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January 18, 2008

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Chris Hoidal
Director, Western Region
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12300 W Dakota Ave., Suite 110
Lakewood, CO 80228

Dear Mr. Hoidal:

On January 14, 2008, TransCanada - GTN received a letter from your office dated January 9, 2008 (CPF 5-2008-1003M) titled "Notice of Amendment."

Following the audit conducted in June of 2007 when these issues were identified TransCanada replaced or made revisions to the procedures in question. The new procedures are attached and electronic copies will be emailed to your office.

With regard to Item 1, TransCanada's welder qualification procedure, Drawing Number 61-E-W-4, has been replaced by Section 5 of TES-WELD-AS-US Welding of Assemblies and Station Piping, and Section 5 of TES-WELD-PL-US Welding of Pipelines and Tie-ins.

With regard to Item 2, TransCanada's IO&M Plan Section 192.479 requires above ground pipe to be coated in accordance with two newly implemented coating specifications: TES-COAT-EPU-US External Epoxy/Urethane Coating Systems, and TES-COAT-STN External Coating Systems For Underground Station Yard Piping. Section 8.0 of each specification requires risers to be coated at the air to soil interface.

With regard to Item 3, TransCanada's procedures Valve and Valve Operator M24 Inspection and Valve and Valve Operator M24 Leak Inspection/Cycle Test have been revised to clarify the intent and requirement that the inspections are to be scheduled and performed in accordance with the requirements of 192.745. In Section 3.0 of each of the TOPs the requirement is stated.

If you have any other questions, please call or write me.

Sincerely,

Ross Parker
Regional Director

Enclosures: TES-WELD-AS-US Welding of Assemblies and Station Piping
TES-WELD-PL-US Welding of Pipelines and Tie-ins
IO&M Plan Section 192.479
TES-COAT-EPU-US External Epoxy/Urethane Coating Systems
TES-COAT-STN External Coating Systems For Underground Station Yard Piping
Valve and Valve Operator M24 Inspection
Valve and Valve Operator M24 Leak Inspection/Cycle Test

Title: **TES-WELD-PL-US Welding of Pipelines and Tie-ins**	Document Type: Specification
Effective Date: 2007/06/15	Revision: 0
Classification: DE-01	Document Owner : Asset Reliability, Technical Support & Technology Management
Originator: David Taylor, Senior Technologist, Asset Reliability, Technical Support & Technology Management	Signature/Date 2007/06/08
Reviewer: Robert Lazor, Engineering Specialist, Asset Reliability, Technical Support & Technology Management	Signature/Date June 07
Reviewer: Evan Vokes, EIT, Asset Reliability, Technical Support & Technology Management	Signature/Date June 8, 2007
Approver: Curtis Parker, Manager, Asset Reliability, Technical Support & Technology Management	Signature/Date June 11, 2007

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 pipeline systems. This specification shall be read in conjunction with API 1104 and covers additional requirements of 49CFR Part 192.

SCOPE

This specification applies to TransCanada (the Company), and is to be used for production welding made at pipeline sites for carbon steel pipe-to-pipe mainline and tie-in girth welds.

This specification does not apply to welds made using welding procedures qualified in accordance with the requirements of ASME Section IX and covered by the Company Specification TES-WELD-AS-US, which include those that are made:
(a) in stations;
(b) at a manufacturing plant or fabrication shop remote from the final location of the weld; or
(c) joining pipe to components, or components to components.

This specification does not apply to welds used in branch connections that are covered by TransCanada Specification TES-WELD-BC.

BRIEF DESCRIPTION OF CHANGE (IF A REVISION)

Specification modified for conversion from Canadian to US standards. This becomes revision 0 of the United States pipeline welding specification.

1 SCOPE

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(c) joining pipe to components, or components to components.

This specification does not apply to welds used in branch connections that are covered by Company Specification TES-WELD-BC.

2 REFERENCE DOCUMENTS

(a) API 1104 *Welding of Pipelines and Related Facilities*
(b) 2007 ASME Boiler and Pressure Vessel Code, Section V: *Nondestructive Examination*
(c) ASTM E 23 *Test Methods for Notched Bar Impact Testing of Metallic Materials*
(d) ASTME E 92 *Standard Test Method for Vickers Hardness of Metallic Materials*
(e) AWS A5.1 *Specification for Carbon Steel Electrodes for Shielded Metal Arc Welding*
(f) AWS A5.4 *Specification for Stainless Steel Electrodes for Shielded Metal Arc Welding*
(g) AWS A5.5 *Specification for Low Alloy Steel Electrodes for Shielded Metal Arc Welding*
(h) 49CFR192. Code of Federal Regulations, Title 49: *Transportation, Part 192 - of Natural and Other Gas by Pipeline: Minimum Federal Safety Standards*
(i) Company Procedure *Selection of Transition Pieces (& Joining Methods) - Applying the Guiding Principle* (Document ID 000006256)
(j) Company Specification *TES-NDT-UT2-US Manual Ultrasonic Examination of Welds*
(k) Company Specification *TES-NDT-UT1 Mechanized Ultrasonic Examination of Pipeline Girth Welds*
(l) Company Specification *TES-NDT-RT-US Radiographic Examination of Welds*
(m) Company Specification *TES-WELD-ABR-US Removal of Arc-burns*

3 GENERAL REQUIREMENTS

Welding shall be performed in accordance with the applicable requirements of:

(a) 49CFR192, API 1104, and any amendment, supplement, or errata issued by the United States Department of Transportation (DOT)and/or the American Petroleum Institute;

(b) this specification; and
(c) Company specifications for Environment, Occupational Health and Safety.

3.1 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 ft or more of cover) and -49°F for any other welds.

3.2 WELDING PROCESS

Welding procedures can utilize the following processes (or combinations thereof): shielded metal arc welding (SMAW); gas metal arc welding (GMAW); pulsed gas metal arc welding (PGMAW); and flux-cored arc welding (FCAW).

Weld deposition can be either manual or mechanized. The Company requirements for welding process selection and acceptable combinations of processes are listed in the Appendices; they apply to pipe grades X60 and higher, in accordance with specific details included in the respective appendix, as shown below:

Appendix	Applicable Pipe Grades
A	X60 to X70, inclusive
B	X80
C	X100

The following additional requirements are applicable for all welding processes:
(a) Fillet welds shall be made using a low hydrogen (LH) welding practice except that it shall be permissible to apply the first pass with other than a LH welding practice.
(b) The fills and cap passes of repair welds in materials of Grade X60 and greater shall be made using low hydrogen welding practices.
(c) Cellulosic consumables are permitted for repair welding in materials up to and including Grade X56, and for pipe wall thickness smaller than 0.275 in.

3.3 JOINT DESIGN

3.3.1 Butt Welds

(a) Butt welds between pipes of unequal wall thickness shall be made using a transition designed in accordance with the requirements of Company procedure specified in References, Item (i).
(b) Mechanized GMAW butt welds shall be made using a compound narrow gap bevel configuration. Mechanized welding systems can use either an automated internal welding clamp or an internal clamp with a copper back-up ring.

3.3.2 Fillet Welds

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

3.4 MATERIALS

3.4.1 Pipe Material

Materials shall be welded according to their grade in one of the following groupings:
(a) Up to Grade X42 inclusive;

(b) Higher than Grade X42 and less than Grade X65;
(c) Each material of Grade X65 and greater requires a separate qualification.

3.4.2 Filler Metals

(a) Filler metals for joining materials up to Grade X56 inclusive shall be selected from the following list (substitutions may be made with Company approval):

Process	CSA W48-01 (AWS A5.1/A5.5) Classification or Trade Name
SMAW	E6010, E7010-G, E7010-P1, E8010-G, E8010-P1, E7018-1, E8018-C2, E8018-G
GMAW	N/A
FCAW	Lincoln Innershield NR-207 , NR-208H

(b) Except for the root pass, filler metals shall meet the minimum yield strength of the highest grade of material being welded.
(c) Filler metals for joining materials with grades higher than Grade X56 shall be selected in accordance with the applicable requirements of Appendix A, B or C of this specification.

3.4.3 Shielding Gases

Components of shielding gases shall have a purity of at least 99.5% and a dew point of -30°F.

4 QUALIFICATION OF WELDING PROCEDURES

4.1 GENERAL

Welding procedure specifications other than those supporting the pre-qualified welding procedure specification data sheets provided by the Company shall be qualified in accordance with the requirements of API 1104 and the additional requirements of this section.

4.2 ADDITIONAL ESSENTIAL CHANGES

(a) Welding procedure specifications shall be limited by the following additional essential changes:
  (i) Preheat and Interpass Temperature: A decrease in either the specified preheat or interpass temperature recorded during procedure qualification.
  (ii) Changes to pulse parameters or pulsed software version used on qualification weld.

(b) Such changes in welding procedure shall necessitate re-qualification of the welding procedure specification or establishment and qualification of a new welding procedure specification.

4.3 CHANGE IN MINIMUM DESIGN TEMPERATURE

A change to a minimum design temperature colder than that used for impact toughness testing during procedure qualification shall necessitate retesting for impact toughness as specified in Paragraph 4.5 and, where applicable, retesting for alternate acceptance criteria as specified in Paragraph 4.8.

4.4 TEST WELD ACCEPTABILITY FOR DESTRUCTIVE TESTING

(a) Test welds shall meet the following requirements:
  (i) visual inspection requirements given in Paragraph 8.1; and
  (ii) the standards of acceptability for nondestructive inspection given in Paragraph 8.1.
(b) Test welds failing to meet the visual inspection requirements shall not be submitted to nondestructive inspection.
(c) Test welds failing to meet the standards of acceptability for nondestructive inspection shall not be submitted to destructive testing.

4.5 IMPACT TOUGHNESS TESTING

(a) Three (3) Charpy V-notch specimens from the weld metal and three Charpy specimens from the heat-affected zone shall be tested at a temperature not warmer than the minimum design temperature in accordance with the requirements of ASTM E 23.
(b) The average value of the Charpy V-notch energy for the three (3) specimens shall be a minimum of 20 ft-lbf; the minimum energy value for any one specimen shall be 15 ft-lbf.
(c) All test values shall be recorded on the Procedure Qualification Record.

4.6 TENSILE TESTING

(a) The Company requires at least one reduced section cross-weld tensile specimen tested with yield strength reported.
(b) The Company may require all weld metal tensile testing for welding consumables used on materials with Grades X70 and higher.

4.7 HARDNESS TESTING

(a) Vickers hardness measurements shall be taken in accordance with the requirements of ASTM E 92, at a load not exceeding 1 kg, on a polished cross-section of the weld along two (2) lines (root level and cap level) as shown on Figure 1.
(b) Hardness value at any measurement point shall not exceed 350 HV.
(c) The measured hardness values of the base metals, heat-affected zones and weld metal shall be recorded on the Procedure Qualification Record.

4.8 ADDITIONAL TESTING FOR ALTERNATE ACCEPTANCE CRITERIA

(a) Where an alternate acceptance criteria is specified for nondestructive inspection of production welds, additional mechanical testing shall be conducted at a temperature not warmer than the minimum design temperature in accordance with the requirements given in Appendix A of API 1104.
(b) The average value of the Charpy V-notch energy shall be a minimum of 30 ft-lbf; the minimum energy value for any one specimen shall be 20 ft-lbf.
(c) Crack tip opening displacement (CTOD) testing shall be reviewed and accepted by the Company, and performed by a testing facility approved by the Company.

4.9 MECHANIZED WELDING

The Company qualifies welding procedures for mechanized GMAW and FCAW by having the contractor produce a series of consistency welds, from which welds are removed for the testing specified above.

5 QUALIFICATION OF WELDERS

5.1 GENERAL

(a) Each welder producing welds shall be entitled to work in the jurisdiction where the Work is performed.

(b) Welders shall be qualified in accordance with the requirements of 49CFR192 Subpart E and in accordance with Section 6 of API 1104.

(c) Welders shall be qualified for butt welds by visual examination and destructive testing, unless otherwise agreed by the Company.

(d) For mechanized gas metal arc welding, it shall be permissible to qualify welders for all passes, except the root pass, by having them use the mechanized welding equipment to produce a half-circumference test weld with the root pass being made by others.

(e) The Company may exempt from qualification welders who can produce proof of qualification for the Work in accordance with the requirements of API 1104.

(f) Welders shall not be qualified on production welding.

(g) Qualification of welders shall be conducted in the presence of the Company.

(h) The Company will accept either single or multiple qualifications as outlined in API 1104, Clause 6.

5.2 TEST WELD ACCEPTABILITY FOR WELDER QUALIFICATION

(a) Welders shall be qualified when they produce a test weld that:

(i) is made in accordance with the requirements of the welding procedure specification;

(ii) meets the visual inspection requirements given in Clause 6.4 of API 1104;and

(iii) meets the standards of acceptability for nondestructive inspection given in Paragraph 8.1.

(b) Test welds failing to meet the visual inspection requirements shall neither be submitted to nondestructive inspection, nor destructive testing.

5.2.1 Single Qualification

Single qualification restricts the welders to the WPS that was used for qualification. A change in any of the essential variables listed in API 1104, Clause 6.2 will require re-qualification.

When test welds are made on pipe NPS 16 or greater, a welder need only weld one-half of the pipe circumference. The total number of specimens required for welder testing shall be removed from the half of the pipe welded.

5.2.2 Multiple Qualification

Welders who complete the multiple qualification testing described in API 1104 Clause 6.3 shall be allowed to weld within the limits described in Clause 6.3.2 of API 1104.

Test welds shall be made on NPS 12 pipe.

5.3 WELDER REQUALIFICATION

The following changes from the conditions used in their test weld shall necessitate re-qualification of the welders:

(i) welding process;
(ii) direction of welding (i.e., from vertical up to vertical down or vice versa);
(iii) welding position; or
(iv) from roll welding to position welding.

5.4 RECORDS OF QUALIFIED WELDERS

Records shall be made of the tests given to welders and of the detailed results of each test. Form TEF-WELD-QUA can be used to record the test results. A list of qualified welders and the procedure specifications in accordance with which they are qualified to weld shall be maintained, and shall be submitted to the Company upon request. Welders shall be assigned a number for the purpose of identification on all welds. Once the number is assigned to a welder it cannot be re-assigned to another welder during that project.

6 PRODUCTION WELDING

6.1 COMPLIANCE WITH SPECIFICATIONS

(a) Records of welding parameters (amps, volts, wire feed speed and travel speed 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 specification. Such records shall be available to the Company. A recommended frequency for measuring on SMAW projects is once every 20 welds and for mechanized GMAW once every 15 welds. The Company reserves the right to adjust the frequency of monitoring on a project by project basis.
(b) 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 that such welds are in compliance.
(c) Non-compliance with the requirements of this specification or the welding procedure specification shall be cause for weld rejection. The cost of rewelding shall be at the Contractor's expense and not chargeable to the Company.

6.2 CLEANING OF PIPE ENDS

Areas to be clean 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 inch from the ends of the pipe.

6.3 PIPE IDENTIFICATION

Pipe identification such as pipe number, grade, heat number, manufacturer and date of manufacture shall be transferred to both ends of a length of pipe cut from a length of pipe. Die stamping of the pipe or weld shall not be permitted for that purpose.

6.4 LAMINATIONS

(a) Should any lamination or split 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.

(b) 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.

6.5 GRINDING OF SEAM WELDS

Submerged arc welded pipe seam welds shall be ground flush (-0, +1/32 in.) with a gradual transition to the weld reinforcement for a minimum distance of 0.40 in from the bevel edge, or 5.0 in where mechanized ultrasonic inspection is specified.

6.6 ALIGNMENT AND FIT-UP

(a) External forces required to align pipes shall be kept to a minimum. If the pipes to be joined are in place below grade, a sufficient length of each end of the pipes shall be exposed so that they can be moved without imposing detrimental external stresses at the joint. If the pipes are 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 code allowable tolerance.

(b) Tack welds shall not be permitted.

(c) Except in the case of bends, longitudinal seam welds shall be located at approximately the 10 o'clock and 2 o'clock positions. For NPS 16 and larger pipe, longitudinal, spiral and skelp end welds in adjacent lengths of welded pipe shall be offset by a minimum distance of 2 in.

(d) Hammering of the pipe shall not be permitted (use of a small hard plastic or steel hammer to signal release of internal clamps is acceptable as long as there is no damage to the pipe surface or adjacent coating).

(e) Except for tie-ins, NPS 4 or smaller pipe, and specific situations approved by the Company, internal line-up clamps shall be used for all welds.

6.7 PIPE SUPPORT

Pipe shall be supported in accordance with standard industry practice. Any occurrence of a section of the line 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.

6.8 WEATHER CONDITIONS

The contractor shall take steps to protect the welds from weather conditions considered detrimental to weld quality. Portable enclosures will be used as required to make conditions satisfactory for welding.

6.9 GROUNDING AND CABLES

(a) Grounding devices shall be designed to prevent arcing. Devices grounding in the bevel area shall be made of steel; copper or bronze tips shall not be used for such purpose.

(b) Welding cables, ground clamps and connections shall be insulated to prevent arcing to the pipe surface.

6.10 PROTECTION OF COATINGS

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

6.11 PREHEATING AND CONTROLLED COOLING

(a) Unless specified otherwise in the welding procedure, preheating temperatures shall be as given in the Table 1.

Table 1: Preheating Temperatures

Application - Process - Grade	Minimum	Maximum
Mainline and tie-ins SMAW, FCAW and SMAW/FCAW up to Grade X56 inclusive	105°F when ambient temperature is colder than 40°F	400°F
Mainline and tie-ins SMAW, FCAW, SMAW/FCAW & GMAW/FCAW higher than Grade X56	212°F *	400°F
Mainline Mechanized GMAW up to grade X80 (inclusive)	122°F	400°F
Mainline Mechanized GMAW higher than grade X80	212°F	400°F
Repairs ALL processes ALL grades	250°F	400°F

*exceptions may be allowed for GMAW/FCAW welding procedures

(b) The Contractor shall preheat a minimum distance of:

(i) 4 in. on each side of the weld for the full circumference in the case of girth welds; or

(ii) 6 in. from any point of the area to be repaired in the case of repairs.

(iii) minimum preheat temperatures shall be maintained for the completion of all welding, except as allowed in Clause 6.15.

(c) Preheat and interpass temperatures shall be checked using temperature-indicating crayons or pyrometers in an area 1-1/2 in. to 2-1/2 in. 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 15 seconds shall elapse after the flame is removed from the surface before preheat and interpass temperatures are measured.

(d) No passes of a weld shall be cooled at a rate greater than that provided by natural air-cooling. Forced cooling is not acceptable.

6.12 START OF WELDING

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

6.13 RELEASE OF LINE-UP CLAMP

When using internal line-up clamps the root pass shall be completed for 100% of the circumference prior to release. For external line-up clamps the root pass shall be at least 50% complete before removal of the clamp, unless stated otherwise on the welding procedure and there shall be no pipe movement until the root pass is 100% complete.

Cautionary Note: To minimize the risk of cracking of mainline manual welds (i.e., manual welds completed with an internal line-up clamp), it may be necessary to weld the hot pass for an approximate length of 1 foot in the area of highest anticipated stresses, prior to moving the pipe. This area would typically be on the bottom of the pipe, but could be on the top of the pipe in an overbend situation, or on the sides of the pipe in a side bend situation.

6.14 CLEANING BETWEEN PASSES

When semi-automatic or mechanized GMAW is used, clusters of surface porosity, bead starts and high points shall be removed by grinding prior to depositing weld metal over them.

