

SUPERSEDED

Technical Specification

**Transport and Main Roads Specifications
MRTS79 Fabrication of Aluminium Components**

July 2017

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SUPERSEDED

1 Introduction

This Technical Specification applies to the fabrication of aluminium components for bridges, other structures and roadside furniture.

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.

Aluminium components shall be fabricated only by a fabricator that is registered by Transport and Main Roads.

For the requirements and information regarding registered 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 1231	<i>Aluminium and aluminium alloys – Anodic oxidation coatings</i>
AS 1664	<i>Aluminium Structures</i>
AS 1665	<i>Welding of aluminium structures</i>
AS 1874	<i>Aluminium and aluminium alloys – Ingots and castings</i>
AS/NZS 1665	<i>Welding of Aluminium Structures</i>
AS/NZS 1734	<i>Aluminium and aluminium alloys – Flat sheet, coiled sheet and plate</i>
AS/NZS 18273	<i>Welding consumables – Wire electrodes, wires and rods for welding of aluminium and aluminium alloys – Classification</i>
AS/NZS 1865	<i>Aluminium and aluminium alloys – Drawn wire, rod, bar and strip</i>
AS/NZS 1866	<i>Aluminium and aluminium alloys – Extruded rod, bar, solid and hollow shapes</i>
AS/NZS 1867	<i>Aluminium and aluminium alloys – Extruded rod, bar, solid and hollow shapes</i>
AS/NZS ISO 9001	<i>Quality management systems - Requirements</i>
CTP – SM01	Procedures Manual: Register for Approved Fabricators of Steelwork, Aluminium and Stainless Aluminium Components
ISO 3834	<i>Quality requirements for fusion welding of metallic materials</i>
MRTS01	<i>Introduction to Technical Specifications</i>
MRTS50	<i>Specific Quality System Requirements</i>
MRTS78A	<i>Fabrication of Structural Stainless Steelwork</i>

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.

Table 4.1 – Hold Points, Witness Points and Milestones

Clause	Hold Point	Witness Point	Milestone
6	1. Verification of welding procedure specification for all welded components		
7.1	2. Approval of test certificates for aluminium	1. Test of aluminium where test certificates are not available	
8.4.4	3. Verification of butt weld preparations		
8.4.5	4. Supply of weld maps		
8.4.6	5. Inspection of completed product		
8.5.5	6. Verification of butt weld preparations for product manufactured outside Australia		
8.5.6	7. Supply of weld maps for product manufactured outside Australia		
8.5.7	8. Verification of completed product manufactured outside Australia		

4.2 Construction procedures

The Contractor shall prepare documented procedures for all construction processes in accordance with the quality system requirements of the Contract.

Construction procedures for those activities listed in Table 4.2 shall be submitted to the Administrator in accordance with the quality system requirements of the Contract.

Table 4.2 – Construction procedures

Clause	Conformance Requirement
6.4.3	Weld procedure specification

Documented procedures are critical as receipt is often accepted 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 Technical Specification are summarised in Table 4.3.

Table 4.3 – Conformance requirements

Clause	Conformance Requirement
7	Tolerances
8	Coatings

5 Registered fabricator

5.1 Registered fabricator

Aluminium fabrication shall only be fabricated by an approved aluminium 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 the departmental website, www.tmr.qld.gov.au

The list of approved suppliers is a live database which is updated on a regular basis. It is recommended that before a Contract commences the Administrator obtains the current list of registered fabricators.

5.1.1 Registered fabricator for aluminium components – in Australia

To be registered as an approved fabricator for aluminium components 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 MRTS79 *Fabrication of Aluminium Components*.

5.1.2 Registered fabricator for aluminium components – outside Australia

To be registered as an approved fabricator for aluminium components, 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 MRTS79. 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 MRTS79.

6 Welding procedure specification

The Contractor shall supply the Welding Procedure Specification for the welding to be undertaken, in accordance with AS 1665 and a copy submitted to the Administrator.

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

Appendix B shows a typical welding procedure specification for the weld undertaken on an aluminium balustrade panel. 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 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 Aluminium

Aluminium shall comply with the following standards, as relevant:

- a) Plate AS/NZS 1734
- b) Drawn bar and rod AS/NZS 1865
- c) Extruded bar and rod AS/NZS 1866
- d) Tube AS/NZS 1867
- e) Castings AS 1874.

The grade of aluminium and / or the manufacturer's part number for fittings shall be as shown in the drawing.

