



RADIOGRAPHIC PROCEDURE: DOUBLE-WALL PANORAMIC TECHNIQUES-BUTT WELDED PIPE

D-33

Department: Gas System Maintenance and Technical Support Approved by: M. K. Johnson	Section: System Integrity Date: 11-12-99 Approved by: S. Y. Chwistek
Rev. #00: This document replaces PG&E Drawings 085210 and 084118. For a description of the changes, see Page 4.	

Purpose and Scope

This gas standard covers radiographic weld inspections in 4" nominal diameter and larger piping that is between 0.156" and 1.25" wall thickness, using double-wall and panoramic techniques, single-wall viewing.

Use this procedure when radiographic inspection is specified to comply with Section 192.243 of G.O. 112-E.

Radiographers must read and understand the contents of this document and API Standard 1104, Section 8.0.

Radiographic inspection shall be performed and interpreted only by qualified personnel who are certified in accordance with the requirements of G.O. 112-E, Section 192.243.

The radiation source used in this testing procedure shall be Iridium 192. Portable x-ray units are approved for radiographic procedures.

Acronyms

API:	American Petroleum Institute
ASTM:	American Society for Testing and Materials
G.O.:	General Order
kV:	kilovolt
SFD:	source-to-film distance

General

This procedure shall be used only under the terms and conditions of a valid state of California radioactive materials license.

Equipment

1. Iridium 192 - Original source intensity shall be approximately 100 curies. Physical dimensions shall be no greater than 1/8" in diameter by 1/8" long.
2. Portable x-ray units - Andrex 150 kV, Andrex 160 kV, and Andrex 160 kV 360° F x-ray.
3. Intensifying screens shall be 0.005" thick lead in front and 0.010" thick lead in back.
4. Film shall be high contrast and relatively fine grained, such as Agfa-Gevaert D4 or D5 film, to produce the results required. A film equivalent to Agfa-Gevaert D7 may be used for large-diameter and extra-heavy wall pipe. The width of the film used shall not be less than 3-1/2" wide and no more than 4-1/2" wide.
5. Cassettes shall be paper or plastic types. Permacel P 741 black crepe tape shall be used to seal light leaks.
6. Penetrameters shall be made of the same material radiographically as the material being welded. Their thicknesses and identifying numbers shall be written as shown in Appendix A.

Location of Penetrameters

7. The radiographic quality shall be evaluated by the image of a properly located penetrameter (see Appendixes B and B-1).
8. The penetrameter shall be placed on the side nearest the radiation source. Where it is physically impossible to do this, a film-side penetrameter shall be placed on the film side of the joint.
9. The penetrameter thickness shall be based on the single-wall thickness.

**Radiographic Procedure: Double-Wall
Panoramic Techniques-Butt Welded Pipe**

10. A lead letter F, at least 1/2" high, shall be placed adjacent to the penetrameter whenever a film-side penetrameter is used.
11. A lead letter S, at least 1/2" high, shall be placed adjacent to the penetrameter whenever a source-side penetrameter is used.
12. When a complete girth weld is radiographed in a single exposure using a source on the inside of the pipe, four penetrameters, equally spaced around the circumference, shall be used. When a girth weld is radiographed using a multiple-exposure procedure, a penetrameter shall be located within 1" of each end of the applicable limits of film coverage.
13. If the weld metal is not radiographically similar to the base metal, a penetrameter shall be placed over the weld metal so that it is on an overlaid portion of the film and moved on each successive exposure in order to get full coverage of the weld.
14. Shims shall be used to produce a total thickness under the penetrameter equal to the nominal thickness of the base metal plus the height of the crown or reinforcement. Shims shall be of a radiographically similar material to the weld metal.

Film Quality

15. All radiographs shall be free from mechanical, chemical or other processing defects that could interfere with the proper interpretation of the radiograph such as:
 - A. fogging,
 - B. processing defects (streaking, watermarks or chemical stains),
 - C. scratches, finger marks, crimps, dirt, static marks, smudges or tears, or
 - D. loss of detail due to poor screens or artifacts caused by defective film.

