

Australian Standard<sup>®</sup>

**Non-destructive testing—Ultrasonic  
testing of fusion welded joints in carbon  
and low alloy steel**



This Australian Standard® was prepared by Committee MT-007, Non-destructive Testing of Metals and Materials. It was approved on behalf of the Council of Standards Australia on 10 May 2007.

This Standard was published on 12 July 2007.

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  - Australian Industry Group
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  - ANSTO
  - Australian Pipeline Industry Association
  - Bureau of Steel Manufacturers of Australia
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  - National Association of Testing Authorities Australia
  - TestSafe Australia
  - Victorian WorkCover Authority
  - Welding Technology Institute of Australia
- 

This Standard was issued in draft form for comment as DR 06720.

Standards Australia wishes to acknowledge the participation of the expert individuals that contributed to the development of this Standard through their representation on the Committee and through public comment period.

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STANDARDS AUSTRALIA

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RECONFIRMATION

OF

AS 2207—2007

**Non-destructive testing—Ultrasonic testing of fusion welded joints in carbon and low alloy steel**

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RECONFIRMATION NOTICE

Technical Committee MT-007 has reviewed the content of this publication and in accordance with Standards Australia procedures for reconfirmation, it has been determined that the publication is still valid and does not require change.

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## NOTES

Australian Standard<sup>®</sup>

**Non-destructive testing—Ultrasonic  
testing of fusion welded joints in carbon  
and low alloy steel**

Originated as AS B261.1—1968 and AS B260.1A—1968.  
Previous edition AS 2207—1994.  
Fourth edition 2007.

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Published by Standards Australia GPO Box 476, Sydney, NSW 2001, Australia

ISBN 0 7337 8278 7

## PREFACE

This Standard was prepared by the Australian members of the Joint Standards Australia/New Zealand Committee MT-007, Non-destructive Testing of Metals and Materials. This Standard supersedes AS 2207—1994, *Non-destructive testing—Ultrasonic testing of fusion welded joints in carbon and low alloy steel*.

After consultation with stakeholders in both countries, Standards Australia and Standards New Zealand decided to develop this Standard as an Australian Standard rather than an Australian/New Zealand Standard.

The objective of this Standard is to specify the qualifications of personnel for non-destructive testing procedures used for ultrasonic testing.

The objective of this edition is to introduce new methods and procedures for ultrasonic testing of fusion welded steels.

The terms ‘normative’ and ‘informative’ have been used in this Standard to define the application of the appendix to which they apply. A ‘normative’ appendix is an integral part of a Standard, whereas an ‘informative’ appendix is only for information and guidance.

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## STANDARDS AUSTRALIA

## Australian Standard

**Non-destructive testing—Ultrasonic testing of fusion welded joints in carbon and low alloy steel**

## SECTION 1 SCOPE AND GENERAL

**1.1 SCOPE**

This Standard sets out methods and requirements for the manual ultrasonic testing of full or partial penetration fusion welded joints in carbon and low alloy ferritic steels, 6 mm or greater in thickness, using A-scan presentation and employing four sensitivity levels.

This Standard does not cover the testing of stainless steel.

It does not cover the testing of longitudinal welds when—

- (a) the radius of curvature of fabrications is less than 125 mm; or
- (b) for tubular fabrications having an outside diameter exceeding 250 mm, the ratio of thickness to outside diameter exceeds 0.22.

NOTE: Advice and recommendations on information to be supplied by the purchaser at the time of enquiry or order are contained in the purchasing guidelines set out in Appendix A.

**1.2 REFERENCED DOCUMENTS**

The following documents are referred to in this Standard:

## AS

- |        |                                                                                                        |
|--------|--------------------------------------------------------------------------------------------------------|
| 1101   | Graphical symbols for general engineering                                                              |
| 1101.3 | Part 3: Welding and non-destructive examination                                                        |
| 1171   | Non-destructive testing—Magnetic particle testing of ferromagnetic products, components and structures |
| 1929   | Non-destructive testing—Glossary of terms                                                              |
| 2083   | Calibration blocks and their methods of use in ultrasonic testing                                      |
| 2812   | Welding, brazing and cutting of metals—Glossary of terms                                               |
| 3998   | Non-destructive testing—Qualification and certification of personnel                                   |

**1.3 DEFINITIONS**

For the purpose of this Standard, the terms and definitions given in AS 1929 apply. For reference to welding terms, symbols and notation, refer to AS 2812 and AS 1101.3.

