

**SECTION 13 - STEEL LINERS AND STEEL
CONDUIT PIPES**

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S13.01 REQUIREMENTS

(1) General

The Contractor shall fabricate, deliver and install steel liners, and steel conduit pipes at the locations shown on the Drawings or directed.

(2) Work to be carried out

The Contractor shall:

- (a) Supply all necessary materials.
- (b) Develop and test suitable weld procedures.
- (c) Prepare all workshop drawings necessary for fabrication and installation of steel liners and steel conduit pipes.
- (d) Fabricate steel liners and steel conduit pipes as shown on the Drawings, including the inspection and repair at the place of manufacture.
- (e) Furnish and install bracing and supports to prevent damage or distortion to steel liners and steel conduit pipes during manufacture, transport, storage and installation.
- (f) Deliver steel liners and steel conduit pipes to the site of the Works.
- (g) Supply and apply corrosion protection coatings to the internal and external surfaces of steel liners and steel conduit pipes.
- (h) Install steel liners and steel conduit pipes in the location and to the lines and grades shown on the Drawings.
- (i) Carry out non-destructive inspection of welds.
- (j) Complete the application of internal and external protective coating.
- (k) Inspect and repair all defects in the welds or coating and any damage to the coating.

(3) Submission to the Engineer

- (a) The Contractor shall submit one transparency and two prints of the working drawings to the Engineer at least ninety (90) calendar days prior to performing any fabrication or installation required for the work. The

Contractor shall certify that these drawings have been checked before submission.

- (b) Submission of the working drawings will not waive or modify this Specification, nor will it relieve the Contractor of any part of his responsibility under the Contract or for the correctness of all his drawings.
- (c) The Engineer may require the Contractor to make changes to the Contractor's drawings necessary to ensure that the Works conform to the requirements of the Contract and the Contractor shall make such alterations when directed.

(4) Terms Used

- (a) The terms "upstream" and "downstream" are considered, for the purpose of this Specification, to correspond with the direction of flow in the steel pipe.
- (b) The term "components" includes all flanges, rings, backing strips and other parts of the steel liners and pressure pipeline required to complete the Works as shown on the Drawings.

(5) As-executed Drawing

Prior to the completion of the Contract, the Contractor shall forward to the Engineer one transparency of all his drawings showing "As Executed" work.

S13.02 MATERIALS

(1) Steel Plate

- (a) Steel plate for steel liners, steel conduit pipes and welded attachments shall comply with JIS G3101 SS 55, ASTM 537 or equivalent.
- (b) In accordance with ASTM A6, the following information forms part of the Specification:
 - (i) Purchaser steel works inspection is required.
 - (ii) Test certificates are required and the Contractor shall make copies available to the Engineer before steel covered by the Certificates is accepted.
 - (iii) Heat analysis is required in accordance with Clause 3 of ASTM A6.
 - (iv) Product analysis is required in accordance with Clause 4 of ASTM A6.

- (v) Test reports are required in accordance with Clause 14 of ASTM A6.
 - (vi) The material shall be impact tests carried out at a temperature of 0°C in accordance with ASTM E23, shall give an energy not less than 27 Nm.
 - (c) The Contractor shall transport steel plate to his place of manufacture and shall stockpile it in an acceptable manner. Plates shall be marked with paint to maintain their identity and shall have the heat number recorded.
 - (d) The Contractor shall submit copies of his steel orders and the steelworks test certificates to the Engineer for information within seven (7) days of receipt of steel at his manufacturing site.
 - (e) All materials stored prior to fabrication and all fabricated items stored prior to application of corrosion protection or transport shall be supported above the ground in a manner which will not cause damage, distortion or high stresses, shall be prevented from rusting and shall be kept free from dirt, grease, oil and other foreign matter.
- (2) Welding Electrodes, Fluxes and Wires
- (a) All welding consumables used for the Works shall be of the highest quality and shall be capable, with the welding processes and procedures used for the Works, of producing weldments to the requirements of this Specification.
 - (b)
 - (i) Submerged arc consumables shall comply with AWS A5.17 Grade F80.
 - (ii) Gas shielded or self-shielded consumables shall comply with AWSA5.20.
 - (iii) Manual metal arc electrodes shall be low hydrogen electrodes complying with AWS 5.1.
 - (c) The characteristics of welding electrodes shall be superior to the base metal in ultimate tensile strength, yield point, and elongation.
 - (d)
 - (i) Welding consumables supplied for the Works shall be equal in all respects to those used for the weld procedure tests and shall be certified to this effect by the material manufacturers.
 - (ii) The Contractor shall supply to the Engineer the manufacturer's certificates certifying that each batch of electrodes and each batch of flux complies with the specification listed in the developed welding procedure, before they are used in production.

