Technical Specification

Transport and Main Roads Specifications
MRTS78 Fabrication of Structural Steelwork

September 2013
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1 Introduction
This specification applies to the fabrication of structural steelwork for bridges, other structures, roadside furniture and poles.

This 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 for registration and information regarding registered fabricators refer to:
Department of Transport and Main Roads
Director (Bridge Construction, Maintenance and Asset Management)
GPO Box 1412
Brisbane QLD 4001

2 Definition of terms
The terms used in this 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

<table>
<thead>
<tr>
<th>Reference</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>AS 1100.101</td>
<td>Technical drawing – General principles</td>
</tr>
<tr>
<td>AS 1100.201</td>
<td>Technical drawing – Mechanical engineering drawing</td>
</tr>
<tr>
<td>AS 1110</td>
<td>ISO metric hexagon bolts and screws – Product grades A and B</td>
</tr>
<tr>
<td>AS 1111</td>
<td>ISO metric hexagon bolts and screws – Product grade C</td>
</tr>
<tr>
<td>AS 1112</td>
<td>ISO metric hexagon nuts</td>
</tr>
<tr>
<td>AS/NZS 1163</td>
<td>Structural steel hollow sections</td>
</tr>
<tr>
<td>AS 1195</td>
<td>Polytetrafluoroethylene (PTFE) skived tape</td>
</tr>
<tr>
<td>AS 1196</td>
<td>Polytetrafluoroethylene (PTFE) moulded sheet</td>
</tr>
<tr>
<td>AS 1214</td>
<td>Hot-dip galvanized coatings on threaded fasteners (ISO metric coarse thread series)</td>
</tr>
<tr>
<td>AS 1237</td>
<td>Plain washers for metric bolts, screws and nuts for general purposes</td>
</tr>
<tr>
<td>AS/NZS 1252</td>
<td>High strength steel bolts with associated nuts and washers for structural engineering</td>
</tr>
<tr>
<td>AS 1275</td>
<td>Metric screw threads for fasteners</td>
</tr>
<tr>
<td>AS/NZS 1554</td>
<td>Structural steel welding Set</td>
</tr>
<tr>
<td>AS/NZS 1554.1</td>
<td>Structural steel welding – Welding of steel structures</td>
</tr>
<tr>
<td>AS/NZS 1554.2</td>
<td>Structural steel welding – Stud welding (steel studs to steel)</td>
</tr>
<tr>
<td>AS/NZS 1594</td>
<td>Hot-rolled steel flat products</td>
</tr>
<tr>
<td>AS/NZS 3678</td>
<td>Structural steel – Hot-rolled plates, floor plates and slabs</td>
</tr>
</tbody>
</table>
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 Specification are summarised in Table 4.1. There are no Milestones defined in the table.

An Administrator’s 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

<table>
<thead>
<tr>
<th>Clause</th>
<th>Hold Point</th>
<th>Witness Point</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>1. Verification of welding procedure sheets for all welded components</td>
<td>Test of steel where test certificates are not available</td>
</tr>
<tr>
<td></td>
<td>2. Approval of Test certificates for steelwork</td>
<td></td>
</tr>
<tr>
<td>7.1</td>
<td>3. Selection of Class 4.6 bolts, nuts and washers for testing</td>
<td></td>
</tr>
<tr>
<td>7.3.1.1</td>
<td>4. Approval of the Class 4.6 bolts, nuts and washers</td>
<td></td>
</tr>
<tr>
<td>7.3.2.1</td>
<td>5. Selection of high strength bolts, nuts and washers</td>
<td></td>
</tr>
</tbody>
</table>
Clause | Hold Point | Witness Point
--- | --- | ---
7.3.2.1 | 6. Approval of the Class 8.8 bolts, nuts and washers |  
8.5.4 | 7. Verification of butt weld preparations |  
8.5.5 | 8. Supply of weld maps |  
8.5.6 | 9. Inspection of completed product |  
8.6.5 | 10. Verification of butt weld preparations for product manufactured outside Australia |  
8.6.6 | 11. Supply of weld maps for product manufactured outside Australia |  
8.6.7 | 12. Verification of completed product manufactured outside Australia |  
11.3.1 |  | Inspection of galvanising
12.3 | 13. 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**