6.15 INTERRUPTIONS IN WELDING

Welding of a production weld shall continue without interruption and the weld temperature shall be maintained above the minimum interpass temperature until at least two (2) passes are completed and two thirds (2/3) of the weld thickness is filled.
The maximum recommend time delay between weld passes is;

- Root and Hot pass - 5 minutes, Hot and first fill - 60 minutes
- Mainline welds shall be completed within 24 hours, Tie-in welds shall be completed the day they are started.

6.16 TRANSITION WELDS

Transition welds shall be designed as specified in Reference (i) 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 transition joints, except as allowed in Appendix D.
(b) Field tie-in welds at a transition joints are acceptable utilizing the limitations stated in Appendix D.

6.17 IDENTIFICATION OF WELDERS

(a) Welders shall be responsible for marking their individual welder number on the top quadrant of the pipe adjacent to each weld they have worked on.
(b) On coated pipe, markings shall not be made closer than 2 in. of the edge of the coating.

(c) Wax-based markers shall not be used for such a purpose.

6.18 CLEAN-UP OF THE WELD

Weld spatter shall be completely removed from the surface of the joint for a minimum distance of 5 in. on each side of the weld or as allowed by the coating cut back.

6.19 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 and removed from the work area so as not to interfere with the progress of work.

7 INSPECTION AND TESTING OF PRODUCTION WELDS

7.1 VISUAL INSPECTION

(a) Completed welds shall be visually inspected in accordance with the requirements of API 1104 section 9.7 and any imperfection shall be assessed using the applicable Standard of Acceptability given in Paragraph 8.2.

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

(i) the repair work is approved by the Company;

(ii) any welding is done in accordance with the requirements of an approved welding procedure; and

(iii) a visual inspection of the weld is performed after the repair work.

7.2 MANDATORY NONDESTRUCTIVE INSPECTION

(a) All production welds shall be nondestructively inspected:

(i) for 100% of their lengths;

(ii) in accordance with the requirements of 49CFR192.243 and API 1104; and

(iii) where such welds are butt welds, using radiographic or ultrasonic methods, or a combination of such methods.

(b) Completed fillet welds shall be inspected using wet magnetic particle inspection (black on white or fluorescent) and any imperfection shall be assessed using the applicable Standard of Acceptability given in Paragraph 8.2

(c) Mechanized GMAW and semi-automatic GMAW/Mechanized FCAW shall be inspected using the ultrasonic method.

7.3 NONDESTRUCTIVE INSPECTION 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 applicable requirements of Company Specifications.

(c) Magnetic particle inspection shall be performed in accordance with the requirements of ASME BPV 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 BPV Code, Section V, Article 6.

8 STANDARDS OF ACCEPTABILITY

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

8.1 WELD PROCEDURE/WELDER QUALIFICATION TEST WELDS

(a) The standards of acceptability for visual inspection, magnetic particle inspection, ultrasonic inspection, and radiographic inspection shall be the applicable Standard of Acceptability given in Section 6 of API 1104 and the additional requirements shown in this section.
(b) Pinholes shall be evaluated as spherical porosity.

8.2 PRODUCTION WELDS

All production welds shall exhibit neat, workmanlike appearance.

The standards of acceptability for production welds shall be those given for production test welds in Section 9 of API 1104 and the additional requirements listed in this section.

9 REPAIR OF WELDS CONTAINING DEFECTS

9.1 CRACKS

Cracks shall not be repaired and shall be removed by cutting out cylinders containing such cracks. Replacement pups, if required, shall be 3 ft (3.28 ft) long or one diameter in length, whichever is the longest.

9.2 APPROVAL FOR REPAIRS

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.

9.3 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:
  (i) the wall thickness exceeds 0.375 in.;
  (ii) a 1 foot wide area centred around the defective weld metal is preheated to a minimum of 122°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 1/16 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 3 ft long or one diameter in length, whichever is the longest.

9.4 WELDING PROCESS AND CONSUMABLES

The repair welding process shall be designed and consumables selected in accordance with the requirements of Paragraph 3.2 and 3.4.2.

9.5 PREHEAT FOR REPAIR WELDING

The repair area shall be preheated in accordance with the requirements given in Paragraph 6.11.

9.6 START AND STOP OF REPAIR WELDS

The start/stop of repair welds shall be ground to conform to the contour of the original weld. The start/stop areas for multipass welds are to be staggered by at least ½ in.

9.7 MINIMUM LENGTH OF REPAIR

The minimum length of a repair shall be 2 in.

9.8 INSPECTION OF REPAIRS

(a) Repairs shall be inspected using the methods and procedures specified for production welds in Paragraph 7.

(b) Proper removal of defects shall be confirmed using the same method used to find the original defects. In particular, where mechanized ultrasonic examination was used to identify the original defect, acceptable removal shall be confirmed by ultrasonic inspection as specified in Company Specifications.

(c) Any imperfection shall be assessed using the applicable Standard of Acceptability given for weld procedure and welder qualification test welds in Paragraph 8.1.

9.9 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.

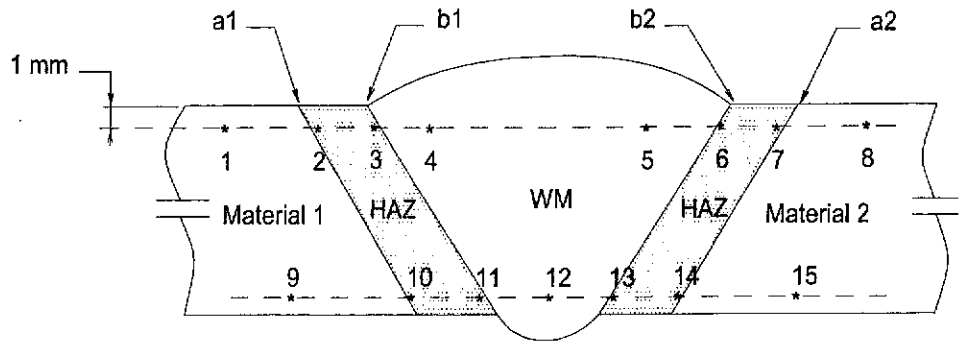


Figure 1: Vickers Hardness Traverse Locations

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.

APPENDIX A: SELECTION OF WELDING PROCEDURES FOR GRADE X60 – X70 PIPE

A1 Purpose

The purpose of this appendix is to communicate the acceptability and availability of various welding process combinations for welding large diameter Gr X60 to Gr X70 pipe in natural gas transmission pipelines in accordance with the requirements 49CFR192 and API 1104. This appendix is provided to contractors bidding for the construction of large diameter pipelines to help them in preparing the welding plan.

A2 Scope

This appendix includes the acceptability of welding processes and consumables, and inspection methods for making and repairing mainline, tie-in and crossing welds in Gr. X60 to Gr. X70 line pipe. It does not include Gr. X80 or higher line pipe or branch connection welds.

A3 Procedure

(a) The welding plan shall be prepared using a limited number of options of acceptable process combinations for each application as given in Clause A3.1 of this appendix. Clause A3.1 also indicates which procedures shall be qualified using project material in order to develop alternate acceptance criteria in accordance with the requirements of API 1104 Appendix A or an acceptable alternative standard.

(b) Process details for each option, such as joint detail and consumables, and inspection methods shall meet the requirements given in Clause A3.2.

(c) Acceptable and qualified options for repair welding are listed in Clause A3.3.

A3.1 Process Combinations and Acceptability for Gr X60 – X70 Pipe

	Option 1	Option 2	Option 3	Option 4	Option 5	Option 6	Option 7
Root Pass	Internal Mechanized GMAW	External Mechanized GMAW			External Cellulosic SMAW (5)		
Hot Pass	External Mechanized GMAW	External Mechanized GMAW	External Mechanized GMAW or External FCAW	External Mechanized GMAW or External LHVD SMAW	External LHVD SMAW or External Cellulosic SMAW(2)	External FCAW or External Cellulosic SMAW(2)	Ext. Cellulosic SMAW
Remaining Passes	External Mechanized GMAW	External Mechanized GMAW	External FCAW	External LHVD SMAW	External LHVD SMAW	External FCAW	Ext. Cellulosic SMAW
Mainline Welding	ACCEPTABLE (1)		ACCEPTABLE (4)		ACCEPTABLE (3)		
Crossings (see Contract Document)	ACCEPTABLE (1)		ACCEPTABLE (4)		ACCEPTABLE (3)		
Tie-ins	N/A				ACCEPTABLE (3)		

GMAW = Gas Metal Arc Welding; SMAW = Shielded Metal Arc Welding; FCAW = Flux-Cored Arc Welding; LHVD = Low-Hydrogen Vertical Down

Notes: (1) Requires procedure qualification for each project. To develop alternate acceptance criteria, procedure qualification in accordance with the requirements of API 1104 Appendix A is required for each wall thickness and consumable combination.
(2) Optional cellulosic hot pass.
(3) Qualified procedures may be available from the Company.
(4) Requires procedure development and qualification. Inspection remains to workmanship criteria.
(5) Optional Semi-automatic GMAW (controlled transfer -STT or RMD) when using FCAW with external gas shielding for remainder of weld.

A3.2 Welding Process Details for Gr X60 – X70 Pipe

	Option 1	Option 2	Option 3	Option 4	Option 5	Option 6	Option 7
Joint Design	Narrow Gap Bevel	Narrow Gap Bevel with copper back-up			Standard Bevel		
Mini. Preheat Temperature	122°F	122°F			212°F		
Root Pass Filler Metal & Shielding Gas	K Nova or ESAB XTi 75Ar-25CO_2	K Nova or ESAB XTi 100 CO_2 or 75Ar-25CO_2			E8010-G or ER70S-G[5] None		
Hot Pass Filler Metal & Shielding Gas	K Nova or ESAB XTi 100 CO_2	K Nova or ESAB XTi 100 CO_2 or 75Ar-25CO_2	K Nova or ESAB XTi 100 CO_2 or 75Ar-25CO_2 or NR-208H[1] None	K Nova or ESAB XTi 100 CO_2 or 75Ar-25CO_2 or Bohler BVD 90[4] None	Bohler BVD 90[4] or E5510-G[2] None	NR-208H or E8010-G[2] No shielding gas or ESAB Tubrod 15.09[5] with 75Ar-25CO_2	E8010-G None
Remaining Passes Filler Metal & Shielding Gas	K Nova or ESAB XTi Fills 100 CO_2 Cap 75Ar-25CO_2	K Nova or ESAB XTi Fills 100 CO_2 or 75Ar-25CO_2 Cap 100 CO_2 or 75Ar-25CO_2	NR-208H None	Bohler BVD 90[4] None	Bohler BVD 90[4] None	NR-208H None Or ESAB Tubrod 15.09[5] with 75Ar-25CO_2	E8010-G None
Inspection Method	Mechanized Ultrasonic Testing		Radiographic Testing or Mechanized Ultrasonic Testing to workmanship criteria[3]				

Notes: (1) Optional FCAW hot pass using NR-208H pending qualification.
(2) Optional cellulosic hot pass.
(3) Check Mechanized Ultrasonic Inspection Procedure status with the Company project manager. Ultrasonic Inspection for semi-auto GMAW.
(4) Bohler BVD 100 subject to prior approval.
(5) Optional semi-automatic GMAW (controlled transfer -STT or RMD) when using FCAW with external gas shielding for remainder of weld.

A3.3 Repair Welding Procedures for Gr X60 – X70 Pipe

I GENERAL REPAIR PROCEDURES

Process:	SMAW, SMAW/FCAW or GMAW/FCAW
Filler Metal:	Root (through-wall repair) E8010-G Hot Pass (through-wall repair) E8010-G Remaining E8018-C2 or Bohler BVD 90* or Lincoln NR-208H Internal backweld where applicable E8018-C2 or Bohler BVD 90* *Bohler BVD 100 subject to prior approval **When using GMAW/Mech. FCAW:** Semi-Auto STT/RMD GMAW (ER70S-G) – root (though-wall repair) Semi-Auto FCAW (ESAB Tubrod 15.09) remaining
Preheat:	250°F Minimum; 400°F Maximum
Position and Direction:	Vertical down welding except for - Root repair in wall thickness larger than 0.590 in.; and - E8018-C2 electrodes. - ESAB Tubrod 15.09
Inspection Method:	Ultrasonic testing for weld repairs originally called by ultrasonic inspection. Radiographic inspection for weld repairs originally called by radiographic inspection.
Qualification:	Qualified procedures may be available from the Company.

II INTERNAL BEAD MISFIRE RERUN (FOR OPTION 1)

Process:	Semi-automatic GMAW
Filler Metal:	K Nova or ESAB XTi, Shielding gas: 75Ar-25CO_2
Preheat:	122°F Minimum; 400°F Maximum
Position and Direction:	Vertical down welding.
Inspection Method:	Ultrasonic testing, included in mainline inspection.
Qualification:	Requires qualification using project pipe and consumables .

APPENDIX B: SELECTION OF WELDING PROCEDURES FOR GRADE X80 PIPE

B1 Purpose

The purpose of this appendix is to communicate the acceptability and availability of various welding process combinations for welding large diameter Gr X80 pipe in natural gas transmission pipelines in accordance with the requirements of 49CFR192 and API 1104. This appendix is provided to contractors bidding for the construction of large diameter pipelines to help them in preparing the welding plan.

B2 Scope

This appendix includes the acceptability of welding processes and consumables, and inspection methods for making and repairing mainline, tie-in and crossing welds in Gr. X80 line pipe. It does not include Gr X60 to Gr X70 and Gr X100 line pipe or branch connection welds.

B3 Procedure

(a) The welding plan shall be prepared using a limited number of options of acceptable process combinations for each application, as given in Clause B3.1 of this appendix. Clause B3.1 also indicates which procedures shall be qualified using project material in order to develop alternate acceptance criteria in accordance with the requirements of API 1104 Appendix A.

(b) Process details for each option, such as joint detail and consumables, and inspection methods shall meet the requirements given in Clause B3.2.

(c) Acceptable and qualified options for repair welding are listed in Clause B3.3.

B3.1 Process Combinations and Acceptability for Gr X80 Pipe

	Option 1	Option 2	Option 3[1]	Option 4	Option 5	Option 6	Option 7[2]
Root Pass	Internal Mechanized GMAW	External Mechanized GMAW or PGMAW			External Cellulosic SMAW		Ext. Semi Automatic GMAW[7]
Hot Pass	External Mechanized GMAW or PGMAW	External Mechanized GMAW or PGMAW	External Mechanized GMAW or External FCAW[1]	External Mechanized GMAW or External LHVD SMAW	External LHVD SMAW or External Cellulosic SMAW[4]	External FCAW or External Cellulosic SMAW[4]	Ext. Mechanized FCAW
Remaining Passes	External Mechanized GMAW or PGMAW	External Mechanized GMAW or PGMAW	External FCAW[1]	External LHVD SMAW	External LHVD SMAW	External FCAW	Ext. Mechanized FCAW
Mainline Welding	ACCEPTABLE [3]		SEE NOTE (1)	ACCEPTABLE [2]	NOT ACCEPTABLE		NOT ACCEPTABLE
Crossings (see Contract Document)	ACCEPTABLE [3]		SEE NOTE (1)	ACCEPTABLE [2]	ACCEPTABLE [5]	SEE NOTE (1)	ACCEPTABLE
Tie-ins	N/A				ACCEPTABLE [5]	SEE NOTE (1)	ACCEPTABLE

GMAW = Gas Metal Arc Welding; SMAW = Shielded Metal Arc Welding; FCAW = Flux-Cored Arc Welding; LHVD = Low-Hydrogen Vertical Down; PGMAW = Pulsed Gas Metal Arc Welding

Notes: (1) Use of FCAW requires prior approval of the Company.
(2) Requires procedure development and qualification. Inspection remains to workmanship criteria.
(3) Requires qualification for each wall thickness using project pipe and consumables to develop alternate acceptance criteria.
(4) Optional cellulosic hot pass.
(5) Qualified procedures may be available from the Company.
(6) Option 1 can be either short circuit transfer or pulsed.
(7) Semi-Auto GMAW shall be controlled dip transfer (STT or RMD)

B3.2 Welding Process Details for Gr X80 Pipe

	Option 1[4]	Option 2[4]	Option 3[1]	Option 4	Option 5	Option 6	Option 7
Joint Design	Narrow Gap Bevel	Narrow Gap Bevel with copper back-up			Standard Bevel		Standard Bevel
Mini. Preheat Temperature	122°F	122°F			212°F		212°F
Root Pass Filler Metal & Shielding Gas	K Nova or ESAB XTi 75Ar-25CO_2	K Nova or ESAB XTi 100 CO_2 or 75Ar-25CO_2			E8010-G N/A		ER70S-G 75Ar-25CO_2
Hot Pass Filler Metal & Shielding Gas	K Nova or ESAB XTi 100 CO_2	K Nova or ESAB XTi 100 CO_2 or 75Ar-25CO_2	K Nova or ESAB XTi 100 CO_2 or 75Ar-25CO_2 or See Note (1) None	K Nova or ESAB XTi 100 CO_2 or 75Ar-25CO_2 or Bohler BVD100 None	Bohler BVD100 or E8010-G[2] None	NR-208H or E8010-G[2] None	ESAB Tubrod 15.09 75Ar-25CO_2
Remaining Passes Filler Metal & Shielding Gas	K Nova or ESAB XTi Fills - 100 CO_2 Cap 75Ar-25CO_2	K Nova or ESAB XTi Fills 100 CO_2 or 75Ar-25CO_2 Cap 100 CO_2 or 75Ar-25CO_2	See Note (1) None	Bohler BVD100 None	Bohler BVD100 None	NR-208H None	ESAB Tubrod 15.09 75Ar-25CO_2
Inspection Method	Mechanized Ultrasonic Testing	Radiographic Testing or Mechanized Ultrasonic Testing to workmanship criteria[3]					Mechanized Ultrasonic Inspection

Notes: (1) Use of FCAW requires prior approval of the Company.
(2) Optional cellulosic hot pass.
(3) Check Inspection Procedure status with the Company project manager.
(4) For PGMAW the wire and shielding gases may differ from those listed, the Company will notify the contractor in the bid document.

B3.3 Repair Welding Procedures for Gr X80 Pipe

I GENERAL REPAIR PROCEDURE

Process:	SMAW
Filler Metal:	Root (through-wall repair) E8010-G Hot Pass (through-wall repair) E8010-G Remaining Bohler BVD100 Internal backweld where applicable Bohler BVD100 or E8018-C2 **When using GMAW/Mech. FCAW:** Semi-Auto STT/RMD GMAW (ER70S-G) – root (though wall repair) Semi-Auto FCAW (ESAB Tubrod 15.09) remaining
Preheat:	250°F Minimum; 400°F Maximum
Position and Direction:	Vertical down welding except for - Root repair in wall thickness larger than 0.590 in.; and - E8018-C2 electrodes. - ESAB Tubrod 15.09.
Inspection Method:	Ultrasonic testing for weld repairs originally called by ultrasonic inspection. Radiographic inspection for weld repairs originally called by radiographic inspection.
Qualification:	Qualified procedures may be available from the Company.

II INTERNAL BEAD MISFIRE RERUN (FOR OPTION 1)

Process:	Semi-automatic GMAW
Filler Metal:	K Nova or ESAB XTi, Shielding gas: 75Ar-25CO_2
Preheat:	122°F Minimum; 400°F Maximum
Position and Direction:	Vertical down welding.
Inspection Method:	Ultrasonic testing, included in mainline inspection.
Qualification:	Requires qualification using project pipe and consumables.

