TES-WELD-AS-US Welding of Assemblies and Station Piping		Document Type: Specification
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1 PURPOSE

This Specification describes the technical requirements for qualification of welding procedures and welders, production welding, visual and nondestructive inspection and repair welding for welds in sweet natural gas and hazardous liquid pipeline systems. This Specification shall be read in conjunction with and covers additional requirements to ASME B31.4, ASME B31.8, API 1104, 49 CFR 192 and 49 CFR 195.

2 SCOPE

This Specification applies to TransCanada (the Company) facilities within the United States of America.

This Specification applies to welds made using welding procedures qualified in accordance with the requirements of ASME Boiler and Pressure Vessel Code Section IX or API 1104 which include those that are made:

(a) in Compressor stations;

(b) in meter stations;

(c) in pump stations;

(d) pipeline assemblies;

(e) at a manufacturing plant or fabrication shop remote from the final location of the weld; or

(f) joining pipe to components or components to components.

This Specification does not apply to pipe-to-pipe production and tie-in girth welds made on pipeline sites covered by the Company Specification TES-WELD-PL-US or to welds used in branch connections that are covered by Company Specification TES-WELD-BC-US.

3 BRIEF DESCRIPTION OF CHANGE

- Included 49 CFR 195 and ASME B31.4 as reference documents.
- Updated references to Company Operating Procedures and Specifications
- Added additional clarification where this Specification would be used.
- Included additional requirements for inspecting weld bevels and locating 'olet' fittings.
- Specification modified for conversion from Canadian to US standards.

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4 REFERENCES

4.1 Codes, Standards and Regulations

(a) 49 CFR 192 Transportation of Natural and Other Gas by Pipeline: Minimum Federal Safety Standards

(b) 49 CFR 195 Transportation of Hazardous Liquids by Pipeline

(c) API 1104 Welding of Pipeline and Related Facilities

(d) ASME Standard B31.4 Pipeline Transportation Systems for Liquid Hydrocarbons and Other Liquids

(e) ASME Standard B31.8 Gas Transmission & Distribution Piping Systems

(f) ASME Boiler and Pressure Vessel Code: Section V Nondestructive Examination, Section IX Welding and Brazing Qualifications and Section VIII, Division 1 Rules for Construction of Pressure Vessels

(g) ASTM A370 Standard Test Methods and Definitions for Mechanical Testing of Steel Products

(h) ASTM E18 Standard Test Methods for Rockwell Hardness of Metallic Materials

(i) ASTM E23 Test Methods for Notched Bar Impact Testing of Metallic Materials

(j) ASTM E92 Standard Test Method for Vickers Hardness of Metallic Materials

(k) ASTM E384 Standard Test Method for Microindentation Hardness of Materials

(l) AWS A5.1 Specification for Covered Carbon Steel Arc Welding Electrodes for Shielded Metal Arc Welding

(m) AWS A5.4 Specification for Stainless Steel Electrodes for Shielded Metal Arc Welding

(n) AWS A5.5 Specification for Covered Low Alloy Steel Arc Welding Electrodes

(o) AWS A5.18 Specification for Carbon Steel Filler Metals for Gas Shielded Arc Welding

4.2 Company Specifications and Procedures

(a) Company Procedure TEP-MECH-TRAN-US Selection of Transition Pieces and Joining Methods (005695478)

(b) Company Specification TES-NDT-RT-US Radiographic Examination of Welds (004472888)

(c) Company Specification TES-NDT-UT2-US Manual Ultrasonic Examination of Welds (004497443

(d) Company Specification TES-WELD-ABR-US Removal of Arc Burns (004472941)

(e) Company Procedure TEP-VALV-FAB Procedure for Supplemental Protection During Valve Fabrication (Cdn-US-Mex) (005741242)

(f) Company Procedure TEP-WELD-CLOS Closure Weld Procedure (003670675)

5 GENERAL

Welding shall be performed in accordance with;

(a) The applicable requirements of 49 CFR 192, 49 CFR 195, ASME B31.4, ASME B31.8 and API 1104, and any amendment, supplement, or errata issued by DOT, ASME, or API;

(b) The additional requirements of this Specification; and

(c) The Company requirements for Environment, Occupational Health and Safety.

5.1 Design Temperature

Welding procedures shall specify, and be qualified at or below, the minimum design temperature. Unless specified otherwise, minimum design temperatures are 23°F for welds in buried pipelines (2 feet or more of cover) and -49°F for any other welds.

5.2 Welding Process

(a) Fillet welds shall be made using a low hydrogen welding process, except that it shall be permissible to apply the first pass with a different process.

(b) The fills and cap passes on butt welds shall be made using a low hydrogen welding process in:

(i) pipe to component or component to component welds;

(ii) pipe to pipe welds; and

(iii) repair welds.

(c) Except where the piping is internally cleaned after welding, the root pass of butt welds in lube oil piping shall be made using gas tungsten arc welding and bare consumables.

5.3 Joint Design

5.3.1 Butt Welds

(a) Butt welds between items of unequal wall thickness shall be made using a transition designed in accordance with the requirements of Company procedure specified in Clause 4.

(b) Bevels angles shall be either 30° -0/+5° or 37.5° ±2.5°, unless otherwise specified, and all field cuts shall be normal to the pipe axis.

(c) Mitre welds are prohibited. Deflections up to 3° caused by misalignment are not considered to be mitre bends.

