

Australian/New Zealand Standard™

**Qualification of welders for fusion
welding of steels—Additional
requirements for Australia and New
Zealand**



AS/NZS 2980:2018

This Joint Australian/New Zealand Standard was prepared by Joint Technical Committee WD-003, Welding of Structures. It was approved on behalf of the Council of Standards Australia on 5 February 2018 and by the New Zealand Standards Approval Board on 31 January 2018.

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Australasian Corrosion Association
Australian Chamber of Commerce and Industry
Australian Industry Group
Australian Steel Association
Australian Steel Institute
Austroads
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Australian/New Zealand Standard™

**Qualification of welders for fusion
welding of steels—Additional
requirements for Australia and New
Zealand**

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PREFACE

This Standard was prepared by the joint Standards Australia/Standards New Zealand Committee WD-003, Welding of Structures, to supersede AS/NZS 2980:2007, *Qualification of welders for fusion welding of steels*.

This edition of the Standard is intended to provide a transition from AS/NZS 2980:2007 to AS/NZS ISO 9606.1:2017.

This Standard continues to give cognizance to the ISO welder qualifications Standard for steels, ISO 9606-1:2012, *Approval testing of welders—Fusion welding, Part 1: Steels*, which has been adopted as the Australian/New Zealand Standard, AS/NZS ISO 9606.1:2017. This edition of AS/NZS 2980 references AS/NZS ISO 9606.1 in its entirety and is intended to be read and interpreted in conjunction with AS/NZS ISO 9606.1. Additional requirements are set out in Australian and New Zealand industry-specific normative appendices, and guidance is provided in informative appendices as follows:

- (a) Appendix A—Guidance on the application of AS/NZS ISO 9606.1 and AS/NZS 2980 (informative).
- (b) Appendix B—Welder qualification assessment for welds in structural steel (normative).
- (c) Appendix C—Welder qualification test for stainless steel tube for the New Zealand Dairy Industry (normative for New Zealand).
- (d) Appendix D—Material groups (informative).

As figures in this Standard are complete only to the extent necessary for illustration, reference needs to be made to the requirements specified in the text.

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.

Statements expressed in mandatory terms in notes to tables are deemed to be requirements of this Standard.

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FOREWORD

This Standard and AS/NZS ISO 9606.1, together, provide a set of technical rules for a systematic qualification test of the welder that enables such qualifications to be independent of the type of product, location, and examiner or examining body.

The principle of this Standard is that a qualification test qualifies the welder not only for the conditions used in the test, but also for all joints that are considered easier to weld provided that the welder has received appropriate training and/or has industrial practice within the range of qualification.

The testing of a welder's skill in accordance with this Standard depends on welding techniques and conditions used in which uniform rules are conformed to, and standard test pieces are used.

When qualifying welders, the emphasis is placed on the welder's ability to manually manipulate the electrode, welding torch or welding blowpipe, thereby producing a weld of acceptable quality.

The ability of a welder to follow verbal or written instructions and verification of a person's skills are important factors in ensuring the quality of the welded product.

STANDARDS AUSTRALIA/STANDARDS NEW ZEALAND

Australian/New Zealand Standard**Qualification of welders for fusion welding of steels—Additional requirements for Australia and New Zealand****1 SCOPE**

This Standard specifies additional requirements to be used in conjunction with AS/NZS ISO 9606.1 for qualification testing of welders for fusion welding of steels, which are for certain unique Australian and New Zealand conditions. For all other situations, the requirements of AS/NZS ISO 9606.1 apply.

NOTE: Appendix A provides guidance on the application of AS/NZS ISO 9606.1 in relation to this Standard.

This Standard applies to welding processes including fusion-welding processes that are designated as manual and mechanized welding. It does not cover fully automated welding processes.

This Standard does not deal with the certification of welders.

2 APPLICATION

This Standard shall be read and applied in conjunction with the requirements of AS/NZS ISO 9606.1. The requirements of AS/NZS ISO 9606.1 apply other than where requirements within the normative Appendices of this Standard specifically indicate otherwise.

The qualification tests prescribed in this Standard are intended to provide a method to qualify welders for the welding of steel structures (in Australian and New Zealand). However, they may also be suitable for the qualification of welders for other applications by agreement. In which case, the tests will be performed in accordance with the requirements of a welding procedure specification (WPS) produced for the purpose.

The qualification test may be used to qualify both a welding procedure and a welder, provided that all the relevant requirements, e.g. test piece dimensions, are satisfied. Where a test is intended as both a procedure qualification and a welder qualification, the welder qualification is not achieved unless the requirements for procedure qualification are also met.

Qualifications in accordance with AS/NZS 2980:2007, requiring prolongation (revalidation) after the date of publication of this Standard, shall be interpreted in accordance with the requirements of AS/NZS 2980:2018.

Welder qualification tests are not intended to be used as a guide for welding during actual construction.

NOTE: Where a welder fails the specified tests, the performance may be used as a basis for measuring the value of further training.

3 REFERENCED DOCUMENTS**3.1 Documents referred to in this Standard**

Documents referred to in Appendices B and C are listed in those appendices. Documents referred to in the rest of this Standard are as follows:

AS

1450 Steel tubes for mechanical purposes

1548 Fine grained, weldable steel plates for pressure equipment

AS	
1796	Certification of welders and welding supervisors
3597	Structural and pressure vessel steel—Quenched and tempered plate
AS ISO	
9712	Non-destructive testing—Qualification and certification of NDT personnel—General procedures
AS/NZS	
1163	Cold-formed structural steel hollow sections
1554	Structural steel welding (series)
1594	Hot-rolled steel flat products
3678	Structural steel—Hot-rolled plates, floorplates and slabs
3679	Structural steel
3679.1	Part 1: Hot-rolled bars and sections
3679.2	Part 2: Welded I sections
4671	Steel reinforcing materials
9606	Qualification testing of welders—Fusion welding
9606.1	Part 1: Steels
ISO/TR	
15608	Welding—Guidelines for a metallic materials grouping system
API	
5L	Specification for line pipe

3.2 Alternatives to AS/NZS ISO 9606.1 referenced documents

ISO reference Standards (normative and informative) from AS/NZS ISO 9606.1 are listed in Clauses 3.3 and 3.4 respectively. For the application of this Standard in conjunction with AS/NZS ISO 9606.1, the parallel-listed Australian or Australian/New Zealand Standards may be used in place of the ISO documents.

