



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

**D-33**

**Asset Type:** Gas Transmission and Distribution      **Function:** Design and Construction  
**Issued by:** [Redacted]      **Date:** 02-23-09  
Original Signed By ←

**Rev. #01:** This document replaces Revision #00. For a description of the changes, see Page 4.

**Purpose and Scope**

This numbered document describes 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 49 CFR 192.243.

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

Radiographic inspection shall be performed and interpreted only by qualified personnel who are certified in accordance with the requirements of 49 CFR 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

**References**

**Document**

<u>Standard of Acceptability for Welding: Nondestructive and Destructive Testing</u> .....	D-31
<u>Welding of Pipelines and Related Facilities</u> .....	API 1104
<u>Nondestructive testing</u> .....	49 CFR 192.243

**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 Attachment A on Page 5.

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**Location of Penetrators**

7. The radiographic quality shall be evaluated by the image of a properly located penetrator (see Attachment B on Page 6 and Attachment B-1 on Page 7).
8. The penetrator shall be placed on the side nearest the radiation source. Where it is physically impossible to do this, a film-side penetrator shall be placed on the film side of the joint.
9. The penetrator thickness shall be based on the single-wall thickness.
10. A lead letter F, at least 1/2" high, shall be placed adjacent to the penetrator whenever a film-side penetrator is used.
11. A lead letter S, at least 1/2" high, shall be placed adjacent to the penetrator whenever a source-side penetrator is used.
12. When a complete girth weld is radiographed in a single exposure using a source on the inside of the pipe, four penetrators, equally spaced around the circumference, shall be used. When a girth weld is radiographed using a multiple-exposure procedure, a penetrator 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 penetrator 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 penetrator 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
  - 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 Attachment B on Page 6).
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 Attachment D on Page 10.

**Source-to-Film Distance**

19. Minimum source-to-film distance for Iridium 192 shall be computed in accordance with Attachment C on Page 8 and Attachment C-1 on Page 9.
20. The film and source shall be placed against the pipe as shown in Attachment B on Page 6.

**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.

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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.

**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 Numbered Document D-31.

**Repairs**

36. Welds showing unacceptable discontinuities shall be repaired as described in Numbered Document 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.

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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.

**Reporting**

43. A record of all procedure qualifications shall be maintained by gas technical support personnel.

44. Records of Certification for company personnel performing radiographic examination shall be maintained by gas technical support personnel.

**Revision Notes**

Revision 01 has the following changes:

1. Added the "References" section.
2. Added the hyperlinks to all references.
3. Changed all appendixes to attachments.
4. Deleted the "Qualification of Procedure" section (former Item 43).
5. This document is part of Change 61.

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**Attachment 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**