(d) The use of backing rings shall not be permitted.

5.3.2 Fillet Welds

Except where specified by the design, fillet welds shall not be permitted for joining pipe larger than NPS 1½.

5.3.3 Tack Welds

(a) Tack welds shall only be permitted within the weld bevel area and shall be full penetration welds or bridge tacks completed using a qualified, low hydrogen welding procedure.

(b) A minimum of four (4) tack welds shall be placed equidistantly around the circumference.

(c) For piping larger than NPS 16, the minimum length of a tack weld shall be 1½ to 2½ in.

5.4 Materials

5.4.1 Pipe and Components

(a) Materials shall be welded according to their P-Number and group number, or S-Number and group number, as given in the ASME Boiler and Pressure Vessel Code, Section IX.

(b) Carbon steel materials manufactured in accordance with standards or specifications, for which P-Numbers or S-Numbers are not given in the ASME Boiler and Pressure Vessel Code, Section IX, shall be considered to be equivalent to S-1 materials with group numbers as given below, provided that the maximum carbon equivalent (CE) does not exceed that given in the following table.

Grade	Maximum Carbon Equivalent (wt %)	S-1 Group Number
Up to Grade X52	Not Applicable	1
Up to Grade X65	0.45	2
Up to Grade X70	0.50	3
Higher than Grade X70	0.50	4

Note: When using the table, the first two columns are intended to be the input, and the value in column 3 is intended to be the output. The Carbon Equivalent (CE) is calculated using the P_{cm} formula in API 5L. The following examples illustrate the intent:

- Pipe with SMYS 52 ksi and less is S-1 group 1, regardless of its carbon equivalent value.
- Grade X56, X60, or X65 material is S-1 group 2 if its carbon equivalent value is 0.45% or less, and S-1 group 3 if its carbon equivalent value is over 0.45% but not over 0.50%.
- Grade X70 material is S-1 group 3 provided its carbon equivalent value is not over 0.50%.
- Grade X80, X90, or X100 material is S-1 group 4 provided its carbon equivalent value is not over 0.50%.
- Material for a grade higher than X52 with a carbon equivalent value over 0.50% is not covered by this table; it should be considered as a special material.

(c) Materials that do not conform to the groups specified in (a) or (b) shall be considered "Special" materials and shall require individual qualification of welding procedures.

5.4.2 Filler Metals

(a) Filler metals for welding carbon steel materials shall be selected from the following list:

Process	AWS A5.1/A5.5/A5.18) Classification or Trade Name
SMAW	E6010, E8010-G/E8010-P1, E7018-1, E8018-C2, E8018-G, E6918 (BVD85), E10018 (BVD 90)
GMAW	ER70-S2, ER70-S3, ER70S-6, ER70-S7
FCAW	E80C-Ni2 Corex 2N, SELECT ARC Select 80C-Ni2
SAW	F8A4-ECNi2-Ni2 Lincoln LAC-Ni2 wire & 882 flux F9A6-EM2-M2-H8 Lincoln LA100 wire & 880M flux

(b) Except as permitted below, electrodes for shielded metal arc welding of carbon steels higher than Grade X56 shall be E8010-G/E8010-P1 for cellulosic root/hot pass and E8018-C2 or E8018-C3 for fill, cap and repairs. On materials less than NPS 4 and less than 0.25 in. WT and where 3/32 in. diameter E8010-G/E8010-P1 electrodes are not available, it shall be permissible to use 3/32 in. 6010 electrodes for the root pass

(c) Filler metals for welding stainless steel materials shall be selected from the following list for SMAW (and GTAW) where -xx means -15 or -16:

Materials Used	**304**	**304L**	**316**	**316L**
Carbon Steel	E309-xx, E312 (ER309, ER312)			
316L	E316L-xx, E308-xx (ER316L, ER308)	E316L-xx, E308L-xx (ER316L, ER308L)	E316L-xx, E316-xx (ER316L, ER316)	E316L-xx (ER316L)
316	E308-xx, E316-xx (ER308, ER316)	E308L-xx, E316-xx (ER308L, ER316)	E316-xx (ER316)	
304L	E308L-xx, E308-xx (ER308L, ER308)	E308L-xx (ER308L)		
304	E308-xx (ER308)			

Note: Material grades are across the top and down the side and bolded. Recommended welding consumables are within the remaining boxes.

5.5 Shielding Gases

Shielding gas components shall have a purity of at least 99.5% and a dew point of -34°C or lower.

5.6 Closure Welds

Welds that will not be hydrotested shall be subject to the conditions outlined in Company Procedure TEP-WELD-CLOS.

6 QUALIFICATION OF WELDING PROCEDURES

6.1 General

Welding procedure specifications (WPS), other than the pre-qualified welding procedure specification data sheets provided by the Company, shall be qualified in accordance with the requirements of API 1104 or ASME Boiler and Pressure Vessel Code Section IX and the additional requirements of this section. Contractors/fabricators shall have qualified welding procedures reviewed and approved by Company welding engineering personnel for carbon steel materials less than NPS 16 and for all sizes of stainless steel materials.

6.2 Acceptable Weld Parameters

(a) Preheat: The minimum preheat shall be recorded at the start of welding, and shall be checked after each pass. Temperatures are to be measured at several locations along the weld and shall be at least 200°F (See also Clause 8.11)

(b) Interpass temperature: The maximum interpass temperature shall not exceed 390°F.

