

Structures

Master Specification

ST-SS-S1 Fabrication of Structural Steel

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ST-SS-S1 Fabrication of Structural Steelwork

1 General

- 1.1 This Part specifies the requirements for the fabrication of structural steelwork.
- 1.2 Unless specified otherwise, all design and / or documentation must comply with the most recent revisions (including published amendments) of the following design standards and / or specifications:

Nuts, Bolts and Washers

- a) AS 1110 ISO metric hexagon bolts and screws—Product grades A and B.
- b) AS 1111 ISO metric hexagon bolts and screws—Product grade C.
- c) AS 1112 ISO Metric Hexagon Nuts.
- d) AS 1214 Hot-dip galvanized coatings on threaded fasteners (ISO metric coarse thread series).
- e) AS 1237 Plain washers for metric bolts, screws and nuts for general purposes.
- f) AS 1252 High strength steel bolts with associated nuts and washers for structural engineering.
- g) AS 1275 Metric Screw Threads for Fasteners.
- h) AS 4680 Hot-dip galvanized (zinc) coatings on fabricated ferrous articles.
- i) TN62 Assembly and Tensioning of High Strength Bolts and Nuts (Queensland Government Department of Main Roads, Technical Note 62); Part 1 – Class 8.8; Part 2 – Class 10.9; Part 3 – Class 4.6.

Steel

- j) AS 1163 Structural Steel Hollow Sections.
- k) AS 1594 Hot Rolled Steel Flat Products.
- l) AS 3678 Structural Steel - Hot-rolled Plates, Floor Plates and Slabs.
- m) AS 3679.1 Structural Steel - Hot-rolled bars and sections.
- n) AS 3679.2 Structural Steel - Welded I sections.

Welding and Structural

- o) AS 1554.1 Structural steel welding - Welding of Steel Structures.
- p) AS 1554.2 Structural steel welding - Arc Stud Welding, as modified by TP 580 "Welding of Steel Structures".
- q) AS 1796 Certification of Welders and Welding Supervisors.
- r) AS 2214 Certification of Welding Supervisors - Structural Steel Welding.
- s) AS 4100 Steel Structures.
- t) AS 5100 Bridge Design, Part 6: Steel and Composite Construction.
- u) AS 5131 Structural Steelwork – Fabrication and Erection.
- v) Australian Steel Institute: Standardised Structural Connections.
- w) Welding Technology Institute of Australia (WTIA) Technical Notes (available from <https://shop.wtia.com.au>):
 - i) TN01 The Weldability of Steels.
 - ii) TN03 Care and Conditioning of Arc Welding Consumables.
 - iii) TN05 Flame Cutting of Steels

Testing

- x) AS 1171 Method for Magnetic Particle Testing.
- y) AS 1710 Non-destructive Testing of Carbon and Low Alloy Steel Plate and Classification of Quality.
- z) AS 2177.1 Radiography of Welded Butt Joints in Metal.
- aa) AS 2205 Methods of Destructive Testing of Welds in Metal.
- bb) AS 2207 Methods for the Ultrasonic Testing of Fusion Welded Joints in Carbon and Low Alloy Steel.

Quality

- cc) AS 9001 Quality Management Systems – Requirements.
- dd) AS 3834.2 Quality requirements for fusion welding of metallic materials – Comprehensive quality requirements.

2 Quality Requirements

Certification

- 2.1 The fabricating structural steelwork for SA Government projects shall be certified in the appropriate category under the National Structural Steelwork Compliance Scheme (NSSCS).
- 2.2 The supplier of materials shall hold a valid certificate of approval issued by the Australasian Certification Authority for Reinforcing and Structural Steels (ACRS). Refer to <https://www.acrs.net.au/>.
- 2.3 Provision of the above certification shall constitute a **Hold Point**.

