



BSI Standards Publication

Destructive tests on welds in metallic materials — Hardness testing

Part 1: Hardness test on arc welded joints
(ISO 9015-1:2001)

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National foreword

This British Standard is the UK implementation of EN ISO 9015-1:2011. It is identical to ISO 9015-1:2001. It supersedes BS EN 1043-1:1996 which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee WEE/-1, Briefing committee for welding.

A list of organizations represented on this committee can be obtained on request to its secretary.

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EUROPEAN STANDARD
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EN ISO 9015-1

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English Version

Destructive tests on welds in metallic materials - Hardness testing - Part 1: Hardness test on arc welded joints (ISO 9015-1:2001)

Essais destructifs des soudures sur matériaux métalliques -
Essais de dureté - Partie 1: Essai de dureté des
assemblages soudés à l'arc (ISO 9015-1:2001)

Zerstörende Prüfung von Schweißverbindungen an
metallischen Werkstoffen - Härtetest - Teil 1:
Härtetest für Lichtbogenschweißverbindungen (ISO
9015-1:2001)

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Foreword

The text of ISO 9015-1:2001 has been prepared by Technical Committee ISO/TC 44 "Welding and allied processes" of the International Organization for Standardization (ISO) and has been taken over as EN ISO 9015-1:2011 by Technical Committee CEN/TC 121 "Welding" the secretariat of which is held by DIN.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by September 2011, and conflicting national standards shall be withdrawn at the latest by September 2011.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN [and/or CENELEC] shall not be held responsible for identifying any or all such patent rights.

This document supersedes EN 1043-1:1995.

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Endorsement notice

The text of ISO 9015-1:2001 has been approved by CEN as a EN ISO 9015-1:2011 without any modification.

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 3.

Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

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International Standard ISO 9015-1 was prepared by Technical Committee ISO/TC 44, *Welding and allied processes*, Subcommittee SC 5, *Testing and inspection of welds*.

ISO 9015 consists of the following parts, under the general title *Destructive tests on welds in metallic materials — Hardness testing*:

- *Part 1: Hardness test on arc welded joints*
- *Part 2: Microhardness testing of welded joints*

Annexes A and B of this part of ISO 9015 are for information only.

Destructive tests on welds in metallic materials — Hardness testing —

Part 1: Hardness test on arc welded joints

1 Scope

This part of ISO 9015 specifies hardness tests on transverse sections of arc welded joints of metallic materials. It covers Vickers hardness tests in accordance with ISO 6507-1, normally with test loads of 49,03 N or 98,07 N (HV 5 or HV 10).

However, the principles may be applied to Brinell hardness testing (with appropriate testing loads of HB 2,5/15,625 or HB 1/2,5) in accordance with ISO 6506-1 and micro hardness testing in accordance with ISO 6507-1 and ISO 9015-2.

NOTE Testing should be carried out to ensure that the highest and the lowest level of hardness of both parent metal and weld metal is determined.

This part of ISO 9015 does not apply to test welds in austenitic stainless steels.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this part of ISO 9015. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this part of ISO 9015 are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of ISO and IEC maintain registers of currently valid International Standards.

ISO 6506-1, *Metallic materials — Brinell hardness test — Part 1: Test method*.

ISO 6507-1, *Metallic materials — Vickers hardness test — Part 1: Test method*.

ISO 9015-2, *Destructive tests on welds in metallic materials — Hardness testing — Part 2: Microhardness testing on welded joints*.

3 Principle

The type and extent of testing shall be as specified by the relevant application standard or by agreement between the contracting parties.

Hardness testing shall be carried out in accordance with ISO 6507-1 or ISO 6506-1.

The hardness tests may be carried out in the form of rows of indentations, R, or as individual indentations, E.

When types of weld are not shown in the examples in Figures 1 and 2, the test procedure shall be appropriate to the welded joint.

Unless otherwise specified, the test shall be carried out at ambient temperature (23 ± 5) °C.

4 Symbols and terms

The symbols and terms to be used are specified in Table 1 and represented on Figures 1 to 8.

Table 1 — Symbols and terms

Symbol	Term	Unit
E	Individual indentation	—
R	Row of indentations	—
HV	Vickers hardness	a
HBW	Brinell hardness	b
L	Distance between the centrepoint of the indentations in heat affected zone	mm
H	Distance of rows of indentations from the surface reference line or fusion zone	mm
t	Thickness of test specimen	mm

^a The unit of symbolisation for Vickers hardness is given in ISO 6507-1.
^b The unit of symbolisation for Brinell hardness is given in ISO 6506-1.

5 Preparation of test specimens

The preparation of the test specimen shall be in accordance with ISO 6507-1 or ISO 6506-1.

A cross-section of test piece shall be taken by mechanical cutting, usually transverse to the welded joint.

This operation and the subsequent preparation of the surface shall be carried out carefully so that the hardness of the surface to be tested is not affected metallurgically.

The surface to be tested shall be properly prepared and preferably etched, so that accurate measurements of the indentations can be obtained in the different zones of the welded joint.

6 Test procedure

6.1 Rows of indentations (R)

Figures 1 to 7 give examples of hardness indentations made in rows including the distance from the surface in such a way that these rows or parts of them permit an assessment of the welded joint. If required by the contracting parties, additional rows of indentations and/or different locations may be made. The location shall be stated in the test report.

In metals such as aluminium, copper and their alloys, the rows on the root-side of butt welds [see Figure 2 a)] may be unnecessary. Typical rows for T-joints in these materials are given in Figure 2.

The number and spacing of indentations shall be sufficient to define hardened or softened regions due to welding. The recommended distance between the centrepoint of the indentations in the heat-affected zone (HAZ) is given in Table 2.

NOTE 1 Table 2 also applies with Brinell testing using the same distances provided appropriate loads are used.

Sufficient indentations shall be made to ensure that unaffected parent metal is tested. In the weld metal, the distance between indentations shall be selected and checked so that the results obtained will enable assessment of the welded joint to be made.

