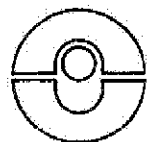


UIC Code **8 9 7 - 2 2**

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1st edition 1.1.94

**Technical specification
for the quality control
of welded joints on rolling stock
in aluminium and aluminium alloys**



International Union of Railways

**NUMERISATION DANS
L'ETAT DU DOCUMENT**

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Leaflet to be classed in volumes :

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

Amendments

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Preliminary remarks :

A double vertical line (||) in the margin denotes modifications introduced on the date shown at the foot at the page.

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

Note

This leaflet forms part of a set which also includes :

- | | |
|----------------|---|
| Leaflet 897-20 | Technical specification for the approval of welders for fusion-welding of aluminium and aluminium alloys. |
| Leaflet 897-21 | Technical specification for the approval of a procedure for fusion welding of aluminium and its alloys. |
| Leaflet 897-23 | Technical specification for the execution and control of test joints in aluminium and aluminium alloys. |

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Appendix

1 - Purpose and classification

1.1 - Purpose

This leaflet defines the conditions for the welding and inspection of welded joints previously defined using an approved welding procedure.

It shall apply to welded joints on joints made of aluminium and aluminium alloys (1).

It shall define :

- the classification of welded joints,

It shall include :

- the approval of welding procedures (1),
- inspection of welding conditions on test joints (mock-ups),
- inspection made before, during and after the weld is executed.

For special applications, the customer railway may also stipulate special requirements in the specification.

This leaflet shall apply to the arc welding procedures defined below. Each welding procedure may be manual, semi-automatic or automatic, as the case may be.

- 13 arc welding with core wire with shielding gas,
- 14 arc welding with refractory electrode with shielding gas,
- 15 plasma arc welding.

(1) In accordance with Leaflet 897-21

For other procedures not mentioned above, a specific approval programme shall be established.

1.2 - Classification of welded joints

The class of a welded joint shall be decided by the design office taking into account the stresses experienced by the joints in service, and approved by the technical department of the user.

The class of a welded joint shall correspond to a specified level of permissible defects, as indicated on the drawing.

Joints are classified according to three quality classes, in descending order.

Class B : high-quality welded joints exposed to severe conditions and subject to dynamic stress in service. For certain joints subjected to fatigue, post-welding treatment may be performed (Area of Post-Welding Treatment) (1).

Class C : quality welded joints with assemblies, sub-assemblies or parts affecting the strength of the material.

Class D : Standard quality welded joints.

The permitted tolerances for defects in these classes are covered in the Appendix to this Leaflet.

(1) Post-welding is not part of the thermal treatment. It includes operations such as removal of waste metal, shot blasting, remelt of weld using a process such as TIG, etc.

2 - Characteristics

2.1 - Physical characteristics of the welds

2.1.1 - Appearance

The appearance of the welds shall be such that they conform to the acceptance criteria given in Appendix.

2.1.1 - Internal condition

The internal condition of the weld shall be such that the nature, form, number and frequency of the hidden defects comply with the acceptance criteria given in Appendix.

2.2 - Geometric characteristics of the welds

The geometry of the welds shall be such that their form and dimensions comply with the values laid down by the drawings (1) and the acceptability criteria. In the special case of fillet welds, the weld shall, as far as possible, be continuous and symmetrical.

In the absence of any indication in the specification, the relevant defects and tolerances shall be those given in Appendix to this Leaflet.

2.3 - Geometric characteristics of the joints

After welding, the geometry of the welded parts, sub-assemblies and assemblies shall comply with the dimensions and tolerances determined by the drawings.

(1) According to ISO 2553

2.4 - Mechanical characteristics of the welded joints

Unless otherwise specified at the time of order, the mechanical characteristics shall be guaranteed by the acceptance of the WPS (1).

2.4.1 - Tensile strength across the weld

The tensile strength across the weld, measured on a standard test piece (2), shall be equal to at least the minimum guaranteed tensile strength of the parent metal in the heat-treated condition.

2.4.2 - Fracture test

The broken cross-sections of the test pieces shall not show defects that exceed the limits defined in Appendix.