APPENDIX C: SELECTION OF WELDING PROCEDURES FOR GRADE X100 PIPE

C1 ***Purpose***

The purpose of this appendix is to communicate the acceptability and availability of various welding process combinations for welding large diameter Gr X100 pipe in natural gas transmission pipelines in accordance with the requirements of 49CFR192 and API 1104. This appendix is provided to contractors bidding for the construction of large diameter pipelines to help them in preparing the welding plan.

C2 ***Scope***

This appendix includes the acceptability of welding processes and consumables, and inspection methods for making and repairing mainline, tie-in and crossing welds in Gr X100 line pipe. It does not include Gr X60to Gr X70 and Gr X80 line pipe or branch connection welds.

C3 ***Procedure***

(d) The welding plan shall be prepared using a limited number of options of acceptable process combinations for each application, as given in Clause C3.1 of this appendix. Clause C3.1 also indicates which procedures shall be qualified using project material in order to develop alternate acceptance criteria in accordance with the requirements of API 1104 Appendix A.

(e) Process details for each option, such as joint detail and consumables, and inspection methods shall meet the requirements given in Clause C3.2.

(f) Acceptable and qualified options for repair welding are listed in C3.3.

C3.1 Process Combinations and Acceptability for Gr X100 Pipe

	Option 1	Option 2	Option 3	Option 4	Option 5	Option 7[4]
Root Pass	Internal Mechanized GMAW	External Mechanized PGMAW			Ext. Cellulosic SMAW	Ext. GMAW (STT/RMD)
Hot Pass	External Mechanized PGMAW	External Mechanized PGMAW	External Mechanized PGMAW or External FCAW	External Mechanized PGMAW or External LHVD SMAW	External LHVD SMAW	Ext. Mechanized FCAW
Remaining Passes	External Mechanized PGMAW	External Mechanized PGMAW	External FCAW	External LHVD SMAW	External LHVD SMAW	Ext. Mechanized FCAW
Mainline Welding	ACCEPTABLE (2)	ND(1)	ND(1)	ND(1)	NOT ACCEPTABLE	NOT ACCEPTABLE
Crossings (see Contract Document)	ACCEPTABLE (2)	ND(1)	ND(1)	ND(1)	ACCEPTABLE (3)	ACCEPTABLE (3)
Tie-ins	N/A				ACCEPTABLE (3)	ACCEPTABLE (3)

GMAW = Gas Metal Arc Welding; SMAW = Shielded Metal Arc Welding; FCAW = Flux-Cored Arc Welding; LHVD = Low-Hydrogen Vertical Down

Notes: (1) No data avaiblable at this point. Development required for evaluation.
(2) Requires qualification for each wall thickness using project pipe and consumables to develop alternate acceptance criteria.
(3) Qualified procedures may be available from the Company.

C3.2 Welding Process Details for Gr X100 Pipe

	Option 1[2]	Option 2	Option 3	Option 4	Option 5[2]	Option 6[2]
Joint Design	Narrow Gap Bevel	Narrow Gap Bevel with copper back-up			Standard CSA Bevel	Standard CSA bevel
Mini. Preheat Temperature	212°F	212°F			212°F	212°F
Root Pass Filler Metal & Shielding Gas	K-Nova 75Ar-25CO_2	N/A N/A			E8010-G or ER70S-G (Lincoln)	ER70S-G (Lincoln)
Hot Pass Filler Metal & Shielding Gas	Oerlikon NiMo-1 85Ar-15CO_2	N/A N/A	N/A N/A	N/A N/A	E10018-G None	ESAB Tubrod 15.09 75Ar-25CO_2
Remaining Passes Filler Metal & Shielding Gas	Oerlikon NiMo-1 85Ar-15CO_2	N/A N/A N/A	N/A N/A	N/A N/A	Bohler BVD110 None	ESAB Tubrod 15.09 75Ar-25CO_2
Inspection Method	Mechanized Ultrasonic Testing					

C3.3 Repair Welding Procedures for Gr X100 Pipe

I GENERAL REPAIR PROCEDURE

Process: SMAW or GMAW/FCAW

Filler Metal: Root (through-wall repair) E8010-G
Hot Pass (through-wall repair) E10018-G
Remaining Bohler BVD110
Internal backweld where needed Bohler BVD110, E10018-G or E8018-C2
When using GMAW/Mech. FCAW:
Semi-Auto STT/RMD GMAW (ER70S-G) – root (though wall repair)
Semi-Auto FCAW (ESAB Tubrod 15.09) remaining

Preheat: 250°F Minimum; 400°F Maximum

Position and Direction: Vertical down welding except for
- Root repair in wall thickness larger than 0.590 in.; and
- E8018-C2 electrodes.
- ESAB Tubrod 15.09

Inspection Method: Ultrasonic testing for weld repairs originally called by ultrasonic inspection.
Radiographic inspection for weld repairs originally called by radiographic inspection.

Qualification: Qualified procedures may be available from the Company.

II INTERNAL BEAD MISFIRE RERUN (FOR OPTION 1)

Process: Semi-automatic GMAW

Filler Metal: K Nova - Shielding gas: 75Ar-25CO_2

Preheat: 250°F Minimum; 400°F Maximum

Position and Direction: Vertical down welding.

Inspection Method: Ultrasonic testing, included in mainline inspection.

Qualification: Requires qualification using project pipe and consumables.

APPENDIX D - WELDING RESTRICTIONS ON TRANSITIONS JOINTS

Welding restrictions on Transitions Joints

The tables listed below detail the welding restrictions on transition welds. In all cases the requirements of Paragraph 6.6, "Alignment", of this specification shall be adhered to. In the event that the information listed below does not adequately cover a specific installation an engineering review shall be completed. The Contractor shall provide the TransCanada representative with a plan for the welding of transition joints for approval prior to the work commencing.

Applies to pipe greater than NPS 14, not in a station				
	Crossings (roads, water, railroads)	**Assemblies**	**Maintenance (Pipe replacement)**	**Notes**
Final Tie-ins	Not Acceptable	Acceptable*, when counter bore and taper transitions are used	Acceptable, * when counter bore and taper transitions are used and pipe is less than 24 metres (1 joint) in length	*Taper transitions when wt difference is less than 0.1 in. When greater than 0.1 in., engineering approval is needed as well as two forms of NDE.
Tie-in/Section welds at Counter Bore and Taper transitions	Acceptable **	Acceptable	Acceptable	** for pipe sections less than or equal to 3 joints (240 feet) in length to a fixed installation
Tie-ins at Taper/back bevel transitions	Not acceptable***	Acceptable*	Acceptable*	***for pipe lengths greater than 80 feet (1 joint)

Applies to pipe less than NPS 16, Grade less than 386 MPa and not in a station				
	Crossings (roads, water, railroads)	**Assemblies**	**Maintenance (Pipe replacement)**	**Notes**
Final Tie-ins or Tie in welds	Acceptable (*)	Acceptable (*)	Acceptable (*)	(*)Taper transitions on pipe wall thickness greater than 0.1 in. difference, two forms of NDE.
Final Tie-ins or Tie-in welds (> 0.2 in. difference)	Not Acceptable (**)	Not Acceptable (**)	Not Acceptable (**)	(**)Taper transitions on pipe wall thickness difference greater than 0.2 in. requires an engineering assessment and approval.
Tie-in/Section welds at Counterbore and Taper transitions	Acceptable	Acceptable	Acceptable	Not commonly used for pipe less than NPS 16.

End of Document

Title: **TES-WELD-AS-US Welding of Assemblies and Station Piping**	Document Type: Specification
Effective Date: 2007/05/15 Revision: 0	
Document Owner :	Asset Reliability, Technical Support & Technology Management
Originator: David Taylor, Technologist, Asset Reliability, Technical Support & Technology Management	Signature/Date
Reviewer: Robert Lazor, Engineer, Asset Reliability, Technical Support & Technology Management	Signature/Date
Reviewer: Evan Vokes, EIT, Asset Reliability, Technical Support & Technology Management	Signature/Date
Approver: Curtis Parker, Manager, Asset Reliability, Technical Support & Technology Management	Signature/Date

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 pipeline systems. This specification shall be read in conjunction with and covers additional requirements to ASME B31.8, API 1104 and 49 CFR 192.

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 Section IX or API 1104 which include those that are

(a) in Compressor stations;
(b) made at a manufacturing plant or fabrication shop remote from the final location of the weld; or
(c) 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).

This specification does not apply to welds used in branch connections that are covered by Company Specification TES-WELD-BC-US.

BRIEF DESCRIPTION OF CHANGE (IF A REVISION)

Specification modified for conversion from Canadian to US standards.

Table of Contents

1 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 Section IX or API 1104 which include those that are:

(d) in Compressor stations;
(e) made 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).

This specification does not apply to welds used in branch connections that are covered by Company Specification TES-WELD-BC-US.

2 REFERENCE DOCUMENTS

(a) API 1104 *Welding of Pipeline and Related Facilities*
(b) ASME Boiler and Pressure Vessel Code: Section V *Nondestructive Examination* and Section IX *Welding and Brazing Qualifications*
(c) ASME Standard B31.8- *Gas Transmission & Distribution Piping Systems*
(d) ASTM E 23 *Test Methods for Notched Bar Impact Testing of Metallic Materials*
(e) ASTM E 92 *Standard Test Method for Vickers Hardness of Metallic Materials*
(f) AWS A5.1 *Specification for Carbon Steel Electrodes for Shielded Metal Arc Welding*
(g) AWS A5.4 *Specification for Stainless Steel Electrodes for Shielded Metal Arc Welding*
(h) AWS A5.5 *Specification for Low Alloy Steel Electrodes for Shielded Metal Arc Welding*
(i) AWS A5.18 *Specification for Carbon Steel Electrodes and Rods for Gas Shielded Arc Welding*
(j) 49 CFR 192 *Transportation of Natural and Other Gas by Pipeline: Minimum Federal Safety Standards*
(k) Company Procedure *Selection of Transition Pieces (& Joining Methods) - Applying the Guiding Principle* (Engineering and Construction Document - Item ID 000006256)
(l) Company Specification *TES-NDT-RT-US Radiographic Examination of Welds*
(m) Company Specification *TES-NDT-UT2-US Manual Ultrasonic Examination of Welds*
(n) Company Specification *TES-WELD-ABR-US Removal of Arc-burns*

3 GENERAL

Welding shall be performed in accordance with;

(a) the applicable requirements of 49 CFR 192, 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.

3.1 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 ft or more of cover) and -49°F for any other welds.

3.2 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.

3.3 JOINT DESIGN

3.3.1 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 2(k).
(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.

3.3.2 Fillet Welds

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

3.3.3 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 4 tack welds shall be placed equidistantly around the circumference.
(c) For piping larger than NPS 16, the minimum length of each tack weld shall be 1½ to 2½ in.

3.4 MATERIALS

3.4.1 Pipe and Components

(a) For ASME welds, 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) For API welds, materials shall be welded according the material groupings in API 1104.

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

3.4.2 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-C1, E8018-G
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

Alternate consumables recommended by the Contractor may be considered for approval by the Company.

(b) Except as permitted below, SMAW electrodes for welding of carbon steels higher than Grade X56 shall be E8010-G/P1 for cellulosic root/hot pass and E8018-C2 or E8018-C1 for fill, cap and repairs. The company will also accept the use of E6010 on the root/hot pass as an alternative to E8010-G/P1.

(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.

3.4.3 Shielding Gases

Shielding gases shall have a purity of at least 99.5% and a dew point of -30°F or lower. For pre-mixed gases, each component gas shall have a purity of at least 99.5% and a dew point of -30°F or lower.

4 QUALIFICATION OF WELDING PROCEDURES

4.1 GENERAL

Welding procedure specifications shall be qualified in accordance with the requirements of API 1104 or ASME Section IX and the additional requirements of this section. Contractors/fabricators shall have welding procedures qualified in accordance with either of these standards for carbon steel and stainless steel materials.

Welding procedures for NPS 16 and larger pipe may be available from the Company for use by the Contractor upon request.

4.2 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.
Material test records (MTR) and carbon equivalent (calculated as per API 5L) shall be provided with all new procedures qualified on materials of Grade X56 and higher, and shall be part of the WPS documentation.

4.3 ADDITIONAL ESSENTIAL CHANGES

Welding procedure specifications shall be limited by the following additional essential variables and shall require requalification of the WPS:

(a) Carbon Equivalent: For steels X70 and greater, an increase in carbon equivalent exceeding 0.05% for pipe or components.
(b) Shielding Gas Composition: A change of more than 1% in the nominal content of any gas comprising more than 5% of the shielding gas.
(c) Electrical Characteristics: For gas shielded processes, a change in metal transfer mode (i.e. change from short arc, spray or pulsed transfer to another transfer mode).
(d) A change of greater than 1% in the nominal content of any gas comprising more than 5% of the shielding gas is an essential change and requires requalification of the welding procedure specification.

4.4 CHANGE IN MINIMUM DESIGN TEMPERATURE

A change to a minimum design temperature colder than that used for impact toughness testing during procedure qualification shall necessitate retesting, i.e. as specified in Clause 4.6 for Charpy testing.

4.5 TEST WELD ACCEPTABILITY FOR DESTRUCTIVE TESTING

(a) Test welds shall meet the following requirements:
  (i) visual inspection requirements given in Clause 8; and
  (ii) the standards of acceptability for nondestructive inspection given in Clause 8.
(b) Test welds failing to meet the visual inspection requirements shall not be submitted to nondestructive inspection.
(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.

4.6 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 at a temperature not warmer than the minimum design temperature in accordance with the requirements of ASTM A 370.

(b) For pipe with WT 0.5 in. and less, the largest possible specimen size shall be machined. On pipe with WT 0.5 in. and greater, the bottom edge of the specimen shall be 1/16 in. from the ID surface.

(c) Specimens shall be removed from the top half of the pipe at the 3:00 or 9:00 O'clock positions.

(d) 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.

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

4.7 HARDNESS TESTING

Welding procedure qualification records shall include microhardness or macrohardness traverses (see Fig. 1 for recommended locations) 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 Standard E 384. The maximum hardness reading shall be 350 HV using a load of 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 Standard E 18. 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 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.

4.8 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 submitted for review by the Company prior to use.

5 QUALIFICATION OF WELDERS

5.1 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, ASME Section IX, or API 1104 approved editions. The applicable standard for testing and the extent of testing will be determined by the Company, based on the work being performed.

Welders shall not be qualified on production welding.

5.2 TEST WELD ACCEPTABILITY FOR WELDER QUALIFICATION

5.2.1 Single/Multiple Qualification

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

(a) is made in accordance with the requirements of the welding procedure specification;
(b) meets the visual inspection requirements given in Clause 8; and
(c) meets the standards of acceptability for nondestructive inspection given in Clause 8 or meets the destructive test requirements of the applicable standard given in 49 CFR 192.

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

Welder tests completed for multiple qualifications shall be destructively tested.

5.2.2 Welding Compressor Station Pipe and Components

In addition to the requirements for single and multiple qualifications, welding of pipe and components for compressor stations require that welder qualification testing shall be destructively tested.

5.3 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, and a copy shall be provided to the Company upon request.

6 PRODUCTION WELDING

6.1 COMPLIANCE WITH SPECIFICATIONS

Production welding shall be performed by qualified welders in accordance with qualified welding procedure specifications that have been approved by the Company. 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 for review by the Company if requested.

(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.

6.2 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 entire 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 end of the pipe.

6.3 PIPE IDENTIFICATION

(a) 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.

(b) Die stamping of the pipe or weld shall not be permitted.

6.4 LAMINATIONS

(a) Should any lamination or split end be discovered at the beveled 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-beveled.

(b) Ultrasonic, liquid penetrant or magnetic particle inspection methods must be used to confirm that the new cut end is free of laminations.

6.5 GRINDING OF SEAM WELDS

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. Where identified by the Company, pipe seams shall be ground flush for a distance of 6 in. from the edge of the weld bevel to accommodate mechanized ultrasonic inspection.

6.6 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 into alignment without subsequently 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. Electric resistance welded pipe, longitudinal, spiral and skelp end welds in adjacent lengths of welded pipe shall be offset by a minimum distance of 2 in.

(c) Hammering on 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 the joining of pipe to components 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 6.19.

(g) Pipe ends damaged or dented shall be cut and rebevelled.

(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.

6.7 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.

6.8 WEATHER CONDITIONS

It shall be permissible to use portable enclosures to make conditions satisfactory for welding.

6.9 GROUNDING AND CABLES

(a) Grounding devices shall be designed to prevent arcing. Devices grounding in the bevel area shall be made of steel; copper or bronze tips shall not be used for such purpose.

(b) Welding cables and connections shall be insulated to prevent arcing to the pipe surface.

6.10 PROTECTION OF COATINGS

Consideration shall be given to protect existing coatings on piping to minimize damage that may result from the welding operations. Markings made by the Contractor shall be such that the do not leave a residue on the pipe surface.

6.11 PREHEATING AND CONTROLLED COOLING

(a) Unless specified otherwise in the welding procedure, preheating temperatures shall be as given in the Table 1.

(b) The Contractor shall preheat a minimum distance of:

(i) 4 in. on each side of the weld for the full circumference in the case of girth welds; or

(ii) 6 in. from any point of the area to be repaired in the case of repairs.

(iii) minimum preheat temperatures shall be maintained for the completion of all welding, except as allowed in Clause 6.18.

(c) Preheat and interpass temperatures shall be checked using temperature indicating crayons or pyrometers in an area 1-1/2 in. to 2-1/2 in. 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 15 seconds shall elapse after the flame is removed from the surface before preheat and interpass temperatures are measured.

(d) No passes of a weld shall be cooled at a rate greater than that provided by natural air-cooling. Forced cooling is not acceptable.

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	212°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

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 and to ensure that the seals are not damaged as a result of preheating or welding.

6.12 NUMBER OF WELDERS

A minimum of two (2) welders shall be required for welds larger than NPS 16 and for the root pass and hot pass of NPS 16 welds, with the exception of rolled welds.

6.13 START OF WELDING

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

6.14 REMOVAL OF BRIDGE TACKS AND ALIGNMENT LUGS

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

6.15 CLEANING BETWEEN PASSES

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

6.16 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.

6.17 WELD CAPPING

(a) For pipe to component or pipe to 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 component or the taper angle if any.

(b) If the component has a compound bevel (i.e. 37.5° nominal and then 10°), the cap shall reach the edge between the 10° bevel and the external diameter of the component or the taper angle if any.

(c) In any case, the maximum cap overlap shall be 1/16 in. beyond the design bevel edge. The slope of the cap shall not exceed 30° and the weld thickness on the component or valve side shall not exceed 1.5 times the nominal pipe wall thickness.

6.18 INTERRUPTIONS IN WELDING

(a) Except as permitted below, welding of a production weld shall continue without interruption (includes welding and grinding) 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 (2/3) of the weld thickness is filled. The weld shall be preheated before welding is resumed.

(b) For GMAW/SAW or GMAW/SMAW/SAW combined rolled welds, it shall be permissible to let the weld cool down before the first SAW pass provided the assembly is not moved. The weld shall be wrapped in an insulating blanket if the ambient temperature is below 40°F and welding has to be interrupted. The weld shall be preheated before welding is started.

6.19 BACKWELDING

When attaching components/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 component and pipe. The root pass metal reinforcement shall be removed by grinding before backwelding.

6.20 TRANSITION WELDS

Transition welds shall be designed as specified in Clause 3.3.1. The preferred type of transition joint is the combination 'counterbore and taper'.

Welding of transition joints shall be completed as follows:

(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 6.19 and Table 2.

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

6.21 IDENTIFICATION OF WELDERS

(a) Welders shall be responsible for marking their individual welder identification 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 4 in. from the edge of the coating cutback (approximately 8 to 10 in. from the weld centerline). The welder identification shall also be recorded on the NDE inspection record and on the relevant drawings/spool sheets.

