SARA SAE PRIVATE LIMITED

Management System Document Control Cover Sheet

Document Title	Ref. No.	Revision No.
Procedure for Radiographic Testing	**SES-26-703**	6

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Document Control Stamp (Valid only if in red)

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Revision Status

Revision No.	Effective Date	Description / Summary of Revision
0	23.06.2008	Initial Issue as NOV Sara
1	02.10.2011	Change of name of company fro0om NOV Sara to SARA SAE
2	10.11.2012	Amendments added to clauses high lighted
3	18.12.2015	Amendments added to clauses highlighted for compliance to ASTM E 94, API 6A, API 16A, API 16C, API 17D
4	28/06/2016	Amendments added as per client comments.
5	20/07/2020	Amendments done as per API 6A 21st Ed. Addendum 1 and ASME Sec V 2019.
6	18/07/2021	Amendment added to clause bold for compliance to ASME sec V-2021

1.0 SCOPE:

This Radiographic Testing Procedure details out the minimum requirements to be met in performing radiographic examination by GAMMA RAY. It covers the items such as welded joints and adjacent base metal for various types of metallic products.

The procedure also provides the acceptance criteria required pertaining to the applicable code and when no code is specified or the client has an in-house specification for accepting the products, the same shall govern.

2.0 REFERENCE DOCUMENTS

The latest edition of the Standards and References cited were utilized in the current release of this inspection method. Changes to these Standards and References determined to affect the quality of the products and services of the project shall be cause for revision to this document.

1. ASME (B & PV) Code Section V, Article II - 2021.
2. ASTM E-94:2017 Standard Practice for Radiographic Testing
3. ASTM E-747:2018 Standard Practice for Design, Manufacture, and Material Grouping Classification of Wire Image Quality Indicators
4. ASNT SNT-TC-1A Recommended Practice 2020 edition
5. API – 6A – 21st Edition – Addendum - 1 & 2

3.0 PERSONNEL REQUIREMENTS:

3.1 All NDT Personnel performing radiographic testing in accordance with this procedure shall be qualified and certified in accordance with Companies Written Practice which is based on ASNT Recommended Practice for Qualification and Certification of NDT Personnel SNT—TC-1A,2020

3.2 The required documentation supporting the qualification and certification shall be established and be available upon the request by client.

3.3 Qualified Radiographic Testing Level III or Level II shall be responsible for the interpretation and evaluation of radiographic results and the establishment of Radiographic Testing Techniques in accordance with the applicable standard and specification.

3.4 Qualified RT Level I may operate equipment and perform radiographic testing under the direct supervision of RT level II.

3.5 The radiographic examination shall be carried out under the guidance or supervision of a certified NDT Level II or Level III individual.

3.6 Near vision acuity examination shall be ensured natural or corrected atleast one eye such that the NDT personnel is capable of reading a minimum of Jaeger No.1 or Equivalent type and size letter at a distance of not less than 12 inch (30.5 cm) on a standard jaeger test chart. This shall be administrated annually.

4.0 SURFACE PREPARATION:

3.1 Materials

Surfaces to be radiographed shall satisfy the requirements of applicable materials specification, with additional conditioning, if necessary, by any suitable process to a degree that surface irregularities cannot mask or be confused with the image of any discontinuity.

4.2 Welds

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

4.3 Surface Finish

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

5.0 BACK-SCATTER RADIATION CHECK

5.1 A lead symbol "B" with minimum dimension of 11mm in height and 1.5mm in thickness shall be attached to the back of each film holder during each exposure to determine if back scatter radiation is exposing the film.

5.2 The radiographs shall be considered unacceptable if a light image of the "B" appears on the darker background of the radiograph. However, a darker image on a lighter background need not be a cause for rejection.

6.0 SAFETY REGULATION

6.1 All NDT personnel performing radiography are required to comply with the requirements of the national regulations.

6.2 Personnel radiation exposure shall not exceed the limits required in the above said regulation.

7.0 EQUIPMENT AND MATERIAL

7.1 Radiation Sources

A radiation source to be used in accordance with this procedure is IR -192, not to exceed 55 curies.

7.2 ***Film***

7.2.1 Selection

Radiographic film shall be ASTM type I or type II (fine grain, high contrasts). Film shall be selected to produce radiographs possessing acceptable sensitivity Density and contrast. Type I film shall be used for radiography of pipe diameters of 203mm or less nominal size. Expiry and batch number of the film is recorded and controlled. The brand and designation is

A-Kodak AA400
B-Kodak MX 125
C-Agfa D7
D-Agfa D4

Film holders are designated to prohibit light leaks and to minimize entrapment of foreign material.

7.2.2 Handling and Storage

Film shall be handled carefully to avoid physical strain, such as pressure, creasing, buckling, etc.
Processed Radiography films shall be prevented for 10 years from oil, dust,dirt,direct exposure to the sunlight, & film covered with papers.
Unprocessed film shall be separated from gamma emitter by sufficient distance to avoid fogging. Storage in the presence of chemical fumes, humidity, light, heat, and pressure shall be avoided.

7.2.3 Processing

Films processing shall be done by manual processing or automatic processing in accordance with the requirements of ASTM SE-94 the chemical manufacturer's recommendations and time and temperature charts.

Processing chemicals, water, film hanger and other film processing equipment shall be free from dirt and any other contaminant that may affect the quality of the film. Care should be taken to maintain space between film hangers during processing of films to avoid contact between films.