The Contractor shall supply to the Administrator prior to the commencement of fabrication, copies of the aluminium manufacturer's test certificates, showing the chemical properties and results of tensile and elongation tests.

Aluminium fabrication shall not commence until the Administrator has reviewed and approved the material test certificates. **Hold Point 2**

If test certificates are not available, then the Contractor shall submit to the Administrator for approval a proposal for selecting samples for testing of tensile strength and elongation, chemical analysis and in accordance with the appropriate Australian Standard at no expense to the Principal. **Witness Point 1**

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 aluminium.

This section outlines the most commonly used Australian Standards used for the supply of the aluminium. If other Australian Standards are used in the fabrication of a component, these standards will be outlined on the certified RPEQ Engineering drawings.

This section also requires the Fabricator to supply the Administrator with the material test certificates for all material used in the fabrication of the aluminium components. This requirement was introduced as the Transport and Main Roads – Structures section found that some merchants were sourcing materials which did not comply with the requirements of the relevant Australian Standards.

The Administrator is required to verify that the materials supplied to the fabricator match the material test certificates supplied for approval.

7.2 Welding electrodes

Welding electrodes shall be compatible with the parent metal and shall be classified and identified in accordance with the provisions of AS/NZS 18273.

7.3 Bolts, nuts and washers

Bolts, nuts and washers shall be stainless steel Grade 316 unless noted otherwise in the drawing.

Stainless steel bolts and nuts shall have an ISO coarse pitch metric thread. Bolts shall be supplied in accordance with MRTS78A *Fabrication of Structural Stainless Steelwork*.

8 Fabrication

8.1 General

All aluminium components shall be fabricated in accordance with AS 1664 and AS/NZS 1665.

8.2 Holes

All holes shall finish accurately to size and in the position shown in the drawing and 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 in the drawing.

All holes shall be drilled. Punching of holes shall not be permitted.

8.3 Bending of aluminium plate or sheet

Bending of aluminium plate or sheet 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.

8.4 Welding

8.4.1 General

Welding shall be carried out in accordance with the provisions of AS/NZS 1665 except as amended by Clause 8.4.2, 8.4.3, 8.4.4, 8.4.5 and 8.4.6.

8.4.2 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 conditions (a) to (f) of Clause 4.5.2 of AS/NZS 1665.

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 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 within the fabricators organisation with the inspection of product.

8.4.3 Welding personnel

All welders shall satisfy conditions A and B of Clause 4.5.3 of AS/NZS 1665. 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 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) Fourth year apprentices subject to approval by Director (Bridge Construction, Maintenance and Asset Management).
- c) Second year and third year apprentices are permitted to undertake only fillet welds subject to approval by Director (Bridge Construction, Maintenance and Asset Management).
- d) Transport and Main Roads reserves the right to withdraw welder qualification if welding is below Transport and Main Roads requirements.

To ensure that the welders are suitably qualified for the welding to be undertaken on Transport and Main Roads projects. Transport and Main Roads requires all Structural Purpose (SP) welding to be undertaken by a welder who has a trade qualification or demonstrate competence equivalent to a trade qualification subject to approval by the Director (Bridge Construction, Maintenance and Asset Management).

8.4.4 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 the butt weld preparations are prepared in accordance with the weld procedure specification. **Hold Point 3**

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 specification are used to ensure the welded joint is prepared correctly and the welder is following the weld settings nominated on the welding procedure specification.

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:

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

If you are unsure of the requirements, we recommend contacting Transport and Main Roads Structures.

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.

8.4.5 Weld maps

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

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

The weld map shall be submitted to the Administrator for approval before the product is dispatched for protective coating. **Hold Point 4**

It is critical that all fabricated aluminium components are documented correctly. It is important to record which staff member welded a joint and which staff member checked a particular joint. This section outlines the conformance requirement for the supply of the conformance documentation. This section is used to track the 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.

8.4.6 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 the product is available for inspection. For all aluminium products the Administrator shall ensure the following inspections are undertaken: **Hold Point 5**

