Technical Specification

Transport and Main Roads
MRTS78 Fabrication of Structural Steelwork

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Queensland Government

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Contents

1 Introduction

This Technical Specification applies to the fabrication of structural steelwork for bridges, other structures, roadside furniture and poles.

This Technical Specification shall be read in conjunction with MRTS01 *Introduction to Technical Specifications*, MRTS50 *Specific Quality System Requirements* and other Technical Specifications as appropriate.

This Technical Specification forms part of the Transport and Main Roads Specifications Manual.

Structural steelwork shall be fabricated only by a fabricator that is registered by Transport and Main Roads.

For the requirements and information regarding registration of fabricators refer to the departmental website, www.tmr.qld.gov.au

2 Definition of terms

The terms used in this Technical Specification shall be as defined in Clause 2 of *MRTS01 Introduction to Technical Specifications*.

3 Referenced documents

Table 3 lists documents referenced in this Technical Specification.

Table 3 – Referenced documents

Reference	Title
AS 1100.101	*Technical drawing – General principles*
AS 1100.201	*Technical drawing – Mechanical engineering drawing*
AS 1101.3	*Graphical symbols for general engineering - Welding and non-destructive examination*
AS 1110	*ISO metric hexagon bolts and screws – Product grades A and B*
AS 1111	*ISO metric hexagon bolts and screws – Product grade C*
AS 1112	*ISO metric hexagon nuts*
AS 1195	*Polytetrafluoroethylene (PTFE) skived tape*
AS 1196	*Polytetrafluoroethylene (PTFE) moulded sheet*
AS 1214	*Hot-dip galvanized coatings on threaded fasteners (ISO metric coarse thread series)*
AS 1237	*Plain washers for metric bolts, screws and nuts for general purposes*
AS 1275	*Metric screw threads for fasteners*
AS 4100	*Steel structures*
AS/NZS 1163	*Structural steel hollow sections*
AS/NZS 1252	*High strength steel bolts with associated nuts and washers for structural engineering*
AS/NZS 1554	*Structural steel welding Set*
AS/NZS 1554.1	*Structural steel welding – Welding of steel structures*
AS/NZS 1554.2	*Structural steel welding – Stud welding (steel studs to steel)*

Reference	Title
AS/NZS 1594	*Hot-rolled steel flat products*
AS/NZS 3678	*Structural steel – Hot-rolled plates, floor plates and slabs*
AS/NZS 3679.1	*Structural steel – Hot-rolled bars and sections*
AS/NZS 4291.1	*Mechanical properties of fasteners made of carbon steel and alloy steel – Bolts, screws and studs*
AS/NZS 4291.2	*Mechanical properties of fasteners – Nuts with specified proof load values – Coarse thread*
AS/NZS 4680	*Hot-dip galvanized (zinc) coatings on fabricated ferrous articles*
AS/NZS 4855	*Covered electrodes for manual metal arc welding non-alloy and fine grain steels- Classification*
AS/NZS ISO 14174	*Welding Consumables – Fluxes for submerged arc welding and electroslag welding - Classification*
AS/NZS ISO 14341	*Welding Consumables – Wire electrodes and welding deposits for gas shielded metal arc welding of not alloy and fine grain steels - Classification*
AS/NZS ISO 17632	*Welding Consumables – Tubular cored electrodes for gas shielded and non gas shielded metal arc welding of not alloy and fine grain steels - Classification*
AS/NZS ISO 9001	*Quality management systems – Requirements*
ASTM A 240M	*Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet and Strip for Pressure vessels and for General Applications*
ASTM A 480M	*Standard Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, sheet, and Strip*
BCM-P-011	*Registration Procedure: Registered Suppliers of Steel Fabricated Products*
EN 14399 - 4	*High-Strength Structural Bolting Assemblies For Preloading – Part 4: System HV - Hexagon Bolt And Nut Assemblies*
ISO 3834	*Quality requirements for fusion welding of metallic materials – Comprehensive quality requirements*
MRTS01	*Introduction to Technical Specifications*
MRTS50	*Specific Quality System Requirements*
MRTS91	*Conduits and Pits*

4 Quality system requirements

4.1 Hold Points, Witness Points and Milestones

General requirements for Hold Points, Witness Points and Milestones are specified in Clause 5.2 of MRTS01 *Introduction to Technical Specifications*.

The Hold Points and Witness Points applicable to this Technical Specification are summarised in Table 4.1. There are no Milestones defined in the table.

An Administrators Checklist is available to aid administrators (Refer Appendix B) to ensure they are supplied with the correct information during the fabrication of steel structures.

Table 4.1 – Hold Points and Witness Points

Clause	Hold Point	Witness Point	Milestone
6	1. Verification of welding procedure specification for all welded components		
7.1.1	2. Approval of third party certification or material test certificates for steelwork		
7.3.1.1	3. Approval of the Class 4.6 bolts, nuts and washers	1. Selection of Class 4.6 bolts, nuts and washers for testing	
7.3.2.1	4. Approval of the Class 8.8 bolts, nuts and washers	2. Selection of high strength bolts, nuts and washers	
8.5.4	5. Verification of butt weld preparations		
8.5.5	6. Supply of weld maps		
8.5.6	7. Inspection of completed product		
8.6.5	8. Verification of butt weld preparations for product manufactured outside Australia		
8.6.6	9. Supply of weld maps for product manufactured outside Australia		
8.6.7	10. Verification of completed product manufactured outside Australia		
11.3.1		3. Inspection of galvanising	
12.3	11. Bolt tensioning procedure and demonstration of capability		

4.2 Construction procedures

Construction procedures which are required to be submitted by the Contractor to the Administrator in accordance with the quality system requirements of the Contract are listed in Table 4.2.

Table 4.2 - Construction procedures

Clause	Conformance Requirement
6	Welding procedure specification

These procedures are critical. Note that the receipt of these procedures is often seen as a de facto approval. In every case a response should be made to the Contractor acknowledging receipt of the procedures

4.3 Conformance requirements

The conformance requirements which apply to lots of work covered by this Technical Specification are summarised in Table 4.3.

Table 4.3 - Conformance requirements

Clause	Conformance Requirement
10	Tolerances

5 Registered fabricator

The full registration requirements and procedure for registration are detailed in BCM-F-011 *Application for registration – Fabrication of steelwork*.

5.1 Registered fabricator

Steelwork shall only be fabricated by a registered fabricator. Registration as a fabricator will be reviewed periodically or earlier if unsatisfactory performance is reported. Information regarding registration status can be obtained from the departmental website, www.tmr.qld.gov.au

5.1.1 Registered fabricator for major bridge infrastructure – in Australia

To be registered as a Registered Fabricator of Steelwork for Bridge Structures and Gantry Structures which span over road carriageways, a fabricator shall:

a) Operate a quality system certified to AS/NZS ISO 9001 or ISO 3834. The system will be audited by Transport and Main Roads to ensure that fabricators are working as stated in their system requirements and the system conforms to the requirements of Transport and Main Roads Contracts. The AS/NZS ISO 9001 shall be certified by a JAS/ANZ accredited certifier.

b) Demonstrate technical conformance to MRTS78, and

c) Have an Inspection and Test Plan, including Hold Points acceptable to the department for fabrication of structural components which demonstrates compliance with this Technical Specification.

5.1.2 Registered fabricator for minor bridge infrastructure – in Australia

To be registered as a Registered Fabricator of Steelwork other than Bridge Structures and Sign Gantries which are adjacent to carriageways, a fabricator shall:

a) Operate a quality system certified to AS/NZS ISO 9001 or ISO 3834. The system will be audited by Transport and Main Roads to ensure that fabricators are working as stated in their system requirements and the system conforms to the requirements of Transport and Main Roads Contracts. The AS/NZS ISO 9001 shall be certified by a JAS/ANZ accredited certifier.

b) Demonstrate technical conformance to MRTS78, and

c) Have an Inspection and Test Plan, including Hold Points acceptable to the department for fabrication of structural components which demonstrates compliance with this Technical Specification.

5.1.3 Registered fabricator – outside Australia

To be registered as a Registered Fabricator of Steelwork, a fabricator shall:

a) Operate a quality system certified to AS/NZS ISO 9001 and ISO 3834. The system will be audited by an Auditor acceptable to Transport and Main Roads. The Auditor shall ensure that the fabricators are working as stated in their system requirements and the system conforms to the requirements of Transport and Main Roads Contracts. The AS/NZS ISO 9001 shall be certified by a JAS/ANZ accredited certifier.

b) Demonstrate technical conformance to MRTS78. The technical capability shall be audited by an Auditor acceptable to Transport and Main Roads. The Auditor shall ensure that the fabricators are able to comply with the requirements of MRTS78, and

c) Have an Inspection and Test Plan, including Hold Points acceptable to the department for fabrication of structural components which demonstrates compliance with this Technical Specification.

6 Welding procedure specifications

The Contractor shall supply the Welding Procedure Specification for the welding to be undertaken, in accordance with AS/NZS 1554.1 and a copy submitted to the Administrator.

Welding shall not be carried out until the appropriate Welding Procedure Specification has been approved. **Hold Point 1**

Attachment 1 shows a typical welding procedure specification for the weld undertaken on the Transport and Main Roads standard bridge traffic barrier intermediate post. The welding procedure specification outlines the way the welded joint needs to be prepared and the welding parameters for the placement of the welds.

The Administrator is required to ensure that the welding procedure specifications supplied by the fabricator reflect the welding the designer has specified on the drawings. Transport and Main Roads Structures section can review the welding procedure specifications if the Administrator is unsure of the technical requirements.

7 Materials

7.1 Steel plate and sections

Steel shall comply with the requirements of the following standards:

- Rolled plate AS/NZS 1594
- Hollow sections AS/NZS 1163 Grade L0
- Hot-rolled steel plates AS/NZS 3678
- Hot-rolled steel sections AS/NZS 3679.1

And the following requirements of the above Australian Standards, steel shall also comply with the following requirements.

a) Silicon Content:

Material supplied in accordance with AS/NZS 1163, where the Silicon content is greater than 0.24% shall not be used when steelwork is to be hot dip galvanised in accordance with AS/NZS 4680.

Slit flats and laser cut plate which has a silicon content below 0.1% shall not be used when the steelwork is to be hot dip galvanised in accordance with AS/NZS 4680.

b) Boron Content:

The material test certificates shall report all elements required by the standards listed above plus total boron. If boron is not specified on the material test certificates, then the material shall be tested to determine the total boron.

