



Technical Procedure: RT-0016

**GENERAL PROCEDURE FOR RADIOGRAPHIC  
EXAMINATION**

<b>Division</b>	ALL
<b>Revision Date</b>	April 18, 2009
<b>Pages</b>	1 of 13

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<b>Level III Approved:</b>			CGSB / SNT RTIII
<b>QA Approved:</b>			Quality Manager

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## 1.0 SCOPE

- 1.1 This procedure outlines the procedure for radiographic examinations of ferrous materials and non-ferrous materials. This is a non-destructive examination used for detecting discontinuities that are on or below the surface such as cracks, seams, laps, cold shuts, laminations, inclusions, lack of fusion, or welding discontinuities.
- 1.2 This examination procedure is applicable to in-process, final and maintenance (in-service) examinations.
- 1.3 Examinations may be carried out on forgings, castings, welds on vessels, piping, fittings and valves and related components.
- 1.4 Examination shall be performed in accordance with ASME Section V, Article 2. Examination method will be for Gamma or X-ray sources. This procedure is used in conjunction with a specific technique for the method utilized.

## 2.0 STANDARDS AND SPECIFICATIONS

- 2.1 This procedure is prepared according to ASME Sect V – Article 2
- 2.2 ASTM E-94 Standard Guide for Radiographic Testing.
- 2.3 Acuren Health Safety & Environmental Manual.
- 2.4 Acuren RT-0002 Calibration of Densitometers.
- 2.5 Acuren RT-0007 Density Strip Calibration.
- 2.6 Acuren MISC-0001 SNT NDT Procedures. (SNT-TC-1A)
- 2.7 Acuren Radiation Safety Management System (RSMS).
- 2.8 Acuren Safe Operations and Emergency Procedures Manual for X-Ray devices.

## 3.0 PERSONNEL QUALIFICATIONS

- 3.1 All personnel operating gamma equipment shall be certified as a minimum to a qualified Certified Exposure Device Operator (CEDO), or if they are classified as a Trainee, they shall be 100 % visually supervised by a Certified Exposure Device Operator (CEDO).
- 3.2 Examination personnel shall be qualified and certified in accordance with Acuren Group Inc. written practise MISC-0001.
- 3.3 Techniques and procedures are to be carried out by personnel with a minimum certification of CGSB and SNT Level I and trained in the use of the applicable procedure and technique.
- 3.4 Only personnel having a minimum certification to CGSB and SNT Level II shall carry out final interpretation.

## 4.0 SAFETY

- 4.1 Acuren shall comply with the safety requirements of the Canadian Nuclear Safety Commission and any other federal, provincial, territorial or municipal regulatory authority. Details of these safety requirements are contained in the Acuren Radiation Safety Management System (RSMS)
- 4.2 Applicable sections of the RSMS Manual shall be available in all vehicles used to transport radioactive isotopes and all locations where radiographic examinations are carried out.
- 4.3 All x-ray or gamma ray equipment shall be operated in accordance with the manufacturer's instruction guidelines and/or recommendations.
- 4.4 Chemicals used for development of radiographic film may be corrosive and shall be handled and stored according to the manufacturer's recommendations and WHMIS requirements. Disposal of chemicals and chemical containers shall be in accordance with Provincial and Municipal regulations.
- 4.5 The client is to take reasonable steps to help Acuren with safety concerns relating to positioning and the location of work.

## 5.0 DEFINITIONS AND TERMINOLOGY

- a) ASNT- American Society of Nondestructive Testing
- b) ASTM – ASTM International
- c) ASME – American Society of Mechanical Engineers
- d) NDT – Nondestructive Testing
- e) CGSB – Canadian General Standards Board
- f) SFD – Source to film distance
- g) SOD – Source to object distance
- h) IQI – Image Quality Indicator

## 6.0 EQUIPMENT AND APPARATUS

### 6.1 Selection of Radiographic Source

- a) Unless specified by contract, the source of radiation may be an x-ray emitting machine or gamma rays emitted by a radioactive isotope.
- b) X-rays shall be produced by an x-ray machine operating at any kilovoltage and milli-ampereage that achieves the required radiographic sensitivity.
- c) Where gamma radiation is selected as the source of radiation, Iridium 192 may be used for all total thicknesses 3" (76 mm) or less.