2.4.3 - Fillet weld fracture test

The fillet weld fracture test shall not show cracks or latent fissures particularly at the join between the weld and the sheet.

This examination must not reveal defects that exceed the limits laid down in Appendix.

2.4.4 - Macrographic examination of cross-sections

This examination must not reveal defects that exceed the limits laid down in Appendix.

The penetration and fusion at the root shall be examined on macrographic cross-sections of the welds.

In case of doubt, a micrographic examination shall be carried out.

(1) According to Leaflet 897-21
(2) CEN Norm 10045

3 - Production

3.1 - Approval of welders or operators

All welds must be executed by welders or operators previously approved under the terms of UIC Leaflet 897-20.

3.2 - Approval of welding procedures

For class B and C welds, the procedures used shall have been approved beforehand in accordance with UIC Leaflet 897-21.

3.3 - Approval of filler products

Only filler products approved by the railways may be used. They shall be free from oil and other impurities.

Approval of filler products may take place at the same time as approval of welding procedure specifications. The filler products may then be supplied by the manufacturer with a certificate of chemical analysis.

3.4 - Welding

3.4.1 - General conditions

Welding operations shall be performed under shelter.

The temperature of the parts to be welded must be greater than 5°C.

Where a gas shield is used, special protection shall be required if the welding process is at risk from draughts.

Where pre-heating is necessary, the minimum preheat temperature shall be maintained throughout all the welding operations.

When the component parts are fitted up, irrespective of the preparation procedure used, the welding preparations and the area in their immediate vicinity shall be clean, free from rust, grease, oil, marking chalk, paint and any other impurity.

The ends of welds shall be given particular care. In certain cases, the representative of the railway may require that the weld begin and end outside the working length of the joint, using run-on and run-off plates (extension plates). These extension plates shall be removed after completion of the joint, either mechanically, or by cutting with a blow-pipe, to be followed compulsorily by grinding. This procedure shall also be required for removal of attachments.

For multi-pass welds, before a covering pass is made, the underlying pass shall be cleaned vigorously with a rustproof metallic brush to obtain a clean surface. If this underlying pass shows slag defects, gas porosity, defects, cold laps or undercut, it shall be cleaned up by grinding, milling, graver or file, so that the defects are removed and the covering pass can be made on clean metal throughout.

Any cracking occurring in a weld-bead shall be completely removed before a further pass or any repair by welding is made using a suitable welding procedure.

With manual arc welding, the arc may be struck in the joint, on the extension pieces or on a specially designed part. It is also permitted for the weld to begin outside the working length of the joint.

If a sealing run is planned, it must be preceded by gouging, except in some cases where the representative of the customer railway authorises a sealing run without gouging. The reverse side of the weld must be cleaned vigorously using a suitable method so that a clean surface is obtained. Gouging must remove the defects inherent



in the first pass to be made at the root of the joint, particularly a lack of penetration, possible fissures, end craters, tack beads, etc.

When a sealing run is impossible, the welds may be required to be executed on supporting parts of temporary or permanent nature.

In case of automatic welding with shielding gas (13) the parts must be correctly positioned using suitable structures.

3.4.2 - Edge preparation

The physical and geometric characteristics of the weld edges must comply with those laid down by the WPS. In the absence of any instructions in these documents for welding with shielding gas, the characteristics shall be those covered by the provisions of Standard ISO/DIS 9692.

3.4.3 - Preparation of the parts to be welded

The procedure used for shaping the edges to be welded shall be the object of a prior agreement between the factory and the customer railway.

It may not be modified without the agreement of the latter.

When the parts are cut to length, the necessary additional lengths shall be provided such that once shrinkage has been taken into account, the geometric characteristics of the finished weld parts meet the conditions laid down in the drawings.

Any irregularity on the cutting surface greater than that laid down by the customer railway shall be removed by mechanical machining.

The maximum permitted tolerance for the inclination of the sheared face shall be 1/10 of the thickness of the part. However, for class B T-welds, the faces shall be stood at right angles. Any defect shall be removed by grinding.



