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# WELDING SPECIFICATIONS

MARCH 1975



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19 March 1975

# Arctic Gas

To: Metallurgical Subcommittee Construction Resources & Logistics Subcommittee Pipeline Design Subcommittee Stations & Facilities Design Subcommittee

Gentlemen:

# Re: Welding Specifications

In answer to a deficiency question from the NEB, we will be filing Welding Specifications for:

Field Welding of the Mainline Pipe Double Jointing Pipe Welding of Prefabricated Piping Field Welding of Station and Other Special Piping

Attached please find these specifications which are Revision 1 of the Welding Specifications dated May 1973 previously produced. The major changes introduced in the present revision are as follows:

- Elimination of contractual considerations. (i.e. who pays for what?)
- 2. Revision and rearrangement of the clauses on:
  - Inspection and Testing of Production Welds
  - Standards of Acceptability Nondestructive Testing
  - Radiographic Procedure
- 3. Removal of specific preheat requirements with reference only to the minimum preheat (if required) as established in procedure qualification tests.
- 4. Editorial reworking including clause numbers for each paragraph and dimensions in SI units (in anticipation of the system of measurement to be used).

Your comments on these specifications are requested. I believe we should ask ourselves:

1. Are there requirements included which we are not prepared to follow?

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2. Are there additional specifications or specification requirements which should be included in order to convince the NEB of quality assurance?

Please note that the requirements for notch toughness are presently blank pending further discussion by the Metallurgical Subcommittee. It is expected that the requirements for this clause will be based on Crack Opening Displacement Tests which are being investigated by The Welding Institute under Project 3.5.7 Weld Toughness Verification.

The finalization of these specifications will be an agenda item during the Metallurgical Subcommittee meetings on 9th and 10th April. Please relay comments on these specifications to the writer.

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Yours very truly,

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CANADIAN ARCTIC GAS STUDY LIMITED

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CANADIAN ARCTIC GAS PIPELINE LIMITED ALASKAN ARCTIC GAS PIPELINE COMPANY

SPECIFICATION FOR THE FIELD WELDING OF THE MAIN LINE SPECIFICATION 2950-6-12 REVISION 1

# 1. General

# 1.1 Scope

This Specification covers the main line field welding of a gas pipeline extending from Prudhoe Bay, Alaska, and the Mackenzie River delta region, to the southern part of Canada. It is limited to pipe-to-pipe welds of underground piping. It does include tie-in welds and the welding of valves and fittings to which pipe stub ends or pups have already been welded. Other welding is covered by the following specifications:

2950-6-13 Rev	vision 1	Double Jointing Pipe
2950-6-15 Rev	vision l	Field Welding of Station and Other Special Piping (Field welding of station piping, above ground piping, and the welding of accessories such as blow-down piping, branch connections, fittings and valves).
2950-6-14 Rev	vision l	Welding of Prefabricated Piping

(Prefabrication welding of assemblies

for stations and the main line).

# 1.2 Definitions

The term "Arctic Gas" as used in this Specification shall mean Canadian Arctic Gas Pipeline Limited or Alaskan Arctic Gas Pipeline Company, including their engineering agencies, inspectors and other authorized representatives.

### 1.3 Requirements and Regulations

In Canada, the welding shall be in accordance with the requirements of CSA Standard Z184 - 1973, "Gas Transmission and Distribution Piping Systems". In Alaska, the welding shall be

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in accordance with the requirements of Part 192, Title 49, Code of Federal Regulations, "Transportation of Natural and Other Gas by Pipelines", and API Standard 1104 (13th Edition, July 1973), "Standard for Welding Pipe Lines and Related Facilities".

# 1.4 Low Temperature Service

The low design temperatures for the pipeline require low temperature notch toughness properties (see Clause 7.4.3 of this Specification) in the girth weld and heat-affected zone. Special techniques may be needed to achieve these properties.

# 2. Pipe

### 2.1 Pipe Specification

The pipe will be Grades 65 and 70 conforming to Canadian Arctic Gas Pipeline Pipe Specifications 2950-6-6, "Specification for Mainline Pipe", and 2950-6-7, "Specification for Large Diameter Pipe For -30C Service", or Grades X65 and X70 conforming to Alaskan Arctic Gas Pipeline Company Specifications 2950-6-6, "Specification for Mainline Pipe", and 2950-6-7, "Specification for Large Diameter Pipe For -30C Service".

# 2.2 Pipe Diameters and Wall Thicknesses

This Specification is for the welding of the following pipe sizes:

762 mm (30 in) to 1219 mm (48 in) with nominal wall thicknesses up to and including 31.8 mm.

# 3. Line-Up

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### 3.1 Line-Up Clamps

An internal line-up clamp shall be used wherever possible. An external line-up clamp shall be used where it is impractical to use an internal line-up clamp.

### 3.2 Distance Between Welds

3.2.1 Longitudinal welds in adjacent lengths of longitudinally welded pipe shall be offset by a minimum of 150 mm and shall be in the upper half of the circumference. For spiral welded pipe, the offset shall also be a minimum of 150 mm. Exceptions to this may be necessary in pipe containing bends.

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- Except for transition pieces with valves, the minimum \* ollary 3.2.2 distance between girth welds shall be two diameters. except at status The. In except at status The. In etc. 50% Dec
- 3.3 Hammering

Hammering during line-up shall be kept to a minimum and shall be done only with soft face hammers. Hammer faces shall be nickel overlaid with a minimum of four layers. The electrodes used shall conform to AWS E4N11 nickel welding rods. Once welding of the root bead is commenced, hammering of the pipe at that joint is prohibited.

- 3.4 Pipe of Different Inside Diameters
  - 3.4.1 For pipe of the same nominal outside diameter but different inside diameters because of specified wall thickness differences greater than 1.5 mm, the smaller diameter shall be machined, ground, or filed with a taper not steeper than one in four to obtain the alignment specified in the welding procedure.
  - 3.4.2 If the internal diameter of the pipe affords access, the offset may be backwelded as permitted in Clause 12.3 of this Specification.
- 3.5 Damaged Pipe Ends

Bevelled ends with dents, nicks, cuts or other damage shall be repaired by cutting off a ring and rebevelling. No welding repairs shall be allowed on the end bevel of the pipe.

### Removal of Line-Up Clamps 3.6

- 3.6.1 When an internal line-up clamp is being used, the clamp shall not be removed before 100 per cent of the root pass is completed and the pipe is properly supported. When conditions exist that put excessive stress on the weld, the hot pass shall be completed before removal of the clamp.
- 3.6.2 An external line-up clamp shall not be removed until the completed parts of the root pass, uniformly spaced, cover a minimum of about 75 per cent of the circumference of the joint, and the pipe is adequately supported on each side of the joint.

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Adding Processes

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Acceptable Processes

The welding may be done by the manual Shielded Metal-Arc process using coated electrodes, a Semi-Automatic Gas Metal-Arc process, a combination of Semi-Automatic Gas Metal-Arc and Shielded Metal-Arc process\*, or a fully automatic Gas Metal-Arc process.

> \*A Semi-Automatic Gas Metal-Arc process for the root and second passes and Manual Shielded Metal-Arc welding for all succeeding passes.

Manual Shielded Metal-Arc Process

# 4.2.1 Direction of Welding

The direction of welding shall normally be vertical down.

# 4.2.2 Electrodes

Electrodes for welding shall be subject to Arctic Gas approval at the time of procedure qualification tests.

# 4.2.3 Polarity

Direct current shall be used with the electrode positive. Voltage, amperage, and speed of welding shall be in accordance with the approved welding procedures.

4.2.4 Root Pass and Second Pass Welders

A minimum of two welders shall be used on the root and second passes except as approved in writing by Arctic Gas.

Semi-Automatic Gas Metal-Arc Process

Filler metal and procedures shall be subject to Arctic Gas approval at the time of procedure qualificaton tests.

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# 4.4 <u>Combination of the Semi-Automatic Gas Metal-Arc and Manual</u> Shielded Metal-Arc Processes

The Semi-Automatic Gas Metal-Arc Process may be used for the root and second passes. Succeeding passes shall be deposited with the Manual Shielded Metal-Arc process. Consumables and procedures shall be subject to Arctic Gas approval at the time of procedure qualification tests.

# 4.5 Automatic Gas Metal-Arc Process

When it can be demonstrated that an automatic process can produce acceptable welds, suitable requirements will be established.

### 4.6 Shielding Gases

Shielding gases shall exhibit a water dew point of -40C or lower.

# 5. Welding

# 5.1 Pipe Position

The pipe shall be welded in the fixed horizontal position.

# 5.2 Grounding Clamps

Grounding clamps shall be made of steel and shall have solid contact with the pipe to prevent the possibility of arc burns. Copper or copper alloys shall not be used.

# 5.3 Weld Bead Thickness

Each weld bead shall be 3 mm or less in thickness.

# 5.4 Cleaning the Weld Area

All foreign materials, such as mud, oil, grease, shop paint, etc., shall be removed from both internal and external pipe surfaces for a sufficient distance from the proposed weld to prevent deleterious effects.

# 5.5 Grinding the Root Pass

The root pass shall be cleaned and contour ground to remove undercutting, rough surfaces and other defects using a 4 or 5 mm thick grinding wheel. Power driven buffers shall be used to clean filler and cap passes. All flux, slag, and spatter shall be removed from the completed weld area.

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# 5.6 Removal of Defects During Welding

- 5.6.1 All visible defects and starts and stops with high points must be removed by grinding. Particular attention shall be paid to the cleanliness of the junctions between the weld metal and the fusion faces before deposition of further weld metal.
- 5.6.2 Solidified metal "icicles" on the inside, and projecting micro wire shall be removed by grinding.

# 5.7 Stray Arcs

Arcs shall only be struck on fusion faces and accidental contact of the electrode or of the non-insulated parts of electrode holders with the outer surface of the pipe shall be avoided. Electrode holders should be of the fully insulated type.

- 5.8 Marking of Welds
  - 5.8.1 Each welder shall mark his welds or portions of welds with a unique identification symbol, using chalk or grease-free crayon. (Keel will not be permitted). Identifying marks shall be placed on the external protective coating material, if any, immediately adjacent to the weld.

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- 5.8.2 Each welder of root beads shall place his symbol at the beginning of the upper half of the section he has worked on and all other welders shall write their symbols at an appropriate place beneath those markings.
- 5.8.3 Under no circumstances shall any welder change the symbol assigned to him for the duration of the entire construction period. When any welder is terminated, his symbol shall not be used again by any other welder employed.

# 5.9 Work Stoppages

5.9.1 In the event of work stoppages, or in those cases where the weld cannot be completed before the end of the work period, the partially completed weld shall contain at least three passes.

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- 5.9.2 Before the restart of welding, and where preheat was originally required, the entire weld area for a minimum of 100 mm on each side of the weld shall be preheated to the minimum preheat temperature.
- 5.9.3 Tie-in welds must be completed without any delays.

### 5.10 Weld Protection

Asbestos blankets may be required to protect welds from excessively rapid cooling due to low temperatures, wind, rain, or snow. Other materials, such as fiber glass insulating blankets, may be used if approved by Arctic Gas.

