

# **Fabrication of Aluminium Components**

**(ATS 5430, Ed 1.0 MOD)**

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## Preface

This Specification is the first issue as TS 01750, which adopts and modifies Austroads Technical Specification ATS 5430, Ed 1.0 as a TfNSW Specification. This document superseded TS 01750.1 *Fabrication of Aluminium Structural Members – QA* and TS 01750.2 *Fabrication of Aluminium Structural Members – DC*.

This document sets out the requirements for the fabrication of aluminium components for bridges, gantries, roadside furniture, poles and related structures. This includes the supply of materials, preparation of materials, assembly, welding, testing, inspection, packing, handling and delivery to site.

For the purposes of this document, where TfNSW has identically adopted, or adopted and modified, an ATS document as a Transport Standard, the corresponding Transport Standard should be applied.

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# 1. Scope

- 1.1 This specification sets out the requirements for the fabrication of aluminium components for bridges, gantries, roadside furniture, poles and related structures. This includes the supply of materials, preparation of materials, assembly, welding, testing, inspection, packing, handling and delivery to site. The components may be manufactured from plates and wrought, drawn and/or extruded sections.
- 1.2 The Contractor must ensure that the Fabricator complies with this Specification. The Contractor may be the same entity as the Fabricator.

# 2. Referenced documents

- 2.1 The following documents are referenced in this Specification:

## Australian / New Zealand Standards

AS 1100	Technical drawing (Parts as appropriate)
AS 1101.3	Graphical symbols for general engineering – Welding and non-destructive examination
AS 1231	Aluminium and aluminium alloys – Anodic oxidation coatings
AS 1874	Aluminium and aluminium alloys – Ingots and castings
AS/NZS 1664.1	Aluminium structures – Limit state design
AS/NZS 1665	Welding of aluminium structures
AS/NZS 1734	Aluminium and aluminium alloys – Flat sheet, coiled sheet and plate
AS/NZS 1865	Aluminium and aluminium alloys – Drawn wire, rod, bar and strip
AS/NZS 1866	Aluminium and aluminium alloys – Extruded rod bar, solid and hollow shapes
AS/NZS 1867	Aluminium and aluminium alloys – Drawn tubes
AS 2812	Welding, brazing and cutting of metals - Glossary of terms
AS/NZS ISO 18273	Welding consumables – Wire electrodes, wires and rods for welding of aluminium and aluminium alloys – Classification

## Weld Australia

WTIA TN 02	Successful Welding of Aluminium
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## Transport for NSW standards

TS 00033	Supply of Bolts, Nuts and Washers – (ATS 5420-20, Ed 1.0 MOD)
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### 3. Definitions

3.1 The following definitions apply to this Specification:

<b>Fabricator:</b>	The company undertaking the fabrication of aluminium components in accordance with this Specification.
<b>ITP:</b>	Inspection and Test Plan
<b>PQR:</b>	Procedure Qualification Record
<b>Principal's Registration Scheme</b>	Any scheme for the prequalification, registration or approval of products, manufacturers, suppliers and/or Professional Engineers in operation in the jurisdiction where the steelwork is to be erected
<b>Robot Welder:</b>	The welding process that uses both a robot welding machine and a qualified operator.
<b>WPS:</b>	Welding Procedure Specification

### 4. Quality System Requirements

4.1 The Fabricator must prepare and implement a Quality Plan that includes the documentation in Table 4.1 (where applicable to the fabrication).

**Table 4.1: Quality Plan**

Clause	Description of document
7.1	Procedures for fabrication.
8.1	Details/procedures for welding,
9.1	Procedures for inspection of welds.
12.1	Procedures for transport, handling and storage.

4.2 The Fabricator must submit a program showing the proposed sequence of operations for all members and/or parts, which must be identified by name and mark.

### Prequalification or Registration of Fabricators

4.3 Where a Principal's Registration Scheme is in place for fabricators, the Fabricator must comply with that scheme for aluminium components erected in that jurisdiction. In addition, the Fabricator must be prequalified or registered to the level specified in the tender documents (if any).

HOLD POINT 1	
Process Held	Commencement of fabrication.
Submission Details	The Quality Plan, fabrication program and evidence of prequalification / registration (where applicable) must be provided to the Principal at least 10 working days prior to the commencement of fabrication.

