Title: **TES-WELD-BC Specification for Welding on In-Service Pipelines**	Document Type: Specification
Effective Date: 2005/12/30	Revision: 0
Document Owner:	Pipe Engineering
Originator: David Taylor, Technologist, Technical Support, Pipe Engineering	Signature/Date: (signed copy on file)
Reviewer: David Dorling, Engineer, Technical Support, Pipe Engineering	Signature/Date: (signed copy on file)
Reviewer: David Horsley, Engineer, Technical Support, Pipe Engineering	Signature/Date: (signed copy on file)
Approver: David Chittick, Manager, Technical Support, Pipe Engineering	Signature/Date: (signed copy on file)

PURPOSE

This specification describes the technical requirements for qualification of welding procedures and welders, production welding, visual and non-destructive inspection for in-service welding on sweet natural gas/liquid pipeline systems. This specification shall be read in conjunction with and covers additional requirements to CSA Standard Z662 Oil and Gas Pipeline Systems.

SCOPE

This specification applies to TransCanada (the Company).

This specification applies to carbon steel, branch pipe to carrier pipe or carbon steel component to carrier pipe welds (branch connections, sleeves and stopple fittings) completed on flowing or non-flowing in-service pipelines.

This specification does not apply to welds covered by TransCanada specifications TES-WELD-PL or TES-WELD-AS.

This specification does not include welding procedure datasheets.

BRIEF DESCRIPTION OF CHANGE (IF A REVISION)

This is a new specification combined from procedures issued through out the company for different sizes of branch connections. It supersedes the following documents: "TCPL Manual for the Installation of Hot Tap Branches and Hot Tap Valves", "TransCanada/NGTL Installation welding procedure datasheets".

TABLE OF CONTENTS

1. REFERENCE DOCUMENTS

CSA Z662	Oil and Gas Pipeline Systems, Latest Edition
ASTM E23	Standard Test Methods for Notch Bar Impact Testing of Metallic Materials
ASME BPV Sect. VIII	ASME Boiler and Pressure Vessel code, Section VIII: *Pressure Vessels – Division 1*
ASME BPV Sect. V	ASME Boiler and Pressure Vessel code, Section V: *Nondestructive Examination*

2. DEFINITIONS

Components: Components include integrally reinforced fittings (threadolets, sockolets, weldolets), reinforcing or repair sleeves, split tees (full size or reducing), and stopple fittings.

Buttering: The buttering technique (shown typically in Figures 1 and 2 for branch connections and sleeves / split tees / stopples respectively) consists of the deposition of one layer of weld metal on the surface of the carrier pipe, followed by the deposition of a tempering layer on top of the first layer and coming as close as possible to the edge of the first layer. The buttering technique is used in order to reinforce the pipe wall, minimize the depth of penetration of the HAZ hardness, reduce the HAZ hardness and the risk of underbead cracking.

Temper bead: The vertical up temper bead welding technique is the placing of the last cap pass so that it will temper the previous weld metal pass and the HAZ of the carrier pipe. The vertical up temper bead welding technique is used on branch connections to reduce the carrier pipe HAZ hardness at the toe of the branch fillet weld.

3. GENERAL

(a) Welding shall be performed in accordance with:

(i) the applicable requirements of CSA Z662 and any amendment, supplement, or errata issued by CSA;

(ii) the additional requirements of this specification; and

(iii) the Company requirements for Environment, Occupational Health and Safety.

(b) Welding shall be performed by welders employed by the Company, or by contract welders supervised by a Company representative responsible for the adherence to this specification.

(c) Welding Procedure Datasheets selected from the Company procedure TEP-WELD-BC shall be on site during installation.

(d) Welding procedures supplied by the contractor shall be reviewed and accepted by the Company prior to starting the work and shall be on site during installation.

4. DESIGN TEMPERATURE

Welding procedures shall specify, and be qualified at or below, the minimum design temperature. Unless specified otherwise, the minimum design temperatures are - 5°C for welds on buried pipelines (60 cm or more of cover), and - 45°C for any other welds.

5. HARDNESS CONTROL

(a) Welding procedures (including those for repair, recap, etc.) shall specify, and be qualified with, techniques to control hardness of the weldment that are appropriate for the expected materials and line flowing conditions (less than or equal to 350 Hv).

(b) Except as permitted in (c) below the buttering technique (Figures 1, 2 and 3) shall be used for all permanent welds installed on the carrier pipe when the pipeline is under pressure and is flowing gas/liquid.

(c) The temper bead technique (Figure 4) may be used with prior approval, on carrier pipes with a Carbon Equivalent (CE_{CSA}) less than 0.35 (See also 7.1 (c) and (d)).

(d) The temper bead technique (Figure 4) may be used on welds that are to be removed during the tapping operation (pilot guide, stiffening ring).

(e) The weld faces of components with a Carbon Equivalent (CE_{CSA}) exceeding 0.35 shall be buttered prior to installation (Figure 3a) using a minimum preheat temperature of 150°C and the capping consumable listed on the intended production welding procedure.

6. WELDING PROCESS

(a) On flowing gas/liquid lines, buttering pads shall be made using low hydrogen welding consumables.

(b) On flowing gas/liquid lines, the combination groove/fillet weld shall be made using low hydrogen welding consumables.

(c) For branch connections installed with non-flowing gas and reduced pressure (less than 60 % MAOP), or no pressure, the root pass may be deposited using cellulosic consumables while the remainder of the weld shall be made using low hydrogen consumables.

(d) Welds completed on full encirclement reinforcement saddles, sleeves, split tees and stopple fittings shall be made using low hydrogen consumables.