## SECTION 2 EQUIPMENT AND CALIBRATION

### 2.1 SCOPE OF SECTION

This Section specifies requirements for the ultrasonic testing equipment and its calibration.

### 2.2 EQUIPMENT

The ultrasonic testing equipment shall be capable of displaying the presence of discontinuities likely to be present in fusion welded joints and capable of delineating their boundaries and contours.

The equipment shall employ A-scan presentation and shall have a reserve of sensitivity of at least 20 dB at the maximum beam path used. The equipment and probes shall be capable of operation within a frequency range of 2 MHz to 10 MHz.

Either single or twin compression-wave probes, and angle beam probes are used for the testing of welded joints.

#### NOTES:

- 1 This Standard allows the use of ultrasonic units equipped with data processing facilities.
- 2 Guidance on probe frequency selection is given in Paragraph C2 of Appendix C.

### 2.3 CALIBRATION OF EQUIPMENT

#### 2.3.1 Equipment characteristics

##### 2.3.1.1 *General*

The equipment characteristics shall meet the requirements specified in Clauses 2.3.1.2 to 2.3.1.6 when calibrated in accordance with methods specified in AS 2083.

##### 2.3.1.2 *Assessment of horizontal and vertical linearity*

Horizontal and vertical linearity shall be assessed for the test ranges to be used. Any deviation of the horizontal linearity exceeding 2% over the full screen width, or of the vertical linearity exceeding  $\pm 2$  dB, between 30% and 100% graticule height shall be determined and recorded. Suppression shall not be used for weld testing, unless its effect on vertical and horizontal linearity is determined and recorded.

##### 2.3.1.3 *Gain control*

The gain control shall be calibrated in steps not exceeding 2 dB.

##### 2.3.1.4 *System gain*

The overall system gain shall not be less than 20 dB.

##### 2.3.1.5 *Dominant frequency*

The dominant frequency of the instrument/probe combination shall be recorded for information.

NOTE: To optimize the ultrasonic response of the system, it may be necessary to inductively match the probes with the test unit, using tuning coils.

##### 2.3.1.6 *Resolution*

The equipment shall be capable of resolving adjacent reflectors separated by a distance of 2.5 wavelengths along the beam axis. The distance requirements for the separation of reflectors along the beam axis, for various frequencies, are given in Table 2.1.

### 2.3.2 Voltage stability

Voltage fluctuations shall be within  $-15\%$  to  $+10\%$  of nominal line voltage and shall not be capable of producing either of the following:

- (a) Variations in sensitivity exceeding  $\pm 1$  dB.
- (b) Variations of linearity exceeding the limits specified in Clause 2.3.1.2.

### 2.3.3 Calibration blocks

The calibration blocks specified in AS 2083 shall be used to calibrate the testing equipment.

### 2.3.4 Reference blocks

This Standard requires the use of ferritic steel reference blocks which contain side-drilled holes of specified diameters to establish sensitivity. Reference blocks should be machined from a steel which has similar ultrasonic attenuation characteristics to the material under test. Where such material is not available, corrections for attenuation and transfer differences shall be made in accordance with Appendix D.

NOTE: Appendix E gives details of alternative methods which may be used to establish sensitivity.

## 2.4 COUPLANTS

Couplants shall possess good wetting characteristics and be compatible with the steel under test. When establishing sensitivity, a couplant with similar sound energy transfer characteristics shall be used on the reference block as is used for the test.

**TABLE 2.1**  
**REQUIREMENTS FOR THE SEPARATION OF REFLECTIONS FOR**  
**RESOLUTION CALIBRATION**

| Nominal frequency<br>MHz | Distance of separation of reflectors along beam axis<br>mm |                   |
|--------------------------|------------------------------------------------------------|-------------------|
|                          | Compression-wave probes                                    | Shear-wave probes |
| 2                        | 7.4                                                        | 4.1               |
| 2.5                      | 5.9                                                        | 3.3               |
| 4                        | 3.7                                                        | 2.0               |
| 5                        | 3.0                                                        | 1.6               |
| 10                       | 1.5                                                        | 0.8               |

NOTE: For carbon and alloy steels the nominal velocity of compression waves of 5920 m/s and of shear waves is 3230 m/s.