### 5.11 End Closures

The open ends of the line shall be securely closed at the end of each work period to prevent the entrance of small animals, water, and obstructions. The ends shall not be reopened until work recommences.

### 5.12 Fire Guard

Fire guards shall be provided whenever dry muskeg, peat or other inflammable ground is present in the welding area. The fire guard shall be provided with a water or foam fire extinguisher and shall thoroughly moisten the area under and around the weld seam immediately after completion of each welding operation. The fire guard shall not leave the scene if there are any signs of smoke remaining.

### 6. Preheating

# 6.1 General

The need for preheating will depend upon the welding process selected, the pipe wall thickness, the chemical composition of the pipe material, and the ambient temperature. The welding procedure shall specify the preheating requirements that are to be followed when materials or weather conditions make such treatment necessary. The Procedure Qualification Test shall have demonstrated that acceptable quality welds will be produced when complying with these requirements. Additionally, preheat shall be used when directed by Arctic Gas.

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# 6.2 Heating Methods

Preheating may be accomplished by using induction coils, resistance coils, or gas burners.

# 6.3 Preheat Temperatures

When preheat is required, the joint shall be uniformly heated throughout the wall thickness for a minimum width of 100 mm on each side of the weld to the temperature required by the Procedure Qualification Test.

# 6.4 Dissimilar Steels

When welding dissimilar steels having different preheating requirements, the higher preheat temperature shall govern.

# 6.5 Interpass Temperature

Construction practice shall be such that the temperature prior to the application of the second pass shall not fall below that established by the Procedure Qualification Test.

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### 6.6 Measurement of Preheat Temperature

- 6.6.1 The preheat temperature shall be checked by the use of temperature-indicating crayons, thermocouple pyrometers, or other suitable methods to assure that the required preheat temperature is obtained prior to and maintained during the welding operation.
- 6.6.2 Some types of crayon will not show, once the temperature has been reached, that this temperature is being maintained. In these cases the crayon has to be re-applied if continued temperature observations are to be made.
- 6.6.3 When it is required to bracket the preheat temperature, both low and high indicating crayons shall be used.

### 7. Procedure Qualification Tests

# 7.1 General

The qualification of the welding procedures shall be in accordance with Clause 4.6 of CSA Standard 2184, or in accordance with Clause 2 of API Standard 1104, with the following additions.

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# 7.2 Procedure Development

- 7.2.1 Arctic Gas will conduct welding tests under the expected adverse temperature and weather conditions to set limits on the welding practices and to establish welding procedures to be used, which will be furnished to Contractors on a recommendation basis. The Contractors will assume all responsibility in the use of such welding procedures.
- 7.2.2 In lieu of the use of these procedures, a Contractor may propose procedures developed by himself. All procedures proposed by Contractors for use on this pipeline shall be submitted for consideration to Arctic Gas. This includes any special procedures such as tie-in welds. The welding procedure qualification tests shall be conducted at a mutually satisfactory location in the presence of an Arctic Gas representative with adequate notice being given of test dates.

### 7.3 Grouping of Variables

Procedure Qualification Tests are required for the maximum thickness of all grades of steel and pipe diameters from each manufacturer. No other grouping is permitted. Any change in pipe steel, diameter, manufacturer, or grade and any change in filler metal in production shall require requalification.

# 7.4 Testing of Procedure Qualification

# 7.4.1 Test Requirements

The testing of the procedure qualification butt weld shall be in accordance with requirements of Clause 4.6 of CSA Z184, or in accordance with Clause 2.6 of API 1104, plus the hardness survey shown in Clause 7.4.2 and the notch ductility tests shown in Clause 7.4.3 of this Specification. The hardness test surveys and notch ductility tests will be made on specimens removed from at least one procedure qualification weld made at the lowest temperature permitted by the procedure on pipe from each manufacturer.

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# 7.4.2 Hardness Survey

- 7.4.2.1 A transverse section of the weld shall be removed from a location chosen by Arctic Gas and shall be prepared for testing by machining, grinding, and polishing. Care should be taken to remove a minimum of 5 mm from any torch-cut surface. The polished cross section of the weld shall be given a light etch.
- 7.4.2.2 Three hardness traverses shall be made with indentations at approximately 2 mm intervals. One traverse shall be made across the middle of the weld, and the other two approximately 3 mm in from the inside and outside surfaces. Additional spots shall be checked to assure that the maximum hardness in the heat-affected zone is adequately measured.

7.4.2.3 The hardness shall not exceed 260 HV 10 (R  $_{2}$  24).

# 7.4.3 Notch Ductility Tests

# 7.5 Production Procedure Test

# 7.5.1 Description

After production welding has commenced, two procedure qualification test welds shall be cut from the second day's production on each spread for each procedure being used by each Contractor. Welds which have been rejected on the basis of radiographic insepction shall not be used for these qualifying tests. It is intended that the selected test welds should be typical and as free as possible from defects resulting from welder technique.

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# 7.5.2 Testing

Each of two welds selected shall be tested in dccordance with Clause 4.6.4 of CSA Z184 or Clause 2.6 of API 1104. If both tests are successful, they will constitute the qualification of the production weld procedure for the grade, diameter, wall thickness, and pipe manufacturer tested. If one test fails, two additional test welds will be cut and tested. If both of these test welds are successful, the procedure will be approved. If one or both of these subsequent welds fail, all production welding will be stopped until successful production welding is achieved based on the qualified procedure.

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# 8. Qualification of Welders

# 8.1 General

Each welder shall be qualified in accordance with the applicable requirements of Clause 4.8 of CSA Z184, or Clause 3.0 of API 1104.

### 8.2 Single Qualification

A welder qualifying to the requirements of this clause shall make a test weld using a qualified procedure to join pipe nipples. Two welders may be tested on the same pipe nipples, each welder completing one-half of the test weld. The welders shall make a butt weld in the fixed position with the axis of the pipe in the horizontal plane.

### 8.3 Acceptance Tests

The weld shall be acceptable if it meets the requirements of Clause 4.8.4 of CSA Z184, or Clause 3.3 and Clause 3.4 of API 1104.

8.4 Qualification by Procedure Test

A welder who has successfully made an original Procedure Qualification Test is automatically qualified in that procedure.

# 9. Inspection and Testing of Production Welds

# 9.1 Requirements

Inspection and testing of production welds shall be in

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accordance with Clauses 4.10.2 and 4.11 of CSA Z184, or Clauses 5.0 and 6.0 of API 1104, plus the following explanatory and supplementary requirements.

# 9.2 Visual Inspection

All welds shall be visually inspected around the entire circumference of the weld.

# 9.3 Nondestructive Testing

Nondestructive testing shall consist of radiographic and/or ultrasonic inspection or other Arctic Gas specified methods. The method used shall produce indications of defects which can be accurately interpreted and evaluated. The welds shall be evaluated on the basis of the "Standards of Acceptability - Nondestructive Testing", Clause 10 of this Specification. Welds not meeting the requirements of the method by which they are inspected shall be rejected.

### 9.4 Welds to be Nondestructively Tested

All welds shall be inspected by a nondestructive testing method.

### 9.5 Welds Removed from Line for Testing

Welds may be cut and tested as required by Arctic Gas. The specimens cut to test a welder's work shall be prepared and tested according to the requirements of the Welder Qualification Test. Trepanning methods shall not be used.

# 10. Standards of Acceptability - Nondestructive Testing

### 10.1 General

The standards of acceptability shall be in accordance with Clause 4.11 of CSA Z184 in Canada or with Clause 6.0 of API 1104 in Alaska, plus the following explanatory and supplementary requirements.

### 10.2 Undercutting

Undercutting adjacent to either the cover pass or adjacent to the root bead on the inside of the pipe shall be acceptable only as follows:

# Depth

### Length

Over 1 mm 0.5 mm to 1 mm Less than 0.5 mm

None 50 mm Any length

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# 11. Radiographic Procedure

# 11.1 General

The radiographic procedure shall be in accordance with the applicable provisions of CSA Z184 or API 1104 in Alaska.

### 11.2 Identification Markers

Identification markers at 150 mm intervals shall be used with the "zero" marker at the top "button".

# 11.3 Film Density

Film shall be exposed so that the density shall be between 1.3 and 1.8 throughout the weld. The unexposed base density of the film shall not exceed 0.30.

### 11.4 Penetrameters

Penetrameters shall be used for each radiograph. Each film shall have at least two penetrameters. If a single film is used about the pipe periphery, penetrameters shall not be more than 500 mm apart.

# 11.5 Radiographic Procedure Qualification

- 11.5.1 The radiographic procedure shall be recorded and qualified in accordance with Clauses 8.3 and 8.31 of API 1104.
- 11.5.2 A sample of the qualification radiographs, together with a copy of the procedure qualification shall be available for use as a guide for judging the quality of production radiographs.
- 11.5.3 The radiographic procedure qualification shall be repeated at the option of Arctic Gas whenever any change has been made in the operating technique, or whenever production films vary appreciably in detail, contrast, or density from the Standard Test Radiograph.

# 11.6 Radiographic Reports

The radiographer shall provide a daily record on the report form provided. Each radiograph shall have a consecutive number and the report form shall show the analysis of the radiograph, divided into quarters, throughout the circumference of the pipe, together with a recommendation showing whether the weld

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so examined was within specification or beyond specification. The Arctic Gas welding inspector shall show the disposition of all welds having defects greater than permitted by this Specification.

# 12. Repair or Removal of Girth Weld Defects

# 12.1 General

Repair or removal of defects shall be in accordance with Clause 4.12 of CSA Z184, or Clause 7.0 of API 1104, plus the following clarifications and supplementary requirements.

# 12.2 Corrections During Welding

Correction of an individual bead during deposition of the original weld prior to the laying of a succeeding bead is not considered repair of a defect under this Specification. Stripper beads, which may be necessary to fill the sides of the cover pass, may be deposited upon completion of the original weld. Stripper beads added later, after the weld has cooled down, shall be treated as weld repairs except that their lengths are not limited to 300 mm. Any other repairs require Arctic Gas approval.

# 12.3 Repair Requirements

- 12.3.1 Defects beneath the surface of the cover pass may be repaired in accordance with the requirements of Clause 4.12 of CSA Z184 or Clause 7.0 of API ll04, and the supplementary requirements of this Specification.
- 12.3.2 The defect(s) shall be removed by grinding without cutting completely through the weld.
- 12.3.3 The maximum length of any single repair shall be 300 mm and the minimum length, 50 mm. The minimum distance between any two repairs shall be 300 mm, the total length of repairs in any weld shall not exceed 600 mm.
- 12.3.4 Weld repairs shall be made by the Shielded Metal-Arc process using low hydrogen type electrodes or by the Gas Metal-Arc process.
- 12.3.5 Before repairs are made, the location and limits of the defect(s) shall be accurately marked on the weld. Then the defect(s) shall be entirely removed to clean metal by grinding.