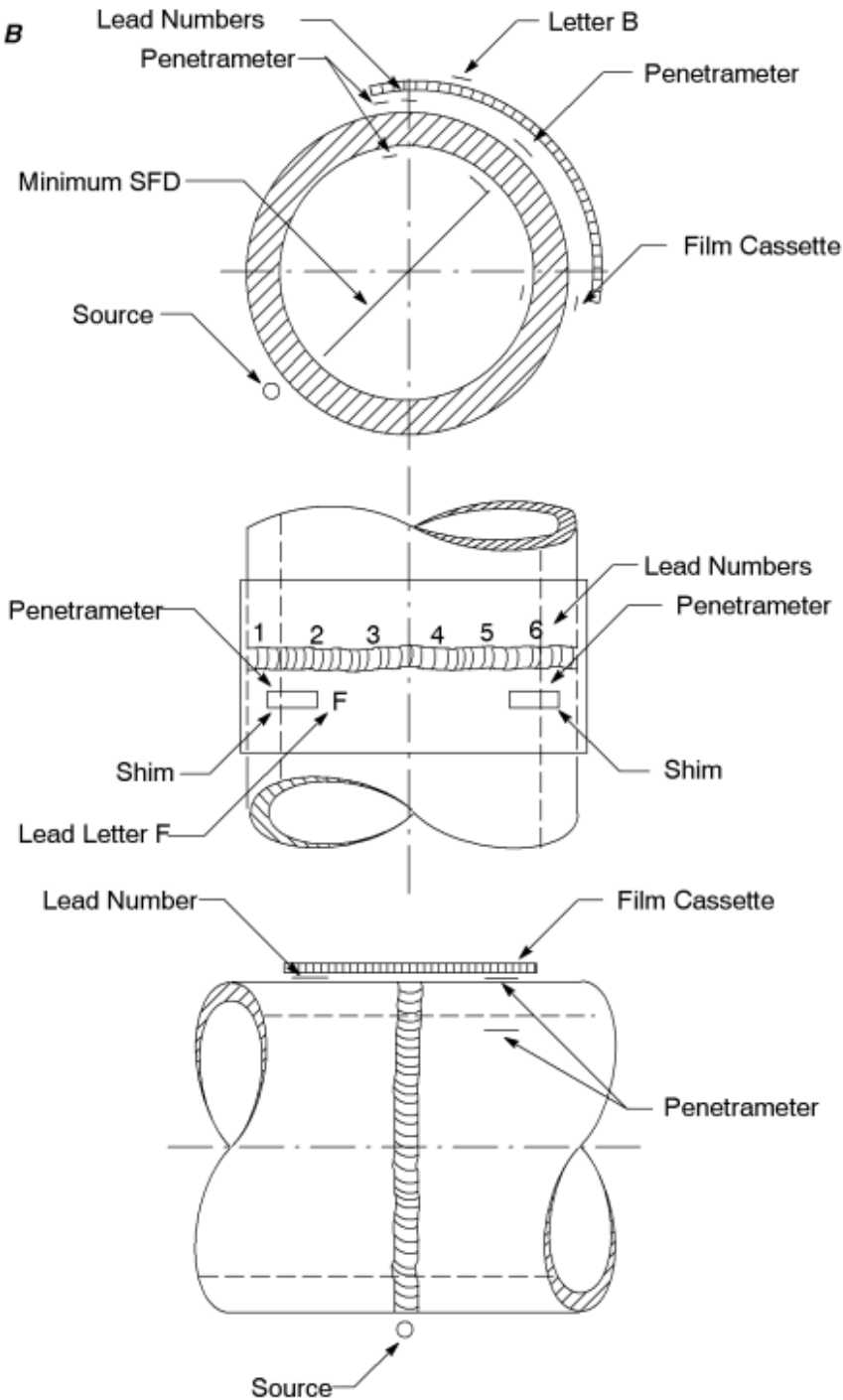
Pipe Wall or Weld Thickness		
Thickness of Pipe (Inches)	Penetration Thickness (Inches)	Identifying Number
0 - 1/4	0.0050	5
1/4 - 3/8	0.0075	7
3/8 - 1/2	0.0100	10
1/2 - 5/8	0.0125	12
5/8 - 3/4	0.0150	15
3/4 - 7/8	0.0175	17
7/8 - 1	0.0200	20
1 - 1-1/4	0.0250	25
1-1/4 - 1-1/2	0.0300	30
1-1/2 - 2	0.0350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