- (iii) The Contractor shall supply to the Engineer the manufacturer's certificates certifying that each batch of welding wire complies with the specification listed in the developed welding procedure. The certificates shall list the check chemical analyses of the wire.
- (iv) The Contractor shall weld a production test plate to confirm that new batches of consumables provide welds with mechanical properties and soundness in accordance with this Specification and shall submit to the Engineer the results of the tests at least one (1) week before use of the new batch of consumables in production.
- (e) (i) All electrodes shall be baked at a temperature as recommended by the electrode manufacturer but not less than 250°C for 4 hours prior to use. After baking, electrodes shall be stored in an oven at a temperature of at least 100°C and shall be withdrawn singly from this oven and if not used immediately shall be rebaked or rejected, as determined by the Engineer.
- (ii) Flux for submerged arc welding shall be dried and stored as recommended by the manufacturer. Storage of flux overnight in supply lines and hoppers of welding machines will not be permitted. The flux shall be clean and dry at all times. Re-use of fused flux will not be permitted. Mixing of fluxes or batches of fluxes will not be permitted.
- (iii) Wire for submerged arc welding shall be clean and dry to the satisfaction of the Engineer.

(3) Miscellaneous Materials

- (a) Bolts, nuts and washers shall comply with ASTM A325 Type 1.
- (b) Materials for internal and external corrosion protection shall be subject to approval and shall be sampled and tested in accordance with Section 20.

S13.03 GENERAL REQUIREMENTS FOR MANUFACTURE

(1) Supervision

- (a) The Contractor shall ensure that all Work is carried out under the direction of qualified and experienced engineering personnel and is supervised by persons whose training and experience in the construction of large welded plate steel structures is acceptable to the Engineer.
- (b) The Contractor shall employ or retain a qualified metallurgist or welding engineer, who is acceptable to the Engineer, and who shall be available to advise on problems associated with materials and welding.

(2) Quality Control

- (a) The Contractor shall be responsible for quality control, supervision and testing during manufacture and installation and shall ensure that all checking of materials, dimensions, tolerances and all inspection of fabrication, welding and transport is carried out. As part of the quality control supervision, the Contractor shall make regular checks of the operation of all cutting and welding equipment and instruments, of the fit-up, pre-heat and interpass heat actually achieved, and of the compliance of welding operators with the details of automatic and manual welding procedure.
- (b) The Contractor shall maintain quality control records of his operations and these shall be available for inspection by the Engineer. The Contractor shall nominate a quality control supervisor to liaise with the Engineer on matters of quality.
- (c) If any part of the manufacture is not in accordance with the detailed workshop drawings or this Specification, the Contractor shall immediately advise the Engineer of the deficiency and the proposed method of rectification. The Engineer shall determine whether rectification is required and the extent and method of rectification. The Contractor shall effect the rectification to the satisfaction of the Engineer.

(3) Inspection

- (a) The Contractor shall ensure that all welding or inspection of fabrication work which forms part of or is attached to steel liners and steel conduit pipes is carried out by personnel individually qualified for the work they perform.
- (b) The Contractor shall maintain a current list of qualified personnel employed on the Works which shall be available at all times to the Engineer.

S13.04 PLATE PREPARATION

(1) General

- (a) All plates shall be accurately prepared and trimmed so that the specified tolerances of fit-up at welded joints and of all fabrication are obtained.
- (b) Cutting and trimming of plates shall be performed by machining or machine flame cutting.
- (c) Hand flame cutting shall be limited to those locations where machining or machine flame cutting are not practicable.

- (d) (i) The finish of edge surfaces which will not form part of a welded joint shall equal Class 2 as defined in Australian Welding Research Association (AWRA) Technical Note No. 5, Flame cutting of Steels, 1975.
- (ii) The finish of edge surfaces which form part of a welded joint shall equal Class 3 as defined in the abovementioned Note.
- (e) All notches whether rounded or sharp, shall be removed from flame cut surfaces by grinding to merge smoothly with adjacent plate surfaces. All burnt metal, slag and scale shall be removed by grinding except that removal by grit blasting will be permitted provided the specified finish is obtained. Slight discoloration of machine flame cut surfaces will be accepted. Repair of flame cut surfaces by welding shall be subject to prior approval.
- (f) (i) All burring of edges shall be removed. All exposed edges shall be rounded or chamfered.
- (ii) The edge surfaces shall not contain flaws, cracks, laminations, slag inclusions or other defects.
- (g) All lugs, brackets, and reinforcements around openings and other members shall conform to the shape of the surface to which they are attached. This shall be accomplished by machining, grinding, gas cutting and grinding, or by pressing the attachment, but not by hammering.
- (h) Rings shall be fabricated into not more than two segments prior to attachment to the pipe shell. The inside surfaces of the ring halves shall be machined or ground to fit the pipe shell to which they will be attached. The final preparation of the closing butt joints for the rings shall be performed after matching the inside surfaces with the pipe shell.

