

2. 18002 Attachment B - Examination and Testing Requirements.
3. 18002 Attachment C - Welding Inspection Log.
4. 18002 Attachment D - Contractor's Proposed Welding Process Checklist.

1.04 SUBMITTALS

- A. Not Applicable.

1.05 QUALITY ASSURANCE

- A. All work within the scope of this specification shall be performed in accordance with this specification and all applicable related documents. No deviations shall be made from this specification or any applicable related documents, without the prior written authorization of the Owner or his Representative for each deviation. The application for each deviation shall completely and specifically define the location of, the nature of, and the reason for the proposed deviation.
- B. In general, fabrication, of any part may be prefabricated at a pipe fabrication shop or at an on-site pipe shop at the option of the Contractor subject to the approval of the owner or his Representative provided pre-assembly does not conflict with erection requirements and sequence of erection hereinafter specified. All drawings required for shop fabrication shall be the responsibility of the Contractor.
- C. It shall be the fabricator's responsibility in dimensioning and fabricating assemblies to conform with the overall piping dimensions as shown on the piping drawings. Piping drawings are drawn to scale, but are not showing weld symbols, thread or socket ends.
- D. All dimensions and locations of piping shall be field verified prior to fabrication and erection to assure accuracy of critical dimensions and freedom from interferences.
- E. The Contractor shall make allowances for normal field corrections which should be expected for this type of project. No extras will be paid for any portion of additional work required because of the Contractor's failure to field check dimensions and finalize penetration locations prior to fabrication.
- F. The Contractor shall allow for field fit-up of piping in order to align with final locations of drilled concrete core holes or chases.
- G. The Contractor shall obtain clearance from the Owner's plant site personnel prior to drilling, cutting, or welding any existing structures, piping, or equipment. The Contractor shall consult with the Owner's plant site personnel prior to drilling into walls to assure that there are not embedded interferences.

- H. All wall and floor penetrations shall be filled and sealed by the Contractor per architectural finish specifications.

1.06 PIPING MATERIALS STORAGE AND HANDLING

- A. Piping materials shall be identified in accordance with the applicable ASTM specifications and inspected, controlled, and protected in a manner that will assure the proper identification of all materials and conformance with the applicable codes and specifications. Incoming materials shall be placed in designated areas for inspection and release per Owner's procedures.
- B. Where the Contractor is furnishing piping materials, such materials shall be delivered in a clean and protected condition. End seals of pipe, flange covers, valve covers, and similar protection shall not be removed until necessary for fabrication or erection.
- C. Care shall be exercised in the handling and storage of all piping materials, including prefabricated and pre-assembled piping, to prevent contamination by grease, moisture, or foreign matter and to avoid physical damage.
- D. Prior to being placed in storage, whether for a short or long period of time, all stainless steel pipe and fittings shall be color coded, with a non-contaminating, non-corrosive, chloride-free marking medium. Precautions shall be taken not to contaminate the product contact surface areas of pipe and fittings with marking medium.
- E. Stainless steel pipe and fittings should preferably be stored indoors and in contact with wood. For long term (6 months or more) outdoor storage, it shall be fully wrapped in polyethylene film and sealed with tape.

1.07 SPECIFICATIONS

- A. All specifications, standards, codes, etc., referred to and designated herein, together with all addenda, revisions, and supplements, shall be considered part of this specification. Specifications, standards, codes, etc., referred to shall be of the latest edition.
- B. All materials, fabrication, assembly, testing and inspection of the piping systems within the scope of this specification shall be in accordance with the ASME Code for Pressure Piping B31.3; [BOCA] Plumbing Code and Local Plumbing Code; 3A-FDA Sanitary Standards, and the Contract Piping Materials Specification.
- C. All conflicts between the requirements of this specification, related specifications, standards, purchase orders or design drawings shall be referred to the owner or his Representative for clarification before proceeding with work on the affected parts.

1.08 SPECIAL FABRICATED MATERIALS

- A. ASTM A36 structural steel shall be used for all structural and support components except as otherwise indicated in the purchase order or the design drawings.
- B. Steel plates to be used for pressure retaining components in piping system shall be in accordance with the following table except as otherwise indicated on the design drawings.
 - 1. Piping System Steel Plates
 - a. Carbon Steel ASTM A285 Grade C
 - b. Type 304 Stainless Steel ASTM A240 Type 304
 - c. Type 316L Stainless Steel ASTM A240 Type 316L
 - d. Type 304L Stainless Steel ASTM A240 Type 304L