Quality Plan

- 2.4 The Contractor shall prepare and implement a Quality Plan that includes, at a minimum, the following documents, procedures and / or instructions:
 - a) evidence of certification;
 - b) names and qualifications of all personnel to be associated in the planning, production and inspection of all welds (except the names of welders to be qualified by testing, vide Clause 7.1 of this Part);
 - c) process to verify the origin and quality of materials and suitability of welding consumables;
 - d) assembly, including dimensional control and details of manufacturing jigs;
 - e) cambering (where applicable) and method of determination of the beam profile which allows for deformation during fabrication;
 - f) repairs and corrections allowed under this Specification;
 - g) shop assembly;
 - h) end finishing for field joints (where applicable);
 - i) proposed sequence of operations and the proposed time required for all members and / or parts;
 - j) system of identification of members and / or parts and components, and erection marks; and
 - k) welding procedures.
- 2.5 If not provided beforehand, this documentation shall be submitted at least 28 days prior to the commencement of the fabrication work.

Safety

- 2.6 The Contractor shall prepare and implement Safe Work Method Statements that address, at a minimum:
- handling and transportation of materials (also refer to ST-SS-C1 “Transportation and Erection of Structural Members” if the members exceed 4.2 m in length);
 - the safety requirements of AS 1554 Part 1;
 - precautions to protect all persons working or present near welding operations, including the control of exposure to arc radiation, hot metal and welding fumes as well as the prevention of electric shock and fire; and
 - where non-destructive tests employing industrial x-ray plant or radioactive isotopes are used, precautions to ensure that people in the vicinity are not be subjected to direct or scattered radiation.
- 2.7 Provision of the documentation listed in this Clause shall constitute a **Hold Point**.

3 Materials

- 3.1 Fasteners and steel shall comply with the following:
- Class 4.6 bolts nuts: AS 1110, AS 1111, AS 1275 to Tolerance Grade 8.
 - Class 4.6 nuts: AS 1112, AS 1275 to Tolerance Grade 8.
 - Class 4.6 washers: AS 1237.
 - Class 8.8 bolts, nuts and washers: AS 1252, AS 1275 to Tolerance Grade 6.
 - Hollow steel sections: AS 1163, Grade L0.
 - Rolled plate: AS 1594.
 - Hot-rolled steel plates: AS 3678.
 - Hot rolled steel sections: AS 3679.1.
 - Welded steel I sections: AS 3679.2.
 - Quenched and tempered steel plate: AS 3597.
- 3.2 All fasteners shall be hot dip galvanized in accordance with AS 1214 (nuts and bolts) and AS 4680 (washers).
- 3.3 All structural steel, associated components and welding consumables shall be manufactured by companies accredited to AS 9001 and shall hold a valid certificate of approval issued by the Australian Certification Authority for Reinforcing and Structural Steels (ACRS). Refer to <https://www.acrs.net.au/>. The production and supply of all purchased components shall conform to this Specification and Clause 4.6 of AS 5131.
- 3.4 For steelwork that is to be hot-dipped galvanized, steels with the following silicon contents are not permitted:
- Equal to or greater than 0.25%.
 - Between 0.04% to 0.14%.
- 3.5 Steels suitable for hot-dipped galvanizing are those with:
- Silicon content of $0.15\% < \text{Si} \leq 0.22\%$; or
 - Silicon content of $\text{Si} \leq 0.04\%$; or
 - Silicon and phosphorous contents of $\text{Si} + 2.5\text{P} \leq 0.09\%$.
- 3.6 Full traceability of materials and components used in the works is required and shall comply with AS 5131.

- 3.7 Unidentified materials shall not be used in structural members. The Contractor shall provide Test Certificates and Certificates of Compliance showing that all materials conform to the tests required by the above Australian Standards. At a minimum, the Test Certificates shall show the following:
- applicable Australian Standard;
 - batch no. / identification;
 - results of mechanical tests (including Charpy V-notch impact tests results where “L0” steel is specified);
 - results of ultrasonic tests; and
 - chemical analysis, including carbon equivalent (where applicable).
- 3.8 Welding consumables shall be in accordance with AS 1554.1 and AS 5131. The Contractor shall provide the manufacturer’s certification that the welding consumables comply with the applicable Australian Standard.
- 3.9 Provision of the Test Certificates and Certificates of Compliance listed in this Clause shall constitute a **Hold Point**.

4 Notice of Work Commencement and Program

- 4.1 At least 2 weeks prior to the commencement of any work associated with fabrication, the Contractor shall submit a complete program of work showing all activities involved in the fabrication process, including cutting, welding, shear stud connectors (where applicable) and application of protective treatment. The Contractor shall also provide advice of any alteration to the program.
- 4.2 Provision of the program and any amended program shall constitute a **Hold Point**.

