

Australian/New Zealand Standard™

Structural steelwork—Fabrication and erection



AS/NZS 5131:2016

This Joint Australian/New Zealand Standard was prepared by Joint Technical Committee BD-001, Steel Structures. It was approved on behalf of the Council of Standards Australia on 21 November 2016 and by the New Zealand Standards Approval Board on 17 November 2016.

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The following are represented on Committee BD-001:

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Australian Chamber of Commerce and Industry
Australian Steel Association
Australian Steel Institute
Austroads
Bureau of Steel Manufacturers of Australia
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Australian/New Zealand Standard™

Structural steelwork—Fabrication and erection

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PREFACE

This Standard was prepared by the Joint Standards Australia/Standards New Zealand Committee BD-001, Steel Structures. The objective of this Standard is to provide best practice requirements for fabrication and erection of structural steel members, components and structural assemblies used for load-carrying purposes in buildings, bridges and other structures.

This Standard incorporates Amendment No. 1 (August 2020). The changes required by the Amendment are indicated in the text by a marginal bar and amendment number against the clause, note, table, figure or part thereof affected.

This Standard is based on the published joint Australian Steel Institute/Steel Construction New Zealand/Heavy Engineering Research Association (HERA) document ‘*Structural Steelwork Fabrication and Erection Code of Practice*’, 1st edition, 2014. Reference was made to EN 1090-2:2008, *Execution of steel structures and aluminium structures*, Part 2: *Technical requirements for steel structures* in the development of this Standard.

The Standard introduces the fundamental concept of ‘construction category’ (CC), which is a risk-based fit-for-purpose categorization of a structure or parts thereof. It is expected the CC categorization will be implemented in other related Standards, such as AS 4100, *Steel structures*, in due course.

It is the intention of Committee BD-001 to revise AS 4100 to align with AS/NZS 5131, principally through removal of material that is covered in AS/NZS 5131 and inclusion of guidance on the assessment of the construction category in AS 4100.

In the interim development period for this Standard, the International Standards Organization (ISO) commenced development of ISO 17607, *Steel structures*, which also makes reference to EN 1090-2, *Execution of steel structures and aluminium structures*, Part 2: *Technical requirements for steel structures*. Committee BD-001 has worked to ensure alignment where possible with ISO/CD 17607.

A1 | Amendment No. 1:2020 includes the following major changes:

- (a) Revisions throughout the document to the wording to reflect Australian Building Codes Board (ABCB) requirements for documents referenced under the National Construction Code (NCC).
- (b) Modifications to the definitions (Section 4) and application (Section 5) of traceability to better align with international practice.
- (c) Normative reference is made to AS/NZS ISO 3834 in Section 7.
- (d) Standard test for evaluation of slip factor, formerly in Appendix G, was moved back to AS 4100 and reference is made to AS 4100.

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/STANDARDS NEW ZEALAND

Australian/New Zealand Standard
Structural steelwork—Fabrication and erection

A1 | SECTION 1 SCOPE, INCLUSIONS AND EXCLUSIONS

1.1 SCOPE

This Standard sets out minimum requirements for the construction of structural steelwork involving fabrication, preparation of steel surfaces for corrosion protection, corrosion protection comprising painting and galvanizing, erection and modification of steelwork. It applies to complete structures, individual members and components, and manufactured components pre-fabricated for inclusion in a steel structure.

This Standard specifies requirements for the construction of structural steelwork produced from the following:

- A1 | (a) Hot-rolled and welded structural steel sections, flat bars and plates including those with a yield stress used in design of 690 MPa or less, which comply with one of the material Standards listed in Section 2 and which were designed using AS 4100 or AS 5100.6 or NZS 3404.
- A1 | (b) Cold-formed structural hollow sections, including hollow sections manufactured by welding, which comply with AS/NZS 1163 and which were designed using AS 4100 or AS 5100.6 or NZS 3404.
- A1 | (c) Weathering steel members and components complying with AS/NZS 3678 and AS/NZS 1594.
- A1 | (d) Steel members in composite steel and concrete structures designed using AS 2327.1 or AS 5100.6 or NZS 3404, including beams, columns, composite slabs and decking.
- (e) Cold-formed purlin and girt members and decking designed using AS/NZS 4600.

This Standard applies to all types of buildings, general structures, crane runway girders, monorails, roadway bridges, rail bridges and pedestrian bridges. Its application includes complete structures, individual members and manufactured components subject to seismic actions or to fatigue.

Some requirements are expressed in terms of construction categories.

NOTE: Guidance on construction categories is provided in Appendix C.

Provisions on inspection of welding and bolting applying to New Zealand only are covered in Appendix I.

1.2 STRUCTURAL ELEMENTS INCLUDED

This Standard applies to the elements of structural steelwork that are shown and sized on the structural design drawings, essential to support the design loads and described as follows:

(a) Structures and substructures—

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- (i) bin support structures;
- (ii) **[text deleted]**
- (iii) conveyor support structures;
- (iv) door frames, if made up from standard rolled shapes or welded from plates and if part of the structural steel frame;
- (v) structural steel frames generally;
- (vi) floor opening frames, if made up from standard rolled shapes or welded from plates and if part of the structural steel frame;
- (vii) bridges;
- (viii) cranes;
- (ix) gantries;
- (x) wharves, jetties and piers;
- (xi) lighting supports;
- (xii) masts and poles, including flagpoles;
- (xiii) roof and wall opening frames if made up from standard rolled shapes or welded from plates and if part of the structural steel frame;
- (xiv) screen support frames if made up from standard rolled shapes or welded from plates;
- (xv) sign supports;
- (xvi) silo support structures;
- (xvii) stairs;
- (xviii) towers; and
- (xix) walkways.

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(b) Elements—

- (i) base plates that are attached to columns;
- (ii) anchor rods and footing bolts that will receive the base plates;
- (iii) roof and wall battens attached to purlins and girts;
- (iv) balustrading and handrailing;
- (v) members made up from standard rolled shapes or welded from plates;
- (vi) bearing plates, if part of the structural steel frame;
- (vii) permanent and temporary bracing;
- (viii) columns and posts made up from standard rolled shapes or welded from plates;
- (ix) connection components manufactured from plate or flat bar, for framing structural steel to structural steel;
- (x) crane runway girders and crane stops made up from standard rolled shapes or welded from plates;
- (xi) embedded structural steel components that will receive structural steel;

- (xii) fasteners, shop and field bolts, nuts and washers, screws and pins, levelling nuts and washers, and associated plates;
- (xiii) floor plates, if attached to the structural steel frame;
- (xiv) finger plate expansion joints cut from steel plate;
- (xv) girts, if made up from standard rolled shapes or welded from plates or cold-formed C or Z or hat sections;
- (xvi) grillage beams;
- (xvii) hangers, if made up from standard rolled shapes or welded from plates and framing structural steel to structural steel;
- (xviii) lintels that are part of the structural steel frame;
- (xix) machinery supports, if made up from standard rolled shapes or welded from plates and if part of the structural steel frame;
- (xx) mechanical and chemical anchors;
- (xxi) monorail beams, if made up from standard rolled shapes or welded from plates and if part of the structural steel frame;
- (xxii) purlins, if made up from standard rolled shapes or welded from plates or cold-formed C and Z or hat sections;
- (xxiii) sag rods and tie rods, if part of the structural steel frame and connecting structural steel to structural steel;
- (xxiv) stud connectors for composite steel-concrete action;
- (xxv) shims and wedges, if permanent;
- (xxvi) struts and stanchions, if permanent and part of the structural steel frame;
- (xxvii) trusses, if made up from standard rolled shapes or welded from plates;
- (xxviii) temporary works such as falsework but excluding scaffolding; and
- (xxix) bridge barriers, including safety protection screens.

1.3 STRUCTURES AND ELEMENTS EXCLUDED

This Standard does not apply to the following structures and elements of structural steelwork:

- (a) Stainless steel members, components and fasteners.
- (b) Castings.
- (c) Forgings.
- (d) Wire and cable elements.
- (e) Hot driven rivets.
- (f) Proprietary structural bearings for girders, trusses or bridges.
- (g) Proprietary expansion joints for bridges or building.
- (h) Crane rails and crane rail fixings.
- (i) Roof and wall sheeting.
- (j) Frames manufactured from light-gauge cold-formed sections, other than hollow sections to AS/NZS 1163.
- (k) Concrete formwork.

- (l) Scaffolding.
- (m) Steel storage racking.
- (n) Steel-framed housing.

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1.4 [TEXT DELETED]

SECTION 2 NORMATIVE REFERENCED STANDARDS

2.1 GENERAL

This Section lists the normative documents referred to in this Standard. Normative referenced documents provide information that is essential to the application of the Standard.

NOTE: The construction specification is also considered to be a normative reference document for this Standard.

Some of these documents are considered to be ‘primary’ referenced documents, i.e. documents that will probably need to be readily available for repeated reference. These documents are indicated in the lists below by an asterisk (*) against the document number.

NOTE: Documents referenced for informative purposes are listed in the Bibliography in Appendix A.

2.2 NORMATIVE REFERENCES

AS

1100	Technical drawing (series)
1100.101	Part 101: General principles
1100.501	Part 501: Structural engineering drawing
1110	ISO metric hexagon bolts and screws—Product grades A and B
1110.1*	Part 1: Bolts
1110.2*	Part 2: Screws
1111	ISO metric hexagon bolts and screws—Product grade C
1111.1*	Part 1: Bolts
1111.2*	Part 2: Screws
1112	ISO metric hexagon nuts
1112.1*	Part 1: Style 1—Product grades A and B
1112.2*	Part 2: Style 2—Product grades A and B
1112.3*	Part 3: Product grade C
1112.4*	Part 4: Chamfered thin nuts—Product grades A and B
1171	Non-destructive testing—Magnetic particle testing of ferromagnetic products, components and structures
1365	Tolerances for flat-rolled steel products
1397*	Continuous hot-dip metallic coated steel sheet and strip—Coatings of zinc and zinc alloyed with aluminium and magnesium
1562	Design and installation of sheet roof and wall cladding
1562.1	Part 1: Metal
1627	Metal finishing—Preparation and pretreatment of surfaces
1627.1	Part 1: Removal of oil, grease and related contamination
1627.2	Part 2: Power tool cleaning
1627.4	Part 4: Abrasive blast cleaning of steel
1674	Safety in welding and allied processes
1674.1*	Part 1: Fire precautions
1674.2*	Part 2: Electrical

AS	
2062	Non-destructive testing—Penetrant testing of products and components
2177	Non-destructive testing—Radiography of welded butt joints in metal
2207	Non-destructive testing—Ultrasonic testing of fusion welded joints in carbon and low alloy steels
2327	Composite structures
2327.1*	Part 1: Simply supported beams
2331	Methods of test for metallic and related coatings
2331.1.4	Part 1.4: Local thickness tests—Magnetic induction and eddy current methods
2812	Welding, brazing and cutting of metals—Glossary of terms
2832	Cathodic protection of metals
2832.1	Part 1: Pipes and cables
2832.2	Part 2: Compact buried structures
2832.3	Part 3: Fixed immersion structures
2832.4	Part 4: Internal surfaces
2832.5	Part 5: Steel in concrete structures
3566	Self-drilling screws for the building and construction industries
3566.1	Part 1: General requirements and mechanical properties
3597*	Structural and pressure vessel steel—Quenched and tempered plate
3894	Site testing of protective coatings
3894.1	Method 1: Non-conductive coatings—Continuity testing—High voltage (brush) method
3894.3	Method 3: Determination of dry film thickness
3894.4	Method 4: Assessment of degree of cure
3894.5	Method 5: Determination of surface profile
3894.6	Method 6: Determination of residual contaminants
3894.7	Method 7: Determination of surface temperature
3894.12	Method 12: Inspection report—Coating
4100*	Steel structures
4291	Mechanical properties of fasteners made of carbon steel and alloy steel
4291.1	Part 1: Bolts, screws and studs
4291.2	Part 2: Nuts with specified property classes—Coarse thread and fine pitch thread
5100	Bridge design
5100.6*	Part 6: Steel and composite construction
5216	Design of post installed and cast-in fastenings in concrete
AS ISO	
9712	Non-destructive testing—Qualification and certification of NDT personnel
13916	Welding—Guidance on the measurement of preheating temperature and preheat maintenance temperature
AS/NZS	
1163*	Cold-formed structural steel hollow sections
1170	Structural design actions
1170.0	Part 0: General principles
1214*	Hot-dip galvanized coatings on threaded fasteners (ISO metric coarse thread series) (ISO 10684:2004, MOD)

