

BALUCHISTAN ENERGY COMPANY LIMITED

DEVELOPMENT OF LPG TESTING LABORATORY AT TAFTAN

SPECIFICATION FOR FABRICATION & INSTALLATION OF PIPING



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1.0 SCOPE

This specification covers the minimum requirements for the fabrication/installation of pipe works.

This specification contains general & detailed fabrication, inspection and testing requirements applicable to all process piping systems and specific fabrication, inspection and testing requirements applicable to the particular project to which this specification is being applied.

The technical requirements outlined herein are equally applicable to piping sub-assemblies (frequently called “Shop Fabricated” piping) and to final erected piping systems (frequently called “Field erected “piping).

This specification contains additional requirements applicable only to fabricate furnishing sub-assemblies for final erection by others.

Fabrication under this specification shall include all components of a piping system, or part thereof, entering into fabricated assemblies, but shall include all valves, bolting, gaskets, flanged fittings, blind flanges, orifice plates and all special items.

The Contractor shall bring his own consumable equipment/machinery and other material and provide all services, skilled and unskilled labor including supervisory and testing personnel needed during construction.



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2.0 APPLICABLE CODES AND SPECIFICATIONS

Work shall be carried out according to the requirements of this specification and will conform to the technical specifications, data sheets and fabrication/ installation drawings.

Where specific details about the execution of any items of work are not included, work shall be carried out according to the requirements of the latest editions of the following standards and Engineering's general specifications described below:

American Society of Mechanical Engineers (ASME)

Section I	Power Boilers
Section II (Part C)	Welding Rods, Electrodes and Filler Metals
Section V	Non Destructive Examination
Section VIII	Pressure Vessels
Section IX	Welding and Brazing Qualifications
B31.3	Process Piping (Latest Edition)
B31.8	Gas Transmission and Distribution Piping Systems
B.1.20.1	Pipe Threads General Purpose (Inch).
B.16.5	Pipe Flanges and Flanged Fittings.
B.16.9	Wrought Steel Butt Weld Fittings.
B.16.11	Forged Steel Fittings. Socket Weld and Threaded.
B.16.20	Ring Joint Gaskets and Groves, for Steel Pipe Flanges.
B.16.25	Butt Welding Ends
B.36.10	Welded and Seamless Wrought Steel Pipe.
B.36.19	Stainless Steel Pipe



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American Society for Testing and Materials

A370	Mechanical Testing of Steel Products
E1 10	Test Method for Indentation Hardness of Metallic Materials
E146	Hardness Conversion Tables for Metals
E380	Metric Practice
E562	Practice for Determining Volume Fraction by Systematic Manual point count

British Standards & Project Specifications

BS 427(Part 1)	Testing of Metals
BS 709	Destructive testing fusion welded joints and weld metal in steel
BS 4870	Specification for Approved Testing of Welding Procedures
BS 5555	Specification for SI Units
BS 5750	Quality Systems

International Organization for Standardization

ISO R 148	Beam Impact Test V-notch for steel
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Manufacturers Standardization Society

MSS SP44	Steel Pipe Line Flanges
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National Association of Corrosion Engineers/ International Organization for Standardization

NACE MR-0175/	Sulfide Stress Cracking Resistant Metallic Materials
ISO 15156	

In case of conflict between this specification and its associated specifications and the above codes and standards, the PC Contractor shall bring the matter to the Client's attention for resolution and approval in writing. In all cases the most stringent requirements shall apply.



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All deviations from the requirements of this specification, its attachments and the referenced codes and standards shall be stated in the Tender. In the absence of such a statement, full compliance will be assumed.

Compliance by the PC Contractor with the provisions of this specification does not relieve him of his responsibility to furnish material of a proper mechanical design suited to meet the specified service conditions and/or local codes governing health and safety.

3.0 MATERIALS

- 3.1 Piping materials shall be as specified in the piping detailed fabrication drawings (isometrics). Alternative materials may only be substituted subject to specific approval of Client.
- 3.2 Materials for non-pressure items, or for reinforcing pads or saddles, which are welded to a pressure part, shall be of the same type and quality of material as for the pressure part.
- 3.3 All pressure parts and attachments shall comply with the requirements of ASME B31.3.

4.0 STORAGE AND HANDLING

- 4.1 All piping materials shall be stored by the PC Contractor in areas demarcated for this purpose.
- 4.2 Pipes and fittings shall be stored in a roofed area on dry wooden platforms.
- 4.3 Valves, control valves, instruments, steam traps, strainers, stud bolts & nuts, small fittings and gaskets shall be stored in a covered, locked premise. In no case shall the
- 4.4 marking on the equipment be removed. Valves and other equipments provided with protective caps shall be stored with the caps up to the moment they are installed.
- 4.5 PC Contractor shall be entirely responsible for safe keeping of all the material and equipment. If any item is lost or damaged, the PC Contractor shall be required to replace it at his own expense.



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- 4.6 Handling of material shall be done with suitable mechanical equipments and safety of workers shall be given top priority.
- 4.7 Unless indicated otherwise, covered space for storage of material shall be considered as PC Contractor's responsibility.
- 4.8 All materials stored shall be distinctly marked. Specially for NACE compliance material.
- 4.9 PC Contractor shall maintain at all times, the record of material received as “Free Issue” from the Client. Client shall be at liberty to check such record any time without prior notice.
- 4.10 Upon project completion the PC Contractor shall hand-over all records of all material after reconciliation.
- 4.11 Material of one specification shall not be placed with different kind of materials. Care must be taken to ensure that alloy piping materials, such as stainless steel and similar, are not contaminated by contact with carbon steel.

5.0 WELDING APPROVALS

5.1 Welding Procedure Specifications (WPS)

- 5.1.1 Every WPS and supporting PQR's shall be compiled and submitted for Client's approval, in accordance with the Submission of Procedures Specification.

5.2 Procedure Qualification

- 5.2.1 Each welding procedure shall be qualified in accordance with the Code and ASME IX. Care shall be taken to ensure that restraint and thermal conditions are at least as severe as production welds represented.
- 5.2.2 The validity of a welding procedure qualification test certificate is restricted to the site at which the test weld was conducted.



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5.2.3 All mechanical testing and inspection shall be conducted after any post-weld treatment that may be required. The procedure qualification test assembly shall be subjected to the same inspection and NDE as required for production welds.

5.2.4 The extent of examination and mechanical testing shall be as defined in Table 3, unless otherwise specified.

5.2.5 In addition to mechanical testing required by the code, the following tests shall be undertaken on each procedure qualification test assembly:

- Bend Tests

Full thickness root and face specimens are required for thicknesses below 19 mm. For material thicknesses 19 mm and above side bend test specimens shall be used.

- Macro-etch Test

Macro-specimens shall be prepared to a 600 grit finish or better and then etched to show the fusion boundary clearly. For 5G and 6G test positions the specimens shall be extracted at the 12 o'clock and 6 o'clock positions.

The macro specimens shall be polished and examined under a magnification of minimum x3.

The macro specimens shall be free of unacceptable defects. A macrograph shall be prepared for each specimen, and submitted as part of the test report, for Client's approval.

- Hardness Survey

For all procedures which cover the welding of a pressure part, a hardness survey shall be carried out on the macro-etch test section. The Vickers hardness test method shall be used in accordance with BS 709. For carbon steel, the hardness value shall not exceed 325 HV. For other materials, hardness requirements shall be approved prior to testing.

Hardness traverses using Vickers test equipment with 22.05 lb load shall be carried out where applicable at the locations detailed below. In the weld metal, 5 indentations evenly spaced along each traverse are to be made. In the HAZ,



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indentations shall be made along the traverse, starting as close to the fusion line as possible, with a spacing of 0.5 mm. A minimum of two indentations are also required in the parent metal from either side of the HAZ. The traverses shall be located 2 mm from both the inner and outer surfaces

– Notch-toughness Testing

For ferrite steel and duplex steel items which operate below 32 °F, austenitic steels operating below minus 158°F and any instances when impact tested base materials are specified, Charpy V-notch impact tests are required. Unless specified in other applicable specifications, the requirements shall be as detailed in Appendix A.

Procedure qualification tests in accordance with BS 4870: or other national standard may be approved in place of those required by the Code.

5.3 Essential Variables

5.3.1 A welding procedure shall be re-qualified when any of the essential variables change from the values used for qualification.

5.3.2 The essential variables shall be:

- Any of applicable essential variables listed in the Code and given in ASME IX.
- Joint Design

Change from single sided to double sided weld or vice versa. Change in root alignment beyond the qualified range. An increase of more than 2 mm in root gap.

- Welding Process

Change in welding process or in combination of welding processes. Change in polarity or from AC to DC or vice versa.

- Material

Any increase in carbon equivalent of carbon steels greater than 0.04% above that qualified.



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- Welding Consumables

A change in electrode diameter used for root runs. Change in type of shielding gas or type of 'bare' filler metal. Change in brand name of flux or flux coated filler metal or filler metal which incorporates flux.

- Pre-heat/ Inter pass Temperatures

Increase of more than 212°F or any decrease in the margin applied to the pre-heat temperature required by Table 4. Any increase in inter pass temperature.

- Heat-Input Energy

Decrease in heat input by more than 10%.

- Post-weld Heat Treatment

Change in heat treatment temperature beyond the range qualified, or change in holding time by more than a factor of two. Any increase in cooling rate.

- Positions

Change in welding position beyond qualified positions as indicated in ASME IX.

5.3.3 For procedures subject to impact testing, the additional essential variables shall be:

- An increase in the specified current range.
- An increase in the maximum electrode diameter.
- An increase in the width of bead or a change from string to weave bead technique.
- Increases in maximum inter pass temperature above 482 °F.
- Any change in consumables.



