DEPARTMENT *of* INFRASTRUCTURE, ENERGY *and* RESOURCES, TASMANIA

BRIDGEWORKS SPECIFICATION

B20 - FABRICATION OF STEEL BRIDGE GIRDERS April 2003

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B20.1 SCOPE

This Specification sets out the requirements for the supply, fabrication, shop assembly and transport to the site of bridge steelwork including beams, diaphragms, cross frames and associated fittings.

B20.2 REFERENCES

The following Australian Standards are referred to in this Specification.

A.S. 1100 Technical Drawing

A.S. 1101 Graphic symbols for general engineering

A.S. 1111 ISO metric hexagon bolts

AS 1112 ISO metric hexagon nuts

A.S. 1163 Structural steel hollow sections.

A.S. 1252 High strength steel bolts for structural engineering

A.S. 1553 Covered electrodes for welding

A.S. 1554 Structural steel welding

A.S. 1710 Non destructive testing

A.S. 1789 Electro plated coatings - Zinc

A.S. 1790 Electro plated coatings - Cadmium

A.S. 1796 Certification of welders and welding supervisors

A.S. 1858 Electrodes & fluxes for submerged arc welding

A.S. 2812 Welding, brazing & cutting of metals - Glossary of terms

A.S. 3678 Hot rolled structural steel plates, floor plates and slabs,

A.S. 3679 Hot rolled structural steel bars and sections

A.S. 4100 Steel structures

A.S. 4680 Hot dip galvanised zinc coatings

B20.3 MATERIALS

B20.3.1 Specifications

Structural grade steel shall conform to the requirements of AS 3678, Hot Rolled Structural Steel Slabs, Plates and Floor Plates, and AS 3679, Hot Rolled Structural Steel Bars and Sections. The grade of steel shall be as shown on the Drawings.

The dimensions of hot rolled structural steel sections shall conform to the requirements of AS 3679.

Structural steel hollow sections shall conform to the requirements of AS 1163, Structural Steel Hollow Sections.

All steel shall be new and shall be supplied in accordance with the provisions of AS 3678 and AS 3679 with the following additions:

(a) Test certificates are required for all steel.

(b) All steel shall be ultrasonically tested to comply with level 2 of AS 1710. Longitudinal scanning is not required.

(c) Product analysis is required.

However any weld repairs carried out at the steel mills shall be clearly marked with paint and such marks shall be preserved by the merchant, supplier and/or fabricator until fabrication of the part containing the weld repaired steel is complete.

Bolts and associated nuts and washers shall be of Commercial Grade 4.6 to AS 1111 or high strength structural bolts to AS 1252 Grade 8.8. as shown on the Drawings. Hot dip galvanising as required shall be in accordance with AS 4680.

Welding consumables shall be in accordance with AS 1554, Part 1. All girder butt welds shall develop the full strength of girder steel. Low hydrogen procedures shall be used at all flange splices. All electrode types proposed for use shall be detailed in the Contractor's Contract Management Plan.

B20.3.2 Testing of Materials

The Contractor shall retain evidence to show that all materials or parts conform to the tests in accordance with AS 3678 and AS 3679. Such evidence shall be available for audit inspection.

Test certificates shall show the results of mechanical tests and chemical analysis (where applicable) of the material or parts used in the work.

All 'heat numbers', tags, stamps and other means of identifying steel with the test certificates shall be preserved. Any steel that cannot be identified must be retested and passed before it may be used in the work.

The cost of all testing shall be borne by the Contractor.

B20.3.3 Precutting of Steel by Merchants and Suppliers

Any cutting or shaping of steel shapes and sections after the steel has left the steel mill shall be regarded as fabrication work and shall be carried out in accordance with this Specification. Any steel merchant or supplier carrying out such precutting or shaping of steel for use in the bridge shall be deemed to be a Sub-Contractor as defined in the General Conditions of Contract.

B20.3.4 Storage of Materials

All steel, whether fabricated or not, shall be stored above the ground on platforms, skids or other supports and adequately protected against corrosion. Excessively rusted, bent or damaged steel will be rejected.

B20.3.5 Defective Materials

Defects arising from the manufacture of the steel that become evident at any stage of fabrication shall be the subject of a non-conformance report.

The cost of repairs or replacement caused by such defects shall be borne by the Contractor.

B20.3.6 Restrictions on the Use of Weld-Repaired Steel

A piece of steel containing a surface defect which has been repaired by welding, where the weld repair could create the effect of a notch that would be detrimental to a part of the structure subject to significant tensile stress or fatigue, shall be the subject of a non-conformance report.

B20.4 FABRICATION

B20.4.1 Fabrication Program

The fabrication program shall form part of the Contractor's Contract Management Plan. This program shall include the proposed system of identification and erection marks together with complete details of fabrication and welding procedures.