## 5. Shop Drawings

- 5.1 Unless specified otherwise in the Contract documents, the Fabricator is responsible for the preparation of shop detail drawings for the fabrication of all members.
- 5.2 The details shown on the shop detail drawings must be consistent with the Drawings and must comply with the following:
- a. The marking plan must show the location where each component will be installed;
  - b. Shop drawings must conform to AS 1100 as appropriate;
  - c. Welding and cutting definitions must conform to AS 2812;
  - d. Welding symbols must conform to AS 1101.3;
  - e. Complete information regarding the location, type, size and extent of all welds must be clearly shown;
  - f. Full details of weld category and level of quality assurance in accordance with Clause 1.6 and Appendix B of AS/NZS 1665;
  - g. Each member must be clearly identified with the identification marks shown on the Drawings. Each type of component must be further identified to readily distinguish it from all other types; and
  - h. For assemblies, all associated bolting, accessories and/or joining details must be shown on the shop drawings.
- 5.3 The shop detail drawings must:
- a. accurately and completely transfer the information from the construction specification; and
  - b. provide for the development of accurate, detailed dimensional information which allows for the accurate fit-up of components during erection.
- 5.4 Each shop detail drawing must be identified utilizing a numbering system allowing traceability throughout the duration of the work. Revisions must be uniquely identified and dated, with the scope of each revision clearly identified.
- 5.5 Where requests for information (RFIs) are issued as part of the process of producing shop detail documentation, a written record of inquiries and responses must be maintained.
- 5.6 The Contractor must certify that the shop detail drawings comply with the requirements of this Specification.



HOLD POINT 2	
Process Held	Commencement of fabrication.
Submission Details	The shop detail drawings and certification must be submitted to the Principal at least 5 working days prior to the commencement of fabrication.

## 6. Materials

### General

- 6.1 Unless specified otherwise on the Drawings or in the Contract documents, the aluminium must comply with the standards listed in Table 6.1.

**Table 6.1: Applicable Product Standards**

Product	Applicable Standard
Aluminium castings	AS 1874
Structural aluminium sheet and plates:	AS/NZS 1734
Structural aluminium drawn wire, rod, bar and strip	AS/NZS 1865
Structural aluminium extruded rod, bar, solid and hollow shapes	AS/NZS 1866
Structural aluminium drawn tube	AS/NZS 1867

- 6.2 Aluminium which is bent, damaged or corroded must not be used.
- 6.3 All grinding of surface defects must produce a surface roughness similar to the finish on surrounding areas.
- 6.4 Any surface defect areas corrected by grinding must not be located on the outside (visible) surface of outside members.
- 6.5 Weld repairs to materials are not permitted.

### Testing

- 6.6 The Fabricator must submit the following for the aluminium materials used in the fabrication to the Principal:
- a. material test certificates;
  - b. material testing results as appropriate; and
  - c. a location map showing where the material will be used.
- 6.7 The material test certificate must show the full chemical composition and the mechanical properties of the material, including yield, tensile and elongation results.

6.8 If testing is required, the following sampling frequency applies:

- a. a minimum of one test per size and grade, or
- b. 2% of the material of the same size and grade.

6.9 Test reports must be NATA-endorsed.

<b>HOLD POINT 3</b>	
Process Held	Commencement of fabrication.
Submission Details	The material test certificates, and test reports must be submitted to the Principal at least 5 working days prior to the commencement of fabrication.

## Traceability and identification

6.10 The Fabricator must:

- a. establish and maintain a comprehensive system of identification records; and
- b. ensure there is traceability between the material test certificates and the materials (including fasteners) being used in the product.

6.11 If requested, the Fabricator must demonstrate the method of traceability and provide copies of all relevant records to the Principal.

6.12 If traceability cannot be established, the material must be tested by a NATA laboratory accredited for the appropriate testing. The results must show the full chemical composition and the mechanical testing results, including yield, tensile and elongation tests. The sampling rate and number of tests must be in accordance with Clause 6.8.

## Fasteners

6.13 Unless specified otherwise on the Drawings or in the Contract documents, fasteners must comply with TS 00033.

6.14 The risk of galvanic corrosion due to contact between dissimilar materials (such as between aluminium and steel) must be assessed and if necessary, measures taken to prevent to the occurrence of galvanic corrosion.