Parent steel materials with a total boron equal to or exceeding 0.0008% will require requalification of the welding procedure specification using the higher boron content material.

Material where has a total boron above 0.0008% can have an impact the capacity of the member in the weld heat affected zone.

Any material which has a total boron content above 0.0008%, will result in the welding procedure specifications becoming invalid for the welding of this material. If the fabricator elects to use the material, the welding procedure specification will need to be re-qualified using the higher boron content material for the qualification of all the welding procedure specification.

c) Charpy V Notch Testing:

The Charpy V-notch impact tests are required and test results are to be supplied for material where “L0” is specified.

7.1.1 Acceptance of the materials

For each shipment of steel to be used in the fabrication of:

a) bridge girders, bridge traffic barrier, safety barrier and pedestrian balustrade

b) other load bearing structures with a design life of 100 years or more, and

c) other steelwork structures.

All materials shall be accepted by one of the following two methods

1. Third party certification
   Steel material shall be manufactured by a supplier who is a member of an independent third party product conformity assessment body acceptable to Transport and Main Roads. ACRS (Australasian Certification Authority for Reinforcing and Structural Steels) is acceptable to Transport and Main Roads.

The steel shall be traceable to a batch or lot.

2. Test certificates
   The Contractor shall supply to the Administrator prior to the commencement of fabrication copies of the steel manufacturer’s test certificates, showing the chemical properties and results of all mechanical testing and charpy V-notch impact tests.
   If test certificates are not available, then the Contactor shall submit to the Administrator for approval a proposal for selecting samples for testing of tensile strength and elongation, cold

and temper bend tests, chemical analysis and charpy V-notch impact test in accordance with the appropriate Australian Standard at no expense to the Principal. Minimum testing requirements are 2% of each size and grade of product with a minimum sample size of one for each size and grade of the steel.

Steel fabrication shall not commence until the Administrator has reviewed and approved either the Third Party Certification or the material test certificates and / or material testing as appropriate.
Hold Point 2

The Administrator is required to verify that the materials supplied to the fabricator match the material test certificates supplied for approval. To make verification of materials easier and ensure that the correct materials have been supplied some steel manufactures are ink printing the material heat number on the member which can be traced back to the material test certificates.
Figure 7.1.1(a) shows the heat number on the SHS member. The material test certificate shown in Appendix A. Attachment 2 matches the material supplied to the fabricator.

This cross check is important as on a number of occasions the material supplied to the fabricator has not matched the material test certificates submitted for approval. If there is no traceability between the material test certificates and the material supplied, we recommend that the material is tested by an NATA accredited test laboratory or is rejected.

Figure 7.1.1(a) – View of the heat number on an SHS member

A similar reference number can be found for plate. Figure 7.1.1(b) shows the unit identification number which can be traced back to the material test certificate.

Figure 7.1.1(b) – View of the identification number on the edge of a steel plate

7.2 Welding consumables

Welding consumables shall be compatible with the parent metal and shall be classified and identified in accordance with the provisions of AS 1554.1, AS/NZS 4855, AS/NZS ISO 14174, AS/NZS ISO 14341, and / or AS/NZS IOS 17632.

7.3 Bolts, nuts and washers

The specific problem which prompted the need to supply the material test certificates in the Transport and Main Road's case was the testing undertaken on a bolt for a major steel bridge structure. Figure 7.3 shows that when the bolt was tested as an assembly the head of the bolt stripped off the shank of the bolt. This is an extremely dangerous failure. There have been structural failures due to the use of non conforming bolts.

Figure 7.3 – Abnormal bolt failure

In the past structural bolts that were outside the standard length range of the commercially available bolts were being manufactured by welding nuts to the end of threaded rod. The practice of welding nuts to the end of a threaded rod is not permitted and Transport and Main Roads - Structures section has developed an individual technical note covering the manufacture of a fabricated bolt. Refer to Technical Note TN66 *Commercial and Fabricated Bolts and Nuts*.

7.3.1 Standard bolts, nuts and washers – Class 4.6

7.3.1.1 Properties

Bolts, nuts and washers shall comply with the requirements of the following standards:

- Bolts AS 1110, AS 1111
- Nuts AS 1112
- Flat Washers AS 1237

Bolts shall be property Class 4.6 in accordance with either AS 1110 or AS 1111, as relevant. Bolt diameter, thread form and pitch shall be to ISO coarse pitch series in accordance with AS 1275 to 8 g tolerances.

Nuts shall be normal hexagonal nuts of property Class 5 in accordance with AS 1112. Diameter, thread form and pitch shall be to ISO coarse pitch series in accordance with AS 1275 to 8H tolerances.

A summary of the properties of Class 4.6 bolts is given in Appendix A.

All bolts, nuts and washers shall be hot-dipped galvanised in accordance with the requirements of AS 1214.

Each batch of bolts and nuts are to be supplied with the following:

a) The bolt supplier shall supply the fabricator with a material test certificate stating the chemical composition, mechanical properties of all bolts supplied. The test certificate shall be able to be traced back to the batch of bolts, and

b) A conforming test certificate from a NATA certified testing laboratory stating the bolt assembly test results and hardness. All bolts are tested as an assembly in the configuration that they will be used (that is, assembled bolt and nut). Samples for testing are to be selected in the presence of the Administrator. **Witness Point 1** The assembly test certificate shall be traceable back to the batch of bolts.

The material test certificates and assembly test reports for each batch of bolts shall be reviewed and approved by the Administrator prior to being used. **Hold Point 3**

7.3.1.2 Testing for Class 4.6 bolts

Class 4.6 bolts, nuts and washers shall be tested in accordance with Clause 7.3.3.

Bolts with a size of M12 and below do not need to be supplied with a material test certificate or an assembly test report.

7.3.1.3 Acceptance of bolts

If one test bolt does not conform to the assembly testing requirements, then the batch of bolts shall be rejected.

In order to ensure that the non-conforming bolts are not re-supplied to the project, the Administrator shall be notified of the non-conforming bolt batch and supply numbers. New bolts shall be supplied with documentary evidence to show the bolts have been sourced from a different batch.

The new batch of bolts shall be tested as per this standard. That is, supplied with a conforming test certificate from a NATA certified testing laboratory outlining the material properties, the mechanical properties and the hardness.

7.3.2 High strength bolts, nuts and washers – Class 8.8

7.3.2.1 Properties

High strength bolts, nuts and washers shall conform to the requirements of AS 1252.

High strength bolts shall be property Class 8.8 in accordance with AS 1252, with diameter, thread form and pitch to ISO coarse pitch series in accordance with AS 1275 to 6 g tolerances.

High strength nuts shall be property Class 8 in accordance with AS 1252, with diameter, thread form and pitch to ISO coarse pitch series in accordance with AS 1275 to 6H tolerances.

A summary of the properties of high strength bolts is given in Appendix A.

All bolts, nuts and washers shall be hot-dipped galvanised in accordance with the requirements of AS 1214.

Each batch of bolts and nuts are to be supplied with the following:

a) The bolt supplier shall supply the fabricator with a material test certificate stating the chemical composition, mechanical properties of all bolts supplied. The test certificate shall be able to be traced back to the batch of bolts, and

b) A conforming test certificate from a NATA certified testing laboratory stating the bolt assembly test results and hardness. All bolts are tested as an assembly in the configuration that they will be used (that is, assembled bolt and nut). Samples for testing are to be selected in the presence of the Administrator. **Witness Point 2** The assembly test certificate shall be traceable back to the batch of bolts.

The material test certificates and assembly test reports for each batch of bolts shall be reviewed and approved by the Administrator prior to being used. **Hold Point 4**

7.3.2.2 Bolt identification marks

All high-strength bolts nuts and washers shall have the identification marks as outlined in Clause 1.5 - Markings of AS 1252.

7.3.2.3 Testing for Class 8.8 bolts

High-strength bolts nuts and washers shall be tested in accordance with Clause 7.3.3.

Bolts with a size of M12 and below do not need to be supplied with a material test certificate or an assembly test report.

7.3.2.4 Acceptance of bolts

If one test bolt does not conform to the assembly testing requirements, then the batch of bolts shall be rejected.

In order to ensure that the non-conforming bolts are not re-supplied to the project, the Administrator shall be notified of the non-conforming bolt batch and supply numbers. The new bolts shall be supplied with documentary evidence to show the bolts have been sourced from a different batch.

The new batch of bolts shall be tested as per this standard. That is, supplied with a conforming test certificate from a NATA certified testing laboratory outlining the material properties, the mechanical properties and the hardness.

Figure 7.3.2.4 shows the label on the box of bolts supplied for a project. The heat number on the box is traceable back to the bolt material test certificate. Refer to Appendix A, Attachment 3. Attachment 4 and Attachment 5 show the bolt assembly test report which is also traceable back to the bolts supplied.

If there is no traceability for the batch of bolts supplied, then the Administrator shall reject the batch of bolts supplied. The Contractor shall replace the non conforming bolts with bolts which do have traceability.

Figure 7.3.2.4 – View of the label on the bolt of bolt supplied

7.3.3 Number of test specimens

The number of bolts and nuts to be tested is based on the number of bolts and nuts of each size purchased in an individual order. Appendix A Table A1 AS/NZS 1252 - Number of Test Specimens shall be deleted and replaced by Table 7.3.3.

Table 7.3.3 - Replacement for Table A1 in AS/NZS 1252

NUMBER OF TEST SPECIMENS FOR BOLTS AND NUTS

Number of pieces in lot	Minimum number of samples
Up to 50	3
51 - 500	4
501 - 35 000	8
35 001 and above	16

The Test Methods for bolts are described in AS/NZS 4291. 1.

The proof load test for nuts shall be in accordance with Clause 8.1 of AS/NZS 4291.2.

Hardness shall be tested in accordance with Clause 8.2 of AS/NZS 4291.2 using a Vickers harness test.

8 Fabrication

8.1 General

All structural steel components shall be fabricated in accordance with AS 1554.1 and AS 4100.

8.2 Cutting and edge preparation of steel sections

8.2.1 Cutting of sections

All members shall be cut to the required length using either of the following processes:

a) saw cut

b) laser cut

c) profile cut, and

d) oxy-acetylene cut.

