# QUALITY CONTROL
# AND
# TECHNICAL OPERATIONS
# PROCEDURE

**TITLE:** RADIOGRAPHIC EXAMINATION (GENERAL) PROCEDURE

**PROCEDURE NO.** QC-TOP-RT-1 **REV.** 03

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## 1.0 SCOPE:

1.1 This procedure provides information, instructions and guidelines by which technicians are able to develop, formulate and perform reliable and effective radiographic examinations.

1.2 The information and techniques contained in this procedure comply with the requirements of ASME Boiler and Pressure Vessel Code Section V.

1.2.1 Should the parameters provided in this procedure not comply with a particular code, standard or specification then an applicable procedure will be developed.

1.3 QUALIFICATION OF INSPECTION AND TESTING PROCEDURES

1.3.1 The weld inspection and test procedures of Technico Inc. are prepared in accordance with Section 6 and 7 of CSA Standard W178.1. All weld inspection and testing will be performed in compliance with this standard.

1.3.2 It is Technico Inc. policy that inspection procedures and revisions that comply with CSA Standard W178.1 be approved by the Canadian Welding Bureau prior to use.

1.4 Weld inspection or weld testing subcontracted by Technico Inc. shall be subcontracted to firms certified to CSA Standard W178.1.

## 2.0 **INTRODUCTION**

Radiography using X-rays or gamma-rays, is a very well-established industrial non-destructive inspection method. Basically, a source of penetrating radiation is placed at a suitable distance on one side of the component under examination with a film in a cassette on the opposite side. A suitable exposure-time is chosen, and after exposure the film is processed (developed, fixed, washed and dried) and then placed on an illuminated viewing screen for visual inspection. The images on the film are interpreted in terms of the nature, shape and size of flaws in the specimen, by a trained and experienced film interpreter.

The radiographic test method is an effective means for detecting internal discontinuities in various materials. Typical discontinuities detectable by this method are inclusions, voids, porosity, lack of weld fusion and penetration.

There are many variables in this procedure and successful completion of any test is dependent upon the understanding and control of those variables.

The radiographic test method is potentially DANGEROUS!

The precautions required to ensure safe work practice are not detailed in this procedure. Reference should be made to the appropriate jurisdictional regulations, company safety procedures and customer requirements.

## 3.0 REFERENCES

3.1 In the preparation of this examination procedure the following references have been utilized;

ASME, Boiler and Pressure Vessel Code Section V - Nondestructive Examination (2001 Edition)

Article 1, General Requirements

Article 2, Radiographic Examination

Article 22, Radiographic Standards

## 4.0 QUALIFICATION OF PERSONNEL

4.1 Personnel performing Radiographic Examinations shall be certified in accordance with the following;

i) CAN\CGSB-48.9712-95, Qualification and Certification of Nondestructive Testing Personnel.

and/or

ii) ANSI/ASNT CP-189-195,
ASNT Standard for Qualification and Certification of Nondestructive Testing Personnel

and/or

iii) SNT-TC-1A (1996 Edition and 1998 Addenda) Recommended Practice for Nondestructive Testing Personnel, Qualification and Certification.

4.2 Certified personnel will be registered with all applicable governing authorities. (i.e; N.B. Dept. of Labour, Client's Quality Assurance Group, etc.)

4.2.1 Personnel qualification, certification and subsequent employment will be subject to Customer/Client acceptance as may be required by contractual obligations.

4.3 PHYSICAL REQUIREMENTS

4.3.1 Personnel shall have an annual vision examination and meet or exceed the following minimum requirements:

i) Distant vision shall equal 20/30 or better in at least one eye, either or corrected or uncorrected.

ii) Near vision shall permit reading J-1 letters on standard Jaeger chart,(or equivalent), in at least one eye, either corrected or uncorrected.

iii) Capable of distinguishing and differentiating between colors appropriate to the radiographic test method.

4.3.2 Vision examinations shall be performed by an Ophthalmologist, Optometrist or other professionally recognized person.

4.3.3 Records of the vision examination shall be retained on file and will be made available, upon request, to comply with code or contract requirements.

4.4 LEVELS OF QUALIFICATION

4.4.1 There shall be three basic levels of qualification. These levels may be further subdivided for situations where additional levels are deemed necessary for specific skills and responsibilities.

4.4.2.1 The three basic levels of qualification shall be as follows:

NDE Level 1: Individuals certified to NDE Level 1 are authorized by Technico to perform the following:

i) Nondestructive testing of materials according to the prescribed NDE technique.

ii) Preparing, operating and caring for equipment and certain calibration procedures as specified by Level 2 or 3 supervisory personnel.

iii) Identifying parts and maintaining accurate records.

iv) Recording results obtained, classifying results in terms of written criteria and reporting results.

4.4.2.2 NDE Level 2: Individuals certified to NDE Level 2 are fully qualified personnel who are authorized by Technico to perform the following:

i) Setting up and calibrating equipment.

ii) Interpreting NDE tests and evaluating the results in accordance with applicable codes and specifications.

iii) Determining the capabilities and limitations of the NDE method for which they are certified.

iv) Choosing and/or applying detailed NDE techniques to products or parts.

v) Developing NDE procedures adapted to problems that are subject of an NDE specification.

vi) Preparing written NDE instructions.

vii) Organizing and reporting nondestructive testing results.

viii) Exercising assigned responsibility for the training and supervision of trainees and Level 1 personnel in the correct and safe use of NDE equipment.

ix) Verifying the technical performance of Level 1 personnel under their supervision.

4.4.2.3 NDE Level 3: Individuals certified to NDE Level 3 are fully qualified personnel who may be authorized by Technico to assume full responsibility for an NDE testing facility and staff and for providing written NDE instructions and NDE procedures to Level 1 and 2 personnel, respectively. NDE personnel classified as Level 3 require all the knowledge and skills expected of Level 2 personnel and shall also be qualified in the following:

i) Establishing and validating the correct NDE methods, procedure and techniques to ensure proper inspection of the part under inspection.

ii) Interpreting standards, specifications, codes and procedures, designating the particular NDE methods, procedures and techniques to be used, and interpreting the results.

iii) Interpreting NDE tests and evaluating specimens in terms of applicable acceptance standards, codes and specifications. (In addition, personnel shall have sufficient knowledge in applicable materials fabrication and product technology to select NDE methods and establish NDE techniques and to assist in establishing test and acceptance criteria where none are otherwise available).

iv) Initiating and assigning NDE testing projects.

v) Exercising responsibility for the instruction and supervision of personnel in the correct and safe use of NDE equipment.

vi) Guiding Level 1 and Level 2 personnel.

vii) Knowledge of the theory and operation of the equipment.

viii) Making recommendations for the purchase of new equipment.

ix) Knowledge of other commonly used nondestructive testing methods, so as to decide on the most appropriate NDE method.

## 5.0 SURFACE PREPARATION

5.1 **Materials Including Castings** - Surfaces shall satisfy the requirements of the applicable material's specification or referencing Code, with additional conditioning, if necessary, by any suitable process to such a degree that the resulting radiographic image due to any surface irregularities cannot mask or be confused with the image of any discontinuity.

5.2 **Welds** - The weld ripples or weld surface irregularities on both the inside (where accessible) and outside should be removed by any suitable process to such a degree that the resulting radiographic image due to any surface irregularities cannot mask or be confused with the image of any discontinuity.

The finished surface of all butt-welded joints may be flush with the base material or may have reasonably uniform crowns, with reinforcement not to exceed that specified in the referencing Code Section.

## 6.0 IDENTIFICATION

6.1 A system shall be used to produce permanent identification on the radiograph traceable to the contract component, weld or weld seam, or part number, as appropriate. In addition, the Client's symbol or name and the date of the radiograph shall be plainly and permanently included on the radiograph. This identification system does not necessarily require that the information appear as radiographic images. In any case, this information shall not obscure the area of interest.

6.2 Location markers which are to appear as radiographic images on the film, shall be placed on the part, not on the exposure holder/cassette. Their location shall be permanently marked on the surface of the part being radiographed when permitted, or on a map, in a manner permitting the area of interest on a radiograph to be accurately traceable to its location on the part, for the required retention period of the radiograph. Evidence shall also be provided on the radiograph that the required coverage of the region being examined has been obtained.

6.2.1 When inaccessibility or other limitations prevent the placement of markers as stipulated by code requirements, a dimensioned map of the actual marker placement shall accompany the radiograph(s) to show that full coverage has been obtained.

## 7.0 FILM

7.1 Various industrial X-ray film types are available to meet the needs of production radiographic work. However, definite rules on the selection of film are difficult to formulate because the choice depends on individual user requirements, such as radiographic quality levels, exposure times and various cost factors. Usually film selection is based on producing a quality radiograph that meets all necessary sensitivity requirements while minimizing exposure time. This is normally attained by using film of low to medium speed, high contrast and low graininess. Information about specific products can be obtained from the manufacturers.

7.2 Cleanliness is one of the most important requirements for good radiography. Cassettes, screens and the surface of the loading/unloading bench must be kept clean, because dirt may cause exposure or processing artifacts in the radiographs.

To avoid finger marks on film surfaces, film should be handled only at their edges, and with dry, clean hands.

Sharp bending, excessive pressure, and rough handling of any kind should also be avoided.

7.3 Unexposed film should be stored in such a manner that they are protected from the effects of light, pressure, penetrating radiation, excessive heat or humidity, damaging fumes or vapours. Detailed recommendations on film storage may be obtained from the film manufacturer. Storage of film should be on a "First in, first out" basis.

## 8.0 SCREENS

8.1 Except when restricted by the referencing Code Section, intensifying screens may be used.

8.2 Lead foil screens of appropriate thickness should be used whenever they improve radiographic quality or penetrameter sensitivity or both. The thickness of the front lead screens should be selected with care to avoid excessive filtration in the radiography of thin or light alloy materials, particularly at lower kilovoltages. In general, there is no exposure advantage to the use of 0.005 in. front and back lead screens below 125 kV in the radiography of 1/4 in. (6.35 mm) or thinner steel thickness. As the kilovoltage is increased to penetrate thicker sections of steel, however, there is a significant exposure advantage. In addition to intensifying action, the back lead screens are used as protection against back-scattered radiation and the thickness is only important for this function. As exposure energy is increased to penetrate greater thicknesses of a given subject material, it is customary to increase lead screen thickness. For radiography using radioactive sources, the minimum thickness of the front lead screen should be 0.005 in. (0.13 mm) for iridium 192, and 0.010 in. (0.25 mm) for cobalt 60.

8.2.1 Other Metallic Screen Materials

Lead oxide screens perform in a similar manner to lead foil screens except that their equivalence in lead foil thickness approximates 0.005in” (0.013 mm).

8.2.2 Fluorescent screens should be used only when the exposure without them would be prohibitively long. In any event, if fluorescent screens must be used, they should be proven capable of achieving the required quality level. Good screen-film contact is essential for the successful use of fluorescent screens. (Refer to manufacturer's recommendations.)

8.3 Screens should be handled carefully to avoid dents and scratches, dirt, or grease on active surfaces. Grease and lint may be removed from lead screens with a solvent. Fluorescent screens should be cleaned in accordance with the recommendations of the manufacturer.

8.4 Screens shall be stored in such a manner as to provide protection from pressure, excessive heat, humidity, damaging vapours, dirt, and rough handling.

8.5 Screens shall be inspected and cleaned periodically. Damaged screens shall be discarded.

## 9.0 BACKSCATTER RADIATION

9.1 To determine if backscatter radiation is exposing the film, a lead symbol "B" with minimum dimensions of 1/2 in. (13 mm) in height and 1/16" in. (1.6 mm) in thickness, shall be attached to the back of each film holder during each exposure. If a light image of the "B", appears on a darker background of the radiograph, protection from backscatter is insufficient and the radiograph shall be considered unacceptable. A dark image of the "B" on a lighter background is not cause for rejection.

9.2 Effects of back-scattered radiation may be reduced by confining the radiation beam to the smallest practical cross section and by placing lead behind the cassette or film.

## 10.0 RADIATION (SOURCE) SELECTION

10.1 Radiation energy affects image quality. In general, the lower the energy of the source utilized, the higher the achievable radiographic contrast. However, other variables such as geometry and scatter conditions may override the potential advantage of higher contrast.

10.2 In all cases whether X-Ray or Gamma is selected, the specified IQI (penetrameter) quality level must be shown on the radiograph.

10.3 The recommended minimum thickness for which radioactive isotopes may be used is as follows:

| | Material Thickness | |
|---|---|---|
| Material | Iridium 192 | Cobalt 60 |
| Steel | 0.75 in. | 1.50 in. |
| Copper or High Nickel | 0.65 in. | 1.30 in. |
| Aluminum | 2.50 in. | ... |

NOTE:
Overall radiographic sensitivity is primarily influenced by factors such as:

a) film selection
b) intensifying screen selection
c) geometric unsharpness
d) film density

The maximum thickness for the use of radioactive isotopes is primarily dictated by exposure time; therefore, upper limits are not shown. The minimum recommended thickness limitation may be reduced when the radiographic sensitivity has been obtained.

10.4 To determine the practical thickness limits for radiation sources for materials other than steel, the use of radiographic equivalence factors may be used. The radiographic equivalence factor of a material is that constant by which the thickness of a material must be multiplied to give the thickness of a "Standard" material (often steel) which has the same absorption.

A radiographic equivalence table is shown in Appendix "C", Form 4009.