6.15 The Contractor must provide evidence of compliance with TS 00033 to the Principal prior to the installation of the fasteners.

<b>HOLD POINT 4</b>	
Process Held	Installation of fasteners.
Submission Details	Refer TS 00033.

# 7. Fabrication

## General

- 7.1 At a minimum, the Quality Plan must include:
- a. Procedures for fabrication and erection;
  - b. System for identification of components;
  - c. Assembly procedures, including dimensional control and details of manufacturing jigs;
  - d. Procedures for attachment of anchorages (where applicable);
  - e. Cutting and edge preparation procedures; and
  - f. Procedures for cambering, curving, bending and straightening (if applicable);
- 7.2 All aluminium components must be fabricated in accordance with AS/NZS 1664.1 and AS/NZS 1665

WITNESS POINT 1	
Process Witnessed	Commencement of Fabrication
Notice Period	At least 5 working days prior notice of the commencement of fabrication must be provided to the Principal

## Handling and storage of aluminium components

- 7.3 All aluminium fabrication must be undertaken in a separate building to carbon steel unless approved otherwise by the Principal.
- 7.4 All aluminium, whether fabricated or not, must:
- a. be stored in such a manner so that it is maintained in its original condition;
  - b. be stored in an area which is free from contaminants such as oil, grease or water;
  - c. be stored in a dry area with an allowance for air flow between the sheets to prevent condensation;
  - d. not be bent or damaged during handling and storage; and
  - e. not be stored in contact with steel.
- 7.5 Aluminium material must not be stored in contact with steel. Aluminium must be stored in an area which is free from contaminants such as oil, grease or water and including the potential for condensation.
- 7.6 Tools used to fabricate or assemble aluminium components must be dedicated tools for aluminium work. Tools previously used on steel must not be used for aluminium work.
- 7.7 The marking of aluminium must not be undertaken with a sharp object or a lead pencil.

- 7.8 Before any marking out or other work is done, the Fabricator must make all plates flat and all bars and sections straight and free from twist so that, when assembled, adjacent surfaces will be in close contact throughout. The methods adopted for the above work must be such that the material is not damaged.

## Cutting and edge preparation of aluminium sections

- 7.9 All material must be cut to the required length as outlined by Clause 6.2 of AS/NZS 1664.1 and Clause 5.1.2 of AS/NZS 1665.
- 7.10 Surfaces produced by cutting must be representative of good workmanship, finished square (unless a bevelled edge is called for), true to the required dimensions and free from defects such as excessive roughness, which would impair the service performance or seriously interfere with subsequent fabrication and protective treatment.
- 7.11 Shearing must not be used for main plates, reinforcing plates, main gussets, splice plates, diaphragms, main members and bracing. Any distortions caused by shearing must be removed.
- 7.12 Grinding must not be used on surfaces prepared for welding.
- 7.13 Re-entrant corners must be rounded smoothly to a radius of not less than 3 mm.
- 7.14 Unless shown otherwise on the Drawings, all corners on exposed edges to must be rounded to remove sharp edges, except where such edges must subsequently be welded. Rolled and extruded edges need not be rounded provided that the corners are not sharp.
- 7.15 Plasma-arc cutting must be carried out wherever possible by machines which are mechanically guided and moved at uniform speed. Hand cutting may only be used only for secondary cuts, hole preparation, repairs and other work where machine cutting is not possible.
- 7.16 Any cut surface to be incorporated in a weld must comply with AS/NZS 1665.
- 7.17 Plasma-arc cutting of plates, sections and other components with surfaces which will be used in the "as-cut" condition must be carried out with procedures giving minimum reduction in properties at the cut surface.

## Repairs

- 7.18 Cut surfaces may be planed or ground to obtain the specified surface roughness. Grinding marks must be parallel to the direction of the cut.
- 7.19 Grinding must not be used on surfaces which will be subsequently welded.

## Bending of plate or sheet

- 7.20 Prior to bending, any rough edges must be smoothed by grinding to reduce the chance of the material cracking or splitting.

- 7.21 Bending of plate or sheet must be carried out in a press brake with a round die to produce a straight bend. The surfaces of the die must be clean so that the plate will not be scratched or pick up contaminants.
- 7.22 There must be no distortion in the adjacent flat surfaces as a result of the bending process.