3.3 Normative references

<i>Reference to International Standard from AS/NZS ISO 9606.1, Clause 2</i>		<i>Australian or Australian/New Zealand Standard that may be used as an alternative</i>	
ISO 857-1	Welding and allied processes—Vocabulary—Part 1: Metal welding processes	AS 2812	Welding, brazing and cutting of metals—Glossary of terms
ISO 3834-2	Quality requirements for fusion welding of metallic materials—Part 2: Comprehensive quality requirements	AS/NZS ISO 3834.2	Quality requirements for fusion welding of metallic materials—Part 2: Comprehensive quality requirements
ISO 3834-3	Quality requirements for fusion welding of metallic materials—Part 3: Standard quality requirements	AS/NZS ISO 3834.3	Quality requirements for fusion welding of metallic materials—Part 3: Standard quality requirements

<i>Reference to International Standard from AS/NZS ISO 9606.1, Clause 2</i>		<i>Australian or Australian/New Zealand Standard that may be used as an alternative</i>	
ISO 5173	Destructive tests on welds in metallic materials—Bend tests	AS 2205.3.1	Methods of destructive testing of welds in metal Method 3.1: Transverse guided bend test
ISO 5817	Welded—Fusion-welded joints in steel, nickel, titanium and their alloys (beam welding excluded)—Quality levels for imperfections	—	As defined in Appendix B, Appendix C, or in the application Standard
ISO 9017	Destructive tests on welds in metallic materials—Fracture test	AS 2205.4.1	Methods of destructive testing of welds in metal Method 4.1: Nick break test
		AS 2205.4.2	Methods of destructive testing of welds in metal Method 4.2: Filler break test
ISO 15609-1	Specification and qualification of welding procedures for metallic materials—Welding procedure specification—Part 1: Arc welding	—	As defined in the application Standard
ISO 15609-2	Specification and qualification of welding procedures for metallic materials—Welding procedure specification—Part 2: Gas welding		
ISO 17636	Non-destructive testing of welds—Radiographic testing of fusion-welded joints	AS 2177	Non-destructive testing—Radiography of welded butt joints in metal
ISO 17637	Non-destructive testing of welds—Visual testing of fusion-welded joints	AS 3978	Non-destructive testing—Visual inspection of metal products and components
ISO/TR 25901	Welding and related processes—Vocabulary	AS 2812	Welding, brazing and cutting of metals—Glossary of terms

NOTE: Whilst ISO 6947 *Welding and allied processes—Welding positions* has not been adopted, its content is technically identical to that of AS 3545 *Welding positions*.

3.4 Informative references

<i>Reference to International Standard from AS/NZS ISO 9606.1, Bibliography</i>		<i>Australian or Australian/New Zealand Standard that may be used as an alternative</i>	
ISO 2560	Welding consumables—Covered electrodes for manual metal arc welding of non-alloy and fine grain steels—Classification	AS/NZS 4855	Welding consumables—Covered electrodes for manual metal arc welding of non-alloy and fine grain steels—Classification
ISO 3580	Welding consumables—Covered electrodes for manual metal arc welding of creep-resisting steels—Classification	AS/NZS 4856	Welding consumables—Covered electrodes for manual metal arc welding of creep-resisting steels—Classification
ISO 3581	Welding consumables—Covered electrodes for manual metal arc welding of stainless and heat-resisting steels—Classification	AS/NZS 4854	Welding consumables—Covered electrodes for manual metal arc welding of stainless and heat-resisting steels—Classification
ISO 9000	Quality management systems—Fundamentals and vocabulary	AS/NZS ISO 9000	Quality management systems—Fundamentals and vocabulary
ISO 14171	Welding consumables—Solid wire electrodes, tubular cored electrodes and electrode/flux combinations for submerged arc welding of non alloy and fire grain steels—Classification	AS/NZS ISO 14171	Welding consumables—Solid wire electrodes, tubular cored electrodes and electrode/flux combinations for submerged arc welding of non alloy and fire grain steels—Classification
ISO 14341	Welding consumables—Wire electrodes and weld deposits for gas shielded metal arc welding of non alloy and fine grain steels—Classification	AS/NZS 14341	Welding consumables—Wire electrodes and weld deposits for gas shielded metal arc welding of non alloy and fine grain steels—Classification (ISO 14341:2010 MOD)
ISO 14343	Welding consumables—Wire electrodes, strip electrodes, wires and rods for arc welding of stainless and heat resisting steels—Classification	AS/NZS ISO 14343	Welding consumables—Wire electrodes, strip electrodes, wires and rods for arc welding of stainless and heat resisting steels—Classification