PART 2 PRODUCTS

2.01 FABRICATION - GENERAL REQUIREMENTS

- A. Where specific details of fabrication are not shown on the drawings or specified, fabrication shall be in accordance with the requirements of the Codes for Pressure Piping, ASME B31.3.
- B. Dimensional tolerances on prefabricated piping assemblies supplied or fabricated by the Contractor shall be in accordance with Pipe Fabrication Institute Standard ES-3.
- C. Prefabricated piping shall provide sufficient field welds to permit the completion of flanged terminal connections without strain on equipment or piping.
- D. When fabricating thermoplastic piping systems, the Contractor shall be required to obtain all necessary instructions in proper fabrication procedures and techniques from a representative of the manufacturer.
- E. All piping material shall be identified and mill certificates are required for all stainless steel and special alloy pipe. No material of unknown specification or reclaimed material shall be used.
- F. All completed piping systems shall be permanently labeled to indicate fluid service and direction of flow, in accordance with Section 15190 - Specification for Mechanical Identification.
- G. In general, all piping shall be tagged with service and direction of flow every 2.44 meters (8 feet) , at change of direction, every valve and each side of a wall or

floor penetration, when services are supplied at different pressures, piping shall be labeled with header pressure.

2.02 LAYOUT, CUTTING AND FITTING UP

- A. Pipe shall be cut accurately to measurements shown on drawings and to suit field conditions. Approved pipe cutters, or other methods approved by the Owner's Representative shall be used. Use full lengths of pipe where length between fittings is less than the mill-random lengths of pipe. Avoid extra joints unless disassembly for maintenance is a consideration.
- B. A template shall be used in laying out headers, miters, laterals and other irregular details to insure accurate cutting and a proper fit-up.
- C. Pipe ends that are to be butt welded shall be beveled in accordance with ANSI B16.25 and applicable welding specification. When necessary to cut pipe in the field for specific pipe dimensions, machined bevels to form the welding groove are preferred, but smooth, clean, slag-free, flame cut, or power cut, bevels are acceptable, matching as near as possible, bevels in accordance with ANSI B16.25.
- D. Threading of steel pipe shall preferably be done after bending, forging, heat treating or welding operations. Where subsequent threading is very difficult and threads are cut first, they shall be fully protected during such operations in a manner approved by the Engineer. Threads shall be concentric with the outside of the pipe and shall conform to ASME B1.20.1.
- E. Pipe ends that are to be socket welded shall be square cut to within the tolerances specified in ANSI B16.11.
- F. Misalignment or improper fit up of piping and components is not acceptable. Flanged faces shall be parallel prior to bolt-up. Connections to equipment shall be made without forcing or springing the piping.
- G. When welded joints involving two different pipe wall thicknesses are to be made, a 4 to 1 taper shall be made on the inside of the thicker pipe to avoid any detrimental mechanical notches in the piping system.
- H. Flange bolt holes shall straddle the established centerline, unless other orientation is required to match the flange connections on equipment.
- I. In general, piping shall be installed without forcing or springing. Where cold springing is required for reduction of thermally induced stress, the cut-short or cold spring location and gap distance will be indicated on the design drawings.
- J. Grinding of stainless steel pipe shall be done with a non-carbonaceous wheel. Low alloy Steel files or backsaws shall not be used on stainless steel pipe.

Chipping will not be permitted on stainless steel pipe. High alloy tool steel files or stainless steel wire brushes shall be used on stainless steel pipe.

- K. Branch connections shall be made in accordance with the requirements of Section 18001 - Specification for General Piping Requirements and the piping design drawings.
- L. Burrs shall be removed by reaming. Other objectionable defects shall be removed by machining, chipping or grinding.
- M. Care shall be taken to remove all dirt, scale, and foreign matter from inside the piping before welding. Where flame cutting is used, all oxidized metal shall be removed prior to welding. Welds shall be free from projections beyond acceptable reinforcements.
- N. Install unions where dismantling of pipe is required to permit maintenance, repair or replacement of equipment and flanged connections are not available.

2.03 WELDING PROCEDURE AND QUALIFICATIONS

- A. The Contractor shall show evidence that all procedures and welders for work covered by these specifications have been qualified in accordance with ASME Code, Section IX. An up-to-date certificate for each weld operator shall be on file at the work site consisting of the welder's name, stencil number, and performance qualification, and be available to the Owner or his Representative upon request. The Contractor shall submit all weld procedures to the Owner or his Representative for approval prior to the start of any work. No welding shall begin until the welding procedures have been approved.
- B. All fabrication, assembly, erection, and/or repair of pipe, and pipe supports or their related system components shall be performed in accordance with the provisions of the applicable code or standard as follows:
 - 1. Power Piping - ANSI Code for Pressure Piping - Section B31.1.
 - 2. Chemical Plant and Petroleum Refinery Piping - ASME Code for Pressure Piping - Section B31.3.
 - 3. ASME Boiler & Pressure Vessel Code - Section VIII - Pressure Vessels.
- C. In the event that new or repair work on piping or piping components must be done at facilities other than the jobsite by others, for the Owner or his Contractor, welding procedures qualifications shall be in compliance with Paragraph A.
- D. Contractor shall state in his quotation what welding processes he intends to use for the following conditions, including whether or not inert gas back-up will be used. He shall fill out Paragraph 3.19 Contractor's Proposed Welding Process, with this information and return to the Owner:

1. Condition a: 100 percent radiography
 2. Condition b: Random radiography
 3. Condition c: No radiographic requirements
- E. Carbon steel welding shall be done by the gas tungsten arc (GTAW), shielded metal arc (SMAW), gas metal arc (GMAW), submerged arc (SAW), flux core arc (FCAW), or a combination of those processes.
- F. Stainless steel welding shall be done by the gas tungsten arc (GTAW) shielded metal arc (SMAW), gas metal arc (GMAW), submerged arc (SAW), flux core arc (FCAW), or a combination of these processes. Where GTAW is used for the root pass, it shall be protected in the inside of the pipe with an inert gas purge maintained until the root pass has been completed.
- G. Stainless steel socketweld and butt welds in pipe sizes 4 inches and smaller shall be made by the gas tungsten arc (GTAW) process.
- H. When welding stainless steel, all foreign matter including marking chalk and paint must be removed for a distance of at least 6 inches from the weld. Stainless steel shall not be welded to galvanized steel.
- I. In fitting up preparatory to final welding, the proper gap shall be maintained while tack welding the pipe and connections in position so that a proper gap is made for a full penetration weld.
- J. Tack welds, line-up clamps and welded braces may be used for temporary joint alignment. If metal braces are used, defects resulting from their removal shall be repaired to the satisfaction of the Owner or his Representative. Braces shall be of the same material as the piping.
- K. Small, sound tack welds which penetrate to the bottom of the welding groove may become a part of the finished weld. Tack welds lacking penetration are not acceptable and must be chipped or ground out. Large tack welds which almost fill the welding groove are not acceptable and must be removed.
- L. Tack welds shall be of the same quality and made by the same process as the rest of the weld or they shall be removed from the weld prior to the completion of the weld.
- M. Permanently welded-in backing rings shall not be used. If, in certain instances, backing rings are, in the opinion of the Contractor, necessary or desirable, he shall so indicate on the drawings and submit a request to the Owner or his Representative for specific approval.

- N. The deposited weld metal shall have essentially the same physical and chemical properties as the base material.
- O. All welds shall have complete penetration and fusion, including single welded butt joints without backing strips. All longitudinal and circumferential pressure retaining joints shall be of the butt type. Longitudinal joints shall be full penetration welds.
- P. All flux and slag shall be completely removed from the surface of all welds (before the next successive layer is applied), by grinding, sand blasting with clean sand, or brushing, using materials of a composition which will not contaminate the surface of the welds to the extent that corrosion resistance is decreased. Any defects shall be removed from each completed pass prior to starting a subsequent pass. The completed weld shall be cleaned of slag and spatter metal on the surface.
- Q. Arc strikes and weld starts shall not be made purposely on the base metal outside the weld groove nor outside an area which will be encompassed by a fillet or socket weld. Inadvertent arc strikes outside of a weld zone shall be removed by grinding or filing and the arc strike area shall be visually examined under 5X magnification or liquid penetrant examination.
- R. Branch connection joints shall be prepared so as to permit full penetration welds of a quality comparable to the circumferential welds in the same piping system.
- S. Where openings for branches are cut in runs of pipe, all material which may drop inside the pipe shall be completely removed before branch lines are welded in place.
- T. All welding of branch connections shall be in accordance with ASME B31.3, latest edition.
- U. Opening in header for Branch connections shall be located 180 degrees from the longitudinal seam in the welded run pipe.
- V. Branch welds shall merge smoothly with the surface of the pipe with no notches or undercutting permitted.
- W. All filler metals shall be properly packaged and stored to prevent damage and deterioration of the materials prior to and during application in welding. Coated electrodes shall be stored in heated cabinets.
- X. For welding of stainless steel to carbon steel, an alloy electrode shall be used which is recommended for the intended purpose and will produce a sound ductile weld. Owner's approval is required prior to welding stainless steel to carbon steel and a qualified welding procedure shall be followed.