(c) Heat Input: The heat input shall range between 16 and 56 kJ/in.

(d) Carbon Equivalent: The carbon equivalent shall be calculated using the P_{cm} formula.

6.3 Materials for Qualification

Welding procedure qualification tests shall be made using a material of the same type as the material to be used in production welding. When joints are to be made between two materials with different base metal characteristics, a procedure qualification shall be made for the applicable combination, even though procedure qualification tests have been made for each of the two base metals welded to each other. Whenever available, materials for qualification shall also have an equivalent API 5L or ASME certification.

For materials having specified minimum yield strength higher than Grade X56, the carbon equivalent shall be reported on the WPS and the manufacturer's material test report attached to the PQR.

All materials should have impact toughness verified at or below the minimum design temperature to ensure suitability for the application.

6.4 Additional Essential Changes

Welding procedure specifications shall be limited by the following additional essential variables:

(a) Base Materials: A change in grade or grouping as defined in Clause 5.4.1.

(b) Carbon Equivalent: For steels Grade X70 and greater, an increase in carbon equivalent exceeding 0.05% for piping having a specified minimum yield strength higher than Grade X56.

(c) Shielding Gas Composition: A change of more than 1% in the nominal content of any gas comprising more than 5% of the shielding gas.

6.5 Change in Minimum Design Temperature

A change to a minimum design temperature colder than that used for impact toughness testing or fracture toughness testing during procedure qualification shall necessitate retesting for impact toughness testing as specified in Clause 6.7.

6.6 Test Weld Acceptability for Destructive Testing

(a) Test welds shall meet the following requirements:

  (i) Visual inspection requirements given in Clause 10; and

  (ii) The standards of acceptability for nondestructive inspection given in Clause 10.

(b) Test welds failing to meet the visual inspection requirements shall not be submitted to nondestructive examination.

(c) Test welds failing to meet the standards of acceptability for nondestructive inspection shall not be submitted to destructive testing. Inspection reports shall be attached to the Procedure Qualification record

6.7 Impact Toughness Testing

(a) Except for stainless steel materials, three (3) Charpy-V notch specimens from each of the weld metal and heat-affected zone(s) shall be tested in accordance with the requirements of ASTM A370 at or below the minimum design temperature.

(b) The average value of the Charpy V-notch energy for the three (3) specimens shall be a minimum of 20 ft-lbs. The minimum value is 15 ft-lbs and only one value may be less than the average 20 ft-lbs.

(c) All test values shall be recorded on the Procedure Qualification Record (PQR).

6.8 Hardness Testing

Welding procedure qualification records shall include microhardness or macrohardness traverses (see Figure 1 for recommended spacing) across the weld, heat-affected zones and parent metal as listed below;

(a) Microhardness tests: These tests shall be performed in accordance with the requirements of ASTM E384. The maximum hardness reading shall be 350 HV using a load of one (1) kg or less.

(b) Macrohardness tests: Either Rockwell B or C, or Vickers shall be used.

(i) Rockwell B or C hardness tests shall be performed in accordance with the requirements of ASTM E18. The maximum hardness shall be 100 if the Rockwell B scale is used or 22 if the Rockwell C scale is used.

(ii) Vickers hardness tests shall be performed in accordance with the requirements of ASTM E92 using a load of ten (10) kg. The maximum hardness shall be 248 HV10.

It shall not be permissible to convert hardness readings from one hardness scale to another hardness scale.

6.9 Records of Welding Procedures

Details of the welding procedure qualification tests and the qualified welding procedure specification shall be recorded. Copies of such records shall be available for review by the Company.

7 QUALIFICATION OF WELDERS

7.1 General

Each welder producing welds shall be entitled to work in the jurisdiction where the Work is performed. Welders shall be qualified in accordance with the requirements of 49 CFR 192 Subpart E, 49 CFR 195 Subpart D, and ASME Boiler and Pressure Vessel Code Section IX.

7.2 Test Weld Acceptability for Welder Qualification

Welders shall be qualified for the Work when they produce a test weld witnessed by the Company that:

(a) Has been made in accordance with the requirements of the welding procedure specification

(b) the visual inspection requirements given in Clause 10; and

(c) Meets the standards of acceptability for nondestructive inspection given in Clause 10.

A welder's first production weld shall not be used for welder qualification; welders must qualify on a coupon prior to production welding.

Test welds failing to meet the visual inspection requirements shall not be submitted to nondestructive inspection.

7.3 Records of Qualified Welders

Records shall be made of the tests given to welders and of the detailed results of each test. A list of qualified welders and the procedure specifications in accordance with which they are qualified to weld shall be maintained for review by the Company.

8 PRODUCTION WELDING

8.1 Compliance with Specifications

Production welding shall be performed by qualified welders in accordance with qualified welding procedure specifications. Records of welding parameters used for production welding, and of the resolution of any non-conformance, shall be maintained to demonstrate compliance with the requirements of this Specification and the welding procedure specifications. Records shall be available to the Company.

(a) The Company reserves the right to measure welding parameters on any production weld. When the parameters measured on a weld do not comply with the specified values, the Company reserves the right to reject such weld and any weld made after the last compliant record, unless the party responsible for the Work can demonstrate such welds are in compliance.

(b) Non-compliance with the requirements of this Specification and of the welding procedure specification shall be cause for weld rejection.

