# RADIOGRAPHIC EXAMINATION

# PROCEDURE

## DOCUMENT NO: PNEC/RT/01.Rev 0

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| **PREPARED & APPROVED BY** | **CERTIFIED BY** | **REVIEWED BY** |

## 1.0 SCOPE

1.1 This document describes the procedure and acceptance standards for radiographic examination of welds in carbon steel, alloy steel and stainless steel materials up to 75mm (3 inch) thickness.

1.2 The extent of examination shall be as required by approved drawings, QAP or Code.

## 2.0 REFERENCE DOCUMENTS

2.1 ASME Boiler and Pressure Vessel Code Section V, Edition 2010

2.2 ASME Boiler and Pressure Vessel Code Section VIII Division-1, Edition 2010

2.3 ASME Boiler and Pressure Vessel Code Section VIII Division-2, Edition 2010

2.4 ASME Boiler and Pressure Vessel Code Section IX Edition 2010

2.5 PNEC/WP/01.PNEC Written Practice for Training, Qualification and Certification of NDE Personnel.

## 3.0 PROCEDURE DEMONSTRATION

Demonstration of the density and IQI image requirement of this procedure on production or technique radiographs shall be considered satisfactory evidence of compliance with this procedure.

## 4.0 QUALIFICATION OF PERSONNEL

The personnel performing Radiographic examination shall be certified as per latest revision of PNEC Written Practice .

## 5.0 SURFACE PREPARATION

5.1 The weld ripples or the weld surface irregularities on both the inside (where accessible) and outside shall be removed by any suitable process to such a degree that the images of surface regularities cannot mask or be confused with the image of any discontinuity on the resulting radiograph.

5.2 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 as specified in Table – 1A or Table 1B below (Based on UW-35 of ASME Section VIII Division-1).

*Table-1A - Maximum Permissible Reinforcement (mm)*

| Material Nominal Thickness (mm) | ***Category B & C Butt welds (mm)*** | Other Welds (mm) |
|---|---|---|
| Less Than 2.4 | 2.4 | 0.8 |
| 2.4 to 4.8, incl. | 3.2 | 1.6 |
| 4.8 to 13, incl. | 4.0 | 2.4 |
| 13 to 25, incl. | 4.8 | 2.4 |
| 25 to 51, incl. | 5.0 | 3.2 |
| 51 to 75, incl. | 6.0 | 4.0 |

*Table-1B - Maximum Permissible Reinforcement (inches)*

| Material Nominal Thickness (inch) | ***Category B & C Butt welds (inch)*** | Other Welds (inch) |
|---|---|---|
| Less Than 3/32 | 3/32 | 1/32 |
| 3/32 to 3/16, incl. | 1/8 | 1/16 |
| 3/16 to 1/2, incl. | 5/32 | 3/32 |
| 1/2 to 1, incl. | 3/16 | 3/32 |
| 1 to 2, incl. | 1/4 | 1/8 |
| 2 to 3, incl. | 1/4 | 5/32 |

5.3 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 as specified in Table – 1C or Table 1D below (Based on Table 6.6 of ASME Section VIII Division-2).

*Table-1C - Maximum Permissible Reinforcement (mm)*

| Material Nominal Thickness (mm) | ***Circumferential Joints in Pipe and Tubing (mm)*** | Other Welds (mm) |
|---|---|---|
| 2.5 < t | 2.5 | 0.8 |
| 2.5 ≤ t < 5.0 | 2.5 | 1.5 |
| 5.0 ≤ t < 13.0 | 3.0 | 2.5 |
| 13.0 ≤ t < 25.0 | 4.0 | 2.5 |
| 25.0 ≤ t < 50.0 | 4.0 | 3.0 |
| 50.0 ≤ t < 76.0 | 4.0 | 4.0 |