The cropping/shearing of the following steel sections is not permitted:

a) hot rolled sections

b) hollow section material to the requirements of AS/NZS 1163, and

c) flat bars with a thickness greater than 12 mm.

No rough edges shall be allowed to remain and uneven outer edges shall be dressed off to a true line to the approval of the Administrator.

The cropping / shearing of members is not permitted due to the distortion which is caused during the cutting process.

Figure 8.2.1 – View of the distortion to the web to flange interface

8.2.2 Edge preparation of steel sections

Where welding is to be carried out along the edge of any of the following materials:

a) sheared edges of material 12 mm or thicker

b) rolled edges of plates or flats thicker than 16 mm

c) toes of angles or rolled shapes thicker than 16 mm

then these edges shall be trimmed back by 12 mm in the case of plates and 6 mm in the case of all other sections, to prepare the edge for welding.

Edge preparation shall be performed by either planing or oxy-acetylene cutting. Edges to be welded shall not be sheared.

Preparation of edges by oxy-acetylene cutting shall, wherever possible, be carried out by machine. Machine oxy-acetylene cutting shall be generally as smooth and regular as that produced by edge planing and the edge shall be left free of slag.

Manual oxy-acetylene cutting shall be permitted only where machine oxy-acetylene cutting is not practicable, and only with the approval of the Administrator. The edges resulting from manual oxy-acetylene cutting shall be smoothed by grinding.

Where nominated on the drawings, all re-entrant corners shall be filleted to a radius of 12 mm by drilling a 25 mm diameter hole at each such corner before cutting. The cut lines shall not extend beyond the fillet, and all cutting shall follow closely the lines prescribed.

No rough edges shall be allowed to remain and uneven outer edges shall be dressed off to a true line to the approval of the Administrator.

8.3 Holes

All holes shall finish accurately to size and in the position shown on the drawings. All holes shall be cleaned of all burrs and rough edges.

The axis of the holes shall be at right angles to the surface through which they pass, except where otherwise shown on the drawings.

All holes shall be drilled except for stiffener bar holes through girder webs which may be oxy-acetylene cut. If oxy-acetylene cutting is used, a suitable compass or profile shall be employed to obtain a hole generally as smooth and accurate as a drilled hole.

Punching of holes in material having a thickness greater than 10 mm will not be permitted.

8.4 Bending of plate

Bending of steel plate shall be carried out in a press to produce clean straight bends with no distortion in the adjacent flat surfaces.

Prior to bending, any rags present on sheared edges shall be removed by grinding or filing to prevent the possibility of plate splitting on the outside corner.

8.5 Welding

8.5.1 General

Welding shall be carried out in accordance with the provisions of AS/NZS 1554.1 except as amended by Clauses 8.5.2, 8.5.3, 8.5.4, 8.5.5 and 8.5.6.

8.5.2 Welding supervisor

All work shall be carried out under the supervision of a welding supervisor who shall, in the opinion of the Administrator, conform to at least one the requirements of Clause 4.12.1 (a) to (e) of AS/NZS 1554.1.

All fabricators are required to have a welding supervisor who is responsible for the daily supervision of fabrication. In order for a fabricator to gain approval as a registered supplier Transport and Main Roads' Structures section ensures all welding supervisors are competent to supervise the fabrication of works.

Therefore the Administrators role is to ensure the welding supervisors are performing their role with in the fabricators organisation with the inspection of product.

8.5.3 Welding personnel

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 welding procedure specification undertaken on Transport and Main Roads projects.

All SP welding is undertaken by one of the following welding personnel:

a) trade qualified welding personnel, or by welding personnel with a demonstrated competency equivalent to a trade qualified welder subject to approval by Director (Bridge Construction, Maintenance and Asset Management), and

b) 4th year apprentices subject to approval by Director (Bridge Construction, Maintenance and Asset Management).

2nd year and 3rd year apprentices are permitted to undertake only fillet welds subject to approval by Director (Bridge Construction, Maintenance and Asset Management).

Transport and Main Roads reserves the right to withdraw welder qualification if welding is below the department's requirements.

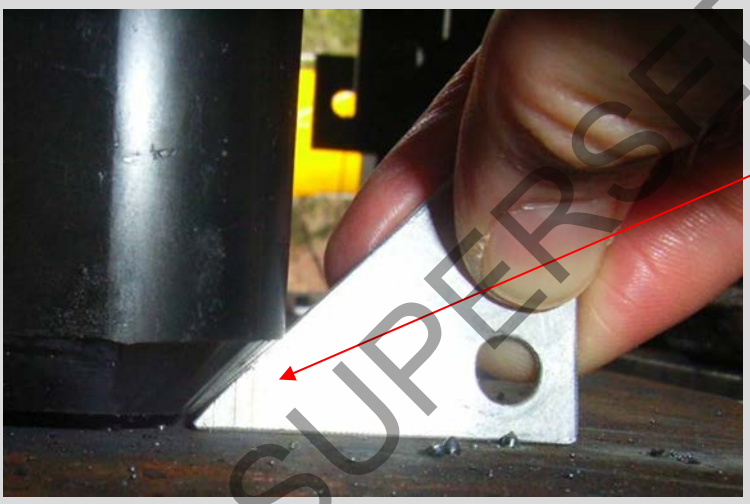
8.5.4 Welding

Not less than three working days prior to any welding commencing on any butt weld joints, the Fabricator shall notify the Administrator that the butt weld preparations are available for inspection. The Administrator shall ensure that the butt weld preparations are prepared in accordance with the welding procedure specifications. **Hold Point 5**

This clause was added to the Technical Specification as some fabricators in the past were not preparing the butt weld in accordance with the drawing requirements. Some fabricators also did not understand the welding symbols or felt the joint did not require the weld specified. This problem has been greatly reduced with the implementation of the Registered Suppliers List.

When fabrication commences, the welding procedure specifications are used to ensure the welded joint is prepared correctly and the welder is following the weld settings nominated on the welding procedure specification. Figure 8.5.4(a) shows the butt weld preparation for the attached welding procedure specification has been undertaken correctly.

Figure 8.5.4(a) – View of the butt weld preparation



If the joint is not prepared in accordance with the procedure, then the Administrator shall order the fabricator to prepare the welded joint in accordance with the welding procedure specification.

When the welding is being undertaken and the welder operates outside the parameters outlined on the welding procedure specification, then the Administrator shall do one of the following:

- the welder shall change back to the welding settings outlined on the welding procedure specification, or
- all work shall cease and the welder shall undertake a macro test using the revised welding parameters.

It is also recommended that when a full penetration butt weld is specified, the Administrator ensures that a full penetration butt weld has been placed. For all full penetration butt welds the first weld run "root run" should be clearly visible when you look on the inside of the member. Refer to Figure 8.5.4(b).

Figure 8.5.4(b) – View of the full penetration butt weld

8.5.5 Weld maps

The fabricator shall provide a weld map outlining the welding undertaken in the manufacture of the steel components. The weld map shall outline the following:

- welding procedure specification number used for the welding undertaken
- welder's initials or welding number for each weld undertaken, and
- welding supervisor's initials or welding number for each weld inspected.

The weld map shall be submitted to the Administrator for approval before the steel product is dispatched for protective coating. **Hold Point 6**

It is critical that all fabricated steelwork is documented correctly. It is important to record which staff member welded a joint and which staff member checked a particular joint. This section is used to track product after the project is completed. This weld map will be used to validate which welding staff were used for the fabrication of product in the event of a structural failure.

8.5.6 Inspection of completed product

Not less than three working days prior to any products being dispatched for protective coating. The fabricator shall notify the Administrator the product is available for inspection. All steel fabricated product the Administrator shall ensure the following inspections are undertaken. **Hold Point 7**

a) 100% of all products shall be visually examined, and

b) A minimum of 50% all gantry structure and bridge structure butt welds shall be non destructively examined. If any welds are found to be defective then 100% of the welds shall be non destructively examined.

The department reserves the right to increase the minimum level of non destructive examination.

Any welding defects found during the inspection shall be repaired prior to the application of the protective coating.

Table 8.5.6 - Product Identification for Non Destructive Testing

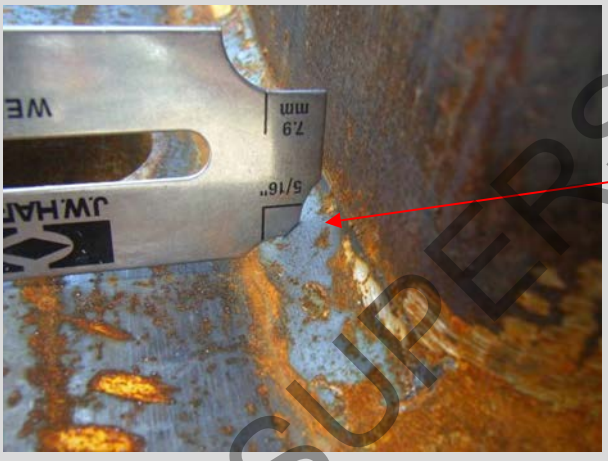
TMR Testing Frequency	NDT			Comment
Products	**Visual**	**UT**	**MPI**	
Major Bridge Infrastructure				
Shop Welding of Girders	100%	50%	50%	If any failure - then - 100%
Fabricated Steel Girders	100%	50%	50%	If any failure - then - 100%
Truss Bridges	100%	50%	50%	If any failure - then - 100%
Roller Steel Girders	100%	50%	50%	If any failure - then - 100%
Overhead and Cantilever Fabricated Gantries	100%	50%	50%	If any failure - then - 100%
Minor Bridge Infrastructure				
Bridge Traffic & Balustrade Rail	100%			
Bridge Throw Screens	100%			
Roadside Mounted Fabricated Sign Gantries	100%			
Steel Replacement Components	100%			
Steel Pile Liners	100%			
Steel Piles	100%			
Bridge Restraint Angles	100%			
Bus Station Structures	100%	50%	50%	50% UT Butt Welds (if any failure - then - 100%) Only for the members which span over a road, such as a walkway
Steel Beam Guardrail - Slip Base Posts	100%			
Traffic Sign Poles - Slip Base Poles	100%			
Road Lighting - Road Lighting Components	100%			
Road Lighting - Traffic Mast Arms, Post	100%			
Grids (RHS section)	100%			
Grids (Railway Line Section)	100%			
Noise Barrier Post	100%			
Noise Barriers on Parapets	100%			
Pit Covers to MRTS91	100%			
Grates	100%			
Miscellaneous Fabrication	100%			
Aluminium Bridge Traffic Rail	100%			
Aluminium Balustrade Rail	100%			
Stainless Steel Welding	100%			

Once all the welding is completed it is recommended that the welding is inspected to ensure that the welds are the correct size and the welds are free of weld defects. Figure 8.5.6(a) shows the way to inspect a fillet weld leg length which is the correct size. Figure 8.5.6(b) shows the way to inspect a fillet weld throat thickness which is the correct size.