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

6.22 CLEAN-UP OF THE WELD

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

6.23 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 and removed from the work area so as not to interfere with the progress of work.

7 INSPECTION AND TESTING OF PRODUCTION WELDS

7.1 VISUAL INSPECTION

Completed welds shall be visually inspected and any imperfections shall be assessed using the applicable Standard of Acceptability given in Clause 8.
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 welding is documented and done in accordance with the requirements of an approved welding procedure by qualified welders; and
(b) the repaired weld is acceptable in terms of a visual inspection after the repair work has been completed;
(c) a written record of the visual inspection is completed.

7.2 MANDATORY NONDESTRUCTIVE INSPECTION

(a) All production welds shall be nondestructively inspected for 100% of their lengths, in accordance with the requirements of the most recent editions of 49 CFR 192, ASME Section IX, and API 1104.
  (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 8. The Company may, at its option, require additional inspection with other NDE methods listed within this specification.

7.3 NONDESTRUCTIVE INSPECTION 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 BPV 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 BPV Code, Section V, Article 6.

8 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

9 REPAIR OF WELDS CONTAINING DEFECTS

9.1 CRACKS

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

9.2 APPROVAL FOR REPAIR AND PROCEDURE

Repair of defects in production welds shall
(a) be performed by qualified welders using welding procedure specifications approved by the Company; and
(b) be recorded on the inspection reports.

9.3 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
  (i) the wall thickness exceeds 0.375 in.;
  (ii) a 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 3 ft long or one diameter in length, whichever is the longest.

9.4 WELDING PROCESS AND CONSUMABLES

The repair welding process shall be designed and consumables selected in accordance with the requirements of Clause 3.2.

9.5 PREHEAT FOR REPAIR WELDING

The repair area shall be preheated in accordance with the requirements given in Clause 6.11.

9.6 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.

9.7 INSPECTION OF REPAIRS

(a) Repairs shall be inspected using the methods and procedures specified for production welds in Clause 7.

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

(c) Repair welds shall meet the applicable Standards of Acceptability given in Clause 8.

9.8 FURTHER REPAIR ATTEMPTS

Multiple repairs based on visual inspection and/or NDE of a defective area of a given weld beyond the first repair shall not be permitted without prior approval of the Company.

10 HEAT TREATMENT & MECHANICAL TESTING

10.1 HEAT TREATMENT

Assembly welds governed by 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.

10.2 MECHANICAL TESTING

When using previously tempered piping 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 completed:

(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.

11 RECORDS

11.1 DRAWINGS FOR MANUFACTURED ITEMS

Drawings for items purchased as a manufactured component (i.e. meter run, header) shall be prepared by and submitted to the Company 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/traceability 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.

11.2 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.

11.3 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) Contract number and/or purchase order number.
l) 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, unless alternate arrangements are agreed upon with the Company. 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) Contract number and/or purchase order number.

l) 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.

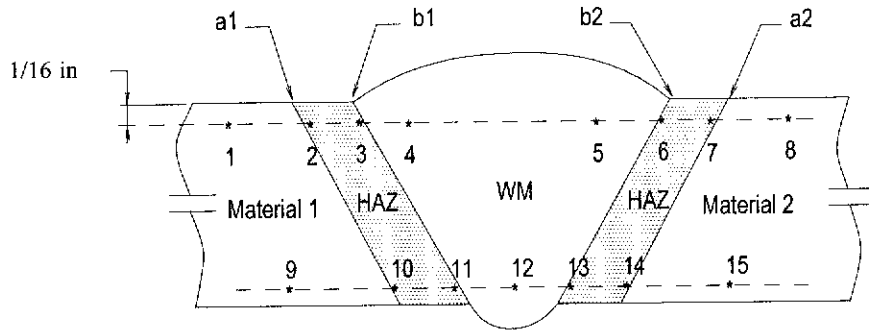


Figure 1: Hardness Traverse Locations

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.

Table 2 Transitions in a Station

Transition Location	Welds involving components in the field	Pipe to pipe	Comments
Final Tie-ins	**Not Acceptable**	**Acceptable**[a]	Counterbored and taper transitions, no restrictions.
		Not Acceptable	Taper transitions on pipe wall thickness difference greater than 3/32 in.
Tie-in welds	**Not Acceptable**	**Acceptable**[a, b]	Counterbored and taper transitions, no restriction.

(a)Taper transitions on pipe wall thickness difference up to and including 3/32 in., NDE for both wall thicknesses is required.
(b)Taper transitions on pipe wall thickness difference greater than 3/32 in., requires an engineering assessment and approval. NDE for both wall thicknesses is required.

End of Document

Title: **TES-COAT-EPU-US External Epoxy/Urethane Coating Systems**	Document Type: Specification
Effective Date: March 19, 2007	Revision: 0
Document Owner: Asset Reliability, Technical Support & Technology Management	
Document Originator: Robert Worthingham, Engineer, Asset Reliability: Technical Support & Technology Management	RAW 20070315 Signature/Date (signed record on file)
Reviewer: Matt Cetiner, Engineer, Asset Reliability Pipeline Integrity	MCetiner 2007/03/15 Signature/Date (signed record on file)
Reviewer: David Taylor, Technologist, Asset Reliability Technical Support & Technology Management (QA only)	2007/03/15 Signature/Date (signed record on file)
Approver: Curtis Parker, Manager, Technical Support and Technology Management – Asset Reliability	2007 MAR 15 Signature/Date (signed record on file)

PURPOSE

This specification describes the requirements for the application and inspection of field spray/brush applied epoxy and epoxy/urethane coatings to be used on below ground corrosion control:

- -- Pipe, piping assemblies, valve assemblies, components and girth welds
- -- Mainline recoating projects
- -- Meter stations recoating projects

This specification is for coating applications on TransCanada facilities in the United States.

SCOPE

This specification applies to application of epoxy and epoxy/urethane to mainline pipe, valves, fittings where pipeline service temperatures do not exceed 150°F. This specification applies to application of all spray and brush applied epoxy and epoxy/urethane coatings used for external corrosion protection of underground gas pipeline systems during the Mainline Recoating Programs, "Pipeline Maintenance Program" (PMP) and SCC "Stress Corrosion Cracking" dig programs.

BRIEF DESCRIPTION OF CHANGE

Rev 0 – Converted from Canadian to US standards.

TABLE OF CONTENTS

1.0 REFERENCES

Steel Structures Painting Council (SSPC) Steel Structures Painting Manual – Volume II.

Swedish Standards Institution (SIS) 05 59 00-1967 Pictorial Surface Preparation Standards for Painting Steel Surfaces.

NACE Recommended Practices: NACE No. 1/SSPC-SP-5, NACE No. 2/SSPC-SP-10, NACE No. 3/SSPC-SP-6 and NACE No. 4/SSPC-SP-7 and SSPC-PA Guide 3 "A Guide to Safety in Coating Application."

ISO 8502-3 Assessment of Dust on Steel Surfaces Prepared for Painting.

The Company Visual Comparator for 0.03% Embedded Abrasive, dated January, 1993.

American Petroleum Institute (API) RP 5L9 Recommended Practice for External Fusion Bonded Epoxy Coating of Line Pipe

NACE Standard Recommended Practice RP0394-2002 "Application, Performance, and Quality Control of Plant-Applied, Fusion-Bonded Epoxy External Pipe Coating

Steel Structures Painting Council SSPC-VIS 1-89 Visual Standard for Abrasive Blast Cleaned Steel.

TEF-COAT-UG-US Underground Coating Report

2.0 DEFINITIONS

Company: The term Company as used in this specification shall mean TransCanada Transmission, including its engineering agencies, inspectors and other authorized representatives.

Contractor: The term Contractor as used in this specification shall mean those who have been contracted to remove existing tape and coatings and apply the coatings covered in this specification.

Applicator: The term applicator as used in this specification means the company which is applying the coating. Typically this is either the Contractor or their Sub-contractor.

Epoxy: The term epoxy in this specification shall mean a two-component liquid epoxy or epoxy/urethane systems.

Cohesive failure: The term as used in this specification means the separation of the homogeneous coating. Coating left on the steel substrate and coating forced off during evaluation.

Manufacturer: The term manufacturer as used in this specification, shall mean those who manufacture and supply the liquid epoxy or epoxy/urethane systems.

3.0 SAFETY CONSIDERATIONS

The Contractor shall maintain copies of Material Safety Data Sheets (MSDS) for all controlled products and shall ensure his employees (sub-contractors or agents) are familiar with the precautions of the MSDS regarding hazards, necessary personal

protective equipment, first-aid measures, and are trained in the handling and use of these products.

Work gloves and safety glasses shall be worn when handling epoxy. Exposed skin can be protected by applying a barrier cream. Any coating which does contact the skin should be removed immediately using a waterless hand cleaner and in accordance with the manufacture's recommendations. Any activator may be removed using soap and water. Ample supplies shall be made available by the Contractor for this purpose.

Protection from inhalation is required. These products should only be used in well ventilated areas and personnel should wear the appropriate respiratory protection.

During coating application, no open flames, smoking, grinding or welding shall be allowed in the immediate vicinity.

Under no circumstances shall the epoxy/epoxy urethane be removed by heating with an open flame.

To prevent contamination of the contents, coating containers shall not be left open, and only authorized persons shall handle the product.

4.0 GENERAL REQUIREMENTS

All new underground gas pipelines or rehabilitation projects and/or repairs shall be protected against corrosion with the liquid epoxy or epoxy/urethane (brush or spray grade) applied in accordance with this specification and the manufacturer's specification.

The Contractor shall furnish all materials, labor, equipment, tools, instruments, and supervision, incidental to and necessary for the removal of old existing coatings, if any, and the application and inspection of the external coating in accordance with this Specification. All quality control measurements and inspections shall be carried out and recorded by the Contractor on TEF-COAT-UG-US Underground Coating Report. The Company shall have the right to review the Applicator's work and records at any time.

The Contractor shall be responsible for complying with all of the requirements of this Specification.

The Contractor shall provide NACE certified Level I or II coating inspectors. The Inspector shall have an excellent knowledge of the application procedures generally used for high performance coatings. The Inspector should know the characteristics of air and airless spray, and shall be familiar with the procedures used to apply coatings properly with such equipment.

All underground metallic components, including piping, valves, flanges, braces, supports, etc., with the exception of those used for grounding, shall be coated according to this specification and shall be handled in such a manner so as to prevent them from being damaged.

Prior to commencing surface preparation operations, the surface must be examined for the presence of any deleterious materials, such as heavy corrosion or rust scale, existing elastomeric, or rubber-like old coatings, or previously applied tape protective systems that will require removal. If any such materials are present that cannot readily be removed by the blast cleaning process, it will be necessary to conduct a pre-blast cleaning

surface preparation. The pre-blasting surface preparation may use any Company approved processes, such as solvent cleaning, use of hand or power tools, water blast cleaning or hydro-jetting, or other removal methods that will accomplish removal of the deleterious material prior to blast cleaning. After removal, the surface should again be inspected to ensure that any deleterious material remaining may be readily removed during the subsequent blast cleaning operations.

For spray and brush applications, the Contractor shall use coating personnel that have been pre-qualified by the Manufacturer and approved by the Company. Only those Contractors or Subcontractors who have previously been pre-qualified and approved by the Company shall spray or brush apply epoxy systems covered by this specification. It is the Contractor's responsibility to ensure that employees or sub-contractors are manufacturer qualified before bidding on Company work. Re-qualification of personnel shall be once every calendar year.

5.0 COATING MATERIAL

5.1 GENERAL

The Company approved liquid epoxy to be used shall be:
(No alternative materials are acceptable)

a) Spray Grade:
Specialty Polymer Coating SP-2888RG Epoxy/Urethane
Specialty Polymer Coating SP-3888 Epoxy
Specialty Polymer Coating SP-6888 Epoxy
Specialty Polymer Coating SP-7888 Epoxy
Denso North America – Denso 7250
3M Scotchkote 327

b) Brush Grade:
Denso Protal 7200 Epoxy
Specialty Polymer Coating SP- SP-2888RG Epoxy/Urethane
Specialty Polymer Coating SP-3888 Epoxy
Specialty Polymer Coating SP-6888 Epoxy
3M Scotchkote 327

5.2 CERTIFICATION

The Applicator shall ensure coating material is:

a) Certified by the manufacturer and that it is compatible with the requirements of this specification.

b) Identified with the following:
i) manufacture's name;
ii) product description;
iii) batch number;
iv) date of manufacture;
v) location of manufacture; and
vi) manufacturing identification number

c) Handled and stored in accordance with the manufacturer's recommendations at all times.

d) Within the shelf life recommended by the manufacturer.

5.3 COATING OF VALVES, FITTINGS AND PIPE

The coating material for valves, fittings and pipe shall be spray grade liquid epoxy. Brush grade shall only be used on difficult areas and on short sections of pipe (less than 6.5 linear feet), for repairs and as tie-in coating.

The crotch area; including the outlet portion; of all tees with a nominal run diameter greater than NPS 16 and run diameter to outlet diameter ratio in excess of 0.6 shall not be coated until after secondary hydrotesting has been completed to avoid cracking of the coating.

5.4 COATING OF GIRTH WELDS

Coating material for girth welds shall be spray or brush grade and shall be applied according to sections 6.0 and 7.0 of this specification.

5.5 COATING OF TIE-INS

The following coatings and specifications shall be used when tying-in the new liquid epoxy/epoxy urethane with existing coatings:

Existing Coating	Tie-in Coating	Specification
Liquid Epoxy	Liquid Epoxy	This specification
Fusion Bond Epoxy	Liquid Epoxy	This specification
Extruded Polyethylene	Shrink Sleeves	TEP-COAT-HSS
Coal Tar, Asphalt, Tape	Petrolatum and Fiberglass outerwrap Or Moldable Sealant with Bonded Polyethylene Outerwrap	See Appendix 2 of this specification

Any disbonded coating or tape shall be removed until well adhered coating is found.

The recoating should take place in accordance with the following requirements:

- The damaged FBE/Coal Tar/Asphalt/Tape coated area shall be completely removed by scraping and/or grit blasting.
- The existing FBE/Liquid Epoxy/Coal Tar/Asphalt/Tape coating shall be either sweep-blasted or roughened by cross-hatch sanding with 60-80 grit sandpaper for a distance of 2 in - 4 in to ensure intercoat adhesion. The existing coating shall then be wiped with a clean, dry rag to remove any dust or residual blast products. The liquid epoxy shall be coated up to and onto the existing coating according to this specification.

6.0 SURFACE PREPARATION

Surfaces to be blast cleaned shall be free of oil, grease, injurious contamination, slivers, mud, soils, rough welds, burrs, weld spatter, etc. Prior to blast cleaning, the Contractor shall carefully examine the bare pipe for oil and grease. Any oil, grease or magnetic particle inspection products or ultrasonic couplant shall be removed in accordance with SSPC-SP-1 using acetone, xylene or MEK and the pipe shall be heated to remove any moisture. The pipe's surface temperature shall be at least 5F° above the dew point temperature during blast cleaning and inspection, but shall not exceed 240°F. Relative ambient humidity shall not exceed 90%.

The edge of weld bevels and internal surfaces shall be protected during blast cleaning and coating application. The blast media and coating material shall be prevented from entering the valves, fittings and pipe. No amount of blast media in a valve, fitting or pipe shall be acceptable.

Edges of the existing coating shall be roughened by power brushing or by sweep blasting the coating for a minimum distance of 4 inch.

The exterior metal surface shall be abrasive blast-cleaned to a near white finish SSPC-SP-10 (NACE # 2) or better. The blasted surface shall not have more than 0.03% of the area covered by embedded abrasive. Embedded abrasive level shall be verified using The Company's "Visual Comparator for 0.03% Embedded Abrasive," dated January 1993.

Material for abrasive cleaning shall be the appropriate blend of grit to produce an angular surface profile of 2.5 mils minimum to 4.5 mils maximum. Target Green Diamond, Target Black Magic, Starblast XL, Black Beauty, Barshot, Black Lightning or a Company approved equivalent shall be used.

The Contractor shall have available on site colour prints of Swedish Pictorial Surface Preparation Standard Sa 2 ½ or the SSPC-VIS 1-89 Visual Standard for Abrasive Blast Cleaned Steel.

For girth welds, the surface profile of the blast cleaned area shall be measured on at least every tenth weld using replica tape and a spring micrometer. The profile depth shall be a minimum of 2.5 mils.

Metal areas that develop flash rust due to exposure to rain, moisture or humidity shall be given a sweep blast to return them to their original clean blasted condition. The surface to be blasted shall be recoated immediately. A sweep blast shall be carried out when a blasted surface is left overnight.

The compressed air supply used for blast cleaning shall be free of water and oil. Separators and filters shall be used on the compressed air supply to ensure that contaminants such as oil and water are not deposited on the steel surface.

Residual blast products shall be removed from all blasted surfaces using a clean dry bristle brush, vacuum or clean dry compressed air.

Copper bearing abrasives shall not be used.

7.0 COATING APPLICATION

7.1 GENERAL

External pipe surface shall be free of moisture, oil and grease and any other injurious contaminants prior to the application of the coating.

7.2 PREHEATING

Preheating shall be used to ensure that the pipe surface is maintained at the minimum temperature specified both during the application of the coating and during curing for at least 4-hours after the coating is tack free.

The pipe surface temperature, at every point around the pipe circumference, shall be a minimum of 50°F and a minimum of 5F °above the dew point temperature prior to coating application. The dew point and pipe surface temperature shall be determined at the start of daily coating application and at least once every four hours during coating. The dew point shall be determined by the Contractor and/or the coating inspector using a sling psychrometer and psychrometric charts.

Except for tie-in welds, if the pipe surface temperature is below 50°F, an induction heating coil (or Company approved equal) shall be used to preheat the surface. Preheating shall raise the surface temperature so that coating application takes place when the pipe surface is at or above the minimum temperature as specified in this section.

The pipe surface temperature shall be measured by the Contractor and/or the Company inspector using a surface thermometer approved by the Company.

Where the surface to be coated is less than 50°F, the surface shall be preheated by using an induction heater immediately after blast cleaning. The preheat temperature for the coating application shall be either:

i) 150°F - 170°F when pipe surface is between 50°F and 15°F; or
ii) 185°F - 195°F when pipe surface is 15°F or colder.

The preheat temperature shall be measured using a surface thermometer or by a method approved by the Company.

For tie-in welds, preheating may be accomplished using a direct flame. The direct flame shall not contaminate the pipe surface. All propane tanks shall be vapor type with a company approved filter in line. The surface shall be prepared in accordance with Clause 6.0. Preheating shall raise the surface temperature so that coating application takes place when the pipe surface is at or above the minimum specified temperature. After preheating, the surface shall be abrasive blast cleaned according to Clause 6.0. The blasted surface may be re-heated with a direct flame, to touch up the preheat, provided that the flame does not contaminate the surface, result in condensation of moisture on the pipe surface, or result in any reduction of surface cleanliness.

Preheating shall not damage the mainline coating or the coating being repaired, or raise the temperature of the pipe above 240°F.

Valves shall be coated in an enclosure or indoors with no direct heat applied to the valve assembly. The minimum surface temperature of 50°F shall be maintained until 4-hours after the coating is tack free.

7.3 APPLICATION

The coating shall be applied immediately after preheating has been completed. No solvents are to be added to the epoxy system.

Brush Grade: The coating is a two component system (activator and base) and shall be mixed and applied in accordance with manufacturer's recommended practice.