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5.4 Welders Qualification (Including Welding Operators)

- 5.4.1 Welders shall be qualified in accordance with the applicable Code, ASME IX or BS 4871 Part 1.
- 5.4.2 Welder qualifications in accordance with other recognized national standards may be substituted subject to Client's approval.
- 5.4.3 All Procedures Qualification Record (PQR) & Welders Qualification Test (WQT) are subject to the Client's witness and approval.

6.0 WELDING REQUIREMENTS

6.1 General

- 6.1.1 This section defines the general requirements for all materials and those specific to carbon steel and low alloys steels. For materials other than carbon steel, welding and fabrication shall also comply with the requirements of the appropriate Appendix to this Specification.

6.2 Weld Bevels and Preparations

- 6.2.1 Weld bevels and preparations, including those necessary for repair welding may be prepared by machining, arc-air gouging, chipping, grinding or guided gas torch cutting. Thermal cutting or arc-air gouging shall be carried out using the same pre-heat as required on the approved welding procedure. Items cut from bulk material shall be identified to material type.
- 6.2.2 Where the method of preparation is other than machining or grinding, cut surfaces shall be finally prepared by grinding or machining to clean, bright, sound metal.
- 6.2.3 The finished weld preparation shall conform with the geometry specified in the approved welding procedure and shall be visually inspected to confirm that the preparation is smooth, uniform and free from tears, cracks, gouges, scale, or any discontinuities which might affect weld quality.



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6.2.4 Before thermal cutting or welding of galvanized steel, the galvanizing shall be removed from immediate work area by grinding or pickling, such that molten zinc does not contact work piece during cutting or welding.

6.2.5 Welding onto surfaces painted with a weldable primer may be carried out, when Approved.

6.3 Care and Protection

6.3.1 Welding areas shall be protected from adverse weather conditions at all times during pre-heating, welding, post-weld heat treatment and non-destructive examination. For gas shielded welding, special precautions shall be taken to protect the welding area from draughts.

6.3.2 When the base metal temperature falls below 41 °F, and to remove dampness, the weld preparation and surrounding metal for a distance of three times the wall thickness or 25 mm whichever is greater shall be pre-heated to 86°F prior to welding.

6.3.3 Contamination of one material by another shall be avoided by segregation of materials within the fabrication area.

6.3.4 Arc strikes outside the weld preparation are not permitted. Any stray arc marks shall be removed by grinding and inspected by magnetic particle or dye penetrates methods. Confirmation of maintenance of the minimum design wall thickness shall be required.

6.3.5 Weld metal shall be deposited in a controlled sequence to minimize distortion and prevent the build up of excessive internal stresses.

6.3.6 Pipes shall not be moved (except for rotation on rollers) or lifted until at least 50% of the final weld depth has been deposited in circumferential seams.

6.4 Alignment and Fit-Up

6.4.1 Root alignment of butt-welds shall be within the limits of the qualified WPS. Tolerances of ± 0.75 mm for GTAW and ± 1.5 mm for other fusion welding processes shall apply, unless wider tolerances are approved subject to qualification



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- 6.4.2 When misalignment cannot be overcome by repositioning of work pieces one of the following methods shall be employed:

Grinding or machining, provided that minimum design thicknesses are maintained and a maximum taper of 1 in 4 (or 14°) is applied.

Weld buttering, in accordance with an approved procedure, to produce a maximum taper of 1 in 4 (or 14°).

- 6.4.3 Hammering shall not be used to achieve fit-up or overcome misalignment.
- 6.4.4 Other methods of overcoming misalignment, such as heating or working with jacks shall not be used unless specifically approved, after the Contractor has demonstrated that the mechanical properties of the material will subsequently meet the relevant requirements.
- 6.4.5 Where clamps or other methods of support are used to achieve fit-up, they shall not be removed until at least 10% of the final volume of weld metal has been deposited.
- 6.4.6 Dimensions shall conform to those shown on the drawing.
- 6.4.7 Parts to be welded shall be securely held by clamps or tack welds to maintain the required alignment and geometry.

6.5 Welding Process

- 6.5.1 The following welding processes are generally permitted:

Manual shielded metal-arc welding (SMAW)
Gas tungsten arc welding (GTAW)
Flux cored arc welding (FCAW)
Submerged arc welding (SAW)

- 6.5.2 Other processes may also be permitted, subject to Company's approval.
- 6.5.3 When GMAW process is used, deposition shall be in the spray mode. The dip-transfer mode is not permitted, except, if specifically, approved, for root runs in carbon steel.



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- 6.5.4 When GTAW process is used, the welding current shall be either alternating (AC) or direct with the tungsten electrode connected to the negative supply terminal (DC-) the arc shall be initiated by a high frequency device and terminated by a current decay (crater fill) device. Electrodes shall be 2% thoriated tungsten. Shielding gases shall be oxygen-free and shall flow at 11-21 ft³/hour. This process shall be used with the addition of filler metal. At each weld interruption, the hot end of the filler metal shall be cooled in the gas shield or shall be discarded. The torch shall have a gas lens.
- 6.5.5 Complete GTAW Process shall be used for butt / fillet-welds in pipe of diameter 2" and less, also root and hot passes of all welds except utility piping shall be GTAW Process. Filling, capping in pipe diameter greater than 2" can be done by SMAW Process.
- 6.5.6 All welds shall be multipass, with a minimum of two runs.
- 6.5.7 Peening is prohibited on all passes.
- 6.5.8 All pressure-containing butt-welds, including branch welds, shall be full penetration welds. This shall be achieved by the following means:

For carbon steel, a single sided weld with a SMAW, GTAW root run. SMAW electrodes for utilities service lines the root pass in pipe of 3" NB or larger shall not exceed 2.5 mm wire size. GTAW shall be used for the root pass in less than 3" NB pipe.

For non ferrous metals, a single sided weld with a GTAW root run using an inert gas back purge.

6.6 Welding Consumables

- 6.6.1 Welding consumables shall conform to ASME II, Part C or a recognized national or industry standard, unless otherwise approved. When two or more brands of consumable are in use, they shall be positively identified and segregated to avoid confusion.
- 6.6.2 All welding consumables shall be identifiable & compatible with base materials being welded. Deposited weld metal shall be of similar chemical composition to base material (except for dissimilar metal joints) and shall exhibit mechanical properties at least equal to those of the base material. When different grades of material are joined, weld metal shall not significantly overmatch the lower grade material.



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- 6.6.3 Alloying elements shall be introduced to the weld pool primarily from the filler wire, not from flux. Bare filler wires shall be free from grease and oil before use.
- 6.6.4 Welding consumables shall be supplied and stored in sealed, dirt-proof and moisture-proof containers or bags.
- 6.6.5 Welding electrodes and fluxes shall be stored and dried in accordance with consumable Manufacturer's recommendations. Low hydrogen electrodes shall be segregated from other types during storage, and shall be baked to produce a weld metal hydrogen content of 10 ml H₂/100g maximum.
- 6.6.6 Submerged arc flux may be reclaimed for recycling after use, only according to the Approved procedure. Recycled flux shall be mixed with new flux in accordance with Manufacturer's recommendations, but at a maximum of 40% of the total volume.
- 6.6.7 Consumables for dissimilar metal combinations shall be subject to Client's approval

6.7 Tack Welds

- 6.7.1 Tack welds shall be made by qualified Welders on 5G / 6G, using Approved consumables as specified in the Approved WPS. Tack welds shall only be made within V or groove and not outside.
- 6.7.2 When tack welds are to be incorporated into the final weld, they shall be grounded and feathered and visually inspected to be crack free.
- 6.7.3 Defective tack welds and tack welds which are not to be incorporated into the final weld shall be carefully removed by grinding, to leave a correct weld preparation.

6.8 Pre-Heat

- 6.8.1 The pre-heat temperature for welding and thermal cutting shall be specified in the WPS and shall meet the requirements of the Code.

For carbon steel, pre-heat shall be as indicated in Table 2, unless alternative pre-heat levels are justified by the PC Contractor on the basis of an appropriate national standard or recognized calculation method. If the pre-heat temperature used in the qualification test exceeds the level determined, the same margin shall be applied in calculating pre-



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heat temperatures for all combined thicknesses applicable to the relevant weld procedure.

- 6.8.2 Pre-heat shall be applied by electrical resistance heating or by oxy-gas torch or by other Approved means. Deposition of carbon or direct flame impingement shall be avoided. Cutting torches shall not be used for pre-heating.
- 6.8.3 Pre-heat shall be applied in a gradual and uniform manner to the entire length of the joint and shall be maintained throughout the welding operation or as required in the Approved WPS.
- 6.8.4 The pre-heat temperature shall be established throughout the joint and surrounding parent metal for a distance of three times the parent metal thickness or 50 mm whichever is the greater from the joint.
- 6.8.5 The pre-heat shall be measured, using a contact pyrometer or temperature indicating crayons, at representative positions including the extremities of the required heated zone and both root-side and face-side of the joint. Where access to only one face is possible, the heat source shall be removed for a period of one minute per 25 mm of parent metal thickness to allow for temperature equalization prior to measuring the pre-heat temperature.
- 6.8.6 For tack welds and welds involving high restraint or severe stress concentrations, such as patch welds, cruciform joints, partial penetration welds or where misalignment exceeds 3 mm, the required pre-heat shall be raised by at least 77°F above that required by Item 5.8.1.
- 6.8.7 Pre-heating is not required for stainless steel except when joined to ferritic steel.

6.9 Temporary Attachments

- 6.9.1 Temporary attachments which are welded to the work piece shall be of the same quality material as the work piece. Such attachments include cleats, bridges, backing strips, etc.
- 6.9.2 Temporary attachments shall be welded to the work piece by qualified Welders using the same consumables and pre-heat as specified on the Approved WPS for permanent attachments.