(2) Tapers

Where a butt weld is required between plates of different thickness, the thicker plate shall be trimmed to a smooth taper for a distance not less than four times the offset, including the width of the weld, or as shown on the Drawings.

S13.05 FABRICATION TOLERANCES

(1) Tolerance on Weld Preparations for Butt Joints

- (a) Weld preparations whose cross-sectional dimensions vary from those shown on the workshop drawings by more than the following tolerances shall be corrected before welding:

Size of root face	+/-1.5 mm
Location of root face	+/-2.0 mm
Root gap	+/-1.5 mm
Groove angle	+10.0, -5.0 degree
Radius of J and U grooves	+3.0, -0.0 mm

- (b) (i) If the gap exceeds 1.5 mm but is less than 5 mm the size of the fillet weld will be increased by the amount of the gap.
- (ii) Gaps greater than 5 mm will be corrected by machining the ring.
- (c) The maximum separation between the surfaces of butt welded material and permanent backing material shall not exceed 1.5 mm.
- (d) The maximum offset between abutting external surfaces at any position along a butt joint shall not exceed 2 mm for longitudinal joints and 3 mm for circumferential joints.

(2) Match-marks

- (a) The fabricated parts shall be adequately match-marked as shown on the Drawings. Each part shall be identified with a number and a mark indicating the direction of flow and its top and bottom vertical centerline. The location of the plane of the bend shall be marked on all miter sections as well as the top and bottom match points. The marked vertical plane through the centerlines of all components and the marked planes of bends shall be within 3 mm of the true position of the plane.
- (b) Marking shall be performed with paint wherever practicable. Punch or die marks, if essential, shall be light so as to not damage the plate and shall not be located on or immediately adjacent to edge preparations. Marking may be performed during or after fabrication and shall be completed before delivery from the factory.

S13.06 WELDED ATTACHMENTS

(1) Definition of Attachments

- (a) Permanent attachments are defined as those which are essential for the operation or maintenance of the steel liners and steel conduit pipes. Permanent attachments shall be as shown on the Drawings.
- (b) Temporary attachments are those attachments required for erection, handling and joint alignments. The Contractor shall show all required temporary attachments on his workshop drawings before submitting these drawings to the Engineer. Temporary attachments shall be welded to the steel pipes in the workshop.

- (2) (a) Welding of all attachments shall be done in accordance with the developed welding procedures. Temporary attachments shall not be welded all round in connecting them to the pipe shell.
- (b) All temporary attachments required for erection shall be cut off and ground flush as soon as they have fulfilled their function. Flush shall mean level with the adjacent plate surface within a tolerance of ± 1 mm, this tolerance to be achieved by a smooth transition with a maximum angular deflection not exceeding 10 degree between tangents to the cross-section at adjacent points.

S13.07 WELDING

(1) General

- (a) All welding including tack welds and welds for temporary attachments shall be carried out strictly in accordance with the developed welding procedures. All welders and welding machine operators shall be individually qualified. The Technician of the Contractor shall be certified from the CWI.

(2) Welding Equipment and Procedures

- (a) The welding process, welding consumables, weld procedure and weld preparation shall be selected by the Contractor subject to the requirements that the weldment performance is in accordance with this Specification.
- (b) All welding shall be performed by the electric arc method and automatic welding equipment shall be used wherever practicable.

(3) Cleaning

All surfaces to be welded and the adjacent plate surfaces shall be thoroughly cleaned of scale, rust, oil or other foreign matter down to a clean surface for a distance of at least 15 mm from the welding edge. Each run of weld metal shall be thoroughly cleaned and all slag removed before the next run is deposited.

(4) Tack Welds

Items to be welded shall be assembled and retained in position for welding by any suitable methods. Tack welds, where used, shall be laid in accordance with the developed weld procedures. Where tack welds are not removed and form part of the completed weld, then the specified test welds required shall include tack welds as proposed for production. Provided the test weld meets the requirements of this Specification, the tack welds will be permitted to remain in the weldment.

(5) Correction of Fit-up

Correction of major irregularities in fit-up shall not be carried out by hammering but minor adjustments are permissible provided care is taken to avoid damaging the plate.

(6) Root Gap

Where a root gap is specified the edges of butt welds shall be held so that the correct gap is maintained within permitted tolerances during welding.

(7) Preheating

- (a) When preheating is part of the weld procedure, it shall be performed before and during tack welding and shall be maintained as a minimum temperature during welding.
- (b) Pre-heating of joints shall be carried out using fixed gas burners or electric blankets wherever possible.
- (c) The Contractor shall provide any temperature indicators necessary to satisfy the Engineer that minimum pre-heat is being maintained over a width of six times the plate thickness.
- (d) The necessity for pre-heat and control of interpass temperature will be nominated by the Contractor with the weld procedures on the basis of the run size, joint thickness, steel composition and type, the welding process and the type of electrode. Notwithstanding satisfactory results in weld procedure tests, the Engineer may direct, for some welds, a higher pre-heat to compensate for lack of accurate fit-up, for variations in plate composition and for additional restraint.