For metals which harden in the HAZ as a result of welding, two additional indentations in the HAZ shall be made at a distance $\leq 0,5$ mm between the centrepoint of the indentation and the fusion line (see Figures 3 to 7).

For other joint configurations or metals (e.g. austenitic steels) special requirements can be given by the relevant application standard or by agreement between the contracting parties.

NOTE 2 For electroslag welds, the loads given in Table 2 may be used. Rows of indentations for electroslag welds can be made similar to Figure 1 a).

Table 2 — Recommended distance, L , between the centrepoint of the indentations in the heat affected zone (HAZ)

Hardness symbol	Recommended distance between indentations	
	L mm ^a	Aluminium, copper and their alloys
Ferrous metals ^b		
HV 5	0,7	2,5 to 5
HV 10	1	3 to 5
HBW 1/2,5	not applicable	2,5 to 5
HBW 2,5/15,625	not applicable	3 to 5

^a The distance of any indentation from the previous indentation shall be not less than the value allowed by ISO 6507-1 for the previous indentation.

^b Excluding austenitic steels.

6.2 Individual indentations (E)

Figure 8 shows typical areas for the location of individual indentations. The series 1 to 4 gives information about the unaffected parent metal, the series 5-10 refers to the HAZ and the series 11 to 14 to the weld metal. Otherwise, the location of the indentation can be determined on the basis of metallographic examination.

To prevent the influence of deformation caused by an indentation, the minimum distance between the centrepoint of individual indentations in any direction shall be not less than 2,5 times the mean diagonal/diameter of the nearest adjacent indentation.

For metals which harden in the HAZ as a result of welding, at least one indentation shall be made in the HAZ at a distance $\leq 0,5$ mm between the centrepoint of the indentation and the fusion line.

For testing with individual indentations, the areas shall be numbered as shown in Figure 8.

7 Test results

The hardness values shall be recorded in relation to the position of the indentation.

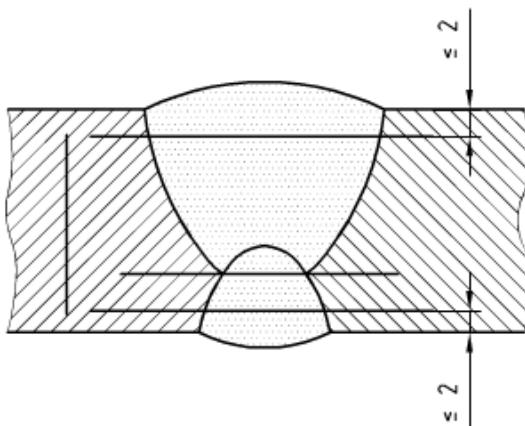
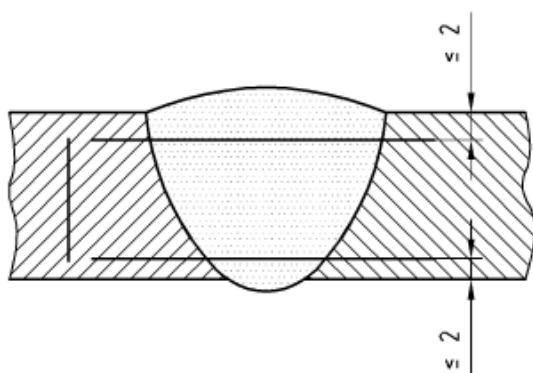
8 Test report

A test report is required. The information to be recorded is listed in annexes A and B.

The use of the format given in annexes A and B is recommended.

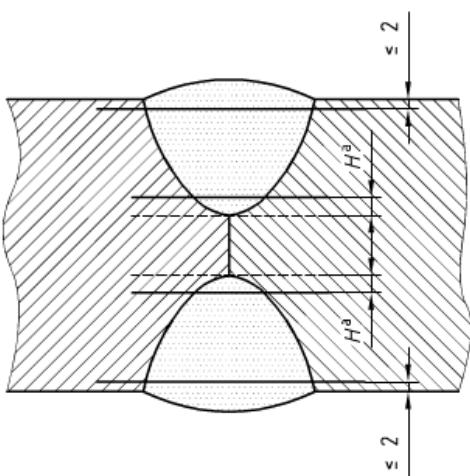
Other formats may be used provided they contain all the required information. Additional information may be required by the relevant application standard or by agreement between the contracting parties.

Dimensions in millimetres

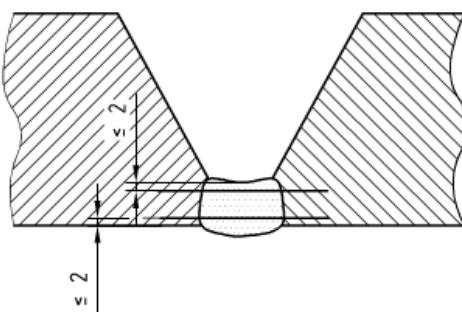


a) Butt weld from one side only both single and multirun

b) Butt weld from both sides both single and multirun



a For multirun welds only.



c) Partial penetration butt weld from both sides both single and multirun

d) For assessment of hardenability on single run root runs (e.g. for TIG weld on pipe and/or plate)