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- 6.9.3 Temporary attachments shall be removed, prior to post weld heat treatment, by grinding, machining or thermal methods, not by hammering. When thermal cutting is used, the attachment shall be cut 3 mm from the work piece surface and the remnants shall then be removed by grinding or machining.
- 6.9.4 After removal of any attachment, the work piece surface shall be ground and examined by magnetic particle or dye penetrate method.
- 6.9.5 Carbon steel attachments shall not be welded to stainless steel or other non-ferritic materials.

6.10 Precaution against Preferential Weld Corrosion

- 6.10.1 Any mill-scale present shall be removed by abrasive blasting.
- 6.10.2 Weld metal nominal composition shall be selected to avoid preferential weld corrosion with any particular parent material. For carbon steel in the absence of specific test data or specific recommendations, Figure 4 may be used to determine optimum nickel and/or copper contents.

7.0 FABRICATION

Fabrication of all piping shall be in accordance with the requirements of piping drawings and specifications. Where specific details of fabrication are not included, work shall be carried out in accordance with the latest edition of ASME B31.3, Process Piping.

7.1 General

- 7.1.1 Piping shall be fabricated by the method stated in this specification; i.e. welded, screwed or flanged.
- 7.1.2 Internals of valves and other in-line equipment, which may be damaged due to heat from welding, shall be removed prior to welding.

7.2 Butt-Welded Piping

- 7.2.1 Permanent backing strips shall not be used. Temporary backing strips shall be used only with Client's prior approval.



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7.3 Socket Welded Piping

- 7.3.1 All material entering this type of piping specification shall comply with the relevant piping specification.
- 7.3.2 Pipe ends shall be cut square and deburred prior to being located in the fitting.
- 7.3.3 Minimum rating of socket welded fittings shall be class 3000#. When socket welding fittings or valves are used, pipe shall be spaced approximately 1.5 mm to avoid “bottoming” which could result in excessive weld stress.

7.4 Screwed Piping

- 7.4.1 The PC Contractor shall use thread cutting lubricant of an approved type.
- 7.4.2 The correct number of threads shall be cut on pipes to comply with standard for threads.
- 7.4.3 Minimum rating of screwed fittings shall be class 3000#.
- 7.4.4 Jointing compounds and thread sealing tapes shall be approved by the Company and shall be used for all threaded joints except those requiring seal welding.
- 7.4.5 Generally seal welding is not allowed. When seal welding is required, jointing compounds or tapes shall not be used; all exposed threads shall be covered by seal weld. Seal welding shall be performed by qualified Welders, in accordance with the Approved WPS.
- 7.4.6 Excessive wrench markings on pipe and fittings due to joint making shall be avoided and cause for rejection.

7.5 Flanged Joints

- 7.5.1 Flanges shall preferably be welding neck with bore matching pipe internal diameter (ID) unless otherwise specified and / or authorized.
- 7.5.2 Flange bolt holes shall straddle horizontal and vertical centre-lines, except when otherwise specified on approved drawings, and shall match the orientation of mating flanges.



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- 7.5.3 Internal weld surfaces at orifice flanges and other flow measuring devices shall be ground flush. The length over which this requirement applies will be specified elsewhere.
- 7.5.4 All loose weld neck flanges to be field welded shall be tacked in position for shipping. Alternatively, they may be bolted to fixed mating flanges or shipped in hessian sacks which are securely attached to the spool.

7.6 Bending

- 7.6.1 Unless specified otherwise on drawings and specifications or unless Approved, bends in pipes shall be affected using proprietary manufactured elbows.
- 7.6.2 Bends shall be free of cracks, wrinkles, bulges, kinks and other serious defects and shall not be excessively scaled. 'Cut and shut', creased or corrugated bends are not permitted. Weld repair of defective bends is not permitted.
- 7.6.3 When permitted, 'cold' bends shall be made at or below 1202°F for carbon steel.
- 7.6.4 After bending, cold bends shall be suitably heat treated, unless it can be demonstrated that the strength, hardness, ductility and notch toughness conform to specified requirements, in the "as-bent" condition.
- 7.6.5 All traces of bending filler materials and other contaminants shall be removed prior to heat treatment. No lead-or sulfur-containing materials shall be used as fillers.
- 7.6.6 When permitted, 'hot' bends shall be made as per procedure approved by the Company.
- 7.6.7 All heating and heat treatments shall be performed in a uniform and controlled manner using an enclosed furnace, electrical resistance heaters or electrical induction methods. The use of hand held gas torches is permitted only on low pressure, utilities (stream trace, drain & cooling water etc.) and small bore piping of less than 1½" Ø pipes.
- Any bending, hot or cold and any post-bending heat treatment shall be performed in accordance with a written procedure that has been approved.
- 7.6.8 After bending, the pipe wall thickness at the thinnest point shall not be less than the nominal wall thickness minus tolerance and corrosion-and erosion-allowance. Bends



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intended for use in lines which will require pigging shall be gauge tested to ensure true bore and radius, prior to installation.

7.6.9 Mechanical properties after bending shall be determined for bends of Inspection Classes 1 and 2. One production test bend shall be made for each cast of pipe, with bend radius and pipe diameter representative of minimum bend radius/pipe diameter ratio to be used in production. One tensile test and one set of notch toughness specimens (when impact testing is required) shall be removed from the extrados of each test bend. Transverse samples shall be used when the pipe size permits and are mandatory for pipe diameters of 12 inches NB and larger.

7.6.10 When bending is performed on longitudinally welded pipe, the weld shall be positioned at the neutral axis and test bends shall additionally be tested in the weld zone by taking tensile tests and notch-toughness test samples as required for weld procedure qualification testing. Welds shall be subjected to 100% crack detection after bending. Girth welds shall not be incorporated into bends.

7.6.11 All production tests shall meet the requirements for yield strength and elongation of parent metal, ultimate tensile strength and notch-toughness energy at appropriate temperature.

7.7 Prefabricated Pipework's

7.7.1 Proposed maximum sizes of prefabricated spools shall be submitted for Company's approval.

7.7.2 When piping spools are fabricated for free issue to site, spool ends may be identified as 'cut to fit' (CTF) on the approved drawings.

7.7.3 When 'CTF' spools are specified, a minimum of 100 mm additional length to that dimensioned on drawings shall be left for cutting at the installation stage. 'CTF' ends shall be Left Square and plain.

7.8 Post Weld Heat Treatment (PWHT)

7.8.1 PWHT shall be carried out according to a heat treatment procedure which shall meet the requirements of the Submission of Procedures Specification.



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7.8.2 PWHT shall be achieved by one of the following methods:

- In an enclosed furnace
- By local electrical resistance heating
- By local inductive heating.

7.8.3 Manual gas torches or exothermic chemical heating packs shall not be used for PWHT.

7.8.4 When local PWHT is used, the work piece shall be heated symmetrically. For butt-welds and branch/attachment welds, a full circumferential band around each pipe extending a distance, $1.5 \times e$ on either side of the weld centre-line shall be heated to the minimum soaking temperature, and at least half the soak temperature shall be reached at a distance of L either side of the weld,

Where $L = 2.5 \sqrt{Re}$

R = internal radius of tubular component, e = wall thickness.

7.8.5 To avoid adverse thermal gradients, thermal insulation shall be applied over the heated band to a distance $2 \times L$ either side of the weld centre-line.

7.8.6 When heating is by gas burners, direct flame impingement on the work piece shall not occur. The furnace atmosphere shall be controlled to avoid excessive oxidation.

7.8.7 The temperature of the work piece shall be measured by pyrometers or attached thermocouples. Sufficient pyrometers/thermocouples shall be used to ensure an even distribution of temperature throughout the heated zone.

7.8.8 Pipe ends, flange faces, threads and any other machined surfaces shall be suitably protected against oxidation during the heat treatment cycle.

7.8.9 The temperature of the work piece shall not exceed the upper limit of the holding temperature specified on the approved heat treatment procedure.

7.8.10 The temperature of the work piece throughout its heated portion shall be continuously and automatically recorded on a chart. PWHT records shall be retained as part of the documentation required by the Company.

7.8.11 All temperature measuring and recording equipment, including thermocouples, shall be suitably calibrated. Calibration records will be subject to scrutiny by the Company.



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7.8.12 Welding on to a part which has been heat treated is not permitted, except by Company's approval, when the requirement for further PWHT shall be as indicated in the applicable code.

8.0 INSPECTION AND TESTING

8.1 General

8.1.1 Inspection and non- destructive examination shall be carried out in accordance with procedures which have been approved.

8.1.2 NDE Operators shall be qualified in accordance with a recognized standard and shall be approved prior to commencement of NDE work. As a minimum requirement, NDE shall be supervised by an Operator qualified to ASNT-TC-1A Level II or suitable equivalent.

8.1.3 The Company shall be given the opportunity of witnessing all inspection, NDE and testing.

8.2 Fabrication Tolerances

8.2.1 All fabricated piping shall meet the tolerances shown in Figure 2.

8.3 Extent Of Non-Destructive Examination

8.3.1 Inspection classes for welding procedure qualifications tests are shown in Table 1.

8.3.2 The extent of examination to be carried out for each inspection class shall be as shown in Table 2. All fabricated piping shall be examined to the extent shown.

8.3.3 Welding Inspection requirements applicable for design, supply and commissioning are shown in Table 3.

8.3.4 NDE and final inspection shall be carried out after any PWHT which may be required but not before the weld has cooled to ambient temperature. When PWHT is not required, NDE and final inspection shall be carried out at least 48 hours after the completion of welding.

8.3.5 Where less than 100% examination is specified, the prescribed examination shall be carried out at those locations where the presence of defects is deemed to be most



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harmful to the structure, and/or locations where experience has shown that defects are most likely to occur. The percentage shall be based upon actual number of welds with 100% examination performed on each weld to be tested. The extent of examination shall include welds made by each and every Welder/Operator.