Any departure from the program of approved fabrication and welding procedures as may be found necessary during the progress of the work shall be the subject of a revision to the Contract Management Plan.

The method of fabrication, procedure and sequence of welding shall be consistent with a minimum of distortion and of residual shrinkage stresses in the finished work.

B20.4.2 Shop Drawings

The Contractor shall be responsible for the preparation of shop drawings for all steelwork, including temporary falsework and erection equipment.

All shop drawings shall be submitted in duplicate to the Superintendent for review not less than 21 days prior to the anticipated date of commencement of fabrication. One copy of each drawing will be returned to the Contractor with the Superintendent's comments and/or acceptance in writing within 14 days after such submission. Fabrication shall not commence until receipt of the Superintendent's written acceptance.

The drawings shall show full and complete information regarding the size, location and type of welds and the sequence that shall be employed to minimise construction stresses and distortion. The approved welding procedures shall be fully detailed on the shop drawings and strictly adhered to in production.

Review by the Superintendent shall indicate that the general requirements of the design have been satisfied. Review shall not be taken to infer that the details, dimensions or the correct matching of connections or joints has been checked and this remains the responsibility of the Contractor.

Drawings submitted for review shall be of good standard and any drawing that clearly requires considerable amendment will be returned for alteration, without a review of the corrections that may be required. Following alterations the drawings shall be resubmitted, and shall bear a revision number or letter with all modifications being clearly indicated. Drawings shall be to AS 1100, welding symbols to AS 1101 and welding definitions to AS 2812.

Variations from the shop drawings shall not be made except with the written agreement of the Superintendent.

B20.4.3 Workmanship and Inspection

All workmanship shall be of first class quality with accuracy sufficient to ensure that all parts will fit together properly on erection.

The welding shall be performed to Category SP of AS 1554, Part 1.

The Superintendent shall have full liberty at all reasonable times to enter the Contractor's premises for the purpose of inspecting work. Any work found defective or which is not in accordance with the Drawings and Specification shall be the subject of a non-conformance report and shall be rectified or replaced.

The Contractor shall supply free of charge all labour, tools, scaffolding etc., required in connection with inspection of the work.

B20.4.4 Dimensional Tolerances for Fabrication

Measurements of length shall be checked with a certified steel measuring tape or band. Dimensions of the Drawings are for a temperature of 15^{o}C.

Dimensions of fabricated members shall be within the tolerances shown on Drawings. Where tolerances are not so specified they shall be as follows:

(a) Overall length (See below for continuous girders)

Up to and including 25 m	$\pm$ 5 mm
Additional allowance to be made to the above for each additional 10 m or part thereof	$\pm$ 2 mm

(b) Centre to Centre of any pair of bearings

Up to 50 m	$\pm$ 5 mm
Greater than 51 m	$\pm$ 10 mm

Continuous girders. Due allowance shall be made during fabrication for any changes in dimensions which may result from the erection procedure.

(c) Deviation from specified camber in assembled length

Up to 55 m in length	± 5 mm
Greater than 55 m length	± 10 mm

(d) Girder sweep (variation from straightness)

The sweep of any girder unit shall not exceed 6 mm or 1 mm per 2 m of girder, whichever is the greater, measured between the ends of the girder unit. Sweep shall be even throughout the length of the girder unit. In an assembly, girder units shall be aligned so as to be within 6 mm of the correct plan position. The variation from straightness of compression members, bracing members or struts shall not exceed:

Welded, rolled and hollow section L/1000 or 3 mm

whichever is the greater where L is the length of the finished member.

(e) Centreline Deviations

Maximum allowable deviations between centreline of web and centreline of flange of built-up girders at contact surface -

Within 500 mm of the end of the girder at

splice points	1 mm
At all other points	3 mm

(f) Variation from flatness of webs

In any length of 150 mm 2 mm

In the length between stiffeners or in length

equal to the depth of the girder:

Exterior girders	5 mm
Interior girders	8 mm

Variations from flatness of girder webs shall be determined by measuring offsets from a straight edge whose length is no less than the least dimensions of any panel. The straight edge shall be placed in any position of maximum variation in the web with the ends of the straight edge adjacent to opposite panel boundaries.

(g) Warpage and Tilt

Combined warpage and tilt of the flanges of welded girders shall be determined by measuring the offset of the edges of the flanges from their position as shown on the Drawings. This offset shall not exceed 1/200 of the total width of flange or 3 mm whichever is the greater.

(h) Flatness of Bearing Seats

Out of flatness of seats, base plates or sole plates -

To be set on fresh grout or concrete	5 mm max
To be set on elastomeric bearing pads	2 mm max
To be set on unmachined steel or lead	0.25 mm max
To be set on machined steel surfaces	0.20 mm max

(i) Deviation from Specified Depth

The maximum deviation from specified depths for welded beams and girders measured at the web centreline shall be -

For depths up to 1 m	± 4 mm
For depths over 1 m	± 5 mm

	At splices	± 2 mm
(j)	Widths of Flange Plates	± 2 mm

(k) Twist

The angular rotation of any cross-section relative to an end cross-section shall not exceed 10 mm per metre of depth of girder.