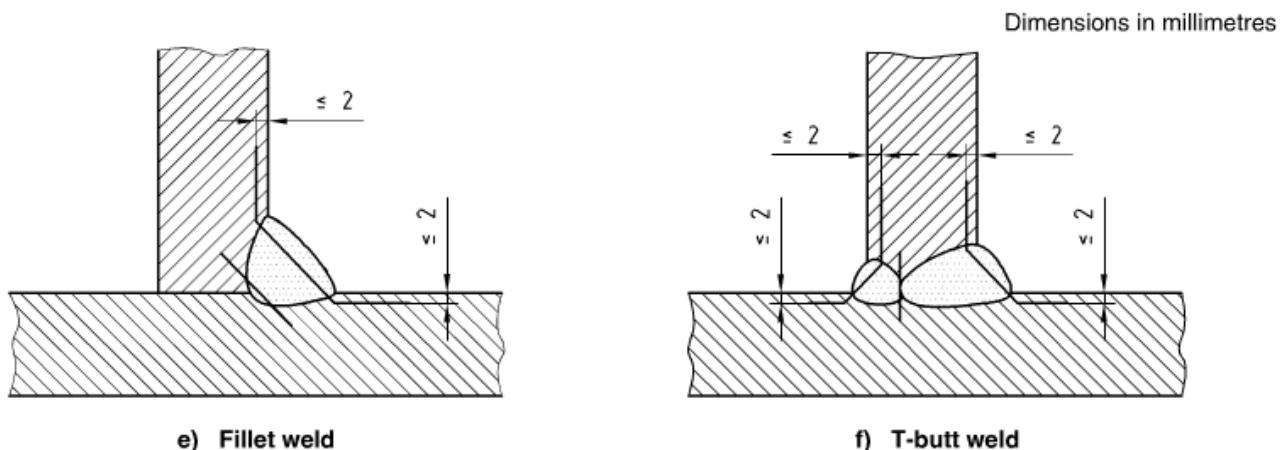
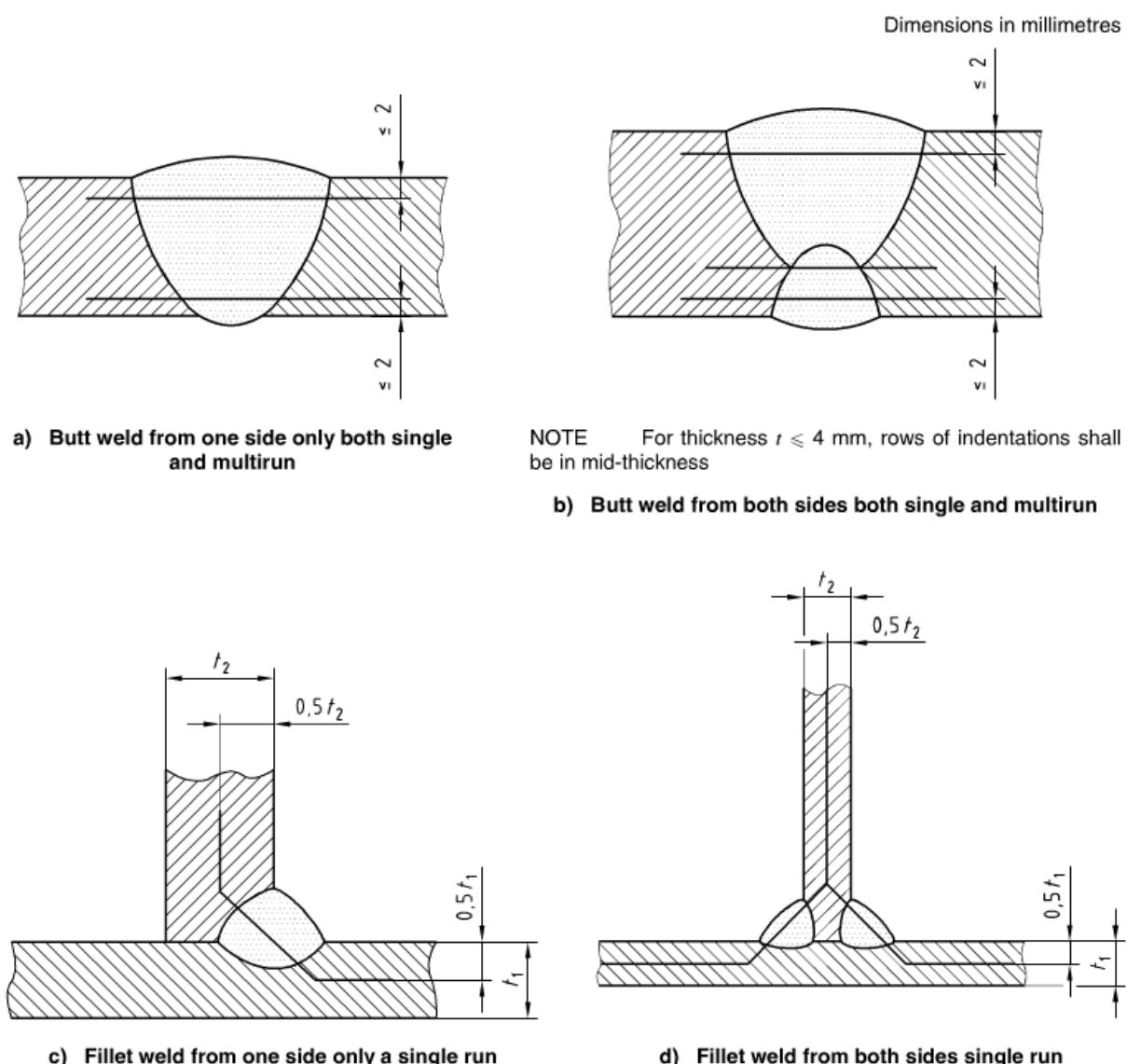