(8) Sequence of Welding

- (a) The sequence of welding and tack welding shall be selected by the Contractor to reduce distortion and minimize shrinkage stresses and shall be marked on the Contractor's drawings before submission.
- (b) In general, all welds shall be deposited in a sequence that balances the applied heat of welding on various sides as much as possible 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 towards points where they have a greater relative freedom of movement, and points expected to have lesser shrinkage and with as little restraint as possible. After commencement of the welding of any restrained joint, welding shall be continued to completion or to a point that will ensure freedom from cracking before the joint is allowed to cool below the minimum pre-heat and interpass temperature.

(9) Welding Practice

- (a) Butt welds shall be welded from both sides of the plate, except where a permanent backing strip is used.
- (b) The metal at the bottom of the first side welded shall be removed so as to provide clean sound metal on which to deposit the subsequent welds. When arc-air gouging is used, the gouging head shall be mechanically driven. Any welder or welding machine operator to be used for manual back gouging of welds shall demonstrate his gouging ability to the Engineer by completing the appropriate gouging test from BS 4820 or directed by the Engineer. Demonstrations shall be carried out at the Contractor's expense.
- (c) The welding procedure for a butt weld welded from one side of the plate against a backing strip shall provide complete fusion. Special care shall be taken to ensure that the root is properly fixed and that distortion due to contraction of the weld metal is minimized.
- (d) Welding shall, wherever practicable, be carried out in the down hand position.
- (e) After welding has been stopped for any reason, care shall be taken in restarting to ensure proper fusion and penetration between the plates, the weld metal and the previously deposited weld metal, which shall be thoroughly clean and free from slag.
- (f) Where applicable, run-on and run-off plates shall be provided for butt welds.
- (g) Suitable allowances shall be made for distortion and shrinkage.
- (h) Fillet welds shall be made so as to ensure proper fusion and penetration of the weld metal at the root of the fillet.
- (i) Plates which will form part of a T-weld shall be ultrasonically checked for laminations before welding.
- (j) The arc shall be struck only on those parts of parent metal or of the weld metal where metal is to be applied. Accidental arc strikes on surfaces where weld metal is not to be applied shall be repaired as directed.

(10) Surface Imperfections

Unacceptable surface imperfections in the pipe shell shall be removed by grinding, provided that the ground surface merges smoothly with the plate surface and that the final plate thickness meets the requirements of ASTM A6 Table 1. Larger imperfections shall not be repaired without prior approval.

(11) Weld Finish

- (a) (i) Butt welds which have a smooth even weld crown not exceeding 2.5 mm in height will not require grinding of the weld crown.
- (ii) Local areas of the weld shall be smoothed by grinding to eliminate excess crown height or uneven weld profile if the surface is not suitable for non-destructive inspection and application of corrosion protection.
- (iii) In the case of misaligned plates the height of the weld crown shall be measured from the lower surface of the plates welded.
- (b) Fillet or T-welds with a smooth even profile will not require grinding. Local grinding of areas of uneven profile shall be carried out by the Contractor as directed.

S13.08 WELDING PROCEDURES

(1) Submission of Procedures

- (a) The Contractor shall develop the welding procedures for the Works for all welded joints in or attached to the steel liners and steel conduit pipelines. The developed procedures shall be described in detail in a written submission of all welding procedures which shall be submitted at least ninety (90) days before initial welding on any permanent steelwork. The Engineer may require the Contractor to carry out additional development work or provide additional details of welding procedures, if the submitted information is incomplete or the development work does not define the working limits of the procedure.
- (b) At least the following information shall be provided for all welding procedures:
 - (i) Welding process (e.g. manual metal arc welding, automatic submerged arc welding, etc).
 - (ii) Material specification and the range of thickness to which the procedure specification applies.
 - (iii) Joint design (angle of bevel and size of root face, root opening, backing strips or bars if used, etc) and tolerance limits on fit-up.
 - (iv) The makes and brands of electrodes and fluxes, and the nominal composition of filler metal and shielding gases.
 - (v) Conditioning procedure for manual metal arc electrodes and submerged arc flux.

- (vi) Size and type of electrodes, approximate number of runs, size of electrodes used for each run, sequence of runs and arc energy limits for each run.
- (vii) Electrical characteristics (current and polarity, and the range of voltage, current and welding speed).
- (viii) Welding position.
- (ix) Pre-welding and post-welding heat treatment (method of heating, temperature range and methods of control).