7. JOINT DESIGN

7.1 Branch Connection Welds

(a) Branch connection welds between the branch pipe/fitting and the carrier pipe shall be designed as a combination full penetration groove weld on the branch with a reinforcing fillet weld.

(b) Except as permitted in (c) and (d), branch connection welds shall be made using the buttering technique.

(c) The temper bead technique (see also 5 (c)) may be used for carrier pipes with a wall thickness exceeding 9 mm.

(d) The temper bead technique (see also 5 (c)) may be used for carrier pipes with a wall thickness smaller than 9 mm and larger than 6 mm provided the wall thickness ratio between the branch pipe and the carrier pipe does not exceed 1.5.

(e) The minimum included angle for the weld joint between the carrier pipe and the bevel on the branch pipe shall be 45° as specified in CSA Z662, Figure 7.5.

7.2 Fillet Welds

Fillet welds are used for the reinforcement saddle, sleeves, split tees and stopple fitting installations and shall be as specified on the drawing accompanying the specific welding procedure datasheet. Except as specified on the installation drawing, the ends of full-encirclement reinforcement saddles shall not be welded to the carrier pipe.

7.3 Tack Welds

Tack welds shall be completed using the root consumable listed on the welding procedure datasheets and shall be full penetration tacks.

8. MATERIALS

8.1 Pipe and Components

(a) Materials shall be welded according to the diameter, wall thickness and carbon equivalent (CE) requirements of CSA Z662.

(b) Branch stubs shall be fabricated from pre-tested pipe.

(c) The end preparation on branch piping may be machined or flame cut for sizes ranging from 60.3 mm to 508 mm OD (NPS 2 to NPS 20).

(d) The end preparation of branch piping 610 mm OD (NPS 24) and larger shall be machine cut.

(e) The end preparation for reinforcement saddles, sleeves and stopple fittings shall be machined. When long seam full penetration groove welds are required to join the two halves of sleeves or stopple fittings, and unless specified otherwise on the

drawings, the bevels shall be machined and a recess shall be machined to accommodate a backing strip used to prevent penetration of the weld into the carrier pipe.

8.2 Filler Material

(a) Welding consumables shall have mechanical properties that are appropriate for the materials to be welded. Such mechanical properties shall be proven by a butt weld using such materials and consumables that meets the procedure qualification requirements for tensile strength for butt welds in CSA Z662 or ASME BPV, Section IX, and the additional requirements given in Paragraphs 9.5 and 9.6 of this specification.

(b) Filler metals shall be handled and stored in accordance with CSA Z662 requirements and the manufacturer's recommendations.

9. QUALIFICATION OF WELDING PROCEDURES

9.1 General

(a) Welding procedure specifications shall be qualified in accordance with the requirements of CSA Z662 Clause 7.2.5 and this section, and the applicable requirements of CSA Z662 Clause 10.9.2.

(b) Welding procedure specifications intended for use on flowing gas or liquid filled pipelines shall be qualified using flowing water or water spray technique. Weld cooling rates shall be measured in accordance with the procedure given in Appendix A and recorded on the WPS and PQR.

(c) Qualification of welding procedure specifications shall be conducted in the presence of a representative of the Company.

(d) Welding procedure specifications and procedure qualification records shall be submitted to the company for review and acceptance prior to being used for production welding.

9.2 Additional Limitation of Qualification

(a) The following conditions shall require re-qualification of the welding procedure specifications for in-service applications, or establishment and qualification of a new welding procedure specification:

(i) Weld cooling rates during production that are faster than those recorded during qualification.

(ii) Branch-to-carrier pipe diameter ratio exceeding the largest of 67% and the ratio used for qualification.

(iii) Carrier pipe thickness less than 4.8 mm when the wall thickness used for qualification is 4.8 mm or larger.

(iv) Carrier pipe thickness less than the value used for qualification when the wall thickness used for qualification is smaller than 4.8 mm.

(v) Carrier pipe thickness larger than 1.5 times the value used for qualification, when the wall thickness used for qualification is larger than 6.3 mm.

(b) An increase of more than two nominal diameters from the diameter used in qualification for branch pipe or sleeves larger than 323.9 mm OD (NPS 12) shall necessitate production of a test weld that meets the inspection requirements for production welds given in Paragraph 12.

9.3 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 re-testing for impact toughness as specified in Paragraph 9.5.

9.4 Test Weld Acceptability for Destructive Testing

(a) Test welds shall meet the visual inspection requirements for production welds given in Paragraph 12.1 before they can be submitted to non-destructive inspection.

(b) Test welds shall meet the non-destructive inspection requirements for production welds given in Paragraph 12.2 before they can be submitted to destructive testing.

9.5 Impact Toughness Testing

Welding consumables used for in-service welding shall have proven notch toughness for the design temperature specified, testing of welding consumables shall be completed on a single vee circumferencial groove weld:

(a) 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 E 23.

(b) The average value of the Charpy V-notch energy for the three (3) specimens shall be a minimum of 27 J; the minimum energy value for any one specimen shall be 20 J.

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

9.6 Hardness Testing

(a) For single groove butt-welds, Vickers hardness measurements shall be taken, at a load not exceeding 10 kg, on a polished cross section of the weld along two (2) lines (root level and cap level).

(b) For fillet welds, branch connection welds, and welds including the buttering pad, Vickers hardness measurements shall be taken at a load not exceeding 10 kg on a polished cross section of the weld along the coarse grain heat affected zone next to the fusion line. A minimum of five indentations shall be taken from each weld toe

area (fillet weld, temper bead and edge of buttered layer) in contact with the parent material.