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AS/NZS

- 1252 High-strength steel bolt assemblies comprising bolts, nuts and washers for structural engineering
- 1252.1* Part 1: Technical requirements
- 1554 Structural steel welding
- 1554.1* Part 1: Welding of steel structures
- 1554.2* Part 2: Stud welding (steel studs to steel)
- 1554.4* Part 4: Welding of high strength quenched and tempered steels
- 1554.5* Part 5: Welding of steel structures subject to high levels of fatigue loading
- 1554.7* Part 7: Welding of sheet steel structures
- 1559 Hot-dip galvanized steel bolts with associated nuts and washers for tower construction
- 1594* Hot-rolled steel flat products
- 1873 Powder-actuated (PA) hand-held fastening tools (series)
- 2312 Guide to the protection of structural steel against atmospheric corrosion by the use of protective coatings
- 2908 Cellulose-cement products (series)
- 2980* Qualification of welders for fusion welding of steels
- 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
- 3750 Paints for steel structures (series)
- 4114 Spray painting booths, designated spray painting areas and paint mixing rooms
- 4114.1 Part 1: Design, construction and testing
- 4114.2 Part 2: Installation and maintenance
- 4600* Cold-formed steel structures
- 4680* Hot-dip galvanized (zinc) coatings on fabricated ferrous articles

AS/NZS ISO

- 3834 Quality requirements for fusion welding of metallic materials
- 3834.2* Part 2: Comprehensive quality requirements
- 3834.3* Part 3: Standard quality requirements
- 3834.4* Part 4: Elementary quality requirements

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- 9606 Qualification testing of welders—Fusion welding
- 9606.1 Part 1: Steels
- 17637 Non-destructive testing of welds — Visual testing of fusion-welded joints

[Text deleted]

ISO

- 2859 Sampling procedures for inspection by attributes
- 2859-5 Part 5: System of sequential sampling plans indexed by acceptance quality limits (AQL) for lot-by-lot inspection
- 7976 Tolerances for building—Methods of measurement of buildings and building products
- 7976-1 Part 1: Methods and instruments
- 7976-2 Part 2: Position of measuring points

- ISO
8501 Preparation of steel substrates before application of paints and related products—Visual assessment of surface cleanliness
8501-1 Part 1: Rust grades and preparation grades of uncoated steel substrates and of steel substrates after overall removal of previous coatings

A1 | **[Text deleted]**

- 11127 Preparation of steel substrates before application of paints and related products—Test methods for non-metallic blast-cleaning abrasives
11127-6 Part 6: Determination of water-soluble contaminants by conductivity measurement
14731 Welding coordination—Tasks and responsibilities
15976 Closed end blind rivets with break pull mandrel and protruding head—St/St
15979 Open end blind rivets with break pull mandrel and protruding head—St/St
15980 Open end blind rivets with break pull mandrel and countersunk head—St/St
15983 Open end blind rivets with break pull mandrel and protruding head—A2/A2
15984 Open end blind rivets with break pull mandrel and countersunk head—A2/A2
17123 Optics and optical instruments—Field procedures for testing geodetic and surveying instruments (series)

- ASTM
D4285 Standard Test Method for Indicating Oil or Water in Compressed Air
F959 Standard specification for compressible-washer-type direct tension indicators for use with structural fasteners

- BS
1134 Assessment of surface texture: Guidance and general information
8539 Code of practice for the selection and installation of post-installed anchors in concrete and masonry

- A1 | NZS
3404* Steel Structures Standard
SNZ TS
3404 Durability requirements for steel structures and components
SSPC
SP 1 Solvent cleaning
SP 7 Brush-off blast cleaning
SP 10 Near-white metal blast cleaning
WTIA
Technical Care and conditioning of arc welding consumables
Note 3

SECTION 3 TERMS AND DEFINITIONS

3.1 GENERAL TERMS

For the purposes of this Standard, the following general terms and definitions apply.

3.1.1 Architecturally exposed structural steelwork (AESS)

Structural steelwork that is exposed to view and considered a fundamental component of the architectural intent of the structure.

3.1.2 Authority

A body having statutory powers to control the design and erection of a structure.

3.1.3 Coating quality level

The extent of required documentation, inspection and testing of protective coating work depending on the severity of the environment and complexity of the surface preparation and coating application.

3.1.4 Competent person

A person who has acquired, through education, training, qualification or experience or a combination of these, the knowledge and skill enabling that person to perform the required task correctly and safely.

3.1.5 Component

An element of a structure, which may be a member, a cleat or plate or an assembly of several smaller members or plates.

3.1.6 Construction

All activities performed for the physical completion of the parts of the construction works that are structural steelwork. This comprises procurement, fabrication, welding, mechanical fastening, transportation, surface treatment, corrosion protection, erection and the inspection, certification and documentation thereof.

3.1.7 Construction category

Classified set of requirements specified for the construction of the works as whole, of an individual component or of a detail of a component.

NOTE: Both ISO 2394 and European Standards use the term 'execution' to describe all activities performed for the physical completion of the works (i.e. procurement, fabrication, welding, mechanical fastening, transportation, erection, surface treatment and the inspection and documentation) and this term may be considered equivalent to 'fabrication and erection'. 'Execution Class' (EXC) is the term used in European Standards to refer to a risk-based categorization of a structure, similar in intent to the construction category adopted in this Standard. It should be noted, however, that the two categorizations are not based on the same risk matrix assessment and cannot be used interchangeably.

3.1.8 Construction specification

Set of documents covering technical data and other requirements for a particular steel structure, including those specified to supplement and qualify the provisions of this Standard.

3.1.9 Construction works

All things that are constructed or result from construction operations. This term covers both building and civil engineering works and refers to both structural and non-structural components.

3.1.10 Constructor

The person or organization undertaking the construction of the works or components thereof.

3.1.11 Designer

The person or organization responsible for defining the technical data and other requirements for a particular steel structure, as contained in the construction specification.

3.1.12 Direct tension indicator

A device that is capable of indicating the achievement of a specific minimum bolt tension in a structural bolt.

A1 | 3.1.101 Effective firm contact area

The area within one bolt diameter of any holes but not less than 25 mm from the edge of any hole and all areas within the bolt group.

3.1.13 Erector

The person or organization assembling the works on-site as part of the overall construction works.

3.1.14 Fabrication

All activities required to produce and deliver a component. As relevant, this comprises procurement, preparation and assembly, welding, mechanical fastening, transportation, surface treatment, corrosion protection, inspection and documentation thereof.

3.1.15 Fabricator

The person or organization undertaking the fabrication of the complete works or components thereof. The fabricator may subcontract components of the works to another fabricator.

3.1.16 Firm contact

A1 | The condition that exists between plies in a bolted connection where the plies are solidly seated against each other, but not necessarily in continuous contact, over the effective firm contact area.

3.1.17 Importance level

A category that characterizes a structure in terms of the circumstances of its occupancy and its use, as defined in the National Construction Code (NCC) for Australia, and AS/NZS 1170.0, *Structural design actions*, Part 0: *General principles* for New Zealand and for structures in Australia not covered by the NCC.

3.1.18 Manufacturer

The person or organization producing the material and standard or proprietary components used in the works.

3.1.19 Material

A product used for fabricating a component and which remains as part of it, e.g. structural steel rolled steel members, mechanical fasteners and welding consumables.

3.1.20 Nonconformity

Failure to meet an expectation that is stated, implied or obligatory.

3.1.21 Non-slip fasteners

Mechanical fasteners or welds that do not allow slip to occur between connected plates of members at the serviceability limit state so that the original alignment and relative positions are maintained.

3.1.22 Preparation and assembly

All activities performed on the constituent steel products in order to produce the parts ready for assembly and inclusion in a fabricated item. As relevant, this comprises identification, handling and storage, cutting, shaping and holing.

3.1.23 Quality

Degree to which a set of inherent characteristics fulfils requirements.

NOTE: See AS/NZS ISO 9000 for further information and guidance.

3.1.24 Strength limit state

A limit state of collapse or loss of structural integrity.

3.1.25 Structural steelwork

Steel structures or manufactured steel components used in construction works.

3.1.26 Structure

Organized combination of connected parts designed to carry loads and provide adequate rigidity.

3.1.27 Supplier

The distributor, stockist or importer supplying the steel material or component.

3.1.28 Supplier declaration of conformity (SDoC)

A document issued by the supplier declaring that the products supplied comply with the requirements of the relevant Australian Standard and that the documentation required by the Standard is available for issue.

3.1.29 Tensile strength

A1 | The minimum ultimate strength in tension specified for the grade of steel in AS 4100, AS 5100.6 and NZS 3404 as appropriate.

3.1.30 Tolerance

The difference between the permissible maximum (or upper) limit of size or dimension and the permissible minimum (or lower) limit of size or dimension.

3.1.31 Works

Parts of construction works that are structural steelwork.

3.1.32 Yield stress

A1 | The minimum yield stress in tension specified for the grade of steel in AS 4100, AS 5100.6 and NZS 3404, as appropriate.

3.2 TYPES OF TOLERANCE

For the purposes of this Standard, the following terms and definitions relating to types of tolerance apply.

3.2.1 Erection tolerance

An essential tolerance checked during erection or a geometrical tolerance checked after erection, which might be required to meet a function other than those of an essential tolerance, such as for appearance or fit-up.

3.2.2 Essential tolerance

Basic limit for a geometrical tolerance necessary to satisfy the design assumptions for a structure in terms of design capacity and stability (see AS 4100, AS 5100.6 and NZS 3404).

3.2.3 Fabrication tolerance

An essential tolerance checked during fabrication or a geometrical tolerance checked during fabrication.

3.2.4 Functional tolerance

A tolerance which might be required to meet a function other than those of an essential tolerance, such as for appearance or fit-up.

3.2.5 Manufacturing tolerance

Permitted range in the size and dimensions of a steel product resulting from the manufacture of the product.

3.3 CONNECTION TYPES USING MECHANICAL FASTENERS

For the purposes of this Standard, the following general terms and definitions relating to types of connections using mechanical fasteners apply.

3.3.1 Bearing-type connection

Connection affected using either snug-tight mechanical fasteners, or high strength mechanical fasteners tightened to induce a specified minimum tension in the mechanical fastener, in which the design action is transferred by shear in the fasteners and bearing on the connected parts at the strength limit state.

3.3.2 Friction-type connection

Connection affected using high-strength mechanical fasteners tightened to induce a specific minimum tension in the mechanical fastener, such that the resulting clamping action is able to transfer the design shear forces at the serviceability limit state acting in the plane of the common contact surfaces by the friction developed between the contact surfaces.