Radiographic examination (to the specified extent) shall be performed after the completion of the post weld heat treatment (if any). If during radiography inspection 20% or more defective found then inspection requirement will increase to 40% and if 20% or more again defective found then 100% radiography inspection have to perform.

8.4 Methods of Non-Destructive Examination (NDE)

8.4.1 Visual examination shall be carried out before during and after fabrication in accordance with Article 9 of ASME Section V and the Code.

8.4.2 Magnetic particle examination, liquid penetration examination and radiography shall be carried out in accordance with ASME Section V and the Code.

8.4.3 Radiographic testing (RT) shall comply with the following:

- Where possible the single wall-single image technique shall be used.
- Wire type Image Quality Indicators (IQI) to a national standard shall be used.
- Only lead intensifying screens shall be used.
- Film density shall be 2 to 3. Fully processed films shall not be further treated to alter film density.
- Unless otherwise specified, the sensitivity of the technique shall be a maximum of 2% of section thickness but shall not exceed 1% for thickness of 50 mm or greater.
- The film shall be high contrast, fine grained (Agfa D5 or equivalent) or better.

8.4.4 When MPI is used, the following shall apply:

- Surface condition shall be sufficiently smooth to avoid false defect indications.
- MPI shall be performed using electromagnetic yokes. The "prod" method shall not be used, except with Purchaser's specific approval.



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8.4.5 Generally, MPI shall be used for ferritic steels and DPT shall be used for all other materials.

8.4.6 Ultrasonic examination in accordance with Article 5 of ASME Section V may be substituted for radiography of a completed weld subject to Company's approval and only providing following conditions are met:

- Inside surface of weld shall be 100% visually examined.
- When welding is performed from both sides of joint, inside surface of weld shall be 100% inspected by magnetic particle technique.
- Outer surface of weld shall be 100% inspected by magnetic particle technique.
- Client/Company shall be given the opportunity to witness all NDE on weld in question.
- Transducers shall operate at a frequency between 1 MHz and 5 MHz.

8.4.7 NDE reference points shall be marked on the work piece by an Approved method and clearly identified in NDE reports.

8.4.8 The general substitution of ultrasonic examination for radiography is not acceptable for hydrocarbon services except for systems where the wall thickness exceeds 19 mm or when approved.

8.5 Acceptance Levels For Defects

8.5.1 Limitations on defects shall be as stated in the Code, except as follows:

- Incomplete penetration is not allowed for any butt or branch welds of Inspection Classes 1 or 2

8.5.2 Additional limitations for various materials are to be approved by the Company.



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8.6 NACE Service Material

- 8.6.1 For CS, LTCS and Stainless Steel Type 316, hardness measurements shall be carried out on specimens from the parent metal, weld metal and the heat affected zone (HAZ). Hardness shall be less than 22 HRC.

All process piping as indicated in isometrics shall fulfill the requirements of NACE MR-0175/ ISO 15156. Accordingly heat treatment where required shall be performed as per ASME section VIII to achieve the required hardness of welding joints.

8.7 Repair Welding

- 8.7.1 Repairs shall be carried out in accordance with the approved procedure and shall be subjected to 100% NDE using the same methods as specified for the original weld.
- 8.7.2 Weld repair procedures shall be qualified by a test weld which simulates the repair technique, unless the repair is effected using an identical weld procedure to that of the original weld.
- 8.7.3 All repairs to pipe work shall be specifically recorded.

8.8 Production Mechanical Tests

- 8.8.1 For inspection, when required in case of high pressure lines, when the number of welds made using a particular weld procedure exceeds fifty, one production joint shall be cut out for mechanical testing for every one hundred (or part thereof) welds made. Joints to be cut shall be selected by the Company. The Contractor shall restore the affected line by welding a new piece of material of the required quality and size.
- 8.8.2 Each production test weld shall be subjected to the same mechanical testing as the corresponding procedure qualification test and shall meet the same requirements. In the event of failure to meet specified requirements, the Company may require additional tests to be made or may require more stringent NDE acceptance criteria.

8.9 Production Hardness Testing

- 8.9.1 For carbon steel subject to PWHT and/or post bending heat treatment hardness checks shall be performed on welds and/or bends as follows:



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- Where complete spools are furnace heat treated, 10% of welds and 10% of bends in each furnace charge.
- For any other method, 100% of welds and bends.

The extent of testing may be reduced at the Company's discretion if satisfactory results are consistently being achieved.

8.9.2 The test shall be performed by the portable Brinell method according to ASTM E110 using a "Poldi", "Tele Brineller" or other tester (such as "Equotip") subject to written agreement with Company. For welds each check shall consist of two indents with one in the weld bead and one in the base material as close as practicable to the edge of the weld. The macro-hardness values shall not exceed 200 BHN for carbon steel welds or 225 BHN for ferritic alloy welds.

8.10 Hydrostatic Testing

8.10.1 Contractor shall submit a detailed procedure for hydrostatic testing for Company's approval. Testing shall be performed in accordance with the approved procedure.

8.10.2 Pressure testing shall be carried out after completion of cleaning and flushing operations and before painting or insulation of the pipe work. Pressure testing may be integrated with flushing following pickling operations; however, if rusting of the pipe work is likely to occur after pressure testing; pickling shall be carried out after pressure testing and before drying.

8.10.3 Pipework which is to be pressure tested shall be prepared as follows:

- Positive displacement meters and their strainers, turbine meters, orifice plates, rupture discs, control valves, relief valves and all in-line instruments shall not be installed or, if already installed, shall be removed and replaced by a dummy spool, spacer or blind flange, as appropriate;
- All in-line valves shall be in the fully-open position; check valves may be left in-situ provided that the source of pressurization is upstream and that, after testing, a the system can be relieved/drained downstream;
- Block valves shall be in the fully-open position, with a blind flange fitted;



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- All equipment, such as vessels, pumps etc., shall be blanked off;
- The pipe work to be tested shall be fitted with a vent at each high point and a drain at each low point;
- Spring pipe supports and other variable type supports shall be blocked to prevent movement.

8.10.4 At least two pressure gauges shall be fitted and these shall be positioned at the highest and lowest points in the pipe work. The pressure gauges (dial size 4”) shall be selected to show the required test pressure at between 50% and 90% of full-scale deflection and shall be calibrated prior to use. To permit temperatures effect to be correctly accounted for, pipe work temperature shall be monitored in representative locations by thermocouples; where possible, combined pressure/temperature/time recorders shall be used to provide a permanent record of each test.

8.10.5 Unless otherwise specified, the test fluid shall be cleaned with fresh water. For pipe work which includes stainless steel, the water shall contain 15 ppm maximum chloride. The pipe work shall be filled slowly with the test fluid, with all vents and other connections which may serve as vents, open to allow air to be expelled.

8.10.6 Pressure testing shall be carried out, generally in accordance with the Code. The test pressure shall be as shown on the relevant piping class data sheet (see project Piping Material Specification). The test pressure shall be held for sufficient time to permit all joints to be inspected, with a minimum duration of 1 hour.

8.10.7 After completion of the test, the pressure shall be released slowly. The vents shall be opened and then the test fluid shall be drained out. All drains shall be opened to ensure that the test fluid is removed.

8.11 Flushing

8.11.1 After successful completion of hydrostatic testing, the lines shall be cleaned by flushing, blowing or swabbing.

8.11.2 The PC Contractor shall provide the equipment required and shall carry out all operations involved in cleaning.



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- 8.11.3 All foreign material e.g. scale, rust, dirt, welding rods, etc., shall be removed from the inside of the piping system.
- 8.11.4 Compressors, pumps, control valves, relief valves, filters, steam trap and instruments shall be removed before cleaning operations. The PC Contractor shall provide temporary connections to bypass these items. After these items in the piping system using new gaskets.
- 8.11.5 Steam and gas piping shall be blown with compressed air until it is completely clean.
- 8.11.6 Other lines shall be flushed with water till they are completely clean.
- 8.11.7 Cleaning operations shall be performed until Client is satisfied that the piping systems are thoroughly cleaned.

8.12 Test Records

Records shall be made of each piping system or pipe section thereof, during the testing procedure. All related documentation shall be sent to the Client for information. These records shall include:

- 1) Date of test
- 2) Isometric view of tested pipe section with test duration and identification.
- 3) Test fluid full specification including possible inhibitor etc.
- 4) Test pressure in gauge bar
- 5) Certification by the field Client
- 6) Photocopy of the chart showing both pressure and time of test

The following requirements are additional with regard to the article 345.2.7 of chapter VI of ASME B31.3 code.

8.13 Post Test Works

The PC Contractor shall be fully responsible for removal of the water used for cleaning and testing operations.



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The PC Contractor shall supply all necessary devices and works, such as temporary connections, draining lines and/or ditches as may be necessary, connected to the general plants drainage system with the previous approval of the Client.

Upon completion and acceptance of tests, provisory devices as previously described, shall be removed, and jobsite left in its final contractual like condition according to the relevant drawings issued and/or approved by the Client. The gaskets shall be renewed on dismantled flanged joints.

8.14 Repairing

In case leaks have been detected, the following procedure shall apply:

- Repairing works shall be performed according to ASME B31.3.
- The repaired section shall be brought up to full test pressure.
- The pipe section shall be allowed to stabilize with respect to temperature, and the test started and run for the full time period required. See here above Para about testing.
- In all cases, leaks which develop during the test and cause the pressure to fall shall be cause for the test to be restarted.
- The documentation to be supplied shall be according to MW-1031 and the present specification.

8.15 Cleanup and Acceptance

8.15.1 Cleanup

Further to welding, testing back filling and CLIENT's acceptance of said works, the PC Contractor shall be responsible for clearing up the job site.

Structures shall be placed in condition as good as or better than at the beginning of constructions. These repairs shall be satisfactory to the CLIENT and his tenant. PC Contractor shall restore to original condition all public Rights-of-Way, which have been interrupted by the works.