*Table-1D - Maximum Permissible Reinforcement (inches)*

| Material Nominal Thickness (inch) | ***Circumferential Joints in Pipe and Tubing (inch)*** | Other Welds (inch) |
|---|---|---|
| 3/32 < t | 3/32 | 1/32 |
| 3/32 ≤ t < 3/16 | 3/32 | 1/16 |
| 3/16 ≤ t < ½ | 1/8 | 3/32 |
| 1/2 ≤ t < 1 | 5/32 | 3/32 |
| 1 ≤ t < 2 | 5/32 | 1/8 |
| 2 ≤ t < 3 | 5/32 | 5/32 |

**t is the nominal thickness of the thinner section at the weld joint**

## 6.0 BACKSCATTER RADIATION

6.1 A lead letter '**B**' with minimum dimensions 13mm (½ inch) in height and 1.5mm (1/16 inch) in thickness shall be attached to the back of each film holder, to determine if backscatter radiation is exposing the film.

6.2 If a light image of the letter '**B**' appears on a darker background of the radiograph, protection from backscatter is insufficient and the radiograph shall be considered unacceptable. Corrective measures shall be taken and the area shall be re-radiographed till satisfactory results are obtained. A dark image of the letter '**B**' on a lighter background is not cause for rejection.

## 7.0 SYSTEM OF IDENTIFICATION OF RADIOGRAPHS

7.1 A system of identification shall be used to produce a permanent identification on the radiograph with the following details as a minimum:

- Manufacturer's symbol or name (PNEC)
- PNEC Work order number
- Weld seam / part / item number
- Welder Identification
- Date of radiograph

7.2 Repairs shall be identified with symbol R1 for first repair and R2, R3, etc. for subsequent repairs. Re-shot films shall be identified with symbol RT.

7.3 The above identification need not appear as radiographic images. In any case, this information shall not obscure the area of interest.

## 8.0 MONITORING DENSITY

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

## 9.0 RADIOGRAPHY EQUIPMENT

Either X-Ray machine or gamma ray source (Iridium-192) may be used.

## 10.0 FILM & PROCESSING

10.1 Radiography shall be done using industrial radiography film to obtain the required radiographic quality and sensitivity. Kodak's AA-400 or MX-125, Agfa-Gaevert's D4 or D7, or equivalent may be used.

10.2 Processing shall be done manually in atmospherically controlled (air conditioned) dark room free from light leakages. Processing chemicals shall be used within the manufacturer's recommended shelf life or product expiry date as specified.

10.3 Developing shall be done for a period between 4 to 8 minutes at a temperature of 20±2°C as per Table-2 below. The film shall be agitated at an interval of 1 to 2 minutes to ensure even development.

**Table-2 – Developing Temperature and Time**

| Development temperature (°C) | 18 | 19 | 20 | 21 | 22 |
|---|---|---|---|---|---|

| | | | | | |
|---|---|---|---|---|---|
| Developing time (Minutes) | 6 to 8 | 4.5 to 7.5 | 5 to 8 | 4.5 to 7.5 | 4 to 7 |

10.4 The film shall be placed in a stop bath for 30 seconds to 1 minute before being transferred to the fixer tank, to prevent the fixer solution from being neutralized too rapidly.

10.5 The fixing time shall be at least double the developing time, but shall not exceed 15 minutes. At the interval of 2 to 3 minutes, film shall be agitated to ensure even fixing.

10.6 Washing after developing and fixing shall be done in running water. Water temperature should be 16°C to 24°C.

10.7 After washing, the films shall be immersed for 1 to 2 minutes in a wetting agent solution before drying be normal evaporation. A film drying cabinet incorporating circulating heated air approximately at 60°C may be used to assist in drying.

## 11.0 INTENSIFYING SCREENS

11.1 Intensifying screens consisting of 0.10 mm to 0.13 mm thick lead screens in direct contact with film shall be used at front and back of the film.

11.2 Screens shall be free of dirt, oxide, coatings, wrinkles, pitting and other defects.

11.3 Fluorescent screens shall not be used.

## 12.0 IMAGE QUALITY INDICATORS (IQI)

12.1 The IQI used shall be either the hole type or the wire type.

12.2 Hole type IQIs shall be manufactured and identified in accordance with requirements or alternates allowed in SE-1025. Wire type IQIs shall be manufactured and identified in accordance with requirements or alternates allowed in SE-747, except that the largest wire number or the identity number may be omitted.

