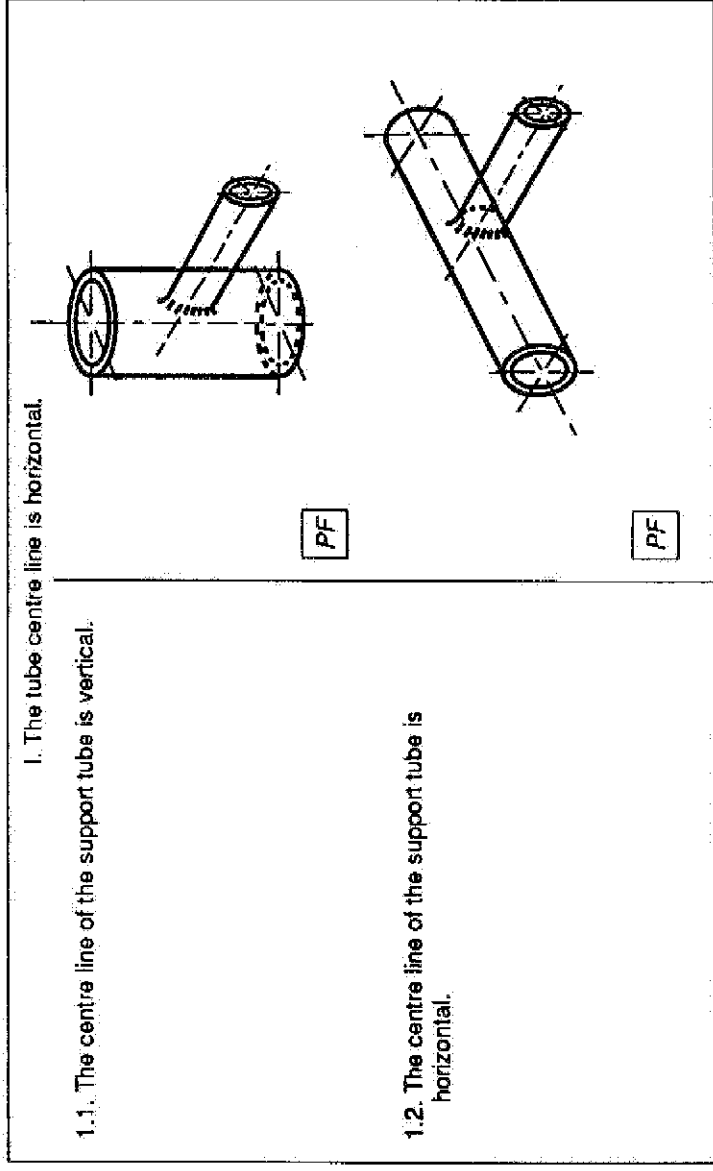
Fig. 2b

ROTATING TUBE	
<p>The tube centre line is horizontal. The plate is in a vertical plane. Tube and plate rotate during the welding process.</p>	 <p>PB</p>
<p>The filler metal is applied in an area most convenient for the welder or operator.</p>	
FIXED TUBE	
<p>I. The tube centre line is horizontal, the support plate is vertical.</p>	 <p>PF</p>
<p>1.1 Vertical-upwards : Welding is performed from the bottom towards the top in a vertical plane.</p>	

<p>1.2 Vertical-downwards : Welding is performed from the top towards the bottom in a vertical plane.</p>	 <p>PG</p>
<p>II. The tube centre line is vertical, the support plate is horizontal.</p>	 <p>PB</p>
<p>2.1 Flat position : Welding is performed in flat position.</p>	 <p>PD</p>
<p>2.2 Overhead position : Welding is performed in the overhead position.</p>	

Welding of a tube branch connection on a tube. Tubes fixed

Fig. 2c



4.1.2 - Forms and minimum dimensions of the test pieces

Each test piece shall consist of two or more parts welded together by one or more welder(s) or operator(s). Several welders or operators can work on the same test piece, if the use of several welding processes is involved.

Figs. 3, 5, 7 and 9 of Appendices 1 and 2 show diagrams of all welding positions on the joints to be made.

4.1.3 - Fabrication of test pieces

The welding procedure for the test must be determined by mutual agreement between the Railway and the manufacturer (welding process filler materials...).

The welder or operator will be told which welding process to use.