3.3.3 Full tensioning

A method of installing and tensioning a mechanical fastener that induces a specific minimum tension in the mechanical fastener.

3.3.4 Snug tight

The tightness in the bolts in a bolted connection attained by a few impacts of an impact wrench or by the full effort of a person using a standard podger spanner to bring the plies into firm contact.

3.4 WELDED CONNECTIONS

For the purposes of this Standard, the definitions of weld types given in AS 2812 apply.

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SECTION 4 DESIGN, SPECIFICATION, DOCUMENTATION AND TRACEABILITY

4.1 CONSTRUCTION SPECIFICATION

4.1.1 General

All necessary information and technical requirements for the construction of every element of the works shall be clearly set out in the construction specification. There shall be procedures in place for dealing with variations to the construction specification where variations are required. There shall be procedures in place for the resolution of any discrepancies or inconsistencies in the construction specification.

The construction specification shall include all of the following items that are relevant:

- A1 |
- (a) The design data and design details to the extent nominated in AS 4100, AS 5100.6 (in Australia) and NZS 3404 (in New Zealand).
 - (b) The required additional information listed in Appendix B, Paragraph B1.
 - (c) The selection of relevant options listed in Appendix B, Paragraph B2.
 - (d) The assignment of responsibilities listed in Appendix B, Paragraph B3.
 - (e) Details of the construction category required (Clause 4.1.2).
 - (f) Any variations from or additions to the tolerances specified in Appendix F.
 - (g) Any requirements for architecturally exposed structural steelwork (AESS) (Section 10).
 - (h) Any special requirements for the fabrication and erection of the works.
 - (i) Responsibilities for managing compliance.
 - (j) For New Zealand only, additional information as detailed in Appendix I.

4.1.2 Construction category

Four construction categories denoted CC1, CC2, CC3, CC4 are nominated in this Standard, for which requirements increase in strictness from CC1 to CC4.

NOTE: The requirements for CC4 are additional to CC3. The additional requirements for CC4 are not fully defined in this Standard. CC4 applies to unusual or special structures for which it is expected that requirements additional to those for CC3 will be defined at a project specific level or by a particular organization, agency or business.

A construction category shall apply to either the whole structure or to parts of the structure or to specific details. A structure may therefore have multiple construction categories, provided that all parts of the structure are categorized. A detail or group of details will normally be ascribed one construction category. The choice of construction category does not necessarily have to be the same for all components.

The construction category shall be nominated in the construction specification. If no construction category is specified, then CC2 shall apply.

The list of requirements related to construction categories is specified in Appendix B, Paragraph B4.

NOTE: Guidance on the selection of construction category is given in Appendix C. The choice of construction category is related to the importance factor, the service category and the fabrication category as set out in Appendix C.

4.1.3 Treatment grades

The treatment grades are to make steel surfaces with imperfections, including welded and fabricated surfaces, suitable for the application of paints and related products.

Three treatment grades, denoted P1 to P3, are defined in Clause 9.8.4, for which the required strictness increases from P1 to P3.

Treatment grades may apply to the whole structure or to a part of the structure or to specific details. A structure can include several treatment grades. A detail or group of details will normally be ascribed one treatment grade.

NOTE: Treatment grades are related to the expected life of the corrosion protection and may be related to the type of corrosion protection system used in a particular area of a structure.

4.1.4 Geometrical tolerances

The following three types of geometrical tolerance are detailed in Appendix F:

- (a) Manufacturing tolerances.
- (b) Fabrication tolerances.
- (c) Erection tolerances.

Some of these tolerances are also considered to be essential tolerances because the particular geometrical tolerance shall be complied with in order to satisfy the design assumptions for the structural element in terms of design capacity as defined in the design Standards AS 4100, AS 5100.6, AS 2327.1 or NZS 3404.

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4.2 DESIGN STAGES

Two separate but related design stages are recognized in this Standard as follows:

- (a) *The erection design stage*, which provides for the performance of the structure and elements during the erection (refer Section 11).
- (b) *The in-service design stage*, which provides for the performance of the structure primarily in the final in-service condition. The construction specification is a usual deliverable from this stage.

4.3 USE OF BUILDING INFORMATION MODELLING

Where the construction specification requires the implementation of digital project models such as Building Information Models (BIM) to convey all or a defined portion of the project information between the relevant stakeholders, the specific requirements for process, hardware, software and competent personnel necessary shall be documented.

NOTE: The workflow and integration between project stakeholders necessary would usually be defined in the Project BIM Brief or the BIM Management Plan.

Where a digital model is utilized in the project, all references in this Standard to fabrication and erection documentation shall equally apply to the digital model.

The following issues shall be addressed:

- (a) Production of a digital fabrication model consistent with the digital design model.
- (b) Establishing the owner of the digital design model and ensuring the rights and obligations of ownership are clearly understood.
- (c) Requirements and responsibilities for accuracy and maintenance of the digital design model.
- (d) Preferably, utilization of an open Standard (see Note 1) for the exchange of digital steelwork data, depending on the exact nature of the use case.

NOTES:

- 1 CIS/2 and ISO 16739 are examples.
 - 2 Comments attached to the individual elements as specified in the CIS/2 Standard should be used to annotate the digital fabrication model.
- (e) Implementation of digital document management, version control and a system to record review, approval and final release of the digital fabrication model for preparation of shop detail documentation and fabrication of structural steel.

4.4 SHOP DETAILING DOCUMENTATION

4.4.1 Production

The production of the shop detail documentation and related responsibilities shall be defined in the construction specification.

4.4.2 Scope of documentation

The shop detailing documentation shall show, in standard engineering drawing manner, clear and complete information on each assembly, component and connection of the work.

The information shall include—

- (a) identification;
- (b) steel type and grade;
- (c) dimensions of items;
- (d) required camber, where applicable;
- (e) fabrication methods including, where applicable, hot- or cold-forming and post-weld heat treatment;
- (f) location, type and size of welds or bolts;
- (g) weld categories and bolting categories;
- (h) orientation of members;
- (i) location of temporary connections;
- (j) surface preparation methods, corrosion protection system and any detailing requirements specific to the selected coating system;
- (k) procedures necessary for shop and site assembly;
- (l) lifting and support points for handling and transport;
- (m) temporary bracing, if required for handling and transport;
- (n) required fixings for building elements;
- (o) procedures for erection including temporary bracing;
- (p) set out of items relative to project grid and rise level;
- (q) all set out points as shown on structural and architectural drawings and their dimensions relative to grid;
- (r) particular welding and material testing requirements as nominated by the engineer; and
- (s) marking plans for all items including holding down bolts, shear studs and chemical anchors.

The shop detailing documentation shall be in accordance with the relevant parts of the AS 1100 series, including AS 1100.101 and AS 1100.501.

4.4.3 Production of shop detail documentation

The shop detail documentation shall—

- (a) accurately and completely transfer the information from the construction specification; and
- (b) provide for the development of accurate, detailed dimensional information which allows for the accurate fit-up of components during erection.

Each shop detail drawing shall be identified utilizing a numbering system allowing traceability throughout the duration of the works. Revisions shall be uniquely identified and dated, with the scope of each revision clearly identified.

Where requests for information (RFIs) are issued as part of the process of producing shop detail documentation, a written record of inquiries and responses shall be maintained.

NOTE: RFIs may be issued in order to seek an interpretation or a clarification of the construction specification or a resolution of discrepancies.

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4.4.4 Review of shop detail documentation

The construction specification shall nominate the competent person responsible for review of the shop detail documentation. All such documentation should be annotated as either approved or approved subject to corrections noted thereon.

4.5 DOCUMENTATION REQUIRED

4.5.1 Quality documentation

The following matters relating to quality shall be documented for all construction categories except CC1 and for Coating Quality level PC2:

- (a) The allocation of tasks and authority during the various phases of the project.
- (b) The procedures, methods and work instructions to be applied.
- (c) An inspection and test plan specific to the works (see Clause 13.1).
- (d) A procedure for handling changes and modifications.
- (e) A procedure for handling nonconformities.
- (f) A procedure for handling requests for concessions.
- (g) A procedure for handling disputes related to quality.
- (h) Any hold points or requirements to witness inspections or tests, and any consequent access requirements.
- (i) A procedure for document control and control of records.
- (j) A procedure for corrective and preventative actions.
- (k) A procedure for quality audits.
- (l) A review of contractual requirements (see Note 1).
- (m) A technical review of contractual requirements (see Note 1).

NOTES:

- 1 Clause 5 in each of the AS/NZS ISO 3834 series of Standards addresses this topic and may be used in part or full to enable compliance with this requirement.
- 2 For CC1, the quality documentation should be consistent with the elements outlined in Appendix D.

4.5.2 Quality plan

For CC2, it shall be specified in the construction specification if a quality plan for the execution of the works is required. For CC3 and CC4 and for Coating Quality level PC2 a quality plan shall be prepared for execution of the works.

A quality plan shall include the following:

- (a) A general management document which shall contain a review of the specification requirements against process capabilities.
- (b) An organization chart and managerial staff responsible for each aspect of the construction.
- (c) Arrangements for inspection including allocation of responsibility for each inspection task.
- (d) Quality documentation prior to construction, as defined in Clause 4.5.1, which shall be produced before execution of the construction step to which they relate.
- (e) Details of records of inspections and checks to be carried out or demonstration of qualification or certification of intended implemented resources. Include notification that execution records related to a hold-point that affect continuation of construction shall be produced before the hold-point is released.

NOTE: Appendix E provides guidance on the content of a quality plan recommended for the fabrication and erection of structural steelwork.

4.5.3 Safety of the works

All risks and hazards from fabrication, welding, coating, mechanical fastening and erection shall be identified and managed to ensure that all work is carried out in a manner that does not endanger the health and safety of personnel.

In particular, due consideration shall be given to the following:

- (a) Requirements relating to welding activities (see AS 1674.1 and AS 1674.2), including the control of emitted fumes, especially when welding through paints, primers and other surface coatings.
- (b) Requirements relating to the safety of the works as specified in various sections of this Standard.

NOTES:

- 1 Guidance on the management of risk is given in AS/NZS ISO 31000.
- 2 Guidance on additional safety precautions is given in WTIA Technical Notes 7 and 22.

4.5.4 As-built documentation

Sufficient documentation shall be prepared during construction as a record of the as-built structure in order to demonstrate that the works have been carried out according to the construction specification.

4.5.5 Documentation of decisions

Decisions required by this Standard should be fully documented. Copies of all relevant documentation should be retained.

In cases where a competent person's judgement is proposed, documentation should include details of any competent persons judgement relied upon, including the extent to which the judgement was relied upon and the qualifications and experience of the person.

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4.6 PURCHASING—COMPONENTS AND SUBCONTRACTED SERVICES

4.6.1 General

A documented purchasing procedure for both components and subcontracted services shall be maintained. The procedure shall be capable of monitoring trends in supplier performance. The procedure shall be operated by a named representative.

All purchases shall reflect the requirements of the construction specification and conform to the requirements specified in the order.

Purchasing information shall describe the product to be purchased, including the following where appropriate:

- (a) Requirements for approval of product, procedures, processes and equipment.
- (b) Requirements for qualification of personnel.
- (c) Quality management system requirements.
- (d) The required construction category.
- (e) Requirements for verification of product, including where applicable, verification at the suppliers' premises.

A system shall be established to maintain and document inspection or other activities sufficient to ensure that purchased product meets specified purchase requirements.