(l) Flatness of Flanges

Deviation from flatness of girder flanges in lengths between stiffeners or in a length equal to the depth of the girder shall not exceed 2 mm for exterior girders or 4 mm for interior girders.

(m) Root Edges and Root Faces

Alignment of root edge faces in butt welded joints	± 2 mm

(n) Stiffeners

Maximum deviation from straightness of edge in contact with web	2 mm
Deviation from flatness	
Bearing and other stiffeners which mate with diaphragms and cross frames	3 mm
All other stiffeners	6 mm
Where the stiffeners are shown as not welded to the top flange the gap shall not exceed	0.75 mm

(o) Shear Connectors

Positions longitudinally or transversely	± 3 mm

B20.4.5 Straightening

All plates shall be flat and rolled bars and shapes straight before marking out or being worked. Straightening shall be done only if the procedure is detailed in the Contractor's Contract Management Plan and by methods that will not damage the material. When assembled, adjacent surfaces shall be in close contact throughout. Sharp kinks and bends will be a cause for rejection.

B20.4.6 Plates and Flats

Plates and flats shall be aligned in such a manner that the main stresses will be in the direction of rolling.

Stripped plates shall be finished square, straight and plane without burrs or imperfections.

Plates shall be marked before cutting so as to be identifiable at all times.

B20.4.7 Cutting and Edge Treatment

Steelwork may be cut by machine cutting, oxy-gas cutting, or carbon arc cutting. Surfaces produced by such cutting shall be finished true and smooth to the required dimensions. Where finish of the cut edges is not satisfactory they shall be ground or machined or repaired at the Contractor's cost.

(i) Machine Cutting, Shearing, Cropping or Sawing

Machines used for shearing, cropping and sawing of plate to final dimensions shall have sharp blades that have been correctly set. Shearing or cropping will not be permitted for main plates, reinforcing plates, main gussets, splice plates, rolled sections and shapes, and not used for steel thicker than 12 mm. Treatment of edges and corners shall be as for oxy-gas cutting.

(ii) Oxy-gas Cutting

Steel may be oxy-gas cut to shape and length, provided a regular surface, free from excessive gouges and striations is obtained by the use of a template-guided machine. The quality of flame cut surfaces shall be equivalent to, or better than, shown as Class Z in AWRA Technical Note 5. Any rejected material shall be replaced by the Contractor at his own cost. Re-entrant corners shall be smoothly rounded to a radius of not less than 20 mm, and all corners and exposed edges shall be rounded to a radius of approximately 3 mm. Flame cutting by hand shall be done only where a suitable procedure is detailed in the Contractor's Contract Management Plan.

(iii) Carbon-Arc Gouging

Carbon-arc gouging may be used in the fabrication of structural steel, for removing defective welding, back gouging of butt welds, and preparing plates for butt and fillet welds.

(iv) Other Steel Cutting Procedures

Other methods of cutting steel may be used only if detailed in the Contractor's Contract Management Plan

(v) Identification of Cut Plates

The suppliers serial number of the parent piece of steel shall be transferred by the Contractor to an inside face lower corner of the plate components and returnable off-cuts during the plate cutting operations. Plate identification shall be stamped with low stress concentration stamps on the inside surfaces of webs and flanges at non-critical points.

(vi) Treatment of Edges

After cutting, the edge of flanges, webs and exposed edges not meeting the requirements of clause (ii) above shall be ground or machined to a smooth even finish.

Steel with occasional striations or gouges which are less than 3 mm in depth may be accepted provided that these defects are removed by grinding. The resulting depression, which shall not exceed 3 mm, shall be tapered out smoothly for a distance of at least 75 mm on both sides of the defect. Any steel having striations or gouges with a depth of 3 mm or greater shall be the subject of a non-conformance report. Nothing in this Clause shall be construed to relieving the Contractor from the tolerances shown elsewhere in this Specification.

Distortion caused by shearing shall be removed by grinding. Sheared or cropped ends of shear connectors need not be ground. Exposed corners shall be machined or ground to radius of approximately 3 mm. Rolled edges need not be ground provided that the corners are rounded and the edges are reasonably square and straight.

B20.4.8 Splices

Splices will normally not be permitted other than at points shown on the Drawings. Should the Contractor desire to splice any members elsewhere, full details of the design and position of the proposed splices shall be included with the shop drawings. Shop splices in the component parts of welded members shall be made before the parts are assembled. Splices shall be free from sharp kinks.

