SARA SAE PRIVATE LIMITED

Management System Document Control Cover Sheet

Document Title	Ref. No.	Revision No.
Procedure for Radiographic Testing	**SES-26-703**	**4**

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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	Clause 6.12.10 amended. Annexure 'A' , RT report format amended.

Contents

1.0 PURPOSE

1.1 To establish the requirements for radiographic inspection utilizingXray or Gamma radiography.

1.2 To provide a system of general conditions and specific instructions as an aid to qualified personnel required to perform radiographic inspection.

2.0 SCOPE

2.1 This procedure gives the methods, techniques, quality, and reporting requirements necessary for the radiographic inspection of fusion welded butt joints in steel and Hot worked parts & Castings.

2.2 This is the Company approved procedure and shall be adhered to at all times except where the Client or Contract specifies other requirements.

3.0 DEFINITIONS

3.1	Company	-	*SARA SAE PRIVATE LIMITED*
3.2	Client	-	Those Companies, Organizations or Individuals to Which the Company is contracted to provide Services.
3.3	Contract	-	The form of agreement for the provision of the Services to the Client by the Company.
3.4	Services	-	All things provided under the Contract including all Activities to be carried out by the Company for the Client
3.6	General Definitions	-	For the purpose of this procedure the definitions Given in ISO 9000 / ISO 17025 shall apply.

4.0 REFERENCES

4.01	ASME SECTION I	-	Power Boilers (Latest Edition)
4.02	ASME B31.1	-	Power Piping (Latest Edition).
4.03	ASME B31.3	-	Process Piping (Latest Edition).
4.04	ASME V	-	Non-destructive Examination (Latest Edition),
4.05	ASME VIII	-	Rules for the Construction of Pressure Vessels.

Division 1, 2 & 3.(Latest Edition).

4.06	ASME IX	-	Qualification Standard for Welding and Brazing Procedures,Welders, Brazers an d Welding & Brazing Operators (Latest Edition).
4.07	AWS D1.1 / D1.1 M	-	Structural Welding Code-Steel (Latest Edition).
4.09	API 650	-	Welded Steel Tanks for Oil Storage (Latest Edition)
4.10	API 653	-	Tank Inspection, Repair, Alteration and Reconstruction, (Latest Edition).
4.11	API 1104	-	Welding of Pipelines and Related Facilities (Latest Edition).
4.12	DEP 61.40.20.30-GEN.	-	Welding of Pipelines and Related Facilities (Amendments to API 1104).
4.13	API 570	-	Piping Inspection Code: Inspection, Repair, Alteration, and Rerating of In Service Piping Systems (latest edition)
4.14	API 510	-	Pressure Vessel Inspection Code InService Inspection, Rating, Repair, and Alteration (latest edition)

4.15 SARA SAE Quality Assurance Manual

4.15.1 SDP-22-004 Personal Certification

4.15.2 SDP-27-009 Control of Non-conforming Products

4.16 American Petroleum Institute (API)

4.16.1 Specification 6A “Specification for Well Head and Christmas Tree Equipment”

4.16.2 Specification 16A “Specification for Drill Through Equipment”

4.16.3 Specification 16C “Specification for Choke and kill system”

4.16.4 Specification 16D “Specification for Control System for Drilling Well Control equipment”

4.17 American Society for Testing of Metals :

4.17.1 ASTM E-94 , “ Standard Guide for Radiographic Testing” (Latest Ed)

4.17.2 ASTM E-142 -- “Standard Practice for controlling quality of Testing” (Latest Edn)

4.17.3 ASTM E-747 -- “Standard Test Method for controlling Quality of Radiographic Examination using Wire Penetrants” (Latest Edn)

4.17.4 ASTM E 186 - Standard Reference Radiographs for Heavy-Walled (2 to 4 1/2-in. (51 to 114-mm)) Steel Castings

4.17.5 ASTM E280 - Standard Reference Radiographs for Heavy-Walled (4 1/2 to 12-in. (114 to 305-mm)) Steel Castings

4.17.6 ASTM E446 - Standard Reference Radiographs for Steel Castings Up to 2 in. (51 mm) in Thickness

5.0 RESPONSIBILITIES

5.1 The President / Manager QAshall be responsible for ensuring that the necessary resources are

made available for the requirements of this procedure to be carried out.

5.2 NDT Level III shall be responsible for ensuring that the requirements of this procedure are fully implemented at all times.

5.3 All employees involved in the implementation of this procedure shall be responsible for adherence to the requirements stated within.

5.4 The Radiation Safety Officer / License holder as appropriate (RSO) shall be responsible for ensuring that all radiographic operations are carried out in a safe manner and shall be the focal point for any radiation related matters.

5.5 The RSO shall be responsible to advise and notify the management on the potential hazards of radiological work on all areas, authorization and training of persons involved in ionizing radiation, implementation of radiation safety measures to be made available in an emergency, including drills. All other responsibilities are detailed in the Job Description Record duly signed by the RSO prior to commencement of work.