## SECTION 3 METHODS OF TEST

### 3.1 SCOPE AND GENERAL

This Section specifies designations for test methods and surface preparation, and specifies the test method requirements for seven common basic configurations of welds. For each method, requirements are given for—

- (a) the minimum preparation of the test surface (see Clause 3.3);
- (b) preferred scanning positions for normal and angle probes; and
- (c) the evaluation of discontinuities.

Procedures are given for the examination of—

- (i) parent metal over the entire scanning surface;
- (ii) heat-affected zone; and
- (iii) weld metal.

The test method shall be specified in the relevant product specification or application code. The scanning sensitivity for normal probes used for the detection of parent metal discontinuities which may interfere with the test, is specified in Clause 3.5.2.2. If such discontinuities are present and no alternative scanning method is specified for subsequent examination, the test report shall state the reasons why sections of the weld have not been fully examined.

The test report shall also include all instances where it has not been possible to scan from specified surfaces because of limitations of access.

The examination of the weld shall be carried out on scan lines parallel to, or at right-angles to, the weld axis and at a separation not exceeding the width of the transmitting probe crystal.

### 3.2 DESIGNATION OF TEST METHODS AND SURFACE PREPARATION CATEGORIES

#### 3.2.1 Designation of test methods

##### 3.2.1.1 *Ultrasonic*

Ultrasonic test methods are designated as follows:

- (a) The initial letters, UM, to signify ‘ultrasonic method’.
- (b) A letter (A to G) to indicate the actual method for a particular type of weld configuration (see Clause 3.2.1.2).
- (c) A dash followed by a number (1 to 4) to indicate the extent of testing and the evaluation sensitivity.

##### 3.2.1.2 *Test method designations for various weld configurations*

Test methods which enable the test operator to determine the location, size and subsequent identification of discontinuities in seven different types of weld configurations are designated by letter as follows:

- (a) For butt welds having double preparation and complete penetration: UMA
- (b) For butt welds having single preparation: UMB
- (c) For tee butt welds with complete penetration: UMC

- (d) For tee butt welds with incomplete penetration: UMD
- (e) For tee butt welded cruciform joints with incomplete or complete penetration: UME
- (f) For butt welds with set-through configurations (including nozzles): UMF
- (g) For butt welds with set-on configurations (including nozzles): UMG

NOTE: The examination of other weld types may be derived from the requirements for the seven weld types specified.

### 3.2.1.3 Examples of designation

UMA-1: Designates the ultrasonic method of test for butt welds which have double preparation and are fully penetrated. It requires a specified comprehensive scanning pattern and evaluation at Level 1 sensitivity.

UMA-3: Designates the ultrasonic method of test for a double preparation fully penetrated butt weld configuration requiring a less comprehensive scanning pattern than that for UMA-1 and evaluation at Level 3 sensitivity.

### 3.2.2 Designation of surface preparation categories

This Standard recognizes the following surface preparation categories:

- (a) SP1: All surfaces except weld reinforcement are linished or fine ground (see Figure 3.1(a)).
- (b) SP2: All surfaces are linished or fine ground and the weld reinforcement dressed (see Figure 3.1(b)).
- (c) SP3: All surfaces are linished or fine ground and the weld reinforcement ground flat (see Figure 3.1(c)).
- (d) SP4: All surfaces are linished or fine ground and the weld reinforcement ground flush (see Figure 3.1(d)).

## 3.3 PREPARATION OF TEST SURFACES

### 3.3.1 General requirements

All surfaces over which probes are to be traversed shall comply with the following requirements:

- (a) The profile shall be sufficiently regular to permit uniform probe contact throughout the test. Weld spatter and loose scale are completely removed from the adjacent parent metal and the scanning surface.
- (b) Any paint or other surface coating which interferes with the test shall be removed.
- (c) The roughness of the test surface shall not exceed  $3.2 \mu\text{m } R_a$ .  
NOTE: Hot-rolled steel with totally adherent millscale generally complies with this requirement.
- (d) When echoes from the reinforcement (see Figure 3.1(a)) are likely to interfere with the test, the reinforcement shall be dressed to a smooth contour (see Figure 3.1(b)).
- (e) Where scanning procedures require the probe to be traversed along the crown of the weld, the weld reinforcement shall be ground flat over an area of sufficient size to accommodate the probe (see Figure 3.1(c)).  
NOTE: This is required when scanning the weld root using normal probes, or when using angle probes to detect transverse discontinuities.
- (f) Where scanning procedures require the probe to be traversed across the weld, the weld reinforcement shall be ground flush (no underflush) with the parent metal (see Figure 3.1(d)).