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**Attachment B**



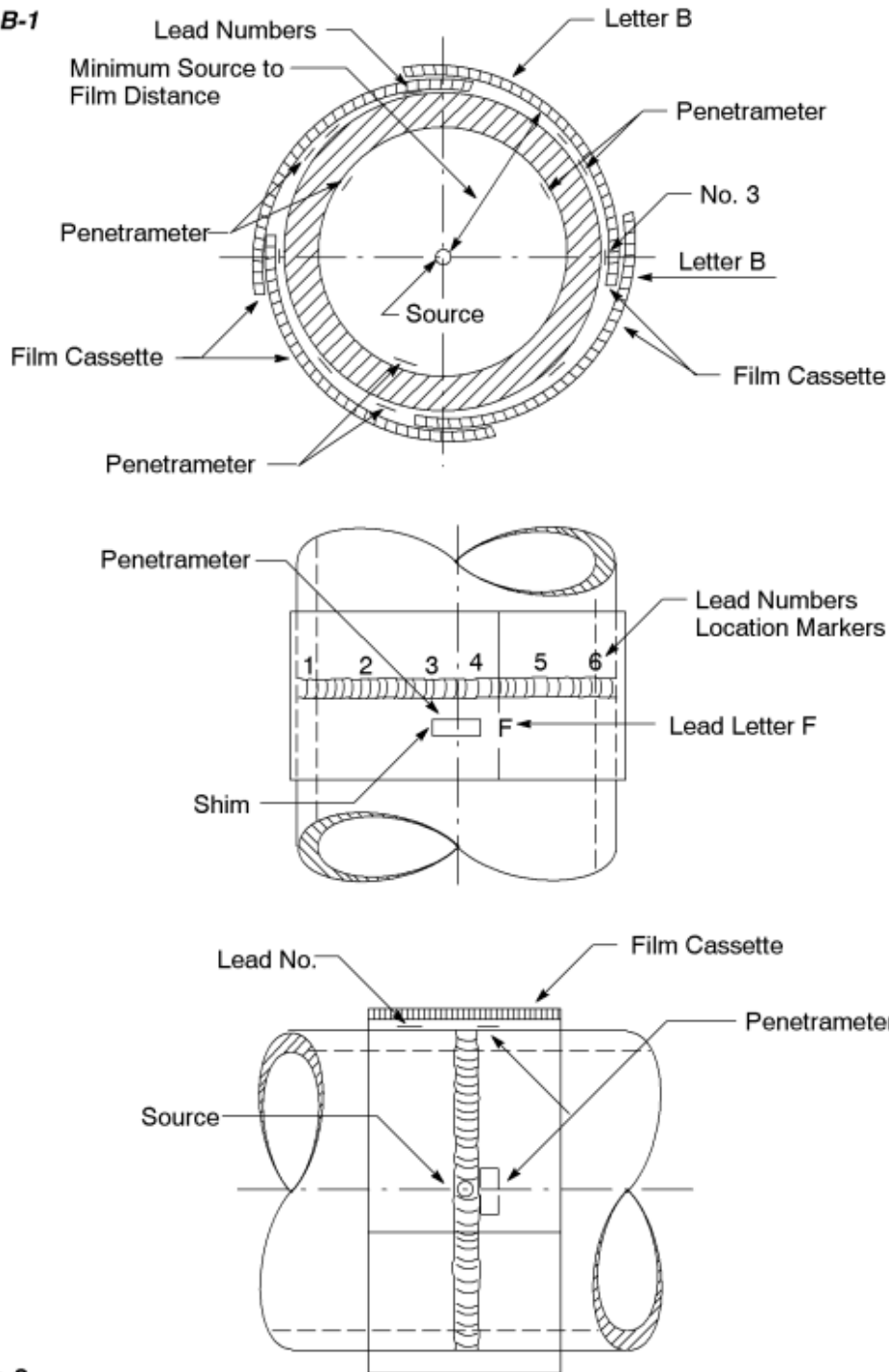
**Note for Figure 1**

The penrameter shall be source side, whenever possible. When using a film-side penrameter, a lead letter F shall be placed adjacent to the penrameter. 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**