B20.4.9 Web Stiffeners

Bearing stiffeners of girders, stiffeners at cross-frames, and stiffeners at points of concentrated loads shall be milled or ground to bear uniformly against the girder flanges, where they are not welded.

Where intermediate stiffeners are designed to be fitted against flanges and not welded, the fit against the girder flanges shall be sufficiently close to prevent the entry of water after painting.

B20.4.10 Cambering

The Contractor shall include in the Contractor's Contract Management Plan his method for the adjustment to the camber in built-up sections. If hot bending is used, the temperature of steels conforming to AS 3678 & 3679 shall not exceed 650^{o}C. After hot bending, the steel shall be allowed to cool slowly in air to ambient temperature. While cooling, the work shall be protected from draughts or other rapid movement of air. In the measurement of camber allowance shall be made for deflection due to self weight.

B20.5 WELDING

B20.5.1 General

All items of equipment for welding and gas cutting shall be of an appropriate design and of adequate capacity, and shall be maintained in such condition as to enable experienced operators to follow the procedures and satisfy the requirements of the Drawings and this Specification.

Welding shall be carried out by either automatic or manual processes, and Contractors shall detail in their Contract Management Plan which processes they propose to use. Welding processes used may include one or more of the following:

Manual Metal-Arc Welding

Submerged-Arc Welding

Metal Inert Gas (MIG) Welding

Stud Welding

All welding shall comply with AS 1554.

In localities where a total fire ban is imposed, the use of oxy-cutting and welding equipment may not be allowed unless a permit is obtained from the appropriate Authority. Where there is a risk of fire at any time the Contractor shall supply fire extinguishers and knap-sack equipment and clear all combustible material for a radius of 3 metres around the locality of the work.

B20.5.2 Preparation of Material for Welding

Surfaces and edges to be welded shall be smooth, uniform and free from fins, tears, cracks and other defects that would adversely affect the quality or strength of the weld. These surfaces shall also be free from loose scale, slag, rust, grease, moisture or other material that will prevent proper welding. Surfaces within 75 mm of any weld location shall be free from any paint or other material that may prevent proper welding or cause objectionable fumes during welding.

Edges of material thicker than specified in the following list shall be trimmed if, and as, required to produce a satisfactory welding edge.

(i)	Sheared edges of material thicker than	12 mm
(ii)	Rolled edges of plates, other than Universal Mill Plate, thicker than	10 mm
(iii)	Toes of angles or rolled shapes, other than Universal Beam Sections, thicker than	16 mm
(iv)	Universal Mill Plate or edges of flanges of Universal Beam Sections thicker than	25 mm

Preparation of edges shall wherever practicable be done by machine methods.

Machine flame-cut edges shall be substantially as smooth and regular as those produced by edge planing, and shall be left free of slag.

Manual flame-cutting will be permitted only where machine gas cutting is not practicable.

Preparation of edges for butt welding, acceptable thickness transition for butt welded plates, and acceptable weld profiles for fillet and butt welds shall be in accordance with AS 1554.

B20.5.3 Assembly for Welding

The parts to be joined by fillet weld shall be brought into as close contact as practicable. The gap between parts shall not exceed 1 mm. If the gap must be greater than 1mm then the legs of fillet welds shall be increased by the amount of the separation. Joints shall be of a sufficiently close fit to exclude water after painting.

Parts to be joined by butt welds shall be carefully aligned and the misalignment of parts to be joined shall not exceed 10 percent of the thickness of the thinner part joined, or 3 mm whichever is the lesser. In correcting misalignment in such cases, the parts shall not be drawn into a greater slope than 1 in 2.5. Root edges or root faces of butt welds in hollow sections shall not be out of alignment by more than 25 percent of the thickness or 3 mm, whichever is the lesser.

Members to be welded shall be brought into correct alignment and held in position by bolts, clamps, wedges, struts and other suitable devices, or by tack welds, until welding has been completed.

The use of jigs and fixtures, where practicable, is recommended. In the design of holding devices, suitable allowances shall be made for warping and shrinkage.

Tack welds shall be subject to the same quality and procedure (including preheat) requirements as the final welds. Tack welds shall be cleaned of all slag and shall then be fused thoroughly with the final weld. Defective cracked or broken tack welds shall be removed before final welding.

B20.5.4 Control of Distortion and Shrinkage Stresses

In assembling and joining parts of a structure or built up components, and in welding reinforcing parts to members, the welding procedure and sequence shall be such as will minimise distortion and shrinkage. Butt weld splices shall be made by first butt welding flanges followed by butt welding of webs.

The proposed weld procedures including procedures for welding sequence and distortion control shall be detailed in the Contractor's Contract Management Plan. As far as practicable, all welds shall be deposited in a sequence that will balance the heat applied to the assembly while the welding progresses.