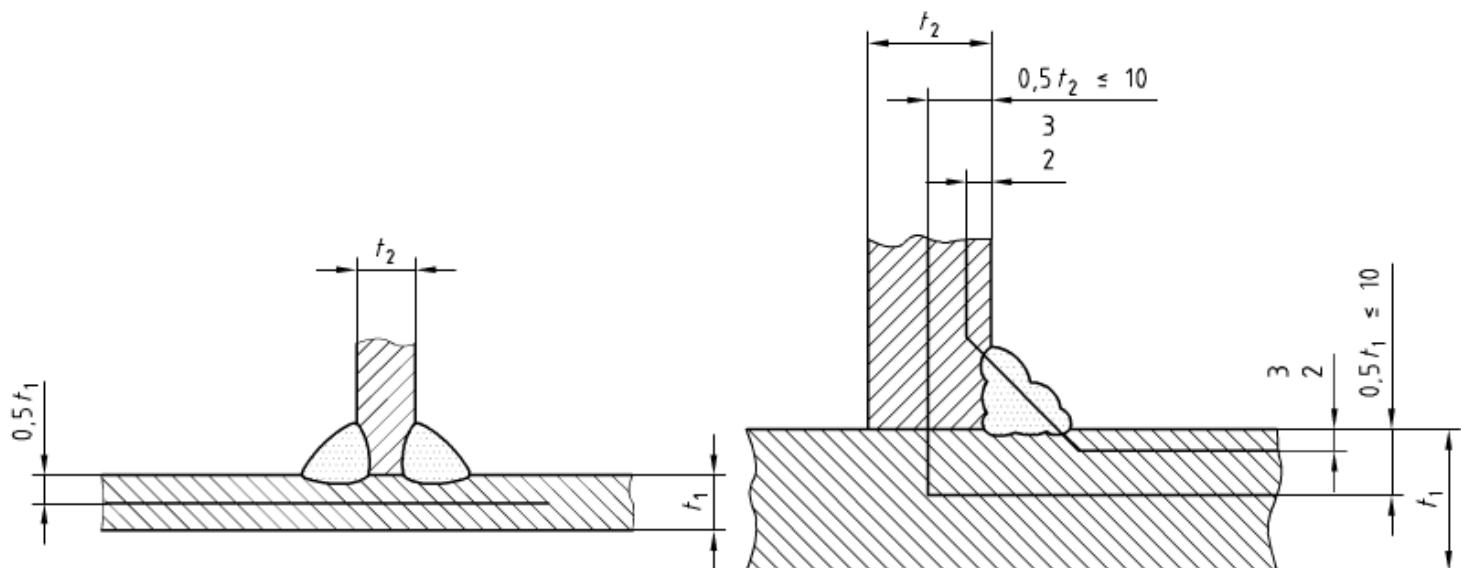
Figure 1 — Examples of rows of indentations (R) in steel welds



NOTE For thickness $t \leq 4$ mm, rows of indentations shall be in mid-thickness

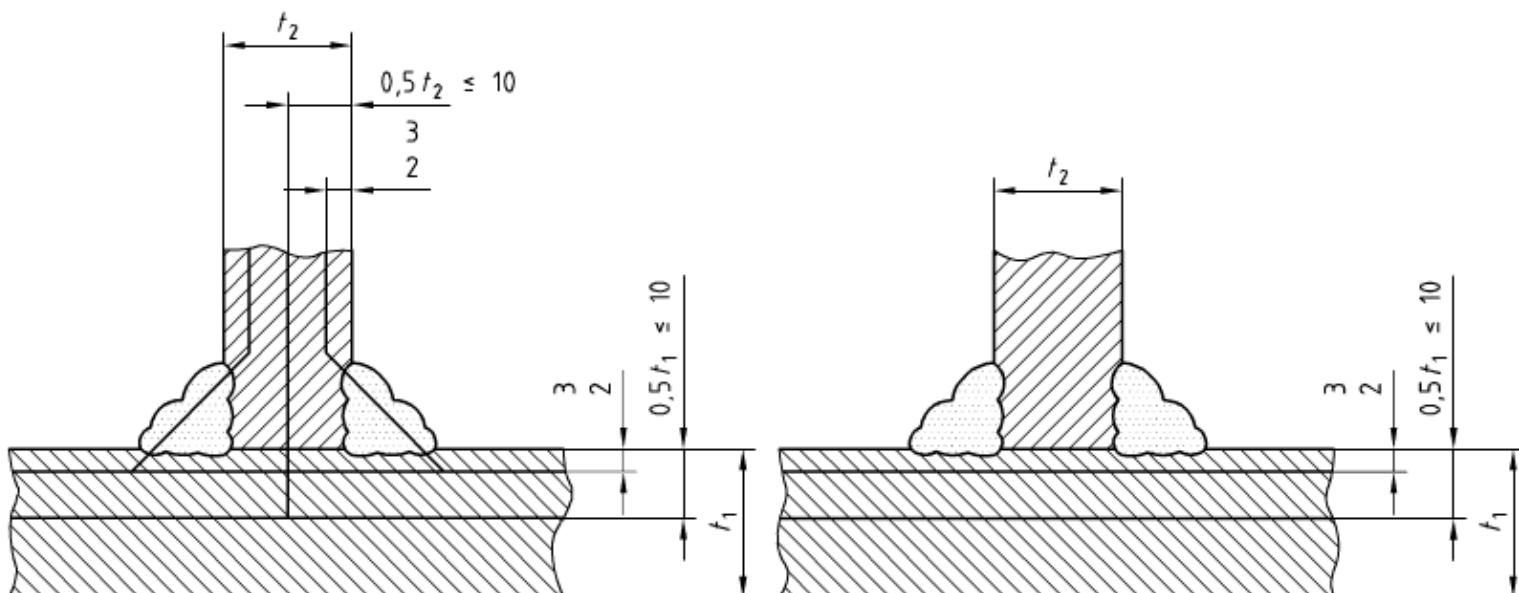
Figure 2 — Examples of rows of indentations (R) in aluminium, copper and their alloys