(c) Welding procedure specifications resulting in weld metal or heat-affected zone hardness values in excess of 350 HV shall be evaluated to determine that they are suitable for the avoidance of hydrogen-induced cracking.

(d) The measured hardness values of the base metal, weld metal and heat-affected zones shall be recorded on the Procedure Qualification record.

9.7 Carbon Equivalent Testing

The carbon equivalent (CE) for both the carrier pipe and branch or component shall be established using the formula specified in CSA Z662 from mill test certificates or from chemical analysis. This chemical analysis shall be performed using traditional wet chemistry (i.e., titration methods) or using the inductively coupled plasma (ICP) method. The carbon equivalent shall be recorded on the Procedure Qualification record with copies of the test certificates attached.

10. QUALIFICATION OF WELDERS

10.1 General

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

(b) Welders shall be qualified for the work they will perform – butt-welds, branch connection welds or fillet welds – in accordance with the applicable requirements of CSA Z662, or ASME BPV Section IX where permitted by CSA Z662.

(c) Welders working on flowing gas/liquid pipelines shall also be qualified in accordance with the requirements CSA Z662 Clause 10.9.2.2 using a cooling rate induced by flowing water through a pipe or by water spray on the carrier pipe coupon ID.

(d) Welder qualification test welds for fillet welding, branch connection welding and buttering shall be destructively tested in accordance with the requirements of CSA Z662.

(e) Qualification of welders shall be conducted in the presence of a representative of the Company.

(f) Welders shall be instructed by, or on behalf of the Company on the prevention of hydrogen induced cracking the procedure requirements of in-service welding.

(g) Welders shall review, and demonstrate their understanding of, this specification and the applicable welding procedure prior to starting training and welder testing.

10.2 Test Weld Acceptability for Welder Qualification

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

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

(ii) meets the in-process and final visual inspection requirements for production welds given in Paragraph 12; and

(iii) meets the destructive testing requirements of CSA Z662 Clause 7.8, and where applicable Clause 10.9.2.2.2.

(b) Test welds failing to meet the visual inspection requirements shall not be submitted for destructive testing.

10.3 Practice Weld for In-service Branch Connections

Except when they have used the same welding procedure within the previous three months, prior to welding on a pipeline that is in-service, welders shall review the welding procedure specification and produce a practice weld in accordance with the welding procedure that is applicable to the installation. When the procedure requires more than one welder, each welder shall produce the applicable segment of the practice weld.

11. PRODUCTION WELDING

11.1 Compliance with Specifications

(a) 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 datasheet. Consideration shall be given to implementing an in-process inspection checklist to produce such records. Such records shall be available to the Company.

(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 such welds are in compliance.

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

11.2 Branch Pipe Location

(a) Except as permitted in (b), welds shall not be located within 50 mm of any carrier pipe seam weld or circumferential girth weld. In addition, full encirclement reinforcement saddles shall not cover a circumferential girth weld and the edge of the saddle shall not be located within of 50 mm of the girth weld.

(b) At locations where the design options require the branch connection weld to cross, or be within 50 mm of, the long seam weld, such seam weld shall be inspected using

ultrasonic inspection to ensure it is free of defects. The inspected area shall extend to a minimum of 100 mm on either side of the proposed weld location.

(c) The long seam weld at the location of the reinforcement saddle shall be examined by ultrasonic inspection techniques, before removal of the weld reinforcement, to ensure the weld is free of porosity and/or lack of fusion discontinuities.

11.3 Sleeve/Stopple Location

(a) The complete length of the long seam weld at the location of the sleeve/stopple fitting installation shall be examined by ultrasonic inspection techniques, before removal of the weld reinforcement, to ensure the weld and HAZ are free of toe cracks or surface breaking solidification cracks. Magnetic inspection may be used at locations where the corroded condition of the pipe prevents the use of ultrasonic inspection.

(b) Fillet welds at the ends of sleeves/stopple shall not be located within 100 mm of a circumferential girth weld.

(c) At locations where the fillet welds cross the long seam weld, the long seam weld shall be inspected using ultrasonic inspection to ensure it is free of defects. The inspected area shall extend to a minimum of 100 mm on either side of the proposed weld location.

11.4 Carbon Equivalent

(a) The carbon equivalent of the carrier pipe calculated using the formula specified in CSA Z662 shall be determined to ensure compliance with the maximum qualified value of the welding procedure specification. Such determination shall be based on mill test certificates, or chemical analysis of the actual pipe.

(b) The coupon removed during the hot tapping operation shall be submitted for chemical analysis.

11.5 Pipe Cleaning

(a) Except in the case of fusion bond epoxy (FBE), the coating on the carrier pipe shall be removed in the proposed area of the full encirclement reinforcement saddle, sleeve or stopple fitting and for a length extending to 300 mm on either side of the proposed area.

(b) The exposed pipe shall be cleaned by wire brushing or sand blasting for a distance extending 150 mm from the edges of the proposed area of the reinforcement saddle, sleeve or stopple fitting installation. Any area of coating disbondment shall be inspected for stress corrosion cracking using wet magnetic particle techniques.

(c) The carrier pipe surface shall be visually inspected for surface discontinuities.

(d) The area where the attachment welds are to be made shall be cleaned to bare metal to remove all coatings, mastic, etc.

(e) The location on the carrier pipe where welding is to take place shall be inspected for stress corrosion cracking using wet magnetic particle techniques.

(f) Where there is an undue delay between this cleaning and the start of welding, the appropriate areas shall be suitably protected and cleaning shall be repeated if necessary before welding.