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**Attachment B-1**



**Note for Figure 2**

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

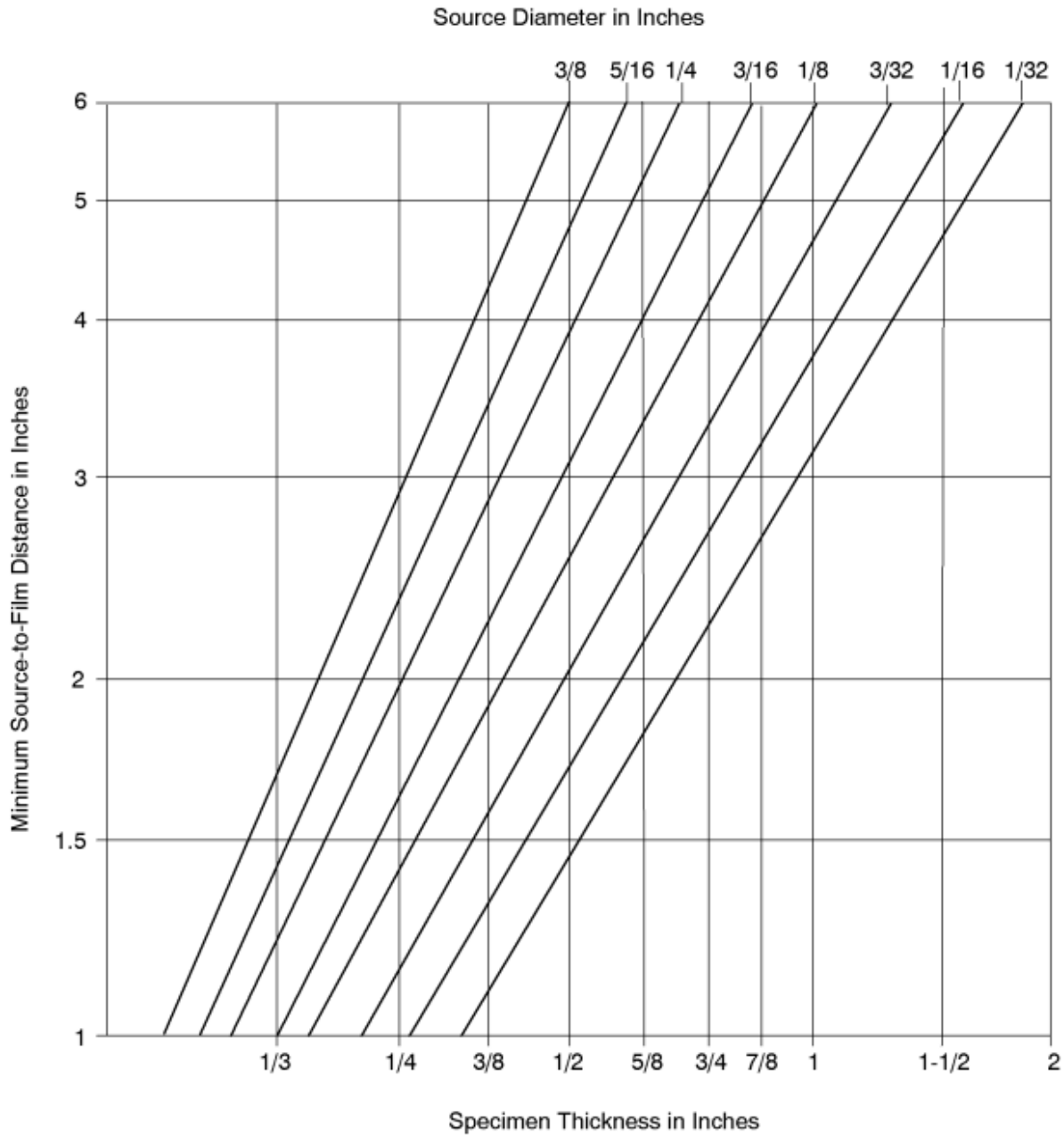
**Figure 2  
Panoramic-Technique Placement of Location  
Markers Film Identification and Source**

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**Attachment C**

**Notes for Figure 3**

Radioactive sources which are uncollimated must have a minimum SFD corrected by the multiplication factors shown in Attachment C-1 on Page 9, if the source length is greater than 1/16". Specimen thickness is for a single wall.