NOTE: The verification of purchased product may be achieved through one or a combination of a number of processes, including assessment of supplier/subcontractor, maintenance of supplier/subcontractor purchasing history, receipt inspection and testing and maintenance of approved supplier lists.

4.6.2 Components

All necessary documentation shall be obtained at the time of purchase for all components utilized in the fabricated structure, including but not limited to raw material, steel members, plates and cleats, assemblies, bolts and consumables. The documentation shall be sufficient to meet the requirements of Clause 5.2 for the construction category applicable to the component or structure as a whole.

Preferably, a Supplier Declaration of Conformity (SDoC) should be obtained for all purchased components. Where an SDoC is not available, documentation sufficient to meet the requirements of this Standard shall be obtained.

4.6.3 Subcontracted services

Where subcontracted services or activities are intended to be used, such as for drafting, cut and drill, forming, welding and fabrication, painting, galvanizing or erection, the procedure shall be as follows:

- (a) Provide the subcontractor with all necessary information to meet the requirements of this Standard for the scope of work being undertaken by the subcontractor.
- (b) Obtain from the subcontractor all necessary records and documentation to ensure the requirements of this Standard and the construction specification for the construction category designated for the scope of work undertaken by the subcontractor can be met.

The subcontractor shall fully comply with the relevant requirements of this Standard for the scope of work undertaken.

Full documentation sufficient to meet the requirements of this Standard shall be provided by the sub-contractor.

4.7 TRACEABILITY

4.7.1 General

A1 | There are three types of traceability referenced in this Standard, as follows:

- (a) Lot traceability (see Clause 4.7.2).
- (b) Piece-mark traceability (see Clause 4.7.3).
- (c) Piece traceability (see Clause 4.7.4)

A1 | 4.7.2 Lot traceability

For lot traceability, the material for a lot of identically fabricated components (main members, purlin cleats, etc.) shall be traceable back to a set of parent material test certificates, but an individual test certificate cannot be assigned to an individual piece of material within that lot of components. Material identification shall be transferred when part material is returned to stock and before further being allocated to other jobs.

A1 | 4.7.3 Piece-mark traceability

For piece-mark traceability, the raw material or fabricated component shall be traceable to the parent material test certificates at all stages through fabrication to incorporation into the works on-site, for each piece-mark, of which there may be many individual pieces. Raw material including all plate and section bought or allocated from stock for the work shall be correlated to the test certificates and incoming inspection records. Material identification shall be transferred when part material is returned to stock and before further being allocated to other jobs.

A1 | 4.7.4 Piece traceability

For piece traceability, the raw material or fabricated component shall be traceable to the parent material test certificates at all stages through fabrication to incorporation into the works on-site, for each piece of steel. Raw material including all plate and section bought or allocated from stock for the work shall be correlated to the test certificates and incoming inspection records. Material identification shall be transferred when part material is returned to stock and before further being allocated to other jobs.

SECTION 5 MATERIALS

5.1 GENERAL

5.1.1 Application

The properties of supplied materials shall be documented in a way that enables them to be compared to the properties specified in the construction specification and relevant Standards referred to in Clauses 5.3, 5.4, 5.5, 5.6, 5.7, 5.8 and 5.9.

5.1.2 Quality management system

The operations detailed in this Section shall be managed under a suitable quality management system.

NOTES:

- 1 An example of a suitable quality management system is set out in AS/NZS ISO 9001.
- 2 The level of documentation will generally increase with the construction category from CC1 to CC4. Guidance on the elements of a suitable quality management system aligned with the requirements of the construction categories is provided in Appendix D.

Quality documentation requirements are set out in Clause 4.5.1.

5.2 DESIGNATION, DOCUMENTATION AND TRACEABILITY

5.2.1 Designation

The designation of all materials used in the construction of the works shall be documented in the construction specification in a manner that is consistent with the designation requirements of the relevant Standard. The extent of identification of materials is covered in Clause 6.2 and in part is associated with traceability as defined in the construction specification and Clause 4.7.

For CC2, CC3 and CC4, if different grades and/or qualities of materials are in circulation together, each item shall be designated with a mark that identifies its grade.

Methods of marking of structural steel material as supplied shall be in accordance with the relevant Standards referred to in Clause 5.1.1. Methods of marking for material during and after fabrication shall comply with Clause 6.2.

Continuously hot-dip metallic coated steel shall be designated as specified in AS 1397.

If marking is required by this Standard, unmarked materials shall be treated as nonconforming product.

5.2.2 Documentation

Inspection documentation shall be provided in accordance with the relevant product specification.

5.2.3 Level of traceability

Types of traceability are defined in Clause 4.7.

For Australia the correlation between traceability and construction category shall be as follows:

- (a) For CC1: Test certificates shall be available for all steel material. The grade of steel shall remain identifiable for all steel material. Individual plate and section components shall be marked or otherwise designated to ensure the grade can be correlated directly with the fabrication drawing or data (see Clause 4.4.2).

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- A1 | (b) For CC2: Test certificates shall be provided for all steel material. Lot traceability for main structural members, connections between main structural members and major plate components (for fabricated plate web girders and the like).
- (c) For CC3 and CC4: Test certificates shall be provided for all steel material. Lot traceability for all items (including cleats, brackets and the like). Piece or piece-mark traceability is required if so designated in the construction specification.

For New Zealand the correlation between traceability and construction category shall be as follows:

- (i) For CC1: No specific requirements
- (ii) For CC2: Test certificates shall be provided for all steel material. The grade of steel shall remain identifiable for all material. Individual plate and section components shall be marked or otherwise designated to ensure the grade can be correlated directly with the fabrication drawing or data (see Clause 4.4.2).
- (iii) For CC3 and CC4: Test certificates shall be provided for all steel material. Lot traceability shall be provided for main structural members, connections between main structural members and major plate components (for fabricated plate web girders and the like). Traceability as per Item (ii) for minor components including cleats, connecting brackets and the like.

Lot traceability shall be provided for all items (including cleats, connecting brackets and the like) if so designated in the construction specification. Piece or piece-mark traceability shall be provided if so designated in the construction specification.

5.3 STRUCTURAL STEELS

5.3.1 General

The construction specification shall specify the required grades, qualities and, if appropriate, coating thickness and finishes together with any required options permitted by the relevant Standard, including any requirements related to hot-dip galvanizing.

For Australia only, steel products and any coating shall conform to the requirements of the relevant product Standards specified in AS 4100 and AS 5100.6 as appropriate.

- A1 | For New Zealand only, steel products and any coating shall conform to the requirements of the relevant product Standards specified in NZS 3404 and SNZ TS 3404.

5.3.2 Thickness tolerances

- A1 | **[Text deleted]**

The dimensional tolerances of the base steel for continuously hot-dip metallic coated steel, including width, thickness, flatness and camber, shall be in accordance with the requirements of AS/NZS 1365.

5.3.3 Surface condition

The surface condition of the structural steel prior to coating, the repair of imperfections and the metallic coating on continuously hot-dip metallic coated steel shall conform to the requirements of the relevant Standard referenced in Clause 5.3.1. Any additional requirements for surface finish, restrictions on surface imperfections or repair of surface defects by grinding or welding shall be stated in the construction specification.

NOTE: Different metallic coated spangle finishes are generally aesthetic in nature and do not impact structural properties. Continuously hot-dip metallic coated steels used in structural application are typically not skin passed.

5.3.4 Additional requirements for particular applications

Additional requirements for seismic and fracture critical applications shall be included in the construction specification and shall be in accordance with AS/NZS 3678.

Any processing requirements before delivery, such as heat treatment, cambering and bending, shall be stated in the construction specification.

5.3.5 Lamellar tearing

The suitability of material for through-thickness requirements should be based on the through-thickness ductility quality criterion as specified in AS/NZS 3678, which is expressed in terms of quality classes identified by Z-values. The choice of material depends on requirements affected by the design of welded connections and the fabrication technique. Appendix H of AS/NZS 1554.1:2014 gives guidance for the choice of Z-qualities to avoid lamellar tearing in welded connections subject to tension stresses in through thickness direction.

If through-thickness tensile testing in accordance with AS/NZS 3678 is required, this shall be stated in the construction specification.

If ultrasonic examination of structural steel in the vicinity of critical welded details is required, such as cruciform joints transmitting tensile forces or bearing diaphragms or stiffeners, this shall be stated in the construction specification and the method of test to be used upon the parent metal shall comply with AS 2207 and AS/NZS 1554.1.

NOTE: Ultrasonic examination will not typically detect inclusions or internal discontinuities normally associated with lamellar tearing (e.g. manganese sulphides) and is therefore not an indicator of through-thickness ductility.

5.4 WELDING CONSUMABLES

All welding consumables shall conform to the requirements of the relevant Standard as listed in the relevant part of AS/NZS 1554.

5.5 MECHANICAL FASTENERS

5.5.1 Corrosion resistance

Coatings of all components of the fastener assembly shall be compatible and shall have similar corrosion resistance.

The corrosion resistance of fasteners and washers shall be comparable to that specified for the fastened components. The corrosion resistance of fasteners and washers shall be stated in the construction specification.

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Protective coatings applied to mechanical fasteners shall conform to the requirements of the relevant product Standard. If not stated therein, requirements should conform with the manufacturer's specifications.

Hot-dip galvanized coatings on fasteners shall comply with AS/NZS 1214.

5.5.2 Terminology

In this clause, the following terms shall apply:

- (a) *Washer* Plain or chamfered washer.
- (b) *Assembly* Bolt with a nut and washer, as necessary.

5.5.3 Structural fasteners for other than tensioned applications

Bolts used for snug-tightened applications (/S categories in AS 4100 and AS 5100.6) shall comply with one of the following Standards:

AS 1110.1, AS 1111.1 and their mechanical properties shall comply with AS 4391.1.

Nuts used for snug-tightened applications shall comply with one of the following Standards:

AS 1112.1, AS 1112.2, AS 1112.3, AS 1112.4 and their mechanical properties shall comply with AS 4291.2.

Screws shall comply with one of the following Standards:

AS 1101.2, AS 1111.2 and their mechanical properties shall comply with AS 4291.1.

NOTE: The Australian Standards listed above are identical adoptions of ISO Standards, which may be used in place of their AS equivalents.

Fasteners for tower construction shall comply with AS/NZS 1559.

The grade of bolt or screw to be used and the relevant Standard shall be stated in the construction specification.

5.5.4 Structural bolt assemblies for tensioned applications

Bolts, nuts and washers used for tensioned applications (/T categories in AS 4100 and AS 5100.6) shall comply with AS/NZS 1252.1.

5.5.5 Direct tension indicators

Compressible-washer-type direct tension indicators and associated hardened nut face and bolt face washers shall be in accordance with ASTM F959. Direct tension indicators shall not be used with weathering steel.

If direct tension indicators are to be employed on tensioned bolts, their use shall be documented in the construction specification.

5.5.6 Weathering steel assemblies

Weathering steel assemblies shall be made of steel with improved atmospheric corrosion resistance, the chemical composition of which shall be as specified in AS/NZS 3678 or AS/NZS 1594.

NOTES:

- 1 Type 3 Grade A fasteners to ASTM A325 would be suitable.
- 2 It is recommended that HDG fasteners are not used with weathering steel. Appropriate weathering steel fasteners should be utilized.

5.5.7 Footing bolts

Chemical and mechanical properties of footing bolts shall be to AS/NZS 4291.1. Nuts shall be supplied as a minimum equivalent to the property class of the bolt material to AS/NZS 4291.2. Thread tolerance 6g shall be specified in the construction specification with dimensional tolerances to AS 1275. Galvanizing shall be to AS/NZS 1214. Plates for attachment shall be to AS/NZS 3678 or AS/NZS 1594.