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- 12.3.6 Repair areas shall be preheated. An area covering a minimum of 100 mm on each side of the repair shall be preheated to the temperature specified and maintained during repair welding. The temperature shall be checked by the use of temperatureindicating crayons.
- 12.3.7 All repair cavities shall be not less than 50 mm in length. All repairs shall be made with a minimum of two passes. The start and stop of repair passes shall not be superimposed over the start and stop of the preceding repair pass. The start and stop of each repair pass shall be ground smooth. The completed repair shall be ground to conform to the surface of the original cover pass:
- 12.3.8 All repairs shall meet the requirements of Clauses 9 and 10 of this Specification.
- 12.3.9 No second repairs shall be made.
- 12.4 Backwelding
  - 12.4.1 Defects on the internal surface of the weld, such as burn-throughs, craters, incomplete fusion or penetration, or root bead undercut, may be repaired by backwelding in compliance with the repair welding requirements of this Specification and the applicable Standards, after preheating (if required), and with the following requirements and/or limitations:
    - A given repair area may consist of one or more defects.
    - b. For any repair area 100 mm or longer, a new rod shall be used for each bead.
    - c. Ends of the completed repair shall extend beyond the ends of the original defective area and shall be ground to a smooth contour blending into the surface of the original root bead pass.
    - d. Any notches resulting from backwelding shall be removed by grinding, including those occurring along the edges of the backweld. The completed backweld shall be cleaned.
    - e. Repairs shall be subject to inspection by Arctic Gas.
  - 12.4.2
- 4.2 Hi-Lo resulting in incomplete penetration may be repaired by backwelding at least 150 mm beyond both ends of the defect.

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### 12.5 Testing of Repairs

Repaired areas shall be re-radiographed or inspected by the same means previously used.

- 12.6 Arc Burns
  - 12.6.1 An arc burn is defined as an area outside the weld where an arc has been struck either by the welding electrode, by a connection in the weld leads or by the grounding clamp. This does not include "trail" where a perceptible indentation has not occurred, or spatter (scattered spherical particles of weld metal). Trail, where a perceptible indentation is present, shall be considered an arc burn under this Specification.
  - 12.6.2 Arc burns shall not be permitted. Arc burns in pipe shall be removed by cutting out cylinders containing the arc burns.
  - 12.6.3 Arc burns in a heavy fitting shall be inspected by Arctic Gas who shall run necessary tests to determine if the fitting can be repaired or must be replaced.

### 12.7 Partial Removal of Weld

The cut-out portion of a weld shall be sufficiently deep and long to remove the defect. At the ends and sides of the cut there shall be a gradual taper from the base of the cut to the outside surface of the weld metal or pipe. The cut profile shall give adequate access for re-welding. When the root of the weld is accessible from the bore of the pipe, a repair to the root may be made by backwelding.

- 12.8 Complete Removal of Weld
  - 12.8.1 Entire welds shall be removed by torch cutting and it is required that a cylinder of pipe containing the weld be cut out not less than 25 mm on either side of the weld. When torch cutting is used, the appropriate preheating shall be applied.
  - 12.8.2 Where a cut has been made through a faulty weld and there has been no serious loss of pipe length, the replacement weld shall be made in accordance with the requirements of this Specification.
  - 12.8.3 Where a cylinder of pipe containing a faulty weld has been removed, a new cylinder of pipe not less than two pipe diameters in length shall be inserted and the two joints required shall be made in accordance with the requirements of this Specification.

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# , CANADIAN ARCTIC GAS STUDY LIMITED ALASKAN ARCTIC GAS PIPELINE LIMITED

SPECIFICATION FOR DOUBLE JOINTING PIPE SPECIFICATION NO. 2950-6-13 REVISION 1

### 1. General

# 1.1 Scope

This Specification covers the double jointing of pipe for a gas pipeline from Prudhoe Bay, Alaska and the Mackenzie River delta region, to the southern part of Canada.

### 1.2 Definitions

The term "Arctic Gas" as used in this Specification shall mean Canadian Arctic Gas Pipeline Limited or Alaskan Arctic Gas Pipeline Company, including their engineering agencies, inspectors and other authorized representatives.

# 1.3 Requirements and Regulations

In Canada, the welding shall be in accordance with the requirements of CSA Standard Z184 - 1973, "Gas Transmission and Distribution Piping Systems". In Alaska, the welding shall be in accordance with the requirements of Part 192, Title 49, Code of Federal Regulations, "Transportation of Natural and Other Gas by Pipeline", and API Standard 1104 (13th Edition, July 1973), "Standard for Welding Pipe Lines and Related Facilities".

# 1.4 Low Temperature Service

The low design temperatures for the pipeline require low temperature notch toughness properties (see Clause 4.4.3 of this Specification) in the girth weld and heat-affected zone. Special techniques may be needed to achieve these properties.

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### 2. Method

# 2.1 Circumferential Welds

The circumferential weld shall be made by automatic submergedarc welding using multiple weld passes, one of which at a minimum shall be on the inside of the pipe. Other processes may be acceptable with the prior approval of Arctic Gas.

# 2.2 Offset of Longitudinal Welds

The longitudinal welds in the jointer length shall be positioned 150 to 200 mm apart.

# 3. Pipe

# 3.1 Specifications

The pipe will be Grade 65 and 70 conforming to Canadian Arctic Gas Study Limited Pipe Specifications 2950-6-6, "Specification for Mainline Pipe", and 2950-6-7, "Specification for Large Diameter Pipe for -30C Service", or Grades X65 and X70 conforming to Alaskan Arctic Gas Pipeline Company Specifications 2950-6-6, "Specification for Mainline Pipe", and 2950-6-7, "Specification for Large Diameter Pipe for -30C Service".

# 3.2 Pipe Diameters and Wall Thicknesses

This specification is for the welding of the following pipe sizes: 762 mm (30 in) to 1219 mm (48 in) with nominal wall thicknesses up to and including 31.8 mm.

### 4. Procedure Qualification Tests

# 4.1 Requirements

The qualification of the welding procedures shall be in accordance with Clause 4.6 of CSA Standard Z184, or Clause 2 of API Standard 1104, with the following additions.

# 4.2 Procedure Development

4.2.1 Arctic Gas will conduct welding tests under the expected adverse temperature and weather conditions to set limits on the welding practices and to establish welding procedures to be used, which will be furnished the Contractors on a recommendation basis. The Contractors will assume all responsibility in the use of such welding procedures.

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4.2.2 In lieu of the use of these procedures, a Contractor may propose procedures developed by himself. All procedures proposed by Contractors for use on this pipeline shall be submitted for consideration to Arctic Gas. This includes any special procedures such as tie-in welds. The welding procedure qualification tests shall be conducted at a mutually satisfactory location in the presence of an Arctic Gas representative.

# 4.3 Grouping of Variables

Procedure Qualification Tests are required for maximum thickness of all grades of steel and pipe diameters from each manufacturer. No other grouping is permitted. Any change in pipe steel, diameter, manufacturer, or grade and any change in filler metal in production shall require regualification.

# 4.4 Testing of Procedure Qualification Weld

# 4.4.1 Test Requirements

The testing of the procedure qualification butt weld shall be in accordance with the requirements of Clause 4.6 of CSA Z184, or Clause 2.6 of API 1104, plus the hardness survey shown in Clause 4.4.2 and the notch ductility tests shown in Clause 4.4.3 of this Specification. The hardness survey and notch ductility tests will be made on specimens removed from at least one procedure qualification weld made at the lowest temperature permitted by the procedure on pipe from each manufacturer.

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# 4.4.2 Hardness Survey

A transverse section of the weld shall be removed from a location chosen by Arctic Gas and shall be prepared for testing by machining, grinding, and polishing. Care should be taken to remove a minimum of 5 mm from any torch-cut surface. The polished cross section of the weld shall be given a light etch. Three hardness traverses should be made with indentations at approximately 2 mm intervals. One traverse shall be made across the middle of the weld, and the other two approximately 3 mm in from the inside and outside surfaces. Additional spots shall be checked to assure that the maximum hardness in the heat-affected zone is adequately measured. The hardness shall not exceed 260 HV 10 (R 24).

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# 5. Qualification of Welding Machine Operators

Before any production welding is performed, each machine operator shall be qualified by making a complete weld with the approved procedure and the weld tested in accordance with the welder qualification requirements of CSA Z184, or of API 1104. During the qualification welding, the operator shall demonstrate that he is proficient with the operation of the equipment and shall make the necessary machine adjustments without assistance.

# 6. Inspection and Testing of Production Welds

### 6.1 Requirements

Inspection and testing of production welds shall be in accordance with Clauses 4.10.2 and 4.11 of CSA Z184, or of Clauses 5.0 and 6.0 of API 1104, plus the following explanatory and supplementary requirements.

### 6.2 Visual Inspection

All welds shall be visually inspected around the entire circumference of the weld.

# 6.3 Nondestructive Testing

Nondestructive testing shall consist of radiographic and/or ultrasonic inspection or other Arctic Gas specified methods. The method used shall produce indications of defects which can be accurately interpreted and evaluated. The welds shall be evaluated on the basis of the "Standards of Acceptability

2950-6-13 March 7, 1975 - Nondestructive Testing", Clause 7.0 of this Specification. Welds not meeting the requirements of the method by which they are inspected shall be rejected.

# 6.4 Welds to be Nondestructively Tested

All welds shall be inspected by a nondestructive testing method.

### 6.5 Welds Removed from Line for Testing

Welds may be cut and tested as required by Arctic Gas. The specimens cut to test a welder's work shall be prepared and tested according to the requirements of the Welder Qualification Test. Trepanning methods shall not be used.

### 6.6 Straightness

Straightness shall be in accordance with Clause 8,6 of CSA Z245.1, or with Clause 6.6 of API 5LX or 5LS applied to the entire jointer length.

# 7. Standards of Acceptability - Nondestructive Testing

# 7.1 General

The standards of acceptability shall be in accordance with Clause 4.11 of CSA Z184, or Clause 6.0 of API 1104, plus the following explanatory and supplementary requirements.

# 7.2 Undercutting

Undercutting adjacent to either the cover pass or adjacent to the root bead on the inside of the pipe shall be acceptable only as follows:

Depth	Length	
Over 1 mm	None	
0.5 mm to 1 mm	50 mm	
Less than 0.5 mm	Any length	

# 8. Radiographic Procedure

8.1 General

The radiographic procedure shall be in accordance with the applicable provisions of CSA Z184, or API 1104.

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# 8.2 Identification Markers

Identification markers at 150 mm intervals shall be used with the "zero" marker at the top "button".

# 8.3 Film Density

Film shall be exposed so that the density shall be between 1.3 and 1.8 throughout the weld. The unexposed base density of the film shall not exceed 0.30.

# 8.4 Penetrameters

Penetrameters shall be used for each radiograph. Each film shall have at least two penetrameters. If a single film is used about the pipe periphery, penetrameters shall not be more than 500 mm apart.

# 8.5 Radiographic Procedure Qualification

- 8.5.1 The radiographic procedure shall be recorded and qualified in accordance with Clauses 8.3 and 8.31 of API 1104.
- 8.5.2 A sample of the qualification radiographs, together with a copy of the procedure qualification, shall be available for use as a guide for judging the quality of production radiographs.
- 8.5.3 The radiographic procedure qualification shall be repeated at the option of Arctic Gas whenever any change has been made in the operating technique, or whenever production films vary appreciably in detail, contrast, or density from the Standard Test Radiograph.