### 3.3.2 Additional surface requirements

Where a particular surface preparation category specified in a product specification or application code is more stringent than the minimum surface preparation requirements of Clause 3.3.1, this category shall apply in addition to the requirements of Clause 3.3.1.

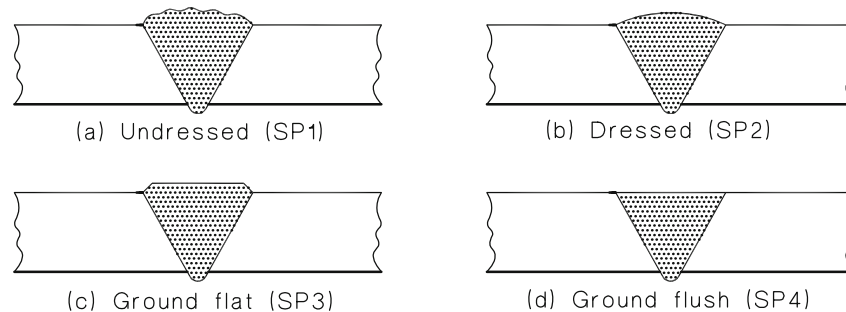


FIGURE 3.1 TYPE AND DESIGNATIONS OF SURFACE PREPARATION FOR WELDS

### 3.4 METHODS FOR SCANNING AND DISCONTINUITY EVALUATION

Welds shall be tested using the scanning positions, probe types and instructions for the evaluation of discontinuities specified in Tables 3.1 to 3.6 as follows:

| Test method designation letter | Weld description                                                              | Table |
|--------------------------------|-------------------------------------------------------------------------------|-------|
| A                              | Butt weld—double preparation—complete penetration                             | 3.1   |
| B                              | Butt weld—single preparation                                                  | 3.2   |
| C                              | Tee butt weld—complete penetration                                            | 3.3   |
| D                              | Tee butt weld—incomplete penetration                                          | 3.4   |
| E (see Note)                   | Tee butt welds—cruciform joint—incomplete penetration or complete penetration | 3.5   |
| F                              | Butt weld—set-through (includes nozzles)                                      | 3.6   |
| G                              | Butt weld—set-on (includes nozzles)                                           |       |

NOTE: The procedures set out in Table 3.4 are applicable only where the thickness difference between components is less than 20%. Where the thickness difference is greater than 20%, the procedures will require modification to obtain adequate scanning of the joint.

The scanning sensitivity to be used when testing welds and parent metal is specified in Clause 3.5.2.

### 3.5 SENSITIVITY

#### 3.5.1 General

All welds shall be scanned using the levels of sensitivity specified in Clause 3.5.2. Discontinuities detected shall be evaluated in accordance with one of the sensitivity levels specified in Clause 3.5.3 as required by the relevant product specification or application code.

The relationship between the scanning sensitivities specified in Clause 3.5.2, the evaluation sensitivity levels specified in Clause 3.5.3.2, and the requirements for recording and sizing are summarized in Table 3.7.

NOTES:

- 1 Alternative methods of establishing sensitivity are given in Appendix E.
- 2 Since it is impracticable to produce test blocks with holes at all possible beam path lengths, it is common practice to produce a distance-amplitude correction curve or attenuation correction curve for the detector equipment/probe combination and material used in the test (see Clause 3.5.4).

Beam angles shall be chosen to ensure that the angle of incidence to the major reflecting surfaces of expected discontinuities is essentially normal. Where this is not possible, additional gain shall be added to both the scanning and evaluation sensitivity as follows:

| Angle of incidence, degrees | Additional gain, dB |
|-----------------------------|---------------------|
| $\leq 10$                   | 0                   |
| $> 10 \leq 15$              | 6                   |
| $> 15 \leq 20$              | 12                  |

The use of more than one beam angle to obtain a maximum indication from a particular discontinuity shall be considered.

NOTES:

- 1 Incident angles greater than  $20^\circ$  to the major expected reflecting surface should not be used.
- 2 Planar discontinuities normally lie along the welding preparation faces.
- 3 Guidance on the development of testing procedures for welds is given in Appendix F and factors influencing probe selection are outlined in Appendix C.

### 3.5.2 Scanning sensitivity

#### 3.5.2.1 General

A high level of scanning sensitivity to ensure that all discontinuities are detected irrespective of their nature, size or orientation.