Welding of materials of property class 8.8 and above shall not be permitted. Welding of nuts shall not be permitted unless they are specifically selected as a weldable product type.

NOTES:

- 1 The use of threaded rod for footing anchor bolts is not preferred. Threaded rod may not transfer load in the desired manner and may cause localised cracking through the interlocking effect of the threads in the concrete substrate. Threaded rod of any property class should not be bent to form shaped bolts as this may cause cracking of the material at the bend location. Threaded rods should not be welded as full penetration may not be achieved and thread roots can cause cracking in the heat affected zone.
- 2 The preferred fabrication method is a smooth shaft anchor bolt with either rolled or cut threads on one or both ends for attachment of plates and fittings. This fabrication method ensures direct load transfer through the bolt to the footing. Anchor bolts may be coated or sheathed to assist with bond breaking of the concrete to ensure elongation of the bolt and correct load transfer to the footing. Bolts with rolled threads may be manufactured from reduced diameter bars.

5.5.8 Locking devices

If required, locking devices such as nuts or bolt types which effectively prevent loosening of the assembly if subjected to impact or significant vibration shall be specified in the construction specification along with the relevant Standard.

Unless otherwise specified in the construction specification, products complying with ISO 2320, ISO 7040, ISO 7042, ISO 7719, ISO 10511, ISO 10512 and ISO 10513 may be used.

5.5.9 Tapered washers

Tapered washers shall comply with the relevant Standard cited in Clauses 5.5.3 and 5.5.4.

5.5.10 Fasteners for thin gauge components

Self-drilling screws shall comply with AS 3566.1. The grade and type of screw to be used should be specified in the construction specification.

Blind rivets shall comply with ISO 15976, ISO 15979, ISO 15980, ISO 15983 or ISO 15984. The grade of rivet, type and relevant Standard to be used should be specified in the construction specification.

Cartridge-fired pins and air-driven pins shall be classified as special fasteners (see Clause 5.5.11).

5.5.11 Special fasteners

Special fasteners are fasteners not covered by Australian, New Zealand or ISO Standards listed herein. They shall be fully specified in the construction specification, together with any tests required and installation instructions.

5.5.12 Delivery, identification and documentation

Fasteners complying with Clauses 5.5.3, 5.5.4 and 5.5.7 shall be delivered and identified in accordance with the requirements of the relevant Standard cited in the relevant clause.

5.5.13 Mechanical and chemical anchors

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All mechanical and chemical fasteners shall be designed and specified in the construction specification in accordance with AS 5216. Additional job specific requirements shall also be stated in the construction specification.

5.6 STUDS AND SHEAR CONNECTORS

Studs for arc stud welding, including shear studs for steel/concrete composite construction in accordance with AS 2327.1 and NZS 3404, shall comply with the requirements of AS/NZS 1554.2. Each stud shall be furnished with a ferrule and, if required, a deoxidizing and stabilizing flux each of which shall be suitable for the intended application. The grade, relevant material Standard, type and length of stud to be used shall be stated in the construction specification.

Shear connectors that comprise rolled sections shall comply with AS/NZS 3679.1.

Shear connectors that are mechanical fasteners shall comply with the relevant Standards listed in Clauses 5.5.3 and 5.5.4.

5.7 EXPLOSIVE FASTENERS

All explosive fasteners shall comply with, and shall be installed in accordance with AS/NZS 1873.

The grade, type and length of explosive fastener shall be stated in the construction specification.

5.8 GROUTING MATERIALS

Details of the grouting materials to be used shall be specified in the construction specification. Such materials shall be either: cement-based grout, special grout or concrete with small aggregate (10 mm or less).

Cement-based grout for use between steel base plates or bearing plates and concrete footings shall be as follows:

- (a) For nominal thickness not exceeding 25 mm—Portland cement grout.
- (b) For nominal thickness between 25 mm and 50 mm—fluid Portland cement grout that is not leaner than 1 part cement to 1 part fine aggregate.
- (c) For nominal thickness of 50 mm and above—stiff Portland cement grout that is not leaner than 1 part cement to 2 parts fine aggregate.

Concrete with small aggregate shall only be used between steel base plates or bearing plates and concrete footings that have gaps with nominal thickness of 50 mm and above.

- A1 | Special grout should be supplied with detailed instructions for use that are provided by the manufacturer and should be applied in accordance with the manufacturer's written instructions.

5.9 STORAGE OF MATERIALS

- A1 | All material, including material supplied by the client, should be stored according to the manufacturer's specifications such that the material will not be adversely affected. Identification shall be maintained during storage.

SECTION 6 PREPARATION, ASSEMBLY AND FABRICATION

6.1 GENERAL

6.1.1 Application

This Section specifies the requirements for identification, handling and storage, cutting, shaping, holing and assembly of steel materials into fabricated items.

Structural steelwork shall be fabricated to the relevant fabrication tolerances specified in Appendix F.

A1 | The fabrication facility and all equipment used during the fabrication process shall be suitably maintained to ensure that use, wear and failure do not cause significant inconsistency in the manufacturing process and the requirements of this Section are consistently met.

6.1.2 Quality management system

The operations detailed in this Section shall be managed under a suitable quality management system.

NOTES:

- 1 An example of a suitable quality management system is set out in AS/NZS ISO 9001.
- 2 The level of documentation will generally increase with the construction category from CC1 to CC4. Guidance on the elements of a suitable quality management system aligned with the requirements of the construction categories is provided in Appendix D.

Quality documentation requirements are set out in Clause 4.5.1.

6.1.3 Work method statements

A documented work method statement shall be prepared for each operation covered by this Section and for each stage of the work before any work is undertaken. The work method statements shall be made available to all relevant personnel involved in the works.

6.1.4 Steelwork to be painted or galvanized

Steelwork to be painted or galvanized shall also comply with the requirements of Clauses 9.3 and 9.8 in addition to the requirements of this Section.

6.1.5 Architecturally exposed structural steelwork

Steelwork identified in the construction specification as 'Architecturally Exposed Structural Steelwork (AESS)' shall comply with the requirements of Section 10 in addition to the requirements of this Section.

6.2 IDENTIFICATION AND TRACEABILITY

A record of test reports and test certificates supplied by the manufacturer for each item of steel supplied for fabrication shall be maintained.

A tracking system shall be established.

A1 | The tracking system shall support the requirements of Clause 5.2.3 for Australia or New Zealand as appropriate.

For New Zealand only, the tracking system shall also support the following:

- (a) Identification and traceability of welders for CC3 and CC4. Traceability of welders to individual welds shall be available either by documentation (e.g. weld plan) or welder ID stamp for primary connection welds.

- A1 | (b) Identification and traceability of welding procedures for CC3 and CC4. Documentation allowing traceability of welding procedures (WPS) and individual welds shall be available.

During fabrication any marking of steel members and components shall be such as to not damage the steel material. Hard stamping may be used for identification, except where specifically prohibited in the construction specification.

NOTE: Areas where hard stamping may be specifically prohibited include members or components subject to impact or fatigue or in locations where plastic hinges may occur.

The following requirements apply to hard stamped, punched or drilled marks for marking single components or packages of similar components unless otherwise specified in the construction specification:

- (1) Shall be used only for grades of steel up to GR 350.
- (2) Shall not be used on coated materials for cold-formed components.
- (3) Shall only be used in the specified areas where the marking would not affect the fatigue life.

If the use of hard stamps, punched or drilled marks is not permitted, it shall be specified in the construction specification whether soft or low stress stamps may be used. Any areas where identification marks are not permitted or shall not be visible after completion shall be specified in the construction specification.

Any steel member or component which is not clearly identifiable shall be classed as unidentified steel and shall be treated in accordance with Clause 13.3.7.

6.3 HANDLING AND STORAGE

- A1 | Members, components and fasteners should be handled, stacked and stored in accordance with the relevant manufacturer's instructions in such a way that damage and permanent deformation is not caused to them during preparation, fabrication and assembly.

Storage, handling and transport of painted steel members and components shall comply with Clause 9.9.19. Storage, handling and transport of galvanized steel members and components shall comply with Clause 9.10.10.

6.4 CUSTOMER SUPPLIED PROPERTY

Customer supplied property provided for use or incorporation into the works shall be identified, verified, protected and safeguarded.

NOTE: Customer supplied property can include components, intellectual property and personal data.

Customer supplied property shall be verified in a similar manner to purchased components (see Clause 4.6). Any customer property lost, damaged or found to be unsuitable for use shall be reported and records maintained consistent with those required in Clause 4.6.

6.5 CUTTING

6.5.1 Methods of cutting

Steel material may be cut either by a sawing, shearing, cropping, machining, thermal cutting (including laser cutting and plasma cutting) or water cutting process, unless certain processes are otherwise excluded as identified in the construction specification or elsewhere in this Standard. Particular requirements for cut edges affecting coatings and corrosion protection are detailed in Clause 6.5.4.

Shearing of steel material over 16 mm thick shall not be carried out when the item is to be galvanized and subject to tension force or bending moment inducing tension, unless the

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resulting item is subsequently stress relieved. Shearing of edges shall not be undertaken in areas designated as yielding regions in seismic design to AS 4100 and AS 5100.6 earthquake design categories D and E or NZS 3404. In such applications, any material prepared by shearing shall be sheared 3 mm oversize with the excess material subsequently removed by machining.

All such material and regions shall be suitably identified in the construction specification.

6.5.2 Roughness of cut

Any cut surface not incorporated in a weld shall have a roughness not greater than the appropriate value given in Table 6.5. Roughness shall be measured using the Centre Line Average (CLA) method specified in BS 1134.

TABLE 6.5
MAXIMUM CUT SURFACE ROUGHNESS

Loading type	Maximum roughness CLA Method μm
Static loading	25
Fatigue loading	—
Fatigue detail category ≥ 80 MPa	12
Fatigue detail category < 80 MPa	25
Yielding regions of Category 1, 2, 3 members (New Zealand only)	12

Cut surfaces exceeding these values shall be repaired by grinding until the surface complies with the required value. Any grinding marks shall be parallel to the direction of the cut.

A cut surface to be incorporated in a weld shall comply with the requirements of Clause 7.5.1.

Notches and gouges in cut surfaces, not closer than $20t$ (where t is the component thickness) to one another and not exceeding 1% of the total surface area on an otherwise satisfactory surface, shall be acceptable, provided that imperfections greater than $t/5$ (where t = component thickness), but not exceeding 2 mm in depth, are removed by machining or grinding. Imperfections outside the above limits shall be repaired by welding in accordance with the requirements of Clause 13.6.2.5, except for rail bridges where repair by welding shall not be permitted.

6.5.3 Re-entrant corners

A re-entrant corner shall be shaped notch free to a radius of at least 10 mm by drilling a hole at the corner and cutting to the hole unless stated otherwise in the construction specification for fit-up purposes. A re-entrant corner shall be free of overcut.

NOTE: A re-entrant corner is a corner in which the open angle between the cut faces is less than 180° .

6.5.4 Cut edges to be painted

Cut edges which are to be painted shall comply with the requirements of Clauses 9.8.4 and 9.8.5.

NOTE: Clause 9.8.5 also covers rolled edges.

6.6 SHAPING

6.6.1 General

All steel material shall be straightened or formed or shaped where required to the configuration specified in the construction specification by methods that will not reduce the properties of the steel material below the values used in design (as defined in the construction specification) and specified in the relevant material Standard referenced in Clause 5.3.1.

Steel material may be bent or pressed to the required shape, including the introduction of camber by either hot or cold processes.