7.3 Intensifying Screens:

Only lead intensifying screens or lead foil screens shall be used. Lead Intensifying screens of 0.13mm in thickness shall be used for all thicknesses of material radiographed by gamma source. Lead screen which are an internal part of ready pack film are acceptable. Intensifying screen shall be free from scratches, bulks and other defect that may affect the quality of the radiographs. Screens must be kept in close contact with the film or optimum definition and all cases kept in a clean, maintained condition. Note: Fluorescent Screens shall not be used.

7.4 Penetrameter (IQI) Design

7.4.1 Penetrameter are either the hole type or the wire type and are manufactured and identified in accordance with the requirements or alternates allowed in SE 142 or SE 1025 (for hole type) and SE 747 (for wire type) and appendix II ASME standard

Penetrameter are shown in Table 2 for hole type and Table 1 for wire type.

ISO/DIN (as shown in table 4 and 5) or equivalent as applicable can also be used. Damaged IQI's shall not be used. (i.e. bent wires).

The Penetrameter is made of radiographically similar material to the object being radiographed using 2T essential hole for plaque type IQI or equivalent essential wire for wire type IQI. Below table (Table T-276) shall be used to select type of IQI:

Table T-276
IQI Selection

Nominal Single-Wall Material Thickness Range, in. (mm)	IQI					
	Source Side			Film Side		
	Hole-Type Designation	Essential Hole	Wire-Type Essential Wire	Hole-Type Designation	Essential Hole	Wire-Type Essential Wire
Up to 0.25, incl. (6.4)	12	2T	5	10	2T	4
Over 0.25 through 0.375 (6.4 through 9.5)	15	2T	6	12	2T	5
Over 0.375 through 0.50 (9.5 through 12.7)	17	2T	7	15	2T	6
Over 0.50 through 0.75 (12.7 through 19.0)	20	2T	8	17	2T	7
Over 0.75 through 1.00 (19.0 through 25.4)	25	2T	9	20	2T	8
Over 1.00 through 1.50 (25.4 through 38.1)	30	2T	10	25	2T	9
Over 1.50 through 2.00 (38.1 through 50.8)	35	2T	11	30	2T	10
Over 2.00 through 2.50 (50.8 through 63.5)	40	2T	12	35	2T	11
Over 2.50 through 4.00 (63.5 through 101.6)	50	2T	13	40	2T	12
Over 4.00 through 6.00 (101.6 through 152.4)	60	2T	14	50	2T	13
Over 6.00 through 8.00 (152.4 through 203.2)	80	2T	16	60	2T	14
Over 8.00 through 10.00 (203.2 through 254.0)	100	2T	17	80	2T	16
Over 10.00 through 12.00 (254.0 through 304.8)	120	2T	18	100	2T	17
Over 12.00 through 16.00 (304.8 through 406.4)	160	2T	20	120	2T	18
Over 16.00 through 20.00 (406.4 through 508.0)	200	2T	21	160	2T	20

Wire Penetrameter. the quality of all levels of radiographic testing are determined by a set of wire Penetrameter. The diameter size of the various wires specified in Table 3. Each set of wire Penetrameter must be identified by lead numbers indicating ASTM set material.

7.5 Film Viewing Facilities

7.5.1 The viewing facilities should provide subdued background lighting of an intensity that will not cause troublesome reflections, shadows or glare on the radiograph.

7.5.2 Illuminator shall provide light of an intensity that will illuminate in the areas of interest in the radiograph to their best advantage and free from glare. It shall diffuse light evenly over the entire viewing area to have good interpretation and recognition of actual density.

7.5.3 For routine viewing of high density radiographs, a high intensity illuminators shall be used. These provide an adjustable light source.

8.0 CALIBRATION:

8.1 Verification of Source Size

The equipment manufacturer's or supplier's publication 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 . The maximum radiation source size for IR 192 shall be 3.05mm x 3.05mm (effective size 4.31mm).

8.3 Step Wedge Film and Densitometer:

8.3.1 Densitometers shall be calibrated each 3 months during use as follows: A calibrated step tablet shall be used. The step tablet may be a NIST X-ray Step Tablet (Standard Reference Material SRM 1001) or alternately a step tablet from another supplier, which is traceable to the NIST SRM 1001 X-ray Step Tablet. The step tablet shall have at least five step densities ranging from 0.3 through 3.9. The step tablet may have additional step densities less than 0.3 and greater than 3.9. A calibration certificate shall be provided with the step tablet indicating the tablet ID and recorded values for each step density. For suppliers of step tablets other than NIST, the certificate shall indicate conformance of traceability to NIST instrumentation used in the calibration process, applicable ANSI standards used, verification of measurement on a NIST SRM 1001 step tablet, the ID number of the SRM 1001 step tablet, and calibration date of the step tablet. Precautions should be taken in the storage, handling, and use of the step tablet. In the event it becomes scratched, blemished, or exhibits other signs of deleterious wear, it should be replaced immediately. The step tablet shall be replaced four years from date of first use. 8.3.1 Allow a minimum of 30-min "warm-up" time (or the manufacturer's recommended warm-up time) to stabilize circuitry before starting the calibration procedure or the periodic verification checks described in Section 8. Adjust the "0" reading of the densitometer after the warm-up period.

8.3.2 Select and position for reading the neutral density closest to 0.3, 3.0, and 3.9 on the Calibrated step tablet. Read and record the density for each step.

8.3.3 Compare the densities recorded with the actual density values on the calibrated step tablet or the density values listed on the calibration certificate.

8.3.4 If the densitometer has been calibrated properly, the densities at 0.3, 3.0, and 3.9 steps should not vary more than ±0.05 density units. If any of the recorded density values vary more than ±0.05 density units from the density values on the calibrated step tablet; the linearity of the densitometer is out of tolerance and should be corrected.