(2) Weld Procedure Test Plates

- (a) The Contractor shall weld in the presence of the Engineer the weld procedure test plates nominated in this Clause. The test plates shall be of identical material to the plate used for manufacture of the steel liners and steel conduit pipelines and shall be set with the worst fit-up conditions permitted by the Contractor's welding procedures.
- (b) The test plates shall be subjected to the pre-heat and post-heat treatments specified in the welding procedures.
- (c) The test plates shall be visually inspected and radio graphically examined over the full length and butt welds shall be submitted to mechanical testing only if the extent of rectification required from any cause is less than 5 percent of the length. Test plates which require repair to more than 5 percent of the length shall be rejected.
- (d) The test plates shall be sectioned for mechanical tests without regard to the location of known discontinuities in the weld.
- (e) Test plates for butt welds shall be 900 mm long with the weld centrally located in a strip 450 mm wide. The test plates shall be subject to the same restraints as will apply to production welds and test plates which are excessively distorted after welding will be rejected.
- (f) Test plates for fillet welds shall be 1 m long.
- (g) Test plates shall be identified by steel stamps with details of the test procedure number and the welding procedure, to the satisfaction of the Engineer.

(3) Test Plates for Steel Liners and Steel Conduit Pipelines

The Contractor shall weld at least the following test plates for steel liners and steel conduit pipelines:

- (a) Longitudinal automatic double-sided butt weld, 16 mm plate thickness, in the down hand position.
 - (b) Circumferential automatic double-sided butt welds, 16 mm plate thickness, in the down hand position.
 - (c) Circumferential, semi-automatic or manual, double-sided butt welds, 16 mm plate thickness, consisting of three plates in down hand, overhead and vertical position.
 - (d) Circumferential, semi-automatic or manual, single-sided butt weld against backing strip, 16 mm plate thickness, consisting of three plates in down hand, overhead and vertical position.
 - (e) Circumferential fillet weld for backing strip and seep ring consisting of one plate 50 percent down hand and 50 percent vertical position.
 - (f) Manual weld repair for longitudinal and circumferential butt welds.
- (4) Mechanical Tests on Weld Procedure Test Plates
- (a) Mechanical tests on weld procedure test plates shall be made in accordance with Article II Section IX of the ASME Boiler Code or directed by the Engineer.
 - (b) The following test specimens shall be prepared from each double-sided butt weld test plate:
 - (i) Macro sections for soundness examination and hardness traverse, two off. No portion of the weld or heat affected zone shall show a hardness greater than 300 HV 10.
 - (ii) Side bends tests over a former radius of three times the specimen thickness, two off. Metal separation shall not occur.
 - (iii) Transverse joint tensile specimens - two off. Both shall achieve an ultimate tensile strength not less than the ultimate tensile strength of the parent plate.
 - (c) Mechanical tests for single-sided butt welds against a backing strip shall consist of macro sections and transverse joint tensile test in accordance with paragraph b. above. Two specimens are required for each test plate.
 - (d) On the completion of the test, no crack or other defect at the outer surface of the test piece shall have a dimension greater than 1.5 mm measured across the test piece or 3 mm measured along the length of the test piece. Premature failure at the corners of the test piece shall not be considered cause for rejection.

- (e) Mechanical test on the weld procedure test plate for manual weld repairs are not required.

(5) Responsibility for Testing

The Contractor shall be responsible for carrying out all mechanical tests on procedure test weld plates and shall retain for this purpose an approved laboratory.

S13.09 PRODUCTION WELDING TESTS

(1) General

- (a) During fabrication and installation, the Contractor shall, when directed, carry out production tests on welded joints in accordance with the developed weld procedure to:
 - (i) monitor the soundness and properties of welds on a routine basis
 - (ii) verify that the standard set from the welding procedure test is being maintained, and shall be carried out when directed
 - (iii) confirm that new batches of welding consumables produce welds with mechanical properties and soundness in accordance with the Specification.
- (b) The test welds may be run-on or run-off tabs or separate test plates which simulate as closely as practicable the production weld being checked. Production test plates shall be of sufficient size to accommodate the test specimens listed in Clause S13.08 (4). All production test plates shall be welded in the presence of the Engineer.

(2) Frequency of Testing

- (a) Production test weld plates shall be welded at approximately the following frequency:
 - (i) one test weld per 100 m of longitudinal welds in pipe shells welded by automatic processes
 - (ii) one test weld per 300 m of circumferential welds in pipe shells welded by automatic processes
 - (iii) one test weld per 100 m of butt welds welded by manual or semi-automatic processes.
- (b) Installation test weld plates shall be welded at a frequency of one test weld per five circumferential welds.

- (c) In general the frequency shall be greater than average at the commencement of each welding procedure and shall be arranged to test new supplies of consumables, electrodes, welding wire and flux, as their use is commenced in production welding.

(3) Radiographic and Mechanical Testing

- (a) The production and installation test weld plates shall be radiographically examined to ensure that the standard of welding is at least equal to that required in production. The test plate shall be rejected if rectification is required for more than 5 percent of the weld length.
- (b) (i) Production and installation weld test plates shall be sectioned for mechanical testing in the same manner as procedure weld test plates and shall provide a minimum of 900 mm effective weld test length with the weld centrally placed in a 450 mm wide plate.
- (ii) The Contractor shall be responsible for carrying out mechanical tests on production and installation test welds in accordance with the provisions of this Specification.