## 11.0 RADIOGRAPHIC TECHNIQUE

11.1 The extent of radiographic examination shall be as specified by the referencing Code Section or applicable project specification.

11.2 The direction of the central beam of radiation should be centered on the area of interest whenever practical.

11.3 A single-wall exposure technique shall be used whenever practical and when it is not, a double-wall technique may be used. An adequate number of exposures shall be made to demonstrate that the required coverage has been obtained.

11.4 Radiographic techniques can be specific to a particular component or developed for general/typical arrangements applicable to standard configurations.

Appendix "B" is intended to be an on-going compilation of techniques.

## 12.0 GEOMETRIC UNSHARPNESS

12.1 The focus-film distance necessary to reduce geometric unsharpness (penumbra) to a negligible amount depends upon the film or film-screen combinations, focal-spot size, and object-film distance. Geometric unsharpness of the radiograph shall be determined in accordance with:

$$Ug = Fd/D$$

where:

Ug = geometric unsharpness
F = source size: the maximum projected dimension of the radiating source (or effective focal spot) in the plane perpendicular to the distance D from the weld or object being radiographed
D = distance from source of radiation to weld or object being radiographed
d = distance from source side of weld or object being radiographed to the film

12.1.1 The equipment manufacturer's or supplier's publications, such as technical manuals, decay curves, or written statements documenting the actual or maximum source size or focal spot, shall be acceptable as source size verification.

When manufacturer's or supplier's publications are not available source size may be determined as follows:

i) X-Ray Machines. For X-ray machines operating at 500 kV and less, the focal spot size may be determined by the pinhole method, or in accordance with ASTM Specification E-1165, "Standard Test Method for Measurement of Focal Spots of Industrial X-Ray Tubes by Pinhole Imaging".

ii) Iridium-192 Sources. For Iridium-192, the source size may be determined in accordance with ASTM Specification E-1114, "Standard Test Method for Determining the Focal Size of Iridium-192 Industrial Radiographic Sources".

12.1.2 As an alternative, for determining geometric unsharpness, the use of Nomograms as provided in

ASTM Specification E94 may be found useful.

12.2 The unsharpness formula is included for information and guidance. Geometric unsharpness values shall be within limitations prescribed by the referencing code or specifications.

## 13.0 IQI SELECTION AND PLACEMENT

13.1 Radiography shall be performed with a technique of sufficient sensitivity to display the penetrameter image and the specified hole, or the designated wire of the wire penetrameter, which are essential indications of the image quality of the radiograph.

13.2 At least one penetrameter image shall appear on each radiograph except where provided by code or project specifications.

13.3 Image Quality Indicators (IQI's) shall be either the hole type or the wire type.

i) Hole type IQI's shall be manufactured and identified in accordance with the requirements or alternates allowed in ASTM Specification E1025.

ii) Wire type IQI's shall be manufactured and identified in accordance with the requirements or alternates allowed in ASTM Specification E747 except that the largest wire number or the identity number may be omitted.

13.3.1 IQI's shall be selected from either the same alloy material group or grade as identified in ASTM Specification E1025 or from an alloy material group or grade with less radiation absorption than the material being radiographed.

13.3.2 When weld metal is of an alloy group or grade which has a radiation attenuation that differs from the base material, the penetrameter material selection shall be based on the weld metal and be in accordance with code requirements.

13.3.3 When density limits cannot be met with one penetrameter, and the exceptional density area(s) is at the interface of the weld metal and the base metal, the material selection for the additional penetrameter(s) shall be based on the base material and be in accordance with ASTM Specification E-1025.

13.4 The penetrameter(s) shall normally be placed on the source side of the part being examined.

13.4.1 Where inaccessibility prevents placing the penetrameter(s) on the source side, the penetramter shall be placed on the film side in contact with the part being examined. A lead letter "F" shall be placed adjacent to or on the penetrameter, but shall not mask the essential hole where hole penetramters are used.

13.4.2 When, due to part of weld configuration, it is not practical to place the penetrameter(s) on the part or weld, the penetrameter may be placed on a separate block. Separate blocks shall be made of the same or radiographically similar materials (as defined in ATSM Specification E-1025) and may be used to facilitate penetrameter positioning. There is no restriction on the separate block thickness, provided the penetrameter/area-of-interest density tolerance requirements are met.

i) The penetramter on the source side of the separate block shall be placed no closer to the film than the source side of the part being radiographed.

ii) The separate block shall be placed as close as possible to the part being radiographed.

iii) the block dimensions shall exceed the penetrameter dimensions such that the outline of at least three sides of the penetrameter image shall be visible on the radiograph.

13.5 The designated hole penetrameter with essential hole or designated wire diameter shall be as specified per applicable code and project specifications.

A smaller hole in a thicker penetrameter or a large hole in a thinner penetrameter may be substituted for any section thickness, provided equivalent penetrameter sensitivity (EPS) is maintained and all other requirements for radiography are met.

13.5.1 If the required hole penetrameter image and specified hole, or designated wire, do not show on any film in a multiple film technique, but do show in composite film viewing, interpretation shall be permitted only by composite film viewing.

13.6 **Shims** (under hole penetrameters) A shim of material radiographically similar to the metal shall be placed between the part and the penetrameter, if needed, so that the radiographic density throughout the area of interest is no more than minus 15% from (lighter than) the radiographic density through the penetrameter.

13.6.1 The shim dimensions shall exceed the penetrameter dimensions such that the outline of at lease three sides of the penetrameter image shall be visible in the radiograph.

## 14.0 PROCESSING

14.1 Processing shall be done in accordance with manufacturer's recommendations.

14.2 For guidelines in controlling the consistency and quality of industrial radiographic film processing refer to ASTM Specification E999.

## 15.0 RADIOGRAPHIC DENSITY

15.1 Density Limitations

Technico's standard practice advocates that the transmitted film density through the radiographic image of the body of the appropriate hole penetrameter or adjacent to the designated wire of a wire penetramater and the area of interest shall be 1.8 minimum for single film viewing for radiographs made with an X-ray source and 2.0 minimum for radiographs made with a gamma ray source. For composite viewing of multiple film exposures, each film of the composite set shall have a minimum density of 1.3. The maximum density shall be 4.0 for either single or composite viewing. A tolerance of 0.05 in density is allowed for variations between densitometer readings.

15.1.1 Density limitations may be superceded as allowed by code or applicable project specifications.

15.2 Either a densitometer or step wedge comparison film shall be used for judging film density.

The densitometer shall be calibrated in accordance with ASTM Specification E1079, Calibration of Transmission Densitometers, using a calibrated step wedge film traceable to a national standard.

15.3 Density Variation

i) General - If the density of the radiograph anywhere through the area of interest varies by more than minus 15% or plus 30% from the density through the body of the hole penetrameter or adjacent to the designated wire of a wire penetrameter, within the minimum/maximum allowable density ranges specified, then an additional penetrameter shall be used for each exceptional area or areas and the radiograph retaken. When calculating the allowable variation in density, the calculation may be rounded to the nearest 0.1 within the range specified.

ii) With Shims - When shims are used, the plus 30% density restriction may be exceeded, provided the required penetrameter sensitivity is displayed and the specified density limitations are not exceeded.

15.4 If density limitation and variation are met by using more than one penetrameter, one shall be representative of the lightest area of interest and another the darkest area of interest; the intervening densities on the radiograph shall be considered as having acceptable density.

## 16.0 VIEWING OF RADIOGRAPHS

16.1 Subdued lighting , rather than total darkness, is preferable in the viewing room. The brightness of the surroundings should be about the same as the area of interest in the radiograph. Overall room illumination must be of an intensity that will not cause troublesome reflections, shadows, or glare on the radiograph.

16.2 Equipment used to view radiographs for interpretation shall provide a variable, light source sufficient for the essential penetrameter hole or designated wire to be visible for the specified density range. The illuminator must provide light of an intensity that will illuminate the average density areas of the radiographs without glare and it must diffuse the light evenly over the viewing area. The viewing conditions shall be such that light from around the outer edge of the radiograph or coming through low-density portions of the radiograph does not interfere with interpretation. Masks can be used to exclude any extraneous light from the eyes of the viewer when viewing radiographs smaller than the viewing port or to cover low-density areas.

## 17.0 EVALUATION AND INTERPRETATION

17.1 All radiographs shall be free from mechanical, chemical, or other blemishes to the extent that they do not mask and are not confused with the image of any discontinuity in the area of interest of the object being radiographed. Such blemishes include, but are not limited to:

a) fogging;
b) processing defects such as streaks, watermarks, or chemical stains;
c) scratches, finger marks, crimps, dirtiness, static marks, smudges, or tears;
d) false indications due to defective screens.

17.2 Radiographs shall be evaluated for acceptability in accordance with applicable code or project specifications.

17.3 Where a radiograph indicates discontinuities, the discontinuities shall be classified and recorded.

17.4 When a radiograph indicates a defect requiring repair, and when requested by the Customer, the repair area shall be marked on the component and/or a sketch or trace of the repair area shall be prepared.

17.5 Repaired areas shall be re-inspected by a process that is at least as sensitive as the original process.

## 18.0 **REPORTS**

18.1 The results of all radiographic inspections shall be recorded.

18.1.1 As a minimum, the information recorded on reports shall include;

(a) Applicable referencing code,
(b) Inspection procedure specification and revision number,
(c) Inspection technique,
(d) Provisions for traceability of the specific part or lot inspected, such information is to include the part name or number, line number, drawing number, elevation or location, or any such information used in the identification of a component,
(e) The location and classification of relevant indications,
(f) The inspector's signature and certification level, and,
(g) The date of inspection.

18.2 As standard policy, the customer/client shall receive the completed radiographs with the original of any report and a copy of that report is to be retained and placed on file at the offices of Technico.

18.3 Refer to Appendix "A" which includes copies of the standard report forms to be used for radiographic inspections and also related forms associated with the test method.

# APPENDIX A

NON-DESTRUCTIVE TESTING · INSPECTION · HEAT TREATMENT
Technico
QUALITY ASSURANCE · ENGINEERING

# RADIOGRAPHY REPORT

| | | | |
|---|---|---|---|
| Customer | | | Date Inspected D M Y |
| Project | | | Report No. / Page Of |
| | | | Job No. |
| | | | % Radiography Required |

| | | | | | | |
|---|---|---|---|---|---|---|
| ☐ Ir 192<br>☐ Co 60 | Isotope Intensity Ci | Procedure No. **QC-TOP-RT-1 Rev. 2** | Film | Processing Manual ☐ Automatic ☐ | Line No. | Material |
| ☐ X-Ray | KV / MA | Focal Spot | Code/Spec. | | Dwg/Iso. No. | Before PWHT ☐ After PWHT ☐ N/A ☐ |

| Technique No. | SFD / FFD | IQI | Component Description & Wall Thickness | Identification No. | Welder's Symbol | Film Location Markers | RESULTS ACCEPT | RESULTS REJECT | Film Artifact | Crack | Lack of Fusion | Lack of Penetration | Excess Penetration | Porosity | Slag | Tungsten Inclusion | Concave Root | Undercut Internal | Undercut External | High Low | Linear indication | Burn Through | Hollow Bead | Cold Lap | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
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| Radiographer CGSB Level 1 ☐ 2 ☐ 3 ☐ | D M Y | Interpreter CGSB Level 1 ☐ 2 ☐ 3 ☐ | D M Y | Customer Representative | D M Y | Authorized / Jurisdictional Inspector | D M Y |
|---|---|---|---|---|---|---|---|
| | | | | | | | |

(FORM 400 REV 3)

# RADIOGRAPHIC TECHNIQUE DATA SHEET

Technique No.:

Rev: Page Of

| | |
|---|---|
| RADIATION SOURCE: | REFERENCES: |
| EXPOSURES: | SENSITIVITY: |
| Ug: | IQI (Penetrameter): |
| FFD / SFD: | IQI PLACEMENT: |
| ANGULATION: | SHIMS: |
| FILM: | MARKER PLACEMENT AND SPACING: |
| DENSITY: | EXPOSURE TIME: |
| SCREENS: | |

| SIGNATURES | TITLE | CERTIFICATION | LEVEL | DATE D M Y |
|---|---|---|---|---|
| Prepared By: | | | | |
| Approved By: | | | | |
| Approved By: | | | | |
| Approved By: | | | | |
| | | | | |

(FORM 440 REV 3)

# APPENDIX B

R.T. TECHNIQUES

**B-1** The techniques included in this appendix have been developed and approved for use in conjunction with Technico's - Radiographic Examination (General) Procedure QC-TOP-RT-1.

**B-2** From time to time techniques will be developed in order to accommodate special circumstances associated with customer specifications. The development of any such technique will be done in accordance with this procedure.

After the successful development of a technique a Technique Data Sheet shall be produced and all the relative information acquired during development shall be included with the data sheet and subsequently incorporated into this appendix.

**B-3** When an array of components in a circle is radiographed, at least one penetrameter shall show on each component image.