5.6 The Radiographer / NDT Inspector (R1) shall be responsible to perform Radiographic operations on structural, shipyards, piping and process components within the scope of his RT qualifications and with due consideration to all safety rules and regulations. All other responsibilities are detailed in the Job Description Record duly signed by the Radiographer prior to commencement of work.

5.7 Assistant Radiographer shall be responsible to provide assistance to the Radiographer in the production of radiographs in accordance with company procedures and specifications. All other responsibilities are detailed in the Job Description Record duly signed by the Assistant Radiographer prior to commencement of work.

6.0 PROCEDURE INSTRUCTIONS

6.1 GENERAL

6.1.1 Any surface irregularities, backing rings or strips of such size or configuration that may interfere with interpretation of the radiography shall be removed.

6.1.2 Subject to client approval, grinding may be carried out so that these irregularities cannot be confused with discontinuities.

6.1.3 Gamma radiography will be utilized except when otherwise specified by the Client or the Contract documents.

6.2 RADIATION SOURCES

6.2.1 The radiation energy employed for any radiographic technique shall achieve the density and IQI Requirements of this procedure.
Gamma Radiation : Iridium192
Typical sizes of Gamma Ray Source available from the approved supplier are
1.5 x 2.0mm
2.0 X 2.0mm
2.5 x 2.0mm
3.0 X 2.0mm
Verification of source size:
The equipment manufacturer's or Supplier's publications such as technical manuals,decay curves or written statements documenting the actual or maximum source size/ focal spot shall be acceptable as source size verification.

6.3 QUALITY OF RADIOGRAPH

6.3.1 The manual method of processing shall be utilized for this procedure and normal development time shall be between 4 to 5 minutes at 20°C (68°F). Films shall be

seprated to a minimum distance of ½ inch. Films shall be agitated in two directions for 15 sec. of each minute during development.

However, when temperature is higher or lower than the normal 20°C (68°F), manufacturer's recommended development time versus temperature charts shall be consulted. Room temperature and chemical temperature shall be recorded at the time of film processing. Manufacturer's recommendation shall be followed, likewise, for stop bath, rinse, fixation, washing and drying conditions.

6.3.1b Film processing solution replacement shall be in accordance with manufacturer's recommendation such as Kodak, Agfa, etc. Manufacturer's recommendation literature shall be available in all darkrooms.

6.3.1c Replacement of film processing solution shall be in accordance with manufacturer's recommendation and the Radiographer shall accomplish the Chemical Change Out record.

6.3.1d Manufacturer's recommendation shall be adhered to at all times.

6.3.1e In any time, film processing solution shall be discarded after three months because of aerial oxidation and the buildup of gelatin, sludge, and solid impurities.

6.3.2 All radiographs shall be free from mechanical, chemical or other spurious indications to the extent that they cannot mask or be confused with the image of any discontinuity in the object being radiographed.

6.4.3 Such spurious indications included but are not limited to ;-

a) Fogging

b) Processing defects such as water or chemical marks

c) Scratches, finger marks, crimps, static, smudges and tears.

d) Loss of details due to poor screen film contact.

e) False indications due to defective screens.

6.4.4 Film Drying

a) Manual drying can vary from still air drying at ambient temperature to as high as 60°C (140°F) with air circulated by a fan.
b) Take precaution to tighten the film on hangers so it cannot touch the Dryers.
c) Too hot a drying temperature at low humidity can result in uneven drying and should be avoided.
d) Film manufacturer's recommendation shall be consulted for drying Conditions.

6.5 RADIOGRAPHIC FILM

6.5.1 ASTM Type 1 or Type 2 radiographic film as described below shall be used.

TABLE 1

FILM TYPE	COMMERCIAL NAME	SPEED	CONTRAST	GRAIN
1	AGFA D2,AGFA D4	SLOW	VERY HIGH	EXTRA FINE
1	AGFA D5,KODAK MX 125 or similar	MEDIUM	HIGH	VERY FINE
2	AGFA D7,KODAK AA 400 or similar	FAST	HIGH	FINE

6.6 SCREENS

6.6.1 Intensifying screens shall be of the lead type only. The thickness ranges for screens using various radiation energies are given below.

THICKNESS (mm)

RADIATION	FRONT SCREEN	BACK SCREEN
X-RAYS:		
Less than 120 kv	None	0.100(min)
120 kv - 250 kv	0.027(min)-0.125(max.)	0.027(min)
250 kv - 400 kv	0.027(min)-0.160(max.)	0.027(min)
GAMMA-RAYS		
Iridium 192/Cesium 137	0.027(min)-0.160(max.)	0.027(min)
Ytterbium 169/Thulium 170	0.050(min)-0.160(max.)	0.027(min)

6.6.2 In addition to intensifying action, the back lead screens are used as protection against back-scattered radiation and their thickness is only important for this function.

6.6.3 If there is any question about the adequacy of protection from back-scattered radiation, a lead letterB with minimum dimensions of 13mm height and 1.5mm in thickness, should be attached to the back of the cassette or film holder, and a radiograph made in the normal manner. If the image of this symbol appears on the radiograph as a light image on a darker background, it is an indication that protection against back-scattered radiation is insufficient and that additional precautions must be taken.A dark image of the "B" on a lighter background is not cause for rejection.