Figure 8.5.6(a) – Fillet weld leg length

Method of inspecting the fillet weld leg length. This weld is the correct size as the weld fills the area of the gauge

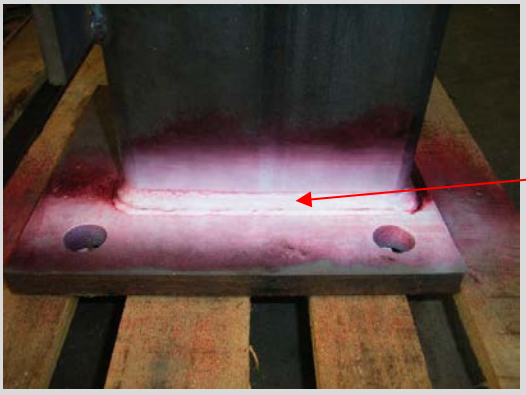
Figure 8.5.6(b) – Fillet weld throat thickness



Method of inspecting the fillet weld throat thickness. The weld should be in contact with the point shown.

If there is a concern that the welding has a lack of fusion weld defect, it is recommended that the weld is inspected using dye penetrant testing. The dye penetrant highlights any weld defects. Refer to Figure 8.5.6(c).

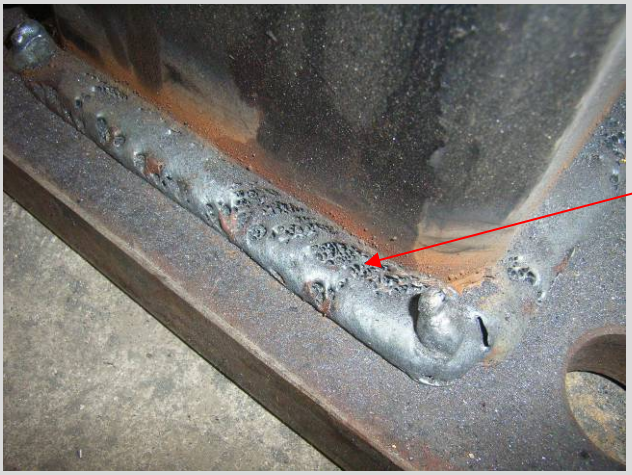
Figure 8.5.6(c) – View of the dye penetrant testing



Dye penetrant identifies the areas where the weld is not correctly fused to the member

One of the most common weld defects is porosity in the weld. Refer to Figure 8.5.6(d).

Figure 8.5.6(d) – View of the porosity in the weld



The other common weld defect is the undercut in the parent material. Refer to Figure 8.5.6(e). The lack of fusion and undercut weld defects is generally associated with equipment failure or a welder not having sufficient understanding of welding. The porosity defect is generally associated with an equipment failure. All these defects can be repaired by grinding back the weld to sound material and placing a correct weld.

Figure 8.5.6(e) – View of the undercut in the post

8.6 Welding undertaken outside Australia

8.6.1 General – outside Australia

Welding shall be carried out in accordance with the provisions of AS/NZS 1554 except as amended by Clauses 8.6.2, 8.6.3, 8.6.4, 8.6.5, 8.6.6 and 8.6.7.

8.6.2 Supervision of the overseas fabrication

All steel fabrication work undertaken overseas, the functions of the Administrator may be undertaken by a person nominated by the Administrator who, in the opinion of Director (Bridge Construction, Maintenance and Asset Management), conforms to the following requirements:

a) Clause 4.12.1 (a) of AS/NZS 1554.1, and

b) has a culturally different background to the country undertaking the fabrication.

8.6.3 Welding supervisor - outside Australia

All work shall be carried out under the supervision of a welding supervisor who shall, in the opinion of the Administrator, conform to at least one of the requirements of Clause 4.12.1 (a) to (c) of AS/NZS 1554.1.

8.6.4 Welding personnel - outside Australia

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 on Transport and Main Roads projects.

For SP welding, have a trade qualification, or demonstrate competence equivalent to a trade qualification subject to approval by Director (Bridge Construction, Maintenance and Asset Management).

Transport and Main Roads reserves the right to withdraw welder qualification if the welding is below the Transport and Main Roads requirements.

8.6.5 Welding – outside Australia

Prior to any welding commencing on any butt weld joints, the fabricator shall notify the Administrator that the butt weld preparations are available for inspection. The Administrator shall ensure that the butt weld preparations are prepared in accordance with the weld procedure sheets. **Hold Point 8**

8.6.6 Weld maps – outside Australia

The fabricator shall provide a weld map outlining the welding undertaken in the manufacture of the steel components. The weld map shall outline the following:

- welding procedure specification used for the welding undertaken
- welder's initials or welding number for each weld undertaken, and
- welding supervisor's initials or welding number for each weld inspected.

The weld map shall be submitted to the Administrator for approval before the steel product is dispatched for protective coating. **Hold Point 9**

8.6.7 Inspection of completed product manufactured outside Australia

All product supplied from an overseas fabricator shall be inspected by the Administrator in Australia at a location suitable to Transport and Main Roads prior to the application of the protective coating. **Hold Point 10**

The Contractor shall be responsible for covering all costs associated with carrying out the following inspections of the completed product:

a) 100% of all products shall be visually examined, and

b) A minimum of 50% of all welds shall be non destructively examined. If any welds are found to be defective then 100% of the welds shall be non destructively examined.

Transport and Main Roads reserves the right to increase the minimum level of non destructive examination.

Any welding defects found during the inspection shall be repaired by an registered fabricator prior to the application of the protective coating.

9 Quality of welds

9.1 General

Permissible levels of imperfection in butt welds shall conform to AS 1554.1 Category SP.

Fillet welds shall conform to weld category SP unless detailed as GP on the drawings.

9.2 Shear connectors

Shear connectors shall be attached to girders in the locations and to the details shown on the drawings.

Stud shear connectors shall be attached to girders by welding in accordance with AS 1554.2.

Stud welding operators shall be qualified in accordance with AS 1554.2 Clause 4.3.

Channel shear connectors shall be attached to girders by welding in accordance with AS 1554.1.

9.3 Threaded holes

Where fabricated steel is to be hot-dipped galvanised, threaded holes shall be fabricated oversize to allow for the resulting reduction in size.

9.4 Member to be straight

9.4.1 All fabrication

All structural steel shall be straight before being drilled, welded or worked. Straightening of either fabricated or as-manufactured steel, if necessary, shall be carried out by means of a steady pressure applied by rollers or presses.

9.4.2 Elements except bridge barrier

Straightening shall not be carried out by means of hammering or by heating unless the Administrator's prior approval has been obtained in writing. **Nonconformance** If straightening by heating is permitted, the steel shall not be heated to a higher temperature than that producing a dark cherry red colour. After heating, the metal shall be cooled slowly in air without any additional means of cooling. Straightening by heating shall not be used on any item manufactured from steel of grade in excess of 300 MPa.

Following the straightening of a bend or buckle, the surface of the metal shall be carefully inspected for evidence of fracture.

10 Tolerances

10.1 General

Tolerances shall comply with the requirements of Clauses 10.2, 10.3, 10.4, 10.5 or 10.6, as applicable.

10.2 Bridge barrier

Bridge barrier shall be constructed to the tolerances detailed in Table 10.2.

Table 10.2 – Tolerances for bridge barrier

Location	Tolerance (mm)
Length of member	± 2
Height of post / balustrade	± 2
Centre of holes	± 2
Line of barrier from plan dimension	± 3

10.3 Girders fabricated from rolled steel sections

Bridge girders fabricated from rolled steel sections shall be constructed to the tolerances detailed in Table 10.3.

Table 10.3 – Tolerances for steel girders

Location	Tolerance
Length of girder	± 3 mm
Squareness of ends	± 3 mm in full depth of girder
Lateral bow if gradual if localised	 12 mm over length of girder 6 mm over length of girder
Lateral kink within middle half of span outside middle half of span	 6 mm over length of girder 3 mm over length of girder
Hog	+ 6 mm, - 0 over length of girder
Position of bearing holes in flange	± 1 mm
Position of holes in web	± 2 mm
Width of bottom flange at expansion bearings	± 1 mm
Surface of bearing area of bottom flange where bearing is attached	The underside of the girder where the bearing is attached shall be machined so that the face has a tolerance on flatness of 0.5 mm and the machined face is perpendicular to the web. The edge of the flange shall have a tolerance of +/- 1 mm from the perpendicular. No more than 2 mm shall be removed by grinding to achieve this standard of flatness.
Warping or tilt of flanges of welded plate girders from a line perpendicular to the plan of the web	1/1000 of depth of web
Deviation from flatness of girder webs within a distance equal to the depth of the girder	1/250 of width of flange
Deviation between centre lines of web and flange of a built up girder	3 mm maximum
Full Contact Splice Joints	The maximum clearance between the abutting surfaces shall not exceed 1 mm, and shall also not exceed 0.5 mm over at least 67% of the contact area.

10.4 Girders fabricated from steel plate

Bridge girders fabricated from steel plate shall be constructed to the tolerances specified in Clause 14.4 of AS 4100.

10.5 Expansion bearings for rolled steel girders

10.5.1 Stainless steel plate

Stainless steel plate shall be supplied with a flatness tolerance across the width of the stainless steel plate of 0.5 mm and a straightness of 0.05 mm over 25 mm in any direction. The terms flatness and straightness are defined in AS 1100.101.

After installation of the studs, the underside shall be polished to a surface roughness Ra with an arithmetic mean deviation of 0.2 µm as defined in AS 1100.201. The plate shall have a flatness tolerance across the width of the stainless steel plate of 0.5 mm and a straightness of 0.05 mm over 25 mm in any direction after installation of the studs.

Stainless steel plate shall conform to the requirements of Grade 316 in accordance with ASTM A240M and ASTM A480M.