- Y. Any galvanized carbon steel piping, which is not bituminous coated and wrapped, and which has been welded, shall receive a high zinc content coating 0.08-0.10mm (0.003-0.004") painted with "Galvicon" or equal on any exterior surfaces of the piping from which the galvanizing has been removed during the welding process.
- Z. Proper ventilation shall be provided when welding galvanized carbon steel piping.
- AA. Welding of galvanized pipe shall not be done in close proximity to stainless steel.
- BB. Contractor shall follow fabrication procedures and techniques recommended by manufacturer for welding valves in order not to damage valve linings or soft seats. This should include: a) limit on welding time, b) wrapping pipe with wet burlap to dissipate heat, c) attaching to the valve tempsilstik 190-204°C (375-400°F). When the indicated mark starts melting, welding should be stopped.
- CC. The purge gas flow rate and sequence shall be maintained during tacking and welding in the range developed by the Contractor under the Welding Procedures.
- DD. No slag nor spatter metal is acceptable on any weld.
- EE. All welds rejected by the inspector shall be rewelded at no cost to the owner. Those welds still rejected shall be removed and the joint shall be properly prepared and re-welded at no cost to the Owner.

2.04 HEAT TREATMENT

- A. Preheating and post weld heat treatment shall be in accordance with the applicable code or piping material specifications.
- B. Preheating is not normally required, but when temperatures are below 50 degrees F, the pipe shall be warmed before welding.

2.05 JOINTING OF THERMOPLASTIC PIPING

- A. All procedures for joining shall satisfy section 2.01.D of this specification.
- B. Joints shall be made using fusion joining process in strict conformance with the manufacturer's instructions. The surfaces to be jointed must be dry.

2.06 COPPER TUBING FABRICATION

- A. All bores and depths of soldered fittings shall conform to the dimensions in ANSI B16.18 and ANSI B16.22.

- B. The filler metal shall be a non-ferrous metal having a solidus above 204°C (400°F) for soldering, and above 408°C (800°F) for brazing. Refer to Piping Material Specification[C1, C2, C3] of Section No. 18001 - Specification for General Piping Requirements.
- C. The flux shall be fluid and chemically active at the soldering/brazing temperature, as applicable.
- D. The surfaces to be soldered or brazed shall be clean and free from grease, oxides, paint, scale and dirt of any kind. Any suitable method may be used to provide a clean wettable surface for soldering. Contractor shall submit to the Owner a cleaning and end prep procedure for solder joints, for approval prior to any such fabrication.
- E. The average clearance between surfaces to be joined shall not be greater than 0.1mm (.004”) or a diametral clearance of 0.2mm (.008”)
- F. The joint shall be brought to soldering or brazing temperature in as short a time as possible to minimize oxidation without localized underheating or overheating.
- G. Solderers and braziers shall follow the procedures as outlined in the Copper Tube handbook published by the Copper Development Association.
- H. Filler metal selection shall be submitted for approval prior to application.
- I. Flux residue shall be removed from piping external surfaces after soldering or brazing.
- J. Inert gas purge may be required to prevent internal surface oxidation when brazing lines to be used for clean/filtered air or other gases. Nitrogen is a suitable purge gas for this application.

PART 3 EXECUTION

3.01 ERECTION - GENERAL REQUIREMENTS

- A. Piping connections to equipment, vessels and machinery shall be made in conformity with details shown on the drawings. Piping connections to equipment shall be installed such that no excessive stresses shall be transferred from the piping system to the equipment.
- B. All assembled piping shall be installed without springing or forcing, and so as to properly clear all openings and equipment. Cutting or other weakening of structural members to facilitate piping installation shall not be permitted.

- C. All piping shall be installed to permit free expansion and contraction without damage to joints or supports.
- D. Thermal expansions of pipe shall be provided for as shown on drawings. Expansion loops shall be installed as shown on drawings. Welding elbows in expansion loops shall have a minimum radius of 1.5 pipe diameters.
- E. Where called for on drawings, the Contractor shall install masonry or concrete piers and anchors to support and anchor pipelines. Supports, anchors, or stays which may deform or alter the shape of the piping, during or after installation, shall not be used.
- F. Anchors may be welded directly to carbon steel pipe. Anchors for stainless steel piping shall be attached by clamps or "U" bolts, unless shown otherwise on drawings.
- G. Bond of concrete to pipe will not be acceptable as anchorage to resist longitudinal thrust.
- H. Suction and intake lines to pumps and compressors shall be installed with temporary line strainers, prior to hydrostatic testing and flushing. Use 0.83mm (1/32") wire by No. 10 mesh basket type.
- I. Drain lines shall be as short as practical.
- J. Drip pan elbows shall be installed between the pressure relief valve and the relief valve discharge (vent line) piping, for all steam system pressure relief valves having a discharge line size 64mm (2-1/2") and larger.

3.02 WELDED JOINTS

- A. Welded joints shall be prepared and made in accordance with Sections 2.02, 2.03 and 2.04 of this Section.