The direction of the general progression in welding on a member shall be from points where the parts are relatively fixed in position with respect to each other toward points where they have a greater relative freedom of movement.

Joints which are expected to have the largest shrinkage shall be welded first with as little restraint as possible.

All shop splices in each component part of a built-up member shall be made before such part is welded to other parts of the member.

Manual fillet welds over one metre in length shall be applied by an intermittent or back step sequence. In this case, welding shall proceed generally from the centre towards the outside edges with the welds in each run applied in the opposite direction to the general progression of the weld.

B20.5.5 Weather Conditions

Welding shall not be done when the air temperature is less than 10^{o}C, unless the parts to be welded are preheated to a temperature warm to the hand within a distance of 75 mm from the point of welding, both laterally and in advance of the welding.

Welding shall not be done when the surfaces are moist, during periods of strong winds, or in showery weather unless the work and the welding operators are adequately protected.

Thermal cutting and welding shall not be done when the metal temperatures are lower than zero ^{o}C unless the Contractor can establish adequate quality control of the process. Welding processes requiring an external gas shield shall not be carried out in a draft or wind of a velocity greater than 8 km/h unless the welding area is protected by a shelter such as to prevent the wind from interfering with the welding process.

B20.5.6 Preheating and Inter-run Control

Control of preheating and inter-run temperatures shall be determined in accordance with AS 1554.

B20.5.7 Fillers

The use of fillers is prohibited except as specified on the Drawings.

B20.5.8 Welding Techniques

(i) General

(a) All butt welds in any part of a member shall be inspected in accordance with this specification before that part is welded to any other part. Copies of the Test Certificates shall be available for audit inspection within 7 days of the date of inspection.

(b) The ends of butt joints shall be welded so as to provide the full throat thickness.

Where root runs are inaccessible, as in the case of hollow sections, backing plates at least 3 mm thick and 50 mm wide shall be used.

(c) Arc strikes outside the weld fusion zone in the parent metal shall be ground clean and repaired as necessary.

(ii) Manual Welding

The maximum size of fillet weld that may be made in one pass shall be 8 mm, except that 10 mm fillet welds may be made in the flat (natural-vee) position.

(iii) Submerged-Arc Welding

(a) Root or butt welds may be sealed with a root pass made by a low hydrogen process when such sealing is necessary to prevent burn-through of the initial submerged arc welding pass.

(b) Where practicable, run-on and run-off tabs shall be used for fillet welds as well as for all butt welds.

(iv) Plug and Slot Welds

(a) Plug welds in the downhand position may be made without interruption.

If the arc is broken, the slag shall be allowed to cool and shall be removed completely before restarting the weld. Plug welds made in the vertical position shall be built up in layers, commencing at the lower side of the hole. The slag shall be cleaned from the weld between successive layers. Plug welds made in the overhead position shall be laid down in layers and the slag removed between successive layers.

(b) Slot welds may be made by techniques similar to those specified above for plug welds except that if the length of the slot exceeds three times it diameter, or if the slot extends to the edge of the plate, the weld shall be made in layers.

The slag shall be removed completely between successive layers.

B20.5.9 Appearance and Finish of Welds

Exposed faces of welds shall be made reasonably smooth and regular, shall conform as closely as practicable to specified dimensions and shall not at any place be less than the specified dimensions.

All weld spatter shall be removed from the surfaces of the weld and the parent metal.

B20.5.10 Quality of Welds

The quality of welds shall be in accordance with the requirements of AS 1554.

B20.5.11 Correction of Welds

(i) Following the identification of any defective welds, consideration shall be given to corrective measures. A non-conformance report shall be raised.

All corrections shall be made at the Contractor's cost. Defective welds may be corrected as specified below.

	DEFECT	CORRECTIVE MEASURE
A	Excess convexity	Reduce to specified size by removal of excess weld metal.
B	Craters, excessive porosity, slag inclusions overlapping and lack of fusion.	Remove defective portions and re-weld.
C	Undercut, undersized welds, excessive concavity, removal of adjacent parent metal during welding.	Prepare, clean and deposit additional weld metal.

(ii) A weld which is cracked shall be removed throughout its length, unless by the use of approved inspection methods the extent of the crack can be shown to be limited and not adversely affect the long term performance of the structure. In this case the cracked weld metal, plus a minimum of at least 50 mm of sound weld metal beyond each end of the crack, shall be removed.

(iii) Where work performed after making a defective weld has made the weld inaccessible or has caused new conditions which would make the correction of the deficiency hazardous, detrimental or ineffective, the original conditions shall be restored by removal of welds or members, or both, before making the necessary corrections. Alternatively the deficiency may be remedied by additional work as approved by the Superintendent.

(iv) All corrective welding shall be in accordance with the requirements of this Specification.

(v) Improperly fitted and misaligned parts may be cut apart and rewelded subject to the preparation of a non-conformance report.