## **Rolling of plate or sheet**

- 7.23 Prior to rolling, any rough edges must be smoothed by grinding to reduce the chance of the material cracking or splitting.
- 7.24 The surfaces of the rollers must be clean so that the plate will not be scratched or pick up contaminants.

## **Holes for bolting**

- 7.25 Unless specified otherwise, the diameters of holes for bolting must be not more than 2 mm larger than the diameters of the bolts shown on the Drawings.
- 7.26 Holes may be either drilled full-size or reamed to full-size after sub-drilling or sub-punching.
- 7.27 The following applies to sub-punched and sub-drilled holes:
- The hole must be smaller in diameter than the nominal diameter of bolts by 3 mm.
  - For sub-punched holes, the diameter of the die must not exceed the diameter of the punch by more than 1 mm and the holes must be clean cut, without torn or ragged edges; and
  - Sub-punched holes must not be used where the diameter of the hole is less than the thickness of the material.
- 7.28 The following applies to sub-punched and sub-drilled holes:
- Reamed or drilled holes must be cylindrical and perpendicular to the face of the member unless shown otherwise on the Drawings.
  - Reaming and drilling must be carried out by mechanical means; and
  - All burrs must be removed and if necessary, assembled parts must be taken apart for removal of burrs caused by drilling and reaming.
- 7.29 The following applies to holes for field connections:
- Holes may be reamed or drilled with the members assembled in the shop in their correct relative position.
  - If the shop assembly procedure is adopted, assemble all adjoining main members in an assembly before reaming or drilling is commenced. All joints and associated splice plates must be matchmarked before the structure is dismantled.

- c. If the shop assembly procedure is not adopted, these connections may be sub-punched or sub-drilled and reamed or drilled from the solid to a hardened steel template not less than 25 mm thick, and all corresponding holes in the members to which they connect must be reamed or drilled to the same template.

7.30 All matching holes in any contiguous group must register with each other so that a gauge or drift 2 mm less in diameter than the holes must pass freely through the assembled contact faces at right angles to them.

## Tolerances

7.31 Unless specified otherwise in the Contract documents, the tolerances in Table 7.31 apply.

**Table 7.31: Fabrication Tolerances**

Application	Tolerance
<b>Bridge traffic barrier and balustrade:</b> AS/NZS 1734 Bridge traffic barrier and balustrade	
Length of rails and balustrade Height of posts $\pm 2$ mm Centre of holes $\pm 2$ mm Finished height of balustrade $\pm 2$ mm Bow in rail and balustrade 1 mm / m	$\pm 2$ mm
Height of posts	$\pm 2$ mm
Centre of holes	$\pm 2$ mm
Finished height of balustrade	$\pm 2$ mm
Bow in rail and balustrade	$\pm 1$ mm / m
Components other than bridge barrier	$\pm 2$ mm

## 8. Welding

### General

- 8.1 At a minimum, the Quality Plan must include:
- inspection and test plans (IPT);
  - qualifications and identification of welders;
  - qualification of welding supervisors and inspectors;
  - system of identification of each welder's work;
  - a copy of the Welding Procedure Specification (WPS);
  - the corresponding Procedure Qualification Record (PQR);

- g. macro test results for the welding staff for each submitted WPS;
- h. procedures and welding sequence for control of distortion;
- i. welding wire batch certificate; and
- j. a draft weld map to show where the WPS will be used.

- 8.2 All macro test reports must be NATA-endorsed.
- 8.3 The WPS must reflect the connection to be welded shown on the Drawings.
- 8.4 All welding must conform to AS/NZS 1665 and the additional requirements in this Clause 8.
- 8.5 All weld spatter must be removed from the surface of the weld and the parent metal. Unless specified otherwise, welding must be Category B.

## Welding consumables

- 8.6 Welding consumables must conform to AS/NZS ISO 18273 for rods or AS/NZS 1865 for continuous wire. Testing of welding consumables must comply with AS/NZS 1665.
- 8.7 Welding consumables must be selected in accordance with Annex ZB of AS/NZS ISO 18273 and must only be used in accordance with the manufacturer's recommendations and AS/NZS 1665.
- 8.8 Welding consumables must be certified, by a recognised authority complying with the requirements of AS/NZS 1665, that the classification and grade of the welding consumables are suitable for welding the aluminium type nominated in the welding procedures.