NON-DESTRUCTIVE TESTING • HEAT TREATMENT • INSPECTION
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# RADIOGRAPHIC TECHNIQUE DATA SHEET

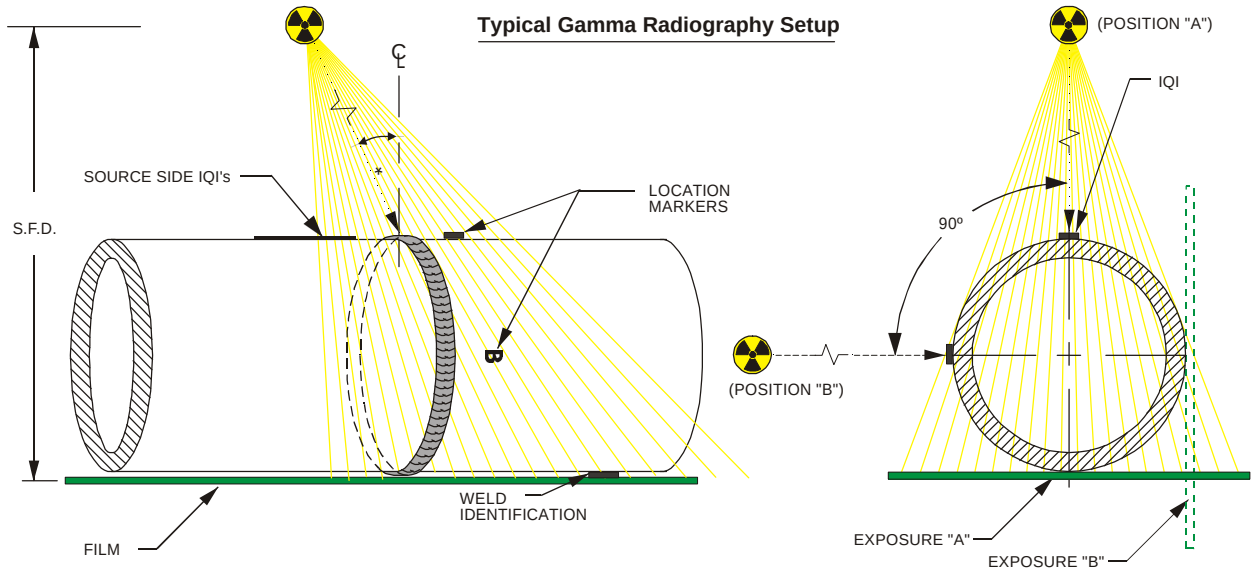
**DOUBLE WALL EXPOSURE, DOUBLE WALL VIEWING**
**ELLIPTICAL TECHNIQUE**
**FOR PIPE BUTT WELDS 3½" (90 mm) OD OR LESS**

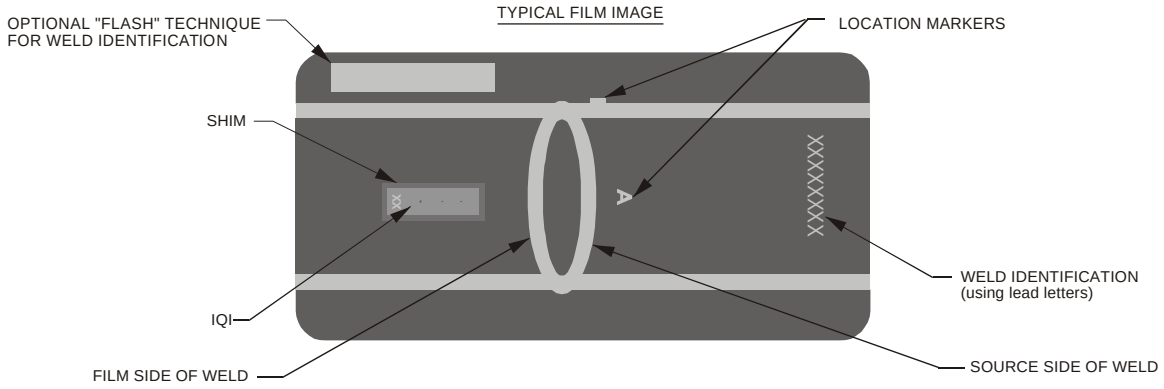
**Technique No.:** RT-1

**Rev:** 03 **Page** 1 **Of** 1

| | | | |
|---|---|---|---|
| **RADIATION SOURCE:** | Gamma or X-Ray | **REFERENCES:** | ASME Sect. V, Art. 1, 2 & 22<br>Technico Procedure QC-TOP-RT-1 |
| **EXPOSURES:** | Two, 90º apart | **SENSITIVITY:** | As required by code and project specifications |
| **Ug:** | As determined by using the formula Ug=Fd/D | **IQI (Penetrameter):** | Either hole type or wire type as required by code and project specifications |
| **FFD/SFD:** | By calculation to satisy code Ug requirements | **IQI PLACEMENT:** | Source side |
| ***ANGULATION:** | 10º to 20º (typical) offset such that the source side and the film side of the weld will not overlap | **SHIMS:** | Shim (if required) with radiographically similar material to match component thickness |
| **FILM:** | Type 1 or 2 recommended or as required by project specifications | **MARKER PLACEMENT AND SPACING:** | Adjacent to weld with spacing to ensure 100% coverage |
| **DENSITY:** | As required by code and project specifications | **EXPOSURE TIME:** | By calculation |
| **SCREENS:** | Lead 0.010" front and back | | |

**Typical Gamma Radiography Setup**




| SIGNATURES | TITLE | CERTIFICATION | LEVEL | DATE D M Y |
|---|---|---|---|---|
| **Prepared By:** Pat Heeney / Ron RIchard | | CGSB | 2 | 12 \| 04 \| 2000 |
| **Approved By:** Tom Boudreau | Operations Manager | CGSB | 2 | 13 \| 04 \| 2000 |
| **Approved By:** Ron Richard | General Manager | | | 13 \| 04 \| 2000 |
| **Approved By:** Kelth Folkins, P.Eng. | QA Manager | | | 13 \| 04 \| 2000 |
| **AUTHORIZED INSPECTOR:** | | | | |

# RADIOGRAPHIC TECHNIQUE DATA SHEET

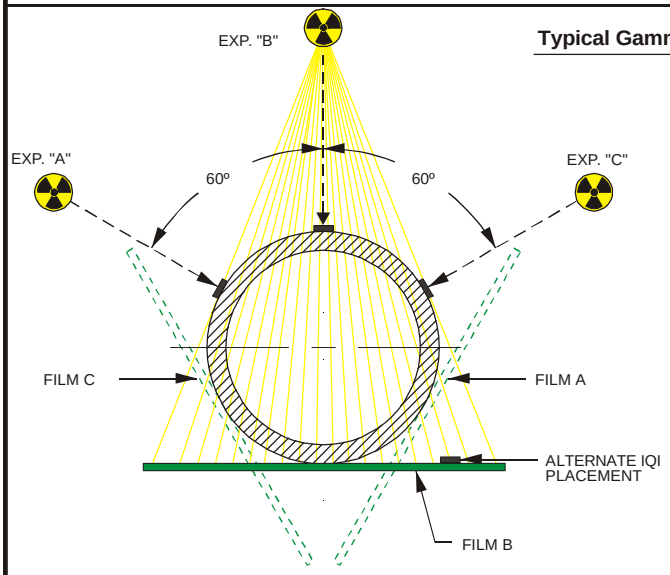
**DOUBLE WALL EXPOSURE, DOUBLE WALL VIEWING**
**SUPERIMPOSED TECHNIQUE**
**FOR PIPE BUTT OR SOCKET WELDS 3½" (90 mm) OR LESS**

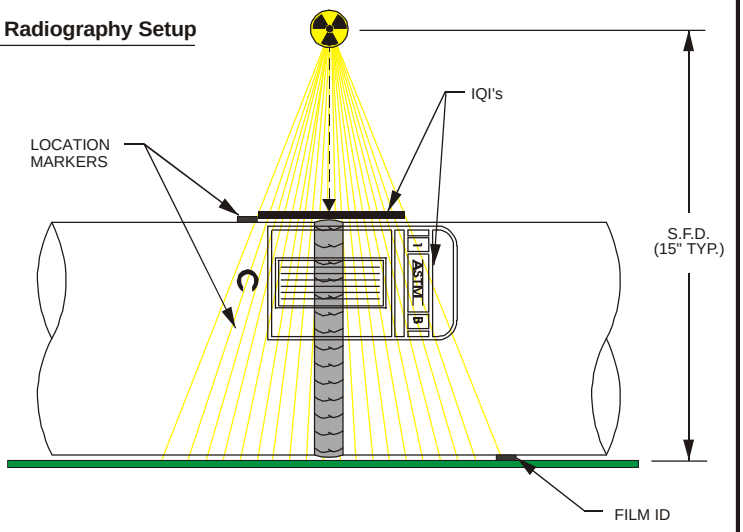
**Technique No.:** RT-2

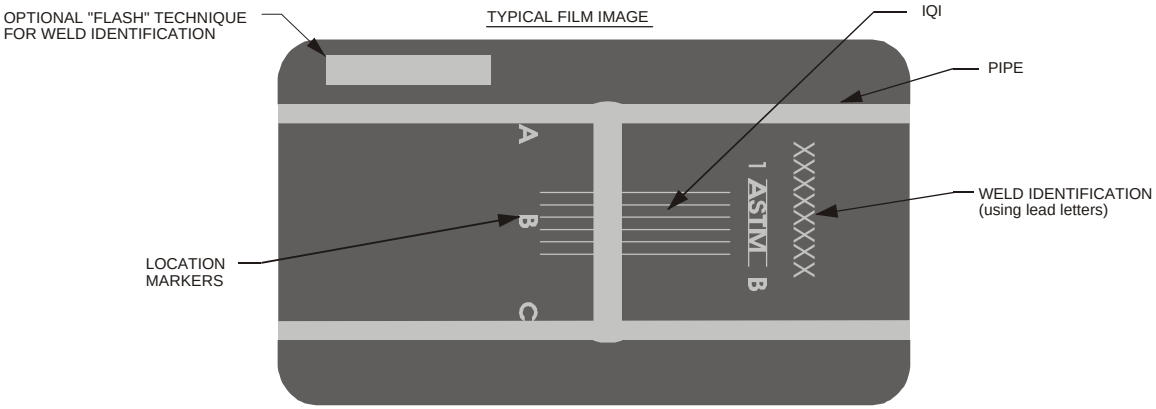
**Rev:** 02 **Page** 1 **Of** 1

| | | | |
|---|---|---|---|
| **RADIATION SOURCE:** | Gamma or X-Ray | **REFERENCES:** | ASME Sect. V, Art. 1, 2 & 22<br>Technico Procedure QC-TOP-RT-1 |
| **EXPOSURES:** | Minimum of three or sufficient number to satisfy coverage and Ug requirements | **SENSITIVITY:** | As required by code and project specifications |
| **Ug:** | As determined by using the formula Ug=Fd/D | **IQI (Penetrameter):** | Either hole type or wire type as required by code and project specifications |
| **FFD/SFD:** | By calculation to satisy code Ug requirements | **IQI PLACEMENT:** | Source side preferred<br>(film side identified with lead letter "F") |
| **ANGULATION:** | 0º to weld | **SHIMS:** | Shim (if required) with radiographically similar material to match component thickness |
| **FILM:** | Type 1 or 2 recommended or as required by project specifications | **MARKER PLACEMENT AND SPACING:** | Adjacent to weld with spacing to ensure 100% coverage |
| **DENSITY:** | As required by code and project specifications | **EXPOSURE TIME:** | By calculation |
| **SCREENS:** | Lead 0.010" front and back | | |

**Typical Gamma Radiography Setup**




| SIGNATURES | | TITLE | CERTIFICATION | LEVEL | DATE D | M | Y |
|---|---|---|---|---|---|---|---|
| **Prepared By:** | Pat Heeney / Ron Richard | | CGSB | 2 | 07 | 09 | 1999 |
| **Approved By:** | Tom Boudreau | Operations Manager | CGSB | 2 | 08 | 09 | 1999 |
| **Approved By:** | Ron Richard | General Manager | | | 08 | 09 | 1999 |
| **Approved By:** | Keith Folkins, P.Eng. | QA Manager | | | 08 | 09 | 1999 |
| | | | | | | | |

# RADIOGRAPHIC TECHNIQUE DATA SHEET

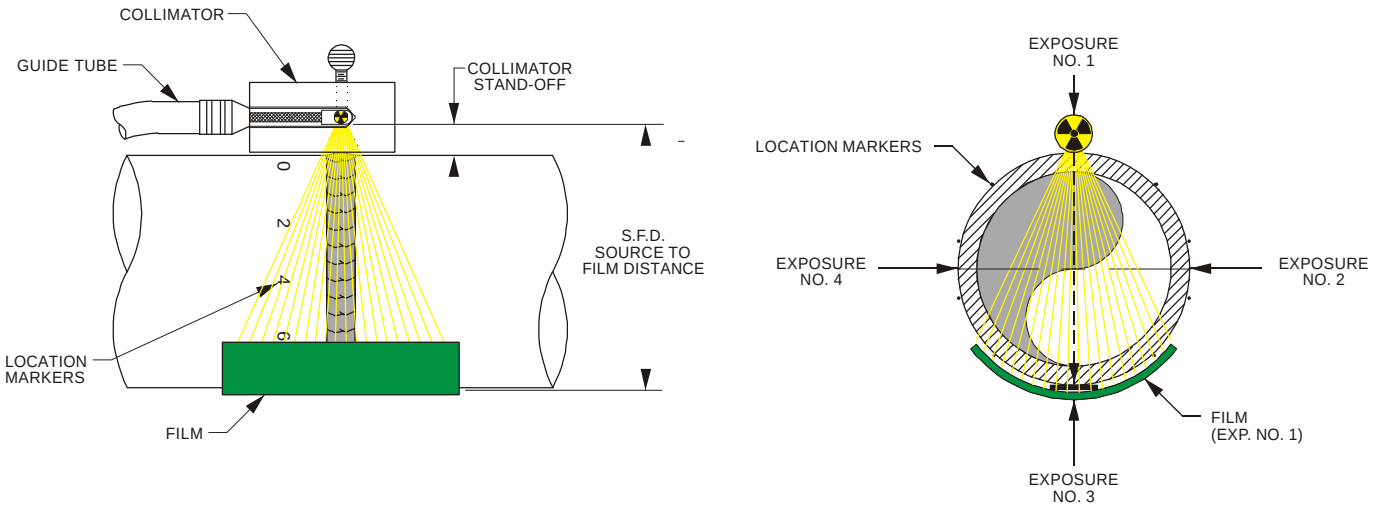
**DOUBLE WALL EXPOSURE, SINGLE WALL VIEWING TECHNIQUE FOR CYLINDRICAL COMPONENTS (i.e. Pipe, Vessels, etc.) 6" (150 mm) DIAMETER OR LARGER**