12.3 ASME standard IQIs shall consist of those in Table-3A for hole type or those in Table-3A for wire type (Based on Table T233.1 and T233.2 respectively of ASME Section V).

**Table-3A - Hole Type IQI Designation, Thickness & Hole Diameters**

| IQI Designation | IQI Thickness mm (inch) | 1T Hole Diameter mm (inch) | 2T Hole Diameter mm (inch) | 4T Hole Diameter mm (inch) |
|---|---|---|---|---|
| 5 | 0.13 (0.005) | 0.25 (0.010) | 0.51 (0.020) | 1.02 (0.040) |
| 7 | 0.19 (0.0075) | 0.25 (0.010) | 0.51 (0.020) | 1.02 (0.040) |
| 10 | 0.25 (0.010) | 0.25 (0.010) | 0.51 (0.020) | 1.02 (0.040) |
| 12 | 0.32 (0.0125) | 0.32 (0.0125) | 0.64 (0.025) | 1.27 (0.050) |
| 15 | 0.38 (0.015) | 0.38 (0.015) | 0.76 (0.030) | 1.52 (0.060) |
| 17 | 0.44 (0.0175) | 0.44 (0.0175) | 0.89 (0.035) | 1.78 (0.070) |
| 20 | 0.51 (0.020) | 0.51 (0.020) | 1.02 (0.040) | 2.03 (0.080) |

| | | | | |
|---|---|---|---|---|
| 25 | 0.64 (0.025) | 0.64 (0.025) | 1.27 (0.050) | 2.54 (0.100) |
| 30 | 0.76 (0.030) | 0.76 (0.030) | 1.52 (0.060) | 3.05 (0.120) |
| 35 | 0.89 (0.035) | 0.89 (0.035) | 1.78 (0.070) | 3.56 (0.140) |
| 40 | 1.02 (0.040) | 1.02 (0.040) | 2.03 (0.080) | 4.06 (0.160) |
| 45 | 1.14 (0.045) | 1.14 (0.045) | 2.29 (0.090) | 4.57 (0.180) |
| 50 | 1.27 (0.050) | 1.27 (0.050) | 2.54 (0.100) | 5.08 (0.200) |

**Table-3B - Wire IQI Designation, Wire Diameter and Wire Identity**

| Set A | | | Set B | | | Set C | | |
|---|---|---|---|---|---|---|---|---|
| Wire Diameter | | Wire Identity | Wire Diameter | | Wire Identity | Wire Diameter | | Wire Identity |
| mm | inch | | mm | Inch | | mm | inch | |
| 0.08 | 0.0032 | 1 | 0.25 | 0.010 | 6 | 0.81 | 0.032 | 11 |
| 0.10 | 0.004 | 2 | 0.33 | 0.013 | 7 | 1.02 | 0.040 | 12 |
| 0.13 | 0.005 | 3 | 0.41 | 0.016 | 8 | 1.27 | 0.050 | 13 |
| 0.16 | 0.0063 | 4 | 0.51 | 0.020 | 9 | 1.60 | 0.063 | 14 |
| 0.20 | 0.008 | 5 | 0.64 | 0.025 | 10 | 2.03 | 0.080 | 15 |
| 0.25 | 0.010 | 6 | 0.81 | 0.032 | 11 | 2.54 | 0.100 | 16 |

## 13.0 FACILITIES FOR VIEWING OF RADIOGRAPHS

Viewing facilities shall provide subdued background lighting of an intensity that will not cause reflections, shadows or glare on the radiograph that interfere with the interpretation process. 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. The viewing conditions shall be such that the light from around the outer edge of the radiograph or coming through low density portions of the radiograph does not interfere with interpretation.

## 14.0 CALIBRATION

### 14.1 Source Size

Equipment manufacturer or isotope supplier's documentation such as technical manual, decay curves, etc. documenting the actual or maximum source size or focal spot shall be acceptable as source size verification.