3.4.4 - Mounting

3.4.4.1 - Welding jigs

The manufacturer shall possess welding jigs, templates and manipulators to enable the following operations to be effected mechanically :

- sufficiently accurate positioning of the parts to be welded,
- optimal position for a clean weld,
- easy and effortless removal of the finished assembly.

The mounting apparatus may only be used to keep the component parts of the joint on the templates and jigs during the tack weld and/or weld proper.

The positioning, tacking or welding jigs shall be sufficiently rigid to ensure that the geometry of the parts is correct after welding.

The specification shall give details of any special requirements to be met by the templates or mounting apparatus.

3.4.4.2 - Saddle joints

Saddle joints shall be executed in a carefully-determined order, to prevent fissuring and giving rise to damaging residual tensions in the joint.

The tack welders shall have received training and must prove themselves capable of making quality tack welds suitable for the parent material and in the appropriate weld class.

In principle, tacking shall be carried out on the right side of the welding groove.

For class B and C welds, no saddle joints shall be executed at the ends of the weld lines or of the gusset, nor in bend curves of radius less than or equal to $10e$, where "e" is the thickness of the element bent.

The length and separation of the tack welds shall depend on the dimensions of the joint.

For class B welds, the specifications may provide for the removal of the tack welds as the welding work gradually progresses.

3.4.4.3 - Removal of saddle joints

The remelting of the saddle joints shall not cause defects that exceed the limits laid down in Appendix.

Defects that are not permitted for the weld class concerned must be totally and carefully removed before execution of the final weld.

The preparation shall be restored if necessary.

3.5 - Welding of joints

3.5.1 - General

The welding work itself shall under no circumstances be undertaken before the appropriate drawings, conditions of execution, WPS and non-destructive inspection programme have been drawn up.

3.5.2 - Welding programme

Before execution of the weld, the manufacturer shall draw up a welding programme. This welding programme shall be sent to the representative of the customer railway.

The welding programme must specify :

- recommended type of edge preparation for the weld,
- phases of manufacture after which a routine non-destructive inspection may be performed,
- the welds to be completed.

A programme of welding sequences shall be drawn up for each important joint, and include the position and order of deposition of the tack welds, the order of deposition of the various joints, and the turning of the parts.

After examination of the welding programme, the customer railway shall send its remarks and counter-proposals to the manufacturer. However, the whole responsibility for the work carried out shall rest with the manufacturer.

The customer railway must also be informed of any modification made to the welding programme during completion of the order.

The method of performing the welding procedures shall be defined by the purchasing specification; reference may be made to the provisions of UIC Leaflet 897-21.

3.5.3 - Welding conditions

The welding parameters and conditions defined by the welding programme shall be respected.

In the case of non-compliance with these factors, a new test joint shall be executed (mock-up) with the parameters and conditions that were really used.

For class B butt welds, wherever possible the weld shall start and finish outside the working length of the joint by providing extension pieces at each end, attached by mechanical means.

The thickness of these extension pieces shall be at least equal to that of the part itself and must undergo the same edge preparation. The extension pieces shall be removed once the joint is finished, either mechanically or by manual oxygen cutting, followed by grinding.

Breaking the extension pieces off by impact shall be prohibited.

For other class B welds and all class C welds, when the ends of the first parts are seen not to meet the requirements of the Appendix, the representative of the customer Railway may require the use of extension pieces in welding the following parts.

Two continuous lateral corner beads, aligned on either side of the element, shall be linked at their far ends by return runs over a length at least equal to the thickness of the element.

No cold hammering shall be permitted.

Repair welding is permitted after prior approval has been granted by the customer Railway.

3.5.4 - Cleaning and finishing of welds

The welds and the immediately surrounding areas shall be cleaned so that a smooth surface is obtained, free of any spatter greater than that defined in Appendix.

Welds requiring particular finishing shall be indicated on the drawing and on the welding programme.

3.5.5 - Straightening of joints

Any straightening of joints shall be subject to the prior agreement of the customer Railway. This agreement shall only be given when the manufacturer has proven his ability to perform the technique he wishes to employ.

At the request of the customer Railway, a non-destructive inspection may be required to ensure the absence of cracking.

Cold peening of weld beads shall not be permitted.