Dimensions in millimetres



e) Fillet weld from both sides single run non load bearing stiffener ($t \leq 4$ mm)

f) Fillet weld from one side multirun

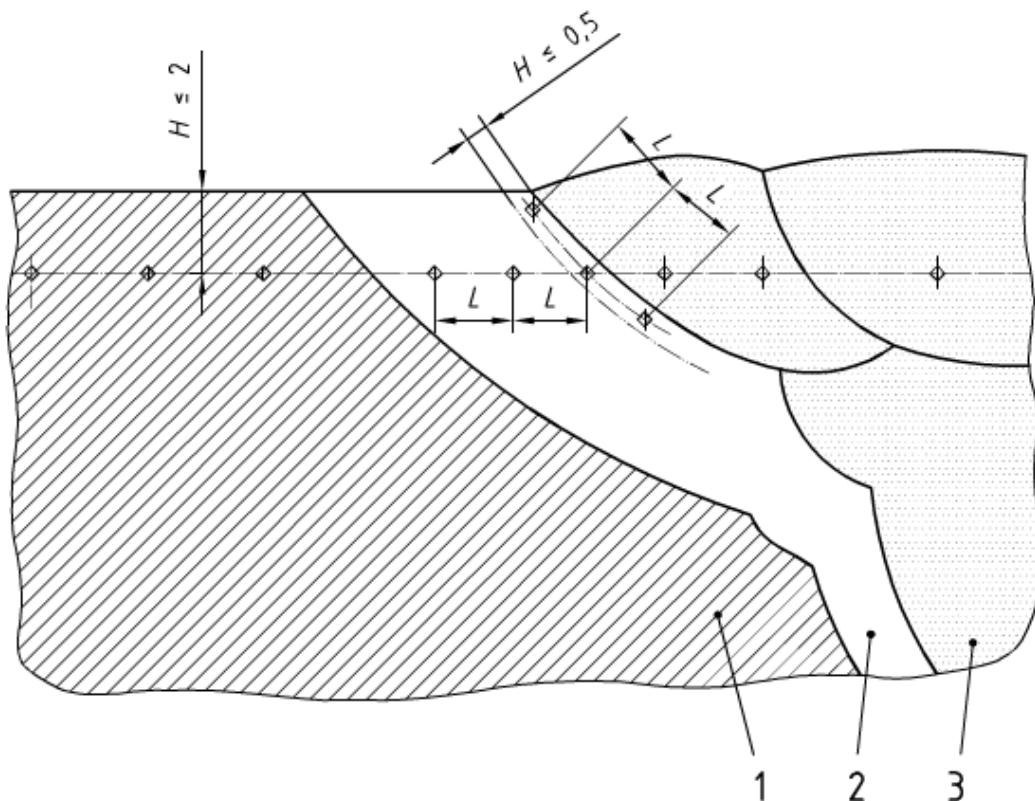


g) Fillet weld from both side multirun

h) Fillet weld from both side multirun non load bearing stiffener

Figure 2 — Examples of rows of indentations (R) in aluminium, copper and their alloys (continued)

Dimensions in millimetres

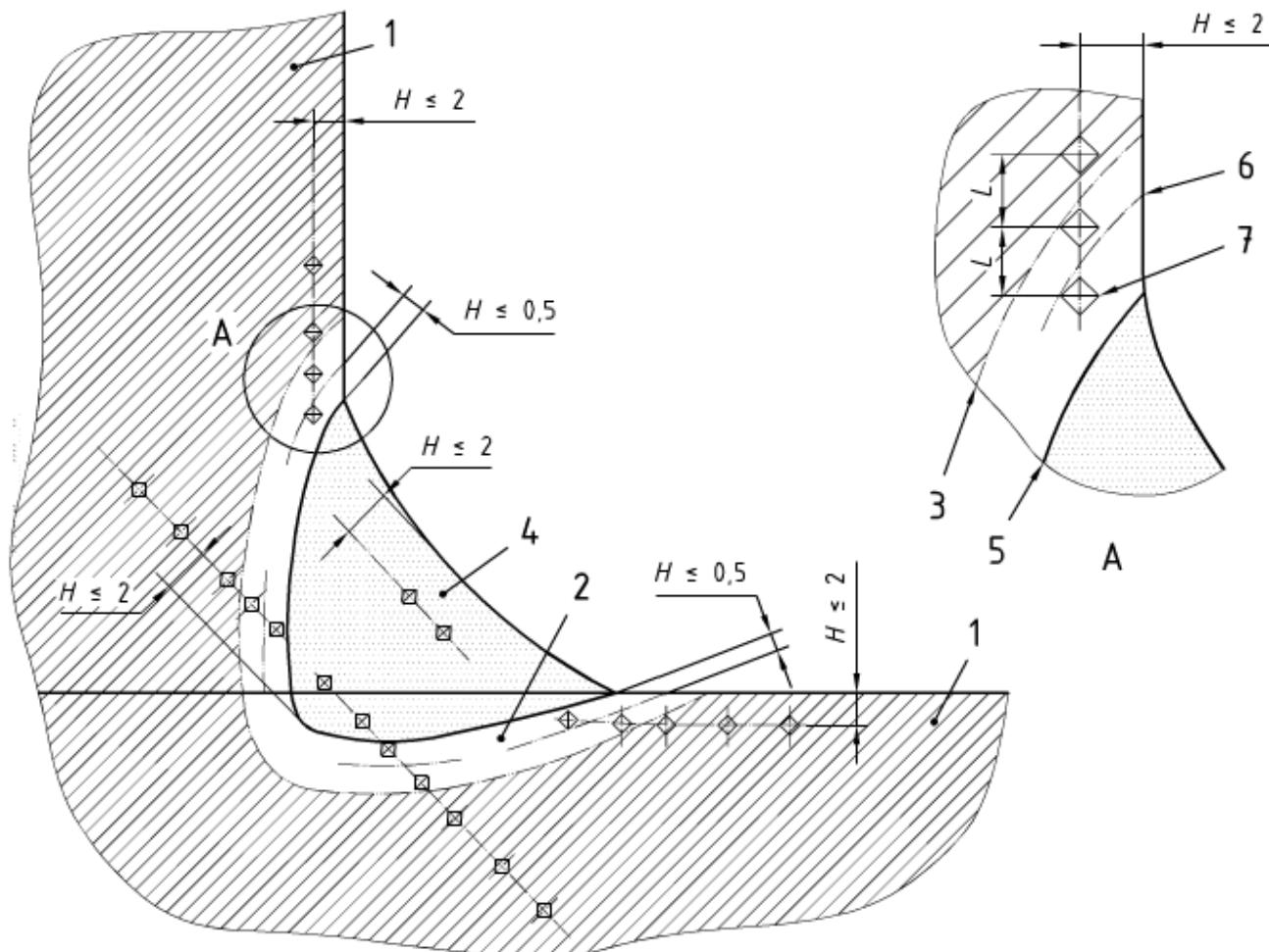


Key

- 1 Parent metal
- 2 Heat affected zone
- 3 Weld metal

Figure 3 — Location of the indentations in butt welds in ferrous metals (excluding austenitic steels)