Spray Grade: The coating shall be airless spray applied in a multi-pass to build to the required thickness using a Hydra-Cat (or Company approved equal) and all necessary ancillary equipment in accordance with the manufacturer's recommended practice. During the coating application, the wet film thickness (WFT) of the applied coating is to be measured by the Contractor using a wet film gauge and shall be brushed out. Wet film measurements are to be made on every joint, elbow, tee etc being coated. If low areas are detected, additional coating shall be applied before tack-free condition occurs.

The coating shall overlap existing coating by a minimum distance of 4 in.

The finished coating shall be generally smooth and free of application defects such as, pinholes, fish eyes, sags, etc.

After the coating has cured to a tack-free condition, the Contractor and/or the Inspector shall measure the dry film thickness (DFT) of each valve, fitting and pipe section (defined as each 65 ft) section or portion thereof) at random in a minimum of five areas using a "Microtest" magnetic gauge or approved equal. The gauge shall be calibrated to a National Bureau of Standards Certified Coating Thickness Standard.

The minimum and maximum thickness of cured coating shall be: 20 – 35 mils. For difficult sections (flanges, crotch areas of tees, weld caps, girth welds, etc.) a maximum DFT of 40 - 50 mils will be allowed. Overcoating of pinhole and holiday repairs shall not exceed a total DFT of 40 - 50 mils for 6 in radius around the holiday. All DFT measurements shall be witnessed by the Inspector or his designated representative.

Neither handling nor backfilling shall be permitted until the coating has cured, as determined by the Inspector.

Valves, fittings or pipes that are to extend above ground shall be coated to at least 18 in above the grade level.

8.0 RISERS

Pipe risers shall be coated with epoxy in accordance with this Standard Specification. This coating system shall extend from the buried vertical elbow of the riser to 18 in above the ground.

9.0 PIPING THROUGH CLAMPS, BRACES, SUPPORTS, ETC.

Where buried piping or in the fabrication of valve assemblies, when pipe passes through a clamp, brace, support, etc., an outer wrap of petrolatum and fiberglass outerwrap shall be applied as per Appendix 2 of this specification.

10.0 INSPECTION

The inspector shall be on site during the surface preparation and coating application.

All quality control measurements and inspections shall be carried out and recorded by the Contractor on TEF-COAT-UG Underground Coating Report

All aspects of surface preparation shall be checked as detailed in Clause 6.0.

The finished coating shall be generally smooth and free of application defects such as pinholes, fish eyes, sags, etc and holidays. Finished coated surfaces shall have the required minimum dry film thickness as per section 7.3. In general, the surface of the coating shall be no rougher than the base or substrate material. Excessive drips, running, sagging or other discontinuities shall be cause for rejection.

The following criteria shall be used when DFT readings are < 20 mils or > 35 mils:

If 10% or more of the DFT readings are either less than 20 mils or greater than 35 mils further testing is to be performed. The Company coating inspector will mark with a felt pen a 12 in x 12 in area on the pipe. The location of the test area is at the discretion of the Company approved inspector. The inspector will take 20 random DFT measurements within the marked area. If 10% of the readings are less than 20 mils or greater than 35 mils, the coating on the entire section of coated pipe, valve, flange, brace, support, etc. shall be removed and recoated.

Exceptions may be permitted when the minimum coating thickness is not applied in one coat. In this case the previous coat shall be allowed to cure to the point of being able to be abraded to remove the coating gloss and if necessary, preheated prior to the application of additional coating.

For difficult areas as mentioned in section 7.3 and for coating repairs of 6 inch or less in radius for holidays and pinholes, a maximum dry film thickness of 50 mils will be allowed. Note: When the DFT is greater than 50 mils, the coating shall not be abraded to reduce the thickness to reach the specified thickness.

The coating shall be checked with a holiday detector set at 100 volts/mil and between 2000-3500 volts DC. Holiday detectors shall be calibrated at the start of the working day and at least every four hours or as specified by the Company. A low voltage (60 to 70 volts) wet sponge holiday detector may be used on nuts and bolts and areas difficult to access.

Inspection with a holiday detector shall not be attempted until the coating is hard dry (coating cure as determined when the coating does not indent when pressed with a thumbnail).

Coating shall be tested for cure as per Clause 12.0.

11.0 COATING REPAIRS

The approved material to be used for repairs is liquid epoxy spray or brush grade as specified in Clause 5.0.

Where preheat is required, the surface temperature shall not exceed 240°F. Extra care shall be taken when heating the surface of valve assemblies in order to minimize any risk of damage to valve seats.

Coated areas that are less than the specified thickness shall be repaired by applying an additional coating so that the total thickness meets the specified requirements. If the coating has cured, the existing coating shall be either sweep-blasted or roughened using a 60-80 grit sandpaper to ensure intercoat adhesion. (Sweep blasting shall be carried out when the coating has hardened enough to ensure blast media is not embedded in the coating). Coating materials shall be applied in accordance with the following requirements:

i) The previously coated surface shall be dry, free from moisture, dust or foreign matter at the time the epoxy is applied.

ii) When the surface temperature is below 50°F, the surface to be recoated shall be preheated in accordance with Clause 7.2.

Coated areas in which the epoxy has not cured properly shall be stripped and recoated in accordance with the following requirements:

i) Uncured coating shall be completely removed by scraping and/or grit blasting.

ii) The surface shall be completely clean, dry and free from uncured coating, moisture and foreign matter while recoating.

iii) Edges of adjacent cured coating shall be feathered and all dust produced by the cleaning and feathering shall be wiped off with a xylene soaked cloth before patching commences.

iv) The surface shall then be prepared and coating applied in accordance with Clauses 6.0 and 7.0.

Holidays shall be repaired in accordance with the following requirements:

i) The surfaces to be coated shall be completely dry, free from moisture, dust or other foreign matter at the time the coating is applied. When the surface temperature is below 50°F, the surface to be recoated shall be preheated according to section 7.2.

ii) Repair areas shall be cleaned by a surface grinder or by grit blasting to remove dirt, scale, rust, damaged coating or any other foreign material.

iii) Edges of the adjacent coating shall be feathered and all dust produced by the cleaning and feathering shall be wiped off with xylene soaked cloth before patching commences.

iv) The two-part epoxy system is to be mixed and applied as per manufacturers specifications.

All repairs shall comply with the requirements of Clauses 6.0 and 7.0.

12.0 CURE TESTS

12.1 CURE TEST USING CROSS HATCH

The coating inspector shall conduct this test on the pipe or pipe assemblies (whenever possible) and/or on test panels. The curing test shall be done when the coating has completely cured as determined by the coating inspector.

12.2 TEST SAMPLES

Prepare samples by grit blasting mild steel panels (approx. 4 in x 4in x ¼ in size) to near white finish.

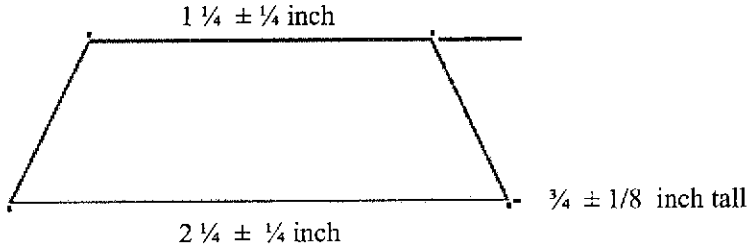
During production run, spray or brush (according to the application that is being tested) apply the coating onto the test samples. A minimum of two samples are required per shift (max. 10 h). The first sample shall be prepared within the first 30 minutes of the production run and the second sample shall be prepared within the last 30 minutes of the production run.

12.3 TEST PROCEDURE

After the coating has cured, conduct a "cross hatch" test using the following procedures:

- Using an utility knife as stated below, make 0.5 inch (approximately) long scribes through to the metal surface to form a V with an angle of approximately 30° at the intersection point.
- Starting at the point of intersection, force the coating from the steel substrate using a sharp pointed knife. Care should be taken to protect the eyes and hands when carrying out this operation.

The utility knife shall having a length, without the blade, of 3 ± 3/4 inch and a one-piece metal blade having dimensions as shown in the following sketch and an exposed cutting edge of 1 ± 1/4 inch.



12.4 RATING

Refusal of the coating to peel or a cohesive failure within the coating shall be recorded as a "Pass."

Cohesive failure, caused by voids leaving a honeycomb structure on the specimen surface, shall constitute a failure.

The extent of the adhesive failure between the coating and the metal substrate shall be recorded. A disbonding to the metal surface of up to 0.2 in from the center point of the cross should be regarded as satisfactory.

12.5 CAUSE FOR REJECTION

Where the test fails to conform to the specified requirements, additional sampling shall be performed to ascertain the extent of failed coating. At the Company's option, all affected

coating determined to have failed the testing may be rejected. Rejected coated pipe shall be stripped and recoated.

12.6 CURE TEST USING SHORE D HARDNESS

The test procedure involves obtaining approx. 30 mils free coating samples from production runs and testing with Shore D Hardness tester.

Coating is considered cured if a Shore D Hardness reading as listed below is obtained. The minimum test frequency shall be four samples per shift (max. 10 h).

The following table gives an outline as to the expected Shore D hardness readings of all approved coatings in this specification.

CURED PIPE COATING TEMPERATURE RANGE	SHORE D RANGE
-60°F to 69°F	90 to 100 Shore D
70°F to 175°F	80 to 95 Shore D

Notes:
Coating thickness must be 30 mils minimum.
Field Shore D meters can give false readings if pushed to fast or too slow. Hold gauge in near-vertical position and press foot of gauge firmly against the coating, but not so firmly as to imbed foot into surface. Consistency is important, test second and third areas the same as the first.

END OF DOCUMENT

APPENDIX 1 - MAINLINE RECOATING

USING LINE TRAVEL EQUIPMENT MAINLINE RECOATING

1.0 GENERAL REQUIREMENTS

The following requirements are only applicable for line travel equipment used on large scale recoating projects and shall be additional to the TES-COAT-EPU specification requirements. The purpose is to identify and measure various parameters of the operation such that if there is any deviation from optimum, such deviations may be determined and corrected in order to guarantee the proper surface preparation and coating application according to the requirements of this specification.

The Contractor shall be responsible for the quality of the Mainline Recoating and shall verify the following:

Equipment Operation
Surface preparation
Coating Application

The Company shall provide supplementary inspection services and shall reserve the right to reject or accept any aspect of the recoating process.

The Contractor shall perform the quality assessment detailed in this section to confirm the operational performance of the Hydroblast Cleaning Module (if any), Surface Preparation Module and the Coating Application Module.

2.0 EQUIPMENT OPERATION

2.1 HYDROBLAST CLEANING MODULE

The Contractor is responsible for the pre-removal of any deleterious material that cannot be readily removed by the Blast Cleaning Module. If a Hydroblast cleaning module is used prior to the Blast Cleaning Module, the resultant surface, after hydroblast cleaning must be examined to ensure that sufficient removal has been accomplished. Any remaining deleterious material such as heavy corrosion, rust scale, tape, tape adhesive, or elastomeric coating, etc. that cannot be readily removed by the Blast Cleaning Module will require further removal. Such removal methods may be done using solvent cleaning, hand or power tools, or other Company's approved method in order to accomplish the desired pre-cleanliness.

2.2 SURFACE PREPARATION MODULE

Operational verification procedures for the Surface Preparation Module shall include a review, periodic sampling, and recording of the following Ammeters, Abrasive Bin Levels, Air Cleaner, and Abrasive Operating Mix as described below:

a) Ammeters

Ammeters shall be monitored for an assessment of the quantity of abrasive blast media being thrown by the blast-cleaning wheel. The ammeter reading is a direct

indication of the loading of the drive motor and shall be monitored and recorded by the Contractor for optimum performance in the ranges and frequencies listed below:

Acceptable Performance:	Barring instantaneous excursions, ammeter readings shall be within the manufacturer's acceptable range. The Contractor shall submit for the Company's approval, evidence of manufacturer's recommended range, recommended frequency of inspection and verification method for ammeter readings.

Ammeter readings found to be outside the manufactures recommended range for extended periods of time may be cause for interruption of the blast cleaning process until corrected in accordance with manufacturers recommended procedures and may require reblasting of affected pipe at the Company's discretion.

b) Abrasive Bin Levels

The Contractor shall be responsible for maintaining abrasive levels within the abrasive feed bin at a minimum level for proper equipment operation.

Optimal performance:	Maintain the abrasive level above storage bin level control probe.
Frequency of Inspection:	In the absence of automatic feed bin low level alarms, the operator shall inspect the abrasive bin level every 60 minutes. Company's Inspector shall inspect every 120 minutes.

Insufficient maintenance of the minimum level shall be cause for interruption of the blasting process until corrected.

c) Air Separators

The Contractor shall monitor the air separators to ensure the removal of oversize contaminants, foreign contaminants, and undersize abrasive particulate. Air separators shall be cleaned as required to ensure control of the abrasive operating mix.

d) Abrasive Operating Mix

The Contractor shall ensure the optimal size profile and mix of the blasting media to obtain the required surface cleanliness and anchor pattern. Verification that the abrasive mix meets the requirements of the specification shall be by screen analysis and abrasive appearance. The Operator and the Company's Inspector shall perform a screen analysis twice daily to insure that the size of the abrasive mix is within the specified size range distribution.

Specification of oversized, properly sized, and undersized abrasive shall be in accordance with that listed in the Project Description.

2.3 COATING APPLICATION MODULE

Operational verification procedures for the monitoring of the Coating Application Module shall include:

a) The Contractor shall submit for the Company's approval, written procedure for verification of the proper operation of the Coating Application Module.
b) Verification of the coating mix ratios and application rates shall be in accordance with the coating manufacturer's recommendations. The Contractor shall submit, for the Company's approval, the mix ratio and application rates, and the methodology to be used for verification of these parameters.

2.3.1 Blast Cleaning Cleanliness

The Contractor shall ensure that the blasted surface meets the requirements of this specification. Cleanliness verification shall be done using SSPC/NACE photographic standards SSPC-VIS 1-89. Visual Comparator shall be performed continually to verify the visual conformance of the blast cleaned surface to the predetermined standard. In addition to the Swedish Pictorial and SSPC Visual Comparators, a job site standard consisting of blast cleaned steel will be used to verify the pipe steel surface preparation. If the blast cleanliness falls below the standards of visual comparator, the blast cleaning module shall be stopped, the problem corrected and the unsatisfactorily cleaned area re-blasted and cleaned until an SSPC SP10/NACE 2 cleanliness has been obtained.

The Inspector shall verify that the Contractor has met the specified requirements for surface cleanliness.

2.3.2 Blast Cleaning Anchor Profile

The Contractor shall ensure that the blast cleaned surface has a 2.5-4.5 mil angular anchor pattern. The anchor pattern profile shall be continually monitored using Testex tape to confirm the depth profile. The Inspector shall perform portable profilometer measurements as warranted to evaluate the angularity of the profile. Insufficient or under angulated profile will require re-blasting to meet the requirements of this specification.

The Inspector shall verify that the Contractor has met the specified requirements for Blast Cleaned Anchor Profile

2.3.3 Surface Contamination after Blast-Cleaning

The Contractor shall check for residual contaminants from incidental wind-blown dust, dirt and debris prior to the coating application. Testing shall be performed as warranted on blast cleaned surfaces that are downstream of the 360 degree air knife blower. Using ISO 8502-3 "Assessment of Dust on Steel Surfaces Prepared for Painting" Scotch Brand Press-O-Film shall be firmly pressed to and rubbed on to the steel surface. The tape is then removed and compared to the pictorial reference in ISO 8502-3. The same procedure shall be followed for testing blast cleaned surfaces between the air knife blower and the coating application module when the line travel module is shut down or interrupted sufficiently long enough to permit a safe reliable test. Piping that does not meet the requirements for allowable residual contaminants as specified in the project description may require re-cleaning using approved procedures or re-blasting.

The Inspector shall verify that the Contractor has met the specified requirements for surface cleanliness after blast cleaning.

2.3.4 Testing of the Applied Coating System

The Contractor shall conduct testing of the applied coating according to section 13.0 of this specification.

Two sections per valve section (pipe rings) of the production run will be cut in order to perform the corresponding laboratory tests.

The quality of the raw coating material will be certified and inferred through the mixing ratio characteristics, ease of spray application, verification of tack-free and curing time, wet and dry film thickness testing and "X" cut adhesion testing that will be carried out in the field.

APPENDIX 2 -TIE-IN PROCEDURE FOR ASPHALT, THIN FILM TAPE

1.0 SCOPE

These procedures describe the technical requirements for tying in old parent coatings to newly applied EPU coatings.

These procedures are for in-service pipelines. This procedure shall not be used for new construction.

Both procedures are acceptable for use. It is up to the project manager and or the construction manager as to which of the following two options are to be used. In below 32°F temperatures, Option 1 may be preferred due to the ease of application.

2.0 OPTION 1 - PETROLATUM COATING AND GLASS OUTERWRAP

Approved Materials

Approved Manufacturer	Coating Component	Approved Product
Denso	Primer	Denso Paste
	Tape	Denso LT petrolatum tape
	Fibreglass outerwrap	Denso syntho-glass

2.1 STORAGE

Coating components shall be stored at 40°F to 115°F. Coating components shall be maintained between 40°F and 115°F during application.

2.3 SURFACE PREPARATION

Remove dirt, dust, moisture and other contaminants from the old coating parent being lapped onto.

2.4 APPLICATION OF PETROLATUM COATING AT TIE IN AREA

Petrolatum coating shall be applied after holiday detection and coating repairs.

Petrolatum shall be applied in accordance with TransCanada Coating Application procedure TEP-COAT-PET for Petrolatum Coating.

Petrolatum primer and tape shall start at least 3 in on the existing parent coating and shall be applied at least up to 3 in onto the newly applied coating.

Glass Outerwrap shall be applied to petrolatum coating as follows:

Use temperate water to activate the resin in the glass outer wrap. In cold weather (32°F or below, ambient temperature), methyl alcohol (cold weather windshield washer fluid) may be used. Soak glass outer wrap in either liquid for twenty (20) to thirty (30) seconds prior to application.

Spiral wrap the glass outer wrap with a minimum overlap of 55% of the wrap width (e.g. for 4 in wide wrap, overlap shall be 2 in). A minimum of two (2) separate layers shall be applied. Additional layers will provide additional mechanical protection.

Apply glass outerwrap to be free of wrinkles and voids.

Glass outerwrap shall be spirally wrapped over the entire petrolatum areas and onto the existing parent coating by 3 in.

Glass outerwrap will be considered ready to backfill when the resin in the glass outer wrap has cured so that there is adhesion between the layers of itself.

3.0 OPTION 2 - KEMA 250 (12)

Approved Material

Approved Manufacturer	Coating Component	Approved Product
Kema Coatings Limited	Tape	Kema 250 (12) Tape

3.1 STORAGE

Maintain tape at temperatures between 60°F and 85°F for at least 24 hours immediately prior to use. Keep tape within these temperature ranges during application.

3.2 SURFACE PREPARATION

Remove dirt, dust, moisture and other contaminants from the old parent coating being lapped onto.

3.3 APPLICATION OF TAPE

Wrap the tape full circumference of the pipe to be coated, starting 3 in on the parent coating. Butt the next wrap of tape to this and continue the process until tape exceeds on the newly applied coating by at least 3 in. Do not overlap the tape onto itself. At each butt seam, apply a wrap around each seam. Apply tape with a 50/50 portion on each side of the butted seam and press firmly down. Use tension in wrapping to obtain conformability to the surface being coated. Applied tape shall be free of wrinkles and voids.