### 8.6 Radiographic Reports

The radiographer shall provide a daily record on the report form provided. Each radiograph shall have a consecutive number and the report form shall show the analysis of the radiograph, divided into quarters, throughout the circumference of the pipe, together with a recommendation showing whether the weld so examined was within specification or beyond specification. The Arctic Gas welding inspector shall show the disposition of all welds having defects greater than permitted by this Specification.

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### 9. Repair or Removal of Girth Weld Defects

# 9.1 General

Repair or removal of defects shall be in accordance with Clause 4.12 of CSA Z184, or Clause 7.0 of API 1104, plus the following clarifications and supplementary requirements.

### 9.2 Correction During Welding

Correction of an individual bead during deposition of the original weld prior to the laying of a succeeding bead is not considered repair of a defect under this Specification. Stripper beads, which may be necessary to fill the sides of the cover pass, may be deposited upon completion of the original weld. Stripper beads added later, after the weld has cooled down, shall be treated as weld repairs except that their lengths are not limited to 300 mm. Any other repairs require Company approval.

### 9.3 Repair Requirements

9.3.1 Defects beneath the surface of the cover pass may be repaired in accordance with the requirements of Clause 4.12 of CSA Z184, or Clause 7.0 of API 1104, and the supplementary requirements of this Specification.

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- 9.3.2 The defect(s) shall be removed by grinding without cutting completely through the weld.
- 9.3.3 The maximum length of any single repair shall be 300 mm and the minimum length, 50 mm. The minimum distance between any two repairs shall be 300 mm. The total length of repairs in any weld shall not exceed 600 mm.
- 9.3.4 Weld repairs shall be made by the Shielded Metal-Arc process, using low hydrogen type electrodes or by the Gas Metal-Arc process.
- 9.3.5 Before repairs are made, the location and limits of the defect(s) shall be accurately marked on the weld. Then the defect(s) shall be entirely removed to clean metal by grinding.
- 9.3.6 Repair areas shall be preheated. An area covering a minimum of 100 mm on each side of the repair shall be preheated to the temperature specified and maintained during repair welding. Temperature shall be checked by the use of temperature-indicating crayons.

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- 9.3.7 All repair cavities shall be not less than 50 mm in length. All repairs shall be made with a minimum of two passes. The start and stop repair passes shall not be superimposed over the start and stop of the preceding repair pass. The start and stop of each repair pass shall be ground smooth. The completed repair shall be ground to conform to the surface of the original cover pass.
- 9.3.8 All repairs shall meet the requirements of Clauses 6 and 7 of this Specification.
- 9.3.9 No second repairs shall be made.

### 9.4 Testing of Repairs

Repair areas shall be x-rayed.

### 9.5 Arc Burns

An arc burn is defined as an area outside the weld where an arc has been struck, either by the welding electrode, by a connection in the weld leads, or by the grounding clamp. This does not include "trail" where a perceptible indentation has not occurred, or spatter (scattered spherical particles of weld metal). Trail, where a perceptible indentation is present, shall be considered an arc burn under these specifications. Arc burns shall not be permitted. Arc burns in pipe shall be removed by cutting out cylinders containing the arc burner.

# 9.6 Partial Removal of Weld

The cut-out protion of a weld shall be sufficiently deep and long to remove the defect. At the ends and sides of the cut there shall be a gradual taper from the base of the cut to the outside surface of the weld metal or pipe. The cut profile shall give adequate access for re-welding.

# 9.7 Complete Removal of Weld

Entire welds shall be removed by torch cutting, and it is required that a cylinder of pipe containing the weld be cut out not less than 25 mm on either side of the weld. When torch cutting is used, the appropriate preheating shall be applied. The replacement weld shall be made in accordance with the requirements of this Specification.

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# CANADIAN ARCTIC GAS PIPELINE LIMITED ALASKAN ARCTIC GAS PIPELINE COMPANY

Specification for the Welding of Prefabricated Piping Specification 2950-6-14 Revision 1

# General

1.

### 1.1 Scope

This Specification covers the welding of prefabricated piping assemblies to be installed in compressor stations, chilling stations, and at any other locations where prefabricated piping will be used along a large diameter gas pipeline extending from Prudhoe Bay, Alaska, and the Mackenzie River delta region, to the southern part of Canada. It will include the prefabrication of branch connections, and prefabricated assemblies of attachments to fittings and valves.

### 1.2 Definitions

The term 'Arctic Gas' as used in this Specification shall mean Canadian Arctic Gas Pipeline Limited or Alaskan Arctic Gas Pipeline Company, including their engineering agencies, inspectors and other authorized representatives.

# 1.3 Requirements and Regulations

In Canada the welding shall be in accordance with the requirements of CSA Standard Z184 - 1973, "Gas Transmission and Distribution Piping Systems". In Alaska the welding shall be in accordance with the requirements of Part 192, Title 49, Code of Federal Regulations, "Transportation of Natural and Other Gas by Pipelines" and API Standard 1104 (13th Edition, July 1973) "Standard for Welding Pipe Lines and Related Facilities".

# 1.4 Low Temperature Service

Most of the piping will be made from steels with superior low temperature properties as indicated by their notch toughness (Charpy V impact properties) at low temperatures. Special welding procedures may be required to maintain notch toughness properties in the heat-affected zone and to obtain them in the weld metal. (See Clause 7.5.3 of this Specification for notch toughness requirements.)

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# 2. Pipe and Fittings

The pipe and fittings to be welded are:				
2950-6-6 Mainline Pipe				
2950-6-7	Large Diameter Pipe for -30C Service			
2950-6-9	Large Diameter Pipe for -50C Service			
2950-6-4	Seamless Pipe			
2950-6-1	Pipeline and Compressor Station Valves - 16" and Larger			
2950-6-10	Valves - 14" and Under			
2950-6-11	Butt Welding Fittings 12" or Larger for Use with High Yield Pipe			
2950-6-8	Small Fittings			
2950-6-5	Forged Steel Pipe Flanges			
Line-Up				

3.1 Tack Welds

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Full fusion at the root is required for tack welds. The length of tack welds shall not be less than 5 percent of the diameter of the pipe with a minimum length of 20 mm. Tack welds so prepared may be incorporated into the body of the weld by fusion, provided the start and finish are ground to feather edges to allow proper fusion. Portions of tack welds exhibiting cracks or unsoundness must be ground out. Tack welds shall be made by qualified welders and deposited in accordance with the approved welding procedure. When the procedure requires preheat, the temperature stipulated shall be obtained prior to tack welding and maintained during the welding operation.

# 3.2 Distance Between Welds

3.2.1 Longitudinal welds in adjacent lengths of longitudinally welded pipe shall be offset by a minimum of 150 mm. For spiral welded pipe, the offset shall also be a minimum of 150 mm.

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- 3.2.2 Where branch connections or fittings are located closely together, there must be adequate clearance between fittings for ease of welding and the distance between the toe of the welds on the surface of the pipe shall be a minimum of half the diameter of the larger branch with a minimum of 100 mm.
- 3.2.3 Branches, fittings, and attachments shall not be located on longitudinal, spiral or circumferential weld seams.

### 3.3 Pipe of Different Inside Diameters

3.3.1 For pipe of the same nominal outside diameter but different inside diameters because of specified wall thickness differences greater than 1.5 mm, the smaller diameter shall be machined, ground, or filed with a taper not steeper than one in four to obtain the alignment specified in the welding procedure.

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- 3.3.2 If the internal diameter of the pipe affords access, the offset may be backwelded as permitted in Clause 12.3 of this Specification.
- 4. Welding Processes

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4.1 Acceptable Processes and Qualifications

The welding may be done by the Manual Shielded Metal-Arc process using coated electrodes, Submerged Arc Welding, Gas Metal-Arc welding, Tungsten Inert Gas welding, or combinations of these processes, and by Gas welding.

### 4.2 Manual Shielded Metal-Arc Process

### 4.2.1 Direction of Welding

The direction of welding shall be vertical up, except that vertical down welding may be used when approved by Arctic Gas, provided the welding procedure has been qualified as required by Clause 7 and the welders qualified in accordance with Clause 8 of this Specification.

### 4.2.2 Electrodes

Low hydrogen electrodes shall be used unless approved by Arctic Gas. The strength of the weld shall be compatible with the base metal.

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### 4.3 Shielding Gases

Shielding gases shall exhibit a water dew point of -40C or lower.

# 5. Welding

5.1 Grounding Clamps

Grounding clamps shall be made of steel and shall have solid contact with the pipe to prevent the possibility of arc burns. Copper or copper alloys shall not be used.

# 5.2 Weld Bead Thickness

Each weld bead shall be 3 mm or less in thickness.

5.3 Cleaning

All foreign materials, such as mud, oil, grease, shop paint, etc. shall be removed from both internal and external pipe surfaces for a sufficient distance from the proposed weld to prevent deleterious effects.

# 5.4 Grinding the Root Pass

The root pass shall be cleaned and contour ground to remove undercutting, rough surfaces and other defects, using a 4 or 5 mm thick grinding wheel. Power driven buffers shall be used to clean filler and cap passes. All flux, slag, and spatter shall be removed from the completed weld area.

### 5.5 Removal of Defects

- 5.5.1 All visible defects and starts and stops with high points must be removed from root, intermediate, and final passes by grinding. Particular attention shall be paid to the cleanliness of the junctions between the weld metal and the fusion faces before deposition of further weld metal.
- 5.5.2 Solidified metal "icicles" on the inside and projecting micro wire shall be removed by grinding.

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# 5.6 Stray Arcs

Arcs shall only be struck on fusion faces and accidental contact of the electrode or of the non-insulated parts of electrode holders with the outer surface of the pipe shall be avoided. Electrode holders should be of the fully insulated type.

# 5.7 Marking of Welds

- 5.7.1 Each welder shall mark his welds or portions of welds with a unique identification symbol, using chalk or grease-free crayon. (Keel will not be permitted.)
- 5.7.2 Each welder of root beads shall place his symbol at the beginning of the upper half of the section he has worked on and all other welders shall place their symbols at an appropriate place beneath those markings.
- 5.7.3 Under no circumstances shall any welder change the symbol assigned to him for the duration of the entire construction period. When any welder is terminated, his symbol shall not be used again by any other welder employed.

# 5.8 Work Stoppages

- 5.8.1 In the event of work stoppages, or in those cases where the weld cannot be completed before the end of the work period, the partially completed weld shall contain at least three passes and shall be protected with a heavy asbestos band to prevent rapid cooling.
- 5.8.2 Before the restart of welding and where preheat was originally required, the entire weld area for a minimum distance of 100 mm on each side of the weld shall be preheated to the minimum preheat temperature.

### 6. Heat Treatment

# 6.1 Heating and Cooling Methods

Heat treatment may be accomplished by a suitable heating method that will provide the required metal temperature, metal temperature uniformity, and temperature control, such as an enclosed furnace, local fuel firing, electric resistance or electric induction. Cooling may be accomplished in a furnace, in air, with the aid of local thermal control, with the application of heat or insulation, or in any other manner required to achieve the desired cooling rate.