Stainless steel plate for bridge bearings shall have a Brinell hardness of not less than 125.

10.5.2 Steel base plate

The steel base plate shall be Grade 250 to AS/NZS 3678.

The plate shall be supplied with a flatness tolerance across the width of the plate of 0.5 mm and straightness of 0.05 mm over 25 mm in any direction. The terms flatness and straightness are defined in AS 1100.101.

The top face shall be machined or polished to a surface roughness, Ra with an arithmetic mean deviation of 0.4 µm as defined in AS 1100.201. The base plate shall then be hot-dipped galvanised in accordance with the requirements of Clause 10.6. The top surface shall be re-machined to a surface roughness Ra of 0.4 µm in both directions.

10.5.3 Polytetrafluoroethylene

The resin used in the manufacture of polytetrafluoroethylene (PTFE) sheets shall be 100% virgin PTFE, complying with AS 1196, Grade A or AS 1195, Grade A, as appropriate.

10.6 Structures other than bridge barrier, girders and expansion bearings

Structures other than bridge barrier and steel I girders shall be constructed to the tolerances specified in Clause 14.4 of AS 4100.

Full contact splice joints shall have a maximum clearance between the abutting surfaces not in excess of 1 mm, and clearance shall also not exceed 0.5 mm over at least 67% of the contact area.

11 Coatings

11.1 Hot-dipped galvanising

All fabricated steelwork shall be hot-dipped galvanised after fabrication in accordance with the requirements of AS 4680.

11.2 Coating on bolts

All bolts with a thread size greater than M10 shall be hot dip galvanised to the requirements of AS 1214.

All bolts with a thread less than M10 and all socket head bolts shall be mechanically plated to the requirements of AS 3566 Class 4.

All bolts with a thread less than M10 and all socket head bolts shall be mechanically plated to the requirements of Fe/Zn 25c2A – AS 1789.

11.3 Finishing after galvanising

11.3.1 Inspection and repairs at galvanising works

Following galvanising and before leaving the galvanising works, the steelwork shall be inspected for coating defects. **Witness Point 3** Repairs to galvanised coatings, where necessary, shall be carried out strictly in accordance with the requirements of AS/NZS 4680.

The galvanising coating thickness should be inspected with a paint thickness gauge and the coating thickness shall be greater than the thickness specified in Table 1 of AS/NZS 4680. In the past it has been found that two common defects affect the long term durability of the galvanised product.

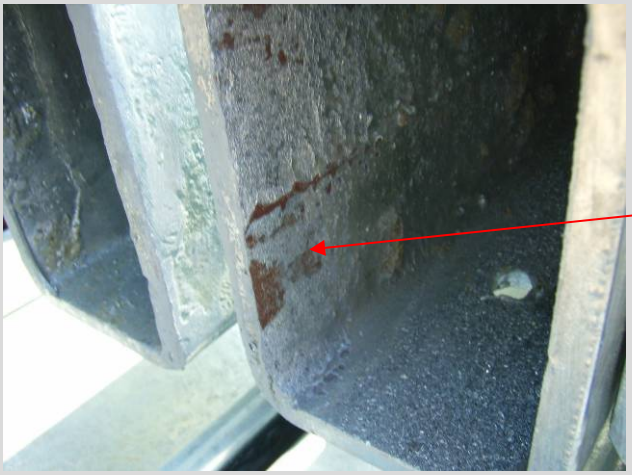
The first defect relates to the thickness of the galvanising. Figure 11.3.1(a) shows the coating thickness on a 9 mm thick rail was only 56 microns. In AS/NZS 4680 there is a requirement for the coating thickness to be greater than 70 microns. When the material test certificate was reviewed, the silicon content was less than 0.09%. Silicon contents between 0.09% and 0.15% are considered very reactive and will achieve the required coating thickness.

Figure 11.3.1(a) – View of the low coating thickness

The second defect relates to the galvanising of hollow sections. Figure 11.3.1(b) shows that the rails had not been galvanised effectively on the inside. The coating thickness gauge in the low area, was well below the 55 micron minimum requirement set out in AS/NZS 4680. Refer to Figure 11.3.1(c). This defect was caused by the by a lack of preflux in the galvanising process.

In both cases the steel work was sent back to the galvanisers to the re-galvanised.

Figure 11.3.1(b) – Rail not galvanised on the inside



The cause of the lack of coating thickness on the inside of the rail is due to the low concentration of preflux in the galvanising process.

Figure 11.3.1(c) – View of the coating thickness

11.3.2 Dressing

All galvanised items shall be dressed free of all lumps, spikes and other zinc protrusions and ash and dross marks shall be removed. Threads on bolts shall be cleaned. Drilled holes shall be checked to ensure they are free of zinc build-up.

The use of power-operated sanding tools or grinders shall not be permitted.

Figure 11.3.2(a) – View of the galvanising lump

Galvanising lumps usually occur at the drainage end of the member and are caused when the molten zinc cools.

Figure 11.3.2(b) – View of incorrect dressing

The excess galvanising was removed to the point where there was no residual zinc to protect the member.

Figure 11.3.2(b) shows the corrosion on the end of the members which has been caused by the power sanding to remove the excess galvanising.

11.3.3 Subsequent repairs to coatings

Any damage which occurs to galvanised coatings during handling, transporting and/or storage shall be referred to the Administrator prior to repair. **Nonconformance** Repairs shall be made using an approved zinc-rich paint or zinc sticks. Under no circumstances shall aluminium paint be used.

In the Technical Specification there is a provision for damaged galvanising to be repaired. AS/NZS 4680 states that the damaged galvanising shall be repaired with an Inorganic Zinc Rich Paint or Zinc stick. When an Inorganic Zinc rich paint is used, the Transport and Main Roads approved process is to apply two coats of Jotun Galvanite by brush. Figure 11.3.3 shows the zinc rich paint applied by brush to the end of the rail.

Figure 11.3.3 – View of the zinc rich paint repair

The zinc rich paint repair is used to repair damaged galvanising. The zinc rich repair is different finish to the new galvanising finish and is not a concern to Transport and Main Roads.

11.3.4 Strapping of galvanised items

All galvanised items shall be strapped with zinc rich primed steel strapping.

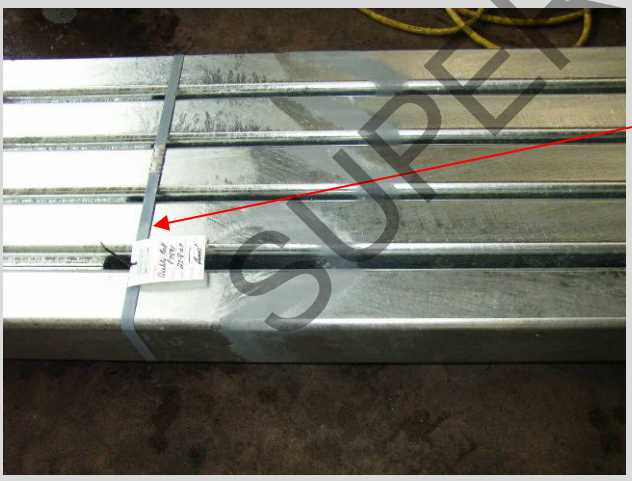
Other strapping materials will be considered subject to approval by Director (Bridge Construction, Maintenance and Asset Management).

When galvanised items are transported from the fabricator to the project site the fabricated item is often strapped together. In the past the galvanised items were strapped together with black strapping. Refer to Figure 11.3.4(a). The concern with the use of black strapping is that the strapping corrodes and leaves rust staining on the galvanised item. This often results in the rejection of the product as it is showing signs of corrosion when in actual fact the strapping had only caused surface staining of the galvanising finish.

Therefore the Technical Specification stipulates that all galvanised items are strapped with zinc rich primed steel strapping for transportation. Figure 11.3.4(b) shows the zinc rich strapping.

Figure 11.3.4(a) – View of the incorrect black strapping

Figure 11.3.4(b) – View of the zinc rich strapping



11.3.5 Additional requirements for bridge barrier

The internal surface of RHS rail components shall be dressed to ensure that the rail connectors can be readily assembled to the rails.

12 Assembly

12.1 General

Assembly of structural steelwork shall be in accordance with AS 4100.

12.2 Bolts, nuts and washers

Unless specifically shown otherwise on the drawings, all bolts shall be supplied with one nut and one washer. The washer shall be placed under the nut when assembling or installing the steelwork. Where a washer is shown under the head of a bolt, a second washer shall be supplied and installed under the nut.

Bolt assemblies shall be installed with a minimum of 3 mm of the bolt end projecting above the top of the nut after assembly.

12.3 Bolt tensioning

All bolt assemblies with a T/B or T/F classification shall be fully tensioned. The bolt tension shall be verified with installation of load indicating washers.

Seven days prior to the erection of any bolted members with a T/B or T/F classification, the Contactor shall provide a bolt tensioning procedure and demonstrate to the Administrator that they have the equipment and technical capability to tension the bolts as stated on the drawings. **Hold Point 11**

The Administrator shall ensure that the Contractor has the capability to tension the bolts correctly. A technical note has been developed which outlines the correct method of how to tension a bolt.

It is recommended that all bolts are tensioned with calibrated tension wrench as shown in Figure 12.3(a).

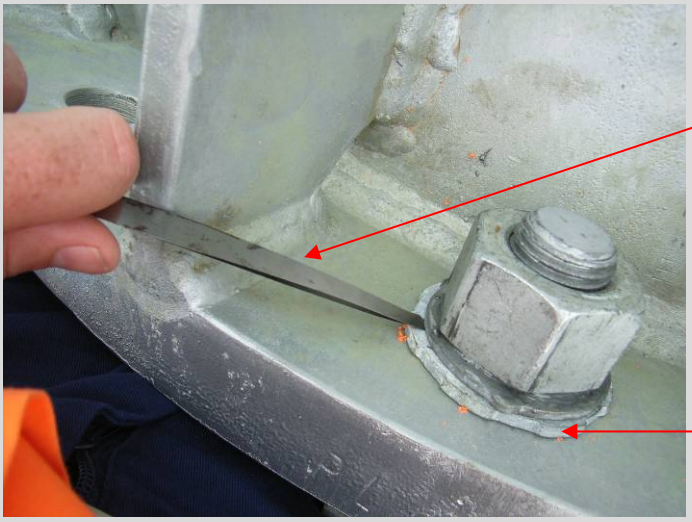
To ensure a T/B or T/F bolt is correctly tensioned, a load indicating washer should be used. Once the bolt has been tensioned, the gap between the load indicating washer and the washer is checked with a feeler gauge to ensure the bolt has been tensioned correctly. Figure 12.3(b) shows the method used to ensure a bolt is tensioned correctly.