<i>Reference to International Standard from AS/NZS ISO 9606.1, Bibliography</i>		<i>Australian or Australian/New Zealand Standard that may be used as an alternative</i>	
ISO 16834	Welding consumables—Wire electrodes, wires, rods and deposits for gas-shielded arc welding of high strength steels—Classification	AS/NZS 16834	Welding consumables—Wire electrodes, wires, rods and deposits for gas-shielded arc welding of high strength steels—Classification (ISO 16834:2012 MOD)
ISO 17632	Welding consumables—Tubular cored electrodes for gas shielded and non gas shielded metal arc welding of non-alloy and fine grain steels—Classification	AS/NZS ISO 17632	Welding consumables—Tubular cored electrodes for gas shielded and non gas shielded metal arc welding of non-alloy and fine grain steels—Classification (ISO 17632:2004, MOD)
ISO 17633	Welding consumables—Tubular cored electrodes and rods for gas shielded and non-gas shielded metal arc welding of stainless and heat-resisting steels—Classification	AS/NZS ISO 17633	Welding consumables—Tubular cored electrodes and rods for gas shielded and non-gas shielded metal arc welding of stainless and heat-resisting steels—Classification (ISO 17633:2004, MOD)
ISO 17634	Welding consumables—Tubular cored electrodes for gas shielded metal arc welding of creep-resisting steels—Classification	AS/NZS ISO 17634	Welding consumables—Tubular cored electrodes for gas shielded metal arc welding of creep-resisting steels—Classification (ISO 17634:2004, MOD)
ISO 17635	Non-destructive testing of welds—General rules for metallic materials	—	As defined in the application Standard
ISO 17639	Destructive tests on welds in metallic materials—Macroscopic and microscopic examination of welds	AS 2205.5.1	Methods for destructive testing of welds in metal—Method 5.1: Macro metallographic test for cross-section examination
ISO 17640	Non-destructive testing of welds—Ultrasonic testing—Techniques, testing levels, and assessment	AS 2207	Non-destructive testing—Ultrasonic testing of fusion-welded joints in carbon and low alloy steel

<i>Reference to International Standard from AS/NZS ISO 9606.1, Bibliography</i>		<i>Australian or Australian/New Zealand Standard that may be used as an alternative</i>	
ISO 18275	Welding consumables—Covered electrodes for manual metal arc welding of high-strength steels—Classification	AS/NZS 4857	Welding consumables—Covered electrodes for manual metal arc welding of high-strength steels—Classification
ISO 18276	Welding consumables—Tubular cored electrodes for gas-shielded and non-gas-shielded metal arc welding of high-strength steels—Classification	AS/NZS ISO 18276	Welding consumables—Tubular cored electrodes for gas-shielded and non-gas-shielded metal arc welding of high-strength steels—Classification (ISO 18276:2005, MOD)
ISO 21952	Welding consumables—Wire electrodes, wires, rods and deposits for gas shielded arc welding of creep-resisting steels—Classification	AS/NZS 21952	Welding consumables—Wire electrodes, wires, rods and deposits for gas shielded arc welding of creep-resisting steels—Classification (ISO 21952:2012 MOD)
ISO 24598	Welding consumables—Solid wire electrodes, tubular cored electrodes and electrode-flux combinations for submerged arc welding of creep-resisting steels—Classification	AS/NZS ISO 24598	Welding consumables—Solid wire electrodes, tubular cored electrodes and electrode-flux combinations for submerged arc welding of creep-resisting steels—Classification
ISO 26304	Welding consumables—Solid wire electrodes, tubular cored electrodes and electrode-flux combinations for submerged arc welding of high strength steels—Classification	AS/NZS ISO 26304	Welding consumables—Solid wire electrodes, tubular cored electrodes and electrode-flux combinations for submerged arc welding of high strength steels—Classification

4 APPENDICES

4.1 Appendix A

NOTE: Guidance on the application of AS/NZS ISO 9606.1 and AS/NZS 2980 is provided in Appendix A.

4.2 Appendix B

The requirements of welder qualification assessment for welds in structural steel (for Australian and New Zealand) shall be in accordance with Appendix B, which is intended to be read and interpreted in conjunction with AS/NZS ISO 9606.1.

4.3 Appendix C

For New Zealand only, additional requirements for welder qualification for the welding of stainless steel tube for applications, such as plant and equipment for the food and dairy industries, shall be in accordance with Appendix C.

4.4 Appendix D

NOTE: Typical grades for ISO/TR 15608 material groups of common steel types are provided in Appendix D.

APPENDIX A

GUIDANCE ON THE APPLICATION OF AS/NZS ISO 9606.1 AND AS/NZS 2980
(Informative)**A1 GENERAL**

This Appendix provides recommendations and guidance on the application of AS/NZS ISO 9606.1 with AS/NZS 2980 to suit Australian and New Zealand conditions.

A2 APPLICATION**A2.1 Scope**

AS/NZS ISO 9606.1 (Clause 1) limits its application to manual or partially mechanized (manual welding where the wire feed is mechanized) processes.

A2.2 Terms and definitions

The definitions of 'examiner' and 'examining body' within AS/NZS ISO 9606.1 (Clause 3) are very broad. To facilitate acceptance of welder certification to this Standard throughout Australia and New Zealand, the examiners should have sufficient technical knowledge and experience to satisfy the examining body of their ability to interpret and apply the requirements of this Standard and the application Standard.

A2.3 Minimum qualification requirement for examiners

The recommended minimum qualification for examiners is as follows:

- (a) *Visual and destructive tests* Examiners assessing test plates and test pieces in accordance with this Standard should hold a formal qualification as a welding supervisor (or higher) or welding inspector. Examples of suitable qualifications are given in AS/NZS 1554 (all parts).
- (b) *Radiographic and ultrasonic examination* Examiners should hold appropriate qualifications at level 2 or higher issued in accordance with AS ISO 9712.

In certain cases, it may be beneficial to utilize the services of an independent examiner or examining body.

In New Zealand, persons issuing reports on destructive and/or non-destructive examinations may need to be an authorized signatory of an organization accredited by International Accreditation New Zealand (IANZ) to conduct the assessment of tests in accordance with this Standard.