Dimensions in millimetres

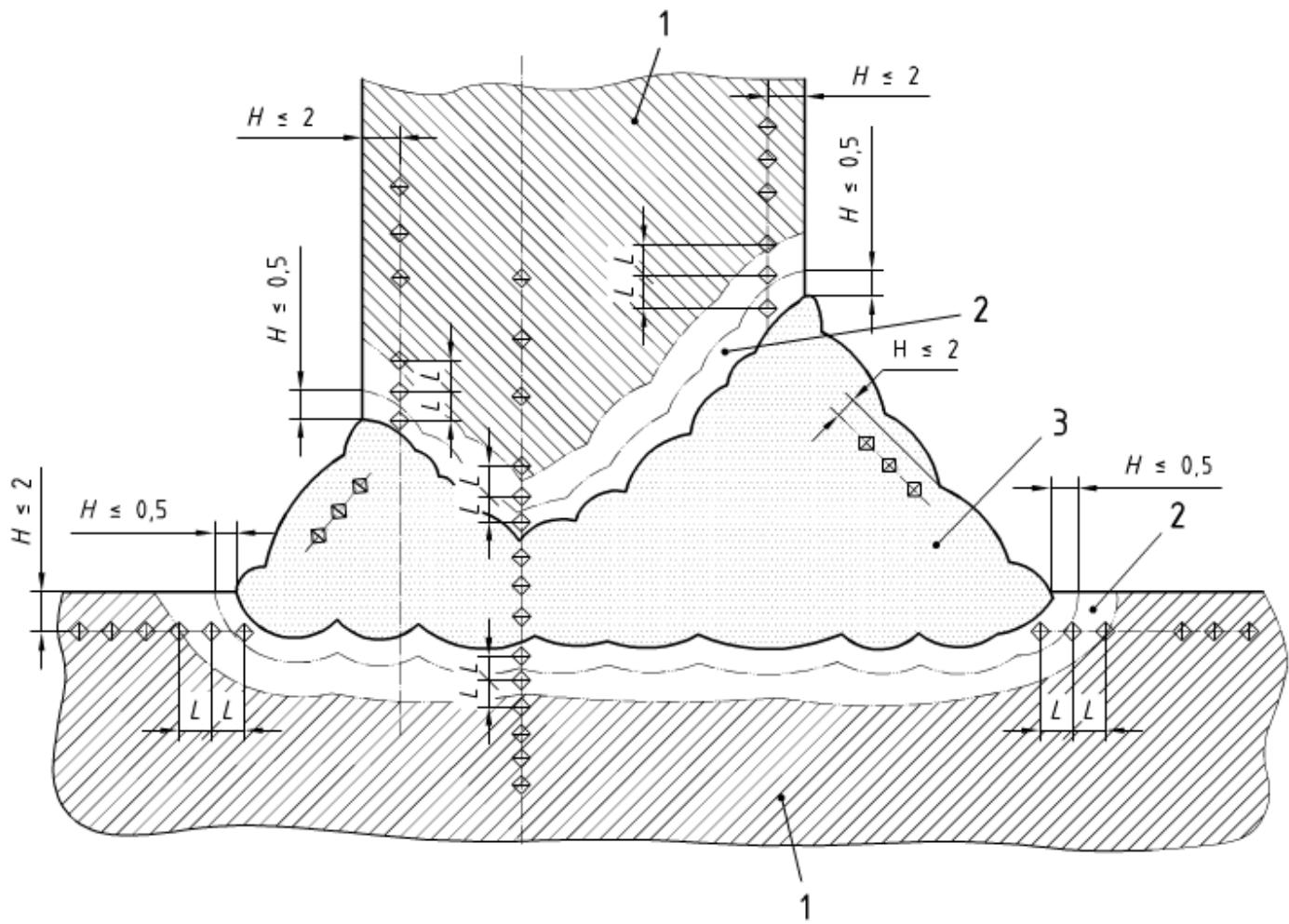


Key

- 1 Parent metal
- 2 Heat affected zone
- 3 Limit of HAZ
- 4 Weld metal
- 5 Fusion line
- 6 Limit for indentations parallel to fusion line
- 7 First indentation

Figure 4 — Location of the indentations in fillet welds, in ferrous metals (excluding austenitic steels)