5 Fabrication

General

- 5.1 Fabrication shall be in accordance with the drawings and with the requirements of AS 4100, Section 14; AS 5131, Section 6; and AS 5100, Part 6.
- 5.2 Unless otherwise specified, all fabricated structures and components shall comply with the requirements of Construction Category CC3 in accordance with AS 4100, AS 5100 and AS 5131.
- 5.3 Unless otherwise specified, Treatment Grade P3 in accordance with AS 5131 shall apply to fabricated structures and components.

Dimensional Tolerances

- 5.4 The Contractor shall take all measurements necessary to demonstrate compliance with the requirements of this Clause. Measurements of lengths shall be checked with a standard steel measuring tape or band and corrected to a temperature of 20°C. Unless noted otherwise, after fabrication the tolerances on any cross-section or deviations from the specified dimensions shall be in accordance with AS 4100, AS 5100 and AS 5131.
- 5.5 Unless otherwise specified, all dimensions and tolerances shall be Class 2 in accordance with AS 5131.
- 5.6 Where parts are to fit together on assembly or erection, tolerances shall be such that all parts fit together within the specified tolerances.
- 5.7 For built-up sections, the deviations from the specified dimensions shall not exceed those specified in AS 5131, Appendix F.

Table ST-SS-S1 5-1 Dimensional Tolerance

Property	Tolerance
Member Dimensions	Member up to and including 5 m shall not exceed ± 2 mm. An additional allowance of ± 2 mm shall be made to the above for each additional 10m or part thereof.
Sweep (variation from straightness)	Not exceed 1 mm per 1000 mm of the member. The sweep shall be measured between the ends of the member and shall be even throughout the length of the member.
Flatness of bearing Seats and Plates	Out of flatness of the surfaces shall not exceed 0.2 mm.
Twist	The angular rotation of any cross-section relative to an end cross-section shall not exceed 10 mm per 1000 mm depth of beam or unit.
Flatness of Surfaces	Deviation from flatness shall not exceed 2 mm per 1000 mm of measuring length over any portion of the surface.
Curvature Tolerance	Deviation from specified profile shall not exceed ± 5 mm.

Bridge Beams

- 5.8 If the work under the Contract includes bridge beams, the curvature of completed beams shall be planar and without sectional twist or buckling, or local buckling of the web or flanges outside of the tolerances specified in AS 5131. The beam profile shown on the drawings is the completed profile of the beam, on its side, after all welding.

Repair of Surface Flaws and Deflects

- 5.9 Surface flaws and defects on plates are deemed to be detrimental to their engineering use and shall be removed in accordance with AS 3678 and AS 3679. However, weld metal shall not be deposited to remove deep surface defects unless prior approval of the welding and repair procedure has been obtained.

6 Shop Detailing and Documentation

General

- 6.1 Shop detailing and documentation shall be in accordance with AS 5131.
- 6.2 Shop Drawings shall be prepared for the fabrication of all members or components.
- 6.3 The Fabricator is responsible for the preparation of Shop Drawings.

Verification

- 6.4 Shop Drawings shall be submitted to the Designer for approval prior to commencing fabrication.
- 6.5 Once approved and certified by the Designer, any changes to the approved Shop Drawings shall be re-submitted for approval.

Shop Drawings Detail

- 6.6 The details shown on the Shop Drawings must conform to the Design Drawings and the following:
- Drawings showing only the cutting dimensions of webs, flanges and the like are not considered to be Shop Drawings.
 - The Shop Drawings must identify the Design Drawings, together with the revision number, on which they are based. Where the Shop Drawings depict any part of the Design Drawings, clearly identify that part on the shop drawings.
 - The marking plan must show the location, as appropriate, of Abutments A and B, Upstream and Downstream, span numbers, pier numbers and North orientation.
 - Welding symbols on the Shop Drawings must conform to AS 1101.3.