6.6.4 Film cassettes and screens shall be kept clean and free from damaged. Dirt may cause exposure artifacts in the radiographs and such dirt may be transferred to the loading bench and subsequently to other screens.

6.7 DENSITY LIMITATIONS

6.7.1 The film density through the area of interest of the radiographic image shall be minimum 1.8 and maximum 4.0 for X-rays and 2.0 min & 3.5 max for Gamma Rays in single film viewing.

6.7.2 A densitometer checked against a step wedge film strip of known density every 90 days shall be used for measuring the density of radiographs.

6.8 GEOMETRICAL UNSHARPNESS

6.8.1 Radiography shall be performed with a geometrical unsharpnessmaximum of 0.5 mm upto 50mm material thickness.

6.8.2 Geometrical UNsharpness (μg) will be calculated using the following formula;-

$$\frac{\text{Source Size x object to film distance}}{\text{Source to object distance}}$$

6.9 IDENTIFICATION OF RADIOGRAPHS

6.9.1 A system of radiographic identification shall be used to produce a permanent and traceable record of radiographs to individual welds.

6.9.2 The radiograph shall be identified using lead letters/numbers and the identification shall include

1. Project/Contract Number.
2. Drawing/Sheet or Line Number.
3. Weld Number / Test Point Number
4. Date.
5. Pipe Diameter and Schedule in Material Size and Thickness.
6. Material Type.

6.9.3 Radiographs after repair shall be identified by the additional symbol R1 for first repair and be numbered R2, R3 for subsequent addition of repair thereafter.

6.9.4 Re-shooting due to poor quality of radiographs, due to confusing artifacts and for any other reasons shall be identified by the symbol RS1 for first re-shoot and be numbered RS2, RS3 for subsequent addition of re-shoot thereafter.

6.9.5 These identifications need not necessarily appear as radiographic images. The identification information shall be plainly and permanently indicated on all the radiographs. In any case this information shall not obscure the area of interest.

6.9.6 If lead markers are used for identification and they formed as radiographic images, corrections can be made using other permanent markers, in case of any mistakes, provided these mistakes are corrected with the prior approval from the client's representative. The signature of the personnel on the film near the corrected location shall be considered having received approval from the respective individual. In such cases the name and designation of the individual signed shall be available on the film with a remark of correction made in this film.

6.10 LOCATION MARKERS

6.10.1 Location markers shall be in the form of metric number tapes with Lead numbers of maximum height of 12mm.

6.10.2 The start position shall be marked in such a manner permitting area of interest on the radiograph to be accurately located.

6.10.3 For circumferential joints tape shall be wrapped on the equipment or pipeline with numbering in clockwise direction.

6.10.4 For longitudinal joints, tape shall be fixed to the equipment or pipeline with numbering in a consistent orientation or direction.

6.11 FILM LAYOUT

6.11.1 Typical film layout will include the information required in 6.9.2 above.

6.12 IMAGE QUALITY INDICATOR (I.Q.I)

6.12.1 The image Quality Indicator material shall have similar radiographic absorption characteristics to that of the material under examination, i.e. use steel for steel, aluminum, etc.

6.12.2 The DIN 54109 wire type I.Q.I., ASTM Wire Type or its equivalent shall be used.

6.12.3 If the density of the radiograph through the area of interest varies by more than minus 15% or plus 30% *from the density adjacent to the designated wire of an IQI* and is still within the density requirements defined in 6.7 then an additional I.Q.I. shall be placed *for each exceptional area or areas and the radiograph.*

6.12.4 When more than one film is used in a single exposure, an I.Q.I. image shall be present on each film, except where a panoramic exposure is taken, when a minimum of three equally spaced I.Q.I.s shall be used.

6.12.5 The I.Q.I. shall be placed across the weld so that the wires are at 90° to the weld seam and 1/8" from the edge of the weld.

6.12.6 The I.Q.I. shall be placed at the edge of the diagnostic film length with the thinnest wire outermost.

6.12.7 The I.Q.I. shall be placed on the source side. Where inaccessibility prevents placing the I.Q.I. on the source side, it shall be placed on the film side in contact with the part being examined.

6.12.8 Wire range from the DIN IQI series 1-7, 6-12 or 10-16 shall be selected in accordance with the following guidelines:

i) Component thickness up to 19mm ---------- IQI series 10-16
ii) Component thickness 16 to 45mm ---------- IQI series 6-12
iii) Component thickness over 40mm ---------- IQI series 1-7

6.12.9 IQI Selection shall be based on the nominal single wall thickness plus maximum allowed weld reinforcement.

6.12.10 Minimum Required Sensitivity shall be 2% for wire type IQI and 2-2T for hole type IQI.

6.13 SENSITIVITY REQUIREMENTS

6.13.1 Radiography shall be performed with a technique of sufficient sensitivity to display the essential wire of a wire type IQI.The essential wire requirements of ASTM/ DIN Wire Type on the Source / Film Sides are as mentioned below.