<table>
<thead>
<tr>
<th>Clause</th>
<th>Conformance Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>Weld procedure specification sheet</td>
</tr>
<tr>
<td>7.1</td>
<td>Test certificates for steelwork</td>
</tr>
<tr>
<td>7.3.1.1</td>
<td>Test certificates for Class 4.6 bolts, nuts and washers</td>
</tr>
<tr>
<td>7.3.2.1</td>
<td>Test certificates for high strength bolts, nuts and washers</td>
</tr>
</tbody>
</table>

These procedures are critical. Note that the receipt of these procedures is often seen as a defacto 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 specification are summarised in Table 4.3.

**Table 4.3 - Conformance requirements**

<table>
<thead>
<tr>
<th>Clause</th>
<th>Conformance Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>Tolerances</td>
</tr>
</tbody>
</table>

### 5 Registered fabricator

The full registration requirements and procedure for registration are details in BCM-P-011 *Registration Procedure: Approved Suppliers of Steel Fabricated Products.*
5.1 Registered fabricator

Steelwork shall only be fabricated by an approved fabricator. Registration as an approved fabricator will be reviewed periodically or earlier if unsatisfactory performance is reported. Information regarding approval status can be obtained from:

Department of Transport and Main Roads
Director (Bridge Construction, Maintenance and Asset Management)
GPO Box 1412
Brisbane QLD 4001

5.1.1 Registered fabricator for major bridge infrastructure – in Australia

To be registered as an Approved 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.

b) Demonstrate technical conformance to MRTS78.

5.1.2 Registered fabricator for minor bridge infrastructure – in Australia

To be registered as an Approved 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.

b) Demonstrate technical conformance to MRTS78.

5.1.3 Registered fabricator – outside Australia

To be registered as an Approved 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.

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.

6 Welding procedure sheets

The Contractor shall supply the Welding Procedure Specification Sheets 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 Sheet has been approved. Hold Point 1
Attachment 1 shows a typical weld procedure sheet for the weld undertaken on the TMR standard bridge rail intermediate post. The weld procedure 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 weld procedures supplied by the fabricator reflect the welding the designer has specified on the drawings. TMR Structures can review the weld procedures 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 1594
- Hollow sections  AS/NZS 1163 Grade L0
- Hot-rolled steel plates  AS 3678
- Hot-rolled steel sections  AS 3679.1

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.

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

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. Witness Point Minimum testing requirements are 2 percent 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 the material test certificates or material testing as appropriate. Hold Point 2

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.
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 manufacturers are ink printing the material heat number on the member which can be traced back to the material test certificates. Figure 1 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 1 View of the heat number on an SHS member**

A similar reference number can be found for plate. Figure 2 shows the unit identification number which can be traced back to the material test certificate.

**Figure 2 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 TMR’s case was the testing undertaken on a bolt for a major steel bridge structure. Figure 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 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 TMR - Structures has developed an individual technical note covering the manufacture of a fabricated bolt. Contact Bridge Construction, Maintenance and Asset Management if you require a copy of the technical note.

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. **Hold Point 3** 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**

7.3.1.2 Testing for Class 4.6 bolts

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

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. **Hold Point 5** 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 6**

Figure 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 4 View of the label on the bolt of bolt supplied**

All bolts supplied shall have a label traceable back to the material test certificate.