8.2 Cleaning of Pipe Ends

(a) Oxides or other extraneous matter shall be removed from the joint prior to commencement of welding.

(b) Flame cut bevels shall be ground to clean metal prior to welding. The bevel surfaces shall be smooth and free of irregularities that could adversely affect the welder's ability to produce high quality welds as required by the appropriate section of this Specification.

(c) Areas to be cleaned shall include the weld bevel and both internal and external pipe surfaces in the vicinity of the weld for a distance of at least 1 in. from the edge of the weld.

8.3 Pipe Identification

Where a pipe is cut, pipe identification such as pipe number, grade, heat number, Company purchase order and manufacturer shall be transferred to both ends of the pipe. Die stamping of the pipe or weld shall not be permitted for that purpose.

8.4 Laminations

(a) When tie-ins are made to existing pipe or facilities, the pipe shall be checked for laminations for the entire 360 degree circumference and 6 in. back from the weld bevel.

(b) Should any lamination or split end be discovered at the bevelled end of a pipe joint, either before or during welding, the joint shall be cut back until the lamination has been completely removed and the end re-bevelled.

(c) Consideration shall be given to using ultrasonic, liquid penetrant or magnetic particle inspection methods to confirm the new cut end is free of laminations or split ends.

8.5 Grinding of Seam Welds

For welds that will later be nondestructively examined using radiography, the pipe seam welds shall be ground flush (-0, +1/64 in.) with a gradual transition to the weld reinforcement for a minimum distance of 1 in. from the bevel edge.

For welds that will later be nondestructively examined using ultrasonic examination, the pipe seam welds shall be ground flush (-0, +1/64 in.) with a gradual transition to the weld reinforcement for a minimum distance of 6 in. from the bevel edge.

8.6 Alignment and Fit-up

(a) External forces required to move the mismatched pipes in alignment shall be kept to a minimum. If the pipes to be joined were in place below grade, a sufficient length of each pipe shall be exposed so that they can be moved without imposing detrimental external stresses at the joint. If the pipes were in place below or above grade and there is not sufficient length to allow free movement, the pipe(s) shall be cut and reinstalled to bring the misalignment within the allowable tolerance, or the pipe shall be cut and a new length of field bent pipe will be installed.

(b) Longitudinal seam welds shall be located such that they will be in the top half of the assembly, but not at the 12 o'clock position, when the assembly is ready for tie-in. Except for electric resistance welded pipe, longitudinal, spiral and skelp end welds in adjacent lengths of welded pipe shall be offset by a minimum distance of two (2) inches.

(c) Hammering of the pipe shall not be permitted.

(d) Line-up clamps, full penetration tacks or bridge tacks shall be used at all times.

(e) For pipe of the same nominal wall thickness, the maximum offset or misalignment of the abutting pipe ends shall not exceed 1/16 in.

(f) For pipe to fitting joints of equal nominal diameter and wall thickness, the external offset shall not exceed 1/8 in. Internal offsets exceeding 3/32 in. shall conform to the conditions specified in Clause 8.19.

(g) Pipe ends damaged or dented beyond these acceptance limits, external or internal offsets specified above, shall be cut and re-bevelled.

(h) The welding of alignment lugs shall only be permitted in the joint bevel and only with the approval of the Company. Alignment lugs shall be made of material that is similar to that being welded and shall be welded with a qualified, low-hydrogen, welding procedure.

(i) Pipe shall be fully inserted into sockolet fittings, utilizing the manufacturer's recommended gap. Gapolets are an acceptable means of maintaining the gap requirements.

(j) All O'let fittings shall be installed a minimum of two (2) inches (toe to toe of welds) from any long or spiral seam weld and any girth weld.

(k) Where transition weld preparations are part of the assembly, the lengths of the counterbores and their surface finish shall be adequate for ultrasonic inspection, if this technique is used.

8.7 Pipe Support

(a) The welding of supports, bracing bars or counter balance weights to pressure piping and components shall not be permitted.

(b) Pipe shall be supported in accordance with standard industry practice. Any occurrence of a pipe or component falling from its support shall be reported to the Company, together with any tests, inspections and remedial work performed as a result of the fall.

8.8 Weather Conditions

Portable enclosures are permitted to make conditions satisfactory for welding.

8.9 Grounding and Cables

(a) Grounding devices shall be designed to prevent arcing and shall be placed on a clean surface.

(b) Devices grounding in the bevel area shall be made of steel; copper or bronze tips shall not be used for such purpose.

(c) Welding shall be insulated to prevent arcing to the pipe surface.

8.10 Protection of Coatings

Consideration shall be given to the protection of the existing coatings on piping to minimize damage that may result from the welding operations.

8.11 Preheating and Controlled Cooling

(a) Preheating temperatures shall be as given in Table 1.