### 14.2 Densitometer and Step Wedge Comparison Film

14.2.1 Densitometers shall be calibrated at least every **90** days during use as follows:

(a) A step wedge calibration film, traceable to a national standard step tablet, and having at least 5 steps with neutral densities from at least 1.0 through 4.0, shall be used. The step wedge comparison film shall have been verified within the last year by comparison with a national standard step tablet, unless prior to first use, it was

maintained in the original light-tight and waterproof sealed package as supplied by the manufacturer. Step wedge calibration films may be used without verification for one year upon opening, provided it is within the manufacturers stated shelf life.

(b) The densitometer manufacturer's step-by-step instructions for the operation of the densitometer shall be followed.

(c) The density steps closest to 1.0, 2.0, 3.0, and 4.0 on the step wedge calibration film shall be read.

(d) The densitometer is acceptable if the density readings do not very by more than ± 0.05 density units from the actual density stated on the step wedge calibration film.

(e) Calibration of Densitometer shall be recorded in Format No : PNEC/RT/01/F3.

(f) Calibration shall be performed be NDE-level II(RT) & same shall be accepted by NDE level III.

### 14.2.2 Periodic Verification

Periodic calibration verification checks shall be performed as described in 14.2.1 above at the beginning of each shift, after 8 hours of continuous use, or after change of apertures, whichever comes first.

### 14.2.3 Documentation

Densitometer calibrations required by 14.2.1 shall be documented, but the actual readings for each step do not have to be recorded. Periodic densitometer verification checks required by 14.2.2 do not have to be documented.

## 15.0 EXAMINATION

### 15.1 Radiographic Technique

A single-wall exposure technique shall be used for radiography whenever practical. When it is not practical to use a single-wall technique, double-wall technique shall be used. An adequate number of exposures shall be used to demonstrate that the required coverage has been obtained.

### 15.1.1 Single Wall Technique

In the single-wall technique, the radiation passes through only one wall of the weld, which is viewed for acceptance on the radiograph.

### 15.1.2 Double Wall Technique

When it is not practical to use a single wall technique, one of the following double wall techniques shall be used.

(a) Single-Wall Viewing: For welds in components, a technique may be used in which the radiation passes through two walls and the weld on film-side wall is viewed for acceptance on the radiograph. When complete coverage is required for

circumferential welds, a minimum of three (3) exposures taken at 120° to each other shall be made.

(b) Double-Wall Viewing: For welds in components 89mm (3.5 inches) or less nominal outside diameter, a technique may be used in which the radiation passes through two walls and the weld in both walls is viewed for acceptance on the same radiograph. For double-wall viewing, only a source side IQI shall be used. Care shall be exercised to ensure that the required geometric un-sharpness is not exceeded. If the geometric un-sharpness requirement cannot be met, single wall viewing shall be used.

(i) For welds, the radiation beam may be offset from the plane of the weld at an angle sufficient to separate the image of source-side and film-side walls so that there is no overlap of the areas to be interpreted. When complete coverage is required, a minimum of two exposures taken 90 degrees to each other shall be made for each joint.

(ii) As an alternative, the weld may be radiographed with the radiation beam positioned so that the images of both walls are superimposed. When complete coverage is required, a minimum of three exposures taken at either 60 degrees or 120 degrees to each other shall be made for each joint.

(iii) Additional exposures shall be made if the required radiographic coverage can not be obtained using the minimum number of exposures indicated in (b) (i) or (b) (ii) above.

## 16.0 RADIATION ENERGY

The radiation energy employed for any radiographic examination shall achieve the density and IQI image requirements of this procedure.

## 17.0 DIRECTION OF RADIATION

The direction of the central beam of radiation shall be centred on the area of interest, wherever practical.

## 18.0 GEOMETRIC UN-SHARPNESS

18.1 **Geometric Un-sharpness Determination**:

Geometric un-sharpness of the radiograph shall be determined in accordance with the formula:

$$Ug = F\,d / D$$

Where, Ug = Geometric Un-sharpness

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 radiograph to the film.