**Technique No.:** RT-3

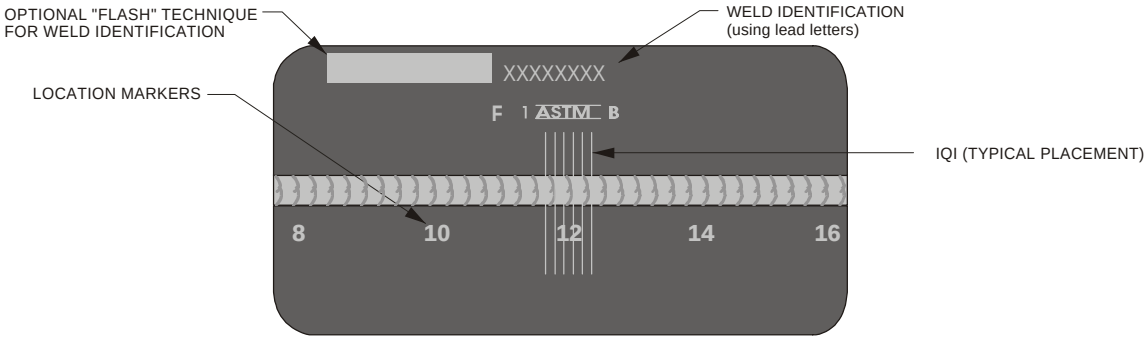
**Rev:** 03 **Page** 1 **Of** 1

| | | | |
|---|---|---|---|
| **RADIATION SOURCE:** | Gamma or X-Ray | **REFERENCES:** | ASME Sect. V, Art. 1, 2 & 22<br>Technico Procedure QC-TOP-RT-1 |
| **EXPOSURES:** | Minimum of three or sufficient number to satisfy coverage and Ug requirements | **SENSITIVITY:** | As required by code and project specifications |
| **Ug:** | As determined by using the formula Ug=Fd/D | **IQI (Penetrameter):** | Either hole type or wire type as required by code and project specifications |
| **FFD/SFD:** | Outside diameter or pipe/vessel plus weld reinforcement and collimator stand-off | **IQI PLACEMENT:** | Film side (identified with lead letter "F") |
| **ANGULATION:** | 90º to weld | **SHIMS:** | Shim (if required) with radiographically similar material to match component thickness |
| **FILM:** | Type 1 or 2 recommended or as required by project specifications | **MARKER PLACEMENT AND SPACING:** | Adjacent to weld with spacing to ensure 100% coverage |
| **DENSITY:** | As required by code and project specifications | **EXPOSURE TIME:** | By calculation |
| **SCREENS:** | Lead 0.010" front and back | | |

**Typical Gamma Radiography Setup**




TYPICAL FILM IMAGE




| SIGNATURES | TITLE | CERTIFICATION | LEVEL | DATE D M Y |
|---|---|---|---|---|
| **Prepared By:** Pat Heeney / Ron Richard | | CGSB | 2 | 07 \| 09 \| 1999 |
| **Approved By:** Tom Boudreau | Operations Manager | CGSB | 2 | 08 \| 09 \| 1999 |
| **Approved By:** Ron Richard | General Manager | | | 08 \| 09 \| 1999 |
| **Approved By:** Kelth Folkins, P.Eng. | QA Manager | | | 08 \| 09 \| 1999 |
| **AUTHORIZED INSPECTOR:** | | | | |

# RADIOGRAPHIC TECHNIQUE DATA SHEET

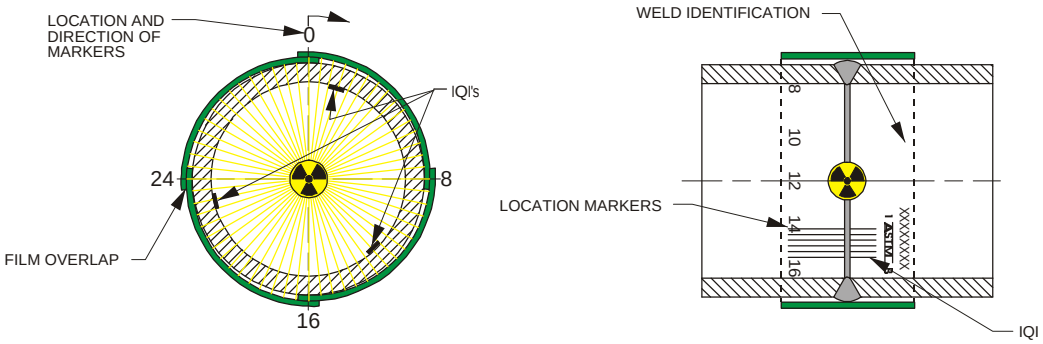
**SINGLE WALL EXPOSURE, SINGLE WALL VIEWING TECHNIQUE FOR CYLINDRICAL COMPONENTS (i.e. Pipe, Vessels, Tanks, etc.)**

**Technique No.:** RT-4

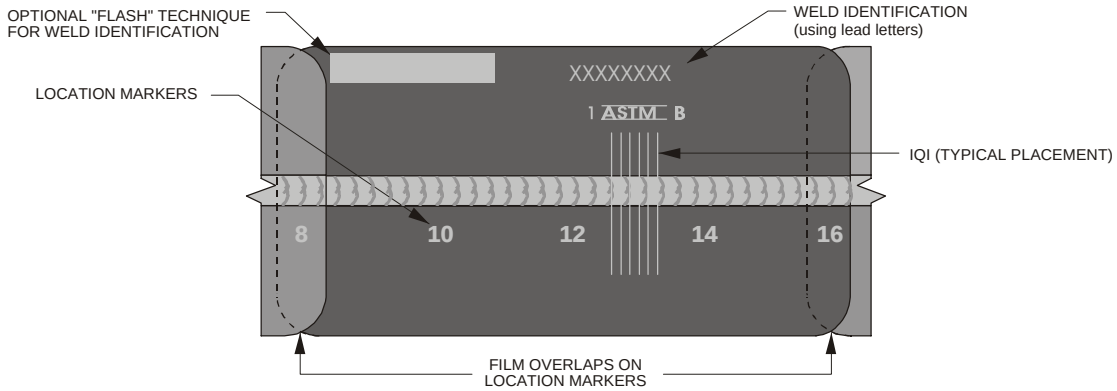
**Rev:** 03 **Page** 1 **Of** 1

| | | | |
|---|---|---|---|
| **RADIATION SOURCE:** | Gamma or X-Ray | **REFERENCES:** | ASME Sect. V, Art. 1, 2 & 22<br>Technico Procedure QC-TOP-RT-1 |
| **EXPOSURES:** | One exposure with source centrally located within component | **SENSITIVITY:** | As required by code and project specifications |
| **Ug:** | As determined by using the formula Ug=Fd/D | **IQI (Penetrameter):** | Minimum of 3 (hole or wire type) placed 120º apart or as required by code and project specifications |
| **FFD/SFD:** | Equal to internal radius plus material thickness | **IQI PLACEMENT:** | Source side preferred, film side to be identified with lead letter "F" |
| **ANGULATION:** | 90º to weld | **SHIMS:** | Shim (if required) with radiographically similar material to match component thickness |
| **FILM:** | Type 1 or 2 recommended or as required by project specifications | **MARKER PLACEMENT AND SPACING:** | Adjacent to weld with spacing to ensure 100% coverage (source or film side) |
| **DENSITY:** | As required by code and project specifications | **EXPOSURE TIME:** | By calculation |
| **SCREENS:** | Lead 0.010" front and back | | |

**Typical Gamma Radiography Setup**




TYPICAL FILM IMAGE



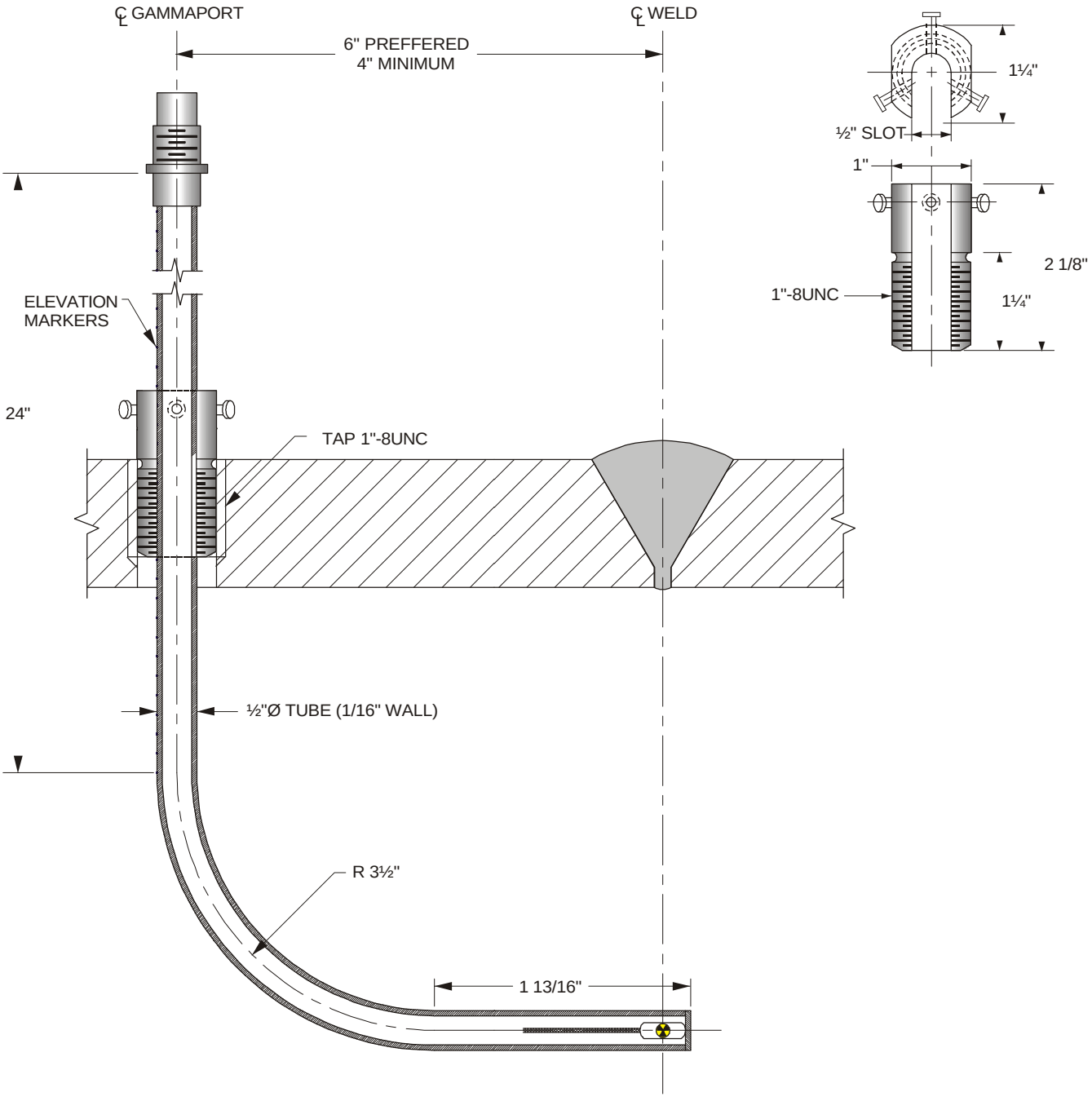

| SIGNATURES | TITLE | CERTIFICATION | LEVEL | DATE D M Y |
|---|---|---|---|---|
| **Prepared By:** Pat Heeney / Ron Richard | | CGSB | 2 | 07 \| 09 \| 1999 |
| **Approved By:** Tom Boudreau | Operations Manager | CGSB | 2 | 08 \| 09 \| 1999 |
| **Approved By:** Ron Richard | General Manager | | | 08 \| 09 \| 1999 |
| **Approved By:** Keith Folkins, P.Eng. | QA Manager | | | 08 \| 09 \| 1999 |
| | | | | |