If the welding procedure is not accompanied by information regarding tack welds and spacing, it will be left to the welder or operator to decide appropriately.

The welds are not to be back gouged.

The combination of parent metals, filler metal and ancillary materials should represent conditions in practice.

The test shall be conducted in the positions proposed by the manufacturer and which are normally used in production.

The welding equipment should be similar to that used in production.

The approval test may be carried out in a workshop, even if the welders are to be employed elsewhere. However, in this case allowance should be made for particularly difficult operating conditions encountered on that site.

All test pieces produced manually must include, at least in the part to be examined, a stop in the run followed by a resumption without intermediate preparation of the welding pass.

The preparation of the test plates and tubes shall be representative of the conditions applied in practice.

Pre-heating and post-heating shall be applied, if intended to be used with this process.

On the other hand, thermal treatment after welding required by the process (due to material properties or thickness) can be omitted, unless the test piece is to be submitted to bend tests.

5 - Inspection of welded joints and acceptance criteria

5.1 - Inspection of welded joints

If the manufacturer does not have facilities to carry out the tests for the approval of welders or operators, a laboratory approved by the Railway may be used.

The ordering specification and its appended documents shall indicate the nature, positioning and dimensions of the markings to be affixed to each welded joint and specimen.

The identification number of the examiner and welder or operator shall be stamped on each welded joint of an approval test.

5.2 - Inspections during the test

Every welded joint for the approval test shall be made in the presence of the examiner or his representative.

Assessment is made of the skill of the welder or operator :

Judgement of:

- the quality of preparation of the edges to be welded,
- the cleanliness of the parts and filler materials.

Observation of :

- the types and dimensions of the filler materials to be used,
- drying of the filler materials, if necessary,
- any welding energy limits imposed,
- welding parameters, such as current setting and type, polarity, voltage, speed of advance, gas flow...
- the heat cycle (pre-heating, temperature between runs...).

The examiner can terminate the test at any time, if it becomes evident that the welder or operator does not have the necessary technical knowledge or required skill to produce an acceptable result.

Any welder or operator, who tries to remove deposited metal in a visibly exaggerated manner by grinding, planing or another process for fear of leaving visible faults, cannot be approved.

The test shall be carried out within a reasonable period of time, which reflects the actual working conditions in accordance with the stated approval conditions.

The time needed to perform the test shall be noted.

5.3 - Inspections after the test

After the weld has been completed, the test assemblies shall be submitted to the inspections and tests shown in Table 7.

Table 7

Test method	Butt welds Plates and tubes			Fillet welds Plates and tubes Welds on tube branch connections		
	Thickness "t" (1)			Thickness "t" (1)		
	1 mm	5 mm	12 mm	1 mm	5 mm	12 mm
visual inspection	1	1	1	1	1	1
dimensional check	1	1	1	1	1	1
radiography (2) or ultrasonic inspection		1	1 (3)			
bend test (4)		4	4			
fracture test	1 (5)	4 (6)	4 (6)	1 (5)	4	4
macro examination (7)				3	3	3

(1) The thickness of the tube corresponds to the design dimension of the brake pipe.
 (2) The radiographic examination is carried out according to the special requirements of the Railway.
 (3) Ultrasonic inspection may replace radiographic examination. Ultrasonic examination must be carried out by approved testers.
 (4) A bend test is made only for methods 131, 135, 311.
 2 bend tests shall be made upwards and 2 downwards
 If tubular test pieces are welded in positions PF, PG and HLO-45, specimens shall be taken from several test pieces.
 (5) Over the whole joint.
 (6) The fracture test may be replaced with a radiographic examination.
 (7) The specimens shall be taken from the start, the end and the point of resumption of the run.

5.3.1 - Number and selection of specimens***Specimen for visual inspection and checking of dimensions***

The specimen consists of the welded joint itself.

Specimen for radiographic examination

The specimen consists of the welded joint itself, because the radiographic examination is carried out along the whole length of the weld, after visual examination and checking of the dimensions.

Specimens for the bend and fracture tests on butt welds

The specimens intended for these tests are selected in accordance with the information given on their position in Figs. 3 and 6 of Appendix 1 to this specification.

The minimum width of each fracture test specimen shall be 40 mm.

The minimum width of each bend test specimen shall be 30 mm.

The specimens are cut out mechanically or with a cutting torch. In the latter case the cutting marks must be eliminated.