Title: **TES-COAT-STN External Coating Systems For Underground Station Yard Piping**	Document Type: Specification
Effective Date: 2002/02/28	Revision: 1
Classification Code: ME09	Document Owner: Engineering and Operation Services
Document Originator: Aida Lopez, Engineer, Pipe Engineering, Program Development	Signature/Date: Signed copy on file
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Reviewer: David Taylor, Technologist, Engineering and Operation Services	Signature/Date: Signed copy on file
Approver: Dan King, Manager, Pipe Engineering Program Development	Signature/Date: Signed copy on file
Approver: David Diakow, Manager, Pipe Engineering, Technical Services	Signature/Date: Signed copy on file

PURPOSE

This specification describes the requirements for the application and inspection of field spray/brush applied epoxy and Epoxy Urethane coatings to be used on Compressor Station Yard Piping.

--pipe, piping assemblies, valve assemblies, components and girth welds
--meter stations experiencing temperatures above 65°C.

SCOPE

This specification applies to application of epoxy and epoxy urethane to station pipe, valves, fittings or where service temperatures exceed 65°C (up to 90°C).
This specification applies to application of all spray and brush applied epoxy coatings used for external corrosion protection of underground gas pipeline systems during the construction of new facilities, Station Recoating Programs, "Pipeline Maintenance Program" (PMP) and SCC "Stress Corrosion Cracking" dig programs.

BRIEF DESCRIPTION OF CHANGE

This specification was revised to incorporate new procedures, new coating materials and changes in inspection requirements. This specification supersedes the following specifications: TCPL EC 13 External Coating Systems for Underground Station Yard Piping, NGTL C-7 Urethane Coating specification for application on compressor station yard piping and components and TES-COAT-STN, Dated 2000/03/31.

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1.0 REFERENCES

Steel Structures Painting Council (SSPC) Steel Structures Painting Manual – Volume II.

Swedish Standards Institution (SIS) 05 59 00-1967 Pictorial Surface Preparation Standards for Painting Steel Surfaces.

NACE National Association of Corrosion Engineers.
NACE Recommended Practices: NACE No. 1/SSPC-SP-5, NACE No. 2/SSPC-SP-10, NACE No. 3/SSPC-SP-6 and NACE No. 4/SSPC-SP-7 and SSPC-PA Guide 3 "A Guide to Safety in Coating Application".

ISO 8502-3 Assessment of Dust on Steel Surfaces Prepared for Painting.

The Company Visual Comparator for 0.03% Embedded Abrasive, dated January, 1993.

CSA Standard Z245.20-98 External Fusion Bond Epoxy Coating for Steel Pipe.

Steel Structures Painting Council SSPC-VIS 1-89 Visual Standard for Abrasive Blast Cleaned Steel.

TEF-COAT-UG Underground Coating Report

2.0 DEFINITIONS

Company: The term Company as used in this specification shall mean TransCanada Transmission, including its engineering agencies, inspectors and other authorized representatives.

Contractor: The term Contractor as used in this specification shall mean those who have been contracted to remove existing tape and coatings and apply the coatings covered in this specification.

Applicator: The term applicator as used in this specification means the company which is applying the coating. Typically this is either the Contractor or their Sub-contractor.

Epoxy: The term epoxy in this specification shall mean a two-component liquid epoxy systems.

Cohesive failure: The term as used in this specification means the separation of the homogeneous coating. Coating left on the steel substrate and coating forced off during evaluation.

Manufacturer: The term manufacturer as used in this specification, shall mean those who manufacture and supply the liquid epoxy or epoxy/urethane systems.

3.0 SAFETY CONSIDERATIONS

The Contractor shall maintain copies of Material Safety Data Sheets (MSDS) for all controlled products and shall ensure his employees (sub-contractors or agents) are familiar with the precautions of the MSDS regarding hazards, necessary personal protective equipment, first-aid measures, and are trained in the handling and use of these products.

Work gloves and safety glasses shall be worn when handling epoxy. Exposed skin can be protected by applying barrier cream. Any coating which does contact the skin should be removed immediately using a waterless hand cleaner and in accordance with the manufacture's recommendations. Any activator may be removed using soap and water. Ample supplies shall be made available by the Contractor for this purpose.

Protection from inhalation is required. These products should only be used in well ventilated areas and personnel should wear the appropriate respiratory protection.

During coating application, no open flames, smoking, grinding or welding shall be allowed in the immediate vicinity.

Under no circumstances shall the epoxy/epoxy urethane be removed by heating with an open flame.

To prevent contamination of the contents, coating containers shall not be left open, and only authorized persons shall handle the product.

4.0 GENERAL REQUIREMENTS

All underground gas pipelines inside the compressor station yard shall be protected against corrosion with the liquid epoxy and epoxy urethane (brush or spray grade) applied in accordance with this specification and the manufacturer's specification. This specification shall be used for all station yard piping located inside the fence, including off site fabricated assemblies. The only exception will be mill coated pipe with FBE "Fusion Bond Epoxy", FBE coated induction bends, tie-ins, and buried flanges.

The Contractor shall furnish all materials, labor, equipment, tools, instruments, and supervision, incidental to and necessary for the removal of old existing coatings, if any, and the application and inspection of the external coating in accordance with this Specification. All quality control measurements and inspections shall be carried out and recorded by the Contractor on TEF-COAT-UG Underground Coating Report. The Company shall have the right to review the Applicator's work and records at any time.

The Contractor shall be responsible for complying with all of the requirements of this Specification.

The coating inspector shall be NACE certified Level II or III. The Inspector shall have an excellent knowledge of the application procedures generally used for high performance coatings. The Inspector should know the characteristics of air and airless spray, and shall be familiar with the procedures used to apply coatings properly with such equipment.

All underground metallic components, including piping, valves, flanges, braces, supports, etc., with the exception of those used for grounding, shall be coated according to this specification and shall be handled in such a manner so as to prevent them from being damaged.

Prior to commencing surface preparation operations, the surface must be examined for the presence of any deleterious materials, such as heavy corrosion or rust scale, existing elastomeric, or rubber-like old coatings (such as coal tar and asphalt), or previously applied tape protective systems that will require removal. If any such materials are present that cannot readily be removed by the blast cleaning process, it will be necessary to conduct a pre-blast cleaning surface preparation. The pre-blasting surface preparation may use any Company approved processes, such as solvent cleaning, use of hand or power tools, water blast cleaning or hydrojetting, or other removal methods that will accomplish removal of the deleterious material prior to blast cleaning. After removal, the surface should again be inspected to ensure that any deleterious material remaining may be readily removed during the subsequent blast cleaning operations. If consideration needs to be given to inspect and evaluate for SCC, refer to the Company's corresponding procedures.

For spray and brush applications, the Contractor shall use coating personnel that have been pre-qualified by the Manufacturer and approved by the Company. Only those Contractors or Subcontractors who have previously been pre-qualified and approved by the Company shall spray or brush apply epoxy systems covered by this specification. It is the Contractor's responsibility to ensure that employees or sub-contractors are manufacturer qualified before bidding on Company work. Re-qualification of personnel shall be once every calendar year.

5.0 COATING MATERIAL

5.1 GENERAL

The Company approved liquid epoxy to be used shall be:

a) Spray Grade:
Specialty Polymer Coating SP-2888RG Epoxy/Urethane
Specialty Polymer Coating SP-3888 Epoxy
Specialty Polymer Coating SP-6888 Epoxy
Specialty Polymer Coating SP-7888 Epoxy
Denso North America – Denso 7250 Epoxy
Kema Coatings – Kema 300 Epoxy

b) Brush Grade:
Specialty Polymer Coating SP-2888RG Epoxy/Urethane
Specialty Polymer Coating SP-3888 Epoxy
Specialty Polymer Coating SP-6888 Epoxy
Denso North America – Denso 7200 Epoxy

5.2 CERTIFICATION

The Applicator shall ensure coating material is:

a) Certified by the manufacturer and that is compatible with the requirements of this specification.

b) Identified with the following:
   i) manufacturer's name;
   ii) product description;
   iii) batch number;
   iv) date of manufacture;
   v) location of manufacture; and
   vi) manufacturing identification number.

c) Handled and stored in accordance with the manufacturer's recommendations at all times.

d) Within the shelf life recommended by the manufacturer.

5.3 COATING OF VALVES, FITTINGS, TEES, HEADERS AND PIPE

The coating material for valves, fittings and pipe shall be spray grade liquid epoxy. Brush grade shall only be used on difficult areas and on short sections of pipe (less than two linear meters), for repairs and as tie-in coating.

The crotch area; including the outlet portion; of all tees with a nominal run diameter greater than NPS 16 and run diameter to outlet diameter ratio excess of 0.6 shall not be coated until after secondary hydrotesting has been completed to avoid cracking of the coating.

5.4 COATING OF GIRTH WELDS

Coating material for girth welds shall be spray or brush grade and shall be applied according to Clauses 6.0 and 7.0 of this specification.

5.5 COATING OF TIE-INS

The following coatings and specifications shall be used when tying-in the new liquid epoxy/epoxy urethane with existing coatings:

Existing Coating	Tie-in Coating	Specification
Liquid Epoxy	Liquid Epoxy	This specification
Fusion Bond Epoxy	Liquid Epoxy	This specification

Extruded Polyethylene	Shrink Sleeves	TEP-COAT-HSS
Coal Tar, Asphalt, Tape	Petrolatum and Fiberglass outerwrap	See Appendix 1 of this specification

Any disbonded coating or tape shall be removed until well adhered coating is found.

The recoating should take place in accordance with the following requirements:

- The damaged FBE/Coal Tar/Asphalt/Tape coated area shall be completely removed by scraping and/or grit blasting.
- The existing FBE/Liquid Epoxy/Coal Tar/Asphalt/Tape coating shall be either sweep-blasted or roughened by cross-hatch sanding with 60-80 grit sandpaper for a distance of 4 cm – 10 cm (1.57 – 4 inches) to ensure intercoat adhesion. The existing coating shall then be wiped with a clean, dry rag to remove any dust or residual blast products. The liquid epoxy shall be coated up to and onto the existing coating according to this specification.

6.0 SURFACE PREPARATION

Surfaces to be blast cleaned shall be free of oil, grease, injurious contamination, slivers, mud, soils, rough welds, burrs, weld spatter, etc. Prior to blast cleaning, the Contractor shall carefully examine the bare pipe for oil and grease. Any oil, grease or magnetic particle inspection products or ultrasonic couplant shall be removed in accordance with SSPC-SP-1 using acetone, xylene or MEK and the pipe shall be heated to remove any moisture. The pipe's surface temperature shall be at least 3°C above the dew point temperature during blast cleaning and inspection, but shall not exceed 115°C. Relative ambient humidity shall not exceed 90%.

The edge of weld bevels and internal surfaces shall be protected during blast cleaning and coating application. The blast media and coating material shall be prevented from entering the valves, fittings and pipe. No amount of blast media in a valve, fitting or pipe shall be acceptable.

Edges of the existing coating shall be roughened by power brushing or by sweep blasting the coating for distance of 10 cm (4 inch) minimum.

The exterior metal surface shall be abrasive blast-cleaned to a near white finish SSPC-SP-10 (NACE # 2) or better. The blasted surface shall not have more than 0.03% of the area covered by embedded abrasive. Embedded abrasive level shall be verified using The Company's "Visual Comparator for 0.03% Embedded Abrasive," dated January, 1993.

Material for abrasive cleaning shall be the appropriate blend of grit to produce an angular surface profile of 0.0635 mm (2.5 mils) minimum to 0.114 mm (4.5 mils) maximum. Target Green Diamond, Target Black Magic, Starblast XL, Black Beauty, Barshot, Black Lightning or Company approved equal shall be used.

The Contractor shall have available on site colour prints of Swedish Pictorial Surface Preparation Standard Sa 2 ½ or the SSPC-VIS 1-89 Visual Standard for Abrasive Blast Cleaned Steel.

For girth welds, the surface profile of the blast cleaned area shall be measured on at least every tenth weld using replica tape and a spring micrometer. The profile depth shall be a minimum of 0.0635 mm (approximately 2.5 mils).

Metal areas that develop flash rust due to exposure to rain, moisture or humidity shall be given a sweep blast to return them to their original clean blasted condition. The surface to be blasted shall be recoated immediately. A re-blast shall be carried out when a blasted surface is left overnight.

The compressed air supply used for blast cleaning shall be free of water and oil. Separators and filters shall be used on the compressed air supply to ensure that contaminants such as oil and water are not deposited on the steel surface.

Residual blast products shall be removed from all blasted surfaces using a clean, dry, bristle brush, vacuum or clean, dry compressed air.

Copper bearing abrasives shall not be used.

7.0 COATING APPLICATION

7.1 GENERAL

External pipe surface shall be free of moisture, oil and grease and any other injurious contaminants prior to the application of the coating.

7.2 PREHEATING

Preheating shall be used to ensure that the pipe surface is maintained at the minimum temperature specified both during the application of the coating and during curing for a least 4-hours after the coating is tack free.

The pipe surface temperature, at every point around the pipe circumference, shall be a minimum of 10°C (50°F) and a minimum of 3°C (5.4°F) above the dew point temperature prior to coating application. The dew point and pipe surface temperature shall be determined at the start of daily coating application and at least once every four hours during coating. The dew point shall be determined by the Contractor and/or the coating inspector using a sling psychrometer and psychrometric charts.

Except for tie-in welds, if the pipe surface temperature is below 10°C, an induction heating coil (or Company approved equal) shall be used to preheat the surface. Preheating shall raise the surface temperature so that coating application takes place when the pipe surface is at or above the minimum temperature as specified in this section.

The pipe surface temperature shall be measured by the Contractor and/or the Company inspector using a surface thermometer approved by the Company.

Where the surface to be coated is less than 10°C, the surface shall be preheated by using an induction heater immediately after blast cleaning. The preheat temperature for the coating application shall be either:

i) 65°C - 75°C when pipe surface is between 10°C and -10°C; or
ii) 85°C - 90°C when pipe surface is -10°C or colder.

The preheat temperature shall be measured using a surface thermometer or by a method approved by the Company.

For tie-in welds, preheating may be accomplished using a direct flame. The direct flame shall not contaminate the pipe surface. All propane tanks shall be vapor type with a Company approved filter in line. The surface shall be prepared in accordance with Clause 6.0. Preheating shall raise the surface temperature so that coating application takes place when the pipe surface is at or above the minimum specified temperature. After preheating, the surface shall be abrasive blast cleaned according to Clause 6.0. The blasted surface may be re-heated with a direct flame, to touch up the preheat, provided that the flame does not contaminate the surface, result in condensation of moisture on the pipe surface, or result in any reduction of surface cleanliness.

Preheating shall not damage the mainline coating or the coating being repaired, or raise the temperature of the pipe above 115°C.

Valves shall be coated in an enclosure or indoors with no direct heat applied to the valve assembly. The minimum surface temperature of 10°C shall be maintained until 4-hours after the coating is tack free.

7.3 APPLICATION

The coating shall be applied immediately after preheating has been completed. No solvents are to be added to the epoxy system.

Brush Grade: The coating is a two component system (activator and base) and shall be mixed and applied in accordance with manufacturer's recommended practice.

Spray Grade: The coating shall be airless spray applied in a multi-pass to build to the required thickness using a Hydra-Cat (or Company approved equal) and all necessary ancillary equipment in accordance with the manufacturer's recommended practice. During the coating application, the wet film thickness (WFT) of the applied coating is to be measured by the Contractor using a wet film gauge and should be brushed out. Wet film measurements are to be made on every joint, elbow, tee etc being coated. If low areas are detected, additional coating shall be applied before tack-free condition occurs.

The coating shall overlap existing coating by a minimum 10 cm (4 inch).

The finished coating shall be generally smooth and free of application defects such as, pinholes, fish eyes, sags, etc.

After the coating has cured to a tack-free condition, the Contractor and/or the Inspector shall measure the dry film thickness (DFT) of each valve, fitting and pipe section

(defined as each 20m section or portion thereof) at random in a minimum of five areas using a "Microtest" magnetic gauge or approved equal. The gauge shall be calibrated to a National Bureau of Standards Certified Coating Thickness Standard.

The minimum and maximum thickness of cured coating shall be: 0.50 mm – 0.89 mm (20 – 35 mils). For difficult sections (flanges, crotch areas of tees, weld caps, girth welds, etc) a maximum DFT of 1.02 mm - 1.27 mm (40-50 mils) will be allowed. Overcoating of pinhole and holiday repairs shall not exceed a total DFT of 40-50 mils for a 152 mm (6 inch) radius around the holiday. All DFT measurements shall be witnessed by the Inspector or his designated representative.

Neither handling nor backfilling shall be permitted until the coating has cured, as determined by the Inspector.

Valves, fittings or pipes that are to extend above ground shall be coated to at least 45 cm above the finished grade level.

8.0 RISERS

Pipe risers shall be coated with epoxy in accordance with this Standard Specification. This coating system shall extend from the buried vertical elbow of the riser to 45 cm above the ground.

9.0 PIPING THROUGH CLAMPS, BRACES, SUPPORTS, ETC.

Where buried piping or in fabrication of valve assemblies, when pipe passes through a clamp, brace, support, etc., an outer wrap of petrolatum and fiberglass outer wrap shall be applied as per Appendix 1 of this specification.

10.0 INSPECTION

The inspector shall be on site during the surface preparation and coating application.

All quality control measurements and inspections shall be carried out and recorded by the Contractor on TEF-COAT-UG Underground Coating Report.

All aspects of surface preparation shall be checked as detailed in Clause 6.0.

The finished coating shall be generally smooth and free of application defects such as pinholes, fish eyes, sags, etc and holidays. Finished coated surfaces shall have the required minimum dry film thickness as per Clause 7.3. In general, the surface of the coating shall be no rougher than the base or substrate material. Excessive drips, running, sagging or other discontinuities shall be cause for rejection.

The following criteria shall be used when DFT readings are < 20 mils or > 35 mils:

If 10% or more of the DFT readings are either less than 20 mils or greater than 35 mils further testing is to be performed. The Company coating inspector will mark with a felt pen a 30 cm x 30 cm area on the pipe. The location of the test area is at the discretion of

the Company approved inspector. The inspector will take 20 random DFT measurements within the marked area. If 10% of the readings are less than 20 mils or greater than 35 mils, the coating on the entire section of coated pipe, valve, flange, brace, support, etc. shall be removed and recoated.

Exceptions may be permitted when the minimum coating thickness is not applied in one coat. In this case the previous coat shall be allowed to cure to the point of being able to be abraded to remove the coating gloss and if necessary, preheated prior to the application of additional coating.

For difficult areas as mentioned in Clause 7.3 and for coating repairs of 152 mm (6 inch) or less radius to holidays and pinholes, a maximum dry film thickness of 50 mils will be allowed. Note: When the DFT is greater than 50 mils, the coating shall not be abraded to reduce the thickness to reach the specified thickness.

The coating shall be checked with a holiday detector set at 100 volts/mil and between 2000-3500 volts DC. Holiday detectors shall be calibrated at the start of the working day and at least every four hours or as specified by the Company. A low voltage (60 to 70 volts) wet sponge holiday detector may be used on nuts and bolts and areas difficult to access.

Inspection with a holiday detector shall not be attempted until the coating is hard dry (coating cure as determined when the coating does not indent when pressed with a thumb nail).

Coating shall be tested for cure as per Clause 12.0.

11.0 COATING REPAIRS

The approved material to be used for repairs is liquid epoxy spray or brush grade as specified in 5.0.

Where preheat is required, the surface temperature shall not exceed 115°C. Extra care shall be taken when heating the surface of valve assemblies in order to minimize any risk of damage to valve seats.