Straightening by means of weld beads shall also be prohibited.

3.6 - Finishing of welds

Welds requiring a special finish shall be indicated on the drawings and in the welding programme. Where the finishing is achieved mechanically, this should be done as far as possible parallel to the direction of the stresses and may be preceded by the production of test joints.

3.7 - Repair of welds

In the event of a welding problem emerging during manufacture, the defective part may be removed either mechanically or by cutting with a blow-pipe.

The manufacturer shall, once the agreement of the customer Railway has been obtained, correct those welds which show unacceptable defects for the corresponding weld class.

4 - Inspection

4.1 - General

The manufacturer's inspection service shall possess the installations and equipment to enable the welded joints to be inspected on a permanent basis.

The manufacturer or his authorised representative shall inform the customer Railway by means of a signed note and the person in charge of the inspection, of all the conditions agreed or required by the specification.

Inspection of preparation and welding work shall be performed before and during the welding, as well as after execution of the welds.

The representatives of the customer Railway shall have freedom of access to all the manufacturing workshops concerned and shall be allowed to perform their monitoring function before and during the work, as well as after its completion.

All safety and hygiene measures required by law shall be observed.

The manufacturer shall keep a written record of the names of his approved welders and keep it available to the customer Railway.

4.2 - Number and nature of inspections to be made

The order and its accompanying documents shall indicate for each type of joint the number and nature of the inspections to be performed.

The manufacturer may, subject to the agreement of the customer Railway, propose other methods of non-destructive inspection to replace or complement the radiographic inspection (dye penetration test, ultrasound, etc.).

The non-destructive inspection programme must define the areas to be inspected.

For destructive testing, the representative of the Railway shall choose the areas to be inspected.

A weld bead requiring correction shall be re-inspected after repair.

4.3 - Execution of inspections

4.3.1 - General

The manufacturer's inspection service shall use inspection equipment that is in perfect working order and entrusted to staff who are competent, qualified and perfectly familiar with the technology of the process used.

4.3.2 - Pre-manufacture inspection

4.3.2.1 - Inspection of component parts

The characteristics of all the materials, including the filler products used in the manufacture of the welded parts, assemblies or sub-assemblies, must satisfy the requirements of the leaflets, the standards shown on the drawings or the product specification, and must have been inspected by the customer railway under the conditions defined by these documents.

4.3.2.2 - Inspection of approval of welders or operators

The welders or operators required to execute the welding operations shall have been approved under the terms of UIC Leaflet 897-20.

4.3.2.3 - Inspection of approval of a procedure on a test joint

The approval of a welding procedure on a test joint may be carried out with the agreement of the customer Railway in accordance with the provisions of Leaflet 897-23.

4.3.2.4 - Inspection of approval of a welding procedure

The approval of a welding procedure must be carried out in accordance with the provisions of UIC Leaflet 897-21.

4.3.3 - Inspection during manufacture

During manufacture, the manufacturer shall ensure that the conditions laid down in point 3 are observed.

The inspector of the customer Railway shall ensure compliance with the requirements by spot checks. If the order requires the production of specimen lengths from the joint, the representative of the customer Railway shall ensure they comply with the conditions. To this end, should the quality prove lacking, all or part of the tests designed for the approval of a welding procedure for test joints shall be performed. These tests shall be carried out either on an actual part or on a sample extension pieces produced at the same time as the part.

Should repeated defects occur in the welds produced by a welder or an operator, the representative of the customer Railway may require that the person concerned be submitted for renewed approval.

4.3.4 - Inspection of finished parts

The visual appearance of the welds must not reveal any defects exceeding the acceptance criteria in Appendix.

4.3.4.1 - Dimensional inspection of welds

The dimensional inspection of the welds shall be performed using suitable instruments. It must not reveal defects exceeding the acceptance criteria in Appendix.

4.3.4.2 - Inspection of welded joints

In the absence of any indication to the contrary in the drawing, the permitted dimensions shall be those defined by the provisions of Leaflet 800-51.

4.3.4.3 - Inspection of the internal condition of welds

Inspection of the soundness of the welds shall be performed by means of non-destructive examination. The methods for the non-destructive inspection shall be approved by the customer Railway.