Specimens for the fracture tests on "T" joint assemblies

The specimens intended for these tests shall be selected in accordance with the information given on their position in Figs. 7 and 8 of Appendix 2 to this specification.

The minimum width of each test specimen shall be 40 mm.

The specimens are cut out mechanically or with a cutting torch. In the latter case the cutting marks must be eliminated.

Specimens for macroscopic examination

The specimens for the macroscopic examination shall consist of the ends of the welded joint with the start and end of the weld and a cross-section through the point of resumption. In the case of fillet welds on tubes, the specimens are taken from equally distributed points on the tube circumference.

5.3.2 - Preparation of specimens

The dimensions of the specimens for the bend and fracture tests of butt welded joints and "T" joints must conform with the information given in Appendices 1 to 3 to this specification.

In addition, the specimens shall be prepared as follows :

Specimen for radiographic examination

Excess root penetration is to be ground flat without touching the parent metal.

Specimens for the bend test (Fig. 4 of Appendix 1)

The excess thickness and excess root penetration are to be ground flat without touching the parent metal. The sharp edges are to be rounded off to a radius of approximately one-tenth of the thickness of the assembled joint.

Specimens for the fracture tests

Butt welded joint (Fig. 10 of Appendix 3).

Only excess root penetration is ground flat without touching the parent metal.

A saw cut or a V-form longitudinal notch is applied on the top side in the angular bi-secting plane in accordance with ISO DIS 148, which has a depth of 1 mm with respect to the top surface of the plate.

The edges are rounded off by grinding.

— "T" joint assemblies.

In order to facilitate the fracture of the weld deposited in the angular bi-secting plane, a saw cut is made, or a light weld run is deposited outside the V-angle formed by this plane along the connecting lines of the fillet weld with the assembled elements.

5.3.3 - Performance of inspections and tests

Checking of dimensions

These are checked with a suitable gauge.

Radiographic examination

The radiographic examination of the weld is carried out by reference to the information given for the methods of Class B of ISO Standard 1106/1 (butt welds of plates) and ISO Standard 1106/3 (butt welds of tubes).

The image quality index is the same as for radiographic examinations of welds to be performed subsequently by the welder and it shall be indicated in the ordering specification.

Ultrasonic examination

The ultrasonic examination of the weld shall be carried out in conformity with the procedure mutually agreed by the manufacturer and the Railway.

Bend tests

— Butt welds.

The bend test shall be carried out in accordance with ISO Standard 5173.

Bending of specimens in accordance with Fig. 4 of Appendix 1 is performed with a mandrel, the diameter of which is equal to the thickness of the specimen, the diameter of the rollers being 50 mm and spacing equal to 4 times the thickness of the specimen.

Fracture test

— Butt welded joints

The fracture of the specimen in accordance with Fig. 10, Appendix 3, is obtained by bending it over a mandrel with a diameter twice the thickness of the specimen.

— "T" joint assembly

The fracture of the specimen shown in Figs. 11 and 12, Appendix 3, is obtained by forcing the two legs forming the joint together under a press.

Macroscopic examination

The order and its associated documents must specify the quality of finish. If not indicated, the reagent used must have the following composition :

— for structural steels of groups 01, 02 and 03

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

— for steels of group 04

Reserved.

— for steels of group 11

Reserved.

6 - Results of inspections and validity of approval**6.1 - Approval**

The welder or welding machine operator having passed all tests of his class is approved.

If the result is unsatisfactory, the welder or operator cannot be approved.

The inspection of the test specimens is carried out by reference to the tolerance limits for each fault (1).

(1) Defined in ISO Standard 6520.

If faults are present, which exceed the permitted limits of Appendix 4, classes B and C, the welder or operator cannot be approved.

6.2 - Validity

The approval is valid for 12 months unless otherwise indicated in the specification. However, a repetition of the examination can be requested immediately, if the welder or operator is seen to produce sub-standard work.

6.3 - Extension conditions

The extension of the approval of a welder or operator without another examination is subject to the following conditions :

- he/she must have carried out his work without an interruption of more than six months,
- he/she must not have infringed regulations,
- he/she must have performed work, which is equivalent to the tests to be undertaken before approval.

When any one of these conditions is not fulfilled, the extension is void.

6.4 - Re-testing

A welder or operator, who has not passed the prescribed tests and examinations, can be re-tested only with the approval of the examiner.