## Qualification of welding procedures

- 8.9 Each welding procedure must be qualified by way of test pieces and/or assemblies in accordance with AS/NZS 1665.

WITNESS POINT 2	
Process	Welding and testing of each test piece and/ assembly
Notification Period	At least 3 working days before the commencement of welding.

- 8.10 The test and / or Inspection Certificates must be obtained from a laboratory with appropriate NATA registration, with all relevant results shown and a statement that the results comply with AS/NZS 1665. The testing operator must have the relevant AINDT certification for the test carried out.

## Welding Supervisor

- 8.11 Welding must be supervised by a Welding Supervisor who satisfies the requirements of AS/NZS 1665 Clause 4.5.2(a) to (g). If the work is not carried out in Australia, the welding supervisor must satisfy the requirements of AS/NZS 1665 Clause 4.5.2(a).
- 8.12 The nominated welding supervisor must be physically present in the workshop or factory office during all welding processes, including tack welding.

## Welding personnel

- 8.13 All welders must demonstrate their competence by welding a test piece qualified by testing in accordance with AS/NZS 1665 Clause 4.5.3.
- 8.14 Any welder who during fabrication, repeatedly produces non-conforming welds must be required to be re-tested. Failure of the re-test must preclude such welder from further similar welding on the works until the welder develops the required proven ability to produce sound welds.
- 8.15 If specified in the Contract documents, after the initial qualification, all welding personnel must undertake a macro test on a 12-monthly basis. This also applies to robot welders

## Robot welder

- 8.16 All welding undertaken by a robot welder must comply with the qualification requirement (a) of Clause 4.5.3 of AS/NZS 1665.
- 8.17 After initial qualification, the robot welder must undertake a macro test on a 12-monthly basis. The macros must be for each WPS used in the Works.
- 8.18 Individual operators of the robot welder must undertake the qualifications detailed in Clause 8.16.
- 8.19 The Principal reserves the right to withdraw approval of the robot welder if the welding is below the minimum requirements outlined in AS/NZS 1665.

## Butt welding preparation

- 8.20 The Fabricator must ensure that the butt weld preparation has been assembled in accordance with the approved WPS, including bevel angle and root gap. If the joint does not comply with the details on the WPS, the Fabricator must either:
- modify the bevel preparation so the joint complies with the WPS, or
  - develop and test a PQR with the new joint details, then qualify the necessary welding staff to the subsequent WPS in accordance with Clause 8.13.



<b>HOLD POINT 5</b>	
Process Held	Butt welding.
Submission Details	Notification that the butt weld preparation is complete must be provided to the Principal at 3 working days before the commencement of butt welding.

## 9. Completion and Inspection of Welds

### General

- 9.1 The Quality Plan must include:
- a. Procedures and program for weld inspection;
  - b. Methods of reporting results of weld inspection; and
  - c. Procedures for correction of faulty welding.
- 9.2 Inspection of welds must be carried in accordance with the methods nominated in AS/NZS 1665.
- 9.3 Unless specified otherwise in the Contact documents, the Contractor must engage a qualified welding inspector who satisfies the requirements of Clause 7.2 of AS/NZS 1665 to carry out all welding inspection required under this Specification.
- 9.4 The weld inspections, to be covered by test certificates, must be carried out:
- a. when all adjacent welds are completed and are sufficiently cool to ensure that no further defects arise after inspection; and
  - b. prior to the application of any protective coating.
- 9.5 The Principal may arrange for second or third party inspection of the welds. The Fabricator must ensure the welded items are positioned so they can be inspected; that is, stacking of items that restricts visibility of completed welds is not permitted. If the welding is not carried out in Australia, the Contractor bears any additional costs incurred by the Principal when undertaking an inspection that it would not have incurred if the welding was carried out in Australia.
- 9.6 Any suspected welding defects must be tested with a suitable non-destructive test.

<b>HOLD POINT 6</b>	
Process Held	Removal of fabricated component from the workshop and / or application of protective coating.
Submission Details	Notification that the completed welds are (or will be) ready for inspection must be provided to the Principal at 3 working days before the removal of the component from the workshop and / or application of protective coating.

- 9.7 If the welding is not carried out in Australia, Hold Point 6 applies at least 3 working days before the component is packaged for transportation to Australia.