PC Contractor shall remove from site all materials, including the pipes, left along the right-of-way after the construction work, whether owned by himself or by CLIENT and shall deliver CLIENT's materials, at points as designated by CLIENT.



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PC Contractor shall remove from the premises all equipment, tools and appliances, which were used by him in the performance of the work.

PC Contractor shall be responsible for all claims, which may result from damage done by him off the right-of-way of the pipeline and plant area. PC Contractor shall make all and any repairs and restorations and shall satisfy all proper claims.

8.15.2 Acceptance

Upon completion of the works, and conformity with the mentioned rules being checked, the CLIENT's acceptance will take place according to the terms and procedures as defined in API Standard 700 latest edition and completed and/or amended by the contract terms.

9.0 CORROSION PROTECTION

9.1 Cleaning

- 9.1.1 On completion of fabrication, the Contractor shall clean inside and outside of all fabricated assemblies to ensure removal of all loose scale, dirt, sand, weld spatter, cutting chips, etc.
- 9.1.2 When pipe work is to be pickled, pickling of pipe work shall be carried out in accordance with the appropriate specification.

9.2 Galvanized Pipework

- 9.2.1 Unless otherwise specified, pipe work of 1½” NB and smaller, designated as galvanized shall be fabricated from pre-galvanized pipe and fittings and shall be of screwed construction.
- 9.2.2 Pipework 2 inch NB and above designated as galvanized, shall normally be of welded construction and shall be hot dipped galvanized after fabrication. Spool sizes shall be chosen to suit available galvanizing facilities.



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9.2.3 Cleaning, galvanizing and subsequent painting of fabricated pipe work shall be in accordance with the Painting Specification.

9.2.4 Any damage to galvanized coatings, such as cutting back for field welding, shallow wrench markings or exposed pipe threads shall be repaired in accordance with the Painting Specification.

9.3 Coating

9.3.1 Surface preparation and painting or coating shall be carried out in accordance with the Painting Specification.

9.3.2 Shop fabricated pipe spools in carbon steel shall be prepared and primed as soon as possible after completion of fabrication, inspection and testing.

9.4 Preservation

9.4.1 After internal cleaning and inspection, all ends; shall be closed off and sealed to prevent mechanical damage and ingress of dirt or water. Flange gasket surfaces shall be protected with a corrosion preventative compound, in accordance with the Project Specification for Preservation and Packing, and covered with either 3 mm thick cover of the same metal as the flange or high density polyethylene sheet with 10 mm thick plywood cover. Covers shall be secured by at least 4 bolts.

9.4.2 Threaded connections shall be sealed using caps or plugs distinctively colored to identify threaded connections.

9.4.3 When open ends of pipes are to be left overnight or between shifts, cover plates or caps shall be fixed to avoid ingress of dirt or water.

10.0 MARKING

10.1 General Requirements

10.1.1 Pipe spool identification shall be clearly written on the pipe using non-corrosive white paint. Die stamping; scratching or bead welding of pipe identification is not permitted.



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10.1.2 If temporary identification markings will be obscured by cleaning, painting, heat treatment or other operations, marking shall be die stamped on a compatible metal disc securely wired to the fabrication.

10.1.3 Loose piping items and fabrications too small for individual paint marking, which will be supplied in hessian or canvas sacks shall be identified using die stamped metal discs securely wired to individual items or to the sack in which case the identification disc shall also denote the contents of the sack.

10.2 Material Certification

10.2.1 Each batch of free issue piping material will be marked and identified by the Mill with the Heat Number corresponding to Heat Number on the Material Certificate.

10.3 Line Identification Code

10.3.1 Each line will be designated with an identification code which will be referenced and used on Company's approved drawings and schedules.

10.3.2 Line identification code will be a composite code containing reference numbers and abbreviations for the following:

- Area
- Service
- Line Number
- Nominal Line Size
- Piping Pressure Class
- Piping Material Class

10.4 Spool Identification Numbers

10.4.1 Each individual spool supplied as a separate item for installation shall be allocated a spool identification number with which it shall be identified.

10.4.2 Spool sequence numbers shall be of two digits, commencing with 01 and shall follow numerical sequence in the direction of flow indicated on the piping isometric. Unless pre-specified on the approved drawings, spool numbers shall be agreed between the Contractor and the Company.



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- 10.4.3 Composite spool identification numbers shall comprise the line identification code without insulation code, plus a spool sequence number plus an additional area or module reference if advised by the Company.

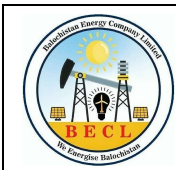
11.0 INSTALLATION OF PIPEWORK

11.1 General Requirements

- 11.1.1 Pipe work shall be installed in accordance with the codes and standards specified in Section 2.0 and the Client approved piping general arrangements, supporting drawings, specifications and schedules.
- 11.1.1 Installation of pipe work shall be carried out under conditions satisfactory to Client.
- 11.1.2 All work performed and complete must meet the approval of Client.
- 11.1.3 The scheduling of work to carry out the installation of pipe work shall be coordinated with the work schedule of other trades and discipline involved in the overall construction. The schedules shall be prepared to the satisfaction of and agreed with Client.

11.2 Pipe Work Erection

- 11.2.1 All pipes shall be inspected before erection to ensure that they are perfectly clean internally.
- 11.2.2 Where possible, pipe work shall be erected on permanent supports designated for the line.
- 11.2.3 During erection of pipe work, suitable supports are to be provided to ensure that no undue stresses are imposed on the pipe.
- 11.2.4 Control or block valves shall not primarily be used to support pipe work.
- 11.2.5 Temporary supports and assemblies used to facilitate the erection of pipe work shall meet the approval of Client regarding safety and suitability.
- 11.2.6 Care shall be taken to avoid undue strain being placed on a vessel or item of equipment etc., by unsupported lengths of piping.



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- 11.2.7 Drainage falls shall be maintained throughout as specified on the drawings.
- 11.2.8 It should be noted that vessel flanges generally are not set sufficiently true to permit prefabrication of the mating pipe flanges without prior checks being made.
- 11.2.9 Where drawings show flanges loose on a closure length of piping, a careful physical check shall be made of closing distance and alignment of flange before cutting and pipe and welding on the flanges.
- 11.2.10 The PC Contractor shall ensure that piping connected to equipment is supported so that minor equipment, valves etc., can be readily removed without further supporting of the pipe and with the minimum of dismantling.
- 11.2.11 The erection of a spool incorporating cut to fit requirements shall be carried out taking full advantage of the inbuilt adjustment to avoid undue stresses in the completed pipe line, the only exception to this shall be when 'cold pull' is specified on the piping drawings, in which case the specified pre-mating gap shall be carefully maintained and the pull made against permanent and secure support anchors.
- 11.2.12 Pipe work shall be fitted into place without springing or forcing.

11.3 Flanged Joints

- 11.3.1 All flanged joints shall be brought up flush and square so that the entire mating surfaces bear uniformly on the gasket, and then made up with uniform bolt tension.
- 11.3.2 It is recommended that the maximum differential stress between two bolts in a flange joint shall not exceed 20% of the lower stress.
- 11.3.3 When bolting flange joints with spiral wound gaskets, the gasket shall be compressed evenly to the thickness of the guide ring. This would be equal to 25% to 35% compression of the original gasket thickness (gasket compression shall be spot checked during bolt tensioning),
- 11.3.4 Steel to cast iron flanged joints shall be made with extreme care, taking up bolts uniformly after careful lateral and parallel alignment.



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11.4 Equipment Flange Connections

- 11.4.1 Flange covers shall be retained on all flange connections to pumps, compressors, turbines and similar mechanical equipment until ready to connect the mating piping.
- 11.4.2 Unless called for hydrostatic test blanks are fitted at the connections to equipment covered in 9.4.1 above. A thin metal plate shall be inserted to protect the equipment against ingress of internal pipe debris resulting from the continuing erection of the piping.
- 11.4.3 Flanges connecting to strain sensitive mechanical equipment e.g., pumps, compressors, turbines, inline instruments etc. shall be fitted up in close parallel and lateral alignment prior to tightening the bolting. To achieve this true alignment, full advantage shall be taken of the 'cut to fit' allowances and loose flanges provided.
- 11.4.4 Flange connections to strain sensitive equipment shall be the last connection made on completion a line or interconnecting system of lines complete with permanent supports.
- 11.4.5 All openings in vessels, columns and other similar equipment items shall be clean and free from obstruction prior to being connected to the pipe work.

11.5 Clamp Type Connector Joints

- 11.5.1 Clamp type connectors shall be installed in accordance with the manufacturer's installation instructions.
- 11.5.2 Hub protectors shall remain on the hubs until they are welded into place or when the connection is toeing assembled.
- 11.5.3 All lubricants and foreign matter shall be cleaned from the hub seating surface and seat ring prior to installation of the connector. The sealing ring should be lubricated only when no coating or plating is present on the seating surface.
- 11.5.4 Correct alignment of the stubs, seal ring & clamps shall be checked before assembly.
- 11.5.5 Torque wrenches are recommended for large stud sizes ($1\frac{5}{8}$ " and larger) to ensure that the minimum preload values are met.