11.6 Lamination and Wall Thickness Check

The area where the attachment welds are to be made shall be subjected to 100% ultrasonic inspection over a minimum band width of 100 mm, centered over the proposed weld location. This area shall be free of laminations and have a wall thickness of not less than 90% of the value specified on the drawings.

11.7 Assessment of the Cooling Rate

The cooling shall be assessed using the procedure given in Appendix A. The measured times shall exceed the values specified on the welding procedure datasheet to ensure that cooling conditions are less severe than during procedure qualification.

11.8 Adjustment of the Welding Machines

Welding machines shall be adjusted to the parameter ranges specified on the Welding Procedure Data Sheet. Welders shall confirm, and record the welding amperage and voltage settings and values prior to welding on the in-service pipe (refer to paragraph 11.1).

11.9 Alignment and Fit up

(a) The branch piping shall be aligned so that it is perpendicular to the axis of the carrier pipe and level within the tolerance specified on the installation drawing to ensure the proper line up of the valve and Hot Tapping equipment.

(b) The carrier pipe and branch pipe shall be supported as specified on the installation drawing to minimize the stress/strain applied at the branch connection weld.

(c) For 610 mm OD (NPS 24) and larger branches, a pilot drill guide shall be centered and welded to the carrier pipe to ensure proper placement of the cutter.

(d) For 610 mm OD (NPS 24) and larger branches and stopples, a 406.4 mm OD (NPS 16) stiffening ring shall be welded to the carrier pipe to prevent the area to be removed from distorting and binding against the opening upon removal.

(e) Welding of the pilot drill guide and stiffening ring shall be completed using the temper bead technique and the fillet portion of the weld procedure specified for the branch connection weld.

(f) Alignment shims are recommended when lining up branch pipe 508 mm OD (NPS 20) and larger or where the branch to carrier ratio is larger than 67%.

(g) Sleeves and stopple fittings shall be installed to minimize the gap between them and the carrier pipe. Areas of wide gap may require weld build up on the carrier pipe (buttering) to allow for the completion of the fillet weld (See Figure 5). A small internal bevel or a counterbore and taper may be required on the stopple fitting to ensure the ends fit onto the buttering pad and the root of the fillet weld does not come in contact with the carrier pipe.

11.10 Grounding

(a) Grounding devices shall be designed to prevent arcing, and shall not have bronze or copper in contact with the pipe or welds.

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

11.11 Weather Conditions

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

11.12 Preheating

(a) For buttered branch connection, sleeve and stopple fitting welds the cooling effect of the flowing gas/liquid makes it impractical to maintain the conventional preheat of 100°C in most cases, however the area of welding shall be preheated locally to completely dry the surface. Refer to the appropriate welding procedure datasheet of more information.

(b) For branch connection and sleeve welds in non-flowing gas conditions, the minimum preheat and interpass temperature shall be 100°C. If the interpass temperature falls below 100°C, welding shall stop and not resume until the minimum preheat temperature is restored. If the interpass temperature is measured above 200°C, welding shall stop and not resume until the temperature falls below 200°C.

11.13 Start of Welding

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

11.14 Number of Welders

Except for the buttering layer, a minimum of two welders shall be required for branch connections welds of 323.9 mm OD (NPS 12) and larger. A minimum of two welders shall be required for sleeves, split tees and stopple fittings.

11.15 Removal of Alignment Shims

Where used, alignment shims shall be completely removed by grinding.

11.16 Cleaning between Passes

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

11.17 Interruptions in Welding

Welding of individual welds in branch connection, sleeve, split tee and stopple fitting installation shall continue without interruption except where a delay is specified on the welding datasheet to facilitate inspection of a buttering layer.

12. INSPECTION AND TESTING OF PRODUCTION WELDS

12.1 Visual Inspection

Welds covered by this specification shall be visually inspected and any imperfections shall be assessed using the Standards of Acceptability given in Paragraph 13.

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) welding is done in accordance with the welding procedure used for production; and

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

12.2 Non Destructive Inspection

12.2.1 Butter Layers

(a) Butter layers shall be inspected for 100% of their surface or circumference, using wet magnetic particle techniques (black on white contrast or fluorescent) and any imperfections shall be assessed using the Standards of Acceptability given in Paragraph 13.

(b) Butter layers for 323.9 mm OD (NPS 12) and larger branch piping shall also be ultrasonically inspected and any imperfection shall be assessed using the Standards of Acceptability given in Paragraph 13.

(c) Butter layers welded for pipes and components 60.3 mm OD (NPS 2) and larger shall be re-inspected after a minimum delay of 12 hours following completion of welding using the requirements of Paragraph (a) above and, where applicable, Paragraph (b) above.

12.2.2 Branch Connection Welds

(a) Branch connection welds shall be inspected for 100% of their circumference using wet magnetic particle techniques (black on white contrast or fluorescent) and any

imperfections shall be assessed using the Standards of Acceptability given in Paragraph 13.

(b) Branch connection welds for 323.9 mm OD (NPS 12) and larger branch piping shall also be ultrasonically inspected and any imperfection shall be assessed using the Standards of Acceptability given in Paragraph 13.

(c) Branch connection welds smaller than 60.3 mm OD (NPS 2) shall be re-inspected after a minimum delay of 6 hours following completion of welding using the requirements of Paragraph (a) above.

12.2.3 Fillet Welds

(a) Fillet welds shall be inspected using wet magnetic particle inspection (black on white contrast or fluorescent) and any imperfection shall be assessed using the Standards of Acceptability given in Paragraph 13.