### 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.

### 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.

### 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**

<table>
<thead>
<tr>
<th>NUMBER OF TEST SPECIMENS FOR BOLTS AND NUTS</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Number of pieces in lot</strong></td>
</tr>
<tr>
<td>-------------------------------</td>
</tr>
<tr>
<td>Up to 50</td>
</tr>
<tr>
<td>51 - 500</td>
</tr>
<tr>
<td>501 - 35 000</td>
</tr>
<tr>
<td>35 001 and above</td>
</tr>
</tbody>
</table>

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
- 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
- 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 5 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 (f) 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 an approved supplier, Structural Materials ensures all welding supervisors are competent to supervise the fabrication of works.

Therefore, the Administrators role is to ensure that 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 weld procedure undertaken on TMR 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)

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).

TMR 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 weld procedure sheets. **Hold Point 7**

This clause was added to the 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 Approved Suppliers List.

When fabrication commences, the welding procedure sheets are used to ensure the welded joint is prepared correctly and the welder is following the weld settings nominated on the weld procedure. Figure 6 shows the butt weld preparation for the attached weld procedure sheet has been undertaken correctly.

*Figure 6 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 weld procedure sheet.

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

- the welder shall change back to the welding settings outlined on the WPS, 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 7.
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:

- weld procedure number used for the welding undertaken
- welder’s initials or welding number for each weld undertaken
- 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 8**

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 that product is available for inspection. All steel fabricated product the Administrator shall ensure the following inspections are undertaken. **Hold Point 9**

a) 100% of all products shall be visually examined

b) A minimum of 50% all gantry structure and bridge structure butt welds shall be Non Destructively tested. If any welds are found to be defective then 100% of the welds shall be Non Destructively Tested.

TMR reserves the right to increase the minimum level of Non Destructive Testing.

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

<table>
<thead>
<tr>
<th>TMR Testing Frequency</th>
<th>NDT</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Products</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Visual</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>UT</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>MPI</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Major Bridge Infrastructure

<table>
<thead>
<tr>
<th>Products</th>
<th>NDT</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shop Welding of Girders</td>
<td>100%</td>
<td>50% 50% If any failure - then - 100%</td>
</tr>
<tr>
<td>Fabricated Steel Girders</td>
<td>100%</td>
<td>50% 50% If any failure - then - 100%</td>
</tr>
<tr>
<td>Truss Bridges</td>
<td>100%</td>
<td>50% 50% If any failure - then - 100%</td>
</tr>
<tr>
<td>Roller Steel Girders</td>
<td>100%</td>
<td>50% 50% If any failure - then - 100%</td>
</tr>
<tr>
<td><strong>Overhead and Cantilever Fabricated Gantry</strong></td>
<td>100%</td>
<td>50% 50% If any failure - then - 100%</td>
</tr>
</tbody>
</table>