- e) Clearly distinguish between shop welds and field welds on the Shop Drawings.
 - f) All splice welds must be shown on the Shop Drawings and be approved by the Designer before fabrication commences.
 - g) Clearly indicate the location of full section splice connections, including extensions and member length make ups.
 - h) Indicate on the Shop Drawings those joints or groups of joints where it is especially important that the welding sequence and technique of welding be carefully controlled to minimise shrinkage stresses and distortion. Clearly indicate those joints where no welding is permitted. The weld lengths specified on the Shop Drawings must be the required effective lengths.
 - i) Clearly identify each member with the identification marks shown on the Design Drawings. Further identify each type of component to readily distinguish it from all other types.
 - j) For assemblies, show all associated bolting, accessories and / or joining details on the Shop Drawings.
 - k) Show details of all holes and attachments required for temporary work such as formwork and lifting lugs. Show methods of sealing all such holes.
 - l) Where fracture critical members exist in a steel structure, identify these members on the Shop Drawings where shown on the Design Drawings, or if not shown on the Design Drawings, identify any fracture critical members as such, following verification by the Designer.
- 6.7 The Designer shall provide certification that the Shop Drawings conform to the above requirements.
- 6.8 The Contractor is responsible for the correctness of the Shop Drawings. Submission and certification of the Shop Drawings does not absolve that responsibility.

7 Welded Fabrication

General

- 7.1 All welding shall be carried out in accordance with AS 1554.1 and AS 5131, Section 7 and follow the recommendations and procedures of the Welding Technology Institute of Australia (refer to WTIA Technical Notes). All welds shall be:
- a) SP category in accordance with AS 1554.1;
 - b) prequalified in accordance with Clause 4.3 and 4.12 of AS 1554.1; and
 - c) subject to visual inspection in accordance with Clause 6.2 of AS 1554.1.
- 7.2 All butt welds shall be complete penetration butt welds.
- 7.3 Welding through protective coatings is not permitted.

Straightening of Material and Components

- 7.4 Material and components shall be straightened and made free from twist so that on assembly, mismatching and misalignment will not occur outside of the specified tolerances. The methods adopted for the above shall be such as not to damage or alter mechanical properties, nor to impair the design or function of the material or component.

Weld Profiles

- 7.5 The finished surface and the profile of all welding shall be smooth and free from sharp edges or crevices that would be detrimental to the performance of the structure or to the protective treatment. Where a satisfactory finish has not been achieved, the weld shall be replaced or repaired, or the surface shall be ground until a satisfactory finish has been achieved.

Splice Welding

- 7.6 Splices at locations not shown on the Design Drawings are not permitted.

- 7.7 All splice welds must be full strength butt welds.
- 7.8 All splices in main girders shall be shop assembled to check alignment, level and fit of the components. Templates, if used, shall be match marked before being dismantled.
- 7.9 Field splice welding shall not be carried out without prior approval, and components shall be fabricated in total with all protective treatment applied prior to transport to site.
- 7.10 Where site-splicing of the beams is permitted, the splice welding procedure shall be subject to a full-size trial weld using a mock-up of plates of the same size as in the completed beam.

Repair of Failed Welds

- 7.11 In the event that any welds fail to meet the requirements of this Specification and the Contractor proposes to repair the work, the Contractor shall prepare a detailed procedure for the repair. If the Contractor cannot demonstrate that the repair will not induce excessive distortion or residual stresses in the fabricated members, the Contractor shall fabricate a replacement member.
- 7.12 Approval of the proposal to repair the weld and the repair procedure shall constitute a **Hold Point**.

Inspection and Testing of Work

- 7.13 The Contractor shall prepare an Inspection Test Plan covering the items in AS 5131, Clause 13.6.
- 7.14 All welding shall be inspected either by a WTIA certified Welding Inspector or an International Institute of Welding Welding Inspector. The Welding Inspector shall be independent of, and not affiliated with, the Fabricator.
- 7.15 The Welding Supervisor and the Welding Inspector cannot be the same person, and they shall not carry out any welding of the works.
- 7.16 Welding Inspections shall comply with AS 5131.
- 7.17 The Contractor shall ensure the fabricated steelwork is available in a position and orientation suitable for inspection and testing and shall provide all assistance to the testing officer to perform the inspection and testing. Not less than 3 working days prior to any steelwork being dispatched for protective coating, the Contractor shall provide notification that the work is available for inspection.
- 7.18 Non-destructive testing (including visual inspection, ultrasonic, magnetic particle, and / or radiographic examination) shall be performed as necessary to qualify welding procedures and to ensure that those procedures are maintained throughout the works.
- 7.19 The extent of magnetic particle examination testing, in accordance with AS 1554.1, Clause 6.5, shall comply with Table ST-SS-S1 7-1Magnetic Particle Examination Testing.