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11.6 Gaskets and Jointing

- 11.6.1 The PC Contractor shall ensure that the correct gasket material and thickness as specified in the Client approved Piping and Valve Materials Specification is used.
- 11.6.2 The PC Contractor shall ensure that correct gasket lubricant as specified and required by the Client approved Piping and Valve Materials Specification is used.
- 11.6.3 Care shall be taken to ensure that the gasket and mating flanges are clean true and free from defects.
- 11.6.4 Joint rings will be supplied as pre-cut joints and shall be set inside the bolt circle.
- 11.6.5 The PC Contractor shall ensure that joint rings do not under any circumstances protrude into the bore.
- 11.6.6 The PC Contractor shall install insulated joint rings, sleeves and washers where indicated on the isometric piping drawings.
- 11.6.7 Electrical testing on insulated joints shall be carried out by the PC Contractor. Each stud bolt shall be 'megged' in turn to each flange and between adjoining flanges.
- 11.6.8 The annular space between insulated flanges shall be completely filled after testing with either hot or cold electrical compound and the whole outer periphery of the flanges shall then be wrapped with 0.3 - 0.5mm thick PVC tape.

11.7 Bolting

- 11.7.1 The PC Contractor shall ensure that all bolting materials and types used are in accordance with the service requirements as specified on individual material specifications in the Client approved Piping and Valve Materials Specification.
- 11.7.2 All flanges bolting shall be checked for correct grade and damage prior to fittings.
- 11.7.3 All flange bolting shall be free to move through mating flanges holes to a plane at right angles to the flange (ace and parallel to the pipe run (misalignment of flange holes resulting in knurling of the nut on the flange will be rejected).
- 11.7.4 All flange stud bolts shall extend fully through their nuts.



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- 11.7.5 Stud bolts cut from long lengths of studding shall have the material grade stamped on the end at each cut.
- 11.7.6 All nut bearing faces, bolt threads shall be lubricated with API 5A2 or equal lubricant during fittings.
- 11.7.7 Bolt tension shall be applied in three stages using the diametrical sequence. 1st stage 25%. 2nd stage 50%. 3rd stage 100%.
- 11.7.8 The PC Contractor shall re-check all bolting for tightness and correct tension on completion of pressure testing.
- 11.7.9 Bolting for ANSI Class 600# and above on size 1½" and over will be one diameter longer and installed using a hydraulic tensioning device.

11.8 Valves

- 11.8.1 Valves shall be orientated in the line so as to be readily operable, and removable, either fully or in part.
- 11.8.2 Gate, Butterfly and Globe valves in horizontal lines shall be installed with their stems orientated as follows in order of preference:

Manual

- a) Vertically upwards
- b) Horizontal (Preferable for Butterfly Valves)
- c) Upwards of 45 deg.

Actuated

- a) Gate/Globe, (including 3 way and Y type) shall only be mounted with the stem vertically upwards.
 - b) Rotary valves (butterfly, throttling ball. etc.) shall only be mounted with the stem horizontal.
- 11.8.3 The PC Contractor shall provide for the checking of gland packing in all valves and for leakage during hydrostatic testing.



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11.8.4 All but welds and socket welded valves shall be tack welded in the position shown on the piping drawings and approval of position obtained from Client before carrying out final welding.

11.9 Pipe Supports

11.9.1 Pipe supports shall not be welded to the pipeline unless specified in the design and piping isometric drawings.

11.9.2 Pipe support elements which are welded directly to the pipeline shall be attached by non-penetrating welds during the fabrication of the pipe or pipe spool. Welding shall be to approved welding procedures in accordance with Welding and Inspection of Piping Specification.

11.9.3 The PC Contractor shall ensure that only supports of the type specified in the design and piping drawings are used.

11.9.4 During installation pipe lines shall not be forced so as to suit the installed support and thereby introduce undue stresses into the line.

11.9.5 Permanent pipe supports shall be installed before the erection of pipe work associated with them.

11.9.6 The PC Contractor shall, ensure that adequate support of heavy valves and fittings before the pipe work is subjected to pressure test or put into service.

11.9.7 Attachment by drilling or welding to structural steel on site shall be carried out only with the approval of Client.

11.9.8 The burning of holes in structural steelwork or component parts is strictly forbidden.

11.9.9 Supporting steelwork shall be set at the correct elevation, being true and level in all respects.

11.9.10 Metallic surfaces of supports which will be inaccessible after erection shall receive a protective coating of paint before assembly of the component, in accordance with the General Painting Specification.



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- 11.9.11 All welding of supports shall be carried out using continuous fillet welds.
- 11.9.12 Hanger rods shall be adjusted to hang correctly after tightening of all component parts/surplus threading may be removed.
- 11.9.13 Pipe hangers shall not be used as temporary lifting attachments.
- 11.9.14 The use of adjacent structures or equipment as temporary supporting of listing attachments shall not be permitted unless authority has been obtained from Client.
- 11.9.15 Spring support units shall be installed in accordance with the manufacturer's instructions and shall not have 'stops' removed until completion of testing. 'Stops' shall be color tagged by manufacturer for identification.
- 11.9.16 The PC Contractor shall ensure that all temporary supports and lashings are removed after the pipe work has been flushed and pressure tested.

11.10 Branch Connections

The branch connections shall be in full compliance with the material specifications according to the piping system.

They shall also comply with the ASME B 31.3 article 304-3, branch connections in metallic piping.

In case of conflict statement the piping classes overrule the ASME B31.3 requirements.

All branch connections shall be jointed to the header with full penetration welds.

All instrument air connections, if any, shall be from the top of the header.

11.11 Instrumentation

- 11.11.1 In-line instruments e.g. Orifice plates, control valves, shut down valves, meters etc. shall be installed by the PC Contractor under the direction and control of the CLIENT's/Engineering Consultant's Instrument Engineer.
- 11.11.2 All instruments installed shall be capable of complete or part removal for maintenance purposes



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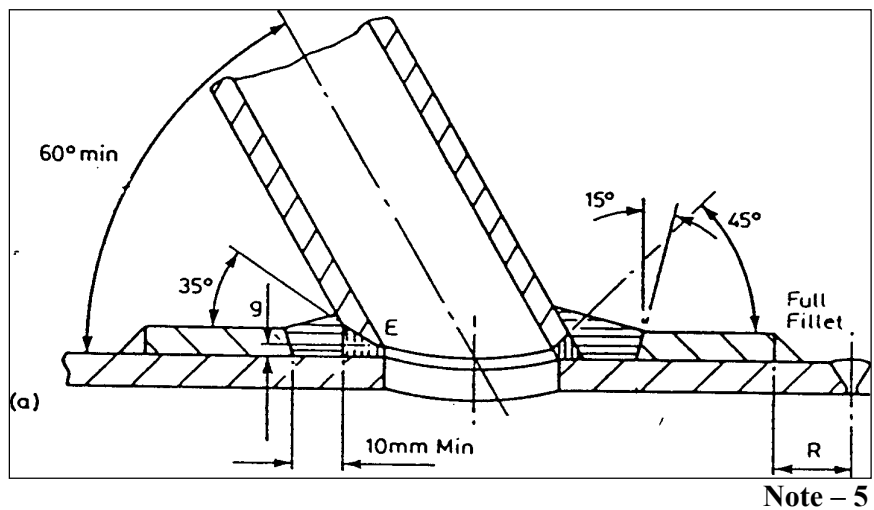
- 11.11.3 Unless otherwise instructed by Instrument Engineering, in-line instruments shall not be installed prior to pressure testing of the pipe work.
- 11.11.4 As specified by the Flushing & Pressure Testing Specification the PC Contractor shall fit "dummy" spools in place of in-line instruments during erection to facilitate pressure testing.

11.12 Field Run Pipe work

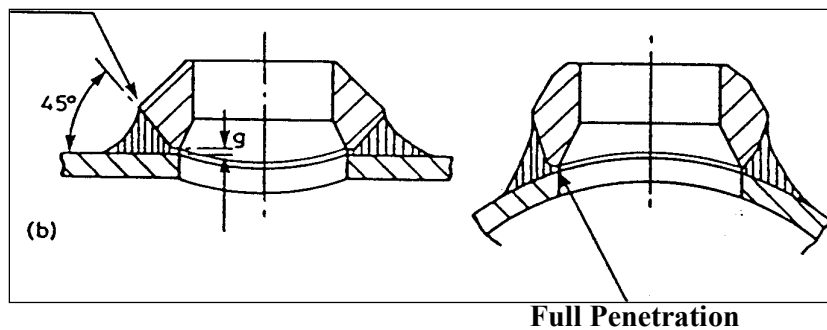
- 11.12.1 Field run lines shall normally be restricted to pipe work of 1.5" nominal bore and below. Galvanized pipe will be field run at sizes 2" NB and below.
- 11.12.2 Field run lines shall be run in accordance with the routing indication on the piping drawings and to the satisfaction of Client.
- 11.12.3 All field run lines shall be installed in an orderly manner, consistent with good operation, neatness of appearance, safety of personnel, economy and usage of the minimum number of fittings consistent with provision for expansion and flexibility.
- 11.12.4 All piping shall be arranged to facilitate supporting and shall be planned for ease of removal of equipment for inspection and servicing.