NOTE: The scanning sensitivity should not be confused with evaluation sensitivity.

#### 3.5.2.2 Sensitivity to be used for parent metal scanning

To detect the presence of features which may interfere with subsequent weld testing, the parent metal gain in a discontinuity-free area shall be set so that the second back echo is displayed at full screen height.

#### 3.5.2.3 Sensitivity to be used for weld scanning

To detect the presence of discontinuities for sensitivity Levels 1, 2 and 3, welds shall be scanned using a gain of at least 6 dB greater than the gain required to bring the signal from a 1.5 mm diameter side-drilled hole which is at least 22 mm long, at the maximum beam path length, to 80% graticule height.

For sensitivity Level 4, welds shall be scanned using a gain of at least 6 dB greater than the gain required to establish the evaluation sensitivity using the required primary reference hole (see Table 3.8).

### 3.5.3 Evaluation sensitivity

#### 3.5.3.1 General

All discontinuities located shall be evaluated in accordance with one of the levels specified in Clause 3.5.3.2, Level 1 being the most sensitive.

Where the evaluation sensitivity is not specified, Level 2 shall be used.

Levels 1, 2 and 3 specify a threshold sensitivity below which no discontinuities other than cracks are reported.

Level 4 uses a number of reference levels which vary with metal thickness and requires the evaluation of discontinuities with a reflectivity equal to, or greater than 20% of the reference level.

### 3.5.3.2 Evaluation sensitivity levels

The sensitivity to be used for the evaluation of discontinuities shall be in accordance with one or more of the following levels:

- (a) *Level 1*—use the gain required to bring the signal from a 1.5 mm side-drilled hole which is at least 22 mm long, at the same beam path length as the discontinuity, to 80% graticule height.

All discontinuities producing echoes equal to or greater than 20% graticule height shall be evaluated.

- (b) *Level 2*—use the gain required to bring the signal from a 1.5 mm side-drilled hole which is at least 22 mm long, at the same beam path length as the discontinuity, to 80% graticule height.

All discontinuities producing echoes equal to or greater than 40% graticule height shall be evaluated.

- (c) *Level 3*—use the gain required to bring the signal from a 1.5 mm side-drilled hole which is at least 22 mm long, at the same beam path length as the discontinuity, to 80% graticule height.

All discontinuities producing echoes equal to or greater than this amplitude shall be evaluated.

- (d) *Level 4*—use the gain required to bring the signal from the appropriate side-drilled hole specified in Table 3.8, at the same beam path length as the discontinuity, to 80% graticule height.

All discontinuities producing echoes equal to or greater than 20% of this amplitude shall be evaluated.

NOTE: Level 4 requires the use of a number of reference holes which vary with metal thickness (see Table 3.8). Sensitivity Levels 1, 2 and 3 require the use of a 1.5 mm diameter reference hole only.

### 3.5.4 Preparation of distance-amplitude correction curves

The evaluation of non-crack-like discontinuities to sensitivity Level 1, 2, 3 or 4 are carried out by comparing the reflectance of the discontinuity with that of a side-drilled hole reflector at the same beam path length. The use of a distance-amplitude correction curve simplifies this evaluation procedure.

The method for preparing a distance-amplitude correction curve is as follows:

- (a) Using a calibration block of suitable dimensions, select a minimum of four probe positions which will give beam path lengths between the minimum and the maximum to be used in the test.

NOTES:

- 1 Calibration block No. 2 of AS 2083 is suitable for use for sensitivity Levels 1, 2 and 3.
- 2 A typical block for use for sensitivity Level 4 evaluation is shown in Figure 3.2.

- (b) Position the probe on the reference block and note the gain required to bring the target echo to 40% graticule height at a beam path length as close as practicable to the maximum to be used (reference level gain A dB).

- (c) Note the gain required to bring the target echoes at other beam path lengths to the same graticule height (reference level gains  $A_1, A_2, A_3 \dots A_n$  dB).
- (d) Plot the gain  $A$  to  $A_n$  against their respective beam path lengths.

The plot obtained shows the gain necessary for the evaluation of discontinuity reflectance at various beam path lengths.

### 3.6 SIZING OF DISCONTINUITIES

Unless other requirements are specified in a product standard or application code, all cracks detected shall be sized for height and length using a method specified in Appendix G.