When a welder or operator fails to pass the re-test, he cannot submit himself for a new test before the expiry of an agreed period of time from the date of failure.

7 - Approval symbols

7.1 - The full approval symbol of a welder or operator shall include all elements given below in the stated order : these symbols indicate :

7.1.1 - The welding procedure

The symbols to be used are given in paragraph 3.1.1.

7.1.2 - Semi-finished products

The symbol for a plate is "P".

The symbol for a tube is "T".

7.1.3 - The type of joint

The symbol to be used for a butt weld is "BW".

The symbol to be used for a fillet weld is "FW".

7.1.4 - The materials group

The symbols to be used are given in paragraph 3.3.1.

7.1.5 - The filler metal

7.1.5.1 - The symbols to be used for coated electrodes for welding steel are indicated in paragraph 3.3.3.1.



The references to the electrode for welding steels of group 01 can be stated separately in accordance with UIC Leaflet 987-2.

7.1.5.2 - The symbols to be used for wires and gases for welding steels of group 01 are indicated in UIC Leaflet 897-7. The references to the wire electrode can be stated separately in accordance with UIC Leaflet 897-7.

7.1.5.3 - The symbols to be used for filler metals for welding steels of groups 02 to 11 shall be specified by mutual agreement between the manufacturer and the Railway in accordance with the appropriate standards.

7.1.6 - Dimensional characteristics of the assembly

The symbol to be used for indicating the thickness is "t".

The symbol to be used for indicating the diameter of a tube is "De".

7.1.7 - The welding position

The symbols to be used are indicated on Figs. 1 and 2 of paragraphs 3.5.1 and 3.5.2.

7.1.8 - Additional note

The symbols to be used are :

- without filler metal	"nw"
- welding with backing	"mb"
- welding with gas shielding of weld root	"gb"
- welding on both sides	"bs"
- back gouging or grinding of welds	"gg"
- welding without backing	"nb"
- without back gouging	"ng"
- control of welding energy	"ch"
- without treatment	"nh"
- pre-heating	"ph"
- treatment by post-heating	"wh"

7.2 - Application

7.2.1 - The full symbol of the welder's approval is formed by placing the individual symbols together in the order set out in paragraph 7.1.3.

7.2.2 - Example

7.2.2.1 - 111 P BW I B t9 PF nb nh

This symbol indicates the following :

111	arc welding coated electrode,
P	welding of a plate,
BW	butt welding,
I	non-alloy low carbon steel,
B	electrode with a basic lime cover,
t9	specimen thickness 9 mm,
PF	butt weld on vertical plate,
nb	without backing,
nh	without thermal treatment.