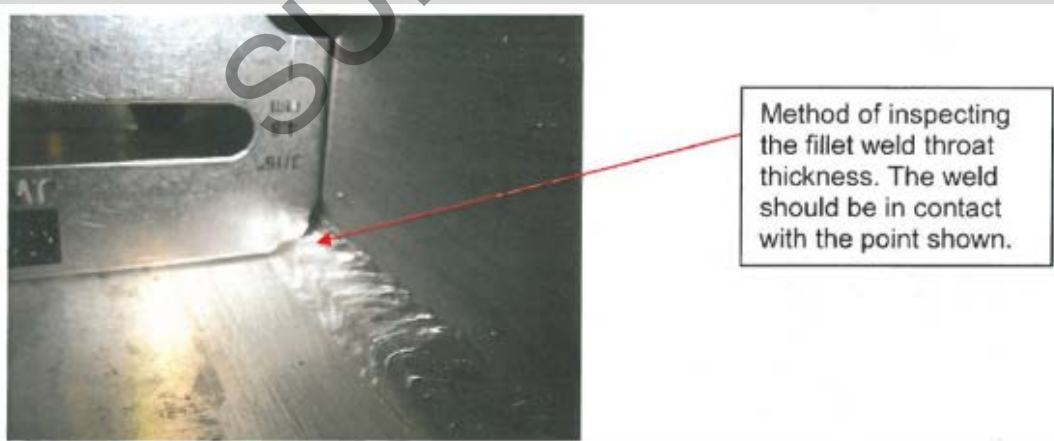
- 100% of all products shall be visually examined.
- Any welding defects found during the inspection shall be repaired prior to the application of the protective coating.

Once all the welding is completed the welding is inspected to ensure that the welds are the correct size and the welds are free of weld defects. Figure 8.4.6(a) shows the way to inspect a fillet weld leg length which is the correct size. Figure 8.4.6(b) shows the way to inspect a fillet weld throat thickness which is the correct size.

Figure 8.4.6(a) - Fillet weld leg length



Figure 8.4.6(b) - Fillet weld throat thickness



One of the most common weld defects is the lack of fusion of the weld to the parent material - Refer to Figure 8.4.6(c) and Figure 8.4.6(d).

Figure 8.4.6(c) - View of the lack of fusion to the weld defect

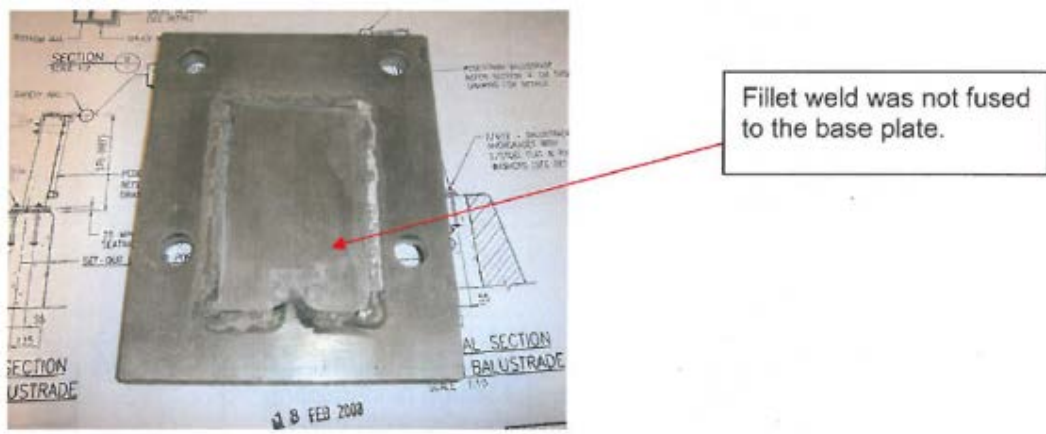
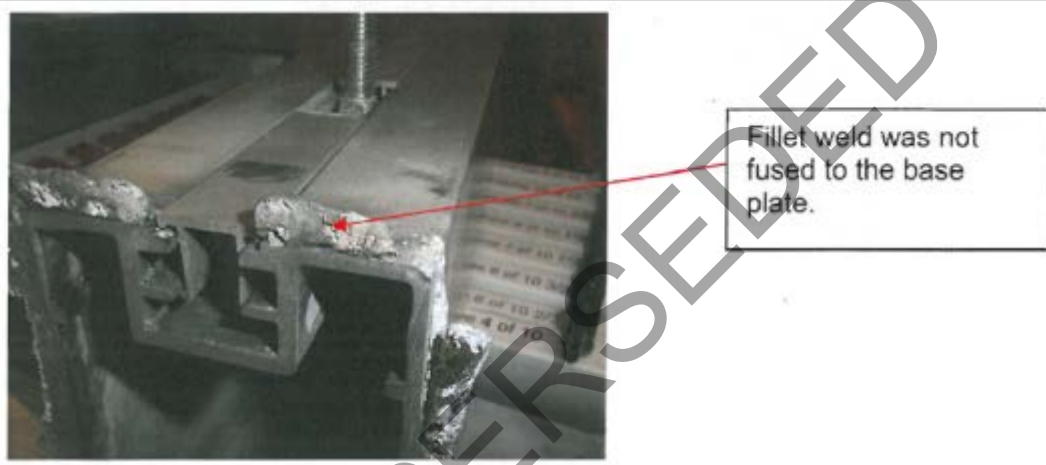
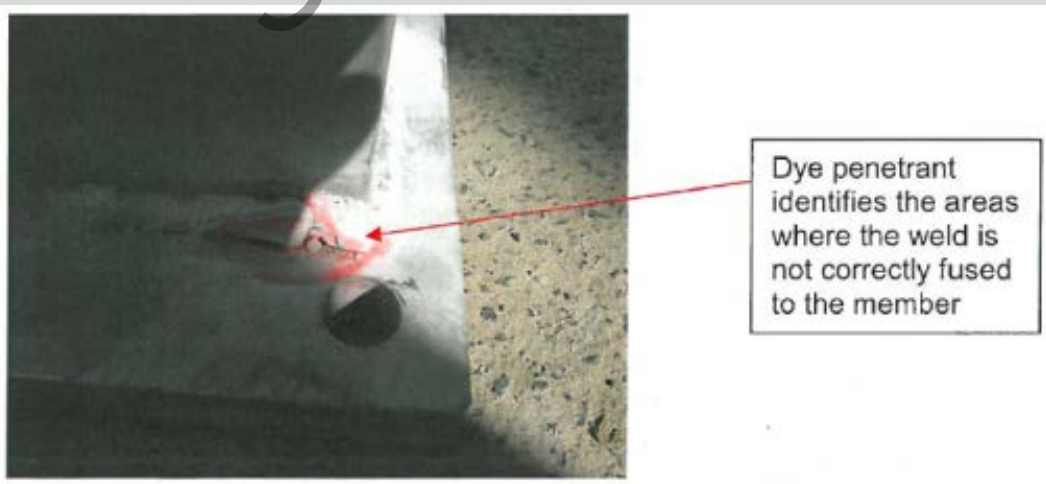