# RADIOGRAPHIC TECHNIQUE DATA SHEET

GAMMA PORT J-TUBE DESIGN
TO BE USED WITH RT-4 AD1

Technique No.: RT-4

Addendum: 1 Rev.: 01




| SIGNATURES | | TITLE | CERTIFICATION | LEVEL | DATE D M Y |
|---|---|---|---|---|---|
| Prepared By: | Pat Heeney / Ron RIchard | | CGSB | 2 | 07 \| 09 \| 1999 |
| Approved By: | Tom Boudreau | Operatlons Manager | CGSB | 2 | 08 \| 09 \| 1999 |
| Approved By: | Ron Richard | General Manager | | | 08 \| 09 \| 1999 |
| Approved By: | Kelth Folkins, P.Eng. | QA Manager | | | 08 \| 09 \| 1999 |
| | | | | | |

# RADIOGRAPHIC TECHNIQUE DATA SHEET

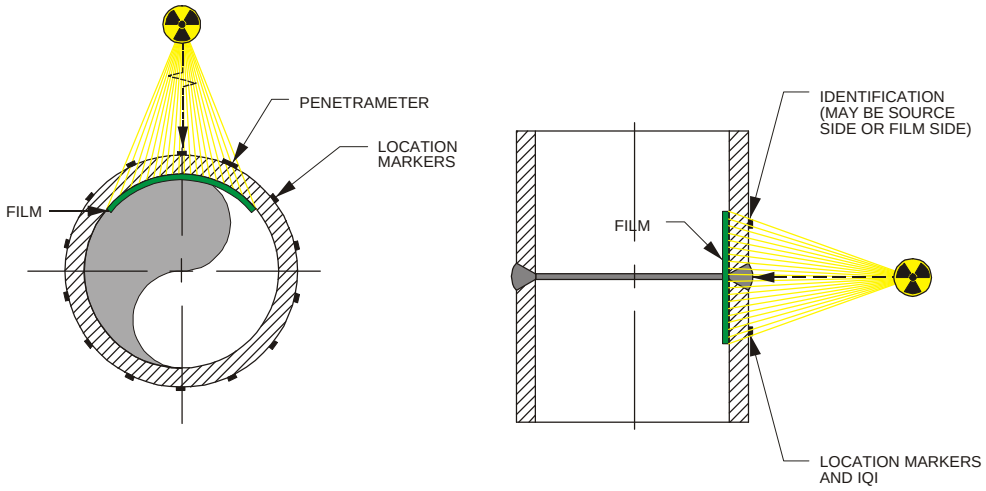
**SINGLE WALL EXPOSURE, SINGLE WALL VIEWING TECHNIQUE**
**EXTERNAL SOURCE PLACEMENT**
**FOR CYLINDRICAL COMPONENTS (i.e. Pipe, Vessels, etc.)**

**Technique No.:** RT-5

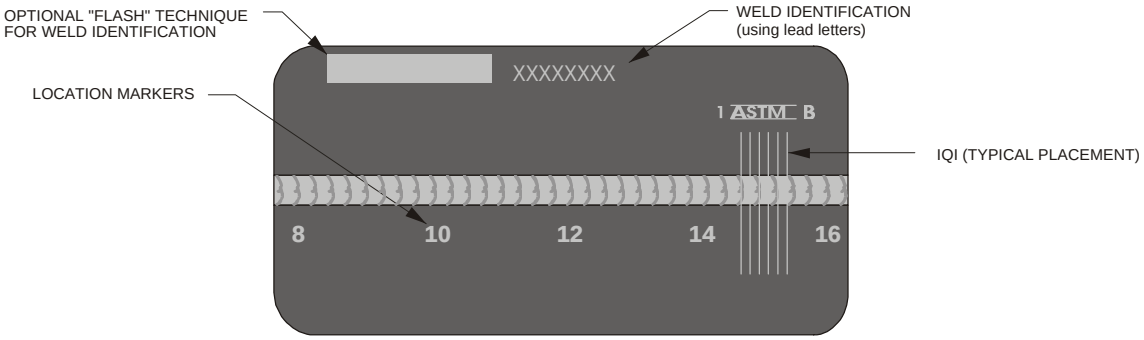
**Rev:** 03 **Page** 1 **Of** 1

| | | | |
|---|---|---|---|
| **RADIATION SOURCE:** | Gamma or X-Ray | **REFERENCES:** | ASME Sect. V, Art. 1, 2 & 22<br>Technico Procedure QC-TOP-RT-1 |
| **EXPOSURES:** | Minimum of three or sufficient number to satisfy coverage and Ug requirements | **SENSITIVITY:** | As required by code and project specifications |
| **Ug:** | As determined by using the formula Ug=Fd/D | **IQI (Penetrameter):** | Either hole type or wire type as required by code and project specifications |
| **FFD/SFD:** | By calculation to satisy code Ug requirements | **IQI PLACEMENT:** | Source side preferred, film side to be identified with lead leter "F" |
| **ANGULATION:** | 90º to weld | **SHIMS:** | Shim (if required) with radiographically similar material to match component thickness |
| **FILM:** | Type 1 or 2 recommended or as required by project specifications | **MARKER PLACEMENT AND SPACING:** | Adjacent to weld with spacing to ensure 100% coverage (film side preferred) |
| **DENSITY:** | As required by code and project specifications | **EXPOSURE TIME:** | By calculation |
| **SCREENS:** | Lead 0.010" front and back | | |

**Typical Gamma Radiography Setup**




TYPICAL FILM IMAGE




| SIGNATURES | TITLE | CERTIFICATION | LEVEL | DATE D M Y |
|---|---|---|---|---|
| **Prepared By:** Pat Heeney / Ron RIchard | | CGSB | 2 | 07 \| 09 \| 1999 |
| **Approved By:** Tom Boudreau | Operatlons Manager | CGSB | 2 | 08 \| 09 \| 1999 |
| **Approved By:** Ron Richard | General Manager | | | 08 \| 09 \| 1999 |
| **Approved By:** Kelth Folkins, P.Eng. | QA Manager | | | 08 \| 09 \| 1999 |
| | | | | |

# RADIOGRAPHIC TECHNIQUE DATA SHEET

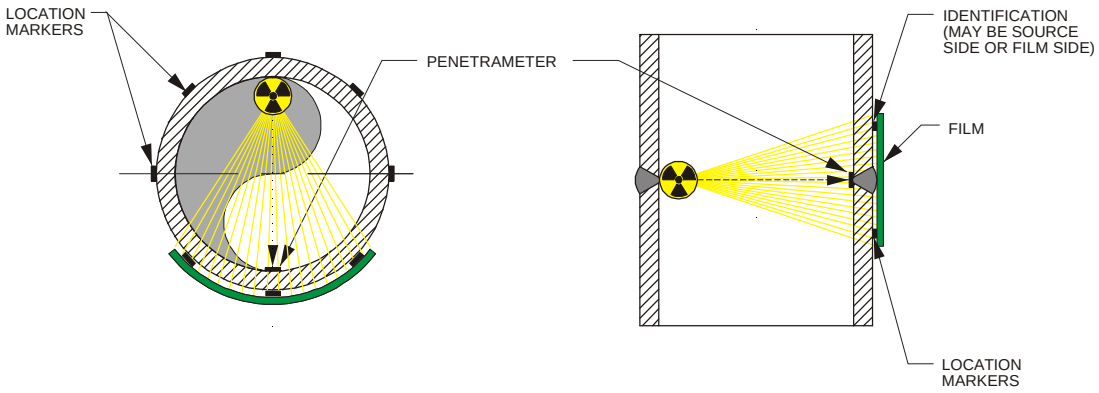
**SINGLE WALL EXPOSURE, SINGLE WALL VIEWING TECHNIQUE**
**INTERNAL SOURCE PLACEMENT**
**FOR CYLINDRICAL COMPONENTS (i.e. Pipe, Vessels, etc.)**

**Technique No.:** RT-6

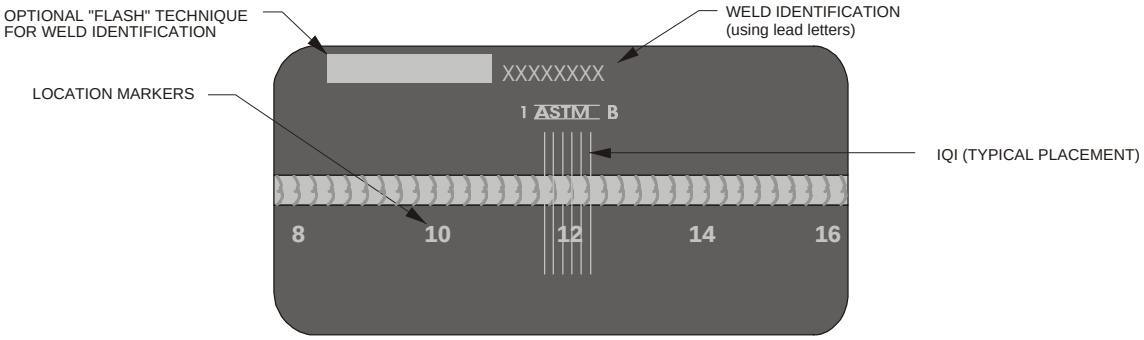
**Rev:** 03 **Page** 1 **Of** 1

| | | | |
|---|---|---|---|
| **RADIATION SOURCE:** | Gamma or X-Ray | **REFERENCES:** | ASME Sect. V, Art. 1, 2 & 22<br>Technico Procedure QC-TOP-RT-1 |
| **EXPOSURES:** | Minimum of three or sufficient number to satisfy coverage and Ug requirements | **SENSITIVITY:** | As required by code and project specifications |
| **Ug:** | As determined by using the formula Ug=Fd/D | **IQI (Penetrameter):** | Either hole type or wire type as required by code and project specifications |
| **FFD/SFD:** | By calculation to satisy code Ug requirements | **IQI PLACEMENT:** | Source side preferred, film side to be identified with lead letter "F" |
| **ANGULATION:** | 90º to weld | **SHIMS:** | Shim (if required) with radiographically similar material to match component thickness |
| **FILM:** | Type 1 or 2 recommended or as required by project specifications | **MARKER PLACEMENT AND SPACING:** | Adjacent to weld with spacing to ensure 100% coverage |
| **DENSITY:** | As required by code and project specifications | **EXPOSURE TIME:** | By calculation |
| **SCREENS:** | Lead 0.010" front and back | | |

**Typical Gamma Radiography Setup**




TYPICAL FILM IMAGE




| SIGNATURES | TITLE | CERTIFICATION | LEVEL | DATE D M Y |
|---|---|---|---|---|
| **Prepared By:** Pat Heeney / Ron RIchard | | CGSB | 2 | 07 \| 09 \| 1999 |
| **Approved By:** Tom Boudreau | Operatlons Manager | CGSB | 2 | 08 \| 09 \| 1999 |
| **Approved By:** Ron Richard | General Manager | | | 08 \| 09 \| 1999 |
| **Approved By:** Kelth Folkins, P.Eng. | QA Manager | | | 08 \| 09 \| 1999 |
| | | | | |

# RADIOGRAPHIC TECHNIQUE DATA SHEET

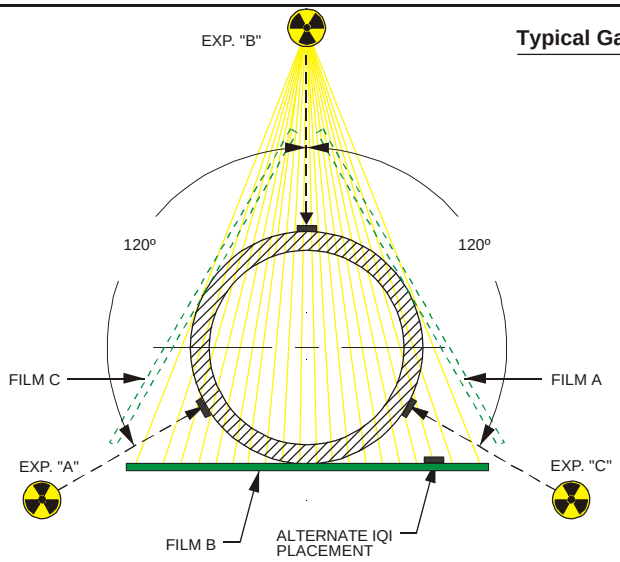
**DOUBLE WALL EXPOSURE, DOUBLE WALL VIEWING**
**SUPERIMPOSED TECHNIQUE**
**FOR PIPE BUTT OR SOCKET WELDS 3½" (90 mm) OR LESS**