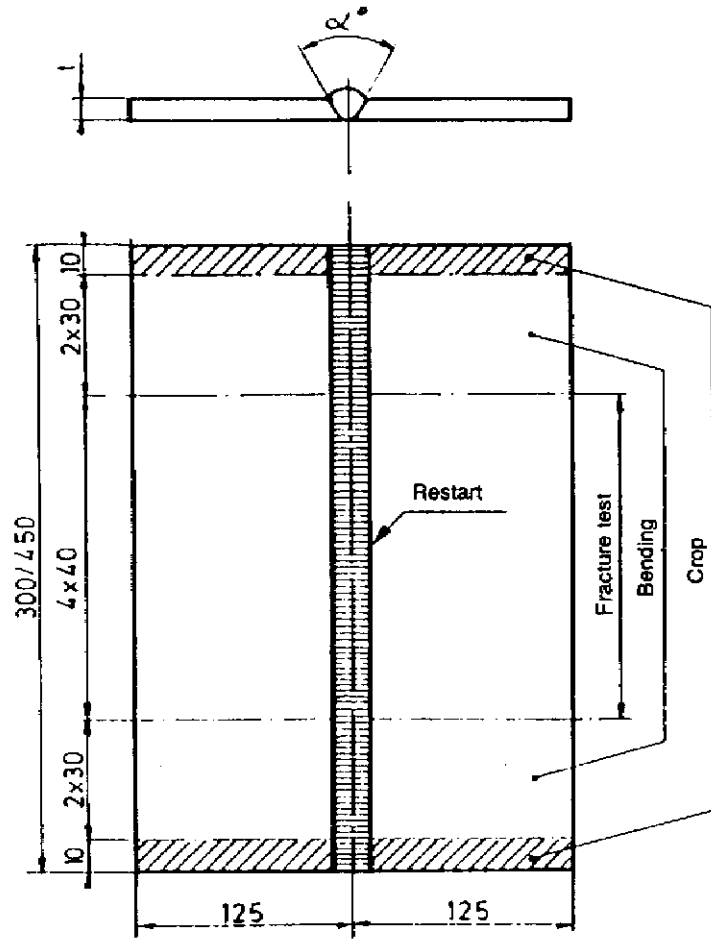


Fig. 3

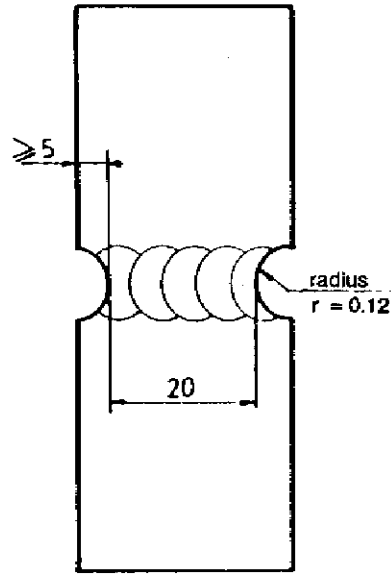


Fig. 4

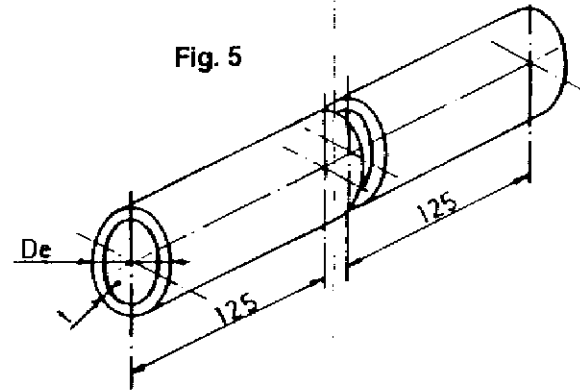


Fig. 5

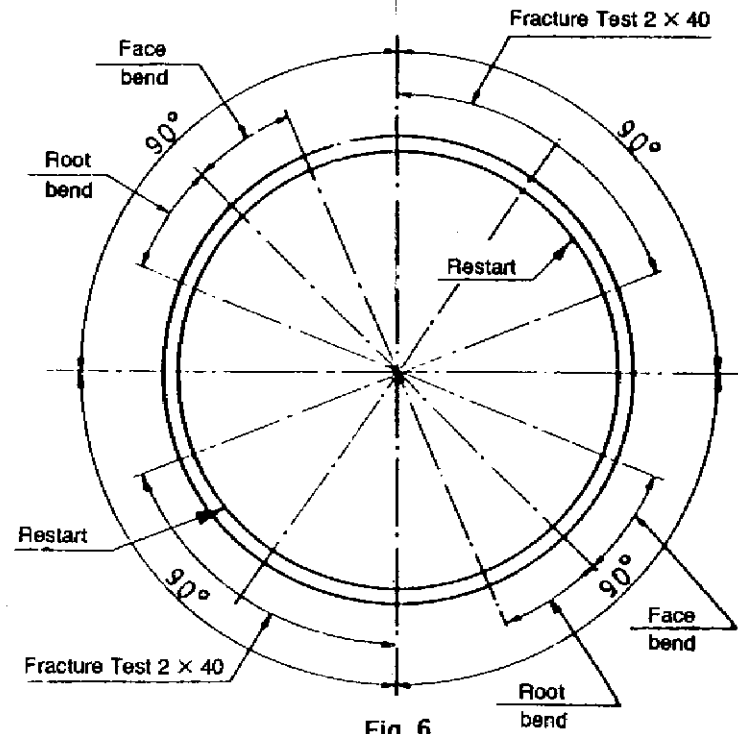


Fig. 6

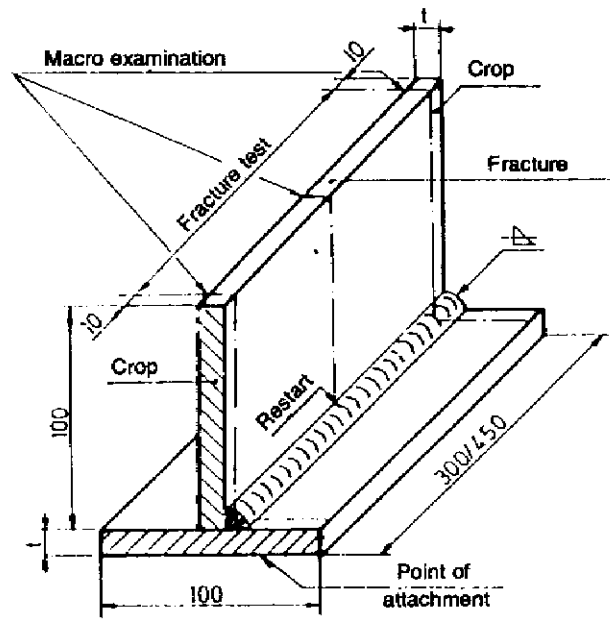


Fig. 7

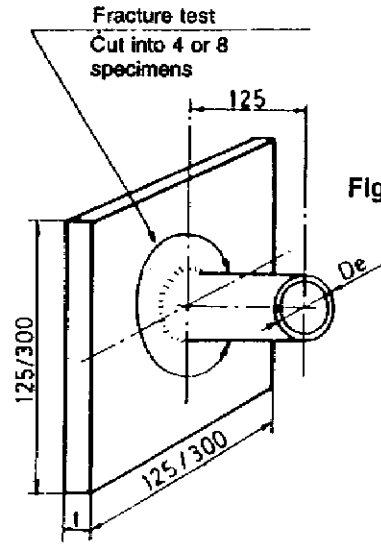


Fig. 8

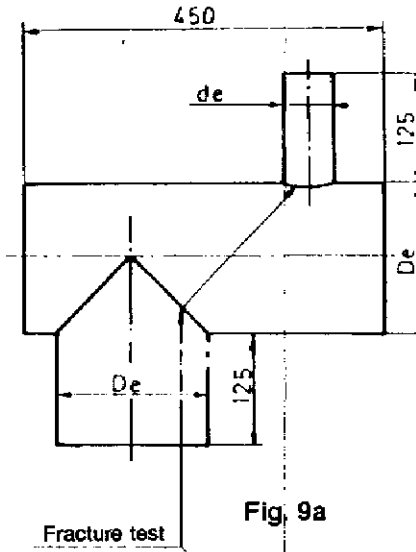


Fig. 9a

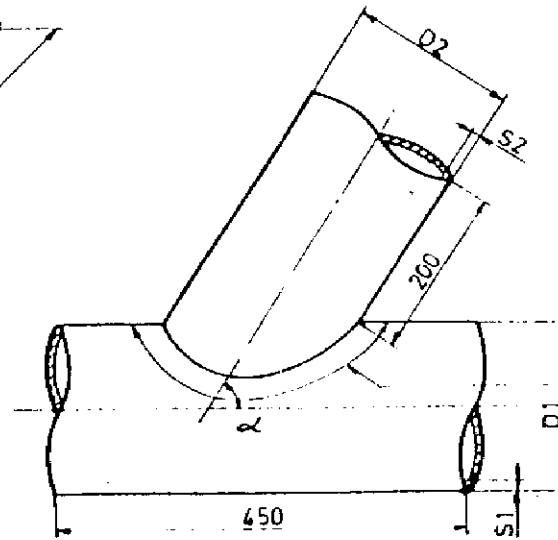


Fig. 9b

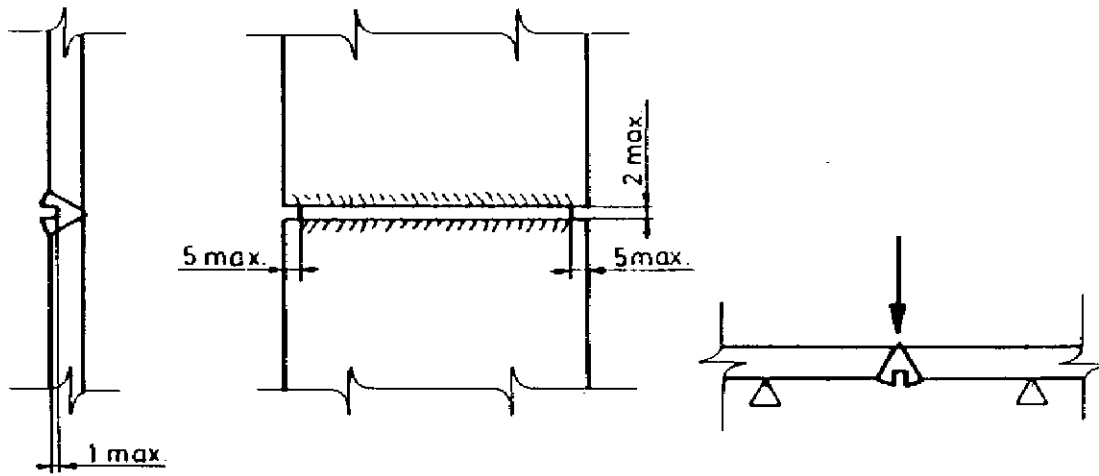


Fig. 10

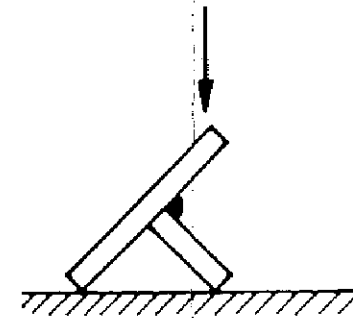
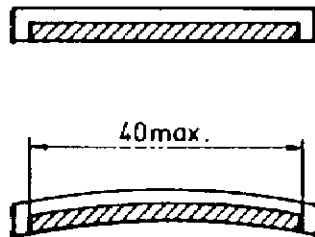


Fig. 11

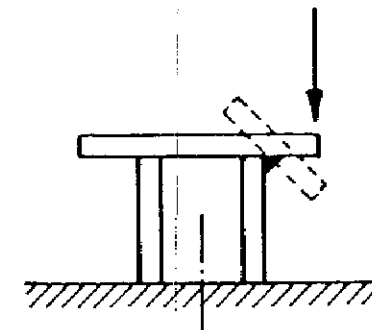


Fig. 12

Limits for fault categories

Fault	Fault types	ISO 6520	Comments	Limits for:	
				Average requirements C (1)	High requirements B (1)
1	Cracks	100		not permitted	not permitted
2	Crater cracks	104		not permitted	not permitted
3	Spheroidal gas-pores; uniformly distributed	2011 2012 2014 2017	Projection in a plane parallel to the weld surface over the whole weld length. Each pore area must be assessed separately.	Pores must not exceed 2 % of the projected surface. Pore cavities must not exceed 3 mm.	Pores must not exceed 1 % of the projected surface. The pore cavity must not exceed 2 mm.