Table ST-SS-S1 7-1Magnetic Particle Examination Testing

Weld Location or Component (as Appropriate to Design)	Minimum Extent of Examination for Each Weld Length
Stiffener welds at crucifix locations	100%
Field-welded or site-welded butt joints	100%
Stiffener fillets at site joints	100%
Edges of flange butt joints	100%
Web to flange single pass fillet welds	20% of each weld length on each girder (1), including at least 1000 mm at: <ul style="list-style-type: none"> • all ends of welds; • support points; • diaphragm locations; plus intermediate portions to make up inspected length
All T butt welds and multi-pass fillet welds to tension flanges (e.g. stiffeners, diaphragms or diaphragm stiffeners) (2)	100%

Weld Location or Component (as Appropriate to Design)	Minimum Extent of Examination for Each Weld Length
T butt welds and multi-pass fillet welds to: <ul style="list-style-type: none"> • compression flange or web plates (e.g. stiffeners, diaphragms or diaphragm stiffeners); • diaphragm stiffener to diaphragm; • end plates to tension flange, compression flange and web plate (1). 	20% of total length
Web to flange multi-pass fillet welds (2)	At locations inspected by ultrasonic or radiographic methods (1)
T butt welds, T butt compound welds and other multi-pass fillet welds (2)	At locations inspected by ultrasonic or radiographic methods (1)
All other welds	The maximum of AS 1554 recommendations
Repairs	
Repaired defects in base metal	100%
Remaining weld after removal of defective weld	100%
Repaired or replaced weld, including temporary welds	100%

Notes:

(1) After three consecutive girders have been welded without defects or repairs to any web to flange fillet weld, magnetic particle examination frequency may be reduced, after approval from the Principal, to one weld on each girder. If defects requiring repair are found subsequently, in an individual web to flange fillet weld, test frequency must revert to the specified rate of 20% of each weld length on each girder, until a further application to reduce the frequency of test is approved.

(2) Inspect over same length portions using both magnetic particle and ultrasonic or radiography methods.

7.20 The extent of radiographic or ultrasonic examination testing, in accordance with AS 1554.1, Clause 6.3 & 6.4, shall comply with Table ST-SS-S1 7-2.

Table ST-SS-S1 7-2 Weld Inspection and Testing

	Test Requirements	Minimum Test Frequency
Fillet welds for bridge girders:		
• Flange to web	Radiographic tested in accordance with AS 2177.	All welds
• Flange to stiffeners		
• Web to stiffeners		
Other fillet welds	Magnetic particle testing in accordance with AS 1171.	15% of welds
Complete penetration butt welds	Ultrasonically testing in accordance with AS 2077.	All welds
Flange butt welds	Radiographic tested in accordance with AS 2177.	All welds

Table ST-SS-S1 7-3 Examination of Weld Length

Weld Location or Component (as Appropriate to Design)	Minimum Extent of Examination for Each Weld Length
Flange butt joints	100%
Web butt joints	300 mm minimum at each end of each joint
Web to flange butt joint	20% of each weld length, including: <ul style="list-style-type: none"> • 500 mm each side of all diaphragms; • 1000 mm at all weld ends; plus intermediate portions to make up inspected length