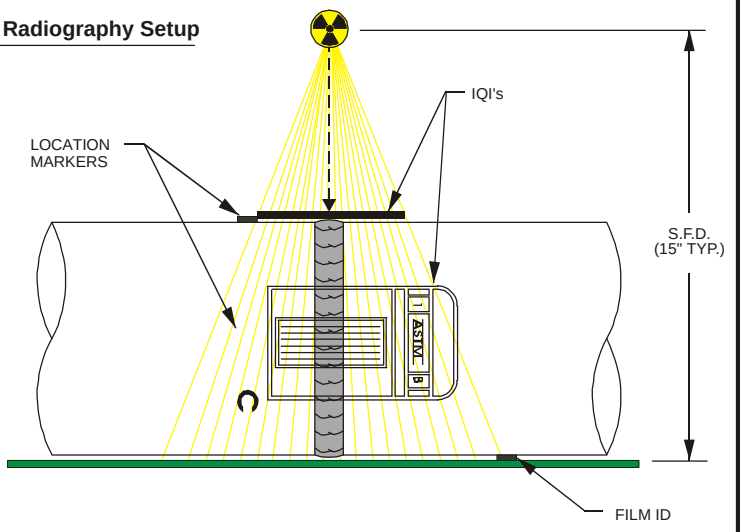
**Technique No.:** RT-7

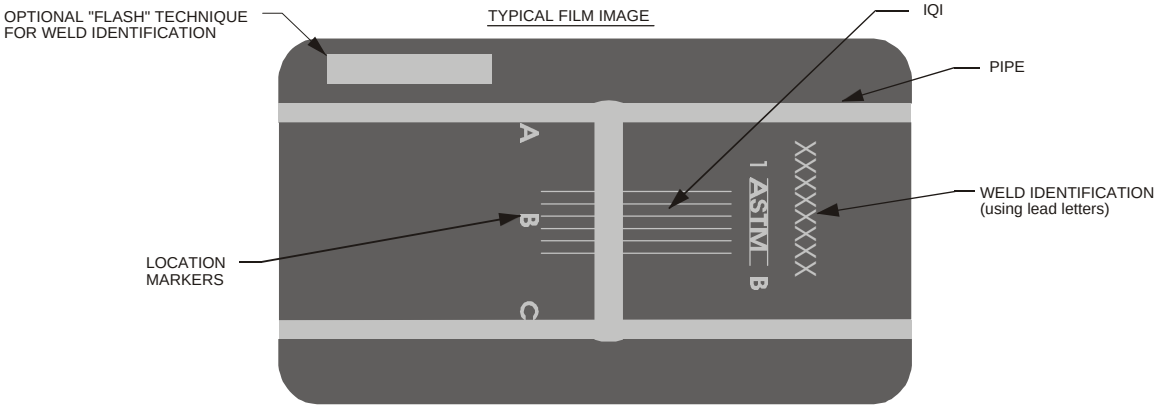
**Rev:** 00 **Page** 1 **Of** 1

| | | | |
|---|---|---|---|
| **RADIATION SOURCE:** | Gamma or X-Ray | **REFERENCES:** | ASME Sect. V, Art. 1, 2 & 22<br>Technico Procedure QC-TOP-RT-1 |
| **EXPOSURES:** | Minimum of three or sufficient number to satisfy coverage and Ug requirements | **SENSITIVITY:** | As required by code and project specifications |
| **Ug:** | As determined by using the formula Ug=Fd/D | **IQI (Penetrameter):** | Either hole type or wire type as required by code and project specifications |
| **FFD/SFD:** | By calculation to satisy code Ug requirements | **IQI PLACEMENT:** | Source side preferred<br>(film side identified with lead letter "F") |
| **ANGULATION:** | 0º to weld | **SHIMS:** | Shim (if required) with radiographically similar material to match component thickness |
| **FILM:** | Type 1 or 2 recommended or as required by project specifications | **MARKER PLACEMENT AND SPACING:** | Adjacent to weld with spacing to ensure 100% coverage |
| **DENSITY:** | As required by code and project specifications | **EXPOSURE TIME:** | By calculation |
| **SCREENS:** | Lead 0.010" front and back | | |

**Typical Gamma Radiography Setup**




| SIGNATURES | | TITLE | CERTIFICATION | LEVEL | DATE D M Y |
|---|---|---|---|---|---|
| **Prepared By:** | Pat Heeney / Ron RIchard | | CGSB | 2 | 07 \| 09 \| 1999 |
| **Approved By:** | Tom Boudreau | Operations Manager | CGSB | 2 | 08 \| 09 \| 1999 |
| **Approved By:** | Ron Richard | General Manager | | | 08 \| 09 \| 1999 |
| **Approved By:** | Kelth Folkins, P.Eng. | QA Manager | | | 08 \| 09 \| 1999 |
| | | | | | |

# RADIOGRAPHIC TECHNIQUE DATA SHEET

**PLATE**
**SINGLE WALL EXPOSURE, SINGLE VIEWING TECHNIQUE**

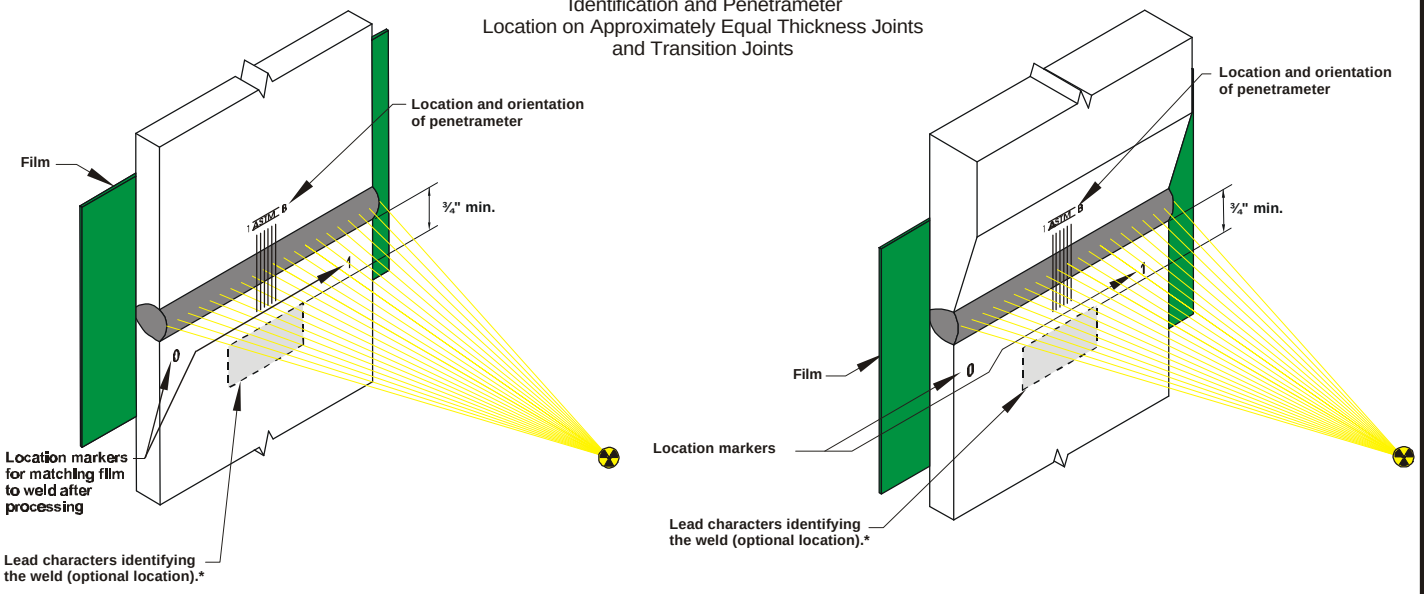
Technique No.: RT-10

Rev: 01 Page 1 Of 1

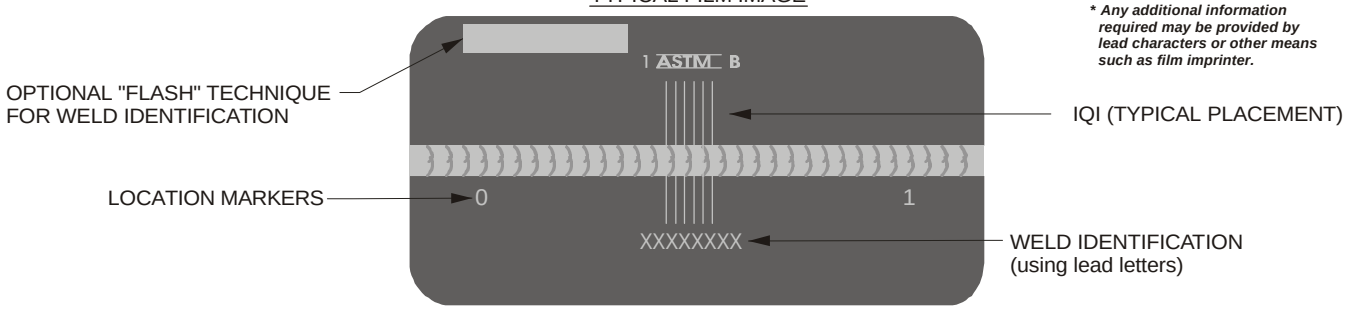
| | | | |
|---|---|---|---|
| RADIATION SOURCE: | Gamma or X-Ray | REFERENCES: | ASME Sect. V, Art. 1, 2 & 22<br>Technico Procedure QC-TOP-RT-1 |
| EXPOSURES: | One | SENSITIVITY: | As required by code and project specifications |
| Ug: | As determined by using the formula Ug=Fd/D | IQI (Penetrameter): | Either hole type or wire type as required by code and project specifications |
| FFD/SFD: | By calculation to satisfy Ug requirements | IQI PLACEMENT: | Source side |
| ANGULATION: | 90º to weld | SHIMS: | Shim (if required) with radiographically similar material to match component thickness |
| FILM: | Type 1 or 2 recommended or as required by project specifications | MARKER PLACEMENT AND SPACING: | Adjacent to weld with spacing to ensure 100% coverage |
| DENSITY: | As required by code and project specifications | EXPOSURE TIME: | By Calculation |
| SCREENS: | Lead 0.010" front and back | | |

## Typical Gamma Radiography Setup

Identification and Penetrameter
Location on Approximately Equal Thickness Joints
and Transition Joints




## TYPICAL FILM IMAGE




** Any additional information required may be provided by lead characters or other means such as film imprinter.*

| SIGNATURES | | TITLE | CERTIFICATION | LEVEL | DATE D M Y |
|---|---|---|---|---|---|
| Prepared By: | P. Heeney/R. Richard | | | | 15 \| 10 \|2002 |
| Approved By: | Tom Boudreau | Operations Manager | CGSB ACCP | 3 | 15 \| 10 \|2002 |
| Approved By: | Ron Richard | General Manager | CGSB ACCP | 3 | 15 \| 10 \|2002 |
| Approved By: | Kelth Folkins, P.Eng. | QA Manager | | | 15 \| 10 \|2002 |
| AUTHORIZED INSPECTOR: | | | | | |

# RADIOGRAPHIC TECHNIQUE DATA SHEET

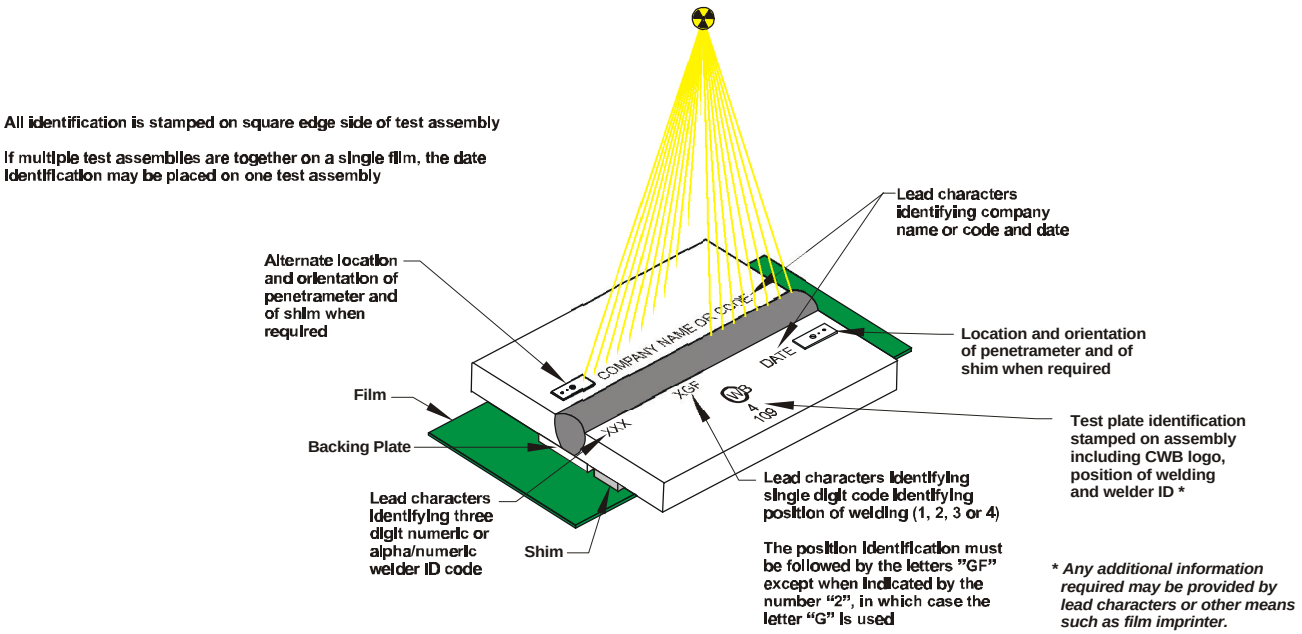
**CANADIAN WELDING BUREAU**
**WELDER'S TEST COUPON**
**a" PLATE WITH BACKING PLATE**