Film Identification

16. Location markers, the images of which will appear on the film, shall be placed adjacent to the welds on the pipe (not the film) and their locations shall be marked on the pipe surface near the weld so it is evident that the weld was completely filmed (see Appendix B).
17. Space the distance between station numbers or markers so that normal exposure and development will produce a density (H and D) range in accordance with the "Film Density" section on Page 3.
18. Maximum acceptable film lengths shall be in accordance with Appendix D.

Source-to-Film Distance

19. Minimum source-to-film distance for Iridium 192 shall be computed in accordance with Appendixes C and C-1.
20. The film and source shall be placed against the pipe as shown in Appendix B.

Time of Radiographic Examination

21. Where post-weld heat treatment is required, radiography shall be performed after the post-weld heat treatment.

Back Scatter

22. A lead letter B, a minimum of 1/2" high and 1/16" thick, shall be attached to the back of each film holder to ensure the use of adequate protection from back scatter. If the letter B is discernible on the radiograph, the test is unacceptable.
23. If back scatter is apparent, a backing lead shall be placed at the back side of the film holder for all exposures. The backing lead thickness shall be 1/16" to 1/8" thick.

Radiographic Procedure: Double-Wall Panoramic Techniques-Butt Welded Pipe

Film Processing

24. The developer shall be maintained at a controlled temperature of 68°F. Time adjustment shall be made for temperature changes greater than 2° F. See the manufacturer's recommendations for machine maintenance.
25. No more film should be developed than can be accommodated with at least a 1/2" separation between hangers.
26. Solutions shall be stirred before processing begins.
27. Film shall be agitated during the development cycle to ensure developing uniformity across the entire surface of the film.
28. Development Time
Follow manufacturer's recommendations on development time.
29. Stop Bath
After development is complete, place the film in an acid bath or, if this is not feasible, rinse the film for not less than 5 minutes. Rigorously follow the recommendations of the film manufacturer.
30. Fixing
Film hangers shall be agitated vertically for about 10 seconds, and again at the end of the first minute, to ensure uniform and rapid fixation.
The fixing time shall be three times the clearing time. If the clearing time exceeds 4 minutes, discard the solution.
31. Washing
The washing efficiency decreases rapidly with decreasing temperatures below 60° F. If the water temperature is above 68° F, remove the film from water as soon as washing is completed, since the gelatin in the film has a natural tendency to soften considerably in warm water.
Water: There shall be a complete change of water at least once a day.
32. After washing, the film shall be rinsed in a bath of water-spot preventive (wetting agent) such as "Photo-Flo" (by Kodak) for approximately 1 minute. This facilitates drainage and helps to minimize clinging water droplets.
33. Drying
Dry the film on the hangers. Ensure that drying racks hold the hanger sufficiently rigid so that the film cannot touch while drying. Do not dry the film on a clothesline outside of the mobile unit.
Ensure that the drying time is adequate to completely dry the film and hangers.

Film Density

34. Film shall be exposed so that the average H and D density in the area of interest of the transparent-based film shall not be less than 1.8 or greater than 4.0.

Acceptance - Rejection of Discontinuities

35. Radiographic examination of welded joints shall conform to Gas Standard D-31, "Standards of Acceptability for Welding Nondestructive and Destructive Testing."

Repairs

36. Welds showing unacceptable discontinuities shall be repaired as described in Gas Standard D-31.
37. All the portions of the welds which have been repaired shall be re-radiographed using the procedure described in this document.
38. Repairs shall be identified with the letter R.

Viewing

39. Only qualified personnel shall view the film for acceptance/rejection and sign the film-viewing reports.
40. Rejected areas on the film shall be circled in red, initialed by the film viewer and identified on the film.