8.4 Periodic Verification

Densitometer's *Periodic* calibration verification checks shall be performed at the beginning of each shift, after 8 hr of continuous use, or after change of apertures, whichever comes first. The densitometer is acceptable if the density readings are within ± 0.05 of the calibration readings

9.0 EXAMINATION PROCEDURE

9.1 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 made to demonstrate that the required coverage has been obtained. (see figure 2 for sketches)

9.1.1 Single-wall Technique

In the single-wall technique, the radiation passes through only one wall of the weld (material), which is viewed for acceptance on the radiograph. The film shall be placed in contact with the weld (material). When the diameters of the pipe or cylinder are such that the source of radiation may be placed inside without reducing the sensitivity below requirements, this method shall be used.

9.1.2 Double-wall Technique

When it is not practical to use single-wall technique one of the following double wall techniques shall be used. (see figure 2 for sketches)

1. *Single wall Viewing* - For materials and for welds in components, a technique may be used in which the radiation passes through two walls and only the weld (material) on the film side wall is viewed for acceptance on the radiograph. When complete coverage is required for circumferential weld (material), a minimum of three exposures, taken 120° apart shall be made.

2. *Double-wall Viewing* - For materials and for welds in components 89mm or less in nominal outside diameter, a technique may be used in which the radiation passes through two wall and the weld (material) in both walls is viewed for acceptance in the radiograph. For double-wall viewing, only a source side Penetrameter shall be used. Care should be exercised to ensure that the required geometric unsharpness is not exceeded If the geometric unsharpness requirement cannot be met, the single-wall viewing shall be used.

1. For weld, the radiation beam may be offset from the plane of the weld at an angle sufficient to separate the image of the source side and film side portions of the weld so that there is no overlap of the areas to be interpreted. When complete coverage is required, at least two exposures taken 90° to each other for each joint.

2. As an alternative, the weld may be radiographed with the radiation beam

positioned so that the images of both walls are superimposed. When a complete coverage is required, a minimum of three exposures taken at either 60° or 120° to each other shall be made for each joint.

3. Additional exposure shall be made if the required radiographic coverage cannot be obtained using the minimum number of exposures indicated above.

9.2 Selection of Radiation Energy

9.2.1 Gamma ray

The recommended minimum thickness for which radioactive isotopes maybe used is as follows.

Minimum thickness*

Material	Iridium 192
Steel	19 mm

* Gamma radiation of Ir-192 may be used for any material thicknesses provided the radiographic technique used demonstrates that the required radiographic sensitivity has been obtained.

9.2.3 Radiographic Equivalence Factors

The radiographic equivalence factor of a material is that factor by which the thickness of the material must be multiplied to give the thickness of a "standard" material (often steel) which has the same absorption. Radiographic equivalence factors of several of the more common metals are given below, with steel arbitrarily assigned a factor of 1.0. The factors may be used to determine the practical thickness limits for radiation sources for materials other than steel

Material	Ir192	Co60
Aluminium	0.3	...
Steel	1	1
Copper or High Nickel	1.1	1.1

9.2.4 The maximum thickness for the use of radioactive isotope is primarily dictated by exposure time; therefore upper limits are not shown. The minimum recommended thickness limitation may be reduced when the radiographic techniques used demonstrate that the required radiographic sensitivity has been obtained.

9.3 Direction of Radiation

The direction of the central beam of radiation should centred on the area of interest whenever practical.

9.4 Geometric Unsharpness:

9.4.1 Geometric unsharpness of the radiograph shall be determined in accordance with

$$U_g = \frac{Fd}{D}$$

Where

Ug - Geometric Unsharpness

F - Source Size: The maximum projected dimension of the radiating source (or focal spot) in the plane perpendicular to the distance D from the weld or object

D - Distance from source of radiation to weld or object being radiographed in mm.

d - Distance from source side of the weld or object being radiographed to the film in mm.

9.4.2 When required by the Referencing Code Section, The calculated geometric unsharpness of the radiograph shall not exceed the following values.

Material Thickness	Ug Maximum
Under 50.8 mm	0.5 mm
50.8 mm through 76.2 mm	0.75 mm
76.2 mm through 101.6 mm	1.00 mm
Greater than 101.6 mm	1.7 mm

Note: Material thickness is the thickness on which the Penetrameter is based. The following formula should be used to determine the minimum source to object distance

D= (fd/Ug)+d

10.0 RADIOGRAPHS IDENTIFICATION:

10.1 Each radiograph shall be identified uniquely so that there is a permanent correlation between the part radiographed and the film. The type of identification and method by which identification is achieved shall be as agreed between the client and inspector.

10.2 Identification on the radiographs shall include the Manufacturer's name, contract number, part name, part number, weld identification, welder code and date. In addition, a letter "R" shall be added to this identification designate a repaired welds followed by number indicating the number of repair to the same weld. An NDE subcontractor's name or symbol may also be used together with that of the Manufacturer.

10.3 Identification on the radiographs shall be placed at least 6.35 mm from the weld edge or on the part of the radiograph such that this identification shall not block the area of interest.

11.0 LOCATION MARKERS:

Location markers (see figure 3) shall be placed on the part not on the exposure holder or cassette to provide proper orientation of the radiographs.

Number belt spacing around the circumference of the piping shall not exceed the following. When using a DWE/DWV technique for pipe welds 89 mm or less in diameter the first exposure shall be identified with a lead letter A and second exposure shall be identified by B and C for third exposure.