Table 1 – Preheating Temperatures

Application - Process – Grade	Minimum	Maximum
Bridge tacks and alignment lugs SMAW, GMAW and FCAW Up to NPS 12 and Grade X42 inclusive	70°F	400°F
Bridge tacks and alignment lugs SMAW, GMAW and FCAW Grades higher than X42 and assemblies larger than NPS 12	170°F	400°F
Pipe ALL processes ALL Grades	212°F	400°F
Components ALL processes ALL Grades	300°F	400°F
Repairs ALL processes ALL Grades	252°F	400°F
Pups to Weld-end Valves (NPS 16 & higher) ALL processes ALL Grades See special precautions below	212°F on pipe side 300°F on valve side	400°F in weld area 300°F at 4 in from weld area on valve body
General precautions for welding on weld-end valves: - The seat-ring gaps shall be protected from contamination by welding debris. - Consideration shall be given to the use of closures, seals, etc., post-weld cleaning and flushing out contaminated grease. - Preheating shall only be applied to the external surfaces while monitoring the temperatures given in Table 1. Precautions shall be taken to protect the valve seat seals, i.e., ensure that valves are fully opened. - For NPS 2 and larger valves, see additional guidelines for welding in Company Procedure TEP-VALV-FAB. - For valves < NPS 2, manufacturers' recommendations should be followed.		

(b) The minimum preheat temperature shall be maintained for a minimum distance of:

(i) 100 mm on each side of the weld for the full circumference in the case of girth welds; or

(ii) 150 mm from any point of the area to be repaired in the case of repairs.

(c) Preheat and interpass temperatures shall be checked using temperature-indicating crayons or pyrometers in an area ten (10) mm to thirty (30) mm from the edge of the bevel and shall be within the specified limits during the passage of the arc. When preheating with a flame, a minimum of fifteen (15) seconds shall elapse after the flame is removed from the surface before preheat temperatures are measured.

(d) No passes of a weld shall be cooled at a rate greater than that provided by natural air-cooling.

(e) Preheat shall be maintained until weld is at least two-thirds (⅔) full. For unequal WT across the weld, the minimum two-thirds (⅔) full shall be measured on the thinner wall thickness.

8.12 Number of Welders

A minimum of two (2) welders shall be required for welds on piping larger than NPS 16 and for the root pass and hot pass of NPS 16 welds, except that only one welder is required for rolled welds.

8.13 Start of Welding

Welding shall not commence until all parts to be joined are secured against relative movement.

8.14 Removal of Bridge Tacks and Alignment Lugs

Bridge tacks and alignment lugs shall be completely removed after they have served their purpose. For material grades greater than X80, tacking/lug attachment areas shall be inspected by magnetic particle inspection for cracking after removal and prior to completion of the root pass.

8.15 Cleaning between Passes

Weld bead starts, high points and starting porosity shall be removed by grinding prior to depositing weld metal over them.

8.16 Maximum Bead Width

(a) Except as permitted below, the maximum width of any weld bead shall be 3/4 in.

(b) It shall be permissible to use a full weave technique with a bead width exceeding 3/4 in. when welding in the fixed position using SMAW electrodes of 5/32 in. diameter or less and at least one of the items being welded does not exceed 0.688 in. nominal wall thickness.

8.17 Weld Capping

(a) For pipe to fitting or valve joint with unequal wall thickness, if the end preparation is a single bevel (30° or 37.5° nominal) the cap shall reach the breaking point between the bevel angle and the external diameter of the fitting or the taper angle, if any.

(b) If the fitting has a compound bevel (37.5° nominal) and then 10°, the cap shall reach the edge between the weld bevel and the secondary bevel (taper angle).

(c) In any case, the maximum cap overlap shall be three (3) mm beyond the edge of the weld bevel. The slope of the cap shall not exceed 30° and the weld thickness on the fitting side shall not exceed 1.5 times the nominal pipe wall thickness.

8.18 Interruptions in Welding

(a) Except as permitted below, production welding shall continue without interruption and the weld temperature shall be maintained above the minimum interpass (preheat) temperature until at least two (2) passes have been completed and two-thirds (⅔) of the weld thickness is filled.

(b) For GMAW/SAW or GMAW/SMAW/SAW combined rolled welds, it shall be permissible to let the weld cool down following the completion of the root and hot passes and the first SAW pass, provided that the assembly is not moved. The weld shall be wrapped in an insulating blanket if the weld is allowed to cool after the hot pass.

8.19 Backwelding

Backwelding is permitted on pipe to fitting welds to account for inherent misalignment from manufacturing.

When attaching fittings/valves to pipe, any area where the internal misalignment exceeds 3/32 in. shall be backwelded using low hydrogen electrodes so as to produce a gradual transition in material thickness between the fitting/valve and the pipe. The root pass metal reinforcement shall be removed by grinding before backwelding.

8.20 Transition Welds

Transition welds shall be designed as specified in Clause 5.3.1. The preferred type of transition joint is the combination 'counterbore and taper'.

Welding of transition joints shall be completed as described below;

(a) Final tie-in welds shall not be permitted at taper transition joints, except as allowed in Table 2;

(b) For limitations on component to pipe welds (fabrication welds) refer to Clause 8.19 and Table 2.

(c) Field tie-in welds at transition joints are acceptable utilizing the limitations stated in Table 2.

Table 2 – Transitions in a Station

Weld Type	Welds Involving Components in the Field	Pipe to Pipe	Notes
Final Tie-ins	**Not Acceptable**	**Acceptable** [1]	▪ Counterbored and taper transitions, no restrictions.
		Not Acceptable	▪ Taper transitions on pipe wall thickness greater than 0.100 in. in difference.
Tie-in Welds	**Not Acceptable**	**Acceptable** [1, 2]	▪ Counterbored and taper transitions, no restriction

[1] Taper transitions on pipe wall thickness up to and including 0.100 in. difference, NDE for both wall thicknesses is required.
[2] Taper transitions on pipe wall thickness difference greater than 0.100 in. requires an engineering assessment and approval. NDE for both wall thicknesses is required.