**Radiographic Procedure: Double-Wall
Panoramic Techniques-Butt Welded Pipe**

41. Film Viewing Facilities

Viewing facilities should be constructed to provide subdued lighting and exclude background lighting of an intensity which may cause reflections on the radiographic film. Equipment used to view film for radiographic interpretation shall provide a high-intensity light source sufficient for the specified density range. This ensures the proper penetrameter and hole for the specified quality level is readily visible for the specified density range. Mask the extraneous light from the illuminator. Mask the edges of the radiograph. If the radiograph contains regions considerably less dense, mask these areas.

Safety

42. Follow all safety regulations in accordance with the emergency and operating procedures of the Pacific Gas and Electric Company and the state of California, Department of Public Health.

Qualification of Procedure

43. When it is impractical to comply with this procedure because of conditions which were not anticipated when the procedure was specified, a new procedure may be qualified. A copy of the revised procedure shall be forwarded to the Director of Gas Technical and Field Support, 123 Mission St., Mail Code H15E, San Francisco.

Reporting

44. A record of all procedure qualifications shall be maintained by the Gas Technical and Field Support.
45. Records of Certification for company personnel performing radiographic examination shall be maintained by the Gas Technical and Field Support.

Revision Notes

Revision 00 has the following changes.

1. Converted PG&E Drawings 085210 and 084118 to Gas Standard D-33.
2. Added an "Acronyms" section.
3. Updated the information on the types of film available for x-ray units in Item 4 on Page 1.
4. The H and D density has been revised in Item 34 on Page 3 to new values.
5. Completely revised Appendix A tables.
6. This document is part of Change 46.

Radiographic Procedure: Double-Wall Panoramic Techniques-Butt Welded Pipe

APPENDIX A

Table 1 Thickness of Pipe Versus Thickness of ASTM E142 Penetrameter

Pipe Wall Or Weld Thickness		
Thickness of Pipe (Inches)	Penetration Thickness (Inches)	Identifying Number
0 - 1/4	0.0125	12
1/4 - 3/8	0.0150	15
3/8 - 1/2	0.0175	17
1/2 - 3/4	0.0200	20
3/4 - 1	0.0250	25
1 - 2	0.0300	30