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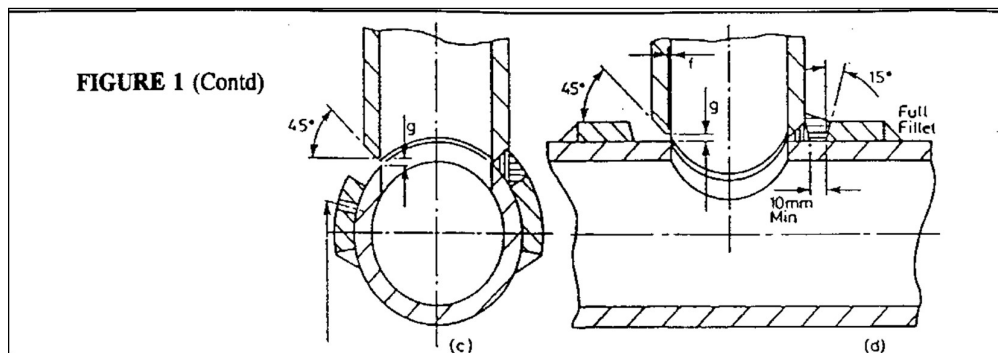
FIGURE 1: BRANCH REINFORCEMENT DESIGN



Full Pen" Butt



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6mm Vent Hole to be tapped NPT

Dimensions for Root Face and Gap

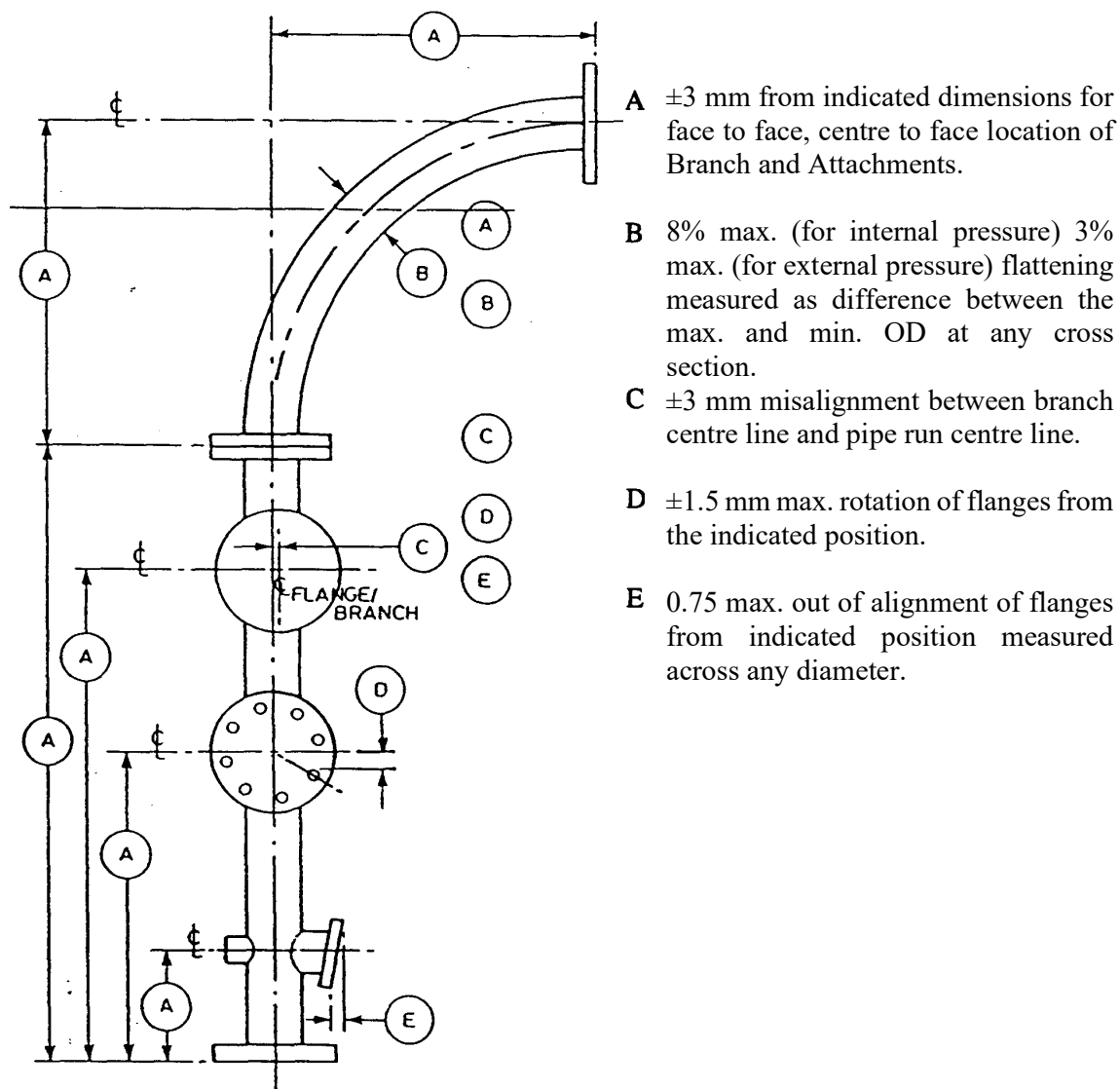
THICKNESS	SMAM		GTAW/GMAW	
(mm)	g(mm)	f (mm)	g(mm)	f (mm)
≤ 22	1.6-4.0	0.8-2.4	0.8-1.6	1.2-2.5
>22	2.5-4.0	0.8-2.4	1.6-3.0	1.2-2.5

Notes

- Reinforcement pads may be split circumferentially or along the axial centre-line and rewarded to the header by full thickness/full penetration weld.
- In all cases the reinforcing pad shall be attached after the branch to header weld has been made and examined.
- Fig 1(a) applies to angled branches in which the branch to header angle is less the 75°. Angles less than 60° are not permitted unless otherwise specified.
- If the crotch weld of angled branches cannot be made from the outside with proper penetration, the weld at "E" shall be made from the inside for 1/3 times diameter of the branch, i.e. 1/6 x D on each side of the axial centre-line.
- Dimension R = 6 times thickness of the header as a minimum.
- If branch reinforcement pads/plates are used the branch connection weld shall be inspected before the reinforcement pad/plate is fitted. The reinforcement weld shall also be examined.
- When socket welds are permitted, they shall be subject to MPI/DPI only.

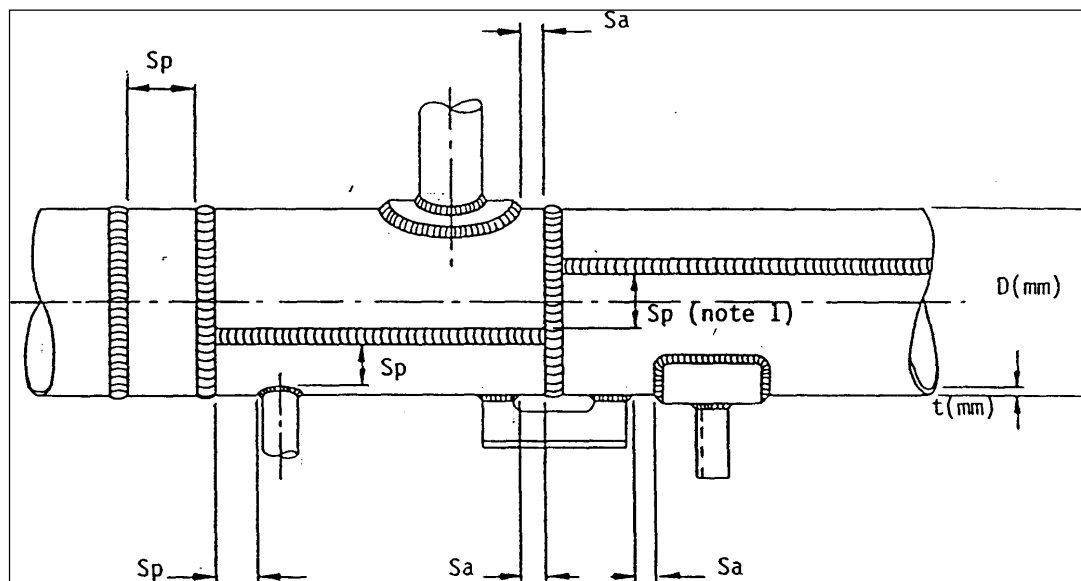
SPECIFICATION FOR FABRICATION & INSTALLATION OF PIPING

FIGURE 2: DIMENSIONAL TOLERANCES FOR FINISHED PIPEWORK



SPECIFICATION FOR FABRICATION & INSTALLATION OF PIPING

FIGURE 3: PROXIMITY OF WELDS



Separation S = Sp or Sa as applicable.

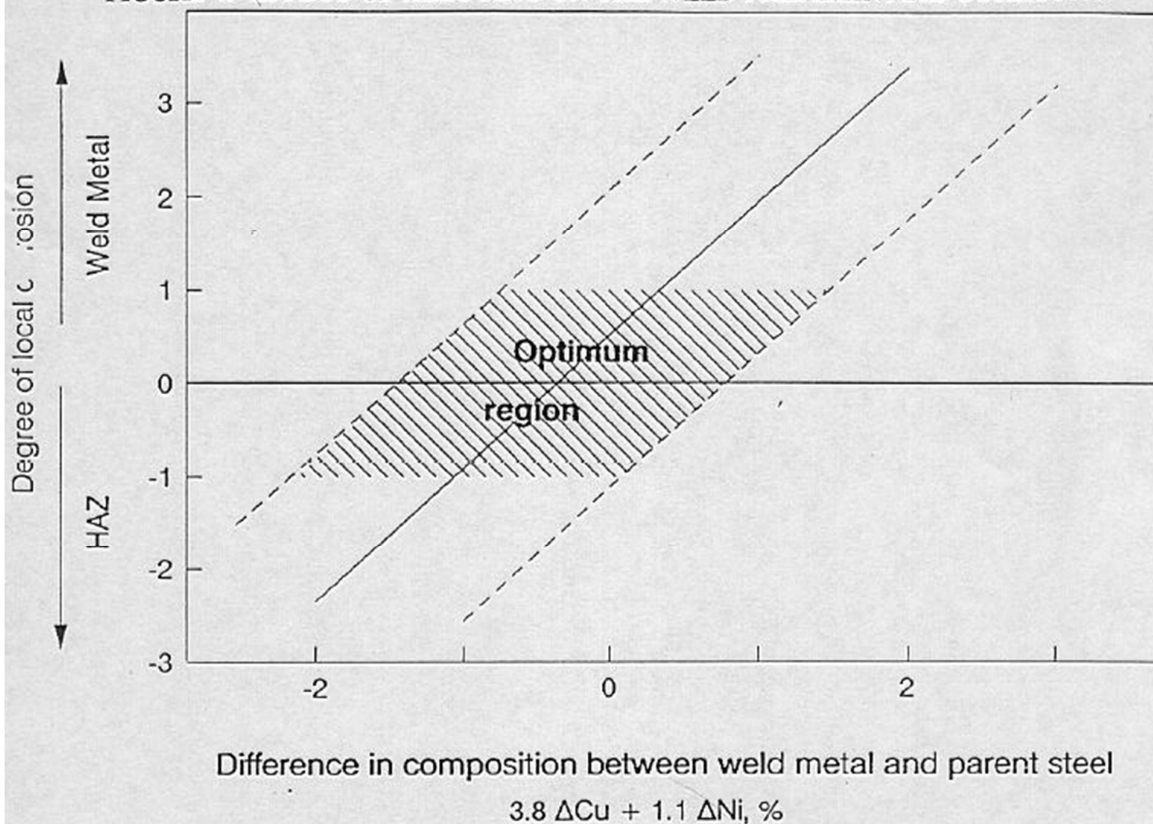
Where Sp = Separation between any two pressure containing welds
 = 100 mm (above 4" NB)
 = 1 diameter (4" NB or less) - can be reduced to 'the greater of 3 times the wall thickness or 40 mm minimum.

and Sa = Separation between an attachment weld and any other weld
 = 40 mm minimum.