3.03 FLANGED JOINTS

- A. Flanged joints shall be made with new gaskets as specified and new bolting materials of uniform material as specified.
- B. Care shall be taken to assure that gaskets are properly positioned prior to tightening of the bolts.
- C. Flanged joints shall be bolted up in a manner which will assure even and adequate pressure on the gaskets, and uniform stresses in the bolts.

- D. Care shall be taken to avoid overtorquing any bolts. All bolts and nuts which are overtorqued shall be replaced.
- E. Flanges shall be made up with mating face in a plane that is exactly perpendicular to the axis of the pipe. Upon erection, flanges shall be so positioned in rotation that the bolt holes shall straddle the vertical flange centerline. All gaskets shall be evenly centered between the flange faces with ring gaskets engaging fully upon raised face flanges, and full face gaskets to OD of flat faced flange. The mating flanges shall mate flush and true, and the bolts shall be tightened uniformly to draw the flanges evenly and firmly upon the gasket. When made up, the bolts shall extend through nuts by at least one full thread.
- F. Prior to installation, bolts for use up to 260°C (500°F) shall be lubricated with a graphite and oil mixture anti-seize compound.
- G. No flanged joints shall be made up if misalignment exceeds the following limits:
1. Alignment - Flange facings shall not be more than 0.04mm per centimeter (3/64" per foot), measured across any diameter, out of line.
 2. Lateral Displacement - The lateral distance between the center of the flanges shall not exceed 3.2mm (1/8") in any direction.
 3. Rotation - The distance between any two mating bolt holes, after one pair of mating bolt holes has been lined up shall not exceed 1.6mm (1/16").
- H. Class 125 cast iron integral or screwed companion flanges shall be assembled with a full-face gasket to O.D. of flange.
- I. Class 150 steel flanges may be bolted to cast iron valves, fittings or other parts, having either integral Class 125 cast iron flanges or screwed Class 125 companion flanges. When such construction is used, the 1.6mm (1/16") raised faces on the steel flanges shall be removed and a full face gasket used.
- J. Raised-face steel and alloy flanges may be bolted to flat-face steel and alloy flanges on equipment without removing the raised face. Raised face flanges are not permitted for mating with nonmetallic flanges.
- K. Flat washers shall be used under the bolt heads and nuts on all nonmetallic flanges.
- L. On stainless steel piping or tubing systems where lap-joint type flanges are permitted, flanges and bolting shall be stainless steel where the flanged joints reside in a clean area or any area where high humidity or corrosive fluids are expected.
- M. Care shall be exercised in tightening of nonmetallic joints to avoid overtightening and deformation of flanges. Use fiber or metal spacers to eliminate any gaps.

3.04 THREADED JOINTS

- A. Care shall be taken to avoid overtightening of threaded joints and care shall be taken to avoid damaging the pipe exterior with the pipe wrench.
- B. Backing off of made-up threaded joints to facilitate fit-up or alignment is not permitted.
- C. Pipe in screwed flanges shall seat within 1.6-3.2mm (1/16"-1/8") of face.
- D. On steel and copper lines under vacuum or instrument air service cutting thread lubricant shall be soap and water. These lines shall be oil free.
- E. Threaded joints shall be seal-welded only when specifically called for in Piping Material Specification or on the design drawings. Thread removal prior to welding shall be in compliance with applicable code.
- F. Threaded joints which are to be seal-welded shall be made up without the use of any joint compound or sealing tape.
- G. Threaded joints which are not to be seal-welded shall be made leak-tight by use of Teflon paste or Teflon tape for temperature up to 204°C (400°F). Threaded joints on sanitary systems, such as relief valves on clean steam lines, shall be made up with teflon tape only.

3.05 ERECTION OF COPPER TUBING

- A. All vertical lines shall be run plumb and straight, and parallel to walls.
- B. Sufficient unions or union type fittings shall be provided for disconnecting equipment, controls, etc. All mechanical connections shall be accessible for maintenance.
- C. Sleeves placed in floors and walls through which tube lines pass shall extend 1 inch on each side. Sleeves may be made of pipe or formed, galvanized steel, and should be sized to allow insulated lines to pass through unobstructed.
- D. Openings shall be properly filled between sleeve and (or) pipe and wall, floor or ceiling opening, to maintain fire rating of same.

3.06 SUPPORTING OF PIPE

- A. Refer to Section 18005 - Specification for Piping Supports.