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- d) Cobalt 60 may be used for all thickness from 1" (25.4 mm) to 8" (200 mm).

## 6.2 Selection Of Radiographic Film

- a) Film brand, size and designation will be selected on the basis of the ability to meet sensitivity requirements and coverage specified by the governing standard, code or specification.
- b) Unless specified by contract, the film brand and designation must be capable of providing full coverage for the area of interest, and have the ability to meet specified sensitivity requirements.

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## 6.3 Radiographic Screens

- a) Fluorescent screens are not permitted by this procedure.
- b) Radiographs may be produced with or without lead screens
- c) Only lead intensifying screens shall be used. Intensifying screens shall be free of any defects that would produce artifacts on the final radiograph.
- d) Screens shall be in direct contact with the film.

## 6.4 Image Quality Indicators

- a) Penetrameter design and selection shall be in accordance with the referencing code section.
- b) Hole type penetrameters or wire type image quality indicators (IQI) shall be used to evaluate film sensitivity.
- c) IQIs shall be selected from either the same alloy material group or grade as identified in SE-1025, or SE-747, as applicable, or from an alloy material group or grade with less radiation adsorption than the material being radiographed.
- d) The thickness on which the penetrameter is calculated is based on the nominal single wall thickness plus the estimated weld reinforcement not to exceed the maximum permitted by the referencing code section.
- e) Where densities may vary by more than allowable by the referencing code sections, an additional IQI will be used for each exceptional area of density to show sensitivity in that area.
- f) The number and placement of penetrameters shall be as specified by governing standard, code or specification.
- Where accessibility permits, source side penetrameters shall be used.

- Film side penetrameters shall be designated by the placement of a lead letter "F" adjacent to or on the penetrameter and shall not be in the area of interest.
  - Hole type penetrameters shall be placed adjacent to the weld where possible.
  - When radiographing welds, the wire penetrameters are to be placed with the wires across the weld area. Any identifying lead numbers must not be in the area of interest.
- g) When hole type penetrameters are selected, shims may be used to compensate for material thickness greater than the parent metal or to compensate for the total material thickness when the penetrameter cannot be placed on the material being radiographed. Shims will be made from radiographically similar material.

#### 6.5 Facilities for Viewing radiographs

- a) The viewing facilities and equipment for viewing shall be as specified by governing standard, code or specification.
- b) Viewing facilities shall provide subdued background lighting of an intensity that will not cause troublesome reflections, shadows, or glare on the radiograph that interfere with the interpretation process.
- c) Masks should be used to control extraneous light coming through lower density areas or the outer edges of the radiograph to prevent interference with the interpretation.
- d) Equipment used to view radiographs for interpretation shall provide a variable light source sufficient for the essential IQI hole or designated wire to be visible for the specified density range.

#### 6.6 Densitometers and Step Wedge comparators

- a) Densitometers or comparison density strips shall be used to assure film density compliance. Densitometers must be checked against a traceable step tablet at the beginning of each shift, after 8 hours of continuous use, or change of apertures, whichever comes first. Readings must be within  $\pm 0.05$  on the step tablet.
- b) Densitometers shall be calibrated every 90 days or when accuracy is questionable. Calibration must be with a step tablet traceable to national standards, having 5 steps and neutral densities from 0.3 to 4.0. The step tablet used for calibration must have been verified within the last year. Densitometers are calibrated as per Acuren Technical procedure RT-0002.
- c) Step Wedge comparison films used will be calibrated as per Acuren Technical procedure RT-0007.

**7.0 GENERAL PROCEDURE**

**7.1 Surface Preparation**

- a) All surfaces shall satisfy the requirements of the applicable materials specification or referencing Code Section, with additional conditioning if necessary. Conditioning can be by any suitable process and shall be to a degree that the resulting radiograph will not show surface irregularities that could mask or be confused with the image of a discontinuity.
- b) Weld surface irregularities shall be removed by a suitable process to the degree that the resulting radiograph will not show surface irregularities that could mask or be confused with the image of a discontinuity. The finished surface of a butt-welded joint 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.

**7.2 Identification of Examination Areas**

- a) All weld areas to be identified with a sequential numbering system that relates to the type of weld being radiographed. The following is the standard in industry. Clients may dictate specific numbering that relates to their needs.