The inspection must not reveal defects exceeding the acceptance criteria in Appendix.

4.3.4.4 - Radiographic inspection

The radiographic inspection programme shall be drawn up by joint agreement with the representative of the customer Railway or laid down in the special specification.

The inspection must not reveal defects exceeding the acceptance criteria defined in Appendix.

The total length to be inspected shall be defined in accordance with documents approved by joint agreement between the customer Railway and the manufacturer.

4.3.4.5 - Ultrasound inspection

Subject to the agreement of the customer Railway, an ultra-sound examination may replace the radiographic examination. The length to be examined by ultrasound shall not be less than that intended for the radiographic inspection.

4.3.4.6 - Additional inspections

Additional inspections to those laid down by this Leaflet, such as examination by magnification, dye penetration, ultrasound or other means may be required by the drawing, the product specification or the specification, or required in the case of hidden defects in parts of similar manufacture which render them unfit for use.

4.3.5 - Conclusion of inspections**4.3.5.1 - Conclusion of tests**

Any test result that does not meet the requirements of this Leaflet shall result in refusal of the part of the test joint concerned or the parts.

Only those tests rendered invalid by a fault in their execution may be restarted. A "fault in execution" shall be taken to mean faulty machining of the test pieces, incorrect set-up in the test machine or a malfunction of the test machine.

Where a faulty test piece gives an unsatisfactory result, the manufacturer may be authorised to effect a retest, subject to the agreement of the customer Railway.

4.3.5.2 - Conclusion of inspections before welding

If the preparation of the surface and edges of a part to be welded does not comply with that used for the test joint, that part may not be used in manufacture.

If the surface treatment of a part is not equivalent to that of the test joint, that part may not be used in its current form.

4.3.5.3 - Conclusion of inspection during manufacture

Non-compliance with the conditions stipulated in point 3 shall lead to the part on which the defect has been noted being refused.

This refusal shall extend to all parts manufactured under the same conditions.

Any welded element produced by a welder or operator who is not approved or has a lower classification than that required for the weld class concerned shall be refused.

4.3.5.4 - Conclusion of inspection of completed welded joints

4.3.5.4.1 - Appearance and dimensions of the welds

Any defect in the appearance or dimensions of a weld which cannot be removed by a mechanical process within the acceptance criteria given in Appendix shall result in refusal of the welded joint.

4.3.5.4.2 - Internal condition

The existence of defects exceeding the acceptance criteria in Appendix shall result in refusal of the joint concerned.

When, in the course of a localised examination of the internal condition of a joint, the existence of an unacceptable defect is noted, the inspection shall be extended to another joint on a part of the weld which is at least as long as that which has just been inspected.

If this examination gives rise to the discovery of new unacceptable defects, the inspection shall be extended to all the welds produced under the same conditions.

The repair of an internal defect on a completed joint may not be carried out until a procedure has been established and accepted by the representative of the customer Railway.

The customer Railway may ask that a test joint be performed to simulate the repair.


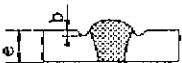
After the repair, the welded joint shall again undergo an examination of its internal condition.

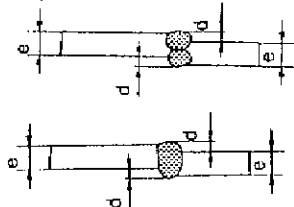
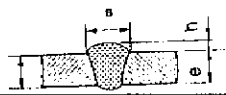

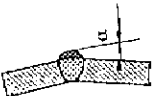
4.3.5.4.3 - Geometry of completed parts

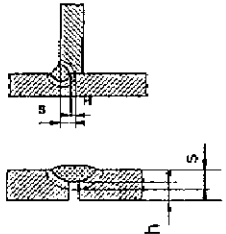
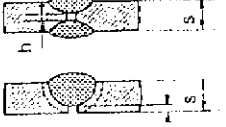
The existence of any defective geometric characteristics or the use of a straightening procedure not previously approved by the representative of the customer Railway shall result in refusal of the corresponding parts.