8.21 Identification of Welders

(a) Welders shall be responsible for marking their unique welder number/letter on the top quadrant of the pipe adjacent to each weld they have worked on using a permanent marker (low stress stamps are not acceptable for pressure piping). Welder markings shall be at least four (4) inches from the edge of the coating cutback (approximately 8 to 10 in. from the weld centerline). The welder identification number/letter shall also be recorded on the NDE inspection record and on the relevant drawing/spool sheet.

(b) Stainless steel welds shall be identified using an indelible (chloride-free) ink marker.

8.22 Clean-up of the Weld

Weld spatter shall be completely removed from the surface of the joint for a minimum distance of four (4) inches on each side of the weld.

8.23 Clean-up of the Work Area

The work area shall be kept free of waste. Pipe pups, bevel shavings, unused welding rods and other surplus materials shall be collected continuously.

9 INSPECTION AND TESTING OF PRODUCTION WELDS

9.1 Visual Inspection

Completed welds shall be visually inspected and any imperfection shall be assessed using the applicable Standard of Acceptability given in Clause 10.

It shall be permissible to repair defects in the cap or root pass detected by visual inspection before nondestructive testing, provided that:

(a) All repair work is approved by the Company;

(b) Any welding is done in accordance with the requirements of an approved welding procedure;

(c) A visual inspection of the weld is performed after the repair work; and

(d) Inspectors shall be trained and their qualifications approved by the Company.

9.2 Mandatory Nondestructive Examination

(a) All production welds shall be nondestructively examined for 100% of their lengths, in accordance with the requirements of Chapter VI of ASME B31.3; and

  (i) Where such welds are butt welds, using radiographic or ultrasonic methods, or a combination of such methods;

  (ii) Where such welds are fillet welds or combination groove/fillet welds, using wet magnetic particle inspection (black on white or fluorescent) on ferrous materials or liquid penetrant inspection on non-ferrous materials.

(b) Any imperfection shall be assessed using the applicable Standard of Acceptability given in Clause 10. The Company may, at its option, require additional inspection with other nondestructive examination methods listed within this Specification.

9.3 Nondestructive Examination Methods

(a) Radiographic inspection shall be performed in accordance with the requirements of Company Specification TES-NDT-RT-US.

(b) Ultrasonic inspection shall be performed in accordance with the requirements of Company Specification TES-NDT-UT2-US.

(c) Magnetic particle inspection shall be performed in accordance with the requirements of ASME Boiler and Pressure Vessel Code, Section V, Article 7. The direct current method of magnetization shall not be used.

(d) Liquid penetrant inspection shall be performed in accordance with the requirements of ASME Boiler and Pressure Vessel Code, Section V, Article 6.

(e) With permission of Company engineering personnel and an approved procedure and operators Phased Array Ultrasonics may be implemented for pipe to pipe butt welds.

(f) If field hardness testing is required, testing shall conform to ASTM E 384 using Equotip or similar portable hardness tester. The instrument shall be calibrated using Vickers hardness blocks and linearity shall be verified at two points outside the expected hardness range.

10 STANDARDS OF ACCEPTABILITY

The standards of acceptability for weld inspection shall meet the requirements of Section 9 of API 1104 and the additional requirements shown in this section.

The standards of acceptability for visual inspection shall meet the following additional criteria for the maximum height of weld reinforcement:

Height of reinforcement, in	Pipe Nominal Thickness, in.
Less than 0.100	Less than 0.512
Less than 0.138	Greater than 0.512 inclusive

10.1 Visual, Magnetic Particle, Liquid Penetrant and Radiographic Inspections

The standards of acceptability for visual inspection, magnetic particle inspection, liquid penetrant inspection and radiographic inspection shall be the applicable criteria given in Table 3.

10.2 Ultrasonic Inspection

(a) Indications of discontinuities characterized as cracks are unacceptable regardless of length or location.

(b) A linear-type discontinuity is unacceptable if the amplitude of the indication exceeds the reference level and its length exceeds:

(i) ¼ in. for $T_w \leq$ ¾ in.;

(ii) $T_w/3$ for $T_w >$ ¾ in. and ≤ 1-1/2 in.; or

(iii) 0.5 in. for $T_w >$ 1-1/2 in..

(c) No indication will exceed a vertical height of 25% Tw for oil service and 50% Tw for gas service.