TYPICAL WELD TYPE	NUMBER SEQUENCE	FOR REPAIRS
Piping welds	X1, X2, X3, .....	X1R1, X1R2, .....
Circumferential welds on vessels	C1, C2, C3, .....	C1R1, C1R2, .....
Longitudinal welds (long seams)	LS1, LS2, LS3 .....	LS1R1, LS1R2, .....
Manway Welds on vessels	MW1, MW2, MW3, .....	MW1R1, MW1R2 ...
All Spot Welds	SP1, SP2, SP3, .....	SP1R1, SP1R2, .....
Tracers from Spot welds	SP1T1, SP1T2, SP1T3	SP1T1R1, SP1T1R2....
Welds that have been "cut out" should be marked with suffix of "CO" after the number		

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- b) A weld map must be generated to record the area that spots have been selected on tanks. Maps must show a roll out from the "zero point" starting on the left side of the tank.
- c) Film shall be identified using any method that permanently identifies the film. As a minimum identification must include Acuren name or symbol, client name, date, job number and unique trace numbers, which will identify the weld or component examined.

### 7.3 Examination coverage

- a) Location markers shall be placed as specified by governing standard, code or specification.
- b) At least two (2) location markers will appear radiographically on each film. The location markers must be placed on the part not on the film cassette.
- c) Location markers incorporated into fibre tapes should be checked periodically for accuracy to imperial or metric increments.
- d) Where multiple films are used for an exposure, radiographic images of location markers shall be visible on each film to indicate complete coverage in the area of interest.
- e) Permanent stamping or marking shall be the responsibility of the client.
- f) As a minimum the reference point and direction shall be marked on the component using a paint stick so that the location of any defects noted in the radiographs can be measured from the marked reference point. References are to show an arrow of direction from a zero point. Clients should reference this location marker to a map for traceability.

### 7.4 Examination Process

- a) Select applicable technique for the configuration and accessibility of the part.
- b) Maximum physical source size for Iridium 192 shall be 5.0 mm, and for Cobalt 60 a maximum of 7.0 mm.
- c) All details shall be recorded on an Acuren radiographic report. All relevant areas identified on the radiographic report must be completed. A copy of the report is attached to this procedure.
- d) Film Processing
  - Film processing may be carried out using the automatic or manual processing method. Processing details as per Acuren procedure RT-0018.
  - For automatic processing, the recommendations of the film, processor and chemical manufacturers shall be followed.
  - Changes in chemistry temperatures can affect development time, therefore, manufacturer's recommended development time versus temperature charts should be consulted.
  - Processing shall be according to manufacturer recommendations and standards guide SE-999 or paragraphs 23-26 of SE-94.
  - Processed film may be packaged by rolling and placing in boxes, flat in envelopes with interleaves, or any other manner suitable to the client.

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e) Direction of Radiation

- Any source to film distance that achieves the required sensitivity and does not exceed the geometric unsharpness ( $U_g$ ) requirements of the governing code, standard or specification is permitted.
- Geometric unsharpness of the radiographs shall be determined in accordance with:

$$U_g = Fd/D$$

where:

$U_g$  = 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, in.

$D$  = distance from source of radiation to weld or object being radiographed, in.

$d$  = distance from source side of weld or object being radiographed to the film.

7.5 Interpretation and Evaluationa) Film Density

- Exposure times for radiographs shall be calculated using exposure calculators, exposure charts, or other established methods capable of determining the amount of exposure in order to have a necessary density in the area of interest specified by the governing standard, code or specification.
- Film density shall be measured between the root pass and the edge of the weld cap using a calibrated densitometer or calibrated comparator density strip.
- Where measured density does not meet the specification or code requirements, the area shall be re-radiographed.
- If any film should become pre-exposed or fogged more than allowable by the referencing code section it shall not be used.

b) Film Quality

- All radiographs shall be free from mechanical, chemical, false indications or other blemishes to the extent that they will not mask or be confused with the image of any discontinuity in the area of interest

of the object being radiographed.