Table 2 Thickness of Pipe Versus Thickness of API Penetrameter

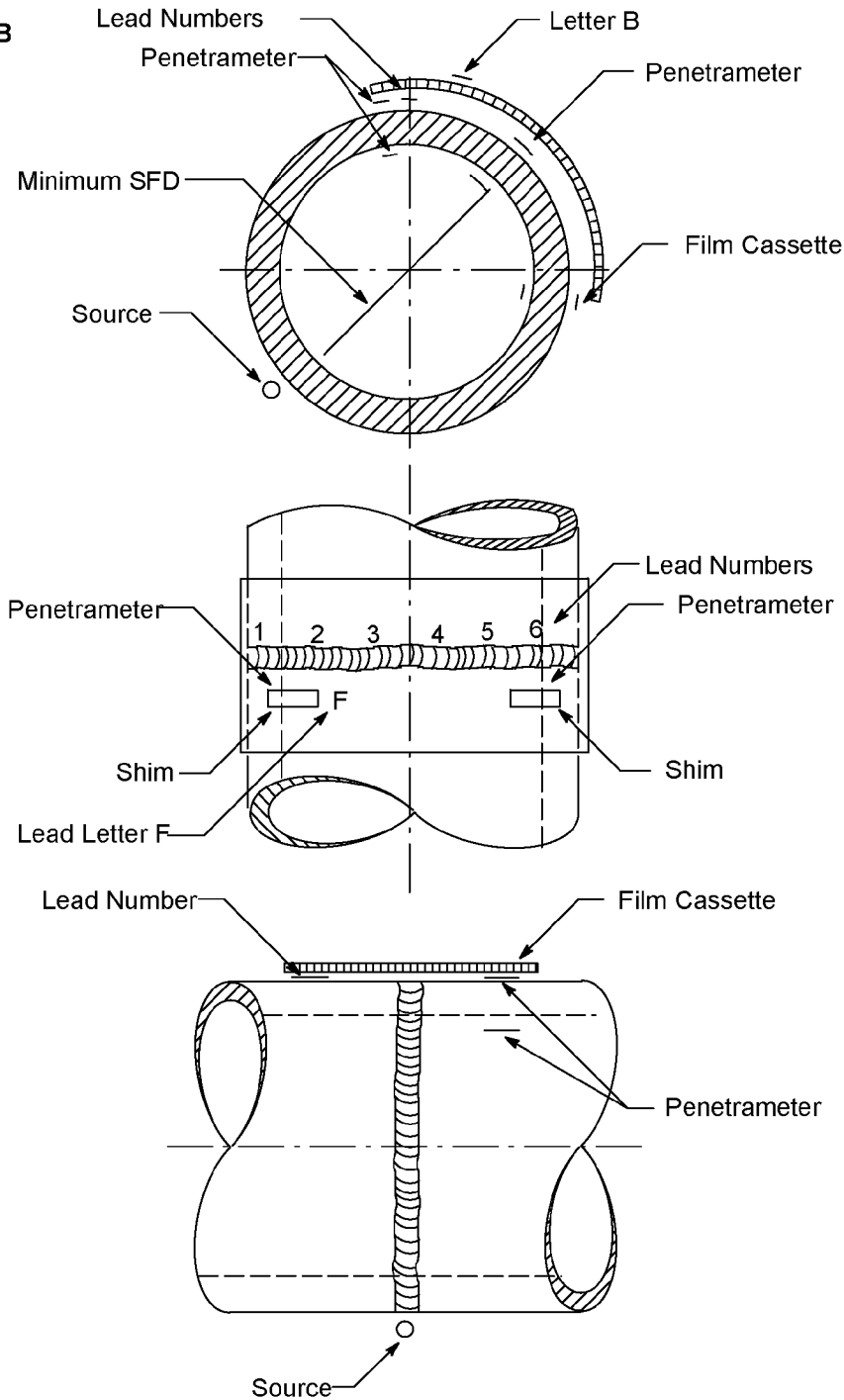
Pipe Wall or Weld Thickness		
Thickness of Pipe (Inches)	Penetration Thickness (Inches)	Identifying Number
0 -1/4	0.0050	5
1/4 - 3/8	0.0075	7
3/8 - 1/2	0.0100	10
1/2 - 5/8	0.0125	12
5/8 - 3/4	0.0150	15
3/4 - 7/8	0.0175	17
7/8 - 1	0.0200	20
1 - 1-1/4	0.0250	25
1-1/4 - 1-1/2	0.0300	30
1-1/2 - 2	0.0350	35

Table 3 Thickness of Pipe Versus Diameter of ASTM Wire Penetrameter

Weld Thickness		
Thickness of Pipe (Inches)	Essential Weld Diameter (Inches)	ASTM Set Letter
0 - 1/4	0.008	A
1/4 - 3/8	0.010	A or B
3/8 - 1/2	0.013	B
1/2 - 3/4	0.016	B
3/4 - 1	0.020	B
1 - 2	0.025	B