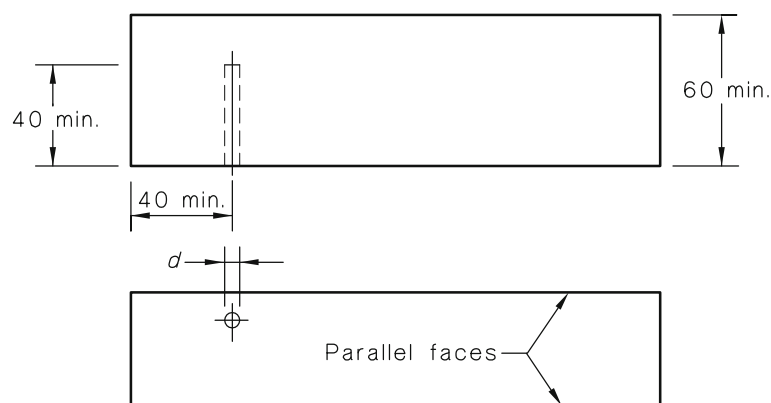
All other discontinuities which produce echoes equal to or greater than the applicable evaluation sensitivity level specified in Clause 3.5.3.2 shall be sized in accordance with the appropriate level of testing as follows:

- (a) *Level 1*—size for height and length using methods specified in Appendix G for normal probes and for angle probes.
- (b) *Levels 2, 3 and 4*—size for length using methods specified in Appendix G for normal probes and for angle probes.

Optional variations for sizing for Levels 2, 3 and 4 may be specified in accordance with Clause 3.7.

The sizing of all discontinuities shall be carried out using either the 6 dB drop technique, the 20 dB drop technique, or the last significant echo technique described in Appendix G.

NOTE: Guidance on the identification of discontinuities is given in Appendix H.



LEGEND:

$d$  = diameter of the calibration hole (see Table 3.8)

NOTE: For requirements for allowable surface roughness see Clause 3.3.1(c).

DIMENSIONS IN MILLIMETRES

FIGURE 3.2 TYPICAL REFERENCE BLOCK FOR SENSITIVITY LEVEL 4

### 3.7 OPTIONAL VARIATIONS IN SIZING FOR LEVELS 2, 3 AND 4

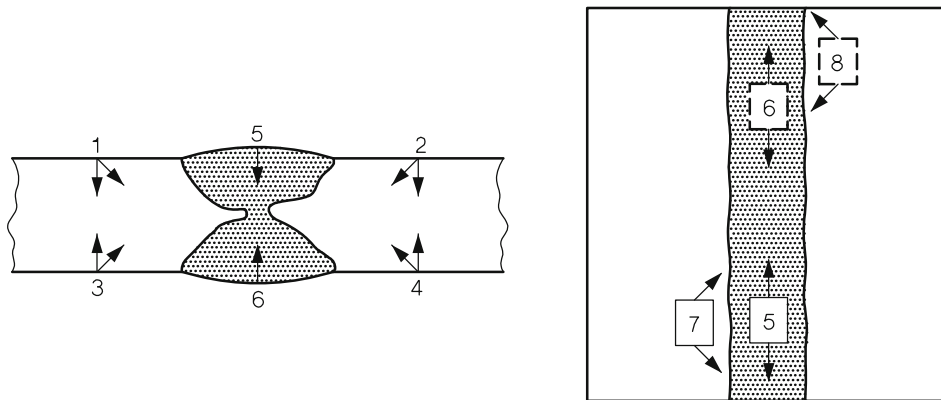
Optional variations in sizing for Levels 2, 3 and 4 which may be specified in a product standard or application code are as follows:

- (a) *Option A*—size all cracks for length using a method described in Appendix G and then proceed in accordance with the specified test method.
- (b) *Option B*—report the location of all cracks and then proceed in accordance with the specified test method.
- (c) *Option C*—size all cracks for length using a method described in Appendix G and then proceed in accordance with the specified test method.

Report the difference in gain between all discontinuities other than cracks, and the reference level.

- (d) *Option D*—size all discontinuities including cracks for length and height using a method described in Appendix G.