Dimensions in millimetres

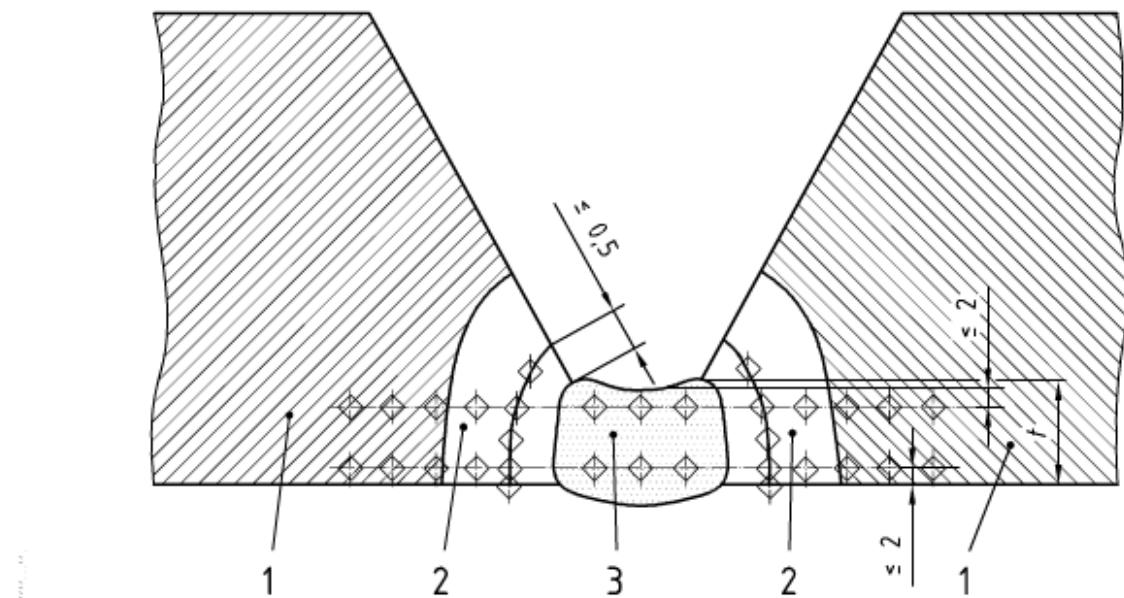


Key

- 1 Parent metal
- 2 Heat affected zone
- 3 Weld metal

Figure 5 — Location of the indentations in T-butt joints, in ferrous metals (excluding austenitic steels)

Dimensions in millimetres



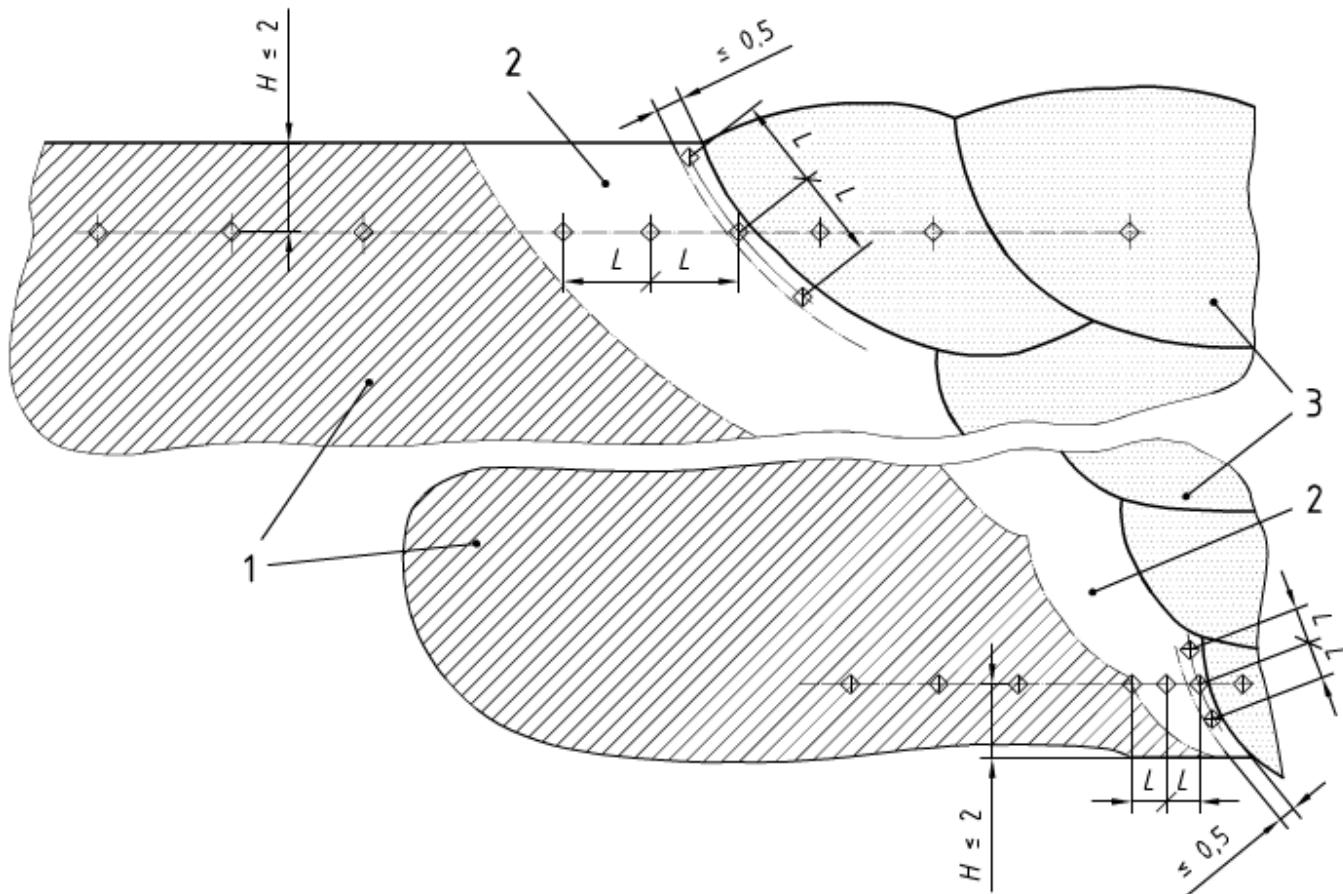
For thickness $t \leq 4$ mm, the rows of indentation shall be in mid thickness

Key

- 1 Parent metal
 - 2 Heat affected zone
 - 3 Weld metal

Figure 6 — Location of the indentations for assessment of hardenability on single run root runs in ferrous metal