Technical Note TN62 Parts 1 to 3 was developed to help explain the correct process which should be used for successfully tension structural assemblies. Refer to https://www.tmr.qld.gov.au/business-industry/Technical-standards-publications/Technical-Notes/Bridges-other-structures

Figure 12.3(a) – View of the pneumatic tension wrench

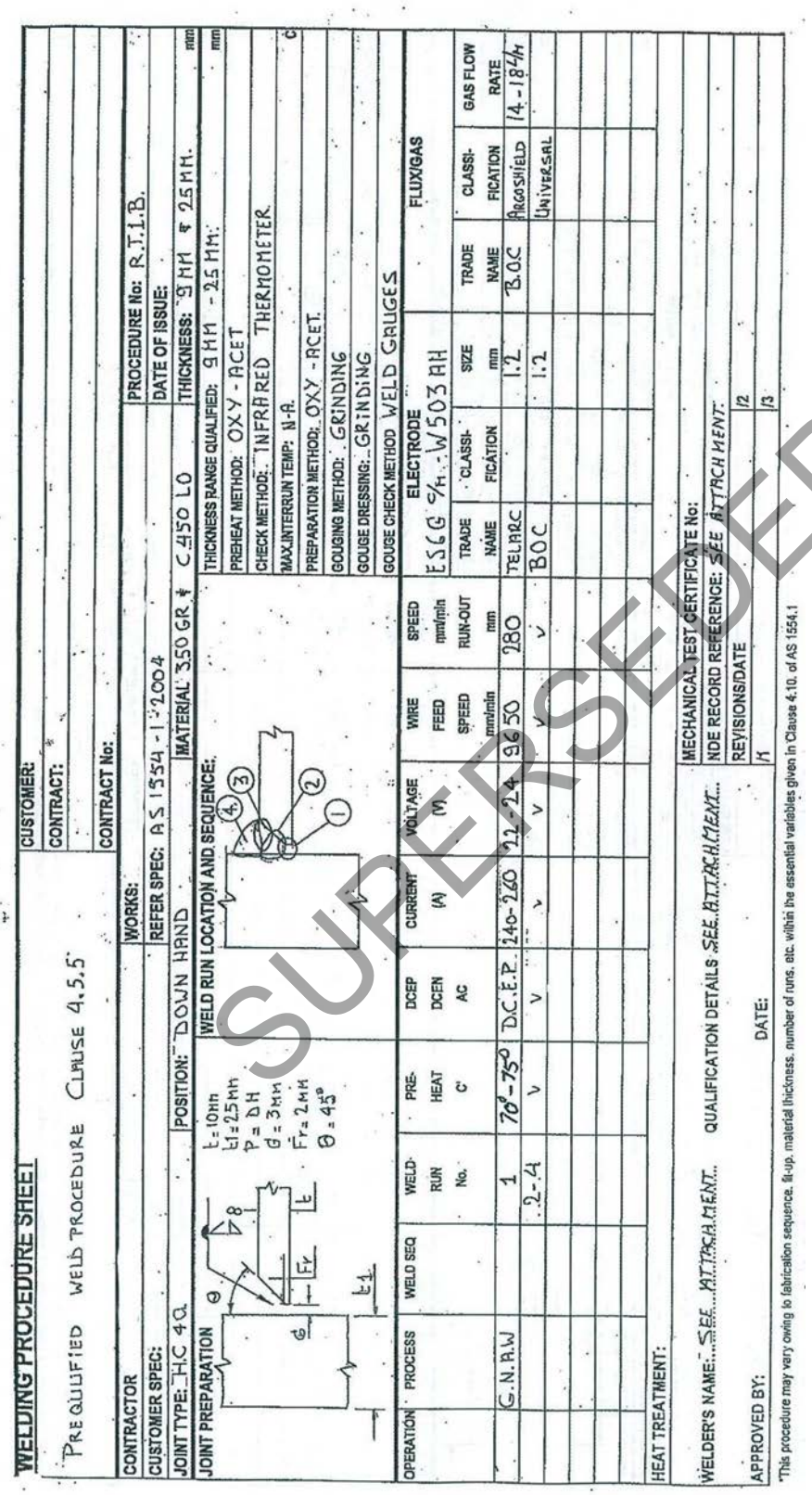
Typical example of a tension wrench used in the tensioning of bolts.

Figure 12.3(b) – View of the method of check bolts are the correct tension



Appendix A – Associated documents

Attachment 1 – Typical Welding Procedure Specification



WELDING PROCEDURE SHEET

PREQUALIFIED WELD PROCEDURE CLAUSE 4.5.5

CUSTOMER:
CONTRACT:
CONTRACT No:

CONTRACTOR — WORKS: — PROCEDURE No: R.T.I.B.
CUSTOMER SPEC: — REFER SPEC: AS 1554-1-2004 — DATE OF ISSUE:
JOINT TYPE: T.H.C 40 — POSITION: DOWN HAND — MATERIAL: 350 GR # C 450 LO — THICKNESS: 9 MM # 25 MM. mm

JOINT PREPARATION — WELD RUN LOCATION AND SEQUENCE:

t = 10mm
t1 = 25mm
P = DH
d = 3mm
Fr = 2mm
θ = 45°

OPERATION	PROCESS	WELD SEQ	WELD-RUN No.	PRE-HEAT C°	DCEP DCEN AC	CURRENT (A)	VOLTAGE (V)	WIRE FEED SPEED mm/min	SPEED mm/min RUN-OUT mm	ELECTRODE TRADE NAME	ELECTRODE CLASSIFICATION	ELECTRODE SIZE mm	FLUX/GAS TRADE NAME	FLUX/GAS CLASSIFICATION	FLUX/GAS GAS FLOW RATE
	G.M.A.W		1	70°-75°	D.C.E.P.	240-260	22-24	9650	280	TELARC		1.2	B.O.C	ARGOSHIELD	14-18 l/h
			2-4	V	V	V	V	V	V	B.O.C		1.2		UNIVERSAL	

HEAT TREATMENT:

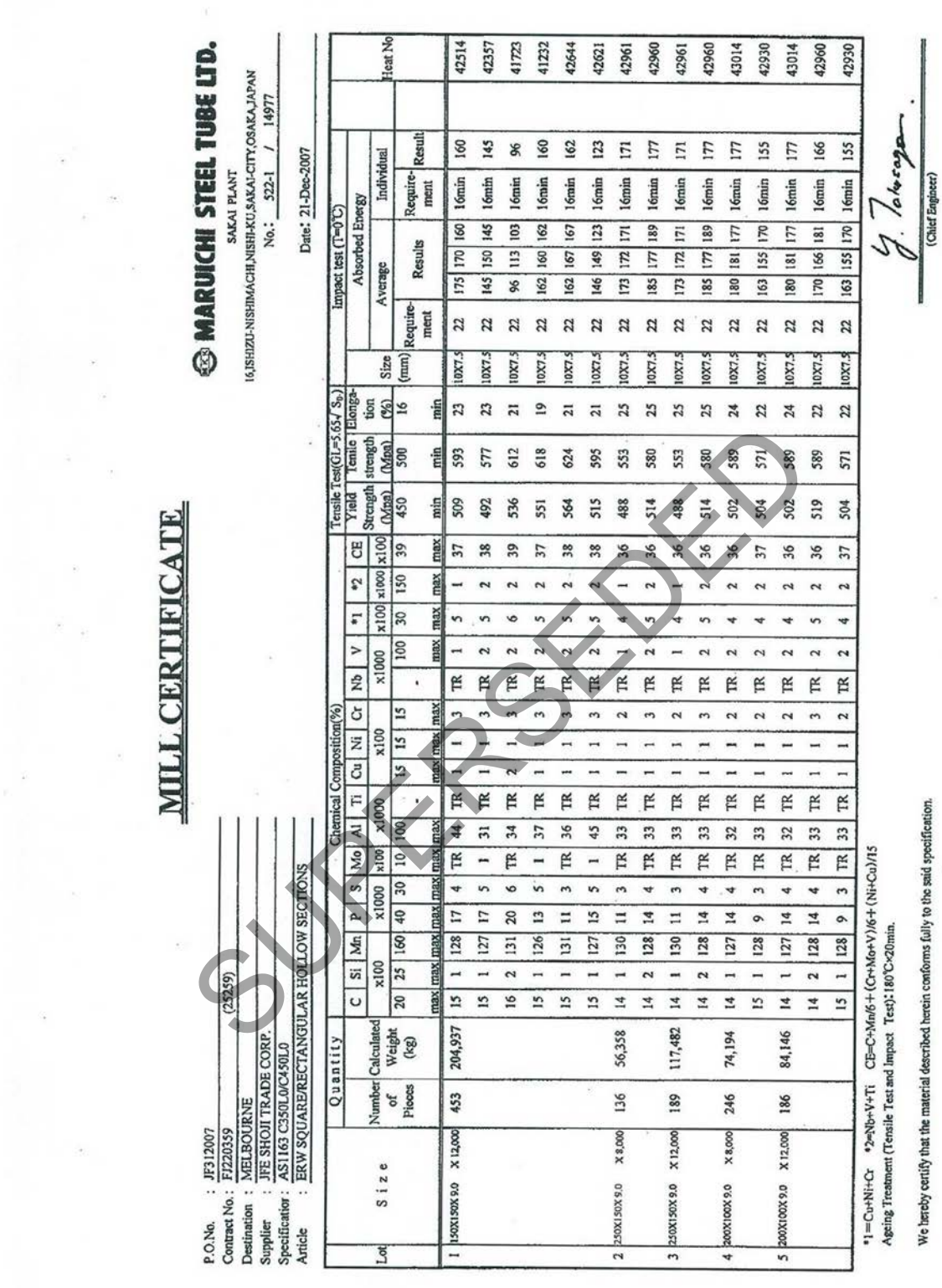
WELDER'S NAME: SEE ATTACHMENT... QUALIFICATION DETAILS: SEE ATTACHMENT...