Technique No.: RT-12

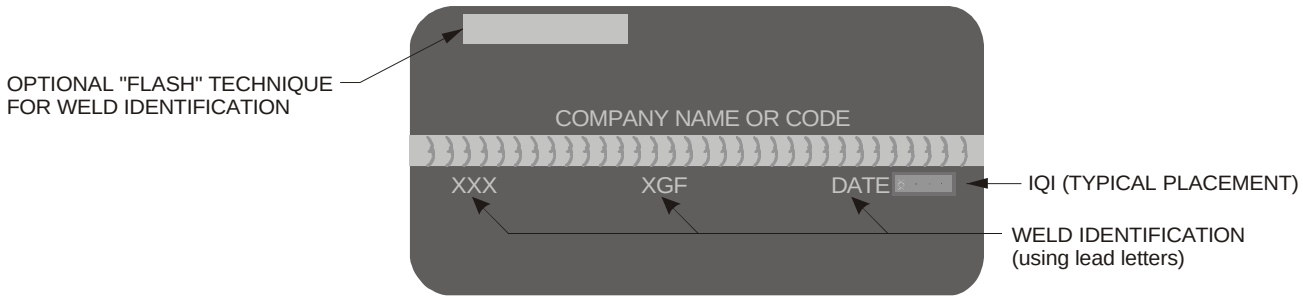
Rev: 01 Page 1 Of 1

| | | | |
|---|---|---|---|
| **RADIATION SOURCE:** | X-Ray | REFERENCES: | ASME Sect. V, Art. 1, 2 & 22, CSA W47.1<br>Technico Procedure QC-TOP-RT-1 |
| **EXPOSURES:** | One | SENSITIVITY: | 4T |
| **Ug:** | 0.005" (0.127 mm) maximum | IQI (Penetrameter): | ASTM 10 |
| **FFD/SFD:** | By calculation to satisy code Ug requirements | IQI PLACEMENT: | Source side preferred |
| **ANGULATION:** | 0º to weld | SHIMS: | Shim with radiographically similar material to match component thickness |
| **FILM:** | Type 1 or 2 recommended or as required by project specifications | MARKER PLACEMENT AND SPACING: | Adjacent to weld with spacing to ensure 100% coverage |
| **DENSITY:** | 1.5 to 3.5 | EXPOSURE TIME: | By calculation |
| **SCREENS:** | Lead 0.010" front and back | | |

**Typical Radiography Setup**




TYPICAL FILM IMAGE




| SIGNATURES | | TITLE | CERTIFICATION | LEVEL | DATE D | M | Y |
|---|---|---|---|---|---|---|---|
| **Prepared By:** | Pat Heeney / Ron RIchard | | | | 17 | 10 | 2002 |
| **Approved By:** | Tom Boudreau | Operatlons Manager | CGSB | 3 | 17 | 10 | 2002 |
| **Approved By:** | Ron Richard | General Manager | CGSB | 3 | 17 | 10 | 2002 |
| **Approved By:** | Kelth Folkins, P.Eng. | QA Manager | | | 17 | 10 | 2002 |
| | | | | | | | |

# RADIOGRAPHIC TECHNIQUE DATA SHEET

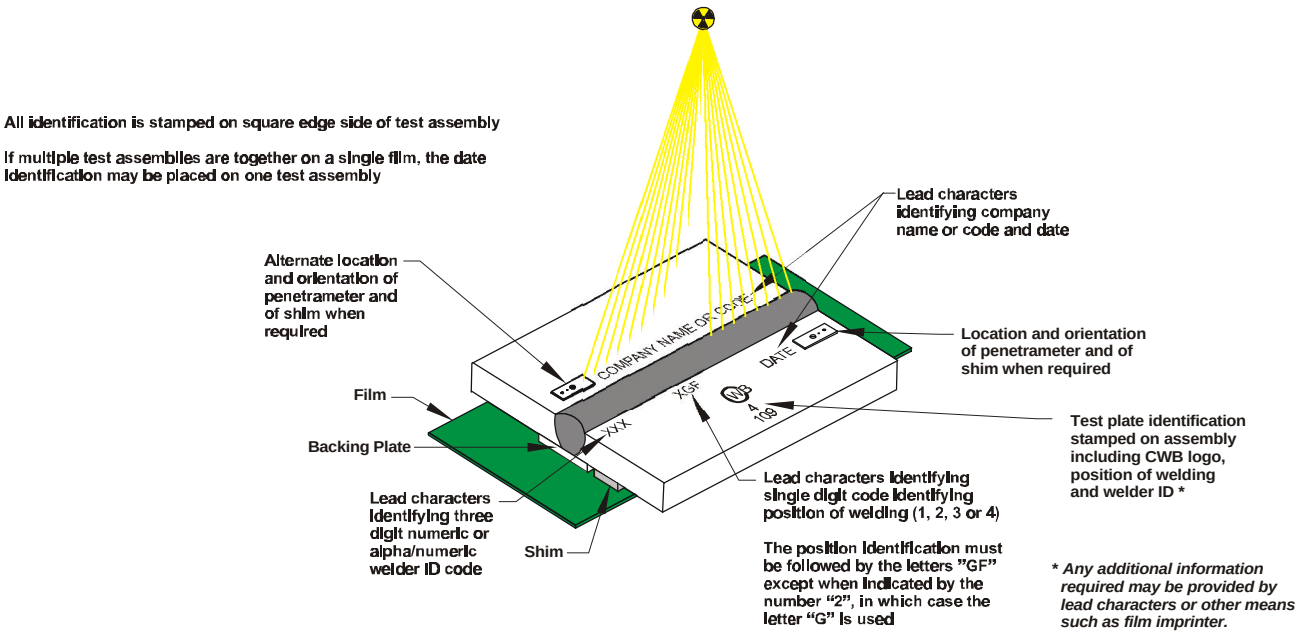
**CANADIAN WELDING BUREAU**
**WELDER'S TEST COUPON**
**½" PLATE WITH BACKING PLATE**

**Technique No.:** RT-13

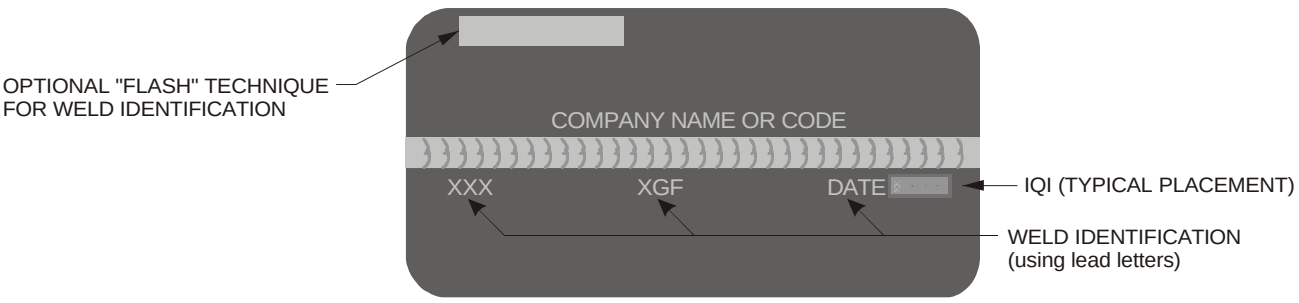
**Rev:** 01 **Page** 1 **Of** 1

| | | | |
|---|---|---|---|
| **RADIATION SOURCE:** | X-Ray | REFERENCES: | ASME Sect. V, Art. 1, 2 & 22, CSA W47.1<br>Technico Procedure QC-TOP-RT-1 |
| **EXPOSURES:** | One | SENSITIVITY: | 4T |
| **Ug:** | 0.005" (0.127 mm) maximum | IQI (Penetrameter): | ASTM 12 |
| **FFD/SFD:** | By calculation to satisfy code Ug requirements | IQI PLACEMENT: | Source side preferred |
| **ANGULATION:** | 0º to weld | SHIMS: | Shim with radiographically similar material to match component thickness |
| **FILM:** | Type 1 or 2 recommended or as required by project specifications | MARKER PLACEMENT AND SPACING: | Adjacent to weld with spacing to ensure 100% coverage |
| **DENSITY:** | 1.5 to 3.5 | EXPOSURE TIME: | By calculation |
| **SCREENS:** | Lead 0.010" front and back | | |

## Typical Radiography Setup




## TYPICAL FILM IMAGE




| SIGNATURES | TITLE | CERTIFICATION | LEVEL | DATE D M Y |
|---|---|---|---|---|
| **Prepared By:** Pat Heeney / Ron RIchard | | | | 17 \| 10 \| 2002 |
| **Approved By:** Tom Boudreau | Operatlons Manager | CGSB | 3 | 17 \| 10 \| 2002 |
| **Approved By:** Ron Richard | General Manager | CGSB | 3 | 17 \| 10 \| 2002 |
| **Approved By:** Kelth Folkins, P.Eng. | QA Manager | | | 17 \| 10 \| 2002 |
| | | | | |

# RADIOGRAPHIC TECHNIQUE DATA SHEET

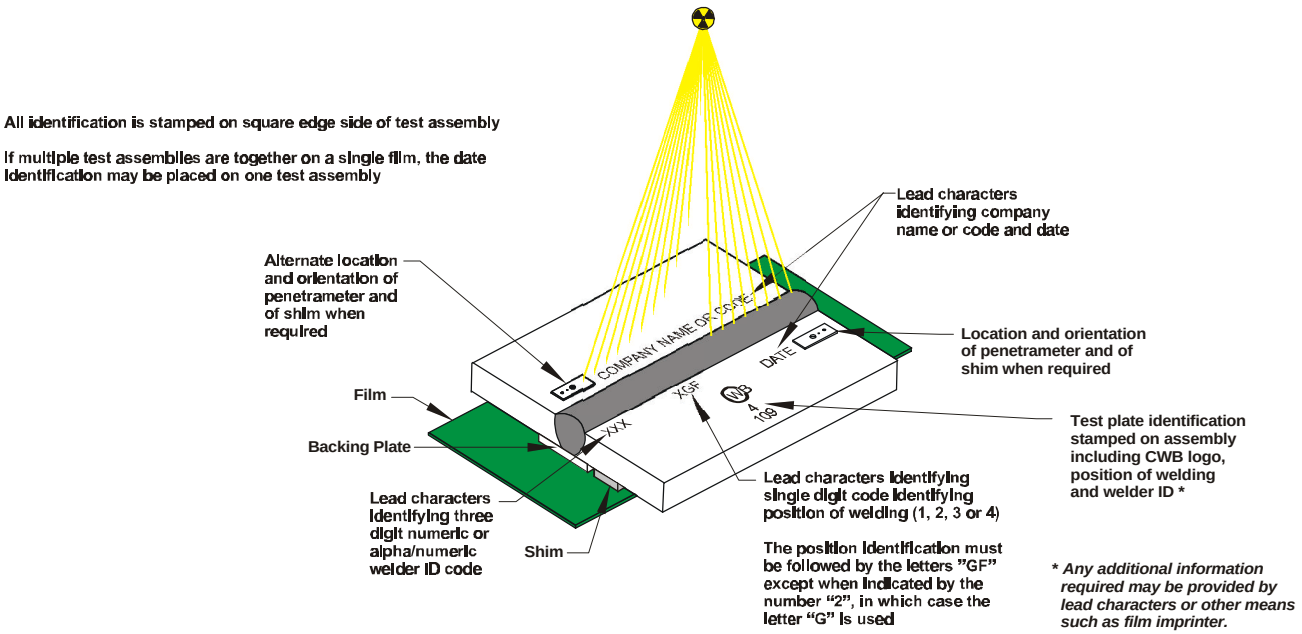
**CANADIAN WELDING BUREAU**
**WELDER'S TEST COUPON**
**¾" PLATE WITH BACKING PLATE**

**Technique No.:** RT-14

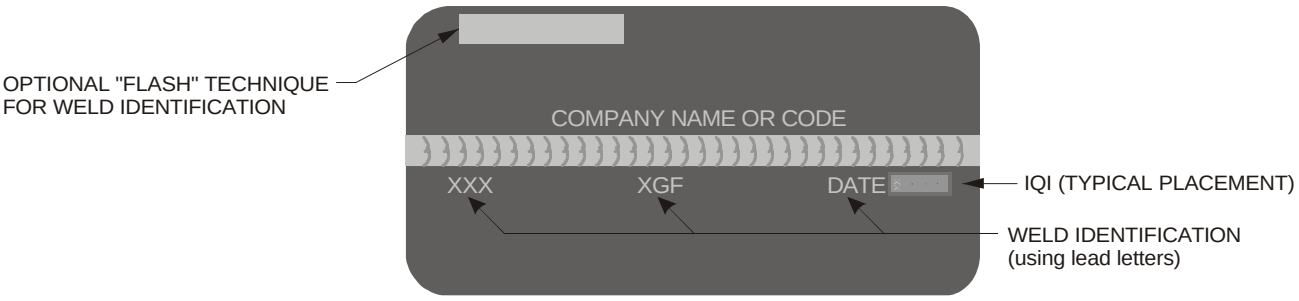
**Rev:** 01 **Page** 1 **Of** 1

| | | | |
|---|---|---|---|
| **RADIATION SOURCE:** | Gamma - Iridium$^{192}$ | REFERENCES: | ASME Sect. V, Art. 1, 2 & 22, CSA W47.1<br>Technico Procedure QC-TOP-RT-1 |
| **EXPOSURES:** | One | SENSITIVITY: | 4T |
| **Ug:** | 0.010" (0.254 mm) maximum | IQI (Penetrameter): | ASTM 17 |
| **FFD/SFD:** | By calculation to satisfy code Ug requirements | IQI PLACEMENT: | Source side preferred |
| **ANGULATION:** | 0º to weld | SHIMS: | Shim with radiographically similar material to match component thickness |
| **FILM:** | Type 1 or 2 recommended or as required by project specifications | MARKER PLACEMENT AND SPACING: | Adjacent to weld with spacing to ensure 100% coverage |
| **DENSITY:** | 2.0 to 4.0 | EXPOSURE TIME: | By calculation |
| **SCREENS:** | Lead 0.010" front and back | | |