4	Clustered porosity	2013	Projection in a plane parallel to the weld surface. The pore area must be limited. Systematic faults are not permitted. The possibility of masked faults must be considered. The pore area in the cluster is calculated in % of the largest of the two surfaces of an envelope covering all welds or on a circle with dia. s (s : nominal thickness of weld).	Pores must not exceed 8 % of the projected surface. The pore cavities must not exceed 3 mm.	Pores must not exceed 4 % of the projected surface. The pore cavities must not exceed 2 mm.

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Fault	Fault types	ISO 6520	Comments	Limits for:	
				Average requirements C (1)	High requirements B (1)
5	Elongated pores; tubular pores crater cracks	2015 2016 2024	Only small pinhole craters are permitted (no systematic faults).	Continuous faults are not permitted. Height and width of local faults must not exceed 3 mm. The length must be smaller than the weld thickness.	Continuous faults are not permitted. Height and width of local faults must not exceed 2 mm. The length must be smaller than the weld thickness.
6	Solid inclusions	300 301	The same limiting conditions apply as for fault no. 5.		
7	Lack of fusion	401		Not permitted.	Not permitted.

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8	Lack of penetration	402	Concerns penetration in butt, fillet and T welds. If the weld thickness is required to be less than the plate thickness, the fault level equals the difference between the normal and actual weld height. If for this weld a real weld thickness greater than the required values must be avoided, additional requirements must be imposed.	Continuous faults are not permitted. Local faults are permitted, if the height is less than 1.5 mm, but does not exceed 10 % of weld thickness. Max. unit length a = 10 mm. Distance between 2 faults b = 6 times the shortest distance. Total length on weld or per 300 mm joint section : c = 20 mm.	Not permitted.
9	Root gap		Root gap on one-sided butt welds. Similarity with alignment fault.	The gap height must not exceed the limiting values fixed for lack of penetration faults (fault no. 8). See also no. 18.	
10	Penetration notches	5011 5012 5013		Continuous faults are not permitted. The height of local faults must not exceed 0.5 mm. Max. length 20 % of weld.	Not permitted.