3.07 INSPECTION AND TESTING OF PIPING

- A. All fabricated piping and tubing shall, as a minimum, meet the examination, inspection and testing requirements of the applicable ANSI/ASME B31 piping code.
- B. Inspectors representing the Owner or his Representative shall have access at all times while work on their Contract is being performed to all sections of the worksite that concern the fabrication and erection of the piping on their Contract. The inspectors shall be afforded all reasonable facilities to satisfy them that the work is being performed in accordance with the requirements of all applicable specifications and procedures. The Owner shall be notified prior to all testing.
- C. All welding performed under this specification shall be subject to visual inspection. This visual inspection shall include an examination of joint details prior to welding, inspection for defects during welding and for defects, undercut, overlay and reinforcement dimensions after welding.
- D. All welded joints (other than sanitary tubing) shall require 10 percent random visual inspection.
- E. Non-destructive examination and testing shall be performed in accordance with Examination and Testing Requirements Tables (Attachment B).
- F. Non-destructive examination results shall be reported on a form similar to that shown in Attachment C Welding Inspection Log.
- G. Non-destructive examination shall be performed prior to any hydrostatic pressure tests.
- H. Hydrostatic testing shall be performed prior to covering pipe with insulation.

3.08 PRESSURE TESTING

- A. As far as is practicable, all pressure tests shall be complete system tests conducted in the presence of the Engineer or Owner's Representative. Pressure vessels, instruments and equipment connected to the piping may be included in the tests if their rated test pressure is not exceeded by the piping system test pressure.
- B. Every precaution shall be taken during testing to ensure the safety of the test operator and other personnel working in the area. Systems to be pressurized shall be provided with appropriate gauges and pressure relieving devices.
- C. All joints, including welds, are to be left uninsulated, unpainted, and exposed for examination during testing.

- D. Equipment and/or instrumentation which is not to be subjected to the pressure test shall be either disconnected from the piping or isolated by blinds or other means during the test. Valves may be used provided the valve is suitable for the proposed test pressure.
- E. Expansion joints shall be provided with temporary restraint, if required, for the additional pressure load under test, or shall be isolated from the test.
- F. Pressure gauges shall not be subjected to pressure in excess of their scale range. All pieces of equipment which do not have their test pressures indicated or whose test pressures are below the piping system test pressure shall be excluded from these tests.
- G. Pressure relief and thermal relief devices which are part of the piping system shall be excluded from these tests either by removal or isolated by test blinds.
- H. Before every test the piping systems shall be visually inspected to assure that there are no obvious defects and that all connections are tight.
- I. Control valves, unless being tested, shall be set and maintained in the open position.
- J. Lines that are spring or counterweight supported and all vapor or gas lines shall be temporarily supported during the test in order to support the test fluid load, if necessary.
- K. All plastic lines shall be hydrostatically tested. An exception to this will be pneumatic hookup lines to instruments, which will receive an in-service pneumatic test.
- L. Lines containing check valves shall have the pressure applied upstream of the check valve so that pressure is applied under the seat. If this is not practical, the check valve disc shall be locked open or removed for the test.
- M. All in-line instruments, gauge glasses, flow meter pots, liquid level float gauges, and all other pressure parts of instruments shall be included in these tests, where feasible.
- N. Joints found to be defective shall be repaired and retested.
- O. Retesting of lines after repairs shall be done at pressure originally specified for the test.
- P. At the completion of the test; all blinds, plugs, caps, etc., used to isolate vessels, instruments, etc. shall be removed; flange faces and threads inspected for damage

and piping reconnected. Gaskets removed after tests shall not be reused. Special care shall be exercised when reconnecting these points to avoid leaks.

3.09 TEST REPORTS AND PROCEDURES

- A. The Contractor shall make a record of the test on the attached "Piping Pressure Test Report" Attachment A, or similar test report for each piping system tested which shall, as a minimum, consist of the following data:
 - 1. Line designation number
 - 2. Date of test
 - 3. Type of test, pressure applied, and length of time at test pressure
 - 4. Tested by
 - 5. Tests witnessed by (Owner's Representative).
 - 6. Comments, if any
- B. A written Safe Work Procedure shall be submitted by the Contractor for approval by the owner or his Representative prior to beginning of Pneumatic tests if the test pressure is to exceed 1.7 BAR (25 psig). The procedure shall cover a minimum of the following items: Pretest visual inspection, areas to be roped off, time schedule for incremental pressure increases, and indoctrination of personnel on hazards on hazards involved, facilities at site for medical care, and fire fighting in case of an emergency.
- C. System diagrams or P&ID's shall be suitable marked showing the boundaries or extent of the test for each system to be tested. These documents are normally included as turnover documents submitted to the Owner subsequent to piping system completion.
- D. Owner's Representative shall signify his acceptance of the tested system by initialing the approved portions of the piping system on the Constructor's record of test, and by any other definite means mutually agreed upon.
- E. All tests shall be performed using a certified pressure gauge having a minimum face diameter of 76mm (3") and in current calibration. The scale range of the test instrument used for any particular test shall be such that the required test pressure falls between 1/3 and 2/3 full scale reading for best accuracy.