A2.4 Reference numbers of welding processes

Welding process terminology utilized in Australia and New Zealand varies from that utilized in Europe and subsequently within ISO Standards. The following should be noted:

- (a) Gas metal arc welding (GMAW) is separated into its variants within the Standard. Commonly referred to as 'MIG' in Australia and New Zealand, the process employing active shielding gases such as argon-based mixed gases and CO₂ is referred to as 'metal active gas welding' (MAG). The term 'MIG' in AS/NZS ISO 9606.1 is reserved specifically for situations where inert shielding gases or gas mixes are utilized.

- (b) Flux cored arc welding (FCAW) is referred to as ‘tubular cored welding’. It can be segregated into a number of variants including—
 - (i) self-shielded tubular cored arc welding;
 - (ii) MAG welding with flux cored electrode; and
 - (iii) MAG welding with metal cored electrode.
- (c) Gas tungsten arc welding (GTAW) is also known as ‘TIG’ in Australia and New Zealand. The term ‘TIG’ is used within AS/NZS ISO 9606.1 with four variations based on the consumables or shielding gases used.
- (d) Manual metal arc welding (MMAW) is known by the same terminology within Australia and New Zealand but users of North American Standards should note the use of the alternative term ‘shielded metal arc welding’ (SMAW).

A2.5 Filler material grouping

Most of the ISO consumable classification Standards provided as examples in AS/NZS ISO 9606.1 (Table 2) have been adopted in Australia and New Zealand. See Clause 3.3 for Australian or Australian/New Zealand Standards that may be used as alternatives to these ISO Standards for the application of this Standard.

A2.6 Test pieces

The test piece lengths (see AS/NZS ISO 9606.1, Clause 6.2) are suitable for most welding processes; however, users should note that longer test pieces may be required where the weld procedure is being qualified as part of the welder’s qualification test process, particularly where additional tests not listed within this Standard may be required.

For high speed or higher amperage welding processes, longer test pieces may be required to ensure adequate crater fill, e.g. SAW.

A2.7 Welding conditions (Section 6.3)

The qualification test of welders should follow weld procedure documents (pWPS or WPS) prepared in accordance with the application Standard or AS/NZS 1554.1 unless otherwise specified. All pWPS or WPS documents should report the material group number (see ISO/TR 15608 and Appendix D of this Standard) of parent materials.

A2.8 Test methods

Test methods should follow those specified in the application Standards or Appendix B unless otherwise specified. The methods are similar to those listed within AS/NZS ISO 9606.1 Clause 6.4 or provide an equivalent technical outcome.

A2.9 Acceptance

AS/NZS ISO 9606.1 (Clause 7) provides for the use of alternative acceptance criteria for imperfections. Two alternative criteria are provided for in the Appendices of this Standard and are identical to that published in the superseded AS/NZS 2980. Appendix B conforms to the requirements of a number of Standards including category SP of AS/NZS 1554.1 and AS/NZS 1554.4. Where required by the specification, other alternatives may be used, e.g. Category FP of AS/NZS 1554.5, AS/NZS 1554.6, etc. Where alternative acceptance criteria is utilized, the welder’s certificate should indicate the name of both the test standard, i.e. AS/NZS 2980, and the alternative acceptance criteria.

A2.10 Revalidation

Revalidation (AS/NZS ISO 9606.1 Clause 9.3) was referred to as Prolongation in AS/NZS 2980 and previous editions of ISO 9606-1. A variety of methods are now available to extend the period of qualification. Welders who change employment during the life of their certificate may be able to obtain ongoing confirmation and validation with their new employer provided that the requirements of Clauses 9.2 and 9.3 are met.

A2.11 Job knowledge (Annex B)

As the optional job knowledge syllabus provided within Annex B is similar to the competency requirements for the AS 1796 theory exams, welders who have successfully passed their AS 1796 Paper A and Paper B theory exams are able claim a job knowledge designation of 'Accepted' on their welders certificate (AS/NZS ISO 9606.1 Section 10).

Welders who have only completed the Paper A theory component of AS 1796 may also claim the job knowledge designation of 'Accepted' when they are being tested using the MMAW process with either cellulosic or non-hydrogen controlled welding consumables.

APPENDIX B

WELDER QUALIFICATION ASSESSMENT FOR WELDS IN STRUCTURAL
STEEL

(Normative)

B1 SCOPE OF APPENDIX

This Appendix provides a specific welder qualification for the welding of structural steel for welders requiring qualification to Category SP of AS/NZS 1554, Part 1 or Part 4.

B2 REFERENCED DOCUMENTS

The following documents are referred to in this Appendix.

AS

- 2177 Non-destructive testing—Radiography of welded butt joints in metal
- 2177.1 Part 1: Methods of test
- 2177.2 Part 2: Image quality indicators (IQI) and recommendations for their use
- 2205 Methods of destructive testing of welds in metal
- 2205.3.1 Method 3.1: Transverse guided bend test
- 2205.4.1 Method 4.1: Nick break test
- 2205.4.2 Method 4.2: Filler break test
- 2205.5.1 Method 5.1: Macro metallographic test for cross-section examination
- 2207 Non-destructive testing—Ultrasonic testing of fusion-welded joints in carbon and low alloy steel
- 3978 Non-destructive testing—Visual inspection of metal products and components
- 4037 Pressure equipment—Examination and testing

AS/NZS

- 1554 Structural steel welding
- 1554.1 Part 1: Welding of steel structures
- 1554.4 Part 4: Welding of high strength quenched and tempered steels
- 2980 Qualification of welders for fusion welding of steels

AS/NZS ISO

- 9606 Qualification testing of welders—Fusion welding
- 9606.1 Part 1: Steels

B3 MINIMUM ACCEPTANCE REQUIREMENTS**B3.1 General**

The minimum acceptance requirements shall be in accordance with this Paragraph B3.