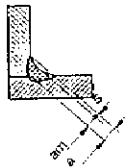

ACCEPTANCE CRITERIA FOR WELDED BUTT AND FILLET JOINTS

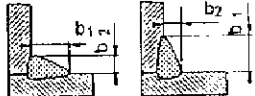
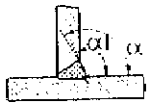
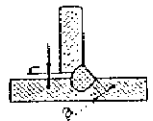
| Defect | Type of defect | ISO 6520 | Limits for: (Dimensions in mm) | | |
|--------|-----------------------------|------------|--------------------------------|--|--|
| | | | Class B High requirement | Class C Medium requirement | Class D Moderate requirement |
| 1 | Cracks | 101 to 106 | Defect not permitted | Defect not permitted | Defect not permitted |
| 2 | Gas pores | 2017 | Defect not permitted | Dimension ≤ 2 Not more than three pores over a length of 200 | Dimension ≤ 3 Not more than six pores over a length of 200 |
| 3 | Shrinkage of craters | 2024 | Defect not permitted | Defect not permitted | Defect permitted if no sharp notch |
| 4 | Solid inclusions at surface | 300 | Defect not permitted | Defect not permitted | No tolerance given |

| | | | | | |
|---|---|------------------|----------------------|--|--|
| 5 | Undercut Sharp | 5011 5012 | Defect not permitted | Defect not permitted | Defect permitted |
| |  | | $b \leq 0.3$ | $b \leq 0.5$ Continuous length ≤ 50 Over a length of 300 Cumulative length ≤ 50 | $b \leq 1$ Continuous length ≤ 60 Over a length of 300 Cumulative length ≤ 80 |
| | Undercut Smooth | | | | |
| |  | | | | |
| 6 | Tool marks | 603 to 606 | Defect not permitted | Defect not permitted without progressive join | Defect permitted unless deep notch > 1 mm |

| | | | | | |
|----|---|-----|---|--|--|
| 7 | Misalignment of edges  | 507 | The limits shown concern deviation in relation to the correct position. What is meant by "correct position" depends on the case concerned. In the absence of any indication to the contrary, sheets shall be considered in the correct position when their centre-lines meet at mid-thickness. Alignment defects measured on the surface may be larger or smaller according to variations in sheet thickness, tube diameter and wall thickness. | | |
| | | | $b \leq 0.1e$ max : 2 | $b \leq 0.15e$ max : 3 | No tolerance given |
| 8 | Weld overfill (Excessive thickness of weld)  | 502 | A smooth transition is required | | |
| | | | $h \leq 1 + 0.1b$ max : 2 | $h \leq 1 + 0.15b$ max : 3 | $h \leq 1 + 0.25b$ max : 5 |
| 9 | Insufficient thickness of weld  | 511 | Defect not permitted | | |
| | | | $h \leq 0.1e$ max : 1 | Continuous length ≤ 50 Over a length of 300 Cumulative length ≤ 50 | $h \leq 0.2e$ max : 2 Continuous length ≤ 60 Over a length of 300 Cumulative length ≤ 80 |
| 10 | Angular misalignment  | 508 | $tg. \alpha \leq 0.1$ or 6 | $tg. \alpha \leq 0.15$ or 9 | $tg. \alpha \leq 0.2$ or 12 |

| | | | | | |
|----|---|-----|----------------------|---|---|
| 11 | Lack of penetration | 402 | Defect not permitted | $h \leq 0.1s$ max : 1 Continuous length ≤ 50 Over a length of 300 Cumulative length ≤ 50 | No tolerance given |
| |   $s = \text{intended penetration}$ $h = \text{lack of penetration}$ | | Defect not permitted | Permitted if defect localised $h \leq 0.1s$ max : 1.5 Continuous length ≤ 50 Over a length of 300 Cumulative length ≤ 50 | $h \leq 0.2s$ Continuous length ≤ 60 Over a length of 300 Cumulative length ≤ 80 |
| 12 | Lack of penetration | | Defect not permitted | $b \leq 1$ | $b \leq 0.25a$ Continuous length ≤ 60 Over a length of 300 Cumulative length ≤ 80 |