(vi) Members distorted by the heat of welding may be straightened by mechanical means or by the carefully supervised application of a limited amount of heat.

B20.6 WELDING EQUIPMENT AND CONSUMABLES

B20.6.1 Arc Welding Equipment and Materials

All welding equipment and consumables shall be as per the requirements of AS 1553, AS 1554 and AS 1858.

B20.7 QUALIFICATIONS OF WELDING OPERATORS

B20.7.1 Safety Precautions

Adequate safety precautions shall be taken during welding operations to protect operators and persons in the vicinity of such operations from electric shocks and the effects of radiations.

Suitable welding screens, preferably fireproof, shall be provided where possible to protect persons working in the immediate vicinity against stray radiation from arc welding. Where the provision of screens is not practicable, care shall be taken that other workmen and the general public are not exposed to harmful radiation and hot metal.

Where non-destructive tests, employing industrial X-ray plant or radioactive isotopes, are used, special precautions shall be observed to ensure that personnel in the vicinity shall not be subject to direct or scattered radiation. The relevant regulations governing the use of X-ray plant and equipment shall be observed.

B20.7.2 Welder Qualification Test

Welding shall be carried out by welding operators who have had suitable training and practical experience in welded construction. Evidence of proper qualification of the welding operator for the work he is required to do shall be submitted to the Superintendent for his inspection before commencing work. If the Superintendent considers the quality of an operator's work is below the required standard or his previous qualification is out of date, he may require the operator to undergo a requalification test, or another operator shall be employed on the work. A welding operator shall hold the following current qualifications:

(a) An 'A; Grade Operator's Certificate for Electric Arc Welding of the Australian Welding Institute,

or

(b) be qualified by all the tests prescribed in AS 1796,

and / or

(c) meet the requirements of AS 1554.

B20.8 STUD CONNECTORS

B20.8.1 General

Stud materials, supply, welding and testing shall be in accordance with AS 1554.2.

B20.8.2 Surface Preparation

The studs shall not be painted or galvanised and shall be free from rust, scale, rust pits and oil at the time of welding.

The surface to which the studs are to be attached shall be cleaned to a surface completely free of all mill scale, rust, dirt, paint, grease, moisture and any other material that might impair the quality of the weld.

B20.8.3 Testing of Welded Studs

A visual inspection will be made to ensure that a sound weld extends for the full circumference of the stud. Discrepancies may be corrected by a manual arc weld of not less than 3 mm all round fillet weld using welding procedures to AS1554-SP.

5% of the installed studs shall be tested apart from those tested as a result of visual inspection. If a stud fails the test, or shows signs of failure, then further studs in the vicinity are to be similarly tested until the faulty stud, or studs, are isolated. Faulty studs shall be replaced.

Within 7 days of the day of testing the Contractor shall submit to the Superintendent a test report containing the following information:

(i) Girder No.

(ii) Number of studs tested.

(iii) Number and location of studs which failed the test.

B20.8.4 Replacing of Studs

When replacing a stud the surface area, after the defective stud has been removed, shall be ground free of any metal from the old weld. Pockets shall be filled with weld metal and ground flush. Replacing of studs shall be at the Contractor's expense.

B20.9 HOLES FOR BOLTING

B20.9.1 General

The diameter of the bolt holes shall be 2 mm greater than the diameters of the bolts shown on the Drawings unless otherwise shown.

Holes may be either drilled full-size or reamed to full-size after sub-drilling or sub-punching. In all cases, sub-drilling may be substituted for sub-punching, and holes may be drilled from the solid metal instead of being sub-punched and reamed, provided such drilling is done with the material assembled in the same manner as is required for reamed work.

B20.9.2 Sub-punched and Sub-drilled Holes

The diameter of the die shall not exceed the diameter of the punch by more than 2 mm.

Holes shall be clean cut, without torn or ragged edges. All sub-punched holes shall be located with an accuracy such that after the steel is assembled and before any reaming is done, a cylindrical pin 3 mm smaller in diameter than the nominal diameter of the punched hole may be inserted perpendicular to the face of the member, without drifting, through at least 75 percent of the adjacent holes in the same plane. If this requirement is not fulfilled, the badly punched pieces will be rejected.

If any hole will not pass a pin 5 mm smaller in diameter than the nominal size of the punched hole, this will be cause for rejection. Drifting to enlarge holes will not be allowed. The Contractor shall be responsible for the accuracy of all holes regardless of variations in dimensions of rolled sections or tolerances allowed in fabrication. The accuracy of sub-drilled holes shall be the same as required for sub-punched holes.

B20.9.3 Reamed or Drilled Holes

Reamed or drilled holes shall be cylindrical and perpendicular to the face of the member. Reaming and drilling shall be done by mechanical means. Connecting parts shall be assembled and held securely while being reamed or drilled and shall be match-marked before separating the parts. Burrs on the outside shall be removed.