Weld Location or Component (as Appropriate to Design)	Minimum Extent of Examination for Each Weld Length
Web to flange splices – welded, single or multi pass, incorporating steel grade 350, or a higher steel grade, in flange plates 25 mm or thicker	50% of the total weld length for affected welds, including 1000 mm at: <ul style="list-style-type: none"> • all ends of welds; • lifting lug locations; • diaphragm locations; plus intermediate portions to make up inspected length
All T butt welds and multi-pass fillet welds to Tension flange (e.g. stiffeners, diaphragms or diaphragm stiffeners, or base plate joint of beams, columns, masts or towers) (1)	100% (1)
T butt welds and multi-pass fillet welds to: <ul style="list-style-type: none"> • Compression flange or web plates (e.g. stiffeners, diaphragms or diaphragm stiffeners); • Diaphragm stiffener to diaphragm; • End plates to tension flange, compression flange and web plate (1). 	10% (1) of total welded length
All site joint welds and field butt welds	100%
Butt or T butt splices between: <ul style="list-style-type: none"> • plate; • rectangular, square or circular hollow sections, e.g. barrier railing; or • hot rolled open sections. 	50% or, if approved, at a reduced frequency of 25% (2)
Butt welds between piling steel lengths (H pile, circular caissons, etc) Possible inclusion of wharfing piling	10% of total number of pile splices, with 100% tested of each splice selected, including testing of the first splice welded
Butt welds and T butt welds of lifting brackets or loops	100%
Butt and T butt welds to repair or make up member lengths	100% of total weld length
Other welds	As required to demonstrate conformity to the limits for imperfections, noting that the minimum extent of examination shall be not less than 10% of weld length

Notes:

(1) Inspect over same length portions using both magnetic particle and ultrasonic or radiography methods.

(2) For butt welding of barrier railing splices or open sections, the Fabricator may apply to reduce the inspection frequency to the lower rate. The application must include:

- a) nomination of a welding preparation and procedure designed to minimise weld defects;
- b) performance data demonstrating that the procedure can produce conforming welds and no nonconforming welds.

After approval, if defects requiring repair are subsequently found in an individual splice weld, the test frequency must revert to the specified rate of 50% of each weld splice until a further application to reduce the frequency of test is approved.

7.21 Provision of inspection and test results demonstrating compliance with the requirements of this Clause shall constitute a **Hold Point**.

Additional requirements for Overseas Fabrication

7.22 If the fabrication takes place outside of Australia, the following additional requirements apply:

- a) All work shall be carried out under the supervision of a welding supervisor who meets at least one of the requirements of Clause 4.12.1 (a) to (c) of AS 1554.1.
- b) All welders shall satisfy the conditions of Clause 4.12.2 of AS 1554.1. All welding personnel require macro re-qualification on a 12 monthly basis for each weld procedure undertaken the Contract.
- c) The fabricated steelwork is made available for inspection in Australia prior to assembly / erection.

8 Steel Cutting

- 8.1 Surfaces produced by cutting shall be finished true and smooth to the required dimensions. All burrs and sharp edges on cut surfaces shall be removed.
- 8.2 Where flame cutting is to be employed, the standard of surface condition of edges of cut plates shall not be inferior to WTIA Flame Cut Surface Roughness Class 2 (refer to WTIA TN05).
- 8.3 Gouges having a depth greater than 3 mm are deemed to be "damaged" vide this Clause 13 "Damage". All edges of flange plates shall be ground to produce a 2 mm radius.

9 Stud Shear Connectors

General

- 9.1 This clause only applies where shear stud connectors are specified on the drawings.

Qualification

- 9.2 The stud material, the stud base, the stud welding procedure and the welding operator shall be qualified in accordance with AS 1554.2, before production welding of studs commences. The Contractor shall provide one week prior notice of qualification of stud welding, welding of stud connectors and testing of studs.
- 9.3 Notification of qualification shall constitute a **Hold Point**.
- 9.4 In addition to these requirements, a further Procedure Test shall be carried out to assess the process and operator. This test consists of welding an additional 4 studs of the size and type to be used on to a test plate of similar thickness, width and condition (i.e. rust) of the actual flange to which the studs will be welded.
- 9.5 The reinforcement formed within the ceramic ferrule shall be formed over 100% of the circumference.
 - a) Two studs shall be tested to withstand a load representing a minimum tensile stress of 415 MPa.
 - b) The remaining 2 studs shall be tested to AS 2205.5.1 "Macro Test". The 2 studs shall indicate complete fusion to the parent material.
- 9.6 All test studs shall pass the above tests. If any stud fails, the procedure test is deemed to be deemed a failure, and further complete procedure tests shall be undertaken until all studs pass.
- 9.7 Successful completion of the Procedure Test shall constitute a **Hold Point**.