D and d shall be determined at the approximate centre of the area of interest.

18.2 **Geometric Un-sharpness Limitation**

The recommended maximum values of geometric un-sharpness are as given in Table-4 below. However, final acceptance of the radiograph shall be on the basis of the ability to see the prescribed IQI and the specified hole or the designated wire of the wire IQI.

**Table-4 - Geometric Un-sharpness Limitation**

| Material Thickness | | Ug maximum | |
|---|---|---|---|
| Inch | mm | inch | mm |
| Under 2 | under 50 | 0.020 | 0.51 |
| 2 through 3 | 50 through 75 | 0.030 | 0.76 |

Note: material thickness is the thickness on which the IQI is based.

## 19.0 LOCATION MARKERS

Location markers, which are to appear as radiographic images on the film, shall be placed on the part and not on the film holder / cassette. Their locations shall be permanently marked on the surface of the part being radiographed, or on a map, in a manner permitting the area of interest on the radiograph to be accurately traceable for 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 area being examined has been obtained. Location markers shall be placed as follows:

19.1 **Single-Wall Viewing**

(a) Source-Side Markers: Location markers shall be placed on the source side when radiographing the following:

(i) Flat component or longitudinal joints in cylindrical or conical components.

(ii) Curved or spherical components whose concave side is toward the source side and when source-to-material distance is less than the inside radius of the component.

(iii) Curved or spherical components whose convex side is towards source.

(b) Film-Side Markers: Location markers shall be placed on the film side when radiographing curved or spherical component whose concave side is towards the source and when the source-to-material distance is greater than the inside radius.

(c) Either-Side Markers: Location markers may be placed on the source side or film side when radiographing either curved or spherical components, whose concave side is towards the source and the source-to-material distance equals the inside radius of the component.

19.2 **Double-Wall Viewing**: For double-wall viewing, at least one location marker shall be placed adjacent to the weld for each radiograph.

19.3 **Mapping the Placement of Location Markers**: When inaccessibility or other limitations prevent the placement of markers as stipulated in 19.1 and 19.2 above, a dimensional map of the actual marker placement shall accompany the radiographs to show that full coverage has been obtained.

## 20.0 IQI SELECTION

20.1 **Material**: IQIs shall be selected from either the same alloy group or grade as identified in SE-1025, or SE-747, as applicable, or from an alloy material group or grade with less radiation absorption than the material being radiographed.

20.2 **Size:** The designated hole IQI or essential wire shall be as specified in Table-5 below (Based on Table T-276 of ASME Section V).

a) Welds with Reinforcement: The thickness on which IQI is based is the nominal single wall thickness plus the estimated weld reinforcement not to exceed the maximum permitted as per Table-1A/1B OR 1C/1D above. Backing rings or strips shall not be considered as part of the thickness in IQI selection. The actual measurement of weld reinforcement is not required.

b) Welds without Reinforcement: The thickness on which IQI is based is the nominal single wall thickness. Backing rings or strips shall not be considered as part of the thickness in IQI selection.

**Table-5 – IQI Selection**

| Nominal Single-Wall Material Thickness Range, mm (inch) | Source Side | | | Film Side | | |
|---|---|---|---|---|---|---|
| | Hole Type Designation | Essential Hole | Wire Type Essential Wire | Hole Type Designation | Essential Hole | Wire Type Essential Wire |
| Up to 6.4 inclusive (0.25) | 12 | 2T | 5 | 10 | 2T | 4 |
| Over 6.4 through 9.5 (0.25 through 0.375) | 15 | 2T | 6 | 12 | 2T | 5 |
| Over 9.5 through 12.7 (0.375 through 0.50) | 17 | 2T | 7 | 15 | 2T | 6 |
| Over 12.7 through 19.0 (0.50 through 0.75) | 20 | 2T | 8 | 17 | 2T | 7 |
| Over 19.0 through 25.4 (0.75 through 1.00) | 25 | 2T | 9 | 20 | 2T | 8 |
| Over 25.4 through 38.1 (1.00 through 1.50) | 30 | 2T | 10 | 25 | 2T | 9 |
| Over 38.1 through 50.8 (1.50 through 2.00) | 35 | 2T | 11 | 30 | 2T | 10 |
| Over 50.8 through 63.5 (2.00 through 2.50) | 40 | 2T | 12 | 35 | 2T | 11 |
| Over 63.5 through 75.0 (2.50 through 3.00) | 50 | 2T | 13 | 40 | 2T | 12 |