(4) Disqualification of Welding Procedures

If the mechanical tests or radiographic examination of a production test weld shows that the weld does not comply with the minimum standard required for a procedure weld, then that welding procedure shall be disqualified and further welding with that procedure shall not be permitted. The procedure shall be resubmitted when the cause of the failure of the production weld has been determined by the Contractor. The failure of the test weld to comply shall not in itself be grounds for the rejection of production welds performed in accordance with the weld procedure before the failure of the test weld. However the Engineer may request additional non-destructive testing to confirm the quality of the production welds completed since the previous production test weld plate.

S13.10 WELDER AND OPERATOR PERFORMANCE QUALIFICATION TESTS

(1) General

- (a) The Contractor shall ensure that all welding or inspection on work is carried out by personnel individually qualified for the work they perform.
- (b) All welders and welding machine operators engaged on welding in accordance with this Section of the Specification shall pass the welder performance tests which are designed to demonstrate their competence to make sound welds of the types on which each is to be employed.

(2) Qualification of Welders

- (a) Welder performance tests shall be performed in accordance with the developed weld procedure. A welder who welds successfully all the test plates required for a welding procedure test will be considered as qualified for the particular welding process, welding position, and type of steel.
- (b) The details of the welder performance test shall be recorded by the Contractor, and shall be included with the test results. Welders who successfully weld test plates in the flat, vertical and overhead positions shall be qualified for all positions.

(3) Requirements for Requalification

- (a) Changes in the procedure which require requalification shall require new welder performance tests. A change in the make of electrodes, fluxes or filler material shall not be a cause for requalification providing that there is no significant change in welding and running characteristics.
- (b) The Engineer may direct a qualified welder to repass the whole or part of the qualification test if there is any reason to doubt the welder's ability to make satisfactory production welds or if the welder, after qualification, has not been engaged on erection using the process and equipment appropriate to the procedure for a period of three months.

(4) Failure to Qualify

If one or more tests fail to meet the requirements, the welder may make two further test welds of each type rejected, both of which shall pass all test requirements. If any of the retests fail, the welder shall undergo further training before resubmission of further test welds.

(5) Welder Performance Test Plates

The welder performance test plates shall comprise at least 300 mm of welding for manual welds and 600 mm for automatic welds. All test plates shall be welded in the presence of the Engineer and shall demonstrate the welder's ability to follow the procedure. After welding, test plates shall be visually examined and radio graphed to ensure that the standard of quality is at least equal to the minimum required in production. If the requisite standard has been attained, the test plate will then be sectioned without regard to any indication on the radiographs. The specimens shall be prepared and tested in accordance with the specified requirements.

(6) Radiography, Macro and Bend Tests

The following tests shall be performed on the test weld and shall constitute a test series for the particular weld, welding process and position being considered. The results shall be assessed in accordance with Clause S13.08 (4).

TESTS FOR WELDER PERFORMANCE TEST PLATES

Test Type	Number of Tests	Method of Testing and Requirement
Macro Test	1	Article II Section IX and Section UW 51 or equivalent
Bend Test	2	Section VIII (1) of ASME Boiler Code or equivalent
Radiography	100%	In accordance with the specification

(7) Qualification for Various Types of Welds

- (a) Manual welders qualifying for circumferential joints steel will be required to perform two test series of double sided welds, one test in which the both sides of the joint have been welded in the vertical position and one test in which one side of the joint has been welded in the overhead position and the other in the down hand position. Manual welders qualified in accordance with this paragraph shall be deemed to be qualified for butt welds welded from a single side against a backing strip.
- (b) Welding machine operators qualifying for longitudinal and circumferential automatic welds steel will be required to perform one test series.
- (c) Welding machine operators qualifying for semi-automatic welds steel will be required to perform one test series.
- (d) Welders qualifying for repairs to automatic or semi-automatic welds will be required to perform one test series and comply with ASTM A573 or directed by the Engineer.

(8) Responsibility of Contractor

The Contractor shall provide all materials and equipment required for welder and operator performance qualification test and shall perform all work, fabrication and machining necessary to prepare the test specimens.

S13.11 WELDING INSPECTION

(1) General

(a) Production Welds

Circumferential and longitudinal production butt welds shall be radio graphically examined for 100 percent of their length.

(b) Field Welds

(i) Circumferential field butt welds for bifurcates and steel conduit pipeline components shall be radio graphically examined for 100 percent of their length.

(ii) Circumferential field butt welds for steel liners shall be ultrasonically tested on a spot basis. The extent of spot testing shall be 10 percent of the length of the circumferential butt welds. The Engineer will direct the location and position of welds to be ultrasonically tested.