11.1. Single Wall Viewing

11.1.1. Source-Side Markers = Location Markers shall be placed on the source side when conducting radiography of the following:

1. Flat component or longitudinal joint in cylindrical or conical components;

2. Curved or spherical components whose concave side is toward the source and when the source to material distance is less than the inside radius of the component;

3. Curved or spherical component whose convex side is toward the source.

11.1.2. Film Side Marker

11.1.2.1 Location Markers shall be placed on the film side when radiographing either curved or spherical components whose concave side is toward the source and the source to material distance is greater than the inside radius.
11.1.2.2 As an alternative to source side placement in 11.1.1, location markers may be placed on the film side when the radiographs shows coverage beyond the location markers to the extent demonstrated in figure 3e

11.1.3. Either Side Markers.

Location Markers may be placed on either side of the when radiographing either curved or spherical components whose concave side is toward the source and the source to material distance is equal to inside radius of the component.

11.2. Double Wall Viewing

For double wall viewing, At least one location marker shall be placed on the source side surface adjacent to the weld (or on the material in the area of interest) for each radiographed.

11.3. Mapping the Placement of Location Marker

When inaccessibility or other limitation prevent the placement of markers as stipulated in 11.1 and 11.2, a dimensioned map of the actual marker placement shall accompany the radiographs to show that full coverage has been obtained.

12.0 SELECTION OF PENETRAMETER

The designated hole type Penetrameter with essential hole or designated wire diameter shall be specified in Table T-276. A smaller hole in a thicker Penetrameter or larger hole in a thinner Penetrameter may be substituted for any section thickness listed in Table T-276, provided the equivalent Penetrameter sensitivity (EPS) is maintained and all other requirements for radiography are met.

12.1. Welds with Reinforcements

The thickness of materials on which the Penetrameter is based shall be the single wall thickness plus the estimated weld reinforcement not to exceed the maximum permitted by the referencing code. Backing ring or strip shall not be considered as part of the thickness in Penetrameter selection.

12.2 Welds without Reinforcements

The thickness of the material under examination on which the Penetrameter is shall be based on the nominal single wall thickness. Backing ring and strip shall not be considered as part of the thickness in Penetrameter selection.

13.0 PLACEMENT OF PENETRAMETER:

13.1. Source Side Penetrameter.

The Penetrameter(s) shall be placed on the source side of the part being examined, except for the condition describe in 13.2 below.

13.2. Film Side Penetrameter.

When it is not accessible to place the Penetrameter on the source side, the Penetrameter shall be placed on the film side in contact with the part being radiographed. A lead letter "**F**" at least as high as the film identification number shall be placed adjacent to or on the Penetrameter, but shall not block the area of interest and the essential hole. (Refer to figure 4)

13.3. Penetrameter location for welds

Wire type Penetrameter shall be placed over the weld metal such that the length of the wire is perpendicular to the length of the weld. Hole type Penetrameter shall be placed adjacent to the weld seam (3.175 mm to 19 mm from the edge of weld seam), except in instances when the weld metal is not radiographically similar to the base material or the geometric configuration makes it inaccessible, in which case, the Penetrameter shall be placed over the weld metal. When configuration or size prevents placing the Penetrameter on the part, or weld. Separate block or shims, as specified in 15.0 of this procedure, shall be placed as closed as possible to the part being radiograph to facilitate Penetrameter positioning. (see figure 4).

14.0 NUMBER OF PENETRAMETER:

14.1. At least one Penetrameter image shall appear on each radiograph, except on the conditions outlined in 14.2 to 14.5. Each Penetrameter shall represent an area of an essentially uniform radiographic density as judge by densitometer.

14.2. Multiple Penetrameter :

For DWE/DWV or SWE/SWV techniques where the length of film to be interpreted is greater than 127 mm two pentameters placed across the weld. One shall be 25.4 mm of the end of the film length to be interpreted and other shall be centre of the film length to be interpreted. If the density of the radiographs varies as stated in paragraph 17.3, then additional Penetrameter shall be used for each exceptional area and the radiographs retaken. If more than one Penetrameter is used, one shall be in the lightest area of the interest and the other in the darkest area of interest.

14.3. Special Cases

1. For cylindrical components where the source is placed on the axis of the object and one or more film is used for single exposure of a complete circumference, at least three Penetrameter, 120° apart are required.

2. For cylindrical component where the source is placed on the axis of the object and one or more film holders is used to radiograph a section of circumferential weld, at least three equally spaced Penetrameter shall be used. One Penetrameter shall be at the approximate centre of the section and one at the end of each section. When the section of the circumferential weld to be radiographed exceeds 240°, the rules of 14.3.1 shall apply. Additional film location may be required to obtain necessary Penetrameter spacing.

3. When section or sections of longitudinal welds adjoining the circumferential weld are being radiograph simultaneously with the circumferential weld, additional Penetrameter shall be placed on the longitudinal welds 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 and one or more film holders are used for single exposure, at least three Penetrameter, spaced approximately 120° apart are required.

5. For spherical components where the source is placed at t he centre of the component and on or more film are used to radiograph a section of a circumferential greater than 120° and less than 240° , at least three equally spaced Penetrameter shall be used. One at the approximate centre of the section being radiographed and one at each end.

6. Where other welds are radiographed simultaneously with 4 and 5, one Penetrameter shall be placed each other weld.

7. When an array of components in a circle is radiographed, at least one Penetrameter shall show on each component image.

8. In order to maintain the continuity of records involving subsequent exposure, all radiographs exhibiting Penetrameter which qualify the techniques permitted in accordance with 1 through 6 above shall be retained.