(1) Approval class according to ISO DIS 5817.

Fault	Fault types	ISO 6520	Comments	Limits for :	
				Average requirements C (3)	High requirements B (1)
11	Weld overfill on butt weld	502		The height of overfill must not exceed 3 mm and in no case 1 mm + 10 % of weld width.	The height of overfill must not exceed 2 mm and in no case 1 mm + 5 % of weld width.
12	Excessive convexity of weld.	503	Measurement of height based on the actual gap.	The height must not exceed 3 mm, but in no case 1 mm + 15 % of the actual gap thickness (1 mm + 7.5 % of bead width).	The height must not exceed 2 mm, but in no case 1 mm + 10 % of the actual gap thickness (1 mm + 5 % of weld width).
13	Fillet weld thickness less than nominal value.			The deviation must only be local and not exceed 1 mm but in no case 0.3 mm + 5 % of the nominal weld thickness.	No deviation is permitted.

14	Filler weld thickness over nominal value.			The deviation must not exceed the limiting values set for excessively convex welds (fault no. 12).
15	Excess penetration.	504		<p>In areas without lack of penetration the penetration height must not exceed 4 mm, but in no case 1 mm + 60 % of penetration width.</p> <p>Penetration must be continuous. The penetration height must not exceed 3 mm, but in no case 1 mm + 30 % of penetration width.</p> <p>For tubes with d less than 25 mm the height of the penetration weld must be less than 1.55 mm.</p>
16	Protrusion	5041		<p>For inert gas welding : The application of borax fluxing on steels of groups 02 and 11 is not permitted.</p> <p>For steels of group 1, surface oxidation traces are permitted</p>
17	Overspill	506		are not permitted
				Not permitted
				Not permitted

(1) Approval class according to ISO 6517.

Fault	Fault types	ISO 6520	Comments	Limits for :	
				Average requirements C (1)	High requirements B (1)
18	Alignment fault	507	The limiting values given relate to deviations from the correct position. The correct position depends on the individual case. Unless indicated otherwise, it is assumed that plates are in the correct position, when the centre lines coincide at plate half-thickness. Positioning faults measured at the surface may vary depending on the different plate thicknesses, tube diameters and wall thicknesses.	Not permitted	Not permitted
19	Angular misalignment	508		← than 1/10	← than 1/20

20	Sag	509 6091 5092 5093 5094			The amount of sag must not exceed the limiting values specified for : - excess penetration (fault no. 15) - lack of thickness (faults no. 13 and 21).
21	Lack of thickness, butt weld	511	The values relate to a smooth and rounded profile. For sharp faults refer to the values given for penetration notches (fault no. 10).	Not permitted	Not permitted
22	Symmetry fault in fillet weld.	512	It is assumed that an asymmetric fillet weld was not specifically stipulated.	The difference between the leg lengths must not exceed 1 mm + 10 % of the throat.	The difference between the leg lengths must not exceed 1 mm + 10 % of the throat.
23	Gas cavity at the root	515			The same limiting values as for fault 8 (lack of penetration). If the edges are fused, the limiting values for fault 10 may be taken as an alternative.

(1) Approval class according to ISO/DIS 5817.

Fault	Fault types	ISO 6520	Comments	Limits for :	
				Average requirements C (1)	High requirements B (1)
24	Poor resumption after stop	517		Not permitted	Not permitted
25	Arc burn	601		Not permitted	Not permitted
26	Spatters	602		A few splashes are permitted	
27	Poor positioning and lack of penetration, fillet weld		Gap between the elements to be joined and poor penetration	Not permitted	Not permitted

(1) Approval class according to ISO/DIS 5817.

Application

With effect from 1 January 1991.

All UIC Railways.

Record References

Last leading under which this question was dealt with :

— *Question 5/SA/FIC - Approval of revised Leaflet 897-11 "Technical specification for the approval of welders for fusion-welding of steels"*
(Traction & Rolling Stock Committee : Paris, June 1990).