## Nonconforming welds

- 9.8 If a nonconforming weld is detected following inspection, one additional weld (which is represented by the inspected weld) must be tested for every non-conforming weld.
- 9.9 All weld repairs must be re-inspected for conformity.
- 9.10 Repairs must be carried out prior any protective coating being applied.

## Weld maps

- 9.11 Once the welding has been completed, the Fabricator must provide a weld map outlining the welding undertaken in the manufacture of the aluminium components. The weld map must outline, for each connection, the following:
- a. WPS number used;
  - b. welder's initials (or welder ID) and date welded; and
  - c. nominated welding supervisor's initials (or welder ID) and date inspected.
- 9.12 The weld maps must be submitted to the Principal prior to the aluminium product being released for protective coating.
- 9.13 A table or legend must be made available if requested to identify the welder's full name and corresponding initials or welder ID.

<b>HOLD POINT 7</b>	
Process Held	Removal of fabricated component from the workshop and/or application of protective coating.
Submission Details	The weld maps must be provided to the Principal prior to the removal of the component from the workshop and/or application of protective coating.

## 10. Shop Assembly

- 10.1 At the earliest possible stage during fabrication, or as indicated on the Drawings or in the Specification, the Fabricator must shop assemble each different combination of members and panels to check the fit of the components and verify the suitability of the templates used in fabrication.

## 11. Protective Coating

- 11.1 Fabricated aluminium bridge barriers, balustrade and rails must be clear anodised. Other components must be coated in accordance with the details shown on the Drawings.

- 11.2 Unless specified otherwise in the Contract documents, anodising of aluminium components must comply with AS 1231 and the following:
- a. the component is anodised after fabrication;
  - b. repairs to the anodised coating and the use of power-operated sanding tools or grinders is not permitted;
  - c. the anodised film has a minimum thickness of 25 µm (AA 25);
  - d. the properties of the finish comply with AS 1956 and are free of all lumps, spikes and other protrusions;
  - e. ash and dross marks are removed; and
  - f. the colour matches the colour of any sample provided.
- 11.3 If requested by the Principal, at least 20 working days prior to application of the coating, the Contractor must supply at least two samples of each aluminium component.
- 11.4 Any aluminium surface which interacts with a concrete surface must be painted with two coats of surface tolerant epoxy in accordance with manufacturer's requirements. This may include the bottom surface of a post or stanchion base plate.

## **12. Marking, Handling and Transportation**

- 12.1 The Quality Plan must include:
- a. Procedures for transport, handling and storage, and
  - b. Details of the measures to prevent distortion and damage to the aluminium work and its protective coating.
- 12.2 Each part must be marked with durable distinguishing marks, including paint of different colours to distinguish similar parts.
- 12.3 The Fabricator must supply an electronic copy of drawings showing these markings to the Principal when the aluminium work is dispatched.
- 12.4 The packing and methods of support and lifting during handling and transportation of all structural aluminium work must be undertaken in a manner to prevent distortion or damage to the aluminium work and its protective coating.

## 13. Certification

- 13.1 Within 20 working days of the completion of fabrication of the aluminium members, the Contractor must submit the following to the Principal:
- a. the Contractor's certification that each item fabricated conforms to the requirements of the Drawings and the Specification; and
  - b. electronic copies of the work-as-executed shop drawings in a format acceptable to the Principal.

## Appendix A Summary of Hold Points, Witness Points and Records

The following is a summary of the Witness Points/Hold Points that apply to this Specification and the Identified Records that the Contractor must submit to the Principal to demonstrate compliance with this Specification.

Clause	Hold point	Witness point	Identified Records
4.1	Commencement of fabrication		Quality Plan and program of work
5.3	Commencement of fabrication		Shop drawings and certification (where applicable)
6.9	Commencement of fabrication.		The material test certificates and test reports
6.15	Installation of fasteners.		Refer TS 00033
7.1		Commencement of fabrication	
8.20	Butt welding		
9.6	Removal of fabricated component from the workshop and/or application of protective coating		Notification that the completed welds are (or will be) ready for inspection
8.9		Welding qualification	
9.13	Removal of fabricated component from the workshop and / or application of protective coating		Weld maps
13			Contractor's certification and the As-Constructed Drawings