15.0 SHIMS UNDER PENETRAMETER:

15.1. For welds, a shim of material radiographically similar to the weld metal shall be placed between the part and the penetrameter, if needed, so that the density throughout the area of interest is no more than minus 15% from (lighter than) the radiographic density through the penetrameter.

15.2. The shims dimensions shall exceed the penetrameter dimensions such that the outline of at least three sides of the penetrameter image shall be visible in the radiograph.

16.0 QUALITY OF RADIOGRAPHS:

16.1 All radiographs shall be free of mechanical, chemical, processing or other blemishes that could interfere the interpretation of results. Such blemishes shall include but are not limited to the following:

a. Fogging

b. Processing defects such as streaks,

water marks or chemical stains

c. Scratches, finger marks, crimps, dirtiness,

static marks, smudges, or tears

d. false indication due to defective screens

e. Loss of details due to poor screen-to-film contact

17.0 RADIOGRAPHIC DENSITY:

17.1. The transmitted film density through the radiographic image of the body of the appropriate hole penetrameter or adjacent to the wire of a wire penetrameter 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 gamma may source. For composite viewing of multiple exposures, each film shall have a minimum density of 1.3. The maximum density shall be 4.0 for both single and composite viewing. A tolerance of 0.05 in density is allowed for variations between densitometer readings.

17.2. Radiographs density shall be measured by calibrated densitometer or Step Wedge.

17.3. If the density of the radiographs anywhere through the area of interest varies more than minus 15% or plus 30% from the density through the body of the hole penetrameter or adjacent to the designated wire of the wire Penetrameter, within the maximum / minimum density required in 17.1, then additional Penetrameter shall be used for each exceptional area or areas and the radiographs retaken.

18.0 PENETRAMETER SENSITIVITY:

Radiography shall be performed with a technique of sufficient sensitivity to display the hole 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. The radiographs shall also display the identifying numbers and letters. 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 viewing.

A minimum sensitivity of 2-2T shall be achieved.

For wire-type IQIs, the essential wire shall be visible within the area of interest representing the thickness used for determining the essential wire, inclusive of the allowable density variations described

19.0 EVALUATION OF RADIOGRAPHS:

All indication shall be evaluated in accordance with the acceptance criteria stated in client specification.
Welds which are rejected shall be recommended for repair and the repaired area shall be radiographed again. The repairs shall be subjected to the same acceptance standard as the original weld.

20.0 REPORTING AND DOCUMENTATION:

20.1 Report shall be done in accordance as per T-290 Article II of ASME Section V.
Documentation of radiographic technique details shall be provided. These details shall include but not limited to the following information;

a) Contract number,

b) Placement Marker Diagram,

c) Identification of welds or components tested (Permanent identification on each radiograph traceable to component weld or part no. as appropriate.

d) Number of exposures,

e) Isotope type,

f) Isotope physical source size

g) Base metal type and thickness, weld thickness, weld reinforcement thickness as applicable.

i) Source-to-object and object to film distance

j) Exposure and film viewing techniques used,

k) Film type

l)No. of film in each film holder/casette

TABLE - 1

WIRE IQI DESIGNATION, WIRE DIAMETER, AND WIRE IDENTITY

Set A			Set B		
Wire Diameter, in.	(mm)	Wire Identity	Wire Diameter, in.	(mm)	Wire Identity
0.0032	(0.08)	1	0.010	(0.25)	6
0.004	(0.10)	2	0.013	(0.33)	7
0.005	(0.13)	3	0.016	(0.41)	8
0.0063	(0.16)	4	0.020	(0.51)	9
0.008	(0.20)	5	0.025	(0.64)	10
0.010	(0.25)	6	0.032	(0.81)	11

Set C			Set D		
Wire Diameter, in.	(mm)	Wire Identity	Wire Diameter, in.	(mm)	Wire Identity
0.032	(0.81)	11	0.100	(2.54)	16
0.040	(1.02)	12	0.126	(3.20)	17
0.050	(1.27)	13	0.160	(4.06)	18
0.063	(1.60)	14	0.200	(5.08)	19
0.080	(2.03)	15	0.250	(6.35)	20
0.100	(2.54)	16	0.320	(8.13)	21

TABLE 2
HOLE TYPE IQI DESIGNATION, THICKENSS AND HOLE DIAMETERS

IQI Designation	IQI Thickness, in. (mm)	1T Hole Diameter, in. (mm)	2T Hole Diameter, in. (mm)	4T Hole Diameter, in. (mm)
5	0.005 (0.13)	0.010 (0.25)	0.020 (0.51)	0.040 (1.02)
7	0.0075 (0.19)	0.010 (0.25)	0.020 (0.51)	0.040 (1.02)
10	0.010 (0.25)	0.010 (0.25)	0.020 (0.51)	0.040 (1.02)
12	0.0125 (0.32)	0.0125 (0.32)	0.025 (0.64)	0.050 (1.27)
15	0.015 (0.38)	0.015 (0.38)	0.030 (0.76)	0.060 (1.52)
17	0.0175 (0.44)	0.0175 (0.44)	0.035 (0.89)	0.070 (1.78)
20	0.020 (0.51)	0.020 (0.51)	0.040 (1.02)	0.080 (2.03)
25	0.025 (0.64)	0.025 (0.64)	0.050 (1.27)	0.100 (2.54)
30	0.030 (0.76)	0.030 (0.76)	0.060 (1.52)	0.120 (3.05)
35	0.035 (0.89)	0.035 (0.89)	0.070 (1.78)	0.140 (3.56)
40	0.040 (1.02)	0.040 (1.02)	0.080 (2.03)	0.160 (4.06)
45	0.045 (1.14)	0.045 (1.14)	0.090 (2.29)	0.180 (4.57)
50	0.050 (1.27)	0.050 (1.27)	0.100 (2.54)	0.200 (5.08)
60	0.060 (1.52)	0.060 (1.52)	0.120 (3.05)	0.240 (6.10)
70	0.070 (1.78)	0.070 (1.78)	0.140 (3.56)	0.280 (7.11)
80	0.080 (2.03)	0.080 (2.03)	0.160 (4.06)	0.320 (8.13)
100	0.100 (2.54)	0.100 (2.54)	0.200 (5.08)	0.400 (10.16)
120	0.120 (3.05)	0.120 (3.05)	0.240 (6.10)	0.480 (12.19)
140	0.140 (3.56)	0.140 (3.56)	0.280 (7.11)	0.560 (14.22)
160	0.160 (4.06)	0.160 (4.06)	0.320 (8.13)	0.640 (16.26)
200	0.200 (5.08)	0.200 (5.08)	0.400 (10.16)	. . .
240	0.240 (6.10)	0.240 (6.10)	0.480 (12.19)	. . .
280	0.280 (7.11)	0.280 (7.11)	0.560 (14.22)	. . .