All reamed or drilled holes shall be located with an accuracy such that after the holes have been reamed or drilled at least 86 percent of the holes in any adjacent group shall show no offset greater than 1 mm between the mating parts.

B20.9.4 Holes for Field Connections

Holes for field connections and field splices of main members shall be reamed or drilled with the members assembled in the shop in their correct position. Unless prior approval is given in writing by the Superintendent to do otherwise, each main member shall be assembled full length before reaming or drilling is commenced. All joints shall be matchmarked before the structure is dismantled.

Holes for field connections of minor members may be sub-punched or sub-drilled and reamed or drilled from the solid to a hardened steel templates not less than 25 mm thick, and all corresponding holes in the members to which they connect shall be reamed or drilled to the same template. Alternatively, these connections may be reamed or drilled with the members assembled.

B20.9.5 Alignment

All matching holes in any adjacent group shall register with each other so that a gauge or drift 2 mm less in diameter than the holes shall pass freely through the assembled contact faces at right angles to them. The Contractor shall be responsible for the accuracy of all holes regardless of variations in dimensions of rolled sections or tolerances allowed in fabrication.

B20.9.6 Supply of Bolts, Nuts, Screws and Washers

Bolts, nuts, screws and washers shall conform to the relevant Australian Standard Specifications:-

Where the length of bolt is not specified, the length of each bolt shall conform to AS 4100.

Details of tests or re-tests, and the number of specimens tested, shall be in accordance with the provisions for Verification Tests set out in AS 1252.

Copies of the test results shall be available for inspection prior to the bolts being installed.

Unless shown otherwise on the Drawings, bolts, U-bolts, screws, nuts and washers shall be supplied with the following protective treatment:-

High strength bolts and associated nuts and washers	Hot dip galvanised in accordance with AS 4680
Commercial bolts, U-bolts and associated nuts and washers	Hot dip galvanised in accordance with AS 4680
Precision bolts and associated nuts and washers	Electroplated in conformity with AS 1790, or in sizes over M16, AS 1789 - Classification Zn 30.

B20.10 INSPECTION AND CORRECTION OF DEFECTS

B20.10.1 General

All material and workmanship shall be subject to inspection by the Superintendent, or his representative, during and after fabrication. To enable the Superintendent to arrange inspection, the Contractor shall give seven days notice in writing before beginning work in the shop and no work shall be done before such period has elapsed. The Superintendent shall have full liberty at all reasonable times to enter the Contractor's shop for the purpose of inspecting work.

B20.10.2 Measurement of Girder Dimensions and Camber

Girder dimensions and camber shall not be finally checked until all welding and heating operations are completed and the member has cooled to a uniform ambient temperature.

B20.10.3 Inspection of Welds

Inspection of welds will be carried out in accordance with AS 1554.

Methods of inspection which shall be used include the following:

Visual inspection, including the use of penetrant dyes, acid etching and photography - 100% of total length of welds.

Radiographic inspection.

Ultrasonic inspection.

No work shall be despatched from the shop until it has been inspected and copies of the test results have been submitted to the Superintendent.

B20.10.4 Radiographic or Ultrasonic Inspection

All non-destructive testing shall be carried out in accordance with the relevant Australian Standard by a NATA approved body.

Ultrasonic inspection will not be permitted for welds in cross sections less than 20mm thick.

Unless shown otherwise in the Drawings the minimum extent of non-destructive inspection that shall be undertaken is as shown in the following table.

LOCATION OF WELD	MINIMUM LENGTH OF WELD TO BE EXAMINED (Percentage of Total Length)
Tension flange splices	100%
Compression flange splices	25%
Web splices	25%
Tee-butt welded joints between girder flanges and webs	5%
Field girder splices	100%

Where less than 100 percent of a weld type is inspected those portions of welds to be subject to non-destructive inspection will be selected at random except for web splices where the sections adjacent to the top and bottom flanges shall be included.

Where weld defects exceed the limits specified the weld will be rejected and corrective measures shall be undertaken. Should a radiograph indicate rejectable linear defects, further checking of the weld adjacent to the defect shall be carried out, either by radiographic, ultrasonic or other approved means. If the defect is found to continue, the full length of the affected weld shall be considered defective and shall be removed and repaired by an approved procedure.

B20.10.5 Cost of Testing

All costs associated with inspection and corrective measures shall be borne by the Contractor.

B20.10.6 Correction of Distortion

(i) Distortion resulting from welding and fabrication may be corrected by mechanical or thermal means with the procedures adopted recorded in the job records.

(ii) When flame heating methods are applied the following restrictions shall apply:

(a) the temperature of steels conforming to AS 3679 shall not exceed 650^{o}C;

(b) artificial cooling shall not be used.

