| Title: TES-NDT-RT Radiographic Examination of Welds | | Document Type: Specification |
|---|---|---|
| Effective Date: 2004/02/28 | Revision: 2 | |
| Document Owner: Pipe Engineering, T[redacted] | | |
| Originator: [redacted] Technologist, Pipe Engineering, Technical Support | : [redacted] Signature/Date - Signed copy on file 2004/02/27 | |
| Reviewer: [redacted] Pipeline Integrity Specialist, Rocky Mountain Region | : [redacted] Signature/Date - Signed copy on file 2004/03/11 | |
| Reviewer: [redacted] President, CogniSpecs Consulting Ltd. | | |
| Approver: [redacted] Manager, Pipe Engineering, Technical Support | : [redacted] Signature/Date - Signed copy on file 2004/03/17 | |

s.19(1)

s.19(1)

## PURPOSE

This specification details the equipment, operator and procedure qualification, quality and reporting requirements for examination of welds by radiography.

## SCOPE

This specification applies to TransCanada (the Company).

This specification applies to welds made for the purpose of welder or welding procedure qualification and to production welds in the pipeline system, between pipes and components of any size and wall thickness.

## BRIEF DESCRIPTION OF CHANGE (IF A REVISION)

This specification was revised to ensure it is compliant with CSA Standard Z662-03. Paragraphs were completely renumbered. There are no technical changes from the previous revision.

TABLE OF CONTENTS

## 1 PURPOSE

This specification details the equipment, operator and procedure qualification, quality and reporting requirements for examination of welds by radiography.

## 2 SCOPE

This specification applies to TransCanada (the Company).

This specification applies to welds made for the purpose of welder or welding procedure qualification and to production welds in the pipeline system, between pipes and components of any size and wall thickness.

## 3 APPLICABLE STANDARDS

Radiographic examination to this procedure shall also meet the requirements of
(a) CSA Z662-03, and any amendment, supplement or errata issued by CSA; and
(b) The Company Environment, Occupational Health and Safety standards.

## 4 REFERENCE DOCUMENTS

(a) CSA Standard Z662-03 *Oil and Gas Pipeline Systems* (referred to as CSA Z662)
(b) Canadian General Standards Board, CAN/CGSB 48.9712 *Qualification and Certification of Nondestructive Testing Personnel*
(c) Company Specification *TES-WELD-AS Welding of Assemblies and Station Piping*
(d) Company Specification *TES-WELD-PL Welding of Pipelines and Tie-ins*

## 5 DEFINITIONS

The following definitions shall be added:

**Assembly Weld** - Weld joining pipe to components or components to components; weld joining pipe to pipe made in stations or at a manufacturing plant or fabrication shop remote from the final location of the weld
**DWDI** - Double-wall, double-image
**DWSI** - Double-wall, single-image
**IQI** - Image quality indicator
**Mainline Weld** - Pipe-to-pipe weld made on a pipeline site
**RT Contractor** - The contractor performing radiographic inspection.
**SWSI** - Single-wall, single-image
**Test Head Weld** - Temporary weld made to join the test head assembly to the pipeline facility, is to be cutout after pressure testing.

## 6 RADIOGRAPHERS

### 6.1 General

(a) Personnel performing these examinations shall be qualified as Level I or Level II Radiographers in accordance with the requirements of CAN/CGSB 48.9712 (Industrial Radiography Category) as specified below.
(b) Film interpretation and reporting shall be performed by a Level II radiographer.
(c) RT Contractor shall assign at least one Level II radiographer per radiographic crew to be responsible for the conduct of the radiographic personnel, the performance of

equipment, the on-site inventory of spare part, and the inspection work, including reports and records.

### 6.2 Approval of Radiographers

(a) RT Contractor shall provide the Company with details of each radiographer prior to the start of the project (i.e., certificates and copy of CGSB tickets).
(b) Radiographers shall be approved when they produce an acceptable procedure qualification radiograph as specified in Paragraph 9.
(c) RT Contractor shall not use a radiographer who is not approved, nor substitute radiographers without prior approval of the Company.

### 6.3 Radiation Safety

(a) Radiographers shall be responsible for the protection and monitoring of every person working with or near radiation in accordance with the regulations of the Department of Health and Welfare Canada, Health Protection Branch.
(b) Personnel involved in Gamma radiography shall be "Qualified Operators" as defined by the Atomic Energy Control Regulations.
(c) A minimum of two Qualified Operators shall be required to perform Gamma radiography.