(b) Fillet welds completed on stopple fittings, split tees or pressure-containing sleeves shall also be ultrasonically inspected and any imperfection shall be assessed using the Standards of Acceptability given in Paragraph 13.

12.2.4 Groove Welds

(a) Groove welds completed on sleeves, split tees and stopple fittings shall be ultrasonically inspected and any imperfection shall be assessed in accordance with the requirements of CSA Z662.

12.3 Non-Destructive Inspection Methods

(a) Ultrasonic inspection shall be performed in accordance with the applicable requirements of ASME BPV Section V, Article 4.

(b) Magnetic particle inspection shall be performed in accordance with the requirements of ASME BPV Section V, Article 7. The direct current method of magnetization shall not be used.

12.4 Qualification on Non Destructive Inspection Personnel

Personnel conducting magnetic particle inspection or ultrasonic inspection shall be qualified in accordance with the applicable requirements of Level II of CAN/CGSB-48.9712. The Company requires that technicians be trained and have experience with the joint configurations on branch connections, sleeves and stopples.

13. STANDARDS OF ACCEPTABILITY

13.1 Standards of Acceptability

(a) The standards of acceptability shall be the applicable Standards of Acceptability given in CSA Z662 Clause 7.11 for visual inspection and magnetic particle

inspection, and those given in CSA Z662 Clause 7.15.10 for ultrasonic inspection, with the following additional requirements.

(i) Cracking - Cracks are not acceptable. If cracking is present, the pressure within the line shall be reduced by 20% of the pressure at the time of welding and action in accordance with the Company's procedure shall be taken.

(ii) Arc burns are not acceptable.

(iii) Incomplete penetration and lack of fusion are not acceptable.

(iv) Exposed slag inclusions/slag lines are not acceptable.

(v) Pinholes shall be evaluated as spherical porosity.

(vi) Stop/Start locations identified by ultrasonic inspection are acceptable provided they are confined to a single pass in depth and do not exceed 3 mm in length determined using the 6 dB drop, or maximum amplitude sizing method.

(vii) Undercut depths less than 0.5 mm or 6% of the nominal wall thickness whichever is the lesser, shall be acceptable regardless of length, provided an appropriate mechanical method is used for assessing the depth of undercut (e.g., needle pit gauge).

(viii) The cumulative length of undercuts exceeding the depth specified in (vii) above in any 300 mm length of weld shall not exceed 50 mm, except that for welds less than 300 mm long the cumulative length shall not exceed 16% of the weld length.

13.2 Reporting

The results of visual inspection, magnetic particle inspection, and ultrasonic inspection shall be reported in writing and properly referenced in a report dated and signed by the non-destructive inspection personnel.

14. REPAIR OF WELDS CONTAINING DEFECTS

14.1 Cracks

Welds containing cracks, regardless of size and location, shall be cut out and replaced.

14.2 Approval of Repair and Procedure

Repair of defects in production welds shall

(i) require approval of the Company;

(ii) be performed by qualified welders in accordance with the welding procedure used during production; and

(iii) be recorded on the inspection reports.

14.3 Removal of Defects

(a) Welds containing defects exceeding the allowable limits of the Standards of Acceptability given in Paragraph 13 shall be repaired, or cutout and replaced.

(b) Defects in welds shall be removed by grinding.

14.4 Inspection of Repairs

(a) All repairs shall be inspected using the methods and procedures specified in Paragraph 12.

(b) Any imperfections shall be assessed using the Standards of Acceptability given in Paragraph 13.

(c) Where a buttering layer technique is used, repairs shall be completed and accepted before the delayed inspection period begins.

15. SELECTION OF WELDING PROCEDURES

Welding procedures shall be selected using procedure, TEP-WELD-BC 'Selection of Branch Connection Welding Procedures Datasheets'. This selection procedure does not include the actual welding procedures datasheets but will assist in ensuring the correct ones are issued for the project.

APPENDIX A: COOLING RATE ASSESSMENT PROCEDURE

BACKGROUND

Attention is drawn to the rapid cooling effect of the gas/liquid flow. Heat dissipation from the weld area will be dependent on flow conditions at the time of attachment and may vary during the welding cycle. On liquid or flowing gas in-service pipelines the cooling effect has to be assessed using the procedure given below and compared to the qualified value prior to proceeding with the application.

PROCEDURE

Equipment Required:

- Chalk or soapstone
- Oxy-acetylene torch with "rosebud" tip
- Digital contact thermometer
- Stopwatch.

Steps:

1) Measure and record the initial pipe temperature T_i in °C
2) Using chalk or soapstone, scribe a 2-in.-diameter circle on the pipe in the area where welding is to be performed.
3) Use the gas torch in a circular motion to quickly heat the entire circle above the minimum heating temperature T_h calculated as $T_h = T_i + 275°C$. The maximum temperature should not exceed 325°C (617°F).
4) After attaining a temperature above T_h, remove the torch and apply quickly the contact thermometer to the center of the circle.
5) While holding the thermometer in contact with the pipe, using a stopwatch, measure and record:
   a. the time required to cool from 250 to 100°C (482 to 212°F), and
   b. the time-temperature measurements every 10°C during cooling from $T_s = T_i + 80°C$ down to $T_f = T_i + 10°C$.
6) If more than one measurement is required and the pipe is still warm from the previous measurements, wait until normal temperatures are restored before repeating steps 2 to 5.