Table 3 – Acceptance Criteria for Assemblies and Station Piping Welds

Imperfection Type See Note (1)	Visual Method	Radiography	Acceptance Criteria See Note (2)
Groove and Fillet Welds Requirements			
Crack	Y	Y	Zero (no evident imperfection)
Lack of fusion	Y	Y	Zero (no evident imperfection)
Surface porosity or exposed slag inclusion	Y	NA	Zero (no evident imperfection)
Groove Welds Only (In addition to Groove and Fillet Welds Requirements Above)			
Incomplete penetration (IP)	Y	Y See Note (4)	Depth of IP < 0.04 in. and < 0.2 T_w Cumulative length of IP < 1-1/2 in. in any 6 in. weld length
Internal porosity	NA	Y	For T_w > ¼ in., 1.5 x dimensions listed in ASME Boiler and Pressure Vessel Code, Section VIII, Division 1, Appendix 4
Slag inclusion, tungsten inclusion, or elongated indication	NA	Y	Individual length < 2 T_w and < 2 in. Individual width < 0.12 in. and < T_w 2 Cumulative length < 4 T_w in any 6 in. weld length
Undercutting	Y	See Note (5)	Depth of undercut < 1 mm and < T_w /4
Concave root surface	Y	Y	Total joint thickness, including weld reinforcement, > T_w
Reinforcement or internal protrusion See Note (3)	Y	NA	Height of reinforcement: < 0.1 in. for T_w < ½ in. < 0.14 in. for T_w > ½ in.
Fillet Welds Only (In addition to Groove and Fillet Welds Requirements Above)			
Undercutting	Y	NA	Depth of undercut < 1 mm and < T_w /4
Height of Reinforcement See Note (4)	Y	NA	< 0.1 in. for T_w < ½ in. < 0.14 in. for T_w > ½ in.

Y Examination method generally used for evaluating this kind of weld imperfection
NA Examination method not generally used for evaluating this kind of weld imperfection

Notes:

1. Accumulation of Different Imperfections: The cumulative length of all imperfections shall not exceed three (3) in. in any 12 in. length of weld, or 25% of the weld length in welds less than 12 in. long.
2. Where two limiting values are separated by "and", the lesser of the values determines acceptance. Where two sets of values are separated by "or", the larger value is acceptable. T_w is the nominal wall thickness of the thinner of two components joined by a butt weld.
3. Height is the lesser of the measurements made from the surfaces of the adjacent components; both reinforcement and internal protrusion are permitted in a weld. Weld metal shall merge smoothly into the component surfaces.
4. Height measured from the theoretical throat. Internal protrusion does not apply. Weld metal shall merge smoothly into the component surfaces.
5. If radiography is used to assess depths of incomplete penetration and undercut, a comparator shim shall be used. Depths are estimated by comparing the density of the film image of the undercut or incomplete penetration with the density of film images of known groove depths in the comparator shims. Shims shall be made of a material that is radiographically similar to the material being inspected and the image of at least one shall appear on each radiograph.

11 REPAIR OF WELDS CONTAINING DEFECTS

11.1 Cracks

Cracks shall not be repaired and shall be removed by cutting out cylinders containing such cracks. Replacement pups, if required, shall be three (3) feet long or one diameter in length, whichever is the longest.

11.2 Approval for Repair and Procedure

Repair of defects in production welds shall:

(a) Require approval of the Company;

(b) Be performed by qualified welders using welding procedure specifications approved by the Company; and

(c) Be recorded on the inspection reports.

11.3 Removal of Defects

(a) Except as permitted below, defects in welds shall be removed by grinding.

(b) It shall be permissible to remove defects in welds by air carbon arc gouging provided that:

(i) The wall thickness exceeds 0.375 in.;

(ii) A one (1) foot wide area centered around the defective weld metal is preheated to a minimum of 150°F and a maximum 300°F before the gouging process begins;

(iii) After gouging and prior to commencement of welding, gouged surfaces are made smooth and free of irregularities by grinding a minimum of 3/32 in. of material from the bottom and edges of the groove;

(iv) The groove preparation is visually examined to ensure that all traces of carburized metal, copper deposits, or other extraneous matter have been removed from the groove; and

(v) Approval is obtained from the Company prior to commencing repair welding.

(c) Any section of pipe that has arc burns that cannot be repaired in accordance with Company Specification TES-WELD-ABR-US shall be cut out and replaced. Replacement pups, if required, shall be three (3) feet long or one diameter in length, whichever is the longest.

11.4 Welding Process and Consumables

The repair welding process shall be designed and consumables selected in accordance with the requirements of Clause 5.2.

11.5 Preheat for Repair Welding

The repair area shall be preheated in accordance with the requirements given in Clause 8.11.

11.6 Start and Stop of Repair Welds

The start and stop of repair welds shall be ground to conform to the contour of the original weld.

11.7 Inspection of Repairs

(a) Repairs shall be inspected using the methods and procedures specified for production welds in Clause 9.

(b) Proper removal of defects shall be confirmed using the same method used to find the original defects.

(c) Any imperfection shall be assessed using the applicable Standard of Acceptability given in Clause 10.

11.8 Further Repair Attempts

Further attempts at repairing a given defective area of a given weld beyond the first repair shall not be permitted without prior approval of the Company.

12 HEAT TREATMENT AND MECHANICAL TESTING

12.1 Heat Treatment

Assembly welds governed by ASME B31.4 or ASME B31.8, where the nominal wall thickness exceeds 1.250 in. shall be stress relieved.

Assembly welds that require stress relief shall be heat-treated between 1100°F and 1200°F for a minimum holding time of 1 hour/1 inch of bevel thickness. Assembly welds that must be stress relieved shall use a qualified welding procedure designed for and qualified with post weld heat-treatment.

12.2 Mechanical Testing

When using previously tempered piping/fitting materials (normalized and tempered, or quenched and tempered, prior to welding) and the stress relieving temperature is less than or equal to the materials' tempering temperature, no mechanical testing in addition to that required by the applicable material standard is required.

When the stress relieving temperature is greater than the materials tempering temperature, the following additional tests shall be conducted:

(a) For materials less than (<) Grade X42, Charpy tests in accordance with the requirements of the applicable material standard shall be conducted after stress relieving. The Charpy toughness requirements of the applicable material standard shall be met. Additional tensile tests are not required. Charpy tests are required on each heat of parent metal.