**TABLE 3.1**  
**TEST METHODS FOR BUTT WELDS—DOUBLE PREPARATION—COMPLETE PENETRATION—UMA METHODS**



**SCANNING POSITIONS FOR UMA METHODS**

| Test method                                          | UMA-1                                                                                               | UMA-2                                                                                                          | UMA-3                                                                                                          | UMA-4                                                                                                          |
|------------------------------------------------------|-----------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------|
| Scanning position:<br>Normal probes<br>—parent metal | 1 and 2, or 3 and 4,<br>over a distance of<br>2.5 $T^*$ from each<br>side of the toe of<br>the weld | 1 and 2, or 3 and 4,<br>over a distance of<br>2.5 $T^*$ from each<br>side of the toe of<br>the weld            | 1 and 2, or 3 and 4,<br>over a distance of<br>2.5 $T^*$ from each<br>side of the toe of<br>the weld            | 1 and 2, or 3 and 4,<br>over a distance of<br>2.5 $T^*$ from each<br>side of the toe of<br>the weld            |
| —weld metal                                          | 5†                                                                                                  | —                                                                                                              | —                                                                                                              | —                                                                                                              |
| Angle probes<br>—weld metal                          | 1, 2, 3 and 4;<br>5 and 6‡; or<br>7 and 8§                                                          | 1 and 2, or 3 and<br>4; and 5 and 6‡;<br>or 7 and 8§                                                           | 1 and 2, or<br>3 and 4                                                                                         | 1 and 2, or<br>3 and 4                                                                                         |
| Sizing of<br>discontinuities                         | Size all indications<br>for height and<br>length<br>(see Clause 3.6)                                | Size all cracks for<br>height and length<br>and all other<br>discontinuities for<br>length<br>(see Clause 3.6) | Size all cracks for<br>height and length<br>and all other<br>discontinuities for<br>length<br>(see Clause 3.6) | Size all cracks for<br>height and length<br>and all other<br>discontinuities for<br>length<br>(see Clause 3.6) |

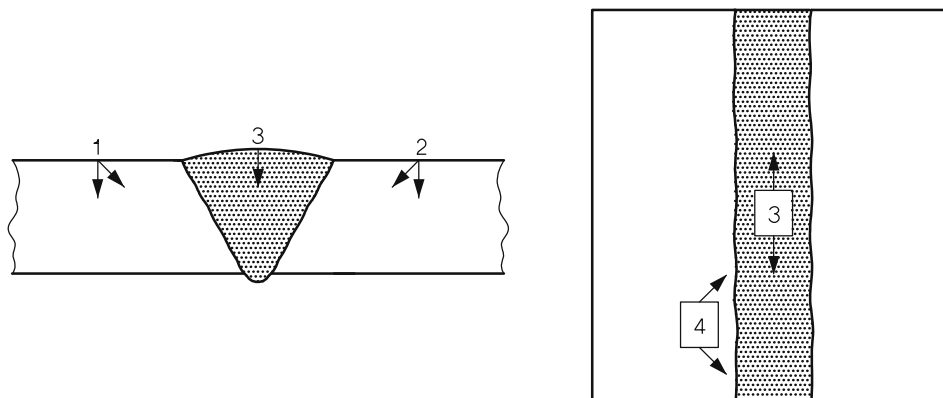
\* Where  $T$  is the parent metal thickness.

† Use scanning sensitivity specified in Clause 3.5.2.3.

‡ Traverse the probe in both directions over the weld.

§ As far as practicable, ensure that the beam axis is parallel to the longitudinal axis of the weld.

**TABLE 3.2**  
**TEST METHODS FOR BUTT WELDS—SINGLE PREPARATION—**  
**UMB METHODS**



**SCANNING POSITIONS FOR UMB METHODS**

| Test method                                          | UMB-1                                                                      | UMB-2                                                                                           | UMB-3                                                                                           | UMB-4                                                                                           |
|------------------------------------------------------|----------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------|
| Scanning position:<br>Normal probes<br>—parent metal | 1 and 2 over a distance of $2.5 T^*$ from each side of the toe of the weld | 1 and 2 over a distance of $2.5 T^*$ from each side of the toe of the weld                      | 1 and 2 over a distance of $2.5 T^*$ from each side of the toe of the weld                      | 1 and 2 over a distance of $2.5 T^*$ from each side of the toe of the weld                      |
| —weld metal                                          | 3†                                                                         | —                                                                                               | —                                                                                               | —                                                                                               |
| Angle probes<br>—weld metal                          | 1 and 2‡, and 3§ or 4                                                      | 1 and 2, and 3 or 4                                                                             | 1 and 2                                                                                         | 1 and 2                                                                                         |
| Sizing of discontinuities                            | Size all indications for height and length (see Clause 3.6)                | Size all cracks for height and length and all other discontinuities for length (see Clause 3.6) | Size all cracks for height and length and all other discontinuities for length (see Clause 3.6) | Size all cracks for height and length and all other discontinuities for length (see Clause 3.6) |