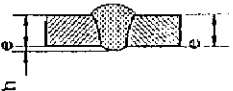
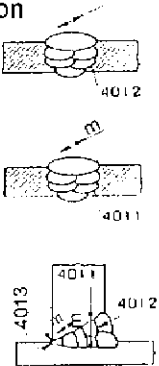
| | | | | | |
|----|--|-----|--|--|--|
| 13 | <p>Insufficient thickness a : specified throat a_m : throat produced Insufficient thickness</p>  <p>Convexity and Concavity</p>  | 503 | $a_m \geq a$ $s \leq 0.1a + 0.5$ max : 2 | $a_m \geq a$ $s \leq 0.1a + 1$ max : 3 | $a_m \geq a$ $s \leq 0.2a + 1$ max : 4 |
|----|--|-----|--|--|--|

| | | | | | |
|----|--|-----|---|---|------------------------------|
| 14 | Assymmetrical weld  | 512 | $\frac{b_1}{b_2} \leq 1.2$ | $\frac{b_1}{b_2} \leq 1.4$ | $\frac{b_1}{b_2} \leq 2$ |
| 15 | Inclination defect  <p> α : measured value α_1 : value requested on drawing. </p> | | $\alpha > 105^\circ$ or $\alpha > \alpha_1$ | $\alpha > 105^\circ$ or $\alpha > \alpha_1$ | No tolerance given |
| 16 | Poor positioning  | | $h \leq 0.5 + 0.1a$ max : 2 | $h \leq 0.5 + 0.2a$ max : 3 | $h \leq 1 + 0.3a$ max : 4 |

| | | | | | |
|--------|--------------------|------------------------------|---|---|---|
| 17 (1) | Fine porosity | 2011 2012 2014 2017 | The pores must not exceed 1 % of the projected surface. The size of one cavity must not be greater than 2 mm. | The pores must not exceed 2 % of the projected surface. The size of one cavity must not be greater than 4 mm. | The pores must not exceed 4 % of the projected surface. The size of one cavity must not be greater than 5 mm. |
| 18 (2) | Coarse porosity | 2013 | Blowholes must not exceed 4 % of the projected surface. The size of one cavity must not exceed 2 mm. | Blowholes must not exceed 8 % of the projected surface. The size of one cavity must not exceed 4 mm. | Blowholes must not exceed 10 % of the projected surface. The size of one cavity must not exceed 5 mm. |
| 19 | Elongated blowhole | 2015 | Continuous defects are not permitted. | Continuous defects are not permitted. | Continuous defects are not permitted. |
| | Wormholes | 2016 | The height and breadth of local defects must not exceed 2 mm. | The height and breadth of local defects must not exceed 3 mm. | The height and breadth of local defects must not exceed 5 mm. |
| | Crater shrinkage | 2024 | Defect not permitted. | The length must be less than the weld thickness. | No tolerance given. |

(1) See remarks in Appendix 4 to UIC Leaflet 897-11 concerning defect 3.

(2) See remarks in Appendix 4 to UIC Leaflet 897-11 concerning defect 4.

| | | | | | |
|-----------|---|------------|---|--|---|
| <p>20</p> | <p>Excessive penetration</p>  | <p>504</p> | <p>Penetration must be continuous. The height of penetration h must not exceed 3 mm and under no circumstances 1 mm + 30 % of the width of penetration.</p> | <p>In areas without lack of penetration, the height of penetration h must not exceed 4 mm and under no circumstances 1 mm + 60 % of the width of penetration.</p> <p>Continuous length ≤ 50 Over a length of 300 Cumulative length ≤ 50.</p> | <p>No tolerance given.</p> |
| <p>21</p> | <p>Lack of fusion Adhesion</p>  | <p>401</p> | <p>Not permitted.</p> | <p>Not permitted if the defects are localised.</p> | <p>Authorised though intermittently and without emergence at surface.</p> |

Application

With effect from 1 January 1994.

All UIC Members.

Record References

Heading under which the question has been dealt with :

- Question 5/SA/FIC - Approval of Leaflet 897-22
"Technical specification for the quality control of welded joints on
rolling stock in aluminium and aluminium alloys".
(Traction and Rolling Stock Committee, York, May 1993).

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