Coated areas that are less than the specified thickness shall be repaired by applying an additional coating so that the total thickness meets the specified requirements. If the coating has cured, the existing coating shall be either sweep-blasted or roughened using a 60-80 grit sandpaper to ensure intercoat adhesion. (Sweep blasting shall be carried out when the coating has hardened enough to ensure blast media is not embedded in the coating). Coating materials shall be applied in accordance with the following requirements

i) The previously coated surface shall be dry, free from moisture, dust or foreign matter at the time the epoxy is applied.

ii) When the surface temperature is below 10°C, the surface to be recoated shall be preheated in accordance with Clause 7.2.

Coated areas in which the epoxy has not cured properly shall be stripped and recoated in accordance with the following requirements:

i) Uncured coating shall be completely removed by scraping and/or grit blasting.

ii) The surface shall be completely clean, dry and free from uncured coating, moisture and foreign matter while recoating.

iii) Edges of adjacent cured coating shall be feathered and all dust produced by the cleaning and feathering shall be wiped off with a xylene soaked cloth before patching commences.

iv) The surface shall then be prepared and coating applied in accordance with Clauses 6.0 and 7.0.

Holidays shall be repaired in accordance with the following requirements:

i) The surfaces to be coated shall be completely dry, free from moisture, dust or other foreign matter at the time the coating is applied. When the surface temperature is below 10°C, the surface to be recoated shall be preheated according to Clause 7.2.

ii) Repair areas shall be cleaned by a surface grinder or by grit blasting to remove dirt, scale, rust, damaged coating or any other foreign material.

iii) Edges of the adjacent coating shall be feathered and all dust produced by the cleaning and feathering shall be wiped off with xylene soaked cloth before patching commences.

iv) The two part epoxy system is to be mixed and applied as per manufacturers specifications.

All repairs shall comply with the requirements of Clause 6.0 and 7.0.

12.0 CURE TESTS

12.1 CURE TEST USING CROSS HATCH

The coating inspector shall conduct this test on the pipe or pipe assemblies (whenever possible) and/or on test panels. The curing test shall be done when the coating has completely cured as determined by the coating inspector.

12.2 TEST SAMPLES

Prepare samples by grit blasting mild steel panels (minimum 100mm x 100mmx 6.4mm size) to near white finish.

During production run, spray or brush (according to the application that is being tested) apply the coating onto the test samples. A minimum of two samples are required per shift (max. 10 h). The first sample shall be prepared within the first 30 minutes of the

production run and the second sample shall be prepared within the last 30 minutes of the production run.

12.3 TEST PROCEDURE

After the coating has cured, conduct a "cross hatch" test using the following procedures:

- Using an utility knife as stated in CSA Z245.20-98, Clause 12.1.1, make two 13 mm (approximately) long scribes through to the metal surface to form a V with an angle of approximately 30° at the intersection point.
- Starting at the point of intersection, force the coating from the steel substrate using a sharp pointed knife. Care should be taken to protect the eyes and hands when carrying out this operation.

12.4 RATING

Refusal of the coating to peel or a cohesive failure within the coating shall be recorded as a "Pass".
Cohesive failure, caused by voids leaving a honeycomb structure on the specimen surface, shall constitute a failure.

The extent of the adhesive failure between the coating and the metal substrate shall be recorded. A disbonding to the metal surface of up to 4 mm from the center point of the cross should be regarded as satisfactory.

12.5 CAUSE FOR REJECTION

Where the test fails to conform to the specified requirements, additional sampling shall be performed to ascertain the extent of failed coating. At the Company's option, all affected coating determined to have failed the testing may be rejected. Rejected coated pipe shall be stripped and recoated.

12.6 CURE TEST USING SHORE D HARDNESS

The test procedure involves obtaining approx. 30 mils free coating samples from production runs and testing with Shore D Hardness tester.

Coating is considered cured if a minimum Shore D Hardness reading as listed below is obtained. The minimum test frequency shall be four samples per shift (max. 10 h).

CURED PIPE COATING TEMPERATURE RANGE	SHORE D RANGE
-50°C through to 20°C	90 to 100 Shore D
21°C through to 80°C	80 to 95 Shore D

NOTES:

1. Coating thickness must be 30 mils minimum.
2. Field Shore D meters can give false readings if pushed to fast or too slow. Hold gauge in near-vertical position and press foot of gauge firmly against the coating, but no so firmly as to imbed foot into surface. Consistency is important, test second and third areas the same as the first.

APPENDIX 1 TIE-IN PROCEDURE FOR ASPHALT, THIN FILM TAPE

1.0 SCOPE

This procedure describes the technical requirements for tying in old parent coatings to new coatings applied in accordance with TES-COAT-STN.

This procedure is for in-service pipelines. This procedure shall not be used for new construction.

2.0 PETROLATUM COATING AND GLASS OUTERWRAP

Approved Materials

Approved Manufacturer	Coating Component	Approved Product
Denso	Tape	Denso Hot Line Petrolatum
	Fibreglass outerwrap	Denso Glass Outer Wrap

2.1 STORAGE

Coating components shall be stored at 5°C to 45°C. Coating components shall be maintained between 5°C and 45°C during application.

2.3 SURFACE PREPARATION

Remove dirt, dust, moisture and other contaminants from the old coating parent being lapped onto.

2.4 APPLICATION OF PETROLATUM COATING AT TIE IN AREA

Petrolatum coating shall be applied after holiday detection and coating repairs. Petrolatum shall be applied in accordance with TransCanada Coating Application procedure for Petrolatum Coating (TEP-COAT-PET for Petrolatum Coatings).

Petrolatum tape shall start at least 75 mm on the existing parent coating and shall be applied at least up to 75 mm onto the newly applied coating.

Glass Outerwrap shall be applied to petrolatum coating as follows:

Use temperate water to activate the resin in the glass outer wrap. In cold weather (0°C or below, ambient temperature), methyl alcohol (cold weather windshield washer fluid) may be used. Soak glass outer wrap in either liquid for twenty (20) to thirty (30) seconds prior to application.

Spiral wrap the glass outer wrap with a minimum overlap of 55% of the wrap width (e.g. for 100mm wide wrap, overlap shall be 50 mm). A minimum of two (2) separate layers shall be applied. Additional layers will provide additional mechanical protection.

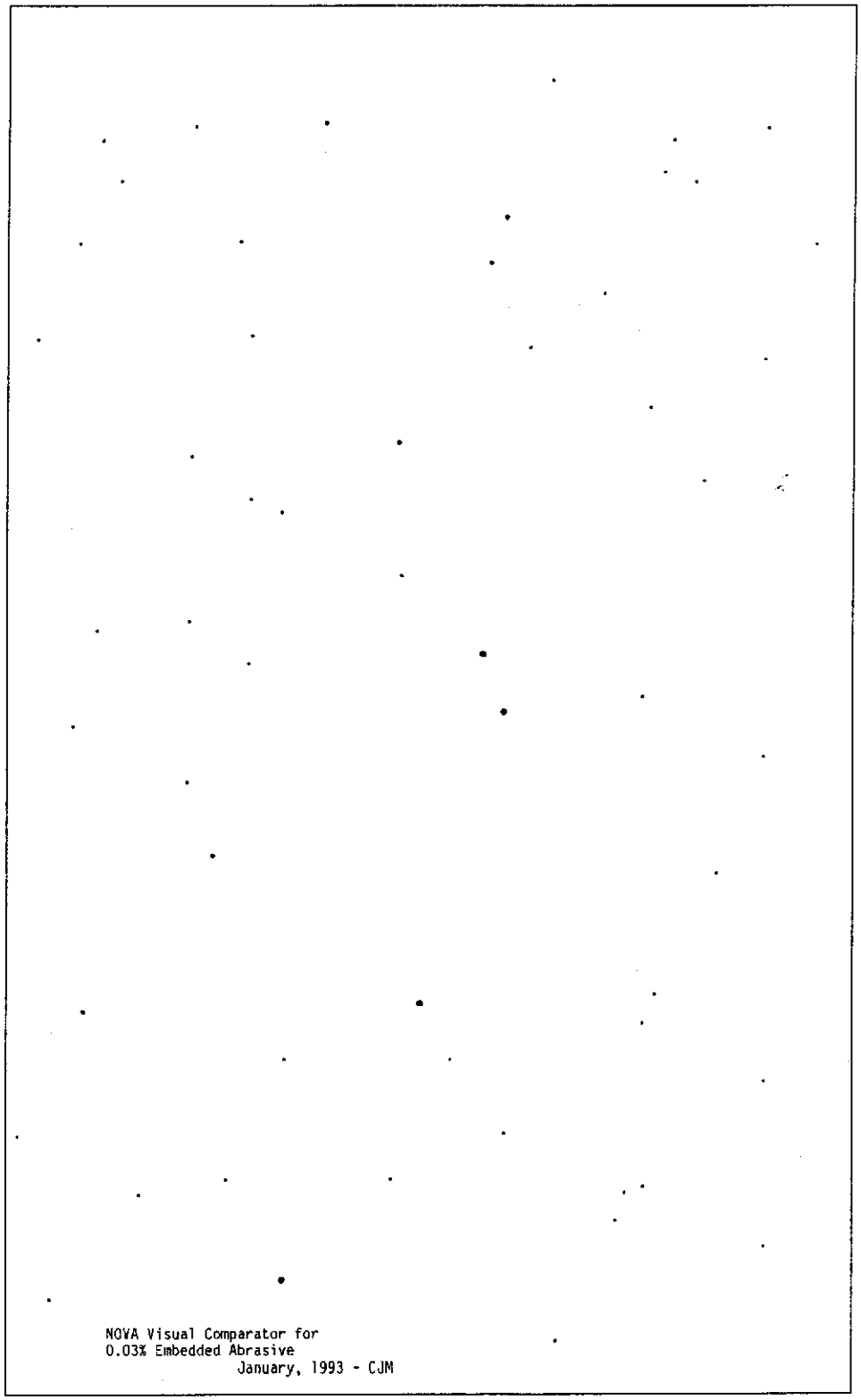
Apply glass outerwrap to be free of wrinkles and voids.

Glass outerwrap shall be spirally wrapped over the entire petrolatum areas and onto the existing parent coating by 75 mm.

Glass outerwrap will be considered ready to backfill when the resin in the glass outer wrap has cured so that there is adhesion between the layers of itself.

END OF DOCUMENT

FIGURE 1: 0.03% EMBEDDED ABRASIVES



TOP Contact: Tom Thrall

Business(es): All | Facility Type(s): All | Driver(s): Regulatory | PM Details: Time Directed

1.0 PURPOSE

The purpose of this TOP is to define the M24 activities necessary to maintain block valves, associated valve operators and quick opening closures so as to provide reliable operation on demand and meet Regulatory requirements. In TransCanada's Pipeline System "Critical Valves" and "Emergency Valves" are synonymous.

2.0 SCOPE

This TOP applies to all critical and non-critical block valves in TransCanada's US facilities. Criticality is defined in Section 5.0.

This TOP also addresses maintenance requirements for quick-opening closures on blowdown assemblies and Launchers/Receivers.

This TOP does not apply to relief valves, check valves or control valves.

3.0 REGULATORY AND OPERATIONAL REQUIREMENTS

To promote the safe operation of pipelines, the protection of the environment, property, employees, and the public, companies are mandated to comply with all applicable State and Federal Acts, Regulations, Codes and Standards. This TOP ensures compliance to the following regulations:

- DOT Subpart M - Maintenance §192.745, September 2003.
- DOT Subpart D – Design of Pipeline Components §192.179, July 1998

Failure to comply may result in serious injury or fatalities, imposed operating restrictions, fines, prosecution, and/or penalties for officers, directors, owners, and lessees. TransCanada policies and procedures are designed to ensure the Company continues to operate in a safe and efficient manner.

For "Critical" valves/operators, this task package is applied on alternate years to the TOP entitled 'Valve and Valve Operator Leak Inspection / Cycle Test' (EDMS No. 003864109) to ensure each critical valve is cycled annually. Coordination and scheduling of these tasks shall be such that all critical valves have been cycled and inspected at intervals not exceeding 15 months, but at least once each calendar year.

4.0 PROCEDURE

4.1 General Inspection Activities

Notes: (1) Outage Requirements: Outage is not required to perform valve and operator inspections, however consultation with Gas Control, Customers and/or Compressor Station Operators may be required to permit the partial or full cycling of valves off their as-found position. Activities in this section will apply to all critical and non-critical block valves, blow down assemblies, and launchers and receivers. **(2) Resource Requirements:** Pipeline, Mechanical, Controls, Qualified Contractors. **(3) References:** (i) All relevant TransCanada internal/external Hazard Advisories; (ii) Related CS&E TOPs (Pre-Job Procedure, Work Authorization/Job Safety Analysis Procedure, Isolation Procedure, Lockout and Tag out Procedures, Job Execution Checklist, Personal Protective Equipment TPP, Product & Chemical Approval Handling Procedure); (iii) Valve Sealant and Sealant Guns (EDMS No. 003864110); (iv) Other references are detailed as applicable within each of the equipment specific sections. **(4) Related Tasks:** None. **(5) Resource Qualifications:**

1. The operating position of each valve (open, closed) shall be readily identifiable. If the position indicator on the valve or operator is damaged or missing report as such on the work order and repair/replace as soon as practicable.

2. The valve tag number / valve name shall be readily identifiable. If it is not, consult the facility drawings to positively identify the valve in question and hand mark the tag / name in a prominent place on the valve or operator as applicable.

3. The valve and operator description, serial number, size, etc. on the AVANTIS Work Order must match the actual installed equipment. If discrepancies are noted, inform appropriate AVANTIS Administrator and have the description changed appropriately.

4. Valves or operators (as applicable) shall be locked in the appropriate position upon leaving the facility. This can be accomplished by any of: (a) locking the operator control panel door, (b) locking the handwheel, handpump, wrench, etc. such that it cannot be used to cycle the valve until unlocked, (c) removing the handwheel or wrench from the operator or valve and locking same to a conveniently located fixed object.

5. Speed control valves, power gas valves, electrical power supply, etc. shall be enabled prior to leaving the facility such that all valves will be functional for automatic operation and/or when unlocked.

4.2 Gas/Hydraulic Operator Inspection (all makes/models)

1. Check with Station, Gas Control as appropriate to obtain permission to cycle valve off normal position. Ensure automatic controls are disabled as required to complete inspection.

2. Visually check operator for oil or gas leaks, cracked fittings, loose parts. Refer to the OEM Valve/Actuator manual.

3. Check manual hand pump operation: Lubricate hand pump pivot points. Check for proper operation by pumping the valve off its limit and back to its original position If pump fails to function properly, determine cause of fault and repair accordingly. Refer to specific manufacturer instructions.

4. Turn off power gas and vent the operator tubing. As appropriate, disconnect power gas line and isolate/disconnect the power gas storage bottle. If so equipped, check linebreak or overpressure control trip settings at this time to record the "as found" condition. Avoid cycling the valve with power gas until hydraulic fluid is checked (step 5 below).

5. Check hydraulic oil levels and condition in both tanks. If contaminants or milky oil color are evident, replace the contaminated oil, including the oil in the operator. Add oil as required so tank levels are correct.

   References: (i) Specific manufacturer instructions, (2) "Proper Oil Levels", Pipe Engineering Valves and Operators website http://pf3d1.tcpl.ca.7030/asset_reliability/valves.html, (3) TCPL Waste Management Process

6. Check the condition of all gas filters, replace if necessary. Fiber or stainless steel filter elements between 40 and 140 microns are acceptable.

7. (applies to gate valves) If valve creep is observed, close valve and mark indicator rod w/ felt pen or similar at full closed position. Determine if problem is related to latches, hand pump assy and/or piston seals, repair or schedule for future repair.

8. Check dessicant packs if so equipped. Replace if saturated.

   Caution! Desiccant cartridges can absorb H_2S if exposed to sour gas. Open only in a well ventilated area and take all suitable precautions. Refer to the H_2S Exposure Control Procedures (EDMS No. 003671879) and Portable Gas Detection of the Atmosphere Procedures (EDMS No. 003835959). Ventilate and test atmosphere for presence of gases etc. Use appropriate PPE if required as per the PPE TPP (EDMS No. 003835639).

9. Reconnect power gas line, tank plugs, and close vent valve. Pressurize the power gas system and perform a leak check.

10. Check power gas regulator setting. Refer to OEM Actuator or Regulator Manual.

11. Relief valves on the operator shall be checked for any damage or leakage. If a leak is found, replace with a new one. Replacement relief valves shall be soft seated type. Contact Asset Reliability for further advice if required.

12. If approval is given from Station and/or Gas Control, partially or fully cycle the valve with power gas. Observe the operator throughout the stroke for leaks, jerky or erratic movement, torquing/twisting of actuator on mounting flange, etc. that would necessitate further examination during maintenance routine and/or corrective maintenance later.

13. Check Poppet block operation, clean / replace poppets if leaks are observed.

14. If applicable, confirm low pressure (line break control) and/or high pressure (over pressure protection) switch settings, adjust as necessary, to ensure the "as-left" condition is correct. Tolerances for low pressure linebreak setting are +5% / -10% of specified setting, and for high pressure overpressure protection is +/- 2% of specified setting. Refer to Asset Reliability.

15. Inform Station and/or Gas Control (as appropriate) when maintenance and servicing has been completed.

16. Record technical findings and enter into AVANTIS work order. Initiate changes to AVANTIS equipment description if discrepancies are noted.

4.3 Electric Operator Inspection (all makes/models)

1. Complete steps 1-2 noted above for Gas/Hydraulic Operator Inspection.

2. Engage manual hand drive and partially cycle valve to ensure correct functioning of manual override

3. Check oil or grease level (as applicable) in operator case and gearhead, replenish or replace if levels are low or contamination (especially water) is evident

   References: Valve Operator Information, Pipe Engineering Valves and Operators website http://pf3d1.tcpl.ca.7030/asset_reliability/valves.html

4. Run operator partially or fully with electric power to ensure correct functioning of operator and torque switch setting. Adjust as required.

5. Complete steps 15-16 noted above for Gas/Hydraulic Operator Inspection.

4.4 Direct Gas Operator Inspection (all makes/models)

1. Complete steps 1-2 noted above for Gas/Hydraulic Operator Inspection

2. Check operator for oil and gas leaks. Gas leaks should be repaired immediately. Oil leaks may be repaired immediately or a corrective work order created to repair at later date.

3. Inspect and clean or replace gas filter(s).

4. Activate hand pump and cycle valve partially to ensure pump is working. Hand pump must be operative on valves classified as "critical".

5. Cycle the valve at least partially using power gas. Make note of any torquing/twisting of the valve operator which would indicate insufficiently tightened operator to stem connections, and correct as necessary.

6. Complete steps 15-16 noted above for Gas/Hydraulic Operator Inspection

4.5 Air/Gas Motor Operator Inspection (all makes/models)

1. Complete steps 1-2 noted above for Gas/Hydraulic Operator Inspection

2. Check operator for oil and gas leaks. Gas leaks should be repaired immediately. Oil leaks may be repaired immediately or a corrective work order created to repair at later date.

3. Inspect and clean or replace gas filter(s).

4. For gate valves, liberally apply grease to the threaded valve stem after removing any hardened contamination from threads.

5. Activate clutch to engage handwheel and cycle valve partially. Manual (handwheel) control must be operative on valves classified as "critical".

6. Check and adjust (as needed) the oil level in the oiler pot. Refer to the OEM Valve/Actuator Manual as necessary.

7. Cycle the valve at least partially using power gas. Note any jerky, erratic or sluggish movement during power gas cycling that would require further investigation and remedy.