#### Minor Bridge Infrastructure

<table>
<thead>
<tr>
<th>Products</th>
<th>NDT</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bridge Traffic &amp; Balustrade Rail</td>
<td>100%</td>
<td></td>
</tr>
<tr>
<td>Bridge Throw Screens</td>
<td>100%</td>
<td></td>
</tr>
<tr>
<td>Roadside Mounted Fabricated Sign Gantry</td>
<td>100%</td>
<td></td>
</tr>
<tr>
<td>Steel Replacement Components</td>
<td>100%</td>
<td></td>
</tr>
<tr>
<td>Steel Pile Liners</td>
<td>100%</td>
<td></td>
</tr>
<tr>
<td>Steel Piles</td>
<td>100%</td>
<td></td>
</tr>
<tr>
<td>Bridge Restraint Angles</td>
<td>100%</td>
<td></td>
</tr>
<tr>
<td><strong>Bus Station Structures</strong></td>
<td>100%</td>
<td>50% 50% 50% 50% UT Butt Welds (if any failure - then - 100%) Only for the members which span over a road, such as a walkway</td>
</tr>
<tr>
<td>Steel Beam Guardrail - Slip Base Posts</td>
<td>100%</td>
<td></td>
</tr>
<tr>
<td>Traffic Sign Poles - Slip Base Poles</td>
<td>100%</td>
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</tr>
<tr>
<td>Road Lighting - Road Lighting Components</td>
<td>100%</td>
<td></td>
</tr>
<tr>
<td>Road Lighting - Traffic Mast Arms, Post</td>
<td>100%</td>
<td></td>
</tr>
<tr>
<td>Grids (RHS section)</td>
<td>100%</td>
<td></td>
</tr>
<tr>
<td>Grids (Railway Line Section)</td>
<td>100%</td>
<td></td>
</tr>
<tr>
<td>Noise Barrier Post</td>
<td>100%</td>
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</tr>
<tr>
<td>Noise Barriers on Parapets</td>
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<td></td>
</tr>
<tr>
<td>Pit Covers to MRTS91</td>
<td>100%</td>
<td></td>
</tr>
<tr>
<td>Grates</td>
<td>100%</td>
<td></td>
</tr>
<tr>
<td>Miscellaneous Fabrication</td>
<td>100%</td>
<td></td>
</tr>
<tr>
<td><strong>Aluminum Bridge Traffic Rail</strong></td>
<td>100%</td>
<td></td>
</tr>
<tr>
<td><strong>Aluminum Balustrade Rail</strong></td>
<td>100%</td>
<td></td>
</tr>
<tr>
<td><strong>Stainless Steel Welding</strong></td>
<td>100%</td>
<td></td>
</tr>
</tbody>
</table>
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 shows the way to inspect a fillet weld leg length which is the correct size. Figure 9 shows the way to inspect a fillet weld throat thickness which is the correct size.

**Figure 8 Fillet weld leg length**

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 10.

**Figure 10 View of the dye penetrant testing**

One of the most common weld defects is porosity in the weld. Refer to Figure 11.
The other common weld defect is the undercut in the parent material. Refer to Figure 12. 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 11 View of the porosity in the weld**

The porosity is caused by a lack of shielding gas. The weld also not fused correctly to the base plate.

**Figure 12 View of the undercut in the post**

Undercut is caused when the amps are too high in the welding process and this causes the parent material to melt into the weld metal.

### 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

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 TMR 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).

TMR reserves the right to withdraw welder qualification if welding is below TMR 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 10

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:

- weld procedure 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 11

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 TMR prior to the application of the protective coating.

Hold Point 12

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
b) A minimum of 50% of all welds shall be Non Destructively Tested. If any welds are found to be defective then 100% of the welds shall be Non Destructively Tested.

TMR reserves the right to increase the minimum level of Non Destructive Testing.

Any welding defects found during the inspection shall be repaired by an Approved TMR 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>
<thead>
<tr>
<th>Location</th>
<th>Tolerance (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length of member</td>
<td>± 2</td>
</tr>
<tr>
<td>Height of post/balustrade</td>
<td>± 2</td>
</tr>
<tr>
<td>Centre of holes</td>
<td>± 2</td>
</tr>
<tr>
<td>Line of barrier from plan dimension</td>
<td>± 3</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Location</th>
<th>Tolerance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length of girder</td>
<td>± 3 mm</td>
</tr>
<tr>
<td>Squareness of ends</td>
<td>± 3 mm in full depth of girder</td>
</tr>
<tr>
<td>Lateral bow</td>
<td></td>
</tr>
<tr>
<td>if gradual</td>
<td>12 mm over length of girder</td>
</tr>
<tr>
<td>if localised</td>
<td>6 mm over length of girder</td>
</tr>
<tr>
<td>Lateral kink</td>
<td></td>
</tr>
<tr>
<td>within middle half of span</td>
<td>6 mm over length of girder</td>
</tr>
<tr>
<td>outside middle half of span</td>
<td>3 mm over length of girder</td>
</tr>
<tr>
<td>Hog</td>
<td>+ 6 mm, - 0 over length of girder</td>
</tr>
<tr>
<td>Position of bearing holes in flange</td>
<td>± 1 mm</td>
</tr>
<tr>
<td>Position of holes in web</td>
<td>± 2 mm</td>
</tr>
<tr>
<td>Width of bottom flange at expansion bearings</td>
<td>± 1 mm</td>
</tr>
<tr>
<td>Surface of bearing area of bottom flange where bearing is attached</td>
<td>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 $\frac{1}{1000}$ of the depth from the perpendicular. No more than 2 mm shall be removed by grinding to achieve this standard of flatness.</td>
</tr>
<tr>
<td>Warping or tilt of flanges of welded plate girders from a line perpendicular to the plan of the web</td>
<td>$\frac{1}{1000}$ of depth of web</td>
</tr>
<tr>
<td>Deviation from flatness of girder webs within a distance equal to the depth of the girder</td>
<td>$\frac{1}{2500}$ of width of flange</td>
</tr>
<tr>
<td>Deviation between centre lines of web and flange of a built up girder</td>
<td>3 mm maximum</td>
</tr>
<tr>
<td>Full Contact Splice Joints</td>
<td>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</td>
</tr>
</tbody>
</table>