Radiographic Procedure: Double-Wall Panoramic Techniques-Butt Welded Pipe

APPENDIX B



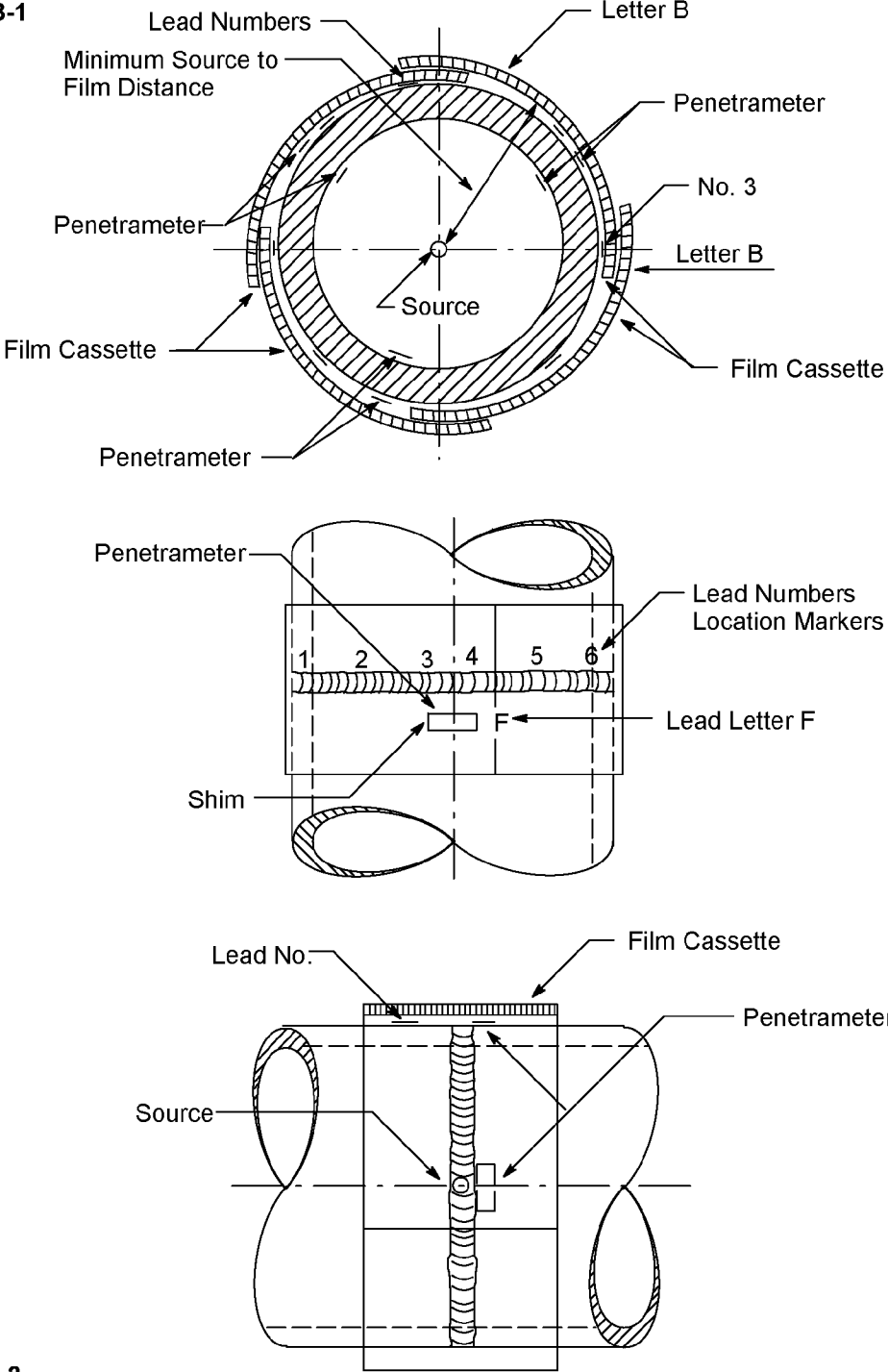
Note for Figure 1

The penetrameter shall be source side, whenever possible. When using a film-side penetrameter, a lead letter F shall be placed adjacent to the penetrameter. Lead numbers shall be placed at 2" intervals around the pipe adjacent to the weld.

Figure 1
Double-wall Technique Placement of Location Markers for Film Identification and Source

Radiographic Procedure: Double-Wall Panoramic Techniques-Butt Welded Pipe

APPENDIX B-1



Note for Figure 2

The penetrameter shall be source side, whenever possible. When using a film-side penetrameter, a lead letter F shall be placed adjacent to the penetrameter. Lead numbers shall be placed at 2" intervals around the pipe adjacent to the weld.