Where steel is to be bent to strains which cause permanent deformation, the design shall be checked to ensure allowance has been made for such permanent deformation in accordance with AS 4100 or AS 5100.6, as applicable.

A1 | NOTE: AS 4100 and NZS 3404 address steel material selection to minimize occurrence of brittle fracture, which is affected by temperature and the degree of bending strain the material may be subjected to during fabrication. Specific limits on bending strain are provided, above which material selection may be affected. The degree of bending strain due to a forming operation may be calculated using the guidance provided in AS 4100 Supp 1.

Shaped components or members that exhibit damage, cracking, tearing or damage to the protective coating shall be classified as nonconforming to the requirements of this Clause.

6.6.2 Hot forming

For hot processes, the temperature of heated areas shall not exceed 620°C. For hot-rolled sections to AS/NZS 3679.1, and plates to AS/NZS 3678, and welded sections to AS/NZS 3679.2, heating should be in the temperature range 580°C to 620°C.

NOTE: Heating hollow section members complying with AS/NZS 1163 above 620°C may adversely affect the material properties.

For quenched and tempered steel to AS 3597, the temperature during heating shall not exceed 570°C, or 30°C below the tempering temperature of the steel, whichever is lower.

Bending and forming in the blue heat range (250°C to 380°C) is not permitted.

6.6.3 Flame straightening

If distortion is to be corrected by flame straightening, this shall be undertaken by local application of heat, ensuring that the maximum steel temperature and cooling procedure are controlled. Maximum steel temperatures shall comply with Clause 6.6.2.

6.6.4 Cold forming

For cold bending of plate to AS/NZS 3678, minimum radii shall conform to the requirements of AS/NZS 3678. For cold bending of rolled sections to AS/NZS 3679.1, minimum radii shall conform to the requirements of AS/NZS 3679.1.

Members distorted by welding shall be straightened by mechanical means, by application of a limited amount of localized heat or by a combination of both methods.

6.6.5 Straightening, curving and cambering of fracture critical members (New Zealand only)

For fracture critical members (FCMs) in bridges mechanical cold working shall not be used. The temperature of heated areas shall not exceed 600°C. Finished FCMs constructed of as-rolled and normalized steels may be heated to produce slight reductions in excessive camber or to produce a curvature equivalent to a circular radius not less than 300 m.

NOTE: For FCMs in bridges, the use of heat above 600°C to assist working is prohibited, to further minimize the risk of such effects occurring and initiating fatigue crack development.

6.7 HOLING

6.7.1 Holing methods

A circular hole shall be either machine cut, or drilled full size, or punched full size or subpunched 3 mm undersize and reamed to size. Allowable cutting processes are defined in general in Clause 6.5.1.

Hand flame cutting of a bolt hole shall not be permitted except as a site rectification measure for holes in column base plates.

The holing requirements related to construction categories are as follows:

- (a) For CC1 and CC2, a punched hole shall only be permitted in steel material whose yield stress (f_y) does not exceed 360 MPa and whose thickness does not exceed $(5600/f_y)$ mm. Otherwise, punching shall be restricted to subpunching 3 mm undersize followed by reaming.
- (b) For CC3 and CC4, punching shall be restricted to subpunching 3 mm undersize followed by reaming.

For New Zealand only, refer also to Clause 6.13 for holing requirements for yielding regions.

A slotted hole shall be either machine cut, or punched in one operation, or formed by drilling two adjacent holes and completed by hand cutting between the holes and subsequent grinding of the length of the hand cut.

All holes shall be free from burrs and rough edges.

Where holes are drilled in one operation through elements clamped together, which would not otherwise be separated after drilling, the elements need not be separated in order to remove burrs.

In areas designated as yielding regions in seismic design to AS 4100 or AS 5100.6 earthquake design categories D and E, fastener holes shall not be punched full sized. If punched, holes shall be punched undersize and reamed or drilled to remove all sheared surfaces.

- A1 | All cutting shall conform to the requirements of Clause 6.5.1. The roughness of the cut surface of the hole shall conform to the requirements of Clause 6.5.2.

6.7.2 Circular hole diameters

- A1 | For steel members designed to AS 4100, AS 5100.6 or NZS 3404, the nominal diameter of a completed bolt hole other than a hole in a base plate shall be 2 mm larger than the nominal bolt diameter for a bolt not exceeding 24 mm in diameter, and not more than 3 mm larger for a bolt exceeding 24 mm in diameter. For a hole in a base plate, the hole shall not be more than 6 mm greater than the anchor bolt diameter. A special plate washer of minimum thickness 4 mm shall be used under the nut if the hole diameter is 3 mm or larger than the anchor bolt diameter. The plate washer shall completely cover the hole such that the minimum distance from the edge of the hole to the edge of the plate washer shall be 0.5 times the hole's diameter.

NOTE: The hole diameter for baseplates intended to be used with mechanical or chemical anchors is given in SA TS 101.

For steel members designed to AS/NZS 4600, the nominal diameter of a completed bolt hole shall be 1 mm larger than the nominal bolt diameter for a bolt not exceeding 12 mm in diameter, and not more than 2 mm larger for a bolt exceeding 12 mm in diameter.

6.7.3 Oversize and slotted hole sizes

- A1 | For steel members designed to AS 4100, AS 5100.6 or NZS 3404, an oversize hole shall not exceed $1.25d_f$ or $(d_f + 8)$ mm in diameter, whichever is the greater, where d_f is the nominal bolt diameter in millimetres.
- A1 | For steel members designed to AS 4100, AS 5100.6 or NZS 3404, a short-slotted hole shall not exceed the diameter, in millimetres, specified in Clause 6.7.2 in width and $1.33(d_f + 10)$ in length, whichever is the greater.
- A1 | For steel members designed to AS 4100, AS 5100.6 or NZS 3404, long-slotted hole shall not exceed the diameter specified in Clause 6.7.2 in width and $2.5 d_f$ in length, where the length of the slotted hole is taken as the total length from one hole edge to another edge along the longest dimension.

For steel members designed to AS/NZS 4600, the dimensions of oversize holes, short-slotted holes and long-slotted holes shall comply with AS/NZS 4600.

6.7.4 Limitations on use of oversize and slotted holes

The use of an oversize or slotted hole shall be limited so that the following requirements are satisfied:

- (a) *Oversize hole* An oversize hole may be used in any or all plies of bearing-type or friction-type tensioned connections, provided hardened or plate washers are installed over the oversize holes under both the bolt head and the nut. The plate washer shall completely cover the hole such that the minimum distance from the edge of the hole to the edge of the plate washer shall be 0.5 times the hole's diameter.
- (b) *Short-slotted hole* A short-slotted hole may be used in any or all plies of bearing-type or friction-type tensioned connections, provided hardened or plate washers are installed over the short-slotted holes under both the bolt head and the nut. The plate washer shall completely cover the hole such that the minimum distance from the edge of the hole to the edge of the plate washer shall be 0.5 times the hole's diameter.
- (c) *Long-slotted hole* A long-slotted hole may be used only in alternate plies of bearing-type or friction-type tensioned connections, provided a plate washer not less than 8 mm thick is installed to completely cover the long-slotted hole under both the bolt head and the nut. The plate washer shall completely cover the hole such that the minimum distance from the edge of the hole to the edge of the plate washer shall be 0.5 times the hole's diameter.

Slotting of holes shall only be performed where indicated by the construction specification. Approval shall be sought where slotting of holes is required and not indicated in the construction specification.

NOTE: The construction specification should state which connections are friction-type and which are bearing-type. Where not stated, clarification should be sought. The use of short- and long-slotted holes is also restricted by the direction of loading in AS 4100 and AS 5100.6 and the construction specification should make it clear that the holes can be slotted and in which direction the slots may run.

6.7.5 Countersinking

Countersinking shall be carried out by drilling after holing is completed. The nominal depth of countersinking shall be at least 2 mm less than the nominal thickness of the outer ply.

Countersinking shall be such that the bolt or screw shall be flush with the outer face of the outer ply when installed.

6.7.6 Holes for pin connections

Holes for pin connections shall be bored smooth, straight and true to gauge at right-angles to the axis of the member.

Pins and holes at pinned connections shall be finished as required in the construction specification.

6.7.7 Weld access holes

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The location and extent of weld access holes shall be subject to review by a competent person. Where required, weld access holes shall have a length from the toe of the weld preparation not less than 1.5 times the thickness of the material in which the hole is made. The height of the access hole shall be not less than 1.5 times the thickness of the material, and not less than 25 mm nor greater than 50 mm. Cut surfaces of the access hole shall comply with Clause 6.5.2. No arc of the weld access hole shall have a radius less than 10 mm.

6.8 FULL CONTACT BEARING SURFACES

Full contact bearing surfaces shall be identified in the construction specification.

Full contact bearing surfaces in splices, at base plates and other connections shall be produced by either cold saw cutting or by machining.

The full contact bearing surfaces at such connections shall be such that, when the ends of the two members are abutted and the members comply with the alignment tolerances of Appendix F, the alignment of the members and the gap shall be within the following tolerances:

- (a) The maximum clearance between the abutting surfaces shall not exceed 1 mm.
- (b) The clearance shall not exceed 0.5 mm over at least 67% of the contact area.

6.9 ASSEMBLY

Assembly of components into fabricated items shall be executed in a manner such that the relevant fabrication and erection tolerances of Appendix F and the requirements of this Section are complied with.

All connections for temporary elements required for the fabrication process shall meet the requirements of this Section and Sections 7 and 8 and any special requirements in the construction specification. Repairs at locations of temporary attachments after their removal shall be carried out in accordance with Clause 7.5.6.

Any requirements for camber or pre-set in members shall be identified in the construction specification.

6.10 ASSEMBLY CHECK

The fit between fabricated members and components at more complex connection interfaces shall be checked and documented before dispatch to the site using either templates or accurate measurements or trial assembly or the method specified in the construction specification. Where required, trial assembly shall involve putting together (including bolting where required) sufficient fabricated members and components of the structure to check that a correct fit is achievable on-site.

6.11 TRANSIT TO SITE

All fabricated members and components shall be protected from damage in transit before they leave the fabrication shop. Particular care shall be taken to temporarily stiffen free ends, prevent permanent distortion during transit, and adequately protect all surfaces prepared for full contact connections. Means shall be provided to minimize damage to the corrosion protection on the steelwork. See Clause 9.9.19 for painted assemblies and Clause 9.10.10 for galvanized assemblies.

All nuts, bolts, washers, screws, small connection plates and steel articles generally shall be packed in containers and identified.

6.12 SUPERVISION

For CC2, CC3 and CC4, cutting, holing, shaping and assembly shall be supervised by a competent person.

NOTE: An example of suitable qualification would be a relevant trade qualification and 10 years' experience in the relevant trade.

6.13 REQUIREMENTS FOR YIELDING REGIONS (NEW ZEALAND ONLY)

6.13.1 Holing

All punched bolt holes in designated yielding regions of category 1, 2 and 3 members for seismic applications shall be punched 3 mm undersize and reamed to final size.

For railway bridges, holes shall not be machine flame-cut full size or punched full size on any members.

6.13.2 Roughness of cutting

Any cut surface not incorporated in a weld in yielding regions of Category 1, 2 or 3 members shall have a maximum roughness (CLA) of 12 μm .

A cut surface to be incorporated in a weld shall comply with AS/NZS 1554.1.