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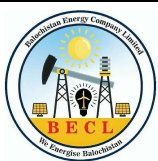
FIGURE 4: EFFECT OF ALLOYING ON THE WELD PREFERENTIAL CORROSION



EFFECT OF ALLOYING ON WELD PREFERENTIAL CORROSION

(ref. D.N.Noble, Welding & Metal Fabrication, July 1991, pp293-298)

This graph is for information only



SPECIFICATION FOR FABRICATION & INSTALLATION OF PIPING

TABLE 1: TYPE AND NUMBER OF MECHANICAL TEST SPECIMENS AND NDE REQUIREMENTS FOR WELDING PROCEDURE QUALIFICATIONS TESTS

Joint Configuration	Pipe Wall Thick. t (mm)	Non –Destruct. Examination (100%)	Cross Weld Tensile Tests	Bend Tests	Charpy V-Notch Tests	Hardness Macro Tests
Butt-weld	t < 19 19 ≤ t < 30 t ≥ 30	RT+MPI+Visual RT+MPI+Visual RT+MPI+Visual	2 2 2	2 root + 2 face 4 side 4 side	4 4 5	2 2 2
Branch-weld	t < 19 t ≥ 19	UT+MPI+Visual UT+MPI+Visual				2 2
Fillet/Part Pen. Weld	All	MPI+Visual				2

TABLE 2: PRE-HEAT REQUIREMENTS FOR CARBON STEEL

Combined Thickness,	Minimum pre-heat, °F		
	Low Hydrogen (max 10 ml/100 g)		
	Heat Input:		
	<1 (kj/mm)	>1 (kj/mm)	>2 (kj/mm)
<30	-	-	-
<35	122	-	-
<40	167	-	-
<45	212	-	-
<50	212	-	-
<55	257	68	-
<60	257	122	-



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TABLE 3: WELDING INSPECTION REQUIREMENTS APPLICABLE FOR DESIGN, SUPPLY & COMMISSIONING

Piping Class	Visual Inspection	Service	Radiography	Rating
A1	100%	Non-hydrocarbon	5%	150#
B1	100%	Hydrocarbon	10%	150#

Any line with wall thickness over ½" (12.7mm) shall be 100% radio graphed.

All Tie-in but welded joints shall be 100% radio graphed



SPECIFICATION FOR FABRICATION & INSTALLATION OF PIPING

APPENDIX A - ADDITIONAL REQUIREMENTS FOR LOW TEMPERATURE SERVICE

1.0 GENERAL

- 1.1 This Appendix applies to all pressure-containing materials and direct attachments which may be subjected to low temperatures during their operational life. It includes low temperatures arising from non-normal service such as auto-refrigeration during blowdown.
- 1.2 All Carbon steel piping systems shall comply with the requirements of the Codes.
- 1.3 All charpy impact tests shall be V-notch type, performed in accordance with ISO R148.
- 1.4 When weld metal impact tests are specified sufficient sets of samples shall be taken and so notched as to represent each process and consumable brand used in the welding of the joint. Branch and attachment weld procedures shall be qualified by a butt-weld joint which has been subjected to Charpy impact testing.

2.0 IMPACT TESTING REQUIREMENTS

2.1 Carbon Steel

- 2.1.1 All pressure-containing items, and attachments directly welded to such items, shall comply with ANSI B31.3, except as modified by the Piping and Valve Specification.
- 2.1.2 All weld procedures for pressure-containing welds shall be qualified by appropriate procedure qualification tests which shall include charpy impact testing of weld metal and heat-affected zone, in accordance with ANSI B31.3,.
- 2.1.3 Heat affected zone impact testing is required on all production test coupons representing low temperature piping.

Heat affected zone impact tests shall comply with the requirements for the parent material, as stated in the Piping and Valve Specification.



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2.2 Stainless Steels and Dissimilar Metal Joints

- 2.2.1 Weld procedures for welds in austenitic stainless steels and for welds between these materials and ferritic steels, shall be subject to charpy V-notch impact testing of the weld metal only. Test requirements shall be the same as specified by ANSI B31.3.
- 2.2.2 When dissimilar joints, which include ferritic steel, are tested, additional impact tests shall be taken from the ferritic heat affected zone. Test requirements shall comply with ANSI B31.3.
- 2.2.3 Weld procedures for welds in duplex austenitic - ferritic steel shall be subject to the same requirements as for carbon steel. When the impact energy requirements of the above cannot be met, impact tests may be accepted if they comply with a minimum average lateral expansion of 0.38 mm, minimum individual lateral expansion of 0.25 mm.



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APPENDIX B - ADDITIONAL REQUIREMENTS FOR 300 SERIES STAINLESS STEEL PIPING

1.0 SCOPE

- 1.1 This appendix covers the special requirements for the fabrication of stainless steels (300 series).
- 1.2 This appendix applies to the following materials:
"18-8" type austenitic stainless steels, including: 304, 304L, 316L, 321 types and other stainless steels as specified by the Company.

2.0 GENERAL

- 2.1 Fabrication of stainless steel shall be carried out in an area separate from that used for carbon/low alloy steels and copper alloys.
- 2.2 Saws, grinders and other tools used on stainless steel shall not be used on other materials.
- 2.3 Cold bends shall be made at or below 797°F, followed by solution annealing.
- 2.4 Hot bends when permitted shall be made at 1697°F - 2102°F followed by solution annealing. Prior to hot bending, stainless steel shall be free from grease, soap and any compound containing sulphur, halogens or low melting point metals.

3.0 WELDING

3.1 Preparation

Cutting shall be by cold sawing or plasma-arc process. Fused edges and heat-affected zone from plasma-arc cutting shall be removed by grinding or machining.

3.2 Process

- 3.2.1 Gas Tungsten Arc Welding (GTAW) shall be used for root runs of single-sided welds. The argon gas back purge shall be maintained during the first filler pass.



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- 3.2.2 Submerged arc welding (SAW) shall not be used, except for welding of heavy sections with Company's prior approval, when heat input shall be restricted to 4 kJ/mm maximum.

3.3 Consumables

- 3.3.1 Welding consumables for conventional austenitic stainless steel shall be as follows:

Material	Consumable Type (AWS designation)
Type 316 or 316L	E316L or ER316L
Type 321	E347 or ER347
Type 304 or 304L	E308L or ER308L

- 3.3.2 For the welding of conventional austenitic stainless steels to carbon steel, E309/ER309 (or E309Mo/ER309MO for joining Type 316/316L to carbon steel) shall generally be used, provided post-weld heat treatment is not required. When post-weld heat treatment is required, E Ni Cr Fe-3 consumables shall be used.

- 3.3.3 Consumables for stainless steels shall produce deposits with 3 to 10% ferrite.

3.4 Heat Control

- 3.4.1 Maximum interpass temperature shall be 302°F.
- 3.4.2 Pre-heating and post-weld heat treatments are not required unless required for ferritic steel in a dissimilar-metal joint.

3.5 Procedure Qualification

- 3.5.1 Weld procedure qualification tests for stainless steel shall be carried out on the same type and grade of material as used in production.

4.0 CLEANLINESS REQUIREMENTS

4.1 Protection of Bore

- 4.1.1 The bore of pipes and other components shall be protected from oxidation during welding by inert gas purge.
- 4.1.2 The extent of purging and/or the use of dams to confine the gas purge shall be specified in the weld procedure specification.



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4.2 Limits of Oxidation

- 4.2.1 Light oxidation of the weld/HAZ is acceptable. This is generally evidenced by discoloration varying from straw to dark brown.
- 4.2.2 Heavier oxidation, as evidenced by dark blue weld metal and/or the formation of a coke-like surface, has a deleterious effect on the corrosion resistance in service and hence is unacceptable.

4.3 Remedial Action

- 4.3.1 Heavily oxidized surfaces, spatter, welding slag and other residues shall be removed by grinding. The final surface condition shall be attained by light grinding with rotary abrasive papers/cloths and by pickling.

5.0 INSPECTION AND TESTING

5.1 Visual Examination

- 5.1.1 All welds shall be 100% visually examined after completion.
- 5.1.2 Weld procedure qualification test assemblies for all stainless steels shall be subject to internal bore examination for correct weld profile and discoloration.

5.2 Non-Destructive Examination

- 5.2.1 The extent of examination shall be as indicated in ANSI B31.3.

5.3 Acceptance Criteria

- 5.3.1 Criteria for cleanliness are given in 4.2 and 4.3.
- 5.3.2 The following features are unacceptable:
- Any cracks
 - Any lack of fusion or lack of penetration at the bore surface
 - Surface-breaking porosity.