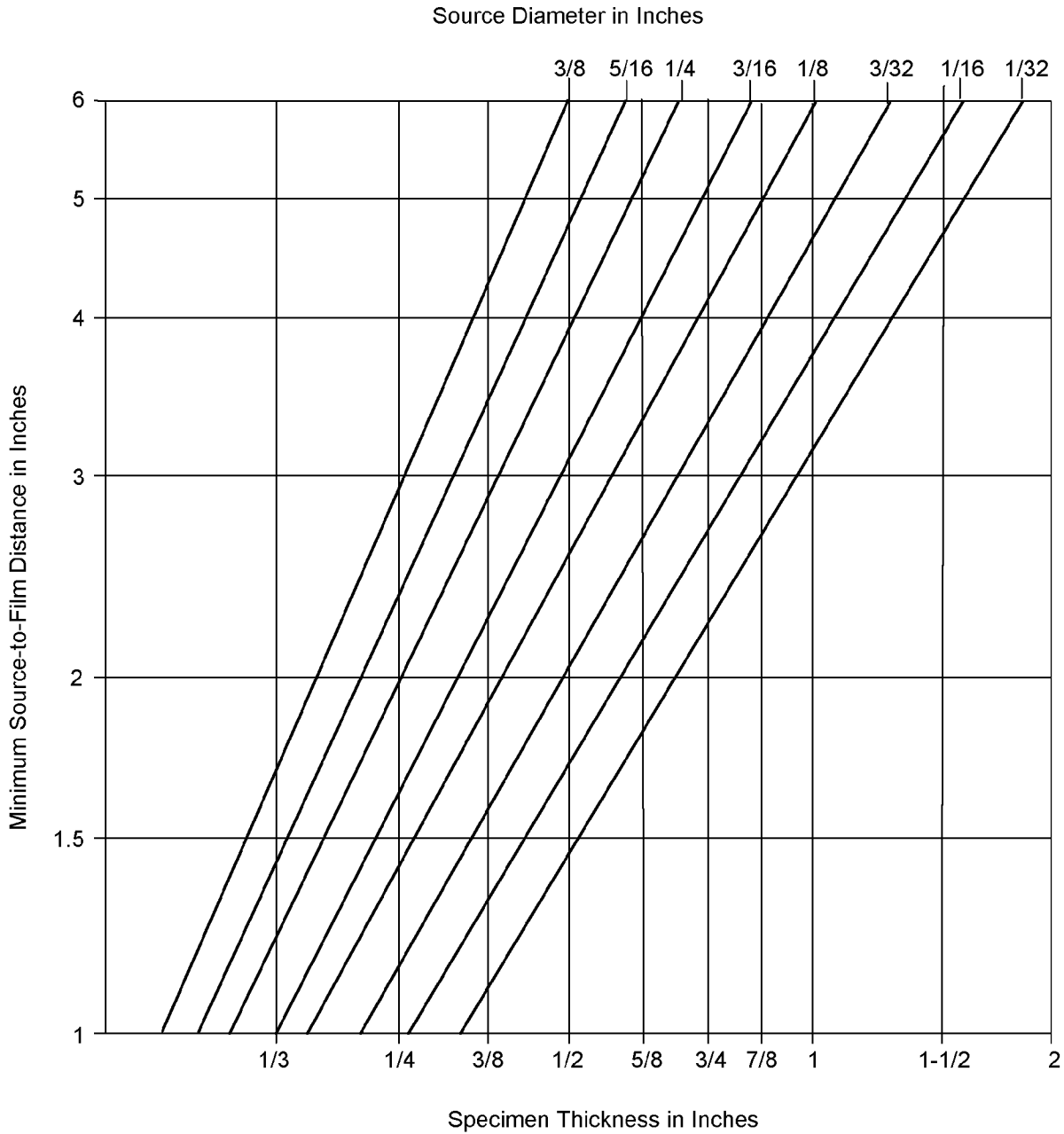
Figure 2 Panoramic-technique Placement of Location Markers Film Identification and Source

**Radiographic Procedure: Double-Wall
Panoramic Techniques-Butt Welded Pipe**

APPENDIX C

Notes for Figure 3

Radioactive sources which are uncollimated must have a minimum SFD corrected by the multiplication factors shown in Appendix C-1, if the source length is greater than 1/16". Specimen thickness is for a single wall.