3.10 HYDROSTATIC TESTS

- A. The hydrostatic test pressure shall be calculated in accordance with the applicable section of ASME B31.3 but shall not exceed the maximum test pressure of any vessels or components included in the test.
- B. All hydrostatically tested systems shall be tested to one and one-half (1-1/2) times the design pressure or to a minimum pressure of 3.4 BAR (50 psig), whichever is

greater. Design pressure is defined herein as the maximum operating pressure shown on the "Service Listing" of Section 18001. All test pressures shall be maintained for a minimum of ten (10) minutes before examination of joints begins. All joints shall be visually examined for any signs of leakage.

- C. When design temperatures are above the test temperatures, adjustments shall be made in accordance with ASME B31.3, Paragraph 345.4.2.
- D. Hydrostatic test pressures shall not be applied until the piping system and the testing medium have reached thermal equilibrium.
- E. When setting the system test pressure, the test gauge shall be monitored and corrections made for any pressure changes due to thermal expansion or contraction. By this procedure the test pressure shall be kept within 0.34BAR (5 psig) or one (1) percent, whichever is greater, of the intended value. After the test pressure is set, the pressure source shall be disconnected from the fill point prior to examination for leakage.
- F. Tested systems shall be vented and drained immediately upon successful completion of the test. All process and solvent lines shall be dried by passing inert gas through them until they are dried to the satisfaction of the Engineer.
- G. No repair welding shall be done on any section of piping that contains water.
- H. Potable water shall be used as the test medium when testing piping systems handling potable or safety shower water.
- I. Water used for testing austenitic stainless materials shall be essentially free from chloride. Chloride content shall not exceed 100 PPM.
- J. All stainless steel lines shall be emptied and dried immediately after hydrostatic test are completed. To avoid the possibility of pitting due to chloride content in water, the time lapse between hydrostatic testing and startup of the plant should not exceed one month or demineralized water should be used as the testing medium.
- K. The Contractor shall be responsible for the removal of water used in testing piping systems.

3.11 PNEUMATIC TESTS

- A. Air tests, when specified, shall be performed with clean, dry air, or nitrogen, as required by process consideration. The source shall be equipped with appropriate pressure regulators, relief valves and gauges.

- B. Air tests shall be performed at the test pressure specified in the Examination and Testing Requirements Tables. If not specified, the test pressure shall be in accordance with ASME B31.3 Section 345.5, nominally 110 percent of design pressure.
- C. Pneumatically testing systems shall include a preliminary check at not more than 1.7 BAR (25 psig). The system shall then be brought up to test pressure in 0.7 BAR (10 psig) increments. Enough time shall be allowed for thermal equilibrium for each incremental step up to and including the final test pressure.
- D. The pressure source shall be disconnected from the test apparatus fill connection prior to examination for leakage. All joints shall be inspected with an approved solution formulated for soap bubble testing.
- E. The system under test shall hold the test pressure, with no indication of pressure loss according to the test gauge, for a minimum period of one (1) hour prior to formal inspection of joints.
- F. Tested systems shall be vented immediately upon successful completion of the test.
- G. No repair welding shall be performed on a pressurized system.
- H. Where both hydrostatic and pneumatic tests are run on a section of pipe, the pneumatic test shall precede the hydrostatic.
- I. On tested systems which do not complete their test successfully, the leaks shall be located, marked, and repaired immediately after depressurizing the test section. Tested systems which fail the pressure test and have been repaired, shall be retested using original test pressures and procedures.

3.12 VACUUM TESTING

- A. System requiring a vacuum test shall be tested by the following procedure:
 - 1. The system shall receive a preliminary pneumatic pressure test at a minimum internal pressure of 1.0 BAR (15 psig) in accordance with Paragraph 3.11 of this specification.
 - 2. The system shall be given an operational vacuum test using the operating vacuum pump or a special test pump. The system shall be considered acceptable if vacuum of 508mm (20") Hg (0.34 BAR) is maintained for a period of four (4) hours and if the pressure does not rise more than 25mm (1") Hg (0.003 BAR) with the pump shut-off.
 - 3. If step 2. is not successful, the system shall be retested per step 1. to locate the leak, using soap and water at all joints, then repaired and given another vacuum test.

3.13 STANDING WATER TEST

- A. The following procedure shall be followed:
 - 1. All portions of the system shall be filled with water.
 - 2. Water shall stand for a period of not less than two (2) hours, prior to inspection of joints.
 - 3. If the system loses water faster than the rate specified, the leaking component shall be repaired and the system retested.
- B. The leak rate shall not exceed values specified by AWWA Spec. C600-64, Section 137. Steel piping systems shall be leak tight. Vent or drain systems fabricated of pressure piping components, either metallic or plastic, shall be leaktight.