If the imperfections in the welder's test piece exceed the permitted maximum specified, then the welder shall be deemed to have failed the test.

B3.2 Visual examination

Each weld test piece shall be examined visually in accordance with the requirements of AS 3978. Aids to visual examination may be used wherever necessary to facilitate the assessment of an imperfection. Inspection aids and measuring devices shall be sufficient to enable the examiner to detect imperfections that could occur on welds and test pieces.

The test welds shall also conform to the following:

(a) *Plate:*

- (i) Conform to the requirements of Table B3.2(A).
- (ii) All craters shall be filled to the full cross-section of the weld.

(b) *Pipe:*

- (i) Conform to the requirements of Table B3.2(A) and B3.2(B).
- (ii) All craters shall be filled to the full cross-section of the weld.

TABLE B3.2(A)
PERMISSIBLE LEVELS OF IMPERFECTIONS IN BUTT AND FILLET WELDS
AS DETERMINED BY VISUAL EXAMINATION (see Notes)

Imperfection type	Maximum permissible dimensions or number of imperfections (see Note 1)
Butt welds	
Cracks	No cracks allowed
Lack of fusion or incomplete penetration	Not allowed
Incompletely filled groove	Not allowed
Burn through	Not allowed
Undercut (see Note 2)	5% of material thickness (t) or 0.5 mm, whichever is less
Shrinkage grooves	As for undercut
Reinforcement (each side)	<i>Plate</i> 3 mm (max.) <i>Pipe</i> See Table B3.2(B) Must be smoothly blended to plate or pipe surface at weld toes.
Root concavity	<i>Plate</i> 1 mm max, total weld thickness $\geq t$ <i>Pipe</i> 1.5 mm max, total weld thickness $\geq t$
Excess penetration	3 mm max
Toe shape (other than above)	Smoothly blended
Slag inclusions	Height: 0.2 t or 2 mm (max), whichever is less Length: t or 25 mm (max), whichever is less
Porosity (see Note 3)	Surface—Not allowed Linear porosity—Not allowed Internal—See loss of cross-sectional area
Loss of cross-sectional area (see Note 3)	$\leq 5\%$
Fillet welds	
Slag inclusions	See Paragraph B3.5(b)
Porosity	Worm-holes: 1 per 100 mm length, max dia.—lesser of $t/3$ or 2.5 mm Internal: See Paragraph B3.5(b)
Undersize—intermittent (see Notes 4 and 5)	$S/10 \leq 1.5$ mm
Other surface imperfections	As for butt welds
Loss of cross-sectional area (see Note 3)	$\leq 5\%$

NOTES:

- 1 For adjacent imperfections, see Paragraph B3.6.3(b).
- 2 Dimensions (length and depth) of undercut shall not exceed that permitted for the qualified WPS.
- 3 For the calculation of the loss of cross-sectional area, all relevant surface imperfections shall be included.
- 4 S = leg length of the fillet weld, see AS/NZS 1554.1.
- 5 The cumulative length (ΣL) of intermittent undersize fillet welds shall not exceed 10% of the length of the weld.

TABLE B3.2(B)
MAXIMUM WELD REINFORCEMENT
FOR PIPE

millimetres	
Pipe wall thickness	Maximum reinforcement
≤10	2.5
≥10 ≤20	3.0
>20	5.0

B3.3 Transverse guided bend tests

Bend test specimens shall be tested in accordance with the requirements of AS 2205.3.1 using a former with a diameter as specified in Clause 6.5.2.3 of AS/NZS ISO 9606.1.

Bend-test specimens shall not reveal any discrete discontinuity ≥ 3 mm in any direction. Discontinuities appearing at the edges of a test specimen during testing shall be ignored in the evaluation unless there is evidence that cracking is due to incomplete penetration, slag or other discontinuity. The sum of the greatest discontinuities exceeding 1 mm but less than 3 mm in any one bend specimen shall not exceed 10 mm.

B3.4 Fracture tests

B3.4.1 Nick break test

Specimens for the nick break test shall be tested in accordance with AS 2205.4.1.

The fractured surface of the weld shall conform to Table B3.2(A) and the following requirements:

- (a) The weld shall be free from individual pores or inclusions, the areas of which exceed 5 mm^2 .
- (b) The total area of all internal imperfections shall not exceed 24 mm^2 over the examination length of the weld, or 5% of the fractured weld surface area, whichever is the lessor.

B3.4.2 Fillet break test

Specimens for fillet break test shall be tested in accordance with AS 2205.4.2.

The fractured surface of the weld shall conform to Table B3.2(A) and the following requirements:

- (a) The weld shall be free from individual pores or inclusions, the areas of which exceed 5 mm^2 .
- (b) The total area of all internal imperfections shall not exceed 24 mm^2 over the examination length of the weld, or 5% of the fractured surface area, whichever is the lesser.

B3.5 Macroetch examination

The specimen shall be prepared and examined in accordance with AS 2205.5.1.

For acceptable qualification, the specimen when examined, shall conform to Table B3.2(A) and the following requirements:

- (a) Butt welds—see Paragraph 3.2.
- (b) Fillet welds shall—
 - (i) have fusion to the root of the joint but not necessarily beyond;
 - (ii) have weld profiles conforming to AS/NZS 1554.1;

- (iii) for porosity larger than 1 mm, have accumulated porosity not exceeding 6 mm; and
- (iv) have no accumulated slag, the sum of the greatest dimensions of which shall not exceed 3 mm.