Nominal Single Wall Material Thickness Range Mm	Source Side		Film Side	
	DIN Wire Type Essential wire	ASTM Wire Type Essential wire	DIN Wire Type Essential wire	ASTM Wire Type Essential wire
Upto 6.4 incl	13	5	14	4
Over 6.4 through 9.5	12	6	13	5
Over 9.5 through 12.7	11	7	12	6
Over 12.7 through 19.0	10	8	11	7
Over 19.0 through 25.4	9	9	10	8
Over 25.4 through 38.1	8	10	9	9
Over 38.1 through 50.8	7	11	8	10

6.13.2 Where the inaccessibility prevents placement of the I.Q.I. on the source side, a film side i.e. shall be used, with a lead letter "F" denoting Film side.

6.13.4 If Gamma radiography is stipulated for a particular project and it's use on certain combination of diameter and specimen thickness, makes it *impossible* to attain the sensitivity levels required then a reference radiograph shall be made, under conditions monitored by the Company, and the attained quality levels shall be the standard for those combination/s of diameter and material thickness providing said standard is acceptable to the Company.

6.14 ALLOWABLE REINFORCEMENT

6.14.1 Allowable reinforcement shall be within specification requirements for cap reinforcement and root penetration.

6.15 RADIOGRAPHIC EXPOSURE TECHNIQUES

6.15.1 The radiographic exposure technique shall be in accordance with table below;-

REF NO	EXPOSURE METHOD	RADIATION EMPLOYED	ASTM FILM TYPE	PIPE DIAMETER O.D. (mm)	REFERENCE
1		X-RAYS	1	88.9 & above	ATTACHMENT
2		X-RAYS	2		7.1 & 7.2
3	DWSI	GAMMA-RAYS	1		
4		GAMMA-RAYS	2		
5		X-RAYS	1	Below 88.9	ATTACHMENT
6	DWDI	GAMMA-RAYS	1		7.3 & 7.4
7	DWDI	X-RAYS	1	Below 88.9	ATTACHMENT
8	(SUPERIMPOSED)	GAMMA-RAYS	1		7.5 & 7.6
9		X-RAYS	1		ATTACHMENT
10	SWSI	X-RAYS	2	168.3 & above	7.7 & 7.8
11	(PANORAMIC)	GAMMA-RAYS	1		
12		GAMMA-RAYS	2		
13		X-RAYS	1		ATTACHMENT
14	SWSI	X-RAYS	2	N/A	7.9 & 7.10
15	(PLATE)	GAMMA-RAYS	1		
16		GAMMA-RAYS	2		

6.15.2 SINGLE WALL VIEWING

6.15.2.1 Circumference butt welds greater than 89 mm outside diameter shall be performed with single wall viewing only.

6.15.3 DOUBLE WALL VIEWING

6.15.3.1 Butt welds in piping with outside diameters up to 89 mm shall be radiographed using a technique in which radiation passes through two walls and both walls of the weld are viewed together.

6.16 VIEWING OF RADIOGRAPHS

6.16.1 Viewing facilities shall provide subdued background lighting of an intensity that will not cause troublesome reflection on the radiographic film.

6.16.2 The viewer used for radiographic interpretation shall incorporate a high intensity light source.

6.17 REPORTING

6.17.1 Reporting requirements will be as specified by the Client or the Contract Document.

6.17.2 If the Client or Contract Document reporting requirements are not available the standard Radiographic report shall be used.

6.17.3 Compilation of report shall be according but not limited to the following : -

(a) Job Order Card (if applicable)

(b) Client Information(if applicable)

(c) Inspection Reports

6.18 ACCEPTANCE STANDARDS

6.181 The acceptance standards for the interpretation of welds radiographed shall be Client requirements or the Contract Document.

6.18.2 If no Client requirements or Contract Document are available the international specification relevant to the work scope shall be used.

6.18.3 Some applicable acceptance standard as per international specifications are listed in annexure - B

6.19 PERSONNEL QUALIFICATIONS

6.19.1 RADIOGRAPHER

6.19.1.1 Radiographers shall be trained, qualified and certified to a minimum ASNT Level II, reference to ASNT-TC-1A, Recommended Practice for Non-destructive Testing Personnel Qualification and Certification", OR international equivalent, i.e., PCN or C.S.W.I.P qualified radiographer.

6.19.2 ASSISTANT RADIOGRAPHER

6.19.2.1 Assistant Radiographers shall be trained, qualified and certified to a minimum ASNT Level I, and shall work only under the direct supervision of a Level II trained radiographer.

6.20 FILM HANDLING, STORAGE AND RECORDS

6.20.1 Radiographs shall be stored together and held for a minimum period of one year after acceptance or completion of the work unless otherwise specified by the Client or Contract Document.

6.20.2 New Film / Unexposed

a) New film or unexposed film should be stored in a manner protected from the effects of light pressure, excessive heat, excessive humidity, damaging fumes or vapors, or penetrating radiation.

b) Film manufacturer's recommendation should be followed on film Storage.

6.20.3 Exposed Film

a) Exposed or processed film should be kept in a film envelope provided by the manufacturer.

b) All other requirements on storage and handling shall be in accordance with manufacturer's recommendation purposes.
Note: It is a common practice that Client kept the used film for their documentation purposes.