3.14 SYSTEM CLEANING AND FLUSHING

- A. The interior of all pipes shall be free from loose mill scale, sand, dirt, slag, weld splatter, rust and other foreign matter when erected. Slight oxidation is permitted on carbon steel pipes.
- B. After erection and welding of piping, lines requiring hydrostatic testing shall be flushed with clean water. The test shall be conducted in the presence and to the satisfaction of the Owner or his Representative.
- C. After erection and welding of piping, all lines requiring pneumatic testing shall be blown free of dirt and debris with clean, dry air to the satisfaction of the Owner or his Representative.
- D. When flushing has been completed, lines shall be drained, permanent strainers shall be cleaned and replaced and any temporary strainers, connections, valves or related items shall be removed. Piping systems shall be placed in normal operating condition including necessary adjustments that may be required to the system.
- E. Disinfecting of potable water pipes shall be done in accordance with the requirements as indicated in Division 15, and in accordance with any local codes.

3.15 SAFETY

- A. The chemicals used in cleaning procedures are potentially dangerous. Precautions shall be taken to protect all personnel, equipment and facilities. Proper attire shall be available to Contractor and owner personnel as required. Contractor shall ensure that adequate safety showers and eye wash stations are provided.

- B. In addition to the above, the Owner's site safety rules shall be in total compliance.

3.16 WASTE DISPOSAL

- A. Compliance to Federal, state and local pollution control regulations are essential. Contractor shall consult with Owner on approved methods of disposing of large volumes of chemical solutions.

3.17 QUALITY ASSURANCE

- A. The Contractor shall maintain all records of field fabrication including records of fabrication steps and all tests and inspection data and all records of cleaning procedures.

END OF SECTION

**ATTACHMENT D
CONTRACTOR'S PROPOSED WELDING PROCESS(ES)**

Inquiry No.

Contractor's Name

Check appropriate box for each use. Contractor must complete and return this form with his proposal.

**EXAMINATION REQUIREMENTS
100% RADIOGRAPHY**

ROOT WELD PROCESS	CS SS		REMAINDER OF WELD	CS SS	
Shielded Metal Arc - SMAW	()	()	Shielded Metal Arc - SM	()	()
Gas Tungsten Arc - GTAW			Gas Tungsten Arc - GTAW	()	()
With Gas Back-up	()	()	Gas Metal Arc - GMAW	()	()
Without Gas Back-up	()	()	Submerged Arc - SAW	()	()
Gas Metal Arc - GMAW			Flux Core Arc - FCAW	()	()
With Gas Back-up	()	()			
Without Gas Back-up	()	()			

RANDOM RADIOGRAPHY

Shielded Metal Arc - SMAW	()	()	Shielded Metal Arc - SMAW	()	()
Gas Tungsten Arc - GTAW			Gas Tungsten Arc - GTAW	()	()
With Gas Back-up	()	()	Gas Metal Arc - GMAW	()	()
Without Gas Back-up	()	()	Submerged Arc - SAW	()	()
Gas Metal Arc - GMAW			Flux Core Arc - FCAW	()	()
With Gas Back-up	()	()			
Without Gas Back-up	()	()			

NO RADIOGRAPHY REQUIREMENTS

Shielded Metal Arc - SMAW	()	()	Shielded Metal Arc - SMAW	()	()
Gas Tungsten Arc - GTAW			Gas Tungsten Arc - GTAW	()	()
With Gas Back-up	()	()	Gas Metal Arc - GMAW	()	()
Without Gas Back-up	()	()			

Gas Metal Arc - GMAW		Submerged Arc - SAW	() ()
With Gas Back-up	() ()		
Without Gas Back-up	() ()	Flux Core Arc - FCAW	() ()

Note: Where inert gas back-up is indicated, it shall not be used unless specifically stated in the purchase order.

END OF ATTACHMENT D

ATTACHMENT A **PIPING PRESSURE TEST REPORT**

Test Number:Date of Test:.....

Line No. or System

Test Medium:Client/Contract No.

Test Pressure:Test Gauge Calibration Date:.....

Test Start Time.....Test Pressure Hold Time:.....

Leaks IdentifiedRepaired & Retested

Test Complete Time.....System DepressurizedInitial

CHECK LIST AFTER PRESSURE TEST

	Completed	Date	Not Required
System Drained	()	()
System Air Dried	()	()
Temporary Equipment Removed Such As:			
Pressure Gauges	()	()
Blind Flanges, Caps, Test Plugs, Hoses, etc.	()	()
Safety and Relief Valves			
Installed/Functional	()	()
Valving Return to Proper Configuration	()	()

Remarks:

I certify this system to be leak-free and structurally sound on the test completion date.

Test Engineer	Date	Field Superintendent	Date
System Accepted: _____		_____	
Owner		Date	

END OF ATTACHMENT A