#### 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 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. 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 13 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 13 View of the low coating thickness**

The second defect relates to the galvanising of hollow sections. Figure 14 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 15. 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 14 Rail not galvanised on the inside**
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.

Galvanising lumps usually occur at the drainage end of the member and are caused when the molten zinc cools.
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 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 TMR approved process is to apply two coats of Jotun Galvanite by brush. Figure 18 shows the zinc rich paint applied by brush to the end of the rail.

![Figure 17 View of incorrect dressing](image1)
The excess galvanising was removed to the point where there was no residual zinc to protect the member.

![Figure 17 View of incorrect dressing](image2)
Figure 17 shows the corrosion on the end of the members which has been caused by the power sanding to remove the excess galvanising.

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 19. 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 specification stipulates that all galvanised items are strapped with zinc rich primed steel strapping for transportation. Figure 20 shows the zinc rich strapping.

**Figure 19 View of the incorrect black strapping**

![Incorrect black strapping](image1)

The black strapping can lead to rust staining of the galvanised members if they are left on site for a period of time.

**Figure 20 View of the zinc rich strapping**

![Zinc rich strapping](image2)

Zinc rich strapping prevents rust staining of the galvanised members.

### 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 13**

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 21.

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 22 shows the method used to ensure a bolt is tensioned correctly.

*Figure 21 View of the pneumatic tension wrench*
Figure 22 View of the method of check bolts are the correct tension

Feeler Gauge used to check the gap between the washer and the load indicating washer.

Load Indicating Washer.
Appendix A: Associated documents

Attachment 1 Typical Weld Procedure
### Attachment 2 Material Test Certificate

**MILL CERTIFICATE**

<table>
<thead>
<tr>
<th>No.</th>
<th>QA (kg)</th>
<th>Q (kg)</th>
<th>W (g)</th>
<th>M (g)</th>
<th>A (g)</th>
<th>T (g)</th>
<th>N (g)</th>
<th>C (g)</th>
<th>Fe (g)</th>
<th>Si (g)</th>
<th>Mn (g)</th>
<th>Cr (g)</th>
<th>Ni (g)</th>
<th>Mo (g)</th>
<th>A1 (g)</th>
<th>A2 (g)</th>
<th>Cu (g)</th>
<th>Ni (g)</th>
<th>Cr (g)</th>
<th>Mo (g)</th>
<th>A1 (g)</th>
<th>A2 (g)</th>
<th>Cu (g)</th>
<th>Ni (g)</th>
<th>Cr (g)</th>
<th>Mo (g)</th>
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<table>
<thead>
<tr>
<th>Specification</th>
<th>Test</th>
<th>Date</th>
<th>Result</th>
<th>Acceptance</th>
<th>Comments</th>
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</table>

**We certify that the material described herein conforms fully to the said specifications.**
**Attachment 3 Bolt Material Test Certificate**