TABLE 3
IQI SELECTION

Nominal Single-Wall Material Thickness Range, in. (mm)	IQI					
	Source Side			Film Side		
	Hole-Type Designation	Essential Hole	Wire-Type Essential Wire	Hole-Type Designation	Essential Hole	Wire-Type Essential Wire
Up to 0.25, incl. (6.4)	12	2T	5	10	2T	4
Over 0.25 through 0.375(6.4 through 9.5)	15	2T	6	12	2T	5
Over 0.375 through 0.50 (9.5 through 12.7)	17	2T	7	15	2T	6
Over 0.50 through 0.75 (12.7 through 19.0)	20	2T	8	17	2T	7
Over 0.75 through 1.00 (19.0 through 25.4)	25	2T	9	20	2T	8
Over 1.00 through 1.50 (25.4 through 38.1)	30	2T	10	25	2T	9
Over 1.50 through 2.00 (38.1 through 50.8)	35	2T	11	30	2T	10
Over 2.00 through 2.50 (50.8 through 63.5)	40	2T	12	35	2T	11
Over 2.50 through 4.00 (63.5 through 101.6)	50	2T	13	40	2T	12
Over 4.00 through 6.00 (101.6 through 152.4)	60	2T	14	50	2T	13
Over 6.00 through 8.00 (152.4 through 203.2)	80	2T	16	60	2T	14
Over 8.00 through 10.00 (203.2 through 254.0)	100	2T	17	80	2T	16
Over 10.00 through 12.00 (254.0 through 304.8)	120	2T	18	100	2T	17
Over 12.00 through 16.00 (304.8 through 406.4)	160	2T	20	120	2T	18
Over 16.00 through 20.00 (406.4 through 508.0)	200	2T	21	160	2T	20

TABLE 4
DIN WIRE TYPE PENETRAMETER

DIN Pack Designation	Wire Diameter mm(inch) Corresponding Wire Number						
1 FE DIN	3.20 (0.125) 1	2.50 (0.098) 2	2.00 (0.078) 3	1.60 (0.062) 4	1.25 (0.050) 5	1.00 (0.040) 6	0.80 (0.032) 7
6 FE DIN	1.00 (0.040) 6	0.80 (0.032) 7	0.63 (0.024) 8	0.50 (0.020) 9	0.40 (0.016) 10	0.32 (0.013) 11	0.25 (0.010) 12
10 FE DIN	0.40 (0.016) 10	0.32 (0.013) 11	0.25 (0.010) 12	0.20 (0.008) 13	0.16 (0.006)) 14	0.125 (0.004) 15	0.1 (0.004) 16

TABLE 5

ISO WIRE TYPE PENETRAMETER

DIN Pack Designation	Wire Diameter mm(inch) Corresponding Wire Number						
1 ISO 7	3.20 (0.125) 1	2.50 (0.098) 2	2.00 (0.078) 3	1.60 (0.062) 4	1.25 (0.050) 5	1.00 (0.040) 6	0.80 (0.032) 7
6 ISO12	1.00 (0.040) 6	0.80 (0.032) 7	0.63 (0.024) 8	0.50 (0.020) 9	0.40 (0.016) 10	0.32 (0.013) 11	0.25 (0.010) 12
10 ISO16	0.40 (0.016) 10	0.32 (0.013) 11	0.25 (0.010) 12	0.20 (0.008) 13	0.16 (0.006)) 14	0.125 (0.004) 15	0.1 (0.004) 16

FIGURE 1

A WIRE TYPE PENETRAMETER

It consist of a number of wires of various diameters sealed in a plastic envelope that carries the necessary identification symbols. The image quality is indicated be the thinnest wire visible on the radiograph