6.21 RADIATION SAFETY

6.21.1 Radiation Safety requirements shall be as specified in the latest revision of the *Radiation Safety Manual.*

6.21.2 In General radiography shall be performed with the use of a collimator except when performing the panoramic technique or when limitation with collimator is noticed.

7.0 ATTACHMENTS

7.1 Explanatory Notes for Technique Nos. 1, 2, 3 & 4

7.2 Diagrams for Technique Nos. 1, 2, 3 & 4

7.3 Explanatory Notes for Technique Nos. 5 & 6

7.4 Diagrams for Technique Nos. 5 & 6

7.5 Explanatory Notes for Technique Nos. 7 & 8

7.6 Diagrams for Technique Nos. 7 & 8

7.7 Explanatory Notes for Technique Nos. 9, 10, 11 & 12

7.8 Diagrams for Technique Nos. 9, 10, 11 & 12

7.9 Explanatory Notes for Technique Nos. 13, 14, 15 & 16

7.10 Diagrams for Technique Nos. 13, 14, 15 & 16

7.11 Annexure 'A' – Report format

7.12 Annexure 'B'

ATTACHMENT 7.1
EXPLANATORY NOTES FOR TECHNIQUE NOS. 1, 2, 3 & 4

ALIGNMENT OF RADIATION BEAM :

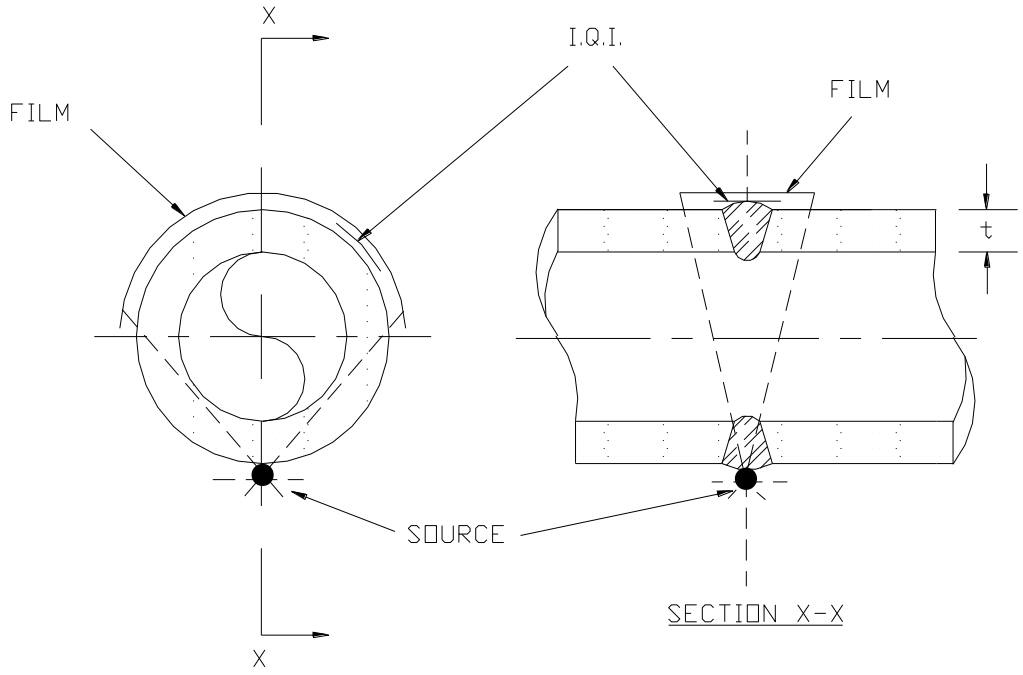
The x-ray tube/source of radiation shall be positioned so that the center of the projected beam passes through the center of the section being examined and shall be offset from the plane through the weld by the minimum distance necessary to prevent the image of one side of the weld confusing the image of the other side. The film shall be placed diametrically opposite the x-ray tube/source of radiation, in close contact with the weld.

NO. OF EXPOSURES :

1. For pipe outside diameter 88.9 mm and above, for schedule 160 and Double extra strong, a minimum of four exposures shall be made for gamma radiography supported by diagnostic film length calculations. For all other wall thickness, a minimum of three exposures shall be made.

2. For pipe outside diameter greater than 88.9mm a minimum of four exposures shall be made for x-ray radiography.

ATTACHMENT 7.2
DIAGRAM FOR TECHNIQUE NOS. 1, 2, 3 & 4
DOUBLE WALL SINGLE IMAGE



ATTACHMENT 7.3
EXPLANATORY NOTES FOR TECHNIQUE NOS. 5 & 6

MINIMUM SOURCE TO FILM DISTANCE (SFD) AND FOCAL POINT TO FILM DISTANCE (FFD) :

The x-ray tube/source of radiation shall be positioned so that a minimum geometric unsharpness is achievable.*A minimum SFD of 6 times the OD of the Pipe has been found to have satisfactorily met the Geometric unsharpness requirements for the common source size of 2.0 x 2.0 mm*