20.3 **Welds Joining Dissimilar Materials or Welds with Dissimilar Filler Metal**

When the weld metal is of an alloy group or grade that has a radiation attenuation that differs from the base material, the IQI material selection shall be based on the weld metal and shall be in accordance with Table-5 above. When the density limits of Clause 23.2 of this procedure cannot be met with one IQI and the exceptional density area(s) is at the interface of the weld metal and the base metal, the material selection for the additional IQI shall be based on the base material and shall be in accordance with Table-5 above.

## 21.0 Use of IQIs to Monitor Radiographic Examination

### 21.1 Placement of IQIs

(a) Source Side IQI(s): The IQI (s) shall be placed on the source side of the part being examined except for the condition described in (b) below.

(b) Film Side IQI(s): Where inaccessibility prevents hand placing the IQI(s) on the source side, the IQI(s) 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 IQI(s), but shall not mask the essential hole where hole type IQI is used.

(c) IQI placement for welds – Hole IQI(s): The IQI(s) may be placed adjacent to or on the weld. The identification number(s) and, when used, the lead letter "F", shall not be in the area of interest, except when geometric configuration makes it impractical.

(d) IQI placement for welds – Wire IQI(s). The IQI(s) shall be placed on the weld so that the length of the wires is perpendicular to the length of the weld. The IQI identification and, when used, the lead letter "F", shall not be in the area of interest, except when geometric configuration makes it impractical.

### 21.2 Number of IQIs:

When one or more film holders are used for an exposure, at least one IQI image shall appear on each radiograph except as outlined in (b) below.

(a) Multiple IQIs: If the requirements of Clause 23.0 of this Procedure are met by using more than one IQI, one shall be representative of the lightest area of interest and the other darkest area of interest; the intervening densities on the radiograph shall be considered having acceptable density.

(b) **Special Cases:**

(1) For cylindrical components where the source is placed on the axis of the component for a single exposure, at least three IQIs, placed approximately at 120 degree apart are required under the following conditions:

(a) When the complete circumference is radiographed using one or more film holders, or;

(b) When a section or sections of the circumference, where the length between the ends of the outermost sections span 240 or more degrees, is radiographed using one or more film holders. Additional film locations may be required to obtain necessary IQI spacing.

(2) For cylindrical components where the source is placed on the axis of the component for a single exposure, at least three IQIs, with one placed at each end of the span of the

circumference radiographed and one at approximate centre of the span, are required under the following conditions.

(a) When a section of the circumference, the length of which is greater than 120 degree and less than 240 degree, is radiographed using one film holder, or;

(b) When a section or sections of the circumference, where the length between ends of the outermost sections span less than 240 degree, is radiographed using more than one film holder.

(3) In (1) or (2) above, where sections of longitudinal welds adjoining the circumferential weld are radiographed simultaneously with the circumferential weld, an additional IQI shall be placed on each longitudinal weld at the end of the section most remote from the junction with the circumferential weld being radiographed.

(4) For spherical components where the source is placed at the centre of the component for a single exposure, at least three IQIs , spaced approximately 120 degree apart, are required under the following conditions:

(a) When a complete circumference is radiographed using one or more film holders, or;

(b) When a section or sections of a circumference, where the length between the ends of the outermost sections span 240 or more degree, is radiographed using one or more film holders. Additional film locations may be required to obtain necessary IQI spacing.