B3.6 Radiography

B3.6.1 Preparation of test piece

If radiographic examination is used in lieu of the prescribed bend or fracture tests, the test piece shall be prepared in accordance with the following:

- (a) The backing bar (when used) shall not be removed.
- (b) Following visual examination to Paragraph B3.2, weld ripples or weld surface irregularities on the test piece shall be removed by any suitable mechanical process to the degree necessary to ensure that resulting radiographic images due to surface irregularities cannot mask, or be confused with, the image of any discontinuity. A witness of weld metal shall remain.

B3.6.2 Radiographic examination

Radiography shall be carried out in accordance with AS 2177.1 using the following test methods as designated by AS 2177.1, for which 'z' is 'S', 'DWS' or 'DWD' as appropriate:

- (a) For thickness ≤ 12 mm.....XR2/z.
- (b) For thickness > 12 mm.....XR2/z, GRI/z or GR2/z.

Where materials of difference thickness are examined, the thinner plate shall determine the technique selection.

Image quality indicator (IQI) sensitivity for each technique shall be as required by Table B3.6.2. The IQI sensitivity shall be measured through the weld using wire type IQI in accordance with AS 2177.2. At least one IQI should be used with each radiograph.

TABLE B3.6.2
SMALLEST DISCERNIBLE WIRE

Method (see Note 1)	Wire number (see AS 2177.2)							
	Weld metal thickness, mm							
	≤ 6	$< 6 \leq 10$	$> 10 \leq 12$	$> 12 \leq 18$	$18 \leq 25$	$> 25 \leq 35$	$> 35 \leq 50$	> 50
XR2/z	13	12	11	10	9	8	7	See Note 2
GRI/z or GR2/z	12	11	11	10	9	8	7	See Note 2

NOTES:

- 1 As designated by AS 2177.1, for which 'z' is 'S', 'DWS' or 'DWD', as appropriate.
- 2 For thicknesses greater than 50 mm, an IQI sensitivity of 2.0% is required.

B3.6.3 Criteria

For acceptance qualification, the weld, as revealed by the radiograph, shall conform to the following requirements:

- (a) The permissible level of imperfections shall not exceed the levels given in Table B3.6.3.
- (b) Adjacent imperfections.
 - (i) *Aligned* Where adjacent imperfections are aligned, they shall be assessed as shown in Figure A3.6.3(a).

- (ii) *Overlapping* Where there is a horizontal displacement between adjacent imperfections, the effective length (l) shall be as shown in Figure A3.6.3(b).
- (iii) *Overlapping vertical displacement* Where imperfections occur above one another in the vertical plane of the weld, they shall be assessed as shown in Figure A3.6.3(c).

TABLE B3.6.3

**PERMISSIBLE LEVELS OF IMPERFECTIONS AS DETERMINED
BY RADIOGRAPHIC OR ULTRASONIC EXAMINATION (see Note 1)**

Type of imperfection (Note 2)	Thick (t) mm	Weighting factor					Maximum permissible imperfection level (see Notes 3 and 4)
		Height of imperfection (h), mm					
		≤ 2	$>2 \leq 4$	$>4 \leq 10$	$<10 \leq 20$	>20	
Cracks	All	Not permitted					
Inclusions, lack of penetration or lack of fusion	≤ 10	1	X	X	X	X	L/5
	$>10 \leq 20$	1	2	X	X	X	L/4
	$>20 \leq 40$	1	2	5	X	X	L/2
		1	2	5	10	X	L
Porosity	All	See Note 5					

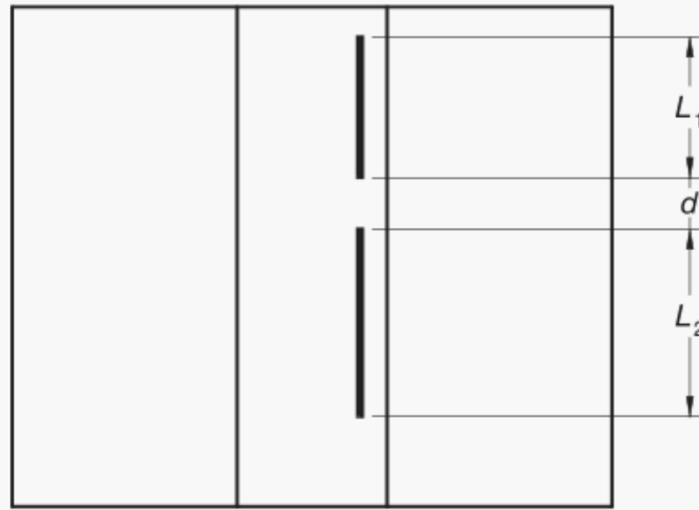
LEGEND:

X = not permitted

1 = weld length under consideration

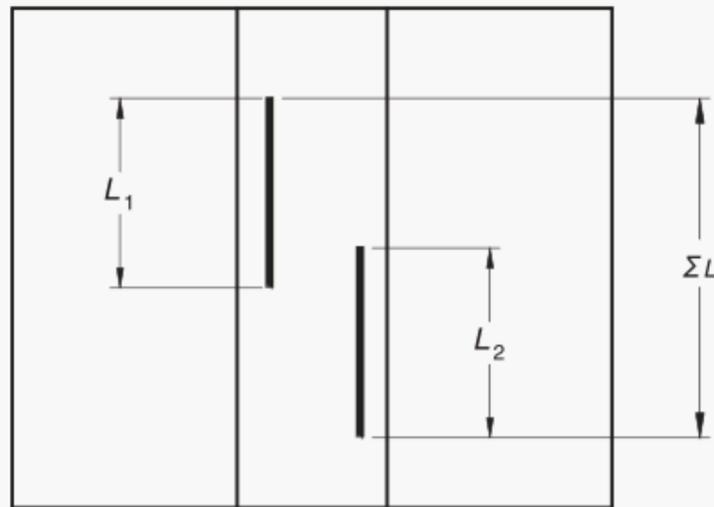
NOTES:

- For adjacent imperfections, see Paragraph B3.6.3(b).
- For the purpose of radiographic and ultrasonic examination, h is to be taken as 2 mm. If the radiographic or ultrasonic examination indicates that height could be greater than 2 mm, h is to be determined by sectioning or vertical ultrasonic sizing in accordance with AS 2207.
- For any length under consideration, the imperfection level shall be calculated by multiplying the length of each imperfection by its weighting factor and adding these weighted lengths to determine a total imperfection level. The total imperfection level shall be less than the maximum permissible imperfection level.
- Any imperfections shall not exceed a height equal to the greater of 2 mm and $t/20$, within a distance of t of the end of a weld.
- Porosity is not considered to be a particularly serious imperfection and is cause for rejection of a weld only where it is present in sufficient quantity to render difficult an inspection for the other imperfections listed in Table B3.6.3. For radiographic inspections, porosity levels representing a loss of projected area of not more than 2% are permitted. If required, reference may be made to porosity charts in AS 4037, to assist in assessing the appearance of this level of porosity on a radiograph.

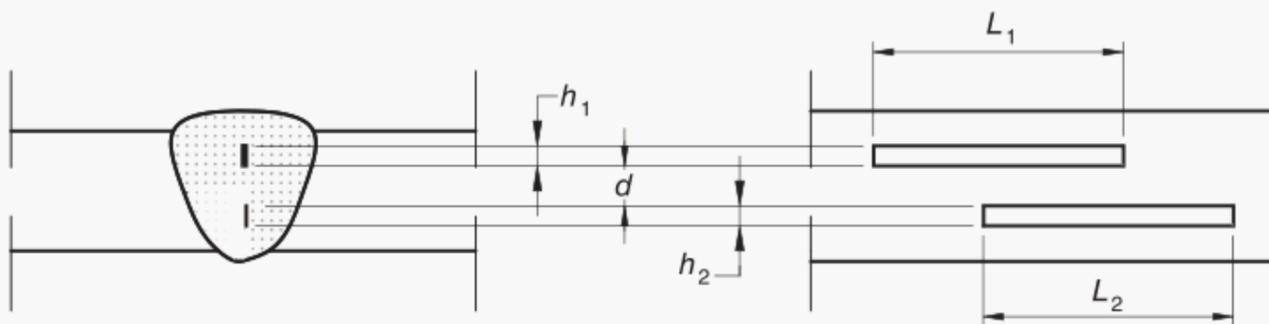


Where d is less than L_1 the smaller imperfection, $\Sigma L = L_1 + L_2 + d$
 Where d is not less than the L_1 smaller imperfection, $\Sigma L = L_1 + L_2$

(a) Aligned imperfections



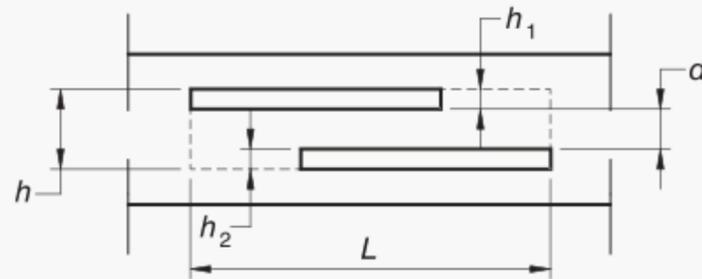
(b) Overlapping imperfections



(i) Cross-section

NOTE: Treat as separate defects.

(ii) Longitudinal section, where $d > 5$ mm



NOTE: Treat as a single defect with dimensions h and L as shown.

(iii) Longitudinal section, where $d \leq 5$ mm

(c) Overlapping vertical displacement

FIGURE B3.6.3 ASSESSMENT OF ADJACENT IMPERFECTIONS

B3.7 Ultrasonic examination

B3.7.1 Method

If ultrasonic examination is used in lieu of the radiographic examination for ferritic steels (see AS/NZS ISO 9606.1 Table 13), it shall conform to AS 2207.

Shear probes shall have a dominant frequency in the range 2.0 MHz to 2.5 MHz, and an essentially square or circular transducer in the size range 15 mm to 22 mm. For plate thicknesses of less than 15 mm, the transducer size may be reduced to 8 mm and frequencies increased to 5 MHz. Compression probes shall have a dominant frequency in the range 4 MHz to 5 MHz, and an essentially square or circular transducer in the size range 10 mm to 20 mm.

B3.7.2 Evaluation

For welds on material with a thickness not greater than 50 mm, evaluation shall be carried out at Level 2, in accordance with AS 2207. For welds on material with thickness greater than 50 mm, evaluation shall be carried out at Level 3. Planar imperfections should be evaluated at an incident angle of less than 10°. Where this is not possible, additional gain shall be added in accordance with Table B3.7.2. For the purposes of Table B3.7.2, planar imperfections shall be considered to lie along the welding preparation faces. The probe angle shall be the actual measured angle, not the nominal angle.

**TABLE B3.7.2
ADDITIONAL GAIN FOR EVALUATION
OF PLANAR IMPERFECTIONS**

Angle of incidence, degrees	Additional gain, dB
≤10	0
>10 ≤15	6
>15 ≤20	12
>20	Not permitted

B3.7.3 Acceptance limits

The maximum permissible levels of imperfections shall be as given in Table B3.6.3.

B4 WELDER'S QUALIFICATION TEST CERTIFICATE

The welder's qualification test certificate shall record the testing Standard as AS/NZS 2980.