**Figure 3
Source-to-Film Distance**

Radiographic Procedure: Double-Wall Panoramic Techniques-Butt Welded Pipe

APPENDIX C-1

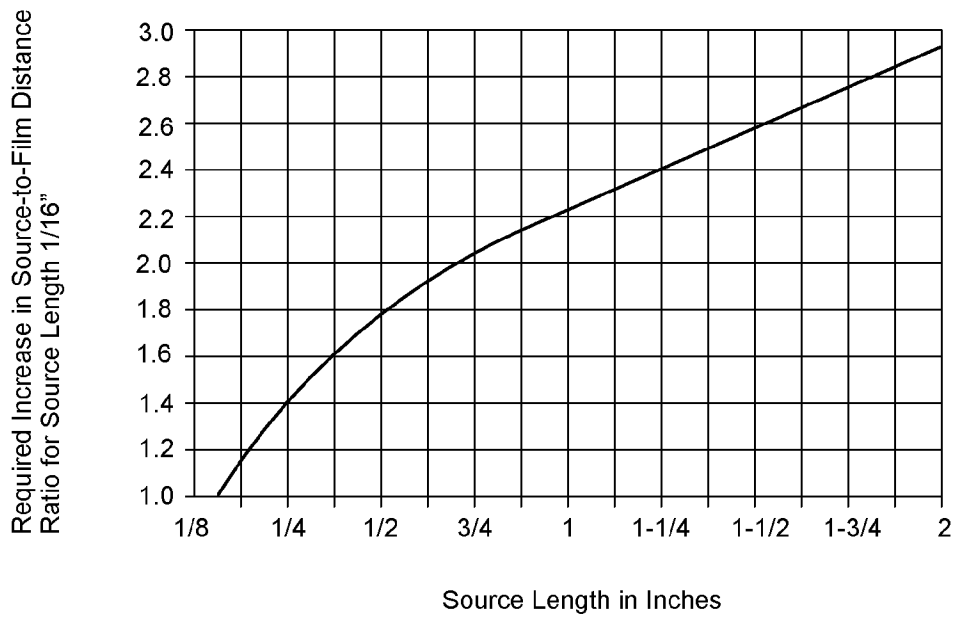


Figure 4
Source-to-Film Distance, Source-to-Length Correction

**Radiographic Procedure: Double-Wall
Panoramic Techniques-Butt Welded Pipe**

APPENDIX D

Table 4 Minimum Acceptable Film Lengths

	Pipe Diameter in Inches																	
	6-5/8	8-5/8	10-3/4	12-3/4	14	16	18	20	22	24	26	28	30	32	34	36	40	42
7 ¹	7.0																	
9 ¹	5.8	9.6																
11 ¹	4.8	8.0	11.0															
13 ¹	4.4	6.7	9.5	13.2														
14 ¹	4.2	6.2	8.5	11.6	15.4													
16 ¹	4.0	5.8	7.9	10.5	13.6	17.3												
18 ¹	3.9	5.6	7.5	9.8	12.5	15.6	19.0											
20 ¹	3.8	5.4	7.2	9.3	11.7	14.5	17.6	22.2										
22 ¹	3.8	5.2	6.9	8.9	11.1	13.6	16.5	20.0	24.4									
24 ¹	3.7	5.1	6.7	8.6	10.8	12.9	15.5	18.5	22.2	26.5								
26 ¹	3.7	5.0	6.6	8.3	10.3	12.3	14.8	17.4	20.7	24.2	28.8							
28 ¹	3.6	5.0	6.4	8.1	10.0	11.9	14.2	16.7	19.6	22.5	26.2	30.6						
30 ¹	3.6	4.9	6.3	7.9	9.7	11.5	13.7	16.0	18.6	21.3	24.5	28.3	32.6					
32 ¹	3.5	4.8	6.2	7.8	9.6	11.2	13.3	15.4	17.9	20.3	23.2	26.7	30.2	34.9				