(2) Repaired Welds

All areas of welds on which repairs have been made shall be radio graphically or ultrasonically examined, as directed by the Engineer, after repairs have been carried out. This examination shall be at the Contractor's expense.

(3) Radiographic Examination

(a) At least thirty (30) days before commencing radiographic examination, the Contractor shall submit details of all radiographic equipment, materials, processes and procedures. These details shall comply with the requirements for certification by an appropriate accreditation agency.

(b) Radiographic techniques shall employ X-rays only and shall comply with techniques 1 or 2 of BS 2600 for longitudinal welds and techniques 1, 2, 7 or 8 of BS 2910 for circumferential welds or directed by the Engineer.

(4) Repair of Defects

Defects which are greater than those permitted in Section UW 51 Section VIII (1) of ASME code are unacceptable and will require repair.

(5) Gouging and Re-welding

If any weld has been examined over the full length and rectification is required over more than 25 percent of the weld length, the entire weld length shall be rejected and the weld shall be cut out and re-welded to the satisfaction to the Engineer. The entire weld shall be re-examined after re-welding.

(6) Ultrasonic Examination

- (a) Ultrasonic examination may be used to check that welds and heat affected zones of pipes are free from cracks and crack-like defects and to locate radiographic indications for repair.
- (b) The Contractor shall make available a technician and equipment for ultrasonic examination of the welds. The Engineer will direct which welds are to be examined. Ultrasonic techniques shall comply with BS 3923 Part 1 or directed by the Engineer.
- (c)
 - (i) At least ninety (90) days before commencing ultrasonic testing the Contractor shall provide details of personnel with their qualifications, details of equipment and a clear specification of methods to be used.
 - (ii) All ultrasonic testing shall be carried out at Level 2 Standard. Where defects are to be sized, all such sizing shall be carried out at Level 1 Standard using the 20 Db drop method.
 - (iii) The roughness of the surface shall not be more than 3.2 micron Ra and shall permit uniform probe contact throughout the test.
 - (iv) Calibration of equipment, techniques, and procedures shall be in accordance with BS 3923 or directed by the Engineer.
- (d) Defects which have been detected by ultrasonic examination shall be repaired as directed. Any defect which produces an ultrasonic echo that fails to reveal the nature of the defect shall be radio graphically examined, if possible, when so directed.

(7) Additional Examination

The Engineer may direct the use of visual, dye-penetrant and magnetic particle to supplement radiographic and ultrasonic methods of examination. These additional methods will be used to ensure that welds do not contain unacceptable defects.

S13.12 HANDLING

(1) Precautions

The lifting and loading equipment and procedures, the transport equipment and the unloading equipment and procedures shall be designed and, if necessary, constructed by the Contractor to carry safely the loads to be supported and to ensure that the components are not overstressed, distorted or damaged. The Contractor's drawings and proposals for the equipment and procedures shall be submitted at least thirty (30) days before any of the components are to be handled. In the event of any damage occurring to the

components, the Contractor shall at his expense, repair the damage to the satisfaction of the Engineer.

(2) Supports and Bracing

- (a) All slings used in lifting or holding any component shall be padded with or constructed from suitable materials and all supports for pipes shall be curved and constructed of wood and rubber sheeting or other suitable materials to ensure that distortion or damage does not occur.
- (b) Bracing shall be used to prevent distortion and shall not be welded to the metalwork of the steel liners and pipes.

S13.13 INSTALLATION

(1) General

The steel liners and steel conduit pipeline components shall be installed in the position and to the lines and levels shown on the Drawings in accordance with the match and flow marks positioned during fabrication.

(2) Precautions

All steel lining components stored before installation shall be supported above the ground in a manner which will not cause damage, distortion or high stresses, shall be prevented from rusting and shall be kept free from dirt, grease, oil and other foreign matter.

(3) Procedures

- (a) Liners and pipe components erected on staging shall be supported on suitable packing to ensure they will be at the correct elevation and alignment when completed. Field joints shall be securely held in position to ensure accurate alignment, curvature and elevation before welding is commenced.
- (b) The Contractor shall ensure that the steel liners and pipeline components are erected so that the longitudinal joints on either side of a field circumferential weld are staggered as shown on the Drawings.

(4) Field Welding

- (a) Field welding shall be performed under suitable portable shelters to ensure protection from draughts and moisture.
- (b) Positioning of steel conduit pipe components and tack welding shall be performed at times when the temperature difference between pipe components or between each side of a pipe component is small.

- (c) Completion of welding at each joint shall follow the tack welding as closely as possible.

(5) Correction of Errors

The liners and pipe components shall not be over-stressed. Any error in the work which prevents proper assembling and fitting of the components shall be reported immediately to the Engineer. Correction of any error shall not commence until the method of correction has been approved.

(6) Tolerances

The following tolerances shall apply to the installation of the steel liners and steel conduit pipelines.