APPENDIX C

WELDER QUALIFICATION TEST FOR STAINLESS STEEL TUBE FOR THE NEW ZEALAND DAIRY INDUSTRY

(Normative)

C1 SCOPE OF APPENDIX

This Appendix provides a specific welder qualification for the welding of austenitic stainless steel tube for applications such as plant and equipment for the food and dairy industries.

C2 REFERENCED DOCUMENT

The following document is referred to in this Appendix:

AS

2062 Non-destructive testing—Penetrant testing of products and components

C3 TEST METHOD

Qualification shall be in accordance with this Standard and the following:

- (a) Test pieces shall be austenitic stainless steel tube of 1.5 mm nominal wall thickness.
- (b) Test pieces welded from one side (single sided) shall be welded with backing gas.
- (c) Test methods shall be visual examination, bend test, and liquid penetrant testing to AS 2062.
- (d) Test pieces shall be evaluated in the as welded condition.

C4 MINIMUM ACCEPTANCE REQUIREMENTS

Unless otherwise specified, the minimum acceptance requirement shall conform to Table C3.

If the imperfections in the welder's test piece exceed the permitted maximum specified, then the welder shall be deemed to have failed the test.

C5 WELDER'S QUALIFICATION TEST CERTIFICATE

The welder's qualification test certificate shall record the testing Standard as 'AS/NZS 2980 Test for Stainless Steel Tube for the New Zealand Dairy Industry' or similar.

TABLE C3
PERMISSIBLE LEVELS OF IMPERFECTIONS IN TEST WELDS

Imperfection	Maximum permissible dimension or number of imperfections
Cracks	Nil
Reinforcement (height)	1.5 mm max.
Excess penetration	1 mm max.
Overlap	Nil
Lack of fusion	Nil
Undercut	0.5 mm max. 25 mm total length per joint
Surface porosity	Nil
Shrinkage groove	Nil
Root concavity	0.5 mm max. provided that— (a) thickness of the weld is not less than the wall thickness; and (b) the root concavity merges smoothly with the adjacent surfaces.
Linear misalignment	0.5 mm across any diameter
Crater, solid inclusion, poor restart, spatter, torn surface, grinding mark, chipping mark	Nil
Heat tint (oxidation)—Internal weld (inside of tube)	The maximum permitted heat tint shall be a straw or light blue colour (see Note)

NOTE: As a guide, the American Welding Society publishes AWS D18.2, *Guide to discoloration levels on inside of austenitic stainless steel tube (small)*. This is a colour chart used to identify the degree of heat tint oxide by number. *Number 4* on this chart equates to the maximum heat tint permitted by this Appendix.

APPENDIX D
MATERIAL GROUPS
(Informative)

Table D1 sets out typical grades and specifications for the ISO/TR 15608 material groups of common steel types. Only those elements that are specified in material Standards or specifications are considered.

TABLE D1
TYPICAL GRADES FOR MATERIAL GROUPS
OF COMMON STEELS (see Notes)

Material		Typical grade or specification
Group	Sub-group	
API 5L		
1	1.2	X52
2	2.1	X60, X65
	2.2	X70, X80
AS/NZS 1163		
1	1.1	C250
	1.2	C350
2	2.1	C450
AS 1450		
1	1.1	C200, H200, C250, H250
	1.2	C350, H350
2	2.1	C450
AS 1548		
1	1.2	PT430, PT460, PT490
2	2.1	PT540
AS/NZS 1594		
1	1.1	HA200, HA250, HU250
	1.2	HA300, HU300, HA300/1, XF300, HU300/1, HA350
	1.4	HW350
2	2.1	XF500
	2.2	XF500
AS 3597		
3	3.1	500, 600, 700, 700PV
AS/NZS 3678 and AS/NZS 3679.2		
1	1.2	200, 250
	1.2	300, 350
	1.4	WR350
2	2.1	400, 450

(continued)

TABLE D1 (continued)

Material		Typical grade or specification
Group	Sub-group	
AS/NZS 3679.1		
1	1.1	250
	1.2	300, 350
2	2.1	400
AS/NZS 4671		
1	1.1	250N
	1.2	300E
2	2.2	500N, 500E
3	3.1	500N

NOTES:

- 1 Impact tested variants of the above grades are not shown for clarity.
- 2 AS/NZS 4671 grade 500N is manufactured by both micro alloying and quench and self-tempering (QST) processes.
- 3 The material groups in this table are those of ISO/TR 15608.

NOTES

NOTES

Standards Australia

Standards Australia is an independent company, limited by guarantee, which prepares and publishes most of the voluntary technical and commercial standards used in Australia. These standards are developed through an open process of consultation and consensus, in which all interested parties are invited to participate. Through a Memorandum of Understanding with the Commonwealth government, Standards Australia is recognized as Australia's peak national standards body.

Standards New Zealand

The first national Standards organization was created in New Zealand in 1932. The New Zealand Standards Executive is established under the Standards and Accreditation Act 2015 and is the national body responsible for the production of Standards.

Australian/New Zealand Standards

Under a Memorandum of Understanding between Standards Australia and Standards New Zealand, Australian/New Zealand Standards are prepared by committees of experts from industry, governments, consumers and other sectors. The requirements or recommendations contained in published Standards are a consensus of the views of representative interests and also take account of comments received from other sources. They reflect the latest scientific and industry experience. Australian/New Zealand Standards are kept under continuous review after publication and are updated regularly to take account of changing technology.

International Involvement

Standards Australia and Standards New Zealand are responsible for ensuring that the Australian and New Zealand viewpoints are considered in the formulation of international Standards and that the latest international experience is incorporated in national and Joint Standards. This role is vital in assisting local industry to compete in international markets. Both organizations are the national members of ISO (the International Organization for Standardization) and IEC (the International Electrotechnical Commission).

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