34 ¹	3.5	4.8	6.2	7.7	9.3	11.0	13.0	15.0	17.3	19.6	22.3	25.5	28.7	32.2	37.3			
36 ¹	3.4	4.7	6.1	7.6	9.1	10.8	12.7	14.6	16.8	19.0	21.5	24.4	27.4	30.7	34.5	39.5		
40 ¹								14.1	16.0	18.1	20.3	22.8	25.4	27.8	31.0	35.0	43.8	
42 ¹								13.8	15.6	17.7	19.8	22.2	24.6	26.6	29.7	33.1	41.2	45.8
44 ¹								13.6	15.3	17.3	19.4	21.7	23.9	26.0	28.6	31.6	39.0	42.8
46 ¹								13.4	15.2	17.0	19.0	21.3	23.4	25.4	27.7	30.4	37.0	40.9
54 ¹								12.8	14.1	15.8	17.8	19.8	21.7	23.2	25.4	27.7	32.6	35.0
60 ¹													20.6	2.2	24.0	26.0	30.5	32.7
66 ¹													19.8	21.4	23.1	24.9	29.0	31.0
72 ¹													19.3	20.7	22.3	23.9	27.8	29.7
80 ¹													18.7	20.1	21.5	23.1	26.4	28.2

¹ Source - Film Distance in Inches

**Radiographic Procedure: Double-Wall
Panoramic Techniques-Butt Welded Pipe**

Notes for Figure 5

T - Penetrameter Thickness

A - Diameter = 2 T

B - Diameter = 1 T

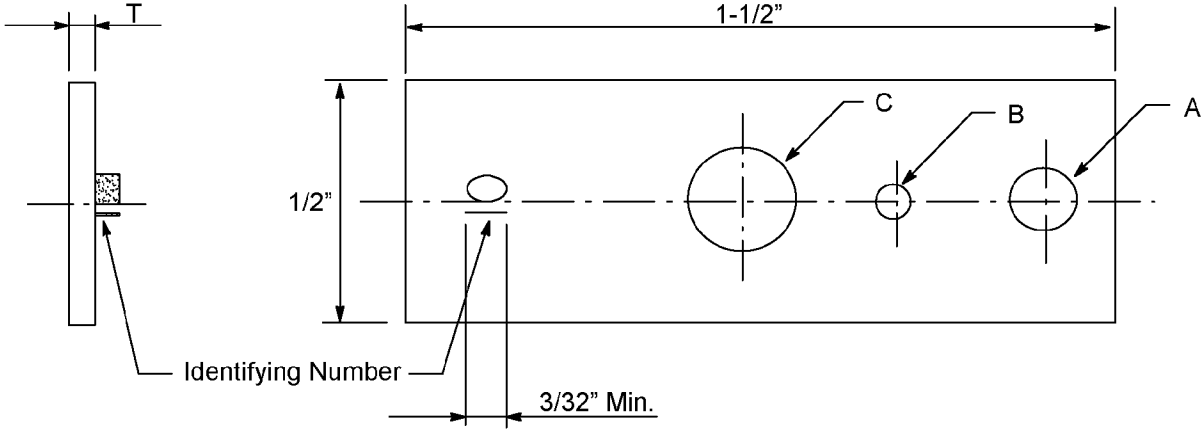
C - Diameter = 4 T

The smallest hole does not need to be less than 1/16" in diameter.

Holes shall be round and drilled perpendicular to the surface.

Holes shall be free of burrs, but edges shall not be chamfered.

Each penetrameter shall carry a lead identification number.



**Figure 5
Standard Penetrameter**