6.13.3 Transition of width and thickness

Members subject to earthquake loads or effects shall comply with the following:

- (a) Transitions in thickness of members shall be undertaken in accordance with the requirements of AS/NZS 1554.1 for non-yielding regions in any category of member or for yielding regions in category 3 members.
- (b) For yielding regions in category 1 or 2 members, the requirements of AS/NZS 1554.1 shall also apply, except that the thickness transition slope shall not exceed 1:2.5, where the former dimension is perpendicular to the line of applied force and the latter dimension is parallel to the line of applied force.
- (c) An abrupt transition of width is permitted where it occurs outside a yielding region.

SECTION 7 WELDING

7.1 GENERAL

7.1.1 Quality requirements

7.1.1.1 *General*

Welding shall be undertaken in accordance with the relevant part of AS/NZS ISO 3834.

The following are recommended to apply to the construction categories:

- (a) CC1: AS/NZS ISO 3834.4 'Elementary quality requirements'.
- (b) CC2: AS/NZS ISO 3834.3 'Standard quality requirements'.
- (c) CC3 and CC4: AS/NZS ISO 3834.2 'Comprehensive quality requirements'.

NOTES:

- 1 For CC1, fabricators conforming to AS/NZS ISO 3834.4 should note that the normative requirements of the relevant part of AS/NZS 1554 exceed those of AS/NZS ISO 3834.4.
- 2 Guidelines for the implementation of AS/NZS ISO 3834 for fusion welding of steel may be found in AS/NZS ISO 3834-6.

7.1.1.2 *Quality management system*

The operations detailed in this Section shall be managed under a suitable quality management system.

NOTE: An example of a suitable quality management system is set out in AS/NZS ISO 9001.

The level of documentation will generally increase with the construction category from CC1 to CC4. Guidance on the elements of a suitable quality management system aligned with the requirements of the construction categories is provided in Appendix D.

Quality documentation requirements are set out in Clause 4.5.1.

7.1.2 Welding requirements

The welding of structural steels shall comply with all the requirements of the relevant Part of AS/NZS 1554 as follows:

- Part 1: Welding of steel structures
- Part 2: Stud welding (steel studs to steel)
- Part 4: Welding of high strength quenched and tempered steels
- Part 5: Welding of steel structures subject to high levels of fatigue loading
- Part 7: Welding of sheet steel structures

The welding of structural steels shall also comply with any additional requirements contained in the construction specification and this Standard.

7.1.3 Requirements of construction specification

Before any welding commences, the construction specification shall be checked for consistency with Clause 4.1 and, in particular, the following information relevant to welding is contained therein, and is shown within the shop detail drawing set:

- (a) Weld category for each weld.
- (b) Weld size for each weld.
- (c) Weld type (butt, fillet, lap, partial penetration, etc.) for each weld.
- (d) Extent of each weld.

- (e) Extent of non-destructive examination required for each weld.
- (f) Construction category (for each weld if different between welds).

7.2 WELDING PLAN

7.2.1 Requirements for a welding plan

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A welding plan should be provided as part of the production planning process (see also Appendix D Paragraph D2).

NOTE: A welding plan should be prepared as follows:

- (a) Where there is the potential for the welding or assembly to overlap or mask previous welds, requiring consideration for sequencing any inspection or testing of welds that may become inaccessible.
- (b) Where there is the potential for lamellar tearing.
- (c) Where existing structures or fabrications require modification (Section 14).
- (d) For large complex fabrications.

7.2.2 Content of a welding plan

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Where required in the construction specification, the welding plan shall include as relevant—

- (a) the welding procedure specifications including welding consumable, any preheating, interpass temperature and post weld heat treatment requirements;
- (b) measures to be taken to avoid distortion during and after welding;
- (c) the sequence of welding with any restrictions or acceptable locations for start and stop positions, including intermediate stop and start positions where joint geometry is such that welding cannot be executed continuously;

NOTE: Guidance for joints of hollow sections is given in AS/NZS 1554.1.

- (d) requirements for intermediate checking;
- (e) turning of components in the welding process, in connection with the sequence of welding;
- (f) details of restraints to be applied;
- (g) measures to be taken to avoid lamellar tearing;
- (h) special equipment for welding consumables (low hydrogen, conditioning, etc.);
- (i) weld category (GP, SP, FP) and associated acceptance criteria for the welds including any specified in the construction specification in accordance with Clause 7.6;
- (j) cross reference to the requirements of the inspection and test plan (see Clause 13.6);
- (k) requirements for weld identification;
- (l) requirements for surface treatment in accordance with Section 9; and
- (m) requirements for welding through coatings.

If welding or assembly overlaps or masks previous welds special consideration is needed concerning which welds are to be executed first and the possible need to inspect/test a weld before the second weld is executed or before masking components are assembled.

Welding requirements related to fatigue or seismic detail categories shall be included in the construction specification.

7.3 WELDING PROCESSES

Welding may be performed by any of the welding processes permitted by the relevant Part of the AS/NZS 1554 series of Standards (see Clause 7.1.2), as appropriate.

Other welding processes shall only be used if permitted by the construction specification.

7.4 QUALIFICATION OF WELDING PROCEDURES AND WELDING PERSONNEL

7.4.1 Qualification of welding procedures

7.4.1.1 *General*

Welding shall be carried out using qualified procedures using a welding procedure specification (WPS) complying with the relevant provisions in the application Standard (see Clause 7.1.2) and Clause 7.2.

If specified, special deposition conditions for tack welds shall be included in the WPS (see also Clause 7.5.7). For joints in hollow section lattice structures the WPS shall define the start and stop zones and the method to be used in order to cope with locations where the welds change from a fillet weld to butt around a joint.

If impact tests, as defined in the relevant Part of the AS/NZS 1554 series of Standards cited in Clause 7.1.2, are specified in the construction specification or the WPS, such tests shall be carried out at the lowest of—

- (a) the design service temperature;
- (b) the actual test temperature specified in the construction specification; or
- (c) the lowest temperature for which the relevant Standard for the steel grade involved requires impact properties.

If welding on shop primers, weld qualification tests shall be carried out using the maximum (nominal + tolerance) accepted film thickness.

For welding processes not included in a Part of the AS/NZS 1554 series of Standards, the qualification of the welding procedure shall be in accordance with Table 7.4

7.4.1.2 *Validity of a welding procedure qualification*

The validity of a welding procedure depends on the requirements of the Standard used for the qualification.

The extension of qualification and any required requalification due to a change in an essential variable of any welding procedure shall be that specified in the relevant Standard.

If specified in the construction specification, for CC3 and CC4 production tests shall be carried out in accordance with the provisions of the construction specification.

For CC3 and CC4, weld procedure traceability is required.

7.4.2 Qualification of welders

For CC1 and CC2, welders shall be qualified in accordance with the requirements of the application Standard (see Clause 7.1.2, as appropriate).

For CC3 and CC4, welders shall be qualified in accordance with the requirements of AS/NZS 2980 or AS/NZS ISO 9606-1.

For CC3 and CC4, identification and traceability of welders is required.

The role of the examiner or examining body shall be fulfilled by the welding coordinator unless otherwise specified in the construction specification.

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Records of all welder qualification tests shall be available for perusal by the welding inspector (see Section 13).

7.4.3 Welding coordination

For all construction categories, welding coordination shall be maintained during the execution of welding by welding coordination personnel suitably qualified for, and experienced in the welding operations they supervise (see Table 7.4).

With respect to the welding operations being supervised, welding coordination personnel shall have technical knowledge of the welding processes and equipment, materials and their behaviour during welding.

NOTE: Guidance on the minimum technical knowledge of welding required in order to provide adequate supervision is provided in AS 2214 and ISO 14731.

TABLE 7.4
TECHNICAL REQUIREMENTS RELATED TO
CONSTRUCTION CATEGORY (STRUCTURAL STEELS)

Description	Construction category			
	CC1	CC2	CC3	CC4
Quality	Clause 7.1.1	Clause 7.1.1	Clause 7.1.1	Clause 7.1.1
Qualification of weld procedures	AS/NZS 1554	AS/NZS 1554	AS/NZS 1554	AS/NZS 1554
Weld category	GP	GP, SP	GP, SP, FP	GP, SP, FP
Welder qualifications	AS/NZS 1554	AS/NZS 1554	AS/NZS 2980	AS/NZS 2980
Welding supervisor or coordinator qualifications	AS/NZS 1554	AS/NZS 1554	ISO 14731	ISO 14731
Identification and traceability of welders	Not specified	Not specified	Required	Required
Traceability of weld procedures	Not specified	Not specified	Required	Required

NOTES:

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- 1 Fabricators complying with AS/NZS ISO 3834.2 and AS/NZS ISO 3834.3 should note that welders should be qualified to AS/NZS 2980. Compliance with AS/NZS ISO 9606.1 is also acceptable (see also Clause 7.4.2).
 - 2 For CC2, the competence of the welding supervisor (or welding coordinator) without formal qualifications to supervise or coordinate work undertaken by the fabricator should be assessed by professional interview.
 - 3 For CC3, depending on work undertaken by the fabricator, the welding supervisor or coordinator may require specific technical knowledge (Clause 7.4.3). The construction specification should specify any additional requirements.
 - 4 When welding steels from steel groups 8Q to 12Q (see AS/NZS 1554.4), welding supervisors and coordinators are recommended to have specific technical knowledge on the welding of quench and tempered steels.
 - 5 Identification and traceability of welds and welders to individual welds is required when specified by either the quality plan or within the contract documents. Identification of the welder can be by welder ID stamps or weld map. Stamping shall not be used on welds subject to high levels of dynamic loading or fatigue.
 - 6 For CC3 and CC4, examples of qualifications that would satisfy the requirements of ISO 14731 for the purposes of this Standard include:
 - (a) *Basic knowledge*—qualifications compliant with AS 2214, AS 1796 certificate 10, New Zealand Institute of Welding Supervisors Certificate, International Institute of Welding qualifications at the level of International Welding Specialist (IWS).
 - (b) *Specific knowledge*—New Zealand Institute of Welding certificate in Welding Engineering, International Institute of Welding qualifications at the level of International Welding Technologist (IWT).
 - (c) *Comprehensive knowledge*—International Institute of Welding qualifications at the level of International Welding Engineer (IWE).

7.5 PREPARATION AND EXECUTION OF WELDING

7.5.1 Joint preparation

7.5.1.1 General

Joint preparation shall be appropriate for the welding process being used and shall be identical to the type of preparation used in the relevant welding procedure test.

Tolerances for joint preparations and fit-up shall comply with the workmanship requirements of the application Standard (see Clause 7.1.2, as appropriate).

The joint preparation shall be uniform and free from fins, tears, cracks and other defects that would adversely affect the quality or strength of the weld.

If large notches or other errors in joint preparation or joint geometry are corrected by welding, a qualified welding procedure shall be used and the area shall be subsequently ground smooth and blended into the adjacent surface. All surfaces to be welded and surfaces adjacent to the weld shall be dry and free from material that would adversely affect the quality of the welds or impede the process of welding (e.g. rust, grease paint organic material, galvanizing, etc.). Mill scale that withstands vigorous hand wire brushing or power wire brushing, rust-inhibiting coatings and anti-spatter compounds that do not interfere with weld quality or the welding process itself may remain.

Prefabrication primers (shop primers) may be left on the fusion faces only if they do not adversely affect the weld quality or the welding process. They shall not be left on fusion faces unless the welding procedure tests were completed with the weld-through primer in place.

7.5.1.2 *Hollow sections*

For circular hollow sections being used as branch components in fillet welded joints, the fit-up of the joint geometry shall suit the requirements of the WPS.

For branch connections in hollow section trusses, any adjustment for lack of fit by a welded surface deposit shall be in accordance with a suitable welding procedure.