<table>
<thead>
<tr>
<th>Item</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbon (C)</td>
<td>0.45%</td>
<td>0.50%</td>
</tr>
<tr>
<td>Manganese (Mn)</td>
<td>0.60%</td>
<td>0.70%</td>
</tr>
<tr>
<td>Phosphorus (P)</td>
<td>0.020%</td>
<td>0.050%</td>
</tr>
<tr>
<td>Sulfur (S)</td>
<td>0.010%</td>
<td>0.030%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Test Description</th>
<th>Yield Stress (MPa)</th>
<th>Ultimate Tensile Stress (MPa)</th>
<th>Min Elong %</th>
</tr>
</thead>
<tbody>
<tr>
<td>001</td>
<td>622</td>
<td>912</td>
<td>17.8</td>
</tr>
<tr>
<td>002</td>
<td>622</td>
<td>912</td>
<td>17.8</td>
</tr>
<tr>
<td>003</td>
<td>622</td>
<td>912</td>
<td>17.8</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Chemical Analysis</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>0.45%</td>
<td>0.50%</td>
</tr>
<tr>
<td>Mn</td>
<td>0.60%</td>
<td>0.70%</td>
</tr>
<tr>
<td>P</td>
<td>0.020%</td>
<td>0.050%</td>
</tr>
<tr>
<td>S</td>
<td>0.010%</td>
<td>0.030%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Mechanical Properties</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tensile Stress (MPa)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yield Stress (MPa)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ultimate Tensile Stress (MPa)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Min Elong %</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**End of Certificate**

Hobson Engineering Pty Ltd acknowledges that the information contained in this certificate is true and correct. The certificate is approved by the relevant authority.
## Attachment 4 Bolt Assembly Test Report

### Mechanical Testing Report

**AlfaTest)**

**A20080301M002**

**Location of Test:** Brisbane Laboratory

**Client Name/Address:** Southeast Fasteners Unit 3b, 828 Banda Road, Coopers Plains QLD 4108

**Client Job No:** Batch No J-20058

**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

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

Test Restrictions/

Deviations:

Compliance:

| Technician/s: | Andrew Whitwell |
| Approved by: | Andrew Whitwell |
| Signature: | |

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### Attachment 5 Bolt Assembly Test Report

#### TEST RESULTS

**AlfaTest Report No:** A20080209-02

**Date of Inspection:** 31 January 2008

#### TENSILE TESTING

<table>
<thead>
<tr>
<th>Bolt Ref</th>
<th>Proof Load (kN)</th>
<th>Nut/Bolt Displacement (Y/N)</th>
<th>Minimum UTS (kN)</th>
<th>Nut Bolt Displacement (Y/N)</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>147</td>
<td>N</td>
<td>203</td>
<td>N</td>
<td>Satisfactory to AS 4291.1, Table 6 &amp; 7</td>
</tr>
<tr>
<td>2</td>
<td>147</td>
<td>N</td>
<td>203</td>
<td>N</td>
<td>Satisfactory to AS 4291.1, Table 6 &amp; 7</td>
</tr>
<tr>
<td>3</td>
<td>147</td>
<td>N</td>
<td>203</td>
<td>N</td>
<td>Satisfactory to AS 4291.1, Table 6 &amp; 7</td>
</tr>
<tr>
<td>4</td>
<td>147</td>
<td>N</td>
<td>203</td>
<td>N</td>
<td>Satisfactory to AS 4291.1, Table 6 &amp; 7</td>
</tr>
</tbody>
</table>

---

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Page 2 of 2
## Appendix B: Administrators checklist