**Typical Radiography Setup**



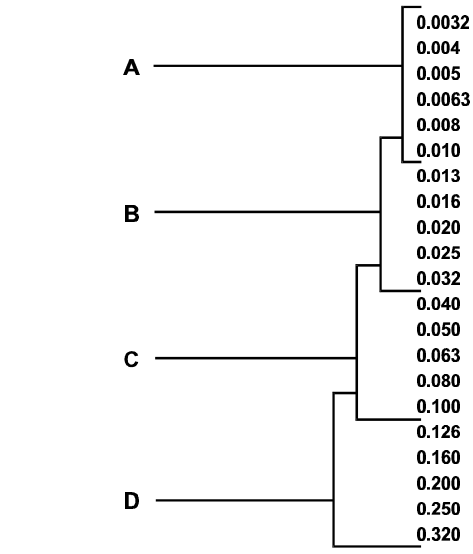

TYPICAL FILM IMAGE




| SIGNATURES | | TITLE | CERTIFICATION | LEVEL | DATE D | M | Y |
|---|---|---|---|---|---|---|---|
| **Prepared By:** | Pat Heeney / Ron RIchard | | | | 17 | 10 | 2002 |
| **Approved By:** | Tom Boudreau | Operations Manager | CGSB | 3 | 17 | 10 | 2002 |
| **Approved By:** | Ron Richard | General Manager | CGSB | 3 | 17 | 10 | 2002 |
| **Approved By:** | Kelth Folkins, P.Eng. | QA Manager | | | 17 | 10 | 2002 |
| | | | | | | | |

# IMAGE QUALITY INDICATOR (IQI) DESIGNATIONS

## WIRE IQI DESIGNATION AND WIRE DIAMETERS (in.)




Extracted from ASME 1998 Section V, Article 2, Table T-233.2
For additional information refer to ASTM E747-97

## HOLE TYPE IQI DESIGNATION, THICKNESS AND HOLE DIAMETERS (in.)

| Penetrameter Designation | Penetrameter Thickness | 1*T* Hole Diameter | 2*T* Hole Diameter | 4*T* Hole Diameter |
|---|---|---|---|---|
| 5 | 0.005 | 0.010 | 0.020 | 0.040 |
| 7 | 0.0075 | 0.010 | 0.020 | 0.040 |
| 10 | 0.010 | 0.010 | 0.020 | 0.040 |
| 12 | 0.0125 | 0.0125 | 0.025 | 0.050 |
| 15 | 0.015 | 0.015 | 0.030 | 0.060 |
| 17 | 0.0175 | 0.0175 | 0.035 | 0.070 |
| 20 | 0.020 | 0.020 | 0.040 | 0.080 |
| 25 | 0.025 | 0.025 | 0.050 | 0.100 |
| 30 | 0.030 | 0.030 | 0.060 | 0.120 |
| 35 | 0.035 | 0.035 | 0.070 | 0.140 |
| 40 | 0.040 | 0.040 | 0.080 | 0.160 |
| 45 | 0.045 | 0.045 | 0.090 | 0.180 |
| 50 | 0.050 | 0.050 | 0.100 | 0.200 |
| 60 | 0.060 | 0.060 | 0.120 | 0.240 |
| 80 | 0.080 | 0.080 | 0.160 | 0.320 |
| 100 | 0.100 | 0.100 | 0.200 | 0.400 |
| 120 | 0.120 | 0.120 | 0.240 | 0.480 |
| 160 | 0.160 | 0.160 | 0.320 | 0.640 |
| 200 | 0.200 | 0.200 | 0.400 | . . . |

Extracted from ASME 1998 Section V, Article 2, Table T-233.1
For additional information refer to ASTM E1025-95

## DIAMETER OF WIRE IQI CORRESPONDING TO HOLE TYPE (1*T*, 2*T*, 4*T*)

| Hole IQI No. | Diameter of Wire With Equivalent Penetrameter Sensitivity (EPS) of Hole (in.) | | |
|---|---|---|---|
| | 1*T* | 2*T* | 4*T* |
| 5 | . . . | . . . | 0.006 |
| 6 | . . . | 0.004 | . . . |
| 8 | 0.0032 | 0.005 | 0.008 |
| 10 | 0.004 | 0.006 | 0.010 |
| 12 | 0.005 | 0.008 | 0.013 |
| 15 | 0.006 | 0.010 | 0.016 |
| 17 | 0.008 | 0.013 | 0.020 |
| 20 | 0.010 | 0.016 | 0.025 |
| 25 | 0.013 | 0.020 | 0.032 |
| 30 | 0.016 | 0.025 | 0.040 |
| 35 | 0.020 | 0.032 | 0.050 |
| 40 | 0.025 | 0.040 | 0.063 |
| 50 | 0.032 | 0.050 | 0.080 |
| 60 | 0.040 | 0.063 | 0.100 |
| 70 | 0.050 | 0.080 | 0.126 |
| 80 | 0.063 | 0.100 | 0.160 |
| 100 | 0.080 | 0.126 | 0.200 |
| 120 | 0.100 | 0.160 | 0.250 |
| 140 | 0.126 | 0.200 | 0.320 |
| 160 | 0.160 | 0.250 | . . . |
| 200 | 0.200 | 0.320 | . . . |
| 240 | 0.250 | . . . | . . . |
| 280 | 0.320 | . . . | . . . |

Extracted from ASME 1998 Section V, Table B-220
For additional information refer to ASTM E747-97

# APPROXIMATE RADIOGRAPHIC EQUIVALENCE FACTORS FOR SEVERAL METALS (RELATIVE TO STEEL)*

| Metal | Energy Level | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 100 kV | 150 kV | 220 kV | 250 kV | 400 kV | 1 MV | 2 MV | 4 to 25 MV | $Ir^{192}$ | $Co^{60}$ |
| Magnesium | 0.05 | 0.05 | 0.08 | . . . | . . . | . . . | . . . | . . . | . . . | . . . |
| Aluminum | 0.08 | 0.12 | 0.18 | . . . | . . . | . . . | . . . | . . . | 0.35 | 0.35 |
| Aluminum alloys | 0.10 | 0.14 | 0.18 | . . . | . . . | . . . | . . . | . . . | 0.35 | 0.35 |
| Titanium | . . . | 0.54 | 0.54 | . . . | 0.71 | 0.9 | 0.9 | 0.9 | 0.9 | 0.9 |
| Iron/all steels | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 |
| Copper | 1.5 | 1.6 | 1.4 | 1.4 | 1.4 | 1.1 | 1.1 | 1.2 | 1.1 | 1.1 |
| Zinc | . . . | 1.4 | 1.3 | . . . | 1.3 | . . . | . . . | 1.2 | 1.1 | 1.0 |
| Brass | . . . | 1.4 | 1.3 | . . . | 1.3 | 1.2 | 1.1 | 1.0 | 1.1 | 1.0 |
| Inconel X | . . . | 1.4 | 1.3 | . . . | 1.3 | 1.3 | 1.3 | 1.3 | 1.3 | 1.3 |
| Monel | 1.7 | . . . | 1.2 | . . . | . . . | . . . | . . . | . . . | . . . | . . . |
| Zirconium | 2.4 | 2.3 | 2.0 | 1.7 | 1.5 | 1.0 | 1.0 | 1.0 | 1.2 | 1.0 |
| Lead | 14.0 | 14.0 | 12.0 | . . . | . . . | 5.0 | 2.5 | 2.7 | 4.0 | 2.3 |
| Hafnium | . . . | . . . | 14.0 | 12.0 | 9.0 | 3.0 | . . . | . . . | . . . | . . . |
| Uranium | . . . | . . . | 20.0 | 16.0 | 12.0 | 4.0 | . . . | 3.9 | 12.6 | 3.4 |

* - Steel arbitrarily assigned a factor of 1.0

Extracted from ASME 1998 Section V, Article 22, Table 2

# ASME 2001 Section V, Article 2, Table T-276

| Nominal Single Wall Material Thickness Range (in.) | Penetrameter | | | | | |
|---|---|---|---|---|---|---|
| | Source Side | | | Film Side | | |
| | Hole Type Designation | Essential Hole | Wire Diameter (in.) | Hole Type Designation | Essential Hole | Wire Diameter (in.) |
| Up to 0.25, incl. | 12 | 2*T* | 0.008 | 10 | 2*T* | 0.006 |
| Over 0.25 through 0.375 | 15 | 2*T* | 0.010 | 12 | 2*T* | 0.008 |
| Over 0.375 through 0.50 | 17 | 2*T* | 0.013 | 15 | 2*T* | 0.010 |
| Over 0.50 through 0.75 | 20 | 2*T* | 0.016 | 17 | 2*T* | 0.013 |
| Over 0.75 through 1.00 | 25 | 2*T* | 0.020 | 20 | 2*T* | 0.016 |
| Over 1.00 through 1.50 | 30 | 2*T* | 0.025 | 25 | 2*T* | 0.020 |
| Over 1.50 through 2.00 | 35 | 2*T* | 0.032 | 30 | 2*T* | 0.025 |
| Over 2.00 through 2.50 | 40 | 2*T* | 0.040 | 35 | 2*T* | 0.032 |
| Over 2.50 through 4.00 | 50 | 2*T* | 0.050 | 40 | 2*T* | 0.040 |
| Over 4.00 through 6.00 | 60 | 2*T* | 0.063 | 50 | 2*T* | 0.050 |
| Over 6.00 through 8.00 | 80 | 2*T* | 0.100 | 60 | 2*T* | 0.063 |
| Over 8.00 through 10.00 | 100 | 2*T* | 0.126 | 80 | 2*T* | 0.100 |
| Over 10.00 through 12.00 | 120 | 2*T* | 0.160 | 100 | 2*T* | 0.126 |
| Over 12.00 through 16.00 | 160 | 2*T* | 0.250 | 120 | 2*T* | 0.160 |
| Over 16.00 through 20.00 | 200 | 2*T* | 0.320 | 160 | 2*T* | 0.250 |

Notes:

† *(a) Welds With Reinforcements.* The thickness on which the penetrameter is based is the nominal single wall thickness plus the estimated weld reinforcement not to exceed the maximum permitted by the referencing Code Section. Backing rings or strips shall not be considered as part of the thickness in penetrameter selection. The actual measurement of the weld reinforcement is not required.

† *(b) Welds Without Reinforcements.* The thickness on which the penetrameter is based is the nominal single wall thickness. Backing rings or strips shall not be considered as part of the weld thickness in penetrameter selection.

†† *(c)* A smaller hole in a thicker penetrameter or a larger hole in a thinner penetrameter may be substituted for any section thickness, provided equivalent penetrameter sensitivity (EPS) is maintained and all other requirements for radiography are met.

† **Extracted from ASME 2001 Section V, Article 2, Para. T-276.2 (a) & (b)**

†† **Extracted from ASME 2001 Section V, Article 2, Para. T-276.2**

# IMAGE QUALITY INDICATOR (IQI) SELECTION

## CSA W59-1989, Table 8-1

| Material Thickness Range (inches) | Penetrameter | | Essential Hole (See Notes) | |
|---|---|---|---|---|
| | Thickness (inches) | Number | 2T | 4T |
| Up to ½ | 0.010 | 10 | 0.020 | 0.040 |
| Over ½ to ⅝ | 0.0125 | 12 | 0.025 | 0.050 |
| ⅝ to ¾ | 0.015 | 15 | 0.030 | 0.060 |
| ¾ to ⅞ | 0.0175 | 17 | 0.035 | 0.070 |
| ⅞ to 1 | 0.020 | 20 | 0.040 | 0.080 |
| 1 to 1¼ | 0.025 | 25 | 0.050 | 0.100 |
| 1¼ to 1½ | 0.030 | 30 | 0.060 | |
| 1½ to 2 | 0.035 | 35 | 0.070 | |
| 2 to 2½ | 0.040 | 40 | 0.080 | |
| 2½ to 3 | 0.045 | 45 | 0.090 | |
| 3 to 4 | 0.050 | 50 | 0.100 | |
| 4 to 6 | 0.060 | 60 | 0.120 | |
| 6 to 8 | 0.080 | 80 | 0.160 | |

***Notes:***

**(1)** *For X-ray the image of the 2T hole shall appear clearly on the radiograph.*
**(2)** *For gamma ray with steel thickness less than 1¼ inch the image of the 4T hole shall appear clearly on the radiograph.*
**(3)** *For gamma ray with steel thickness equal to or greater that 1¼ inch the image of the 2T hole shall appear clearly on the radiograph.*

The following is a list of changes made to Radiographic Examination (General) Procedure QC-TOP-RT-1 Rev. 02:

| | |
|---|---|
| Page 4 | Reference to ASME Section V updated to reflect 2001 Edition |
| Page 4 | Section 4.1 - Addition of reference ANSI/ASNT CP-1898-195<br>Section 4.1 - Reference to SNT-TC1A updated to reflect 1996 Edition & 1998 Addenda |
| Appendix B | Addition or Radiographic Techniques RT-10, RT-12, RT-13, RT-14<br>Addition of Form 4011 - Image Quality Indicator (IQI) Selection - ASME 1998 Section V, Table T-276 |