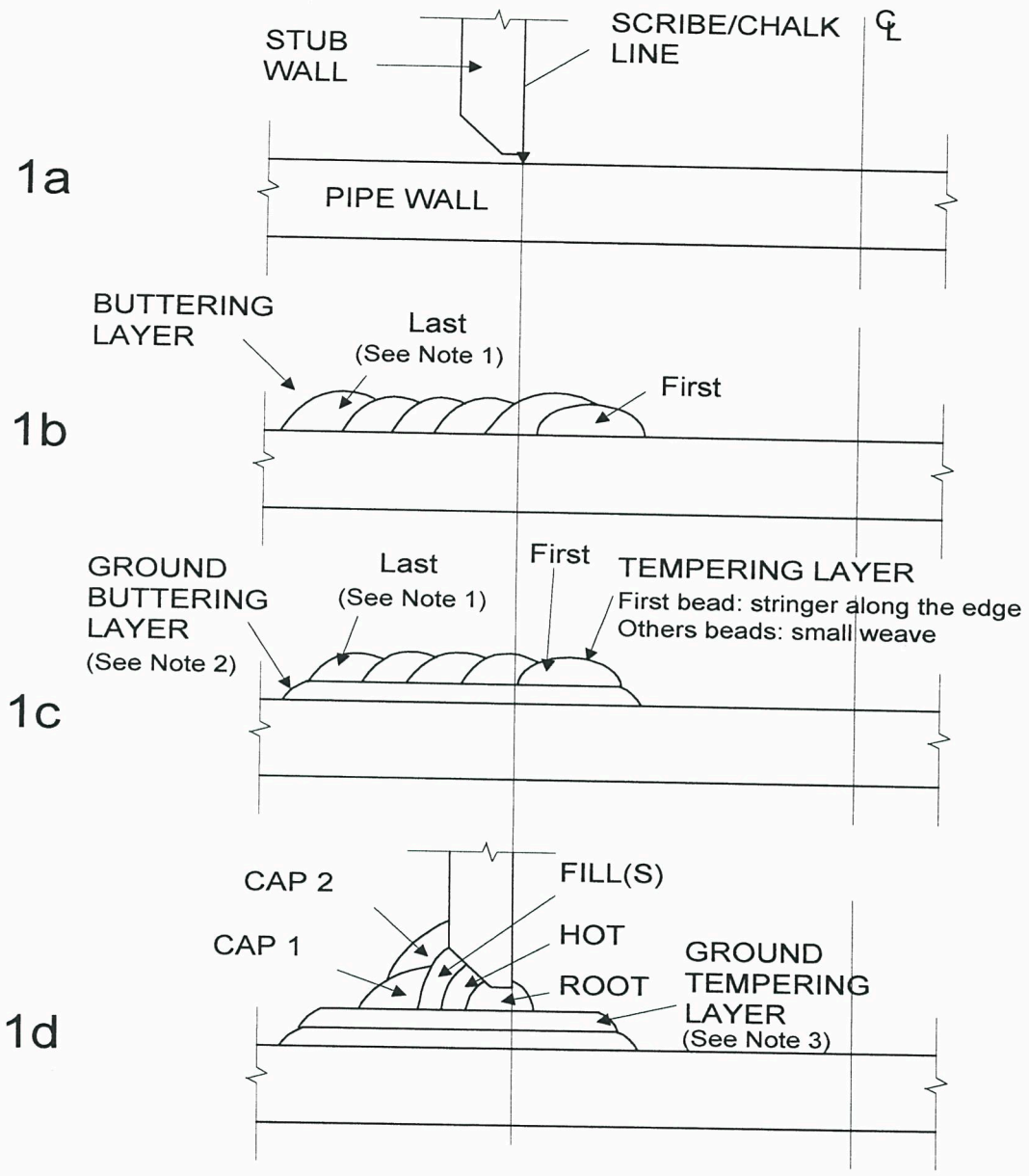

FIGURE 1: WELDING DETAIL AND SEQUENCE – STUB BRANCH CONNECTION WELD

Notes:

1) Number of beads in buttering & tempering layers varies with stub diameter and wall thickness
2) Layer thickness after grinding 1.5 to 2.5 mm. No feathering of edges.
3) Total layer thickness after grinding 2.5 to 3.5 mm. No feathering of edges.
4) Minimum distance from outside edge of butter layer to toe of fillet weld is 6.4 mm.