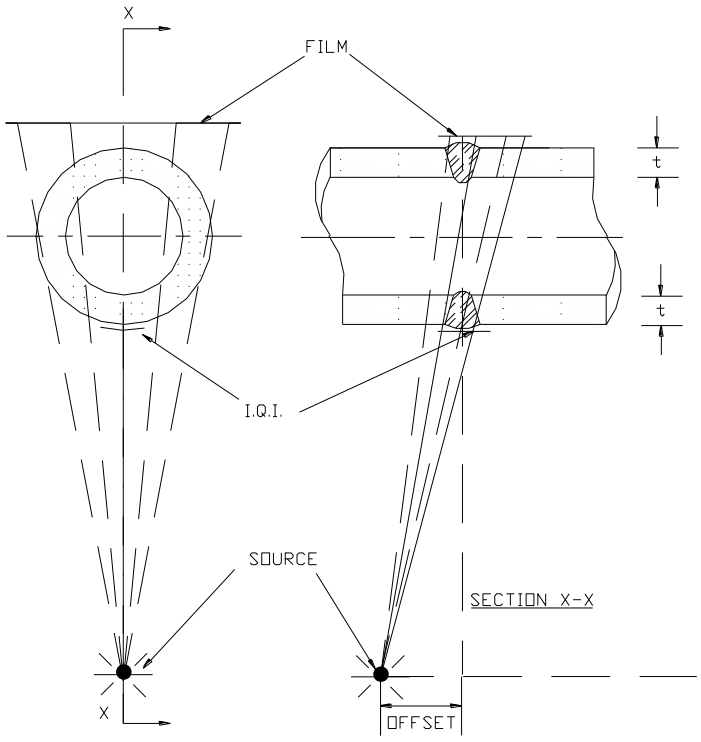
ALIGNMENT OF RADIATION BEAM :

The x-ray tube/source of radiation shall be positioned so that the center of the projected beam passes through the center of the pipe in the plane of the weld. The x-ray tube/source of radiation will be offset by the minimum amount required to provide a viewable elliptical image of two pipe walls on one exposure. At no time shall the minimum offset be less than one fifth (20%) of the source to film distance (SFD) *or* focal point to film distance (FFD). The film shall be placed diametrically opposite the x-ray tube/source of radiation, in close contact with the weld as a "flat" cassette allows.

NO. OF EXPOSURES :

For Gamma radiography & X-ray minimum of two exposures, at 90° apart, shall be made

ATTACHMENT 7.4
DIAGRAM FOR TECHNIQUE NOS. 5 & 6
DOUBLE WALL DOUBLE IMAGE



ATTACHMENT 7.5
EXPLANATORY NOTES FOR TECHNIQUE NOS. 7 & 8

MINIMUM SOURCE TO FILM DISTANCE (SFD) AND FOCAL POINT TO FILM DISTANCE (FFD) :

The x-ray tube/source of radiation shall be positioned so that a minimum *SFD /FFD of 300 mm or the minimum SFD to meet Geometric unsharpness requirements whichever is greater* is maintained.

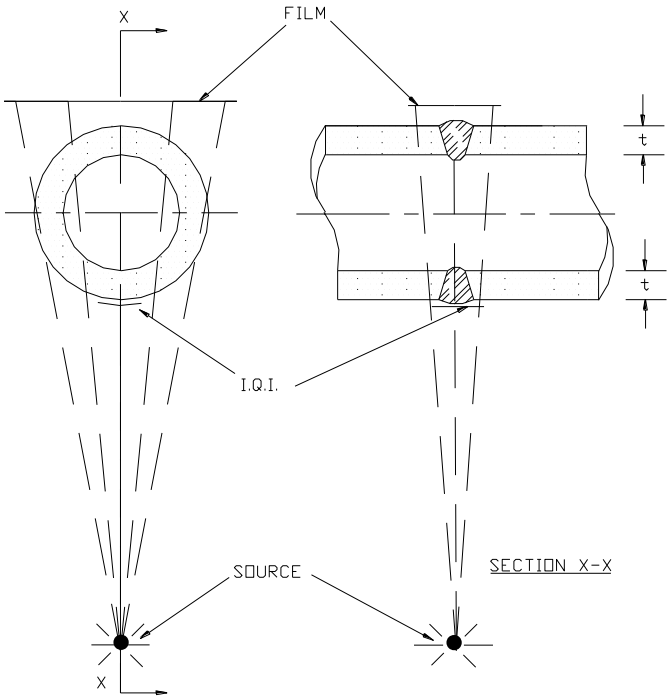
ALIGNMENT OF RADIATION BEAM :

The x-ray tube/source of radiation shall be positioned so that the center of the projected beam passes through the center of the pipe in the plane of the weld, such that the images of the two sides of the weld are superimposed.

NO. OF EXPOSURES :

For Gamma radiography & X-ray minimum three exposures, at 120° apart, shall be made

ATTACHMENT 7.6
DIAGRAM FOR TECHNIQUE NOS. 7 & 8
DOUBLE WALL DOUBLE IMAGE (SUPERIMPOSED)



ATTACHMENT 7.7
EXPLANATORY NOTES FOR TECHNIQUE NOS. 9, 10, 11 & 12

ALIGNMENT OF RADIATION BEAM :

The x-ray tube/source of radiation shall be positioned so that the center of the projected beam passes through the center of the weld under examination and the beam shall be normal to the pipe surface.