7.5.2 Storage and handling of welding consumables

7.5.2.1 *General*

A1 | Welding consumables shall be stored, conditioned and pretreated, handled and used in conformance with the relevant part of the AS/NZS 1554 series. See also Clause 7.5.2.2.

A1 | After consumables have been removed from their original packages, they shall be protected or stored so that their specified properties and welding characteristics are not adversely affected.

Consumables that have not been stored in dry conditions, kept free from rust, oil, grease or other foreign materials shall be discarded.

Welding consumables showing signs of damage or deterioration shall be discarded.

NOTE: Examples of damage or deterioration include cracked or flaked coatings on covered electrodes, rusty or dirty electrode wires and electrode wires with flaked or damaged copper coatings.

7.5.2.2 *Electrodes and fluxes with specific controlled hydrogen properties*

A1 | Unless otherwise specified (see Clause 7.5.2.1), coated electrodes and fluxes with specific controlled hydrogen properties shall be stored in a heated oven or quiver at a temperature $\geq 105^{\circ}\text{C}$ immediately after being removed from their original packaging.

If the original packaging shows evidence of damage, electrodes shall be redried (see Clause 7.5.2.1).

Consumables remaining unused at the end of the welding shift shall be redried (see Clause 7.5.2.1).

NOTE: See Weld Australia's Technical Note 3 for recommendations on the storage and conditioning of arc welding consumables.

7.5.3 Weather protection

The welder, the consumables and the working area shall be adequately protected against the effects of wind, rain and snow.

Welding processes requiring an external gas shield shall not be carried out in a draught or wind with a wind speed of more than 10 km/h, unless the welding area is suitable shielded so as to reduce wind speed below 10 km/h, or unless the welding procedure including wind at the actual wind speed or higher is qualified in accordance with Clause 7.4.

Surfaces to be welded shall be maintained dry and free from condensation.

When the base metal temperature is below 0°C, the base metal shall be preheated to at least the higher of 10°C or the specified minimum preheat temperature shown on the WPS, and this minimum temperature maintained during welding.

Welding and thermal cutting shall not be carried out when the metal temperature is colder than 0°C unless the welding procedure is qualified in accordance with Clause 7.4 for the actual metal temperature below the value of 0°C.

7.5.4 Assembly for welding

Assembly shall be in accordance with the relevant clause in the application Standard cited in Clause 7.1.2, as appropriate.

The alignment of parts to be welded shall be made having regard to the normal tolerances associated with the fabrication and erection procedures to be used. Ends of parts that are to be joined shall be aligned consistent with the requirements of the welding procedure being employed. Suitable allowances shall be made for distortion and shrinkage such that the relevant fabrication tolerances in Appendix F are complied with for the fabricated assembly.

The components to be welded shall be assembled and held in position such that joints to be welded are readily accessible and easily visible to the welder.

Additional welds shall not be introduced and the location of specified welds shall not be changed from what is specified in the construction specification.

Changes to the welding details or additional welds than originally shown on the fabrication drawing shall be approved prior to welding.

7.5.5 Preheating

The need for preheating shall be determined in accordance with the relevant clause in the relevant Part of the AS/NZS 1554 series, as appropriate, and shall be carried out in accordance with AS ISO 13916.

Preheating shall be undertaken in accordance with the applicable WPS and shall be applied during welding, including tack welding and the welding of temporary attachments.

7.5.6 Temporary attachments

If the assembly or erection procedure requires the use of components temporarily attached by welds, they shall be positioned such that they can easily be removed without damage to the permanent steelwork. All welds for temporary attachments shall be made in accordance with an established WPS. Any areas where welding of temporary attachments is not permitted shall be specified in the construction specification.

Temporary attachments shall not be placed in areas not permitted in the construction specification for CC2, CC3 and CC4. Where temporary attachments are permitted in the construction specification, they shall comply with the requirements of the relevant clause in the relevant Part of the AS/NZS 1554 series, as appropriate.

Welds joining temporary attachments to the steel structure shall be made to the same standards as final welds. All temporary attachments shall be removed unless otherwise specified in the construction specification. Temporary welds and attachments shall not be allowed on the tension flanges of beams, girders and similar members.

When temporary welds or attachments are removed, the surface at the location shall be—

- (a) reinstated to a reasonably smooth condition by grinding or a combination of welding and grinding;
- (b) checked by magnetic particle examination or other suitable method in order to ensure soundness; and
- (c) finished to the requirements of the relevant clause in the relevant Part of the AS/NZS 1554 series.

After removal of the temporary attachment, removal of the weld metal or portions of the base metal shall be effected by machining, grinding, chipping, oxygen gouging, air-arc-gouging or plasma gouging in such a manner that the remaining weld metal or base metal is not nicked or undercut and so that the surface of the parent metal can subsequently be carefully ground smooth. Unacceptable portions of the weld shall be removed without substantial removal of the parent metal. The surfaces shall be cleaned thoroughly before welding.

Oxygen-gouged and air-arc-gouged surfaces shall be cleaned by grinding or machining in order to remove all carbon absorption or contamination.

NOTE: The relevant parts of AS/NZS 1554 have limits on the depth of grinding allowed.

7.5.7 Tack welds

For CC2, CC3 and CC4, tack welds shall be made using a qualified welding procedure and comply with the requirements of the relevant clause in the relevant Part of the AS/NZS 1554 series of Standards (see Clause 7.1.2).

All tack welds not incorporated into the final weld shall be removed. Tack welds that are to be incorporated into the final weld shall have a suitable shape and be carried out by qualified welders. Tack welds shall be free from deposition faults and shall be cleaned thoroughly before final welding. Cracked tack welds shall be removed.

7.5.8 Fillet welds

Fillet welds shall comply with the relevant clause of the relevant Part of the AS/NZS 1554 series cited in Clause 7.1.2, as appropriate.

The size of a fillet weld shall be the leg length as defined in AS 2812. The fillet weld size as deposited shall not be less than the specified leg length. Where there is a root gap, the size shall be given by the lengths of the legs of the inscribed triangle reduced by the root gap amount, in accordance with the relevant clause of the relevant Part of the AS/NZS 1554 series.

7.5.9 Butt welds

7.5.9.1 General

The construction specification (shop drawings) shall specify the location of butt welds used as splices to accommodate available lengths of constituent products.

Butt welds shall comply with the relevant clause of the relevant Part of the AS/NZS 1554 series, as appropriate.

The ends of butt welds shall be terminated in a manner that ensures sound welds with full throat thickness.

When specified in the construction specification, run-on/run-off tabs shall be used to ensure full throat thickness at the ends. The weldability of the run-on/run-off tabs shall not be less than that of the parent metal.

After completion of the welds, any run-on/run-off tabs or other supplementary material shall be removed and their removal shall comply with Clause 7.5.6.

If a flush surface is specified, the excess weld metal shall be removed to satisfy the quality requirements (see also Clause 7.5.6).

7.5.9.2 Single sided welds

Complete penetration welds welded from one side may be produced with or without metallic or non-metallic backing material.

Unless otherwise specified in the construction specification, permanent steel backing material may be used. The requirements for its use shall be included in the WPS.

If steel backing is used, it shall have a weldability not less than that of the parent metal to be joined by the weld.

Backing materials shall be fitted tightly to the parent metal and should generally be continuous for the full length of the joint. For CC3 and CC4, permanent backing metal shall be made continuous by means of complete penetration butt welds. Tack welds shall be included in the butt welds.

Flush grinding of single-sided butt welds in joints between hollow sections executed without backing is not permitted, unless otherwise specified. If those welds are fully backed they may be ground off flush with the general surface profile of the parent metal.

7.5.9.3 Back gouging

Back gouging shall comply with the requirements of the relevant clause in the relevant Part of the AS/NZS 1554 series, as appropriate.

Back gouging shall be carried out to a sufficient depth to ensure full penetration into the previously deposited weld metal.

Back gouging shall produce a contour of a single U-shaped groove and have a root radius of not less than 5 mm with its fusion faces readily accessible to allow the welder reasonable access to reinstate the weld.

7.5.10 Welds on weathering steel

Welds on weathering steel shall be carried out using appropriate welding consumables as specified in either AS/NZS 1554.1 or AS/NZS 1554.5 as appropriate.

When C-Mn consumables are used for the body of a multi-run fillet or butt weld, consideration shall be given to the atmospheric resistance of the exposed ends of multi-pass welds after removal of run-on/run-off pieces.

7.5.11 Stud welding

Stud welding of steel studs to steel shall be carried out in accordance with AS/NZS 1554.2. Stud welding operators shall be qualified to AS/NZS 1554.2 for all construction categories.

7.5.12 Seal, slot and plug welds

Seal, slot and plug welds shall comply with the relevant clause of the relevant Part of the AS/NZS 1554 series, as appropriate.

7.5.13 Arc spot welds for light gauge components

Arc spot welds used to weld sheet steel to thicker supporting members shall be in accordance with AS/NZS 1554.7. Arc spot welds shall not be made where the thinnest connected steel material is greater than 3 mm thick, nor through a combination of steel sheets having a total thickness greater than 3 mm.

Weld washers shall have a thickness of between 1 mm and 2 mm with a pre-punched hole of 10 mm minimum diameter.

7.5.14 Post weld heat treatment

If post-weld heat treatment of welded components is necessary or specified in the construction specification, it shall comply with the requirements of AS 4458.

7.5.15 Execution of welding

7.5.15.1 General

Arc strikes outside the area of permanent welds shall be avoided. If stray arc strikes do occur the surface of the steel shall be visually inspected.

Cracks or blemishes resulting from arc strikes on members, other than those members or components identified in the construction specification as not required to be so treated, shall be ground to a smooth contour and checked by magnetic particle examination.

Precautions shall be taken to avoid weld spatter. Weld spatter shall be removed for CC2, CC3 and CC4.

Visible imperfections such as cracks, cavities and other imperfections shall be removed from each run before the deposition of additional runs.

NOTE: Where cracks are noticed during welding, the welding process should be stopped and the reason for cracking investigated.

All slag shall be removed from the surface of the finished weld. Particular attention shall be paid to the junction between the finished weld and the parent metal.

Cleaning of finished welds shall comply with the appropriate clause in the relevant Part of the AS/NZS 1554 series, as appropriate.

Dressing of finished butt welds shall comply with the appropriate clause in the relevant Part of the AS/NZS 1554 series, as appropriate. Any dressing in addition to these requirements shall be specified in the construction specification.

7.5.15.2 Welds on steel to be painted or galvanized

Welds on steelwork to be subsequently painted or galvanized shall also comply with the requirements of Clauses 9.8.2 and 9.8.4 in addition to the requirements of Clause 7.6.

NOTE: The use of anti-spatter sprays and compounds should be avoided on steelwork to be painted or galvanized unless it can be established that such use does not interfere with coating adhesion.

7.5.15.3 Welds on architecturally exposed structural steelwork

Welds on steelwork identified in the construction specification as architecturally exposed structural steelwork (AESS) shall also comply with the requirements of Section 10 in addition to the requirements of this Section.

7.5.16 Welding of continuity stiffeners in earthquake resisting members (New Zealand only)

Corners of continuity stiffener plates placed in the webs of rolled sections with elements greater than 32 mm thick shall be clipped to avoid the k-areas (see Figure 7.5.16) as follows. Along the web, the clip shall extend a distance of 35 mm beyond the tangent of the web-to-flange radius. Along the flange, the clip shall extend 12 mm beyond the tangent of the web-to-flange radius. The welds to the continuity stiffener shall be terminated 5 mm back from the clipped corners.