Figure 8.4.6(d) - View of the lack of fusion to the weld defect



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 8.4.6(e).

Figure 8.4.6(e) - View of the dye penetrant testing



8.4.7 Quality of welds

Permissible levels of imperfection in fillet and butt welds shall conform to weld category B as defined in AS/NZS 1665.

8.5 Welding undertaken outside Australia

8.5.1 General

Welding shall be carried out in accordance with the provisions of AS/NZS 1665 except as amended by Clause 8.5.2, 8.5.3, 8.5.4, 8.5.5, 8.5.6 and 8.5.7.

8.5.2 Supervision of the overseas fabrication

All aluminium fabrication work undertaken overseas shall be supervised by the Administrator or by a person nominated by the Administrator who shall, in the opinion of Director (Bridge Construction, Maintenance and Asset Management), conform to the following requirements:

- a) Clause 4.5.2 (a) of AS/NZS 1665, and
- b) is from a culturally different background to the country undertaking the fabrication.

8.5.3 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 4.5.2 (a) to (c) of AS/NZS 1665.

8.5.4 Welding personnel - outside Australia

All welders shall satisfy conditions A and B of Clause 4.5.3 of AS/NZS 1665. All welding personnel require macro re-qualification on a 12 monthly basis for each weld procedure undertaken on Transport and Main Roads projects.

For all 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 welding is below Transport and Main Roads requirements.

To ensure that the welders are suitably qualified for the welding to be undertaken on Transport and Main Roads projects the department requires all Structural Purpose (SP) welding to be undertaken by a welder who has a trade qualification equivalent to an Australian trade qualification.

8.5.5 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 6**

8.5.6 Weld Maps – outside Australia

The fabricator shall provide a weld map outlining the welding undertaken in the manufacture of the aluminium 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 product is dispatched for protective coating. **Hold Point 7**

8.5.7 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 8

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 a registered fabricator prior to the application of the protective coating.

9 Quality of welds

9.1 General

Permissible levels of imperfection in fillet and butt welds shall conform to weld Category B as defined in AS/NZS 1665.

Once product is fabricated by an overseas fabricator there is a requirement for the completed product to be inspection in Australia prior to the application of a protective coating. The reason the product must be supplied without any protective coating is so non destructive examination of the welds can be performed.

If there are any defects which need to be rectified they will need to be carried out by a registered fabricator.

10 Tolerances

10.1 General

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

10.2 Bridge barrier

The tolerances listed in Table 10.2 shall apply to aluminium bridge barrier.