NO. OF EXPOSURES :

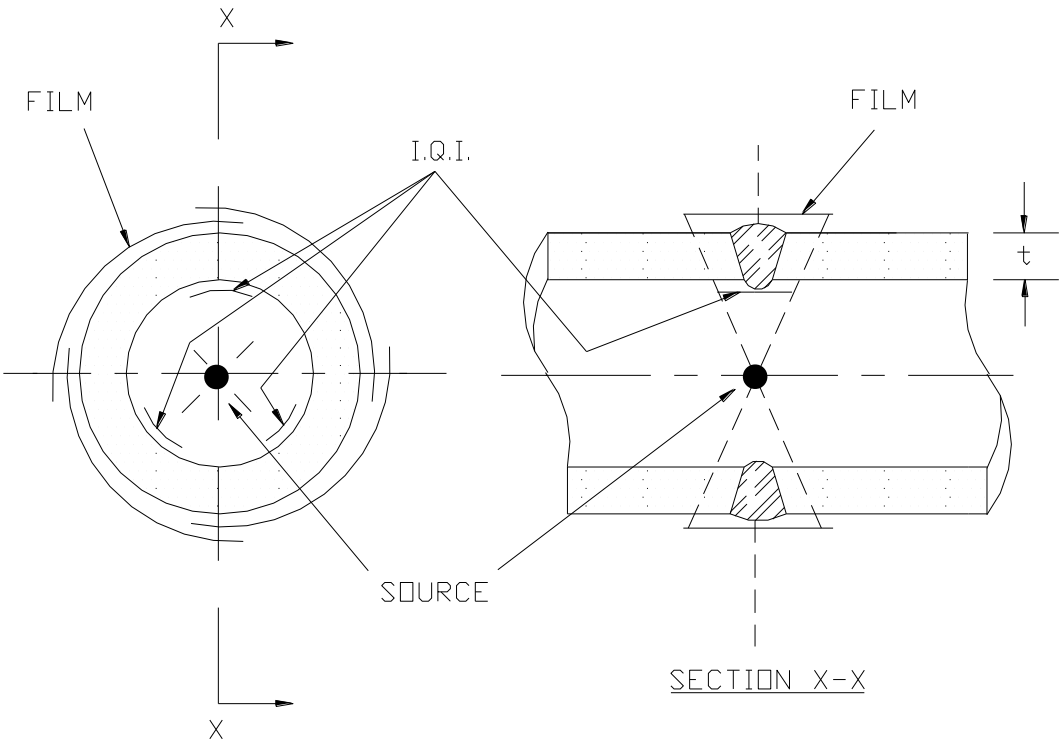
Gamma Radiography

The whole of the circumference weld may be examined in one exposure.

X-ray Radiography

- Using operated internal x-ray crawler, the whole of the circumference weld shall be examined in one exposure with single film of Rollpac type.
- Using directional x-ray tube, a minimum of three exposures shall be made supported by diagnostic film length calculation.

ATTACHMENT 7.8
DIAGRAM FOR TECHNIQUE NOS. 9, 10, 11 & 12
SINGLE WALL SINGLE IMAGE (PANORAMIC)



ATTACHMENT 7.9
EXPLANATORY NOTES FOR TECHNIQUE NOS. 13, 14, 15 & 16

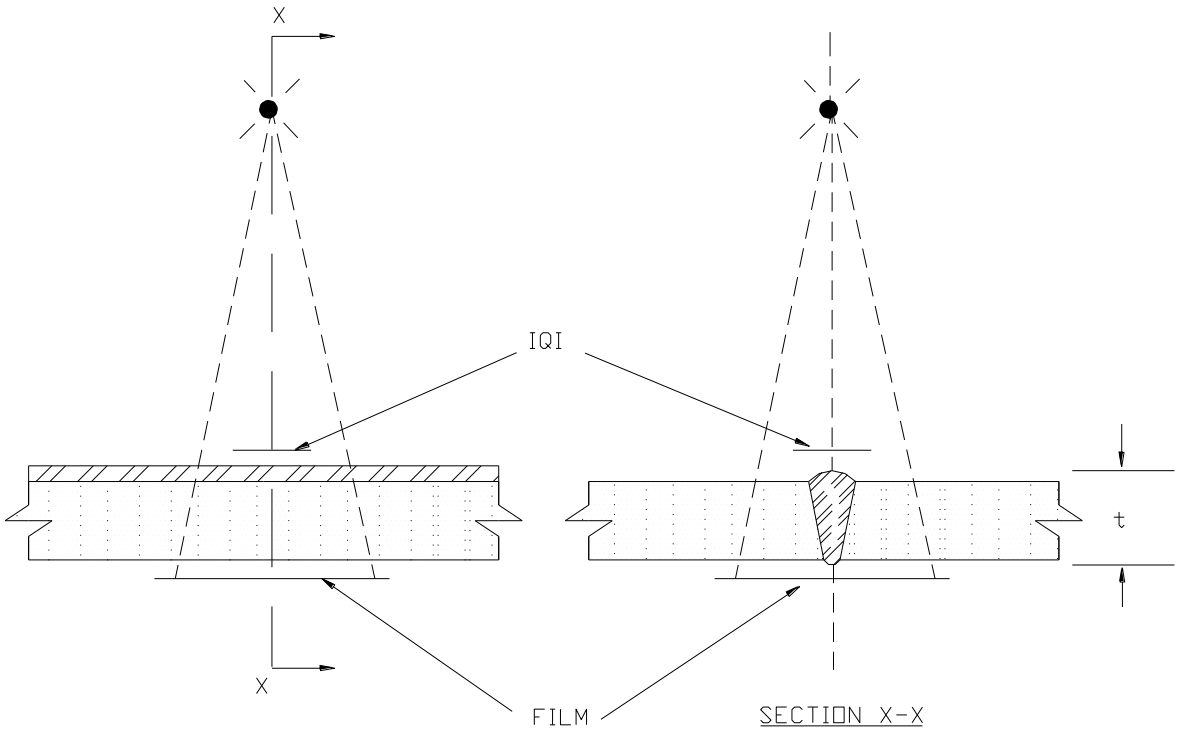
ALIGNMENT OF RADIATION BEAM :