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# 6.2 Preheating

# 6.2.1 General

The need for preheating will depend upon the welding process selected, pipe wall thickness, chemical composition of the steel, and the ambient temperature. The welding procedure shall specify the preheating requirements that are to be followed when the composition of the steel is such that preheating is necessary. The Procedure Qualification Test shall have demonstrated that acceptable quality welds will be produced when complying with the <sup>/</sup> preheat requirements shown in the welding procedure. Additionally, preheat shall be used when directed by Arctic Gas.

### 6.2.2 Preheat Temperature

When preheat is required, the joint shall be uniformly heated throughout the wall thickness for a minimum width of 100 mm on each side of the weld to the temperature required by the Procedure Qualification Test.

# 6.2.3 Dissimilar Steels

When welding dissimilar steels having different preheat requirements, the higher preheat temperature shall govern.

# 6.2.4 Interpass Temperature

Construction practice shall be such that the temperature prior to the application of the second pass shall not fall below that established by the Procedure Qualification Test.

# 6.2.5 Measurement of Preheat Temperature

6.2.5.1 The preheat temperature shall be checked by the use of temperature-indicating crayons, thermocouple pyrometers, or other suitable methods to assure that the required preheat temperature is obtained prior to and maintained during the welding operation.

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- 6.2.5.2 Some types of crayon will not show, once the temperature has been reached, that this temperature is being maintained. In these cases the crayon has to be re-applied if continued temperature observations are to be made.
- 6.2.5.3 When it is required to bracket the preheat temperature, both low and high indicating crayons shall be used.

# 6.2.6 Delays in Welding

If welding is interrupted, or if the weld is allowed to cool prior to postheat treatment, adequate heat treatment or a controlled cooling rate shall be effected to assure that there are no detrimental effects to the weld.

# 6.3 Postweld Heat Treatment (Stress Relieving)

# 6.3.1 General

Postheat treatment shall be performed as necessary to restore or obtain the physical properties (such as strength, ductility, and corrosion resistance, or a combination of these) with respect to material, design, and end use requirements, Physical property requirements shall determine the treatment to be performed, such as stress relief, temper, anneal, or normalize. Postheat treatment of welds shall be compatible with the analysis of the base materials being joined and the weld deposit.

# 6.3.2 Requirements

Postweld heat treatment shall be performed when required by the applicable codes and regulations shown in Clause 1.3 of this Specification. In addition, postweld heat treatment will be required as follows unless agreed otherwise in writing with Arctic Gas:

- a. For all steels except austenitic stainless steels, of a nominal thickness in excess of 31.75 mm.
- b. For welds in piping containing the nickel steels referred to in the following specifications:

2950-6-9 Large Diameter Pipe for -50C Service (all steels).

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2950-6-4 Seamless Pipe - Type III

2950-6-11 Butt Welding Fittings 12" or Larger for use with High Yield Pipe - Type I 2950-6-8 Small Fittings - Type III 2950-6-5 Forged Steel Pipe Flanges - Type II

c. When specified on the drawing.

### 6.3.3 Temperature and Soaking Period

The necessity for postheat treatment of welds, and the temperature and soaking period to be used in order to comply with Clause 6.3.1, shall be established by the Procedure Qualification Test. Regardless of the postheat treatment used, the physical property requirements of Clause 7.5 shall govern.

# 6.3.4 Special Considerations

Temperatures for postweld heat treatments and time at temperature will be as shown on the shop drawings. The temperatures for postheat treatment of carbon steel are usually 600 to 650C, but lower temperatures may be required for some of the piping so as not to exceed tempering temperatures. In such cases, good practice is to limit the temperature to 50C below the tempering temperature. Welds in austenitic stainless steels do not normally require heat treatment.

# 6.3.5 Heating and Cooling Rates

Above 300C the rate of heating shall be less than 200C per hour. Above 300C, the cooling rate shall be less than 250C per hour. Below 300C, the cooling may be in still air.

# 6.3.6 Heating Methods

The heating method selected for restoration of physical properties desired for parts of an assembly shall accomplish this result without adversely affecting other components. Heating a fabricated assembly as a complete unit is usually desirable; however, the size or shape of the unit or the adverse effect of a desired heat treatment on one or more components where dissimilar materials are involved, may dictate alternative procedures such as heating a section of the assembly

2950-6-14 March 6, 1975 before the attachment of others, or local circumferential band heating of welded joints in accordance with Clause 6.3.9 of this Specification.

# 6.3.7 Dissimilar Steels

Postheat treatment of welded joints between dissimilar steels having different postheat requirements shall be that established in the Procedure Qualification Test.

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### 6.3.8 Thickness

If thickness is a factor in determining the requirement for postheat treatment, the nominal pipe wall thickness of the thicker pipe shall govern. For fillet welds, including those for attachment of external non-pressurecontaining parts such as lugs or other pipe supporting elements, the required throat thickness of the fillet weld shall govern.

# 6.3.9 Local Postheat Treatment

- 6.3.9.1 Local postheat treatment of welded joints shall require the entire band to be brought up to a uniform temperature over the circumference of the heated pipe section, with a gradual diminishing of temperature outward from the band.
- 6.3.9.2 When locally heat treating a circumferential weld, the minimum width of the band centered on the weld shall be the larger of:
  - a. Twice the width of the weld reinforcement.
  - b. Width of weld reinforcement plus 50 mm.
- 6.3.9.3 When locally heat treating welded branch connections or other attachments, a circumferential band of the pipe to which the branch or attachment is welded shall be heated to the desired temperature. The width of this band shall extend at least 25 mm beyond the weld joining the branch or attachment to the pipe.

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# 6.3.10 Temperature Checking

Postheat treatment temperatures shall be checked by the use of thermocouple pyrometers or other suitable methods to assure that the requirements established by the procedure specification are accomplished.

6.3.11 Recording of Information

6.3.11.1 The following information shall be recorded by the use of permanent recordings:

a. Heating rate, maximum temperature.

b. Cooling rate.

- 6.3.11.2 The recordings should be made with equipment having the following characteristics:
  - a. Continuous recording.
  - b. Accuracy of recorder (+ 10C)
  - c. Scale on recorder.

0-800C minimum range

0-1000C maximum range

- 7. Qualification of Welding Procedures
  - 7.1 Requirements

The qualification of the welding procedures for use in Canada shall be in accordance with Clause 4.6 of CSA Standard 2184, and in Alaska in accordance with Clause 2.0 of API Standard 1104, with the following additions.

# 7.2 Procedure Development

7.2.1 Arctic Gas will conduct welding tests under the most severe conditions that would be allowed. These tests would set limits on the welding practices and establish qualified welding procedures. These will be furnished the Manufacturers on a recommendation basis. The Manufacturers will assume all responsibility in the use of such welding procedures.

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7.2.2 In lieu of the use of these procedures, a Manufacturer may propose procedures developed by himself. All procedures proposed by the Manufacturer shall be submitted for consideration to Arctic Gas. The welding procedure qualification tests proposed by the Manufacturer shall be conducted in the presence of Arctic Gas with adequate notice being given of test dates.

# 7.3 Dissimilar Steels

Special procedures may be required to weld some of the dissimilar steel combinations.

# 7.4 Grouping of Variables

Procedure Qualification Tests are required for the maximum thickness of all grades of steel, unless written approval is received from Arctic Gas.

### 7.5 Testing of Welding Procedure Test Joint - Butt Welds

### 7.5.1 Testing Requirements

All test welds shall be on pipe. The type and number of test specimens shall be in accordance with requirements of Clause 4.6 of CSA Z184 or Clause 2.6 of API 1104 in Alaska, with the added requirements shown in Clauses 7.5.2 and 7.5.3 of this Specification.

# 7.5.2 Hardness Survey

- 7.5.2.1 A transverse section of the weld shall be removed from a location chosen by Arctic Gas and shall be prepared for testing by machine, grinding, and polishing. Care should be taken to remove a minimum of 5 mm from any torch-cut surface. The polished cross section of the weld shall be given a light etch.
- 7.5.2.2 Three hardness traverses shall be made with indentations at approximately 2 mm intervals. One traverse shall be made across the middle of the weld, and the other two approximately 3 mm in from the inside and outside surfaces. Additional spots shall be checked to assure that the maximum hardness in the heat-affected zone is measured.

7.5.2.3 The hardness shall not exceed 260 HV 10 (R 24).

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# 7.5.3 Notch Ductility Tests

# 8. Qualification of Welders

# 8.1 General

Each welder shall be qualified in accordance with the applicable requirements of Clause 4.8 of CSA Z184 or Clause 3.0 of API 1104.

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# 8.2 Single Qualification

A welder qualifying to the requirements of this paragraph shall make a test weld using a qualified procedure to join pipe nipples. Two welders may be tested on the same pipe nipples, each welder completing one-half of the test weld.

### 8.3 Acceptance Test

The weld shall be acceptable if it meets with the requirements of Clause 4.8.4 of CSA Z184 or Clauses 3.3 and 3.4 of API Standard 1104.

# 8.4 Qualification by Procedure Test

A welder who has successfully made an original Procedure Qualification Test is automatically qualified in that procedure.

# 9. Inspection and Testing of Production Welds

# 9.1 Requirements

Inspection and testing of production welds shall be in accordance with Clauses 4.10.2 and 4.11 of CSA Z184, or Clauses 5.0 and 6.0 of API 1104, plus the following explanatory and supplementary requirements.

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### 9.2 Visual Inspection

All welds shall be visually inspected around the entire circumference of the weld.

# 9.3 Nondestructive Testing

Nondestructive testing shall consist of radiographic and/or ultrasonic inspection or other Arctic Gas specified methods. The method used shall produce indications of defects which can be accurately interpreted and evaluated. The welds shall be / evaluated on the basis of the "Standards of Acceptability -Nondestructive Testing", Clause 10. of this Specification. Welds not meeting the requirements of the method by which they are inspected shall be rejected.

### 9.4 Welds to be Nondestructively Tested

All welds shall be inspected by a nondestructive testing method. In general, all butt welds will be radiographed and may be ultrasonically inspected. Fillet welds will be magnetic particle inspected and may be ultrasonically inspected. Special attention shall be given to the location, size and profile of fillet welds in order to orient the magnetic field perpendicular to the most likely cracking direction.

# 9.5 Welds Removed from Line for Testing

Welds may be cut and tested as required by Arctic Gas. The specimens cut to test a welder's work shall be prepared and tested according to the requirements of the Welder Qualification Test. Trepanning methods shall not be used.

# 10. Standards of Acceptability - Nondestructive Testing

### 10.1 General

The standards of acceptability shall be in accordance with Clause 4.11 of CSA Z184 or with Clause 6.0 of API 1104, plus the following explanatory and supplementary requirements.

### 10.2 Undercutting

Undercutting adjacent to either the cover pass or adjacent to the root bead on the inside of the pipe shall be acceptable only as follows:

### Depth

### Length

over 1 mm 0.5 mm to 1 mm Less than 0.5 mm None 50 mm Any length

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### 11. Radiographic Procedure

# 11.1 General

The radiographic procedure shall be in accordance with the applicable provisions of CSA Z184 or API 1104.

### 11.2 Identification Markers

Identification markers at 150 mm intervals shall be used with the "zero" marker at the top "button".

### 11.3 Film Density

Film shall be exposed so that the density shall be between 1.3 and 1.8 throughout the weld. The unexposed base density of the film shall not exceed 0.30

### 11.4 Penetrameters

Penetrameters shall be used for each radiograph. Each film shall have at least two penetrameters. If a single film is used about the pipe periphery, penetrameters shall not be more than 500 mm apart.

### 11.5 Radiographic Procedure Qualification

- 11.5.1 The radiographic procedure shall be recorded and qualified in accordance with Clauses 8.3 and 8.31 of API 1104.
- 11.5.2 A sample of the qualification radiographs together with a copy of the procedure qualification shall be available for use as a guide for judging the quality of production radiographs.
- 11.5.3 The radiographic procedure qualification shall be repeated at the option of Arctic Gas whenever any change has been made in the operating technique, or whenever production films vary appreciable in detail, contrast, or density from the Standard Test Radiograph.

### 11.6 Radiographic Reports

The radiographer shall provide a daily record on the report form provided. Each radiograph shall have a consecutive number and the report form shall show the analysis of the radiograph, divided into quarters, throughout the circumference of the pipe together with a recommendation showing whether the weld so

2950-6-14 March 6, 1975 examined was within specification or beyond specification. The Arctic Gas welding inspector shall show the disposition of all welds having defects greater than permitted by this Specification.

# 12. Repair or Removal of Weld Defects

# 12.1 General

Repair or removal of defects shall be in accordance with Clause 4.12 of CSA Z184 or Clause 7.0 of API 1104, plus the following clarifications and supplementary requirements.

# 12.2 Corrections During Welding

Correction of an individual bead during deposition of the original weld prior to the laying of a succeeding bead is not considered repair of a defect under this specification. Stripper beads, which may be necessary to fill the sides of the cover pass, may be deposited upon completion of the original weld. Stripper beads added later, after the weld has cooled down, shall be treated as weld repairs except that their lengths are not limited to 300 mm. Any other repairs require Arctic Gas approval.

# 12.3 Repair Requirements

- 12.3.1 Defects beneath the surface of the cover pass may be repaired in accordance with the requirements of Clause 4.12 of CSA Z184 or Clause 7.0 of API 1104 and the supplementary requirements of this Specification.
- 12.3.2 The defect(s) shall be removed by chipping, grinding, machining, air carbon arc, or torch gouging without cutting completely through the weld. The final repair area shall be ground to clean metal.
- 12.3.3 The maximum length of any single repair shall be 300 mm and the minimum length 50 mm. The minimum distance between any two repairs shall be 300 mm. The total length of repairs in any weld shall not exceed 600 mm.
- 12.3.4 Weld repairs shall be made by the Shielded Metal-Arc process using low hydrogen type electrodes or by the Gas Metal-Arc process, except that the same process used in making the original weld may be used in making the repair weld if approved by Arctic Gas.

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- 12.3.5 Before repairs are made, defects shall be entirely removed to clean metal by grinding in a manner acceptable to Arctic Gas.
- 12.3.6 Preheating of repair areas will be required. An area covering a minimum of 100 mm on each side of the repair shall be preheated to the temperature specified and maintained during repair welding. Temperatures shall be checked by the use of temperature-indicating crayons.
- 12.3.7 All repair cavities shall not be less than 50 mm in length. All repairs shall be made with a minimum of two passes. The start and stop of repair passes shall/ not be superimposed over the start and stop of the preceding repair pass. The start and stop of each repair pass shall be ground smooth. The completed repair shall be ground to conform to the surface of the original cover pass.
- 12.3.8 All repairs shall meet the requirements of Clauses 9 and 10 of this Specification.

12.3.9 No second repairs shall be made in these areas.

- 12.4 Backwelding
  - 12.4.1 Defects on the internal surface of the weld, such as burn-throughs, craters, incomplete fusion or penetration, or root bead undercut and defects in the weld may be repaired by backwelding provided the welding is performed in compliance with the welding requirements of this Specification and after preheating (if required), and with the following requirements and/or limitations:
    - a. A given repair area may consist of one or more defect.
    - b. For any repair area 100 mm or longer, a new rod shall be used for each bead.
    - c. Ends of the completed repair shall extend beyond the ends of the original defective area and shall be ground to a smooth contour blending into the surface of the original root bead pass.
    - d. Any notches resulting from backwelding shall be removed by grinding, including those occurring along the edges of the backweld. The completed backweld shall be cleaned.

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- e. Repairs shall be subject to inspection by Arctic Gas.
- 12.4.2 Hi-Lo resulting in incomplete penetration may be repaired by backwelding at least 150 mm beyond both ends of the defect.

### 12.5 Testing of Repairs

Repaired areas shall be re-radiographed, or inspected by the same means previously used.

### 12.6 Arc Burns

- 12.6.1 An arc burn is defined as an area outside the weld where an arch has been struck either by the welding electrode, by a connection in the weld leads or by the grounding clamp. This does not include "trail" where a perceptible indentation has not occurred, or spatter (scattered spherical particles of weld metal). Trail, where a perceptible indentation is present, shall be considered an arc burn under this Specification.
- 12.6.2 Arc burns shall not be permitted. Arc burns in pipe shall be removed by cutting out cylinders containing the arc burns.
- 12.6.3 Arc burns in a heavy fitting shall be inspected by Arctic Gas who shall run necessary tests to determine if the fitting can be repaired or must be replaced.

### 12.7 Partial Removal of Weld

The cut-out portion of a weld shall be sufficiently deep and long to remove the defect. At the ends and sides of the cut there shall be a gradual taper from the base of the cut to the outside surface of the weld metal or pipe. The cut profile shall give adequate access for re-welding. When the root of the weld is accessible from the bore of the pipe, a repair to the root may be made by backwelding.

### 12.8 Complete Removal of Weld

12.8.1 Entire welds shall be removed by torch cutting and it is required that a cylinder of pipe containing the weld be cut out not less than 25 mm on either side of the weld. When torch cutting is used, the appropriate preheating shall be applied.

- 12.8.2 Where a cut has been made through a faulty weld and there has been no serious loss of pipe length, the replacement weld shall be made in accordance with the requirements of this Specification.
- 12.8.3 Where a cylinder of pipe containing a faulty weld has been removed, a new cylinder of pipe of sufficient length to assure good line-up shall be inserted and the two weld joints required shall be made in accordance with the requirements of this Specification.

### 13. Drawings

An isometric line drawing will be prepared and furnished by Arctic Gas for each welded assembly to be fabricated. Shop drawings, showing bevels, weld details, dimensions, etc. shall be prepared by the Manufacturer for use in fabrication.

# 14. Tolerances

Most of the piping will be installed by welding. The diameter, out-ofroundness, and thickness tolerances of the specified pipe must therefore be maintained at the ends to be field welded.

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# CANADIAN ARCTIC GAS STUDY LIMITED ALASKAN ARCTIC GAS PIPELINE COMPANY

Specification for the Field Welding of Station and Other Special Piping Specification 2950-6-15 Revision 1

# General

1.

1.1 Scope

This Specification covers the field welding of compressor station and chilling station piping; the welding of above ground piping, and the welding of accessories such as blowdown piping, branch connections, fittings, and valves in the main line of a large diameter gas pipeline extending from Prudhoe Bay, Alaska, and the Mackenzie River delta region, to the southern part of Canada. Much of the piping will be prefabricated at either manufacturers' plants or at station sites in accordance with Specification 2950-6-14, "Specification for the Welding of Prefabricated Piping." This Specification covers the field welding required to install the prefabricated piping and all other field welding made in place except the welding of the main line, as covered by Specification 2950-6-12, "Specification for the Field Welding of the Main Line."

# 1.2 Definitions

The term "Arctic Gas" as used in this Specification shall mean Canadian Arctic Gas Pipeline Limited or Alaskan Arctic Gas Pipeline Company, including their engineering agencies, inspectors and other authorized representatives.

# 1.3 Requirements and Regulations

In Canada the welding shall be in accordance with the requirements of CSA Standard Z184 - 1973, "Gas Transmission and Distribution Piping Systems". In Alaska the welding shall be in accordance with the requirements of Part 192, Title 49, Code of Federal Regulations, "Transportation of Natural and Other Gas by Pipelines" and API Standard 1104 (13th Edition, July 1973) "Standard for Welding Pipe Lines and Related Facilities."

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### 1.4 Low Temperature Service

Most of the piping will be made from steels with superior low temperature properties as indicated by their notch toughness (Charpy V impact properties) at low temperatures. Special welding procedures may be required to maintain these properties in the heat-affected zone and to obtain them in the weld metal. (See Clause 7.5.3 of this Specification for notch toughness requirements).

# 2. Materials

The pipe, fittings and valves to be welded are:

2950-6-6 Mainline Pipe

- 2950-6-7 Large Diameter Pipe for -30C Service
- 2950-6-9 Large Diameter Pipe for -50C Service

2950-6-4 Seamless Pipe

2950-6-1 Pipeline and Compressor Station Valves - 16" and Larger

2950-6-10 Valves - 14" and Smaller

2950-6-11 Butt Welding Fittings 12" or Larger for Use with High-Yield Pipe

2950-6-8 Small Fittings

2950-6-5 Forged Steel Pipe Flanges

- 3. Line-Up
  - 3.1 Line-Up Clamps

The welds covered by this specification are fabrication welds, including many that join prefabricated assemblies. Line-up clamps should be used wherever practical.

# 3.2 Tack Welds

Full fusion at the root is required for tack welds. The length of tack welds shall not be less than 5 percent of the diameter of the pipe with a minimum length of 20 mm. Tack welds so prepared may be incorporated into the body of the weld by fusion, provided the start and finish are ground to feather

2950-6-15 March 7, 1975 edges to allow proper fusion. Portions of tack welds exhibiting cracks or unsoundness must be ground out. Tack welds shall be made by qualified welders and deposited in accordance with the approved welding procedure. When the procedure requires preheat, the temperature stipulated shall be obtained prior to tack welding and maintained during the welding operation.

### 3.3 Distance Between Welds

- 3.3.1 Longitudinal welds in adjacent lengths of longitudinally welded pipe shall be offset by a minimum of 150 mm and shall be in the upper half of the circumference. For spiral welded pipe, the offset shall also be a minimum of 150 mm. Exceptions to this may be necessary in pipe containing bends or prefabricated sections.
- 3.3.2 Where branch connections or fittings are located closely together, there must be adequate clearance between fittings for ease of welding and the distance between the toe of the welds on the surface of the pipe shall be a minimum of half the diameter of the larger branch with a minimum of 100 mm.
- 3.3.3 Branches, fittings, and attachments shall not be located on longitudinal, spiral or circumferential weld seams.

# 3.4 Hammering

Hammering during line-up shall be kept to a minimum and shall be done only with soft face hammers. Hammer faces shall be nickel overlaid with a minimum of four layers. The electrodes used shall conform to AWS E4N11 nickel welding rods. Once welding of the root bead is commenced, hammering of the pipe in that joint is prohibited.

### 3.5 Pipe of Different Inside Diameters

- 3.5.1 For pipe of the same nominal outside diameter but different inside diameters because of specified wall thickness differences greater than 1.5 mm, the smaller diameter shall be machined, ground, or filed with a taper not steeper than one in four to obtain the alignment specified in the welding procedure.
- 3.5.2 If the internal diameter of the pipe affords access, the offset may be backwelded as permitted in Clause 12.3 of this Specification.

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### 3.6 Damaged Pipe Ends

Bevelled ends with dents, nicks, cuts or other damage shall be repaired by cutting off a ring and rebevelling. No welding repairs shall be allowed on the end bevel of the pipe.

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# 8.7 Removal of Line-Up Clamps

- 3.7.1 When an internal line-up clamp is being used, the clamp shall not be removed before 100 percent of the root pass is completed and the pipe is properly supported. When conditions exist that put excessive stress on the weld, the hot pass shall be completed before removal of the clamp.
- 3.7.2 An external line-up clamp shall not be removed until the completed parts of the root pass, uniformly spaced, cover a minimum of about 75 percent of the circumference of the joint, and the pipe shall have been adequately supported on each side of the joint.

### Welding Processes

# 4.1 Acceptable Processes

The welding may be done by the Manual Shielded Metal-Arc process using coated electrodes, Semi-Automatic Gas Metal-Arc welding, Tungsten Inert Gas welding, or combinations of these processes and Gas welding.

### 4.2 Manual Shielded Metal-Arc Process

# 4.2.1 Direction of Welding

The direction of welding shall be vertical up, except that vertical down welding may be used when approved by Arctic Gas.

# 4.2.2 Electrodes

Low hydrogen electrodes shall be used unless approved otherwise by Arctic Gas. The strength of the weld shall be compatible with the base metal.

### 4.2.3 Root Pass and Second Pass Welders

A minimum of two welders shall be used on the root and second passes for welds on pipe 406 mm (16 - inch) in and larger, except as approved in writing by Arctic Gas. :ion

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5.6.2 Solidified metal "icicles" on the inside and projecting micro wire shall be removed by grinding.

# 5.7 Stray Arcs

Arcs shall only be struck on fusion faces and accidental contact of the electrode or of the non-insulated parts of electrode holders with the outer surface of the pipe shall be avoided. Electrode holders should be of the fully insulated type.

# 5.8 Marking of Welds

5.8.1 Each welder shall mark his welds or portions of welds with a unique identification symbol, using chalk or grease-free crayon. (Keel will not be permitted.) Identifying marks shall be placed on the external protective coating material, if any, immediately adjacent to the weld.

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- 5.8.2 Each welder of root beads shall place his symbol at the beginning of the upper half of the section he has worked on and all other welders shall write their symbols at an appropriate place beneath those markings.
- 5.8.3 Under no circumstances shall any welder change the symbol assigned to him for the duration of the entire construction period. When any welder is terminated, his symbol shall not be used again by any other welder employed.

# 5.9 Work Stoppages

- 5.9.1 In the event of work stoppages, or in those cases where the weld cannot be completed before the end of the work period, the partially completed weld shall contain at least three passes.
- 5.9.2 Before the restart of welding and where preheat was originally required, the entire weld area for a minimum distance of 100 mm on each side of the weld shall be preheated to the minimum preheat temperature.
- 5.9.3 Fabrication or tie-in welds must always be completed without delay and shall not be left incomplete overnight.

# 5.10 Weld Protection

Asbestos blankets may be required to protect welds from excessively rapid cooling due to low temperatures, wind, rain or snow. Other materials, such as fiber glass insulating blankets, may be used if approved by Arctic Gas.

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# 5.11 Fire Guard

The Contractor shall provide fire guards whenever dry muskeg, peat or other inflammable ground is present in the welding area. The fire guard shall be provided with a water or foam fire extinguisher and shall thoroughly moisten the area under and around the weld seam immediately after completion of each welding operation. The fire guard shall not leave the scene if there are any signs of smoke remaining.

# 6. Heat Treatment

### 6.1 Heating and Cooling Methods

Heat treatment may be accomplished by a suitable heating method that will provide the required metal temperature, metal temperature uniformity, and temperature control, such as an enclosed furnace, local fuel firing, electric resistance or electric induction. Cooling may be accomplished in a furnace, in air, with the aid of local thermal control, with the application of heat or insulation, or in any other manner required to achieve the desired cooling rate.

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# 6.2 Preheating

6.2.1 General

The need for preheating will depend upon the welding process selected, pipe wall thickness, chemical composition of the steel, and the ambient temperature. The welding procedure shall specify the preheating requirements that are to be followed when the composition of the steel is such that preheating is necessary. The Procedure Qualification Test shall have demonstrated that acceptable quality welds will be produced when complying with the preheat requirements shown in the welding procedure. Additionally, preheat shall be used when directed by Arctic Gas.

### 6.2.2 Preheat Temperature

When preheat is required, the joint shall be uniformly heated throughout the wall thickness for a minimum width of 100 mm on each side of the weld to the temperature required by the Procedure Qualification Test.

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### 6.2.3 Dissimilar Steels

When welding dissimilar steels having different preheat requirements, the higher preheat temperature shall govern.

# 6.2.4 Interpass Temperature

Construction practice shall be such that the temperature prior to the application of the second pass shall not fall below that established by the Procedure Qualification Test.

# 6.2.5 Measurement of Preheat Temperature

- 6.2.5.1 The preheat temperature shall be checked by the use of temperature-indicating crayons, thermocouple pyrometers, or other suitable methods to assure that the required preheat temperature is obtained prior to and maintained during the welding operation.
- 6.2.5.2 Some types of crayon will not show, once the temperature has been reached, that this temperature is being maintained. In these cases the crayon has to be reapplied if continued temperature observations are to be made.
- 6.2.5.3 When it is required to bracket the preheat temperature, both low and high indicating crayons shall be used.

# 6.2.6 Delays in Welding

If welding is interrupted, or if the weld is allowed to cool prior to postheat treatment, adequate heat treatment or a controlled cooling rate shall be effected to assure that there are no detrimental effects to the weld.

### 6.3 Postweld Heat Treatment (Stress Relieving)

6.3.1 General

Postheat treatment shall be performed as necessary to restore or obtain the physical properties (such as strength, ductility, and corrosion resistance, or a combination of these) with respect to material, design, and end use requirements. Physical property require-

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ments shall determine the treatment to be performed, such as stress relief, temper, anneal, or normalize. Postheat treatment of welds shall be compatible with the analysis of the base materials being joined and the weld deposit.

# 6.3.2 Requirements

Postweld heat treatment shall be performed when required by the applicable codes and regulations shown in Clause 1.3 of this Specification. In addition, postweld heat treatment will be required as follows unless agreed otherwise in writing with Arctic Gas.

- a. For all steels except austenitic stainless steels, of a nominal thickness in excess of 31.75 mm.
- b. For welds in piping containing the nickel steels referred to in the following specifications:

2950-6-9 Large Diameter Pipe for -50C Service.

- 2950-6-4 Seamless Pipe Type III
- 2950-6-11 Butt Welding Fittings 12" or Larger for Use with High Yield Pipe - Type I
- 2950-6-8 Small Fittings Type III
- 2950-6-5 Forged Steel Pipe Flanges Type II
- c. When specified on the drawing.

# 6.3.3 Temperatures and Soaking Period

The necessity for postheat treatment of welds, and the temperature and soaking period to be used in order to comply with Clause 6.3.1, shall be established by the Procedure Qualification Test. Regardless of the postheat treatment used, the physical property requirements of Clause 7.5 shall govern.

### 6.3.4 Special Considerations

Temperatures for postweld heat treatments and time at temperature will be as shown on the shop drawings. The temperatures for postweld heat treatment of carbon steel are usually 600 to 650C; but lower temperatures

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may be required for some of the piping so as not to exceed the tempering temperatures. In such cases, good practice is to limit the temperature to 50C below the tempering temperature. Welds in austenitic stainless steels do not normally require heat treatment.

# 6.3.5 Heating and Cooling Rates

Above 300C the rate of heating shall not be more than 200C per hour. Above 300C, the cooling rate shall not be greater than 250C per hour. From 300C down, the cooling may be in still air.

# 6.3.6 Heating Methods

The heating method selected for restoration of physical properties desired for parts of an assembly shall accomplish this result without adversely affecting other components. Heating a fabricated assembly as a complete unit is usually desirable; however, the size or shape of the unit or the adverse effect of a desired heat treatment on one or more components where dissimilar steels are involved, may dictate alternative procedures such as heating a section of the assembly before the attachment of others, or local circumferential band heating of welded joints in accordance with Clause 6.3.9 of this Specification.

### 6.3.7 Dissimilar Steels

Postheat treatment of welded joints between dissimilar steels having different postheat requirements shall be that established in the Procedure Qualification Test.

# 6.3.8 Thickness

If thickness is a factor in determining the requirement for postheat treatment, the nominal pipe wall thickness of the thicker pipe shall govern. For fillet welds, including those for attachment of external nonpressurecontaining parts such as lugs of other pipe supporting elements, the required throat thickness of the fillet weld shall govern.

# 6.3.9 Local Postheat Treatment

6.3.9.1 Local postheat treatment of welded joints shall require the entire band to be brought up to a uniform temperature over the circumference of the heated pipe section, with a gradual diminishing of temperature outward from the band. 6.3.9.2 When locally heat treating a circumferentail weld, the minimum width of the band centered on the weld shall be the larger of:

a. Twice the width of the weld reinforcement.

- b. Width of weld reinforcement plus 50 mm.
- 6.3.9.3 When locally heat treating welded branch connections or other attachments, a circumferential band of the pipe to which the branch or attachment is welded shall be heated to the desired temperature. The width of this band shall extend at least 25 mm beyond the weld joining the branch or attachment to the pipe.

### 6.3.10 Temperature Checking

Postheat treatment temperatures shall be checked by the use of thermocouple pyrometers or other suitable methods to assure that the requirements established by the procedure qualification are accomplished.

# 6.3.11 Recording of Information

- 6.3.11.1 The following information shall be recorded by the use of permanent recorders.
  - a. Heating rate, maximum temperature.
  - b. Cooling rate.
- 6.3.11.2 The recordings shall be made with equipment having the following characteristics:
  - a. Continuous recording.
  - b. Accuracy of record + 10C.
  - c. Scale on recorder.
    - 0 to 800C minimum range
    - 0 to 1000C maximum range

# 7. Qualification of Welding Procedures

7.1 Requirements

The qualification of the welding procedures shall be in accordance with Clause 4.6 of CSA Standard Z184 or Clause 2.0 of API

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Standard 1104, with the following additions.

- 7.2 Procedure Development
  - 7.2.1 Arctic Gas will conduct welding tests under conditions approximating the most severe weather and temperatures that could prevail where unsheltered welding would be allowed. These tests would set limits on the welding practices and establish qualified welding procedures. These will be furnished the Contractors on a recommendation basis. The Contractors will assume all responsibility in the use of such welding procedures.
  - 7.2.2 In lieu of the use of these procedures, a Contractor may propose procedures developed by himself. All procedures proposed by Contractors for use on this pipeline shall be submitted for consideration to Arctic Gas. The welding procedure qualification tests proposed by a Contractor shall be conducted at a mutually satisfactory location in the presence of Arctic Gas with adequate notice being given of test dates.

# 7.3 Dissimilar Steels

Special procedures may be required to weld some of the dissimilar steel combinations.

# 7.4 Grouping of Variables

Procedure Qualification Tests are required for the maximum thickness of all grades of steel, unless written approval is received from Arctic Gas.

7.5 Testing of Welding Procedure Test Joint - Butt Welds

# 7.5.1 Testing Requirements

All test welds shall be on pipe. The type and number of test specimens shall be in accordance with requirements of Clause 4.6 of Z184 or Clause 2.6 of API 1104, with the added requirements shown in the Clauses 7.5.2 and 7.5.3 of this Specification.

# 7.5.2 Hardness Survey

7.5.2.1 A transverse section of the weld shall be removed from a location chosen by Arctic Gas and shall be prepared for testing by machining, grinding, and polishing. Care should be taken to remove a minimum of 5 mm from any torch-cut surface. The polished cross section of the weld shall be given a light etch. 7.5.2.2 Three hardness traverses should be made with indentations at approximately 2 mm intervals. One traverse shall be made across the middle of the weld, and the other two approximately 3 mm in from the inside and outside surfaces. Additional spots shall be checked to assure that the maximum hardness in the heat-affected zone is measured.

7.5.2.3 The hardness shall not exceed 260 HV 10 (R 24).

7.5.3 Notch Ductility Tests

# 8. Qualification of Welders

# 8.1 General

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Each welder shall be qualified in accordance with the applicable requirements of Clause 4.8 of CSA Z184 or Clause 3.0 of API 1104.

# 8.2 Single Qualification

A welder qualifying to the requirements of this paragraph shall make a test weld using a qualified procedure to join pipe nipples. Two welders may be tested on the same pipe nipples, each welder completing one-half of the test weld.

# 8.3 Acceptance Tests

The weld shall be acceptable if it meets the requirements of Clause 4.8.4 of CSA Z184, or Clauses 3.3 and 3.4 of API 1104.

# 8.4 Qualification by Procedure Test

A welder who has successfully made an original Procedure Qualification Test is automatically qualified in that procedure.

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# 9. Inspection and Testing of Production Welds

# 9.1 Requirements

Inspection and testing of production welds shall be in accordance with Clauses 4.10.2 and 4.11 of CSA Z184, or Clauses 5.0 and 6.0 of API 1104, plus the following explanatory and supplementary requirements.

# 9.2 Visual Inspection

All welds shall be visually inspected around the entire circumference of the weld.

# 9.3 Nondestructive Testing

Nondestructive testing shall consist of radiographic and/or ultrasonic inspection or other Arctic Gas specified methods. The method used shall produce indications of defects which can be accurately interpreted and evaluated. The welds shall be evaluated on the basis of the "Standards of Acceptability -Nondestructive Testing", Clause 10. of this Specification. Welds not meeting the requirements of the method by which they are inspected shall be rejected.

# 9.4 Welds to be Nondestructively Tested

All welds shall be inspected by a nondestructive testing method. In general, all butt welds will be radiographed and may be ultrasonically inspected. Fillet welds will be magnetic particle inspected and may be ultrasonically inspected. Special attention shall be given to the location, size and profile of fillet welds in order to orient the magnetic field perpendicular to the most likely cracking direction.

# 9.5 Welds Removed from Line for Testing

Welds may be cut and tested as required by Arctic Gas. The specimens cut to test a welder's work shall be prepared and tested according to the requirements of the Welder Qualification Test. Trepanning methods shall not be used.

# 10. Standards of Acceptability - Nondestructive Testing

# 10.1 General

The standards of acceptability shall be in accordance with Clause 4.11 of CSA Z184 or Clause 6.0 of API 1104, plus the following explanatory and supplementary requirements.

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# 10.2 Undercutting

Undercutting adjacent to either the cover pass or adjacent to the root bead on the inside of the pipe shall be acceptable only as follows:

### Depth

### Length

over 1 mm 0.5 mm to 1 mm Less than 0.5 mm None 50 mm Any Length

# 11. Radiographic Procedure

### 11.1 General

The radiographic procedure shall be in accordance with the applicable provisions of CSA Z184 or API 1104.

### 11.2 Identification Markers

Identification markers at 150 mm intervals shall be used with the "zero" marker at the top "button".

# 11.3 Film Density

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Film shall be exposed so that the density shall be between 1.3 and 1.8 throughout the weld. The unexposed base density of the film shall not exceed 0.30.

# 11.4 Penetrameters

Penetrameters shall be used for each radiograph. Each film shall have at least two penetrameters. If a single film is used about the pipe periphery, penetrameters shall not be more than 500 mm apart.

# 11.5 Radiographic Procedure Qualification

- 11.5.1 The radiographic procedure shall be recorded and qualified in accordance with Clauses 8.3 and 8.31 of API 1104.
- 11.5.2 A sample of the qualification radiographs together with a copy of the procedure qualification shall be available for use as a guide for judging the quality of production radiographs.

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11.5.3 The radiographic procedure qualification shall be repeated at the option of Arctic Gas whenever any change has been made in the operating technique, or whenever production films vary appreciable in detail, contrast, or density from the Standard Test Radiograph.

# 11.6 Radiographic Reports

The radiographer shall provide a daily record on the report form provided. Each radiograph shall have a consecutive number and the report form shall show the analysis of the radiograph, divided into quarters, throughout the circumference of the pipe together with a recommendation showing whether the weld so examined was within specification or beyond specification. The Arctic Gas welding inspector shall show the disposition of all welds having defects greater than permitted by this Specification.

# 12. Repair or Removal of Weld Defects

### 12.1 General

Repair or removal of defects shall be in accordance with Clause 4.12 of CSA Z184 or Clause 7.0 of API 1104, plus the following clarifications and supplementary requirements.

# 12.2 Correction During Welding

Correction of an individual bead during deposition of the original weld prior to the laying of a succeeding bead is not considered repair of a defect under this specification. Stripper beads, which may be necessary to fill the sides of the cover pass, may be deposited upon completion of the original weld. Stripper beads added later, after the weld has cooled down, shall be treated as weld repairs except that their lengths are not limited to 300 mm. Any other repairs require Arctic Gas approval.

### 12.3 Repair Requirements

12.3.1 Defects beneath the surface of the cover pass may be repaired in accordance with the requirements of Clause4.12 of CSA Z184 or Clause 7.0 of API 1104 and the supplementary requirements of this Specification.

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- 12.3.2 The defect(s) shall be removed by chipping, grinding, machining, air carbon arc, or torch gouging as approved by Arctic Gas without cutting completely through the weld. The final repair area shall be ground to clean metal.
- 12.3.3 The maximum length of any single repair shall be 300 mm and the minimum length 50 mm. The minimum distance between any two repairs shall be 300 mm. The total length of repairs in any weld shall not exceed 600 mm.
- 12.3.4 Weld repairs shall be made by the Shielded Metal-Arc process using low hydrogen type electrodes or by the Gas Metal-Arc process, except that the same process used in making the original weld may be used in making the repair weld if approved by Arctic Gas.
- 12.3.5 Before repairs are made, the location and limits of the defect(s) shall be accurately marked on the weld. Then the defect(s) shall be entirely removed to clean metal.
- 12.3.6 Repair areas shall be preheated. An area covering a minimum of 100 mm on each side of the repair shall be preheated to the temperature specified and maintained during repair welding. The temperature shall be checked by the use of temperature-indicating crayons.
- 12.3.7 All repair cavities shall be not less than 50 mm in length. All repairs shall be made with a minimum of two passes. The start and stop of repair passes shall not be superimposed over the start and stop of the preceding repair pass. The start and stop of each repair pass shall be ground smooth. The completed repair shall be ground to conform to the surface of the original cover pass.
- 12.3.8 All repairs shall meet the requirements of Clauses 9 and 10 of this Specification.

12.3.9 No second repairs shall be made.

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- 12.4 Backwelding
  - 12.4.1 Defects on the internal surface of the weld, such as burn-throughs, craters, incomplete fusion or penetration, or root bead undercut and defects in the weld may be repaired by backwelding provided the welding is performed in compliance with the welding requirements of this Specification and after preheating (if required) and with the following requirements and/or limitations:
    - a. A given repair area may consist of one or more defects.
    - b. For any repair area 100 mm or longer, a new road shall be used for each bead.
    - c. Ends of the completed repair shall extend beyond the ends of the original defective area and shall be ground to a smooth contour blending into the surface of the original root bead pass.
    - d. Any notches resulting from backwelding shall be removed by grinding, including those occurring along the edges of the backweld. The completed backweld shall be cleaned.
    - e. Repairs shall be subject to inspection by Arctic Gas.
  - 12.4.2 Hi-Lo resulting in incomplete penetration may be repaired by backwelding at least six inches beyond both ends of the defect.

# 12.5 Testing of Repairs

Repaired areas shall be re-radiographed, or inspected by the same means previously used.

### 12.6 Arc Burns

12.6.1 An arc burn is defined as an area outside the weld where an arc has been struck either by the welding electrode, by a connection in the weld leads or by the grounding clamp. This does not include "trail" where a perceptible indentation has not occurred, or spatter (scattered spherical particles of weld metal). Trail, where a perceptible indentation is present, shall be considered an arc burn under this Specification.

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12.6.2 Arc burns shall not be permitted. Arc burns in pipe shall be removed by cutting out cylinders containing the arc burns.

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12.6.3 Arc burns in a heavy fitting shall be inspected by Arctic Gas who shall run necessary tests to determine if the fitting can be repaired or must be replaced.

### 12.7 Partial Removal of Weld

The cut-out portion of a weld shall be sufficiently deep and long to remove the defect. At the ends and sides of the cut there shall be a gradual taper from the base of the cut to the outside surface of the weld metal or pipe. The cut profile shall give adequate access for re-welding. When the root of the weld is accessible from the bore of the pipe, a repair to the root may be made by backwelding.

### 12.8 Complete Removal of Weld

- 12.8.1 Entire welds shall be removed by torch cutting and it is required that a cylinder of pipe containing the weld be cut out not less than 25 mm on either side of the weld. When torch-cutting is used, the appropriate preheating shall be applied.
- 12.8.2 Where a cut has been made through a faulty weld and there has been no serious loss of pipe length, the replacement weld shall be made in accordance with the requirements of this Specification.
- 12.8.3 Where a cylinder of pipe containing a faulty weld has been removed, a new cylinder of pipe of sufficient length to assure good line-up shall be inserted as approved by Arctic Gas and the two weld joints required shall be made in accordance with the requirements of this Specification.

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