APPROVED BY: DATE:

MECHANICAL TEST CERTIFICATE No:
NDE RECORD REFERENCE: SEE ATTACHMENT
REVISIONS/DATE
/1 /2 /3

*This procedure may vary owing to fabrication sequence, fit-up, material thickness, number of runs, etc. within the essential variables given in Clause 4.10, of AS 1554.1

Attachment 2 – Material Test Certificate



MILL CERTIFICATE

MARUICHI STEEL TUBE LTD.
SAKAI PLANT
16,ISHIZU-NISHIMACHI,NISHI-KU,SAKAI-CITY,OSAKA,JAPAN

P.O.No. : JF312007
Contract No. : FI220359 (25259)
Destination : MELBOURNE
Supplier : JFE SHOJI TRADE CORP.
Specification : AS1163 C350L0/C450L0
Article : ERW SQUARE/RECTANGULAR HOLLOW SECTIONS

No.: 522-1 / 14977
Date: 21-Dec-2007

Lot	Size	Quantity			Chemical Composition(%)																					Tensile Test(GL=5.65√ S_0)				Impact test (T=0°C)						Heat No
		Number of Pieces	Calculated Weight (kg)		C	Si	Mn	P	S	Mo	Al	Ti	Cu	Ni	Cr	Nb	V	*1	*2	CE		Yield Strength (Mpa)	Tenile strength (Mpa)	Elonga-tion (%)	Size (mm)	Absorbed Energy						
																												Average			Individual			
																												Require-ment	Results		Require-ment	Result		
					x100			x1000		x100	x1000		x100			x1000		x100	x100	x1000	x100													
					20	25	160	40	30	10	100	-	15	15	15	-	100	30	150	39		450	500	16										
					max	max	max	max	max	max	max	-	max	max	max	-	max	max	max	max		min	min	min										
1	150X150X9.0	453	204,937	X 12,000	15	1	128	17	4	TR	44	TR	1	1	3	TR	1	5	1	37		509	593	23	10X7.5	22	175	170	160	16min	160			42514
					15	1	127	17	5	1	31	TR	1	1	3	TR	2	5	2	38		492	577	23	10X7.5	22	145	150	145	16min	145			42357
					16	2	131	20	6	TR	34	TR	2	1	3	TR	2	6	2	39		536	612	21	10X7.5	22	96	113	103	16min	96			41723
					15	1	126	13	5	1	37	TR	1	1	3	TR	2	5	2	37		551	618	19	10X7.5	22	162	160	162	16min	160			41232
					15	1	131	11	3	TR	36	TR	1	1	3	TR	2	5	2	38		564	624	21	10X7.5	22	162	167	167	16min	162			42644
2	250X150X9.0	136	56,358	X 8,000	15	1	127	15	5	1	45	TR	1	1	3	TR	2	5	2	38		515	595	21	10X7.5	22	146	149	123	16min	123			42621
					14	1	130	11	3	TR	33	TR	1	1	2	TR	1	4	1	36		488	553	25	10X7.5	22	173	172	171	16min	171			42961
					14	2	128	14	4	TR	33	TR	1	1	3	TR	2	5	2	36		514	580	25	10X7.5	22	185	177	189	16min	177			42960
3	250X150X9.0	189	117,482	X 12,000	14	1	130	11	3	TR	33	TR	1	1	2	TR	1	4	1	36		488	553	25	10X7.5	22	173	172	171	16min	171			42961
					14	2	128	14	4	TR	33	TR	1	1	3	TR	2	5	2	36		514	580	25	10X7.5	22	185	177	189	16min	177			42960
4	200X100X9.0	246	74,194	X 8,000	14	1	127	14	4	TR	32	TR	1	1	2	TR	2	4	2	36		502	589	24	10X7.5	22	180	181	177	16min	177			43014
					15	1	128	9	3	TR	33	TR	1	1	2	TR	2	4	2	37		504	571	22	10X7.5	22	163	155	170	16min	155			42930
5	200X100X9.0	186	84,146	X 12,000	14	1	127	14	4	TR	32	TR	1	1	2	TR	2	4	2	36		502	589	24	10X7.5	22	180	181	177	16min	177			43014
					14	2	128	14	4	TR	33	TR	1	1	3	TR	2	5	2	36		519	589	22	10X7.5	22	170	166	181	16min	166			42960
					15	1	128	9	3	TR	33	TR	1	1	2	TR	2	4	2	37		504	571	22	10X7.5	22	163	155	170	16min	155			42930

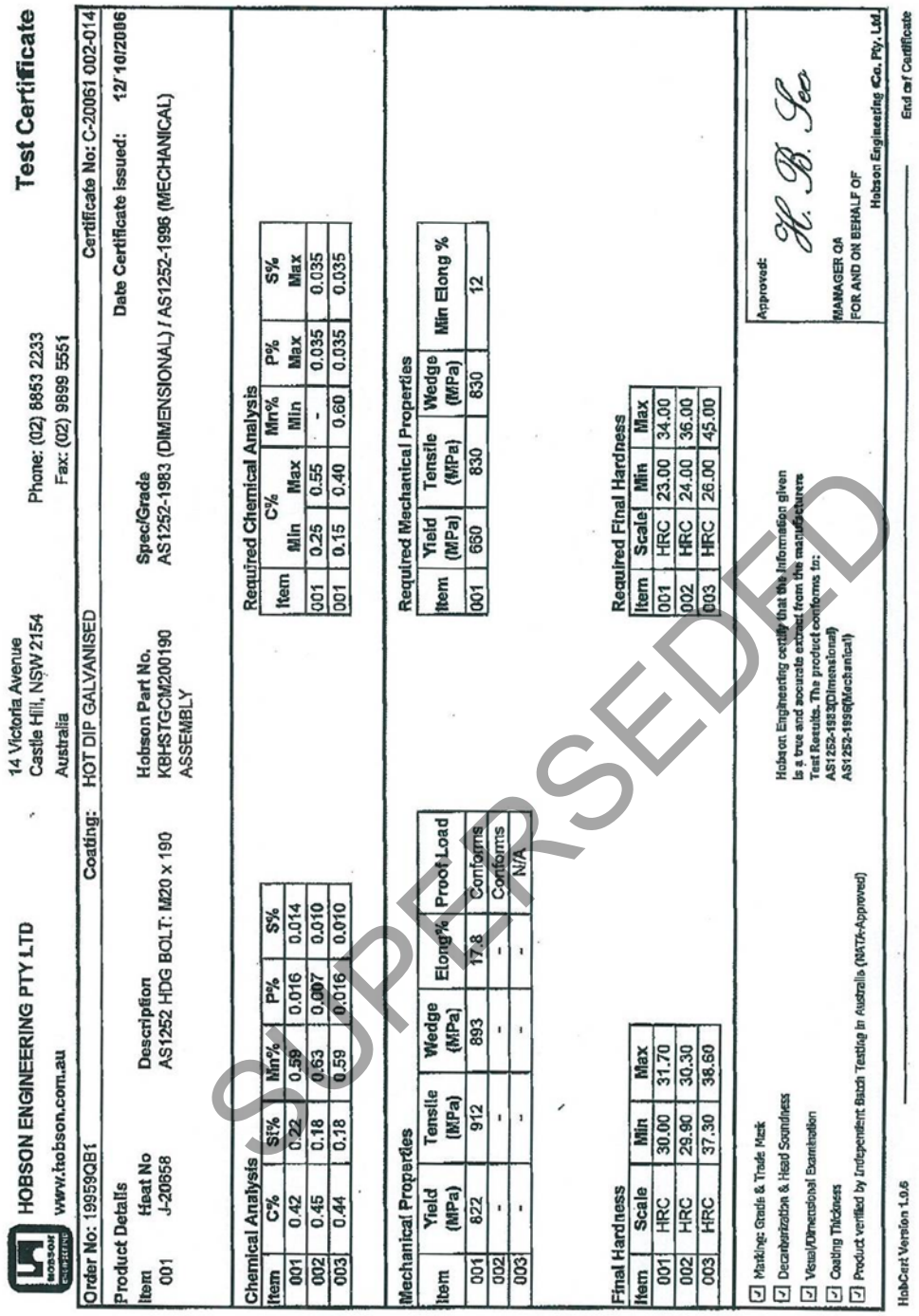
*1=Cu+Ni+Cr *2=Nb+V+Ti CE=C+Mn/6+(Cr+Mo+V)/6+(Ni+Cu)/15
Ageing Treatment (Tensile Test and Impact Test): 180°C-20min.

We hereby certify that the material described herein conforms fully to the said specification.

(Chief Engineer)

SUPERSEDED

Attachment 3 – Bolt Material Test Certificate



HOBSON ENGINEERING PTY LTD
www.hobson.com.au

14 Victoria Avenue
Castle Hill, NSW 2154
Australia

Phone: (02) 8853 2233
Fax: (02) 9899 5551

Test Certificate

Order No: 199590B1 | Coating: HOT DIP GALVANISED | Certificate No: C-20061 002-014

Product Details

Date Certificate issued: 12/10/2006

Item	Heat No	Description	Hobson Part No.	Spec/Grade
001	J-20658	AS1252 HDG BOLT: M20 x 190	KBHSTGCM200190 ASSEMBLY	AS1252-1983 (DIMENSIONAL) / AS1252-1996 (MECHANICAL)

Chemical Analysis

Item	C%	Si%	Mn%	P%	S%
001	0.42	0.22	0.59	0.016	0.014
002	0.45	0.18	0.63	0.007	0.010
003	0.44	0.18	0.59	0.016	0.010

Required Chemical Analysis

Item	C% Min	C% Max	Mn% Min	P% Max	S% Max
001	0.25	0.55	-	0.035	0.035
001	0.15	0.40	0.60	0.035	0.035

Mechanical Properties

Item	Yield (MPa)	Tensile (MPa)	Wedge (MPa)	Elong%	Proof Load
001	822	912	893	17.8	Conforms
002	-	-	-	-	Conforms
003	-	-	-	-	N/A

Required Mechanical Properties

Item	Yield (MPa)	Tensile (MPa)	Wedge (MPa)	Min Elong %
001	660	830	830	12

Final Hardness

Item	Scale	Min	Max
001	HRC	30.00	31.70
002	HRC	29.90	30.30
003	HRC	37.30	38.60

Required Final Hardness

Item	Scale	Min	Max
001	HRC	23.00	34.00
002	HRC	24.00	36.00
003	HRC	26.00	45.00

- [x] Marking: Grade & Trade Mark
- [x] Decarburization & Head Soundness
- [x] Visual/Dimensional Examination
- [x] Coating Thickness
- [x] Product verified by Independent Batch Testing in Australia (NATA-Approved)

Hobson Engineering certify that the information given is a true and accurate extract from the manufacturers Test Results. The product conforms to:
AS1252-1983(Dimensional)
AS1252-1996(Mechanical)

Approved:

MANAGER QA
FOR AND ON BEHALF OF
Hobson Engineering (Co. Pty. Ltd.