Table 10.2 – Tolerances for aluminium fabrication

Location	Tolerance
Length of rails and balustrade	± 2 mm
Height of posts	± 2 mm
Centre of holes	± 3 mm
Height of balustrade	± 2 mm
Bow in rail and balustrade	1 mm / m

10.3 Components other than bridge barrier

The tolerances applicable to aluminium components other than bridge barrier shall be as stated in AS/NZS 1664.

11 Coatings

11.1 Bridge balustrade and rails

All aluminium balustrade and rails shall be clear anodised in accordance with AS 1231. The anodised coating shall have a minimum thickness of 25 microns.

All anodised aluminium components shall be subject to the following special conditions:

- a) repairs to the anodised coating shall not be made
- b) the use of power-operated sanding tools or grinders shall not be permitted, and
- c) all anodised articles shall be dressed free of all lumps, spikes and other protrusions, and ash and dross marks shall be removed.

The anodising is applied once all the fabrication is completed. The anodising help strengthen the aluminium alloys.

11.2 Cast posts and stanchions

The bottom face of cast posts shall be painted with a bitumastic paint.

11.3 All other components

Aluminium components other than bridge barrier shall be coated in accordance with the details shown in the drawing.

Appendix A – Administrators checklist

To aid Administrators and ensure they are supplied with the correct information during the fabrication of aluminium components, a checklist has been developed. Table 1 outlines the Administrators check list.

Table 1 - Administrator checklist

Hold Point Release	MRTS78 Clause Reference	Comment	Yes/No
Welding Procedure Specification	Clause 6 Hold Point 1	The review of the welding procedure specifications to ensure they correspond to the welding outlined on the drawings.	
Material Test Certificates	Clause 7.1 Hold Point 2	Ensure the material test certificate: <ul style="list-style-type: none"> • 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, and • the Charpy V-Notch impact testing is outlined on the test certificate for hollow sections. 	
Inspection of all butt weld preparations	Clause 8.4.4 Hold Point 3	The butt welds are inspected prior to welding commencing.	
Weld Maps	Clause 8.4.5 Hold Point 4	The fabricator is responsible for providing a document which outlines the following: <ul style="list-style-type: none"> • which welding procedure specification was used • who welded each joint, and • who checked the welded joint. 	
Inspection of Completed Product	Clause 8.4.6 Hold Point 5	Product welded shall be inspected by the Administrator before being dispatched for protective coating.	
Inspection of all butt weld preparations – outside Australia	Clause 8.5.5 Hold Point 6	The butt welds are inspected prior to welding commencing.	
Weld Maps – outside Australia	Clause 8.5.6 Hold Point 7	The fabricator is responsible for providing a document which outlines the following: <ul style="list-style-type: none"> • which welding procedure specification was used • who welded each joint, and • who checked the welded joint. 	
Inspection of Completed Product – outside Australia	Clause 8.5.7 Hold Point 8	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.	

Appendix B – Typical welding procedure specification

WELDING PROCEDURE SHEET										
CUSTOMER: PREQUALIFIED WELD PROCEDURE CLAUSE 4.5.5					CONTRACT No:					
CONTRACT:					WORKS:					
CONTRACT No:					PROCEDURE No: R.T.I.B.					
CONTRACTOR:					DATE OF ISSUE:					
CUSTOMER SPEC:					REFER SPEC: AS 1554-1:2004					
JOINT TYPE: HC 40					MATERIAL: 350 GR. C450 L0					
JOINT PREPARATION:					THICKNESS RANGE QUALIFIED: 9MM - 25MM.					
					PREHEAT METHOD: OXY-ACET					
					CHECK METHOD: INFRARED THERMOMETER					
					MAXIMUM RUN TEMP: N-R.					
					PREPARATION METHOD: OXY-ACET.					
					GOUGING METHOD: GRINDING					
					GOUGE DRESSING: GRINDING					
					GOUGE CHECK METHOD: WELD GRIGUES					
OPERATION	PROCESS	WELD SEQ	WELD RUN No.	PRE-HEAT °C	DC/AC	CURRENT (A)	VOLTAGE (V)	WIRE FEED SPEED (mm/min)	SPEED (mm/min)	FLUXIGAS
	G.N.R.W		1	70-75°	DC.E.P.	240-260	22-24	9650	280	ESCG 5/16 W503 RH
			2-4	V	V		V			TELPRC BOC
										TRADE NAME: BOC
										CLASSIFICATION: UNIVERSAL
										TRADE NAME: BOC
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