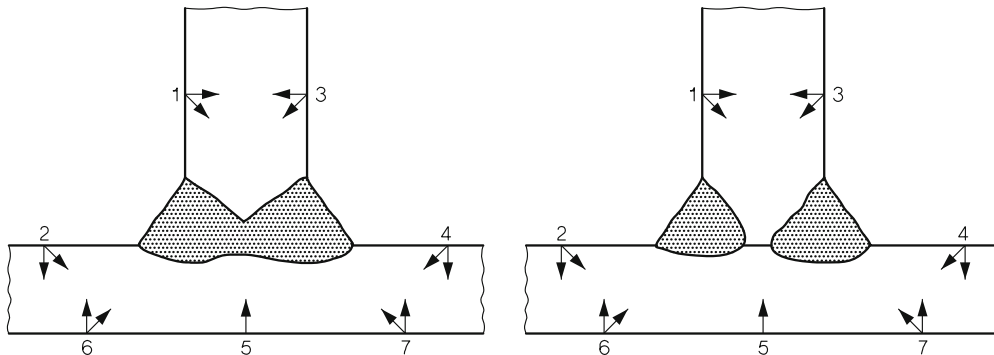
\* Where  $T$  is the parent metal thickness.

† Use scanning sensitivity specified in Clause 3.5.2.3.

‡ For weld root examination refer to Appendix F.

§ Traverse the probe in both directions over the weld and, as far as practicable, ensure that the beam axis is parallel to the longitudinal axis of the weld

**TABLE 3.3**  
**TEST METHODS FOR TEE BUTT WELDS—COMPLETE PENETRATION AND**  
**INCOMPLETE PENETRATION—UMC AND UMD METHODS**



**SCANNING POSITIONS FOR UMC METHODS & SCANNING POSITIONS FOR UMD METHODS**

| Test method                                          | UMC-1<br>UMD-1                                                                                        | UMC-2<br>UMD-2                                                                                                 | UMC-3<br>UMD-3                                                                                                 | UMC-4<br>UMD-4                                                                                                 |
|------------------------------------------------------|-------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------|
| Scanning position:<br>Normal probes<br>—parent metal | 1 and 3 and<br>2 or 6, and<br>4 or 7, over a<br>distance of $2.5 T^*$<br>from the toes of the<br>weld | 1 and 3 and<br>2 or 6, and<br>4 or 7, over a<br>distance of $2.5 T^*$<br>from the toes of the<br>weld          | 1 and 3 and<br>2 or 6, and<br>4 or 7, over a<br>distance of $2.5 T^*$<br>from the toes of the<br>weld          | 1 and 3 and<br>2 or 6, and<br>4 or 7, over a<br>distance of $2.5 T^*$<br>from the toes of the<br>weld          |
| —weld metal                                          | 5†                                                                                                    | 5†                                                                                                             | 5†                                                                                                             | 5†                                                                                                             |
| Angle probes<br>—weld metal                          | 1 or 3‡; or<br>6 and 7§, or<br>2 and 4¶                                                               | 1 or 3‡; or<br>6 and 7§, or<br>2 and 4¶                                                                        | 1 or 3‡; or<br>6 and 7§, or<br>2 and 4¶                                                                        | 1 or 3‡; or<br>6 and 7§, or<br>2 and 4¶                                                                        |
| Sizing of<br>discontinuities                         | Size all indications<br>for height and<br>length<br>(see Clause 3.6)                                  | Size all cracks for<br>height and length<br>and all other<br>discontinuities for<br>length<br>(see Clause 3.6) | Size all cracks for<br>height and length<br>and all other<br>discontinuities for<br>length<br>(see Clause 3.6) | Size all cracks for<br>height and length<br>and all other<br>discontinuities for<br>length<br>(see Clause 3.6) |

\* Where  $T$  is the parent metal thickness.

† Use scanning sensitivity specified in Clause 3.5.2.3.

‡ When scanning from positions 1 and 3 the probe movement is to be between half- and full-skip.

§ When scanning from positions 6 and 7 the probe movement is to be based on half-skip.

¶ When scanning from positions 2 and 4 the probe movement is to be based on full-skip.