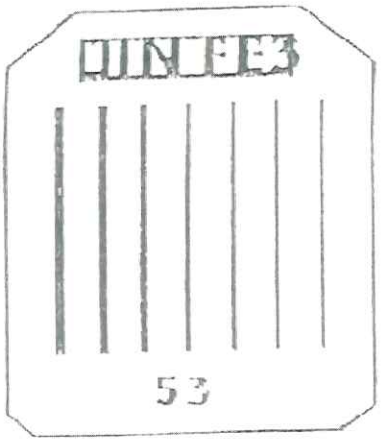
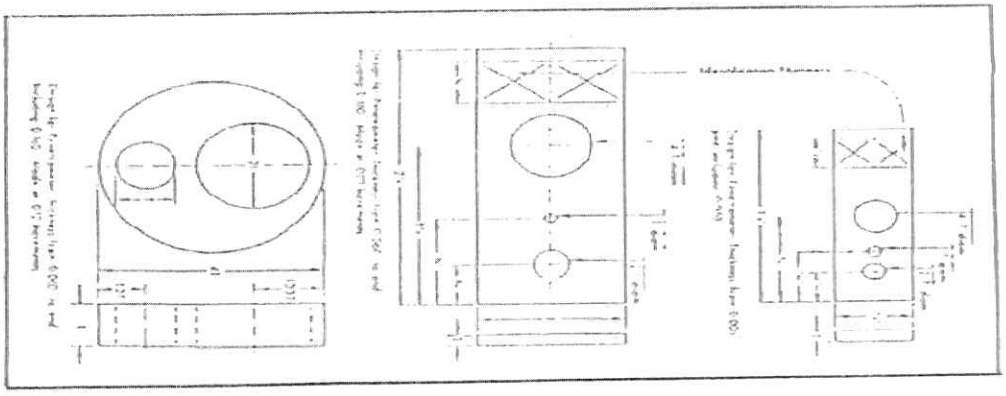
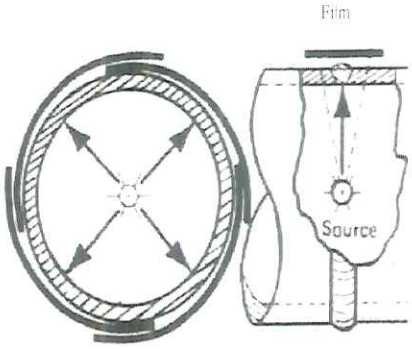
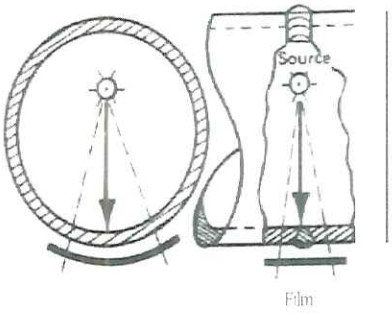
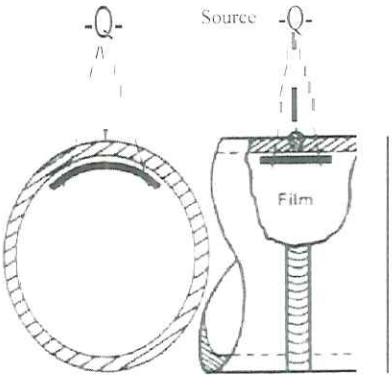


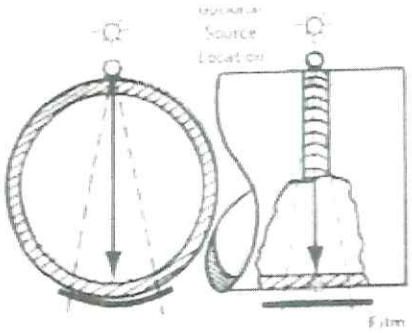
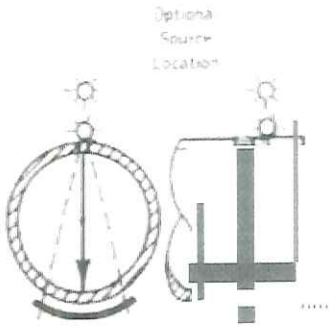
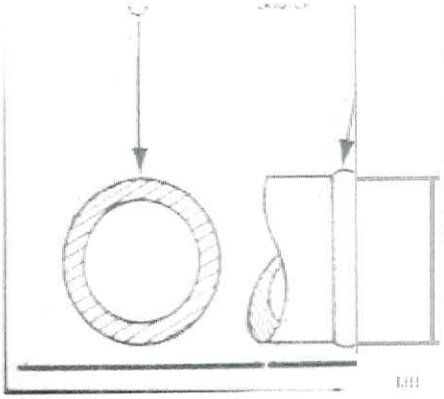
FIGURE 1A

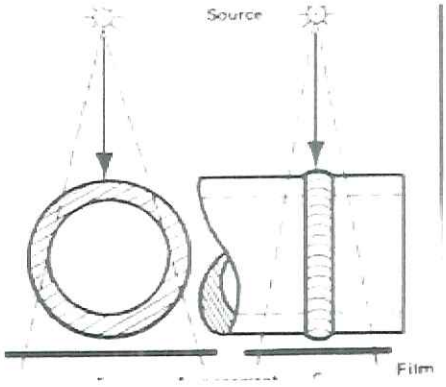
A COMMON HOLE TYPE PENETRAMETER

It consist of a small rectangular piece of metal containing several holes (usually three holes), the dimeter of which are related to the thickness of the penetrameter



Pipe O D	Exposure Techni ue	Radiograph Viewin	End View	Side View	IOI Placement	Location Marker Placement
Any as practicable	Single wall	Single wall			Either side	Either side
Any as practicable	Single wall	Single wall			Either side	Either side
Any as practicable	Single wall	Single wall			Either side	Either side

Pipe O.D	Exposure Technique	Radiograph Viewing	Source-Weld-Film Arrangement End View Side View	IQI location Placement	Marker Placement
Anyas practicable	Double Wall at least 3 Exposures 120deg. To each other for Complete Coverage	Single wall	 d	Either side	Either side
Any as practicable	Double Wall at least 3 Exposures 120deg. To each other for Complete Coverage	Single wall	 e	Either side	Either side
88mm or Less	Double Wall at least 3 Exposures 90deg lo each other for Complete Coverage	Double wall (Ellipse)		Source side	Either side