## 7 EQUIPMENT AND TECHNIQUES

### 7.1 Radiation Sources and Techniques

(a) Radiation sources and techniques shall be as given in the following table:

| Piping Size | Mainline Weld | Tie-in and Repair Weld | Assembly Weld & Test-Head Weld |
|---|---|---|---|
| < 60.3 mm OD (NPS 2) | N/A | N/A | DWDI X-ray or Gamma-ray |
| 60.3 to 219.1 m OD (NPS 2 to 8) | DWSI Gamma-ray | DWSI Gamma-ray | DWSI-Gamma-ray |
| > 219.1 mm and smaller than 406.4 mm OD (> NPS 8 and smaller than NPS 16) | DWSI X-ray or Gamma-ray<br>SWSI Gamma-ray | DWSI X-ray or Gamma-ray | DWSI X-ray or Gamma-ray<br>SWSI Gamma-ray |
| 406.4 mm OD or larger (NPS 16 or larger) | SWSI X-ray | DWSI X-ray | DWSI or SWSI X-ay or Gamma-ray* |

* Radiation source selected with consideration for material thickness, and latitude required to radiograph welds between materials of different thickness.

(b) Gamma-ray radiography shall be performed using radioisotope Iridium 192 in conjunction with class I film specified in paragraph 7.2.

## 7.2 Radiographic Film

Film shall be as specified in the table below for each application:

| Film Brand Name | APPLICATION | | | |
|---|---|---|---|---|
| | Mainline | | Repairs, Tie-ins & Assemblies | |
| | X-Ray | Gamma-Ray | X-Ray | Gamma-Ray |
| AGFA-Gevaert D2 | Yes | Yes | Yes | Yes |
| AGFA-Gevaert D4 | Yes | Yes | Yes | Yes |
| AGFA-Gevaert D5 | Yes | No | Yes | No |
| AGFA-Gevaert D7 | No | No | Yes | No |
| Fuji #50 | Yes | Yes | Yes | Yes |
| Fuji #80 | Yes | Yes | Yes | Yes |
| Fuji #100 | No | No | Yes | No |
| Kodak AA | No | No | Yes | No |
| Kodak AX | No | No | Yes | No |
| Kodak Industrex M | Yes | Yes | Yes | Yes |
| Kodak Industrex R | Yes | Yes | Yes | Yes |
| Kodak Industrex T | Yes | Yes | Yes | Yes |

## 7.3 Viewers

A high intensity viewer shall be provided for each radiographic unit to allow adequate viewing of film having a density up to 4.0.

## 7.4 Densitometers

A calibrated densitometer shall be provided for each radiographic unit to ensure that film densities are within specified limits.

## 7.5 Image Quality Indicators

Wire type Image Quality Indicators (IQI) conforming to ASTM E 747 or ISO 1027 shall be used to measure sensitivity.

## 7.6 Placement of Image Quality Indicators

(a) When multiple film holders are used, the image of one IQI shall appear on each film.
(b) If long film holders or redipak film are used to expose an area greater than 457 mm in length the image of two IQIs shall be visible, one at each end.
(c) For double-wall, single-image radiographs, the IQI shall be placed on the source side.

## 7.7 Transportation

RT Contractor shall have in his possession documentation required by the "Transportation of Dangerous Goods Act".

# 8 FILM QUALITY

## 8.1 Density

(a) Radiographic film density shall be measured through the weld, between the edge of the cap and the image of the root bead.

(b) The density through the image of the weld shall be
  (i) in excess of 2.0;
  (ii) between 2.0 and 3.5 on a pipe-to-pipe or component-to-component weld;
  (iii) between 2.0 and 4.0 on a pipe-to-component weld.

(c) The unexposed base density of the film shall not exceed 0.30.

## 8.2 Sensitivity (Definition of IQI Image)

(a) Except for pipe diameters smaller than 114.3 mm OD and components smaller than NPS 4, the following wire shall be visible on each radiograph:

| Pipe Wall Thickness Range | Essential Wire Diameter |
|---|---|
| Smaller than 6.4 mm | 0.16 mm (0.006 in) |
| 6.4 mm to 12.7 mm | 0.20 mm (0.008 in) |
| Greater than 12.7 mm | 0.25 mm (0.010 in) |

For welds between materials of different wall thickness, the thinner wall shall be used to determine the required number of visible wires.

(b) For pipe diameters smaller than 114.3 mm OD and components smaller than NPS 4, a 0.25 mm (0.010 in) essential wire diameter shall be used.

# 9 RADIOGRAPHIC PROCEDURES

## 9.1 General

(a) A procedure for the production of radiographs shall be established and qualified by each radiographic unit prior to the start of inspection of production welds.

(b) The procedure qualification test shall be witnessed by the Company.

(c) RT Contractor shall have a copy of the radiographic procedure readily available during production radiography.

(d) Changes exceeding the tolerances in any of the variables of the procedure listed in Paragraph 9.2 shall require a requalification of the procedure.