Fabrication

- 9.8 After welding, studs shall comply with the testing requirements of Table ST-SS-S1 9-1 Testing of Studs after welding.

Table ST-SS-S1 9-1 Testing of Studs after welding

Method	Location of studs	Percentage of total length or number
30° hammer bend test in accordance with AS 1554.2, Clause 4.1.1 or 4.1.2	First of each day's studs welded	First two studs welded, or more as required

Method	Location of studs	Percentage of total length or number
Visual scanning	All studs welded	100%
Stud weld ring test using a steel 1 kg hammer, swung freely to strike the stud in two opposite directions. The tested stud must give a clear ring. All studs which do not give a clear sound in the ring test must be subjected to the 10° bend test	All studs welded	100%
10° bend test in accordance with AS 1554.2, Clause 6.1.1 or 6.1.2	All members with stud welds	5% of studs on each member (1 in each 20), and including studs with missing weld flash. Studs with less than 360° of weld flash must be bent 10° in a direction opposite to the missing portion of the flash. If any stud fails, all studs on the member or element must be visually inspected and any stud with less than 360° of weld flash must be tested. Do not bend back studs unless required for clearance

10 Bolted Connections

- 10.1 All high strength bolted connections shall be assembled and tightened in accordance with the requirements of TN62 Assembly and Tensioning of High Strength Bolts and Nuts – Part 1, 2 or 3 as appropriate.
- 10.2 All holes for bolts shall be drilled full size or, where permitted by AS 4100, punched full size. Burnt holes will not be permitted under any circumstances. After assembly of the parts to be joined, all holes shall be true throughout, perpendicular to the face of the member and aligned so as to permit the bolts to be positioned without damage to the threaded portion. The surfaces in contact of parts joined shall be free from distortion and all burrs or ridges shall be removed.
- 10.3 The length of each bolt shall be such that the threaded portion will project through the nut for at least one complete thread and such that the nut will be at least one thread apart from the thread runout. The shanks of bolts shall be of sufficient length so that the thread shall not project through the shear plane.
- 10.4 At least one washer, but no more than 2 washers shall be placed under the part being rotated in tightening. Taper washers shall be used where the part under the bolt head is not perpendicular to the axis of the bolt. Bolts shall be positioned so that the taper washers, if required, shall be fitted under the non-rotating part.

11 Holding Down Bolts

- 11.1 Where high strength bolts or rods are cast into concrete, the bolts or rods shall be firmly held in position by a jig and the rods or bolts shall not be welded.
- 11.2 Where a structure is subjected to fatigue loading (including light poles, traffic gantries, major cantilever signs and tall utility poles), the use of levelling nuts, or not, shall be explicitly stated on the Drawings. Irrespective of the use of levelling nuts, base plates of such structures shall be supported on a pad of high strength grout, constructed such that the void beneath the base plate is completely filled with grout.

12 Mock Set Up

- 12.1 Where the work under the Contract includes beams / structural elements for bridges, the beams / structural elements shall be assembled in the form of a mock set-up in the fabrication workshop to the liens and relative levels and with the support conditions that will apply in the completed structure.
- 12.2 On completion of the mock set-up, a **Hold Point** shall apply.

13 Damage

- 13.1 Any damage to steel work that occurs prior, during or after fabrication is deemed to be a non-conformance.

14 Hold Points

- 14.1 The following is a summary of Hold Points referenced in this Part:

Ref.	Hold Point	Response Time
2.3	Provision of certification	Refer to the Principal
2.7	Submission of Quality Documentation	7 days
3.9	Materials Test Certificates and Certificates of Compliance	7 days
4.2	Provision of the program of work and any amended program	2 days
7.12	Submission of repair procedures for failed welds	2 days
7.21	Provision of test results	2 days
9.3	Notification of stud welding qualification (where part of the Contract)	2 days
9.7	Completion of the Shear Stud Procedure Test (where part of the Contract)	1 day
12.2	Mock set up in workshop of bridge beams and structural elements (where part of the Contract)	2 days

15 Verification Requirements and Records

- 15.1 The Contractor shall supply the following records:

Table ST-SS-S1 15-1 Verification Records

Ref.	Record
5.4	Evidence of compliance with dimensional tolerances