(5) For spherical components where source is placed at the centre of the component for a single exposure, at least three IQIs, with one placed at each end of the radiographed span of the circumference radiographed and one at approximate centre of the span, are required under the following conditions:

(a) When a section of a circumference, the length of which is greater than 120 degree and less than 240 degree, is radiographed using just one film holder, or;

(b) When a section or sections of a circumference, where length between the ends of outermost sections spans less than 240 degree is radiographed using more than one film holder.

(6) In (4) and (5) above, where other welds are radiographed simultaneously with the circumferential weld, one additional IQI shall be placed on each other weld.

(7) For segments of a flat or curved (i.e., ellipsoidal, torispherical, toriconical, elliptical, etc.) component where the source is placed perpendicular to the centre of a length of weld for a single exposure when using more than three film holders, at least three IQIs, one placed at each end of the radiographed span and one in the approximate centre of the span, are required.

(8) When an array of components in a circle is radiographed, at least one IQI shall show on each component image.

(9) In order to maintain the continuity of records involving subsequent exposures, all radiographs exhibiting IQIs that qualify the techniques permitted in accordance with (1) through (7) above shall be retained.

21.3 **Shims under Hole IQIs**

For welds, a shim of material radiographically similar to the weld metal shall be placed between the part and the IQI, 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 IQI.

The shim dimensions shall exceed the IQI dimensions such that the outline of at least three sides of the IQI Image shall be visible on the radiograph.

## 22.0 QUALITY OF RADIOGRAPHS

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 , Processing defects such as streaks, watermarks, or chemical stains.

(b) Scratches, finger marks, crimps, dirtiness, static marks, smudges, or tears.

(c) False indications due to defective screens.

## 23.0 RADIOGRAPHIC DENSITY

23.1 **Density Limitations**

The transmitted film density through the radiographic image of the body of the appropriate hole IQI or adjacent to the designated wire of a wire IQI 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.

23.2 **Density Variations**

(a) 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 type IQI or adjacent to the designated wire of a wire IQI, within the minimum/maximum allowable density ranges specified in 23.1 above, then an additional IQI shall be used for each exceptional area(s) 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 in 23.1 above.

(b) When shims are used with hole type IQIs, the plus 30% density restriction of (a) above may be exceeded and the minimum density requirements of 23.1 do not apply for the IQI, provided the required IQI sensitivity is achieved.

## 24.0 IQI SENSITIVITY

Radiographic shall be performed with a technique of sufficient sensitivity to display the designated hole IQI image and the essential hole, or the essential wire of a wire IQI. The radiograph shall also display the IQI identifying numbers and letters. If the designated

hole IQI image and essential hole, or essential wire, do not show on any film in a multiple film technique, but do show in composite film viewing, the interpretation shall be done only by composite film viewing.

## 25.0 EVALUATION

PNEC's NDE Level II (RT) Personnel shall be responsible for the review, interpretation, evaluation and acceptance of the completed radiographs to assure compliance with this procedure. As an aid to the review and evaluation, the Radiography Technique Sheet(Format No : PNEC/RT/01/REV 1/F2 shall be completed prior to the evaluation. The Radiographic Examination Report shall be completed during the examination. The Radiographic Technique Sheet and Radiographic Examination Report shall accompany the radiographs. Acceptance shall be completed prior to presentation of the radiographs and the accompanying documentation to the AI.

## 26.0 ACCEPTANCE STANDARD

Welds as specified above that are radiographed in accordance with this procedure shall be evaluated with referencing Code as below:

### 26.1 ASME Section VIII Division-1

Acceptable standard shall be in accordance with UW-51 and UW-52 for full and spot radiography respectively.

### 26.2 ASME Section VIII Division-2

Acceptable standard shall be in accordance Part - 7.

### 26.3 ASME Section IX

Acceptance standard for radiography of welder and welding operator test qualifications coupons shall be as per QW-191 of ASME Code Section IX.

## 27.0 REPORTING

Examination shall be reported on Radiography Technique Sheet (Format No: PNEC/RT/O1/REV 1/F2) and Radiographic Examination Report (Format No: PNEC/RT/O1/REV 1/F1)

## 28.0 RETENTION OF RECORDS

Radiographs and reports shall be retained as required by the QC Manual.