8. For low pressure (regulated) gas motors, the regulator output should be approximately 80 psig, and the relief valve should be set at approximately 100 psig. These need not be verified unless operator moves sluggishly (low pressure output from regulator) or leakage from relief valve is noted.

9. If Relief valve is found leaking, replace with a soft seated type relief valve. No further relief valve inspection or testing is required.

10. Complete steps 15-16 noted above for Gas/Hydraulic Operator Inspection.

4.6 Hand Wheel/Gear Set Inspection (all makes/models)

1. Complete steps 1-2 noted above for Gas/Hydraulic Operator Inspection.
2. Cycle the valve partially or fully using hand wheel. Clean and lubricate gate valve stems. If valve cycles smoothly, no further maintenance is required.
3. If gear set appears to bind or is difficult to turn, remove the gear set cover plate and identify source of trouble. Repack with grease as necessary. If evidence of water is found, pack fully with grease and service the cover seals.
4. Complete steps 15-16 noted above for Gas/Hydraulic Operator Inspection.

4.7 Ball and Gate Valve Inspection (all makes/models)

1. Inspect for general operation & check for leaks (Look, listen, feel).
2. Identify which lubricant/sealant risers are for seats and which are for the stem. Inject a top-up quantity (approx. 1/2 oz. per valve diameter inch) of approved lubricant or sealant into each valve seat, using a power grease gun (for larger valves) or handgun (for smaller valves).

   Note: Never inject lube/sealant into ball or gate valve stem seals unless the stem is leaking. Use only a hand operated grease gun for stem sealant injection when it is required.

   References: Sealants and Lubricants, Asset Reliability Valves and Operators website

   http://pf3d1.tcpl.ca.7030/asset_reliability/valves.html
3. If the valve is known or expected to be needed for line isolation within the next 6 months, blow down the valve body bleed if operational conditions allow. If the valve is not needed for any upcoming pipeline outages, proceed to step 4 and do not blow down the valve body cavity.

   Note: If you find liquid as you open the body bleed – STOP – close the valve until a liquid collection tank is available on site.

   Refer to Release Response TOP requirements if any contamination and/or adverse affect is anticipated.

   If the valve does not blow down to zero:

   - Determine if valve is capable of blowing down in the position the valve is currently in. Grove ball valves will not blow down in the open position.
   - Determine the leak rate, using orifice flow tester.
   - Undertake remedial actions to decrease the leakage as time permits
   - Record on AVANTIS work order the measured leakage rate if unable to repair with normal maintenance practice or in time allotted.

   References: Flow Tester Procedure, Asset Reliability Valves and Operators website http://pf3d1.tcpl.ca.7030/asset_reliability/valves.html

Note: Additional steps may be required to address the leaking body bleed prior to entering into Avantis e.g.: Flush & Re-grease, re- adjusting stops.

References: Valve Trouble-shooting Flowchart/procedure, Asset Reliability Valves and Operators website http://pf3d1.tcpl.ca.7030/asset_reliability/valves.html

4. Open or close valve, fully or partially, if possible. Check with Station personnel and/or Gas Control as applicable to obtain permission to cycle valve off normal position. Ensure the valve is not seized.

   Note: This step is typically done during valve operator inspection and need not be repeated if already performed

5. If valve stem extension has been previously winterized (holes drilled for addition of antifreeze), top up the stem with RV type antifreeze or Propylene Glycol. If water is suspected in stem extension, a 1/4" NPT drain hole drilled and tapped just above grade level will confirm if subsequent winterizing is appropriate. Winterizing of critical valves is required if water is present in stem extension and ambient temperatures below 20 degrees Fahrenheit are reasonably expected. Schedule through your MRC.

   References: Valve Stem Winterizing Procedure, Asset Reliability Valves and Operators website http://pf3d1.tcpl.ca.7030/asset_reliability/valves.html

6. Contact Station personnel and/or Gas Control to co-ordinate putting the valves back to normal.

4.8 Plug Valve Inspection (all makes/models)

1. Inspect for general operation & check for leaks (Look, listen, feel).

2. Identify which sealant riser is for the plug and, if applicable, which is for the stem. Inject a top-up quantity (approx. 1 oz. per diameter-inch) of approved lubricant or sealant into valve plug, using a power grease gun.

   Note: Plug valve stem seal injectors do not require routine maintenance. If stem is leaking, add stem packing material as required.

3. Open or close valve, fully or partially (fully if possible) to distribute the grease around the plug and ensure the plug is not seized. Check with Station personnel and/or Gas Control as applicable to obtain permission to cycle valve off normal position.

4. For buried plug valves, if valve stem extension has been winterized (holes drilled for addition of antifreeze), top up the stem with RV type antifreeze or Propylene Glycol. If water is suspected in stem extension, a 1/4" NPT drain hole drilled and tapped just above grade level will confirm if subsequent winterizing is appropriate. Winterizing of critical valves is required if water is present in stem extension and ambient temperatures below 20 degrees Fahrenheit are reasonably expected. Schedule through your FWP.

   References: Valve Stem Winterizing Procedure, Asset Reliability Valves and Operators website http://pf3d1.tcpl.ca.7030/asset_reliability/valves.html

5. Contact Station personnel and/or Gas Control to co-ordinate putting the valves back to normal.

4.9 Small Diameter (< NPS 2) Valve Inspection (all types/makes/models)

1. Check for gas leaks.

2. Inspect exposed threads on nipple (if applicable) for signs of corrosion. Replace if corroded or bent, using schedule 160.

3. Generously apply penetrating oil to stem area, wipe off excess.

4. Cycle valve fully or partially to ensure not seized

Note: Valves whose outboard end is open to atmosphere should be cycled with a plug installed to avoid high flow and minimize high differential across valve

CAUTION!! Double wrench technique must be used when removing plugs, etc. Many small diameter valves are of two or three piece construction and can be inadvertently disassembled with catastrophic results if under pressure.

CAUTION!! Valves attached to piping with threaded nipples shall be opened carefully and supported as appropriate if a high degree of torque is necessary to cycle.

5. Small diameter lubricated plug valves - Inject 2-3 oz. grease prior to cycling.

4.10 Blow down Assemblies / Quick Opening Closures

1. Check blow down cap / quick opening closure to ensure it is not seized and can be removed – the cap need not be fully opened. Lubricate exposed threads as required. Refer to the High Pressure Quick-Opening Closures Procedure (EDMS ID No. 003849586).

2. Ensure Pressure Alert Valve (PAV) and interlocking device (prohibiting opening until pressure is vented) are functional. If the PAV on a Huber/Yale closure fails to indicate pressure when it should, replace it with a stainless steel PAV assy (AVANTIS# 103988) after relieving the pressure behind the end closure.

   References: (1) Hazard Advisory: "Pressure Alert Valves on JM Huber Quick Opening Closures." (2) Hazard Advisory: "Operating Procedures for Launcher / Receiver & Blowdown Quick Opening Closures"

3. Vent valves intended for depressurizing blowdown piping shall be operated to ensure they are not seized. A plug shall be installed in the outboard end prior to cycling to avoid high flows and minimize high differential. Caution must be exercised when removing plug, as a small pocket of high pressure gas will remain behind it.

4.11 Documentation and Reporting

1. Must record confirmation of work done.
2. Corrective Maintenance Work Orders: Create a corrective maintenance work order, to be prioritized locally, for any of the following conditions:
   - Variances between the documented AVANTIS entity description and the actual entity description. (these should be corrected as soon as possible)
   - If "as found" line break or overpressure protection settings are outside the specified tolerances (+ 5% / -10% for line break control, +/- 2% for overpressure protection)
   - Valve creep (gate valves creeping open over time)
   - Significant loss of hydraulic oil from body seals or exhaust
   - Noticeable rotational operator movement during cycling of valve
   - Valve has seized due to corrosion, ice, broken or damaged parts, etc.

5.0 DEFINITIONS

Critical Valves	Valves that, when closed, will isolate segments of pipelines from other segments, and/or isolate Compressor Stations from the pipeline, and/or prevent an influx of sour gas from entering the pipeline. Also includes valves that, when open, would depressurize pipeline or facilities in the event of an emergency.
Emergency Valves	Valves that might be required during an emergency and thus subject to annual valve inspection and cycling. Synonymous with "critical valves" in TransCanada's System.
Grease	The generic term for valve lubricants or valve sealants.
Line Break Control	Pilot actuated control to initiate valve closure when pressure in the pipeline falls below a prescribed set point
Lubricant	Specialized product injected into valve seats to improve sealing ability and reduce operating thrust/torque. Generally less viscous than sealants.
OEM	Original Equipment Manufacturer
Sealant	Specialized product injected into valve seats used to enhance a valve's ability to seal; the term is often used interchangeably with "grease" or "lubricant".
Valve Creep	Inability of valve operator to hold a gate valve in the closed position; line pressure exerted on gate slab forces it open.
Valve Operator	Synonymous with valve actuator, a mechanical device used to cycle a valve and hold the valve in a desired position.

6.0 EQUIPMENT DATA / SITE LOCATIONS

Critical Valves	Non critical Valves
Mainline and Lateral block valves and Station block/bypass valves	Blowdown valves (single)
Side valves (includes C/S suction & discharge valves, lateral side valves)	Cooler valves, Fuel Gas valves, Unit valves, station crossover valves
Crossover (cross-tie) valves between pipelines and loops	Bypass valves (around check valves)
Blowdown valves that are installed on a bypass around the block valve	Capped valves intended for future use
Station ESD / Blowdown valves	Launcher/Receiver isolation valves, Kicker valves
Automated blowdown valves (for overpressure protection)	Pipeline Drip Tank isolation valves
H_2S Block Valve	Run isolation valves

7.0 REVISION HISTORY

Rev. No.	Description	Date (yyyy/mm/dd)	TOP Contact
00	New document. This TOP was developed from the TransCanada source documents: (i) Valve and Valve Operator M24 Inspection (EDMS No. 003671700).	2006/07/03	T. Thrall
01	This TOP was reviewed to now reflect the addition of Northern Border Pipeline with respect to the geographic areas of operation as well with feedback from Dan Cerkoney and Virgil Pfennig. Minor edit cleanup changes were also made to document	2007/08/30	T. Thrall
02	Corrected grammar for DOT intervals of inspection in section 3.0 of TOP as per Tom Thrall and Kurt Smith.	2008/01/15	T. Thrall

8.0 REVIEW AND APPROVAL

	Name (Print)	**Signature**	**Date** (yyyy/mm/dd)
TOP Contact	Tom Thrall Technologist, Asset Reliability	Original Signed	2005/12/06
Reviewer (Peer)	John Lau Technologist, Asset Reliability	Original Signed	2005/12/06
Reviewer (Field Ops)	Virgil Pfennig Pipeline Specialist Northern Border Region		2007/08/30
Reviewer (Field Ops)	Brion Beaver Compliance Specialist, Gas Transmission NW Region	Original Signed	2006/05/10
Reviewer (CSE)	Peter Hecht Sr. HS&E Advisor, Community, Safety & Environment	Original Signed	2006/06/27
Reviewer (Regulatory)	Roel Lancee Sr. Regulatory Compliance Specialist Field Ops – Compliance & Governance	Original Signed	2006/04/13
Approver (Field Ops)	Gunther Herbert Manager, Field Ops – Asset Strategy & Practices	Original Signed	2006/06/28
Approver	Ross Parker Director, GTN & N. Baja Region	Original Signed	2006/05/16
Approver	John McWilliams Director US NE Region	Original Signed	2006/06/05
Approver (Engineering)	David Chittick Manager Asset Reliability - Technical Support & Technology	Original Signed	2005/12/06

TOP Contact: Tom Thrall

Business(es):Pipe, Power Facility Type(s): All Driver(s): Regulatory PM Details: Time Directed

1.0 PURPOSE

The purpose of this TOP is to describe the M24 activities necessary to satisfy DOT Regulatory requirements for annual cycling of critical valves and to identify major root causes of valve failure for corrective action. In TransCanada's Pipeline Systems critical; valves and emergency valves are synonymous.

2.0 SCOPE

This TOP applies to critical block valves/operators as described in section 5 of this TOP.
This TOP does not apply to relief valves, control valves or check valves, or to block valves deemed "non-critical" (see Section 5.0).

3.0 REGULATORY AND OPERATIONAL REQUIREMENTS

This task is a regulatory requirement. The task is driven by:

- DOT 49 CFR 192 Subpart M - Maintenance §192.745
- DOT 49 CFR 192 Subpart D – Design of Pipeline Components §192.179
-

For "Critical" valves/operators, this task package is applied on alternate years to the TOP entitled 'Valve and Valve Operator Inspection' (TOP # 003849601) to ensure each critical valve is cycled annually. Coordination and scheduling of these tasks shall be such that all critical valves have been cycled and inspected at intervals not exceeding 15 months, but at least once each year calendar.

Calibration of high pressure pilots and pressure switches used on overpressure protection equipment is conducted annually as per Task "Pressure Safety Valve (PSV) M12 Inspection, EDMS # 003830442.

4.0 PROCEDURE

4.1 Generic Valve and Valve Operator Leak Inspection / Cycle Test

Notes:
(1) The activities in this section will apply to all critical valves and operators
(2) Outage Requirements: Outage is not required to perform valve and operator inspections; however consultation with Gas Control, Customers and/or Compressor Station Operators may be required to permit the partial or full cycling of valves off their as-found position
(3) Resource Requirements: Pipeline, Mechanical, Controls, Qualified Contractors

(4) References: All relevant CS&E Hazard Advisories. Other references are detailed as applicable within each of the equipment specific Sections

1. Attend pre-job meeting if necessary to coordinate valve cycling with Station personnel, etc.

2. Obtain permission from Station operators, Gas Control, Customers, etc. as applicable to cycle the valve(s) off their normal operating position. Ensure automatic controls are disabled as required to complete the inspection.

3. Visually check the valve, risers and the operator for oil and gas leaks, cracked fittings, loose parts. Relief valves, if found leaking, are to be replaced.

   Note: If gas leaks are found from the valve operator, or the valve is known to cycle frequently it is recommended to inspect the power gas filter and clean or replace as appropriate.

4. Valves that cycle frequently (e.g. Station side and bypass valves) should be greased prior to cycling. For ball valves, approximately ¼ to ½ ounce of grease per diameter inch of valve size should be injected into each seat. Plug valves should always be greased before cycling, and will require ½ to 1 ounce of grease per diameter inch of valve size. No routine greasing is done on stem seals.

5. When approval is given from Station and/or Gas Control, partially or fully cycle the valve. If a full open/close cycle can be made, use power gas or electric power (as applicable) to complete the cycle. If the valve cannot be fully cycled for operational reasons, the hand pump or hand wheel should be used. Observe the operator throughout the stroke for leaks, jerky, erratic or rotational movement that would indicate the need for additional service work.

6. (applies to Gate Valves) If valve creep is observed, close the valve and mark the indicator rod with a felt pen or similar at the full closed position. Determine if the problem is related to latches, hand pump assembly and/or piston seals; repair or schedule for future repair.

7. Ensure critical valves are locked so as to prevent unauthorized tampering and cycling.

8. Inform Station and/or Gas Control when maintenance and servicing is complete.

4.2 Documentation and Reporting

1. Must record confirmation of work done.

2. **Corrective Maintenance Work Orders:** Create a corrective maintenance work order, to be prioritized locally, for any of the following conditions:
   - Variances between the documented Avantis entity description and the actual entity description (discrepancies should be corrected as soon as possible)
   - Valve creep (gate valves creeping open over time)
   - Significant loss of hydraulic oil from body seals or exhaust
   - Noticeable rotational operator movement during cycling of valve

- Valve has seized due to corrosion, ice, broken or damaged parts, etc. (Must be corrected as soon as possible)

4.3 Definitions

Critical Valves	Valves whose functions are to (a) isolate one segment of pipeline from another, (b) isolate major facilities (e.g. Compressor Stations) from the pipeline, (c) vent gas from the pipeline in an emergency, or (d) prevent gas containing hydrogen sulphide from entering the pipeline.
Emergency Valves	Valves that might be required during an emergency and thus subject to annual valve inspection and cycling. Synonymous with "critical valves" in TransCanada System.
Grease	The generic term for valve lubricants or valve sealants.
Lubricant	Specialized product injected into valve seats to improve sealing ability and reduce operating thrust/torque. Generally less viscous than sealants.
Sealant	Specialized product injected into valve seats used to enhance a valve's ability to seal; the term is often used interchangeably with "grease" or "lubricant".
Valve Creep	Inability of valve operator to hold a gate valve in the closed position; line pressure exerted on gate slab forces it open.
Valve Operator	Synonymous with valve actuator, a mechanical device used to cycle a valve and hold the valve in a desired position.

5.0 Equipment Data / Site Locations

This TOP applies to the following valves/operators deemed to be critical.

Critical Valve Functions
Mainline block valves and Station block/bypass valves
Side valves (includes C/S suction & discharge valves, lateral side valves)
Crossover (cross-ties) valves between pipelines and loops
Blowdown/blowoff valves that are installed on a bypass around the block valve
Station ESD / Blowdown valves
Automated blowdown valves (overpressure protection)
H_2S Block Valve

6.0 REVISION HISTORY

Rev. No.	Description	Date (yyyy/mm/dd)	TOP Contact
00	New document. This TOP was developed using the following TransCanada source documents: (i) Valve and Valve Operator Leak Inspection / Cycle Test (EDMS No. 003671699).	2005/09/16	Tom Thrall
01	This TOP was reviewed to now reflect the addition of Northern Border	2007/08/30	T. Thrall

Rev. No.	Description	Date (yyyy/mm/dd)	TOP Contact
	Pipeline with respect to the geographic areas of operation as well with feedback from Dan Cerkoney and Virgil Pfennig.		
02	Corrected grammar for DOT intervals of inspection in section 3.0 of TOP as per Tom Thrall and Kurt Smith.	2008/01/15	T. Thrall

7.0 REVIEW AND APPROVAL

	Name (Print)	**Signature**	**Date** (yyyy/mm/dd)
TOP Contact	Name Tom Thrall Title Technologist Dept. Pipe Engineering	Approved	2005/12/06
Reviewer (Peer)	Name John Lau Title Technologist Dept. Pipe Engineering	Approved	2005/12/06
Reviewer (Field Ops)	Virgil Pfennig Pipeline Specialist Northern Border Region		2007/08/30
Reviewer (Field Ops)	Brion Beaver Compliance Specialist, GTN Compliance & Quality	Approved	2006/05/10
Reviewer (CSE)	Rod Egert Sr. HS&E Advisor, Community, Safety & Environment		
Reviewer (Regulatory)	Roel Lancee Sr. Regulatory Compliance Specialist Community, Safety & Environment	Approved	2006/04/13
Approver (Field Ops)	Dave Kozy Manager Maintenance Program Planning		
Approver (Engineering)	Curtis Parker Manager, Technical Support & Technology Mgmt., Pipe Engineering		
Approver (Field Ops)	Ross Parker Director, GTN & N. Baja Region	Approved	2006/05/24
Approver (Field Ops)	John McWilliams Director, US NE Region	Approved	2005/12/06

192.479 Atmospheric corrosion control: General.

All above ground pipelines are protected against corrosion by appropriate applied external coatings in accordance with established company standards.

Reference:

EDMS # 004266539	Atmospheric Corrosion Inspection
EDMS TES-COAT-EPU-US	External Epoxy/Urethane Coating Systems
EDMS TES-COAT-STN	External Coating Systems for Underground Station Yard Piping
EDMS TES-COAT-P1-US	Paint Systems for Above Ground Facilities
EDMS Coating Application Platform 3 – NPS 16-48	

Technical Standards and Specifications:

61-E-X-2	Specification for Painting