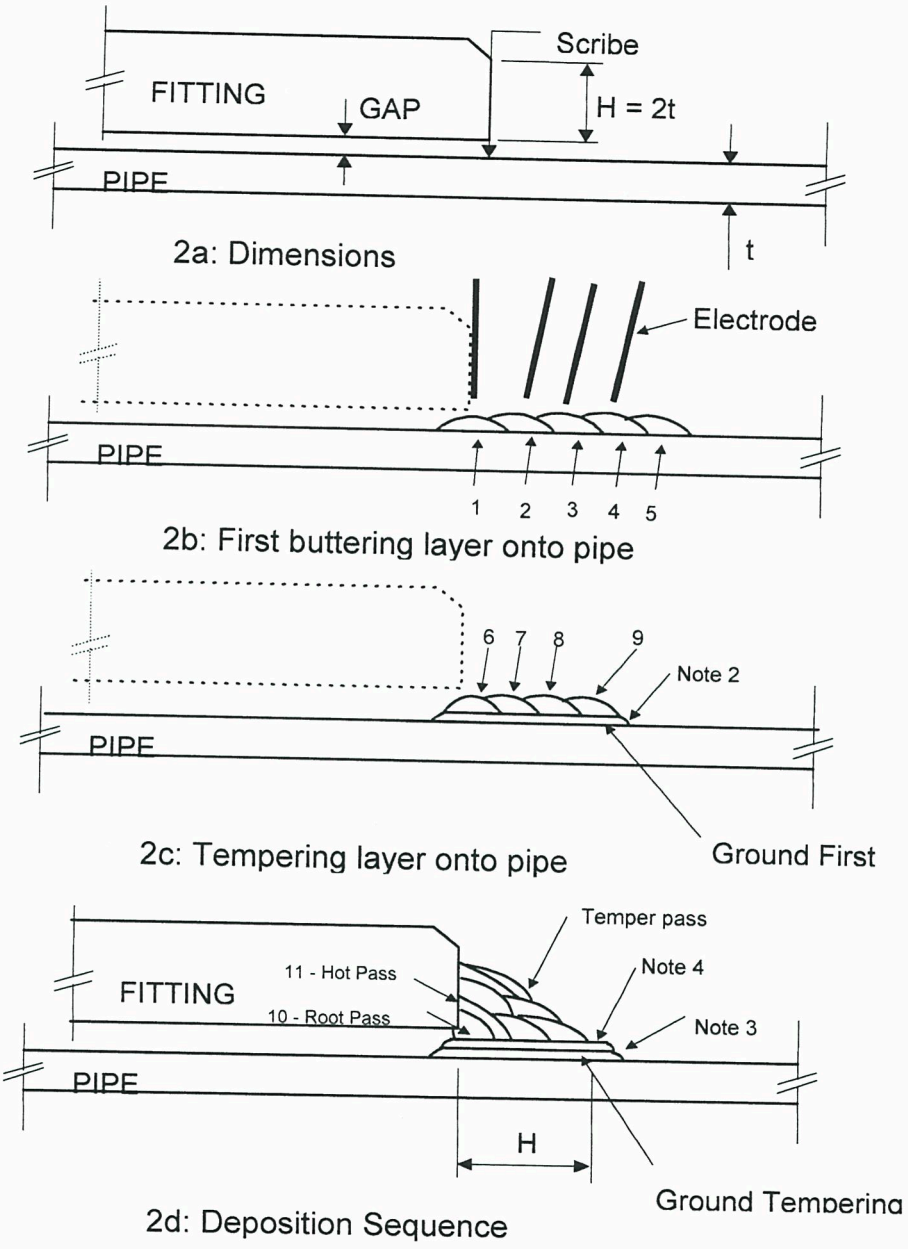

FIGURE 2: WELDING DETAIL AND SEQUENCE – SPLIT TEE / STOPPLE WELD

Notes:

1) Number of buttering runs varies with the size of fillet weld required.
2) Layer thickness after grinding 1.5 to 2.5 mm. No feathering of edges.
3) Total pad thickness after grinding 2.5 to 3.5 mm. No feathering of edges.
4) Minimum distance between toe of fillet weld and edge of buttering pad is 6.4 mm.

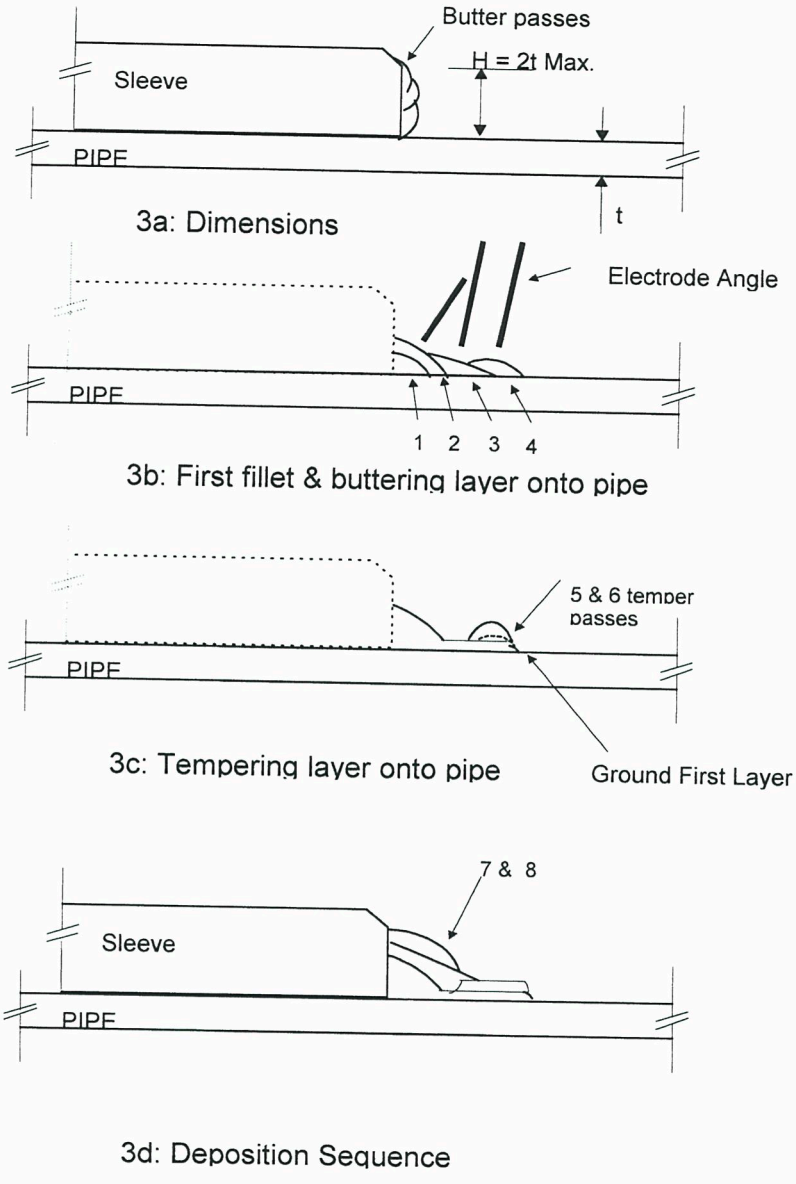

FIGURE 3: WELDING DETAIL & SEQUENCE – PRESSURE CONTAINING SLEEVE

Notes:

1) Number of buttering runs varies with the size of fillet weld required.
2) **Minimum fillet size is the wall thickness of sleeve.**
3) 1st Layer thickness after grinding 1.5 to 2.5 mm. No feathering of edges.
4) Minimum distance between toe of fillet weld and edge of buttering pad is 6.4 mm.
5) Increased gap will increase the minimum fillet weld throat thickness by the same value.
6) See paragraph 7(e) for buttering of fitting.

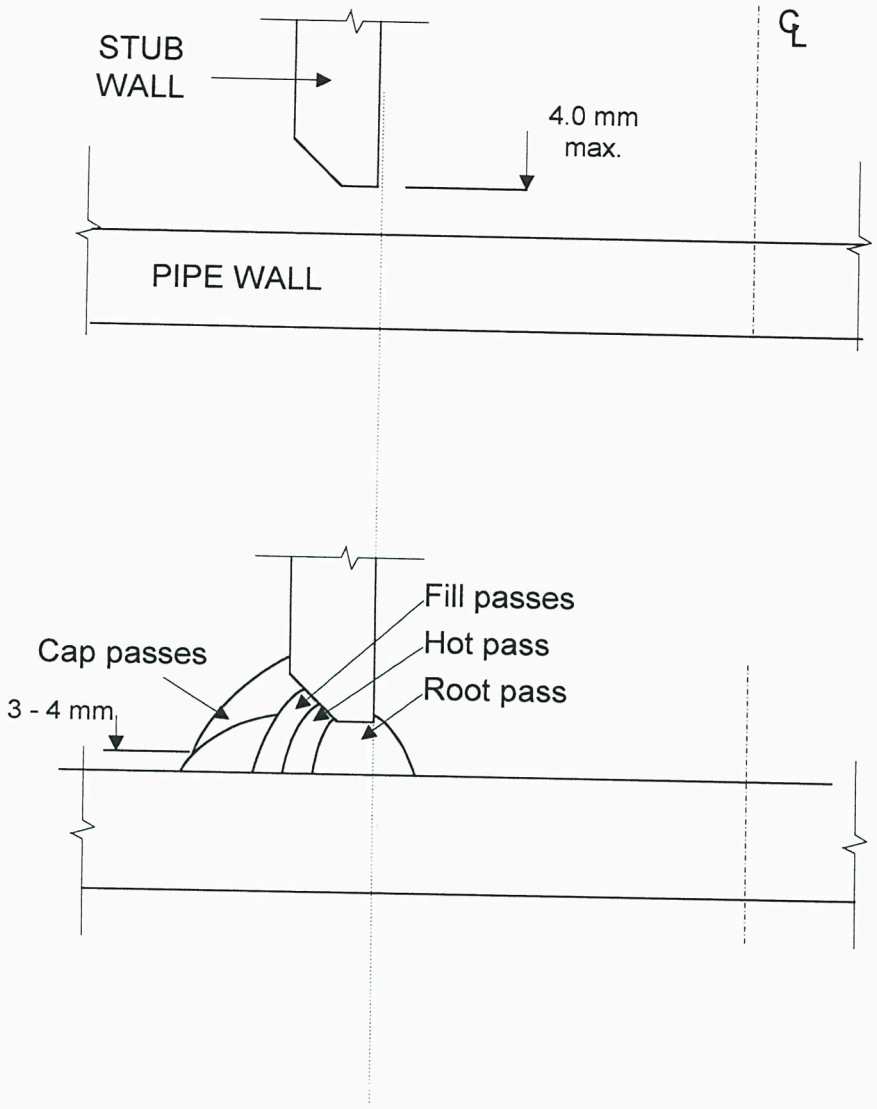

FIGURE 4: WELDING DETAIL AND SEQUENCE – TEMPER BEAD TECHNIQUE

Notes:

1) Number of beads varies with branch (stub) wall thickness.
2) Minimum size of fillet reinforcement is 6.4 mm.
3) Bevel angles will vary around the branch pipe with a maximum of 45°.

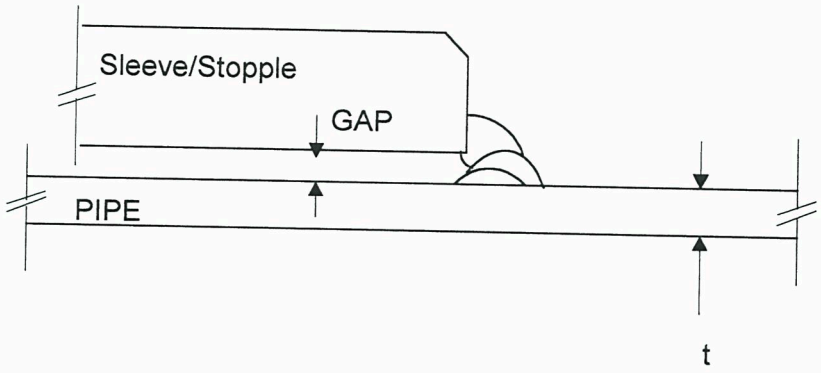

FIGURE 5:
ROOT DEPOSITION TECHNIQUE TO BE USED WHERE THE GAP EXCEEDS 2 MM