(iii) Improperly fitted parts may be cut apart and rewelded only after the preparation of a non-conformance report.

B20.11 END PREPARATION OF GIRDER SEGMENTS

Where field joints are required the ends of all girder units shall be finished true, as shown on the Drawings, to a tolerance of $\pm$ 2 mm over the depth and width of the girder.

B20.12 SHOP ASSEMBLY

Shop assembly will not be required for girders for simply supported girder spans less than 25 m in length. For spans 25 m or greater in length with the steel cross girders or cross frames, the first span fabrication shall be shop assembled to check the fit of the components and verify the suitability of the templates used in fabrication.

All steelwork that is to be connected in the field shall be shop assembled for inspection, except that, where cross frames are connected to the girders by welding, shop assembly of the cross frames will not be required.

Where bolted connections are to be made the holes shall be reamed or drilled while the parts are assembled.

Shop assembled steel structures shall not be dismantled until inspected by the Superintendent.

Notwithstanding the inspection of girders or girder segments after fabrication, errors in the alignment of girders in the field shall be rectified at the Contractor's expense.

B20.13 DEFECTIVE WORKMANSHIP

The Contractor shall be fully responsible for the fabrication of the steelwork in strict accordance with this Specification. Inspection of any completed work or methods by the Superintendent shall not relieve the Contractor of this responsibility. Work that has not been completed in accordance with this Specification shall be removed within the limits assigned by the Superintendent. The acceptance of any material or finished members by the Superintendent shall not prevent their subsequent rejection if found defective.

B20.14 TRANSPORT AND DELIVERY

Each member shall be marked for identification and an erection diagram shall be furnished with the erection marks shown thereon. The proposed system of marking and positions of marks shall be included in a variation to the Contractor's Contract Management Plan.

All prepared field splices in members shall be protected from damage in transit. All loose angles or gusset plates shall be packed in convenient bundles and temporarily bolted or bound together with heavy gauge wire. All small articles, such as bolts, shall be packed in secure containers adequately labelled, with the details and quantity of the contents clearly stated.

Structural members shall be loaded onto such transport and in such a manner that they may be transported and unloaded at their destination without being deformed, excessively stressed or otherwise damaged. All packing and bracing required for satisfactory transport shall be provided by the Contractor.

Any loss or damage occurring up to the time of final acceptance of the work covered by this contract shall be the responsibility of the Contractor.

The Contractor shall provide suitable access to the fabrication works for loading the steelwork. Long girders shall be loaded onto transport so that they can be placed in their positions to minimise turning or manoeuvring.

The Contractor shall be responsible for all special precautions and safety measures, including permits, police escorts etc., necessary for delivery of the steel work.

Any additional expense arising from the inadequate provision of access or from delays in loading shall be borne by the Contractor.

The Superintendent may reject any steelwork that has become damaged during handling, transit or erection. The Superintendent may direct the Contractor to make good, or replace damaged or rejected steelwork, and also direct the Contractor to remove rejected steelwork from the site, all at the Contractor's expense.

B20.15 PAYMENT

The rates in the Bill of Quantities relating to the main steelwork of the superstructure shall include full payment for providing all labour, materials, tools, equipment and any other work incidental to the fabrication of the steelwork superstructure.

The mass of Steelwork used in the calculation of quantities for payment is the net mass calculated from the finished dimensions shown on the Drawings on the basis of 7.85 t/m^3 with the exception that the mass of rolled sections has been computed on the basis of the nominal mass shown in the appropriate Australian Standard. No allowance has been made for the mass of any welds or surface coatings.

Payment for Items in the Bill of Quantities relating to the fabrication of steelwork will not exceed 60% of the scheduled item until all components are delivered to the site.

B20.16 HOLDPOINTS

The following holdpoints have been identified in this Specification:

- Acceptance of shop drawings by the Superintendent (B20.4.2)
- Notice of start of fabrication (B20.10.1)
- Test certificates to Superintendent prior to removal of fabricated steel to site (B20.10.3)
- Inspection of shop assembled elements prior to disassembly (B20.12)

B20.17 INFORMATION TO BE INCLUDED IN CONTRACT MANAGEMENT PLAN

The following information to be included in the Contract Management Plan has been identified in this Specification:

- Steel test certificates (B20.3.1)
- Welding electrode types (B20.3.1)
- Fabrication programme (B20.4.1)
- Steel tape certification details (B20.4.4)
- Welder qualifications (B20.4.3, 20.5, 20.7.2)
- Procedure for straightening steel (B20.4.5)
- Procedure for hand flame cutting (B20.4.7)
- Procedure for cutting steel by other methods (B20.4.7)
- Procedure for camber adjustment (B20.4.10)
- Procedure for welding and distortion control (B20.5)
- Procedure for identification, marking, lifting, transport, storage and erection of steelwork (B20.14)