- (a) The maximum offset between abutting external surfaces at any position along a butt joint shall not exceed 3 mm for circumferential joints.
- (b) The difference between the maximum and minimum internal diameters of the pipe shell measured at any one cross-section shall not exceed 0.4 percent of the mean diameter of the pipe shell.
- (c) The profile, measured on the outside or inside of the pipe shell by means of a gauge of the designed form of the pipe shell and having a length equal to 0.25 of the internal diameter, shall not depart from the designed form by more than 0.2 percent of the mean diameter of the pipe shell.
- (d) The maximum deviation from a straight line parallel to the axis of the pipe shell as measured by a straight edge along the inside of the pipe shall not exceed the following:
 - . 5 mm in 6 m length
 - . 10 mm in 12 m length.
- (e) The centerline of each component shall not deviate by more than 12 mm from the theoretical pipe centerline shown on the Drawings.
- (f) The tolerances listed in this sub-clause may be supplemented by additional tolerances shown on the Drawings.

(7) Grout Plugs

Grout plugs in steel liner sections shall be coated with bond breaking deoxaluminat grease and screwed home before concrete placement. After concrete placement, the grout plugs shall be removed and grouting carried out in accordance with this Specification. After completion of grouting, the grout holes and grout plugs shall be degreased and cleaned then the plug threads shall be wrapped with tape, and the plug screwed tightly into position. The circumference of the plug shall be welded to the pipe as shown on the Drawings.

(8) Protective Coating

The Contractor shall complete the application of the protective coating to the surfaces of steel liners and steel conduit pipes and shall repair all damaged areas of the coating in accordance with this Specification.

S13.14 MEASUREMENT AND PAYMENT

(1) Method of Measurement

- (a) Where payment is by mass, the mass of metalwork shall be determined by multiplying the volume of metalwork, calculated from the dimensions shown on the Drawings, by 7,850 kg per cubic meter.
- (b) In calculating the volume of steel plates, the nominal thickness of plates will be adopted and all fillet welds and weld reinforcements will be disregarded; butt and Tee joints will be considered as the same thickness as the nominal thickness of the adjacent plate; covers and flanges will be considered as the nominal thickness prior to machining. In calculating volumes there will be no deductions made for the holes cut for off-takes or other purposes.
- (c) Notwithstanding other sub-clauses of this Clause, the mass of nuts, bolts and washers will be determined on the basis of nominal mass supplied by the manufacturer. Mass of nuts, bolts and washers not incorporated in the steel liners and pipelines will not be measured for payment.
- (d) All backing strips will be deemed to be included in the measurement of the attached steel liner.
- (e) For the purpose of measurement for payment, steel liners will be considered to include all liner sections installed as shown on the Drawings.

(2) Steel liners, and Steel Conduit Pipes

- (a) Payment for fabrication, delivery and installation of steel liners and steel conduit pipes including transition, reducer and stiffener steel plate will be made at the rates per bid therefor in the Schedules.
- (b) These rates shall include all costs associated with fabrication, delivery and installation to the storage area including the cost of designing and furnishing all plant, equipment, staging, haulage and storage facilities and service, welding of all joints in the pipe shell which make up the individual liners and pipes, bends and closing pieces, all field welding of all joints between the individual liners and pipes corrosion protection of all surfaces, design and fabrication and hydrostatic testing delivery. These rates shall also include the cost of all materials, construction

facilities, professional and technical services, transport, equipment, labor and other necessary charges.

(3) Attachments

Payment for approved attachments welded to the steel liners and steel conduit pipes, for which provision for payment has not been included in the Schedules, will be made at the rate applicable to the steel liners and steel conduit pipes to which the attachments have been welded.

(4) Corrosion Protection

Payment for corrosion protection of the internal surfaces of the steel liners and steel conduit pipes will be made in accordance with Section 17.

(5) Welding

(a) Payment for the development of welding procedures will be made at the lump sum bid therefor in the Schedule for steel liners and steel conduit pipes.

(b) Payment for production welding tests on butt welds will be made at the rate per test series bid therefor in the Schedule. A test series is defined as comprising the tests listed in sub-clause S13.09 (2) for the particular welding process, type of weld and particular welding position being considered.

(b) Payment for welding and testing of welder and operator performance qualification test plates will be made at lump sum bid therefor in the Schedules for steel liners and steel conduit pipes.

(6) Concrete

Concrete required for anchor blocks and concrete encasing the steel conduit pipes will be paid for in accordance with Section 9.

(7) When work is required to be performed under any Clause of this Specification and provision is not made for direct payment of the work, the entire cost of such work shall be deemed to be included in the unit and lump sum prices in Schedule.

(8) The unit and lump sum prices in the Schedule shall include the costs for all materials, construction facilities, professional and technical services, transport, equipment, labor, delivery to site, and other necessary charges.