The x-ray tube/source of radiation shall be positioned so that the center of the projected beam passes through the center of the weld under examination and shall be normal to the plate surface at the point.

LENGTH OF WELD THAT MAY BE EXAMINED WITH ONE EXPOSURE :

Any length of weld may be examined provided that the FFD/SFD is at least equal to the total length of film being exposed in a single plane and that the density at the outer edges of the area of interest does not vary by more than minus 15% from the maximum density at the center of the area under examination.

ATTACHMENT 7.10
DIAGRAM FOR TECHNIQUE NOS. 13, 14, 15 & 16
SINGLE WALL SINGLE IMAGE (PLATE)



ATTACHMENT 7.11

Annexure ‘A’ – Report format

Annexure B

API 6A/17D, PSL 3 (Base Material)

<table>
<tr><th>Defect</th><th>Acceptance Criteria</th></tr>
<tr><td>Cracks, Laps, Bursts</td><td>Not permitted</td></tr>
<tr><td>Elongated Indications</td><td>No elongated indications greater than that given below:
<table>
<tr><th colspan="2">Thickness
T</th><th colspan="2">Inclusion length</th></tr>
<tr><th>mm</th><th>(in)</th><th>mm</th><th>(in)</th></tr>
<tr><td>< 19,0</td><td>(0,75)</td><td>6,4</td><td>(0,25)</td></tr>
<tr><td>19,0 to 57,0</td><td>(0,75 to 2,25)</td><td>0,33T</td><td>(0,33T)</td></tr>
<tr><td>> 57,0</td><td>(2,25)</td><td>19,0</td><td>(0,75)</td></tr>
</table></td></tr>
<tr><td colspan="2">No group of indications in a line that have an aggregate length greater than T in a length of 12T</td></tr>
</table>

Note: T = Material Thickness

API 6A, PSL 4 (Base Material)

Defect	Acceptance Criteria
Cracks, Laps, Bursts	Not permitted
Elongated Indications	No elongated indications exceeding 6.4 mm (1/4 in)
No more than two indications separated by less than 13 mm (1/2 in)	

ASTM E186 and ASTM E446 (Base Material)

Category	Description	Acceptable Severity Level
A	Gas Porosity	2
B	Sand and Slag inclusions	2
C	Shrinkage (all types)	2
D	Crack	None acceptable
E	Hot Tear	None acceptable
F	Insert	None acceptable
G	Molting (E446 only)	None acceptable

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 12*t*, 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 ≤ *t* ≤ 57	0,76 ≤ *t* ≤ 2,25	0,33 *t*	0,33 *t*
> 57	> 2,25	19,0	0,75

RADIOGRAPHIC TESTING REPORT

Doc.No.	Annex. Of SES 26-703 Rev.04
Report No	
Date of RT	

CUSTOMER			**P.O. No**			**Product Description (Code)**			
Procedure No		**Specification**				**Acceptance Criteria**			
Material		**Product Size:**		**Weld Reinforcement**	1.5 mm	**Welding Process**		**WPS No**	

Equipment Used		**RT Technique**		**Film Processing**	
Type:	Gamma Ray	**IQI Type**		**Technique**	
Focal Spot Size		**Technique**		**Development Time**	
Kv/Source		**Wire Visible**		**Wash Time**	
mA/Curie		**IQI Position**		**Fixing Time**	
SFD:		**Film Type & Size**		**Wash Time**	
Exposure Time		**Film Position**		**Drying Time**	
Ug:		**Screens**		**Temperature**	
Density Attained		**Sensitivity Attained* / Quality Level**		**Intensifying Screen:**	

S.No.	Identification of weld joint 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:** Wire-type image quality indicators in accordance with ASTM E747 as per API 6A Cl 7.4.2.2.14 b) has been used and sensitivity ≤ 2% has been reported as per wire type IQI which is equivalent to the 2-2T quality level as per ASTM E1025 table 1 for hole-type IQI.

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