Pipe O.D	Exposure Technique	Radiograph Viewing	Source-Weld-Film Arrangement End View Side View	IQI Placement	Location Marker Placement
88 mm or less	Double Wall at least 3 Exposures 60 or 120 deg. to each other for Complete Coverage	Double Wall read Super-imposed Source and Side and Film Side Images	 g	Source side	Film Side

ACCEPTANCE CRITERIA:
API 6A

10.4.2.12.5 Radiographic Examination Acceptance Criteria—Forged Parts

For PSL 2 and PSL 3, the following acceptance criteria shall apply:

- no cracks, laps, or bursts;
- no elongated indication with a length greater than that given in Table 21:

Table 21—Maximum Length of Elongated Indication

Thickness, T		Inclusion Length	
mm	in.	mm	in.
< 19.0	< 0.75	6.4	0.25
19.0 to 57.0	0.75 to 2.25	0.33T	0.33T
> 57.0	> 2.25	19.0	0.75

- no group of indications in a line that have an aggregate length greater than T in a length of 12T.

NOTE 1 The PSL 2 and PSL 3 requirements do not apply to PSL 4.

For PSL 4 only, the following acceptance criteria shall apply:

- no cracks, laps, or bursts;
- no more than two indications separated by less than 13 mm (1/2 in.);
- no elongated indication exceeding 6.4 mm (1/4 in.).

10.4.2.12.6 Radiographic Examination Acceptance Criteria—Cast Parts

For PSL 2 and PSL 3, the following shall apply:

- ASTM E186;
- ASTM E280;
- ASTM E446;
- maximum defect classification as follows:

Type Defect	Maximum Defect Class
A	2
B	2
C	2 (all types)
D	None acceptable
E	None acceptable
F	None acceptable
G	None acceptable

Welds:

10.4.2.16.3 Acceptance Criteria—Radiographic Examination

The radiographic examination acceptance criteria shall be as follows:

- no type of crack, zone of incomplete fusion, or incomplete penetration;
- no elongated discontinuity that has a length greater than that given in Table 23;

Table 23—Maximum Length of RT Discontinuities

Weld Thickness, T		Discontinuity Length	
mm	in.	mm	in.
≤ 19.0	≤ 0.75	6.4	0.25
> 19.0 to ≤ 57.0	> 0.75 to ≤ 2.25	0.33T	0.33T
> 57.0	> 2.25	19.0	0.75

- no group of discontinuities in a line having an aggregated length greater than the weld thickness, T, in any total weld length of 12T, except where the distance between successive discontinuities exceeds six times the length of the longest discontinuity;
- no rounded indication in excess of that specified in ASME *BPVC*, Section VIII, Division 1, Appendix 4.

API 16 A

The following shall not be accepted:

a) any type of crack, zone of incomplete fusion or penetration,

b) any elongated slag inclusion that has a length equal to or greater than specified in Table 25;

c) any group of slag inclusions in a line having an aggregate length greater than the weld thickness, t, in any total weld length $12t$, except when the distance between successive inclusions exceeds six times the length of the longest inclusion,

d) any rounded indications in excess of that specified in ASME Boiler and Pressure Vessel Code, Section VIII, Division I, Appendix 4.

Weld thickness t		Inclusion length	
mm	(in)	mm	(in)
< 19	$< 0,76$	6,4	0,25
$19 \leq t \leq 57$	$0,76 \leq t \leq 2,25$	$0,33\ t$	$0,33\ t$
> 57	$> 2,25$	19,0	0,75

RADIOGRAPHIC TESTING REPORT

Doc.No.	Annex. A Of SES 26-703 Rev.06				
Report No					
Date of RT					

CUSTOMER		P.O. No		Product Description (Code)			
Procedure No		Specification		Acceptance Criteria			
Material	Product Size:		Weld Reinforcement		Welding Process	WPS No	

Equipment Used		RT Technique		Technique	
Type:	Gamma Ray	IQI Type		DIAGRAM	
Focal Spot Size		Intensifying Screen:			
Kv/Source		Wire Visible			
mA/Curie		IQI Position			
SFD:		Film Type & Size			
Exposure Time		SOD:			
Ug:		No. of film /casette			
Density Attained		Sensitivity Attained* / Quality Level			

S.No.	Identification of weld joint/ comp. for radiography	Area of Interest	Observation	NDT		CUSTOMER		Remarks
				Accepted	Rejected	Accepted	Rejected	
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								
11								
12								
13								
14								
15								
16								
17								
18								

Legend

IP - INADEQUATE PENETRATION, IF - INCOMPLETE FUSION, SI - SLAG INCLUSIONS, IC - INTERNAL CONCAVITY, (P) - POROSITY, CP - CLUSTER POROSITY, HB - HOLLOWBEAD, C - CRACKS, IU - INTERNAL UNDERCUT, EU - EXTERNAL UNDERCUT, TI - TUNGSTEN INCLUSION , SP-SCATTERED PORE, ELP- ELONGATED PORE , AP-ALIGNED PORE , CD - CAP DEPRESSION , GM - GRINDING MARK , FM - FILM MARK, SFD- SOURCE TO FILM DISTENCE, NSD- NON SIGNIFICANT DEFECT, WT-WALL THICKNESS

***Note:** The penetrameter used by using 2T essential hole for plaque type IQI or equivalent essential wire for wire type IQI. Table T-276 shall be used to select type of IQI.

NDT Inspector Level-II		Inspection Authority	
Signature		Signature	
Name		Name	
Date		Date	

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CSWIP 3.1 Welding Inspector
(ID No.-83866)