HobCert Version 1.0.6

End of Certificate

SUPERSEDED

Attachment 4 – Bolt Assembly Test Report

AlfaTest
AlfaTest Pty Ltd
A.B.N. 58 099 333 774

P.O. Box 229, Salisbury Qld 4107
Unit 3 / 121 Evans Road, Salisbury Qld 4107

Phone: (07) 3277 0466
Fax: (07) 3277 0499
E-Mail: info@alfatest.com.au

Form No: MEC001.03

MECHANICAL TESTING REPORT

AlfaTest Report No:	A2008020M02	Date of Inspection:	21 January 2008
Location of Test:	Brisbane Laboratory	Client Order No:	Verbal Don Bann
Client Name/Address:	Southeast Fasteners Unit 3b, 828 Beaudesert Road, Coopers Plains Qld 4108		
Client Job No:	Batch No J-20658		
Project Details:	Load Testing of M20 x 190 Galvanised Bolts and Nut Assemblies		
Item Details:	Qty 4 , M20 x 190 Bolts and Nut Assemblies as supplied		
Sample Details:	Refer Test Results		

TECHNICAL DETAILS
TENSILE TEST

Test Procedure:	TP 210	Test Spec:	TP 210
Client Requirements:	Report Test Results	Acceptance Spec:	Client Requirements
Material Spec:	Marking of 8.8 identified on Bolt	Heat Treatment:	Not Applicable
Surface Coating:	Galvanised	Coating Thickness:	Not Applicable
Test Piece Direction:	Load Tested Longitudinal to Bolt		
Equipment:	Hydraulic Cylinder (100 tonne)	Serial No:	489
Equipment:	Pressure Transducer (700Bar)	Serial No:	543
Extensometer Gauge (mm):	Not Applicable		
Load Range (kN):	1000		
Target Strain Rate:	≤ 3mm/min		
Actual Strain Rate:	≤ 3mm/min		

Test Restrictions/ Deviations:	The scope and conditions of this test procedure are as detailed in the Bolt/Nut Testing Procedure discussed with the Department of Main Roads.
Compliance:	Refer Test Results

Technician/s:	Andrew Whewell Alexander Burton	Approved by:	Andrew Whewell
		Signature:	
		Issue Date:	25 January 2008

NATA
ACCREDITED FOR TECHNICAL COMPETENCE

AlfaTest
AlfaTest Pty Ltd
A.B.N. 58 096 333 774

P.O. Box 229, Salisbury Qld 4107
Unit 3 / 121 Evans Road, Salisbury Qld 4107

Phone: (07) 3277 0466
Fax: (07) 3277 0499
E-Mail: info@alfatest.com.au

Form No: R190.03

TEST RESULTS

AlfaTest Report No: A2008020M02 Date of Inspection: 21 January 2008

TENSILE TESTING

Bolt Ref	Proof Load (kN)	Nut/ Bolt Displacement (Y/N)	Minimum UTS (kN)	Nut/ Bolt Displacement (Y/N)	Comments
Load Testing of M20 x 190 Galvanised Bolts and Nut Assemblies					
1	147	N	203	N	Satisfactory to AS 4291.1, Table 6 & 7
2	147	N	203	N	Satisfactory to AS 4291.1, Table 6 & 7
3	147	N	203	N	Satisfactory to AS 4291.1, Table 6 & 7
4	147	N	203	N	Satisfactory to AS 4291.1, Table 6 & 7

Appendix B – Administrators checklist

Table B1 – Administrator checklist

Hold Point Release	MRTS78 Clause Reference	Comment	Yes/ No
Welding Procedure Specifications	Clause 6 **Hold Point 1**	The review of the welding procedure specificaitons to ensure they correspond to the welding outlined on the drawings.	
Material Test Certificates	Clause 7.1 **Hold Point 2**	Ensure the material test certificates: • match the materials supplied • the grade of the materials match the grade specified on the drawings • the chemical composition is within the Specification of the Australian Standard • the Yield and Ultimate strength are within acceptable bounds as specified by the grade required • the elongation with above the minimum limit in the Australian Standards • the Charpy V-Notch impact testing is outlined on the test certificate for Hollow sections.	
Class 4.6 Standard Bolt Material Test Certificate and Assembly Test Report	Clause 7.3.1 **Witness Point** & **Hold Point 3**	Ensure the material test certificates: • are traceable to the bolts supplied • the grade of the bolts match the grade specified on the drawings • the chemical composition is within the Specification of the Australian Standard • the Yield and Ultimate strength are within acceptable bounds as specified by the grade required • the elongation with above the minimum limit in the Australian Standards • the bolts are supplied with an assembly test report.	
Class 8.8 High Strength Bolt Material Test Certificate and Assembly Test Report	Clause 7.3.2 **Witness Point** & **Hold Point 4**	Ensure the material test certificates: • are traceable to the bolts supplied • the grade of the bolts match the grade specified on the drawings • the chemical composition is within the Specification of the Australian Standard • the Yield and Ultimate strength are within acceptable bounds as specified by the grade required • the elongation with above the minimum limit in the Australian Standards • the bolts are supplied with an assembly test report.	
Inspection of all butt weld preparations	Clause 8.5.4 **Hold Point 5**	The butt welds are inspected prior to welding commencing.	

Hold Point Release	MRTS78 Clause Reference	Comment	Yes/ No
Weld Maps	Clause 8.5.5 **Hold Point 6**	The fabricator is responsible for providing a document which outlines the following: • which welding procedure specification was used • who welded each joint • who checked the welded joint.	
Inspection of Completed Product	Clause 8.5.6 **Hold Point 7**	Product welded shall be inspected by the Administrator before being dispatched for protective coating.	
Inspection of all butt weld preparations – Outside Australia	Clause 8.6.5 **Hold Point 8**	The butt welds are inspected prior to welding commencing.	
Weld Maps – Outside Australia	Clause 8.6.6 **Hold Point 9**	The fabricator is responsible for providing a document which outlines the following: • which welding procedure specification was used • who welded each joint • who checked the welded joint.	
Inspection of Completed Product – Outside Australia	Clause 8.6.7 **Hold Point 10**	Product welded outside Australia is inspected by the Administrator in Australia before the application of the protective coating. All costs associated with the inspection are to be covered by the Contractor.	
Galvanising	Clause 11.3.1 **Witness Point**	• The coating thickness with AS/NZS 4680. • The item is free of lumps, spikes and other zinc protrusions and all dross and ash marks are removed. • All damaged galvanising are repaired by the recommended process of applying two coats of Jotun Galvanite by brush.	
Bolt Tensioning	Clause 12.3 **Hold Point 11**	All T/B and T/F bolts shall be fully tensioned. Prior to the erection of any bolted members, the Administrator shall witness the Contractor undertaking a trial assembly of bolts to be installed to establish that the Contractor has the equipment to tension the bolts correctly.	

Appendix C – Australian Standard requirements for bolts

C1 Class 4.6 Bolts

Class 4.6 bolts and nuts (coarse thread) shall conform to the following table.

Table C1(a) - Proof and ultimate loads for Class 4.6 bolts and nuts

Size	Proof Load of Bolt (kN)	*Minimum Ultimate Tensile Load of Bolts	+Proof Load for Nuts, Hot Dip Galv. (kN)
M10	13.0	23.2	34.2
M12	19.0	33.7	51.4
M16	35.3	62.8	95.8
M20	55.1	98.0	154.4
M22	68.2	121.0	190.9
M24	79.4	141.0	222.4
M27	103	184.0	289.2
M30	126	224.0	353.4
M36	184.0	327.0	514.7
M39	220.0	390.0	614.9
M42	252.0	448.0	705.6
M48	330.8	588.0	926.1
M56	456.8	812.0	1278.9

* Ref: AS 4291.1 – Minimum Ultimate Tensile Loads and Proof Loads, Tables 6-7.

+ Ref: AS 4291.2 – Minimum Proof Loads, Tables 6-7.

Hardness shall be determined in accordance with Clause 8.2 of AS/NZS 4291.2 and mechanical properties shall conform to the following table.

Table C1(b) – Mechanical properties of Class 4.6 nuts

Thread		Stress under Proof Load S_p N/mm^2	Vickers Hardness HV		Style
≥	≤		Min	Max	
–	M4	520	130	302	1
M4	M7	580			
M7	M10	590			
M10	M16	610			
M16	M56	630	146		

C2 High strength bolts

High strength bolts and nuts (coarse thread) shall conform to the following table.

Table C2(a) – Proof and ultimate loads for high strength bolts and nuts

Size	Proof Load of Bolt (kN)	* Minimum Ultimate Tensile Load of Bolts (kN)	+ Proof Load for Nuts, Hot Dip Galv. (kN)
M16	91.0	125.0	182.9
M20	147.0	203.0	285.4
M22	182.0	252.0	353.0
M24	212.0	293.0	411.2
M27	275.0	381.0	534.7
M30	337.0	466.0	653.6
M36	490.0	678.0	951.8
M39	586.0	810.0	1137.0
M42	672.0	929.6	1304.8
M48	882.0	1220.0	1712.6
M56	1218.0	1685.0	2365.0

* Ref: AS 4291.1 – Minimum Ultimate Tensile Loads and Proof Loads, Tables 6-7.

+ AS 1252 – Proof Loads for Nuts, Table 3.2.

Hardness shall be determined in accordance with Clause 8.2 of AS/NZS 4291.2 and shall conform to the following table.

Table C2(b) – Mechanical properties of high strength nuts

Thread		Stress under Proof Load S_p N/mm²	Vickers Hardness HV		Style
>	<		Min	Max	
–	M4	800	180	302	1
M4	M7	855	200		
M7	M10	870			
M10	M16	880			
M16	M39	920	233	353	
M16	M56	890	180	302	2