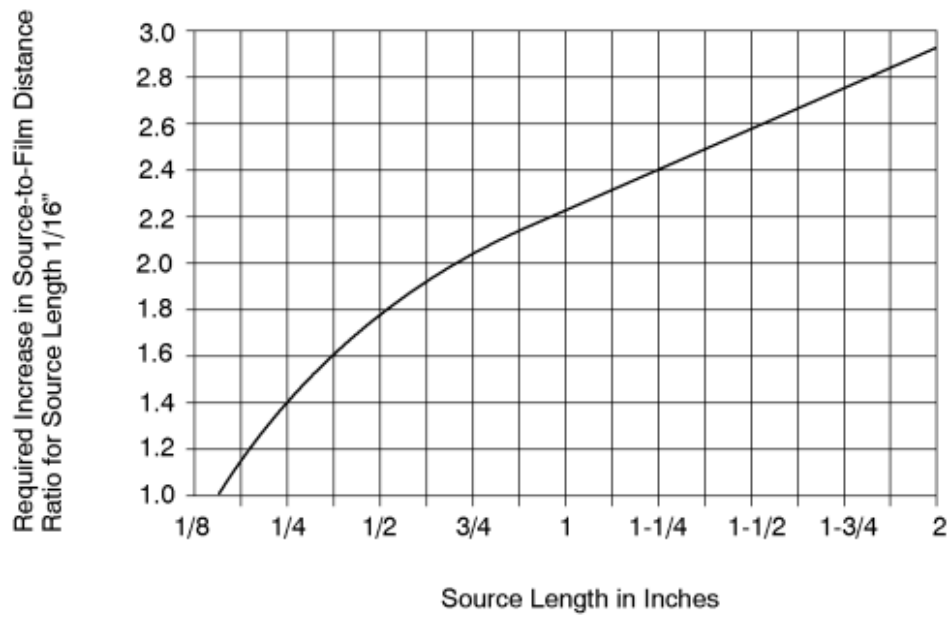


**Figure 3  
Source-to-Film Distance**



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**Attachment C-1**

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

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**Attachment D**

**Table 4 Minimum Acceptable Film Lengths**

Source-to-Film Distance in Inches	Pipe Diameter (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	7.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
9	5.8	9.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
11	4.8	8.0	11.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
13	4.4	6.7	9.5	13.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-
14	4.2	6.2	8.5	11.6	15.4	-	-	-	-	-	-	-	-	-	-	-	-	-
16	4.0	5.8	7.9	10.5	13.6	17.3	-	-	-	-	-	-	-	-	-	-	-	-
18	3.9	5.6	7.5	9.8	12.5	15.6	19.0	-	-	-	-	-	-	-	-	-	-	-
20	3.8	5.4	7.2	9.3	11.7	14.5	17.6	22.2	-	-	-	-	-	-	-	-	-	-
22	3.8	5.2	6.9	8.9	11.1	13.6	16.5	20.0	24.4	-	-	-	-	-	-	-	-	-
24	3.7	5.1	6.7	8.6	10.8	12.9	15.5	18.5	22.2	26.5	-	-	-	-	-	-	-	-
26	3.7	5.0	6.6	8.3	10.3	12.3	14.8	17.4	20.7	24.2	28.8	-	-	-	-	-	-	-
28	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	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	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	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	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	-	-	-	-	-	-	-	14.1	16.0	18.1	20.3	22.8	25.4	27.8	31.0	35.0	43.8	-
42	-	-	-	-	-	-	-	13.8	15.6	17.7	19.8	22.2	24.6	26.6	29.7	33.1	41.2	45.8
44	-	-	-	-	-	-	-	13.6	15.3	17.3	19.4	21.7	23.9	26.0	28.6	31.6	39.0	42.8
46	-	-	-	-	-	-	-	13.4	15.2	17.0	19.0	21.3	23.4	25.4	27.7	30.4	37.0	40.9
54	-	-	-	-	-	-	-	12.8	14.1	15.8	17.8	19.8	21.7	23.2	25.4	27.7	32.6	35.0
60	-	-	-	-	-	-	-	-	-	-	-	-	20.6	2.2	24.0	26.0	30.5	32.7
66	-	-	-	-	-	-	-	-	-	-	-	-	19.8	21.4	23.1	24.9	29.0	31.0
72	-	-	-	-	-	-	-	-	-	-	-	-	19.3	20.7	22.3	23.9	27.8	29.7
80	-	-	-	-	-	-	-	-	-	-	-	-	18.7	20.1	21.5	23.1	26.4	28.2

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**Notes for Figure 5**

T - Penetrameter Thickness

A - Diameter = 2 T

B - Diameter = 1 T