Dimensions in millimetres

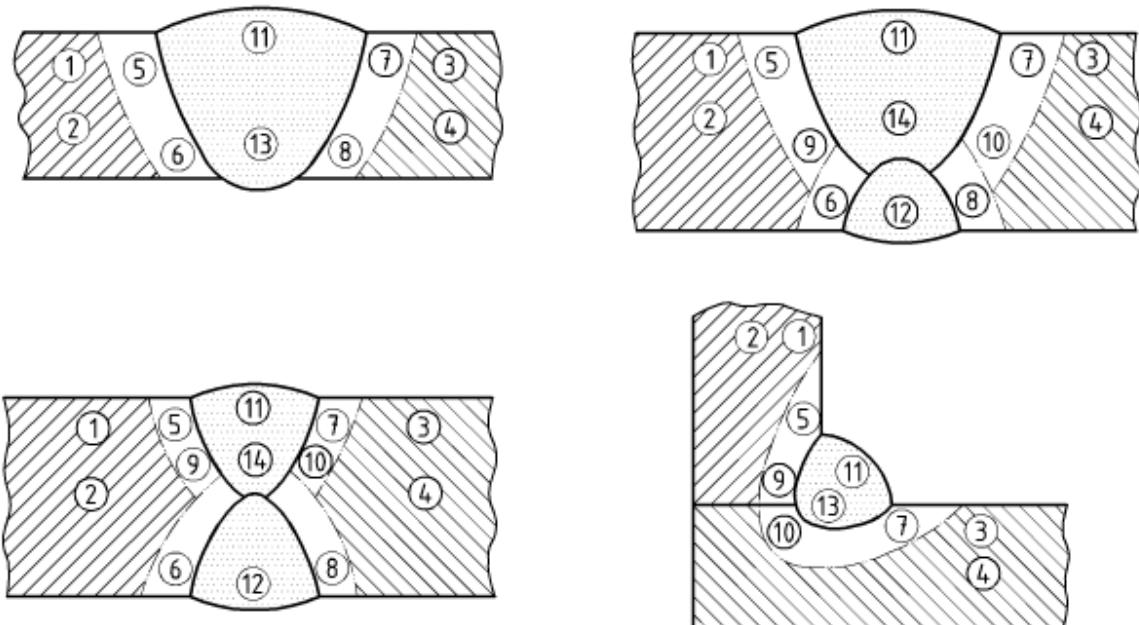


Key

- 1 Parent metal
- 2 Heat affected zone
- 3 Weld metal

Figure 7 — Location of the indentations for assessment of hardenability on multirun root welds in ferrous metal

Dimensions in millimetres



Key

- 1 to 4 Parent metal
5 to 10 Heat affected zone
11 to 14 Weld metal

NOTE Other areas are possible, by agreement.

Figure 8 — Examples showing areas for hardness testing with individual indentations (E)

Annex A
(informative)

Example of a test report for hardness testing (R) on welded joints

Type of hardness test: _____

Parent metal: _____

Thickness of material: _____

Type of weld: _____

Welding process: _____

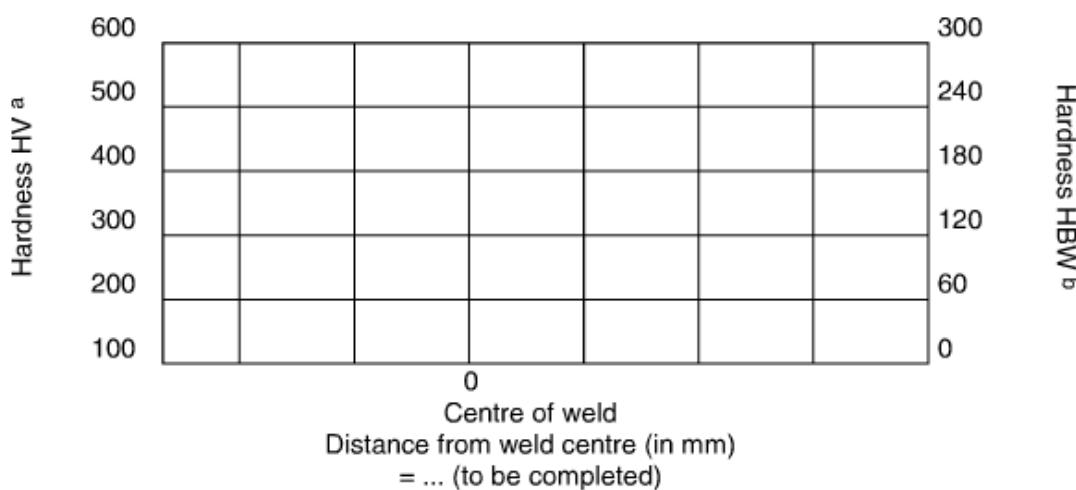
Consumable: _____

Heat treatment and/or ageing: _____

Brief designation of rows of indentations: _____

Notes: _____

Picture or drawing giving dimension and
designating the rows of indentations



^a Indicates load in accordance with ISO 6507-1.

^b Indicates load in accordance with ISO 6506-1.

Annex B
(informative)

Example of a test report for hardness testing (E) on welded joints

Type of hardness test: _____

Parent metal: _____

Thickness of material: _____

Type of weld: _____

Welding process: _____

Consumable: _____

Postweld heat treatment and/or ageing: _____

Notes: _____

Picture or drawing with numbered areas

		Area	Position of indentations	Individual hardness values HV or HBW ^a	
Parent metal	Unaffected metal	1	Parent metal, unaffected, surface		
		2	Parent metal, unaffected, centre		
		3	Parent metal, unaffected, surface		
		4	Parent metal, unaffected, centre		
	HAZ	5	Parent metal, heat affected zone, top of weld		
		6	Parent metal, heat affected zone, bottom of weld		
		7	Parent metal, heat affected zone, top of weld		
		8	Parent metal, heat affected zone, bottom of weld		
		9	Parent metal, heat affected zone, root run, inside		
		10	Parent metal, heat affected zone, root run, inside		
Weld metal		11	Weld metal, final run		
		12	Weld metal, final run		
		13	Weld metal, root run		
		14	Weld metal, root run, inside		

15 to

^a Indicates load in accordance with ISO 6507-1 or ISO 6506-1.

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