- Where required by referencing codes, a lead symbol "B", 0.500" in height and 0.062" thickness shall be attached to the back of each film holder as a check on backscatter radiation. If a light image of the "B" is visible on the radiograph, protection against backscatter is insufficient and the radiograph will be considered unacceptable. A dark letter B is not cause for rejection.
- Demonstration of the density and IQI image sensitivity on production or technique radiographs will be considered satisfactory evidence of compliance with the procedure.

c) IQI Sensitivity

- The sensitivity shall be sufficient to display the required hole or essential wire of the IQI used.
- The radiograph shall display the IQI identifying numbers and letters.
- If a thinner or thicker hole type penetrometer is used, an equivalent IQI sensitivity chart may be used.

d) Interpretation

- Sizing of defects shall be measured directly from the radiograph.
- Completed radiographs to be evaluated, interpreted to the referenced code section, and results documented on an Acuren radiographic report.

7.6 Marking

- a) During examination, parts, components, and/or assemblies shall be marked in accordance with the applicable code or as directed in the contract or purchase order.
- b) Increments corresponding to the location markers and direction of travel shall be marked on the part with a permanent ink marker. These marks provide orientation and location relative to any discontinuities observed during the interpretation.

## 8.0 ACCEPTANCE CRITERIA

- 8.1 The client shall designate the acceptance criteria in accordance with the referencing code or a written specification.
- 8.2 In absence of a designated code or specification, all indications are to be reported with no acceptance or rejection.

## 9.0 POST CLEANING

- 9.1 There is no post cleaning required.

## 10.0 REPORTS AND RECORDS

10.1 Radiographic reports shall be prepared for all exposures taken and shall include all the following information, and any additional client requested information.

- a) Identification, Acuren job number, client job number or contract number, and heat number if applicable.
- b) Dimensional map (if used) of location marker placement.
- c) Number of exposures.
- d) X-Ray voltage or Isotope used.
- e) X-Ray machine focal spot size or physical isotope source size.
- f) Base material type and thickness, weld thickness, weld reinforcement thickness, as applicable.
- g) Minimum source to object distance.
- h) Distance from source side of object to the film at the minimum source-to-object distance.
- i) Film manufacturer and type.
- j) Number of films in each cassette.
- k) Single or double wall exposure.
- l) Single or double wall viewing.
- m) All relevant indications shall be noted on the radiographic report.

10.2 One (1) copy of the report shall be included in the packaging, one (1) copy will be presented to the client representative, and two (2) copies will be submitted to the regional Acuren office for processing.

## 11.0 NONCOMPLIANCE


11.1 All items of non-compliance will be dealt with according to the Acuren quality management system, and a report shall be generated on non-conformance items to correct any problems that may occur.

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**RADIOGRAPHIC TESTING REPORT**

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CLIENT: \_\_\_\_\_  
 ADDRESS: \_\_\_\_\_  
 PHONE: \_\_\_\_\_  
 WORK LOCATION: \_\_\_\_\_

DATE: \_\_\_\_\_  
 ACUREN Job #: \_\_\_\_\_  
 POWO #: \_\_\_\_\_  
 ACCIDENT #: \_\_\_\_\_  
 ACCIDENT DATE: \_\_\_\_\_  
 STATUS: \_\_\_\_\_

MANUFACTURER: \_\_\_\_\_  
 RADIOGRAPH SOURCE:  JIR 19Z  G0660  X-RAY  KV  
 FOCAL SPOT: \_\_\_\_\_  
 STATUS: \_\_\_\_\_

EXAMINATION	TYPE	PROJ.	FILE	INSTR.	TECH.	DATE	TIME	EXPOS.	DEVELOP.	QUALITY	REMARKS
1											
2											
3											
4											
5											
6											
7											
8											
9											
10											
11											
12											
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14											
15											
16											
17											
18											
19											
20											

SIGNATURES: \_\_\_\_\_  
 CLIENT REPRESENTATIVE: \_\_\_\_\_  
 TECHNICAL SUPERVISOR: \_\_\_\_\_  
 PHOTOGRAPHER: \_\_\_\_\_  
 RADIOGRAPHER: \_\_\_\_\_  
 QUALITY CONTROL: \_\_\_\_\_  
 DIRECTOR: \_\_\_\_\_  
 SUPERVISOR: \_\_\_\_\_  
 MANAGER: \_\_\_\_\_  
 GENERAL MANAGER: \_\_\_\_\_

REFER TO CORRECTIVE SHEET FOR SOURCE OR SERVICES AND STANDARD OF CARE

12.0 APPENDIX - RADIOGRAPHIC REPORT

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