### Table 1 Administrator checklist

<table>
<thead>
<tr>
<th>Hold Point Release</th>
<th>MRTS78 Clause Reference</th>
<th>Comment</th>
<th>Yes/ No</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weld Procedure Sheets</td>
<td>Clause 6 <strong>HOLD POINT 1</strong></td>
<td>The review of the weld procedure sheets to ensure they correspond to the welding outlined on the drawings.</td>
<td></td>
</tr>
</tbody>
</table>
| 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. |        |
| Standard Bolt Material Test Certificate and Assembly Test Report | Clause 7.3.1 **HOLD POINT 3**, **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. |        |
| High Strength Bolt Material Test Certificate and Assembly Test Report | Clause 7.3.2 **HOLD POINT 5**, **HOLD POINT 6** | 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. |        |
<p>| Inspection of all butt weld preparations | Clause 8.5.4 <strong>HOLD POINT 7</strong> | The butt welds are inspected prior to welding commencing. |        |
| Weld Maps | Clause 8.5.5 | The fabricator is responsible for providing a document which outlines the following: |        |</p>
<table>
<thead>
<tr>
<th>Hold Point Release</th>
<th>MRTS78 Clause Reference</th>
<th>Comment</th>
<th>Yes/No</th>
</tr>
</thead>
</table>
| HOLD POINT 8       |                         | • which weld procedure was used  
|                    |                         | • who welded each joint  
|                    |                         | • who checked the welded joint. |
| Inspection of Completed Product | Clause 8.5.6 | HOLD POINT 9 | 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 10 | The butt welds are inspected prior to welding commencing. |
| Weld Maps – Outside Australia | Clause 8.6.6 | HOLD POINT 11 | The fabricator is responsible for providing a document which outlines the following:  
|                   |                         | • which weld procedure was used  
|                   |                         | • who welded each joint  
|                   |                         | • who checked the welded joint. |
| Inspection of Completed Product – Outside Australia | Clause 8.6.7 | HOLD POINT 12 | 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 applying two coats of Jotun Galvanite applied by brush. |
| Bolt Tensioning | Clause 12.3 | HOLD POINT 13 | 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 1: Australian Standard requirements for bolts

A1 Class 4.6 Bolts

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

Table A1-A - Proof and ultimate loads for Class 4.6 bolts and nuts

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

+ 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 A1-B - Mechanical properties of Class 4.6 nuts

<table>
<thead>
<tr>
<th>Thread</th>
<th>Stress under Proof Load $S_p$, N/mm²</th>
<th>Vickers Hardness HV</th>
<th>Style</th>
</tr>
</thead>
<tbody>
<tr>
<td>≥</td>
<td>≤</td>
<td>Min</td>
<td>Max</td>
</tr>
<tr>
<td>–</td>
<td>M4</td>
<td>520</td>
<td></td>
</tr>
<tr>
<td>M4</td>
<td>M7</td>
<td>580</td>
<td></td>
</tr>
<tr>
<td>M7</td>
<td>M10</td>
<td>590</td>
<td>130</td>
</tr>
<tr>
<td>M10</td>
<td>M16</td>
<td>610</td>
<td></td>
</tr>
<tr>
<td>M16</td>
<td>M56</td>
<td>630</td>
<td>146</td>
</tr>
</tbody>
</table>
A2  **High Strength Bolts**

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

**Table A2-A - Proof and ultimate loads for high strength bolts and nuts**

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

+ 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 A2-B - Mechanical properties of high strength nuts**

<table>
<thead>
<tr>
<th>Thread</th>
<th>Stress under Proof Load $S_p$ N/mm²</th>
<th>Vickers Hardness HV</th>
<th>Style</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt;</td>
<td>&lt;</td>
<td>Min</td>
<td>Max</td>
</tr>
<tr>
<td>–</td>
<td>M4</td>
<td>800</td>
<td>180</td>
</tr>
<tr>
<td>M4</td>
<td>M7</td>
<td>855</td>
<td>200</td>
</tr>
<tr>
<td>M7</td>
<td>M10</td>
<td>870</td>
<td>233</td>
</tr>
<tr>
<td>M10</td>
<td>M16</td>
<td>880</td>
<td>180</td>
</tr>
<tr>
<td>M16</td>
<td>M39</td>
<td>920</td>
<td>180</td>
</tr>
<tr>
<td>M16</td>
<td>M56</td>
<td>890</td>
<td>180</td>
</tr>
</tbody>
</table>