(b) For materials greater than or equal to (≥) Grade X42, all mechanical tests in accordance with the requirements of the applicable material standard shall be conducted after stress relieving. The requirements of the applicable material standard shall be met. Mechanical tests are required on each heat of parent metal.

When stress relieving is used on untempered piping/fitting materials (those that were not normalized and tempered, or quenched and tempered) the following additional tests shall be conducted:

(c) For materials less than (<) Grade X42, Charpy tests in accordance with the requirements of the applicable material standard shall be conducted after stress relieving. The Charpy toughness requirements of the applicable material standard shall be met. Additional tensile tests are not required. Charpy tests are required on each heat of parent metal.

(d) For materials greater than or equal to (≥) Grade X42, all mechanical tests in accordance with the requirements of the applicable material standard shall be conducted after stress relieving. The requirements of the applicable material standard shall be met. Mechanical tests are required on each heat of parent metal.

13 RECORDS

13.1 Drawings for Manufactured Items

Drawings for items purchased as a manufactured component (ie. meter run, header) shall be prepared by and submitted by the manufacturer for written acceptance. In addition to the information specified in the applicable Company material specification, the drawings shall contain the following:

(a) Welding procedure numbers and revision numbers for the assembly welds.

(b) Maximum qualified CE for each assembly weld procedure, when required.

(c) Specified NDE requirements.

(d) Applicable material specification, revision number, and revision date.

(e) Applicable material number.

(f) When specified the equipment data sheet number(s) and revision(s).

(g) Purchase order number.

(h) The minimum design temperature.

(i) Material traceability numbers.

(j) Project name and number.

(k) Bill of Materials showing the material specification and heat number for each material used in the assembly.

(l) Other applicable information.

13.2 Drawings for Fabricated Assemblies

Drawings for fabricated assemblies will be provided by the Company. The fabricator can chose to work from these drawings or to create spool drawings. In either case the following information shall be included on the as-built drawing or spool sheet:

(a) Bill of Materials showing the material specification and heat number for each material used in the assembly.

(b) Weld procedure numbers (including revision number).

(c) Project name and number.

(d) Contract number and/or purchase order number.

(e) Weld map (drawing showing the weld locations and numbers).

(f) NDE procedure number.

(g) Spool sheet number identified on original drawing.

13.3 Reports and Certificates

The manufacturer shall supply a document package prior to shipping the manufactured component to the Company or its designated delivery point, unless alternate arrangements are agreed upon with the Company. The document package shall include:

(a) The information specified within the Company material specification.

(b) The purchase order number.

(c) A copy of the Company accepted drawing.

(d) Material test reports (MTR), including CE values.

(e) Pressure testing records.

(f) Heat treatment records.

(g) Weld map (drawing showing the weld location and number).

(h) Nondestructive inspection reports; such reports shall identify the procedure number and revision number used for the inspection.

(i) Correlation between the bill of material item number on the accepted drawing, and the piping material manufacturer and heat number.

(j) Project name and number.

(k) Summary of measured welding parameters (amps, volts, travel speed, heat input).

The fabricator shall supply a document package prior to shipping the fabricated assembly to the Company. The field installation contractor shall ensure a document package is supplied to the company at completion of the project. The document package shall include but not be limited to the following:

(a) An approved inspection and test plan.

(b) Completed as-built drawings.

(c) Fabrication spool sheets (with checkers signatures).

(d) Material test records (MTR), including CE values.

(e) Pressure test logs and charts.

(f) Heat treatment report and related charts.

(g) Weld map (drawing showing the weld location and number).

(h) Nondestructive inspection reports; such reports shall identify the procedure number and revision number used for the inspection.

(i) Correlation between the bill of material item number on the accepted drawing, and the piping material manufacturer and heat number.

(j) Project name and number.

(k) Summary of measured welding parameters (amps, volts, travel speed, heat input).

The document package shall be in a format acceptable to the Company, electronic format is acceptable.

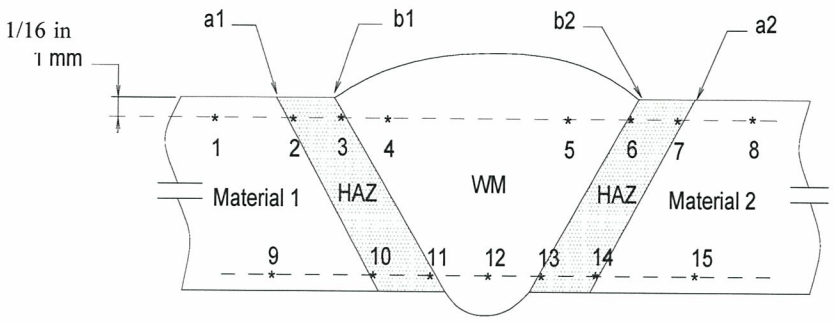

Figure 1 - Hardness Traverse Locations

Lines a1, a2	Boundary visible after etching between heat-affected zone (HAZ) and unaffected parent metal
Lines b1, b2	Boundary visible after etching between weld metal and HAZ. Hardness impressions 3, 6, 11 and 13 should be entirely within the HAZ, as close as possible to the fusion boundary. Impression 2 should coincide with the HAZ of the final run, and impression 6 with the change in profile of the fusion line associated with the final run.

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