## 9.2 Radiographic Procedure Variables

The recorded radiographic procedure shall include the following variables and their tolerances:

(a) Type of material to be radiographed;

(b) Material thickness range for which the procedure is suitable;

(c) Type of radiation to be used with details of effective source size or X-ray machine voltage;

(d) Position of radiation source (external or internal);

(e) Type, thickness and position of intensifying screens and filters;

(f) Sketch showing the geometric arrangement for the production of the radiographs, including minimum source to film distance and radiation angle with respect to the weld;

(g) Film type and brand, length and width;

(h) Exposure conditions in milliampere•minutes or curie•minutes; and

(i) Processing time and temperature for development, stop bath or rinse, fixing, washing and drying.

### 9.3 Qualification Radiographs

(a) Radiographs of welds that are similar to those that will be inspected during production welding shall be made in accordance with the requirements of the procedure using IQIs positioned both on the source side and film side.
(b) IQIs shall be identified as to their location.
(c) An unexposed base film shall be processed in accordance with the requirements of the procedure.
(d) Radiographs shall meet the quality requirements of Paragraph 8.
(e) Radiographs shall be interpreted in accordance with the requirements of the acceptance criteria provided by the Company (Paragraph 10.3), and the results shall be recorded on the form specified in Paragraph 11.1.
(f) Radiographs shall be identified with the RT Contractor's name, radiographer's name, date of test, and procedure number.

## 10 PRODUCTION RADIOGRAPHY

### 10.1 General

(a) Radiographic procedures qualified in accordance with the requirements of Paragraph 9 shall be used.
(b) A single wall radiographic technique shall be used whenever practical.
(c) Except for elliptical radiographs, double wall radiographic method shall require a minimum of three exposures for each weld.
(d) Contact method of radiography shall not be used for welds in piping smaller than 60.3 mm OD or NPS 2.
(e) The elliptical or super-imposed techniques shall be limited to welds of 60.3 mm OD or smaller pipe, or NPS 2 or smaller component.
(f) Film overlap shall not be within 50 mm of the 12 o'clock and 6 o'clock positions.
(g) Welds shall not be radiographed until the surface temperature is below 50°C.

### 10.2 Film Identification

(a) Films shall be clearly identified by lead numbers, letters or flash cards, or any other method approved by the Company to ensure that the location of the weld and any discontinuity in the weld can be quickly and accurately located.
(b) When more than one film is used to inspect a complete circumferential weld, the identification markers shall appear on each film and the weld marker location shall be common to two successive films to ensure that the entire weld has been examined.
(c) Where applicable, the location markers shall be placed in a clockwise direction on the down-stream side of the weld and the zero marker (clearly marked by an arrow) shall correspond to the 12 o'clock position (top dead center).
(d) A number shall be assigned to each weld to be radiographed as follows:
  (i) For pipeline welds, using the sequence specified by the Company, or
  (ii) For assemblies and station welds, using the number specified on the piping drawings.
(e) Replacement welds (cutouts) shall be identified by adding the suffix "CO" to the original weld number.

(f) Repaired welds shall be identified by adding the suffix "R" for the first repair, or "R2" for a second repair, to the original weld number.

### 10.3 Film Interpretation

(a) Radiographs shall be properly dried prior to interpretation.
(b) Final interpretation shall be completed on a high intensity viewer.
(c) The standards of acceptability shall be the applicable requirements given in Company welding specifications TES-WELD-PL and TES-WELD-AS.

## 11 RECORDS AND REPORTS

### 11.1 General

(a) Inspection results shall be recorded on the Company standard radiographic report form, or alternate forms provided by RT Contractor and subject to approval by the Company.
(b) Such reports shall be made available to the Company on a daily basis, at the time designated by the Company.
(c) Radiographic reports and records shall become the property of the Company upon completion of the project.

### 11.2 Inspection Records for Production Welds

RT Contractor shall provide to the Company
(a) the radiographic procedure, qualification radiographs and unexposed base film;
(b) the radiographic films of welds inspected; and
(c) an assessment of the weld quality in accordance with the requirements of the acceptance criteria provided by the Company (Paragraph 10.3).

### 11.3 Packaging of Radiographs

(a) Films shall be packaged as follows:
  (i) For pipeline and tie-in welds, one weld per slot in divided boxes approved by the Company.
  (ii) For assemblies and station welds, in envelops placed in boxes.
(b) Film boxes shall be identified with Project name and number, Range of weld numbers, Dates exposed, Box number, RT Contractor and Radiographer names. Each box shall contain a copy of the interpretation sheet for every film.
(c) Radiographs of replacement welds shall be placed in the same slot or envelop as the original (cutout) weld.
(d) All repair films and/or re-shot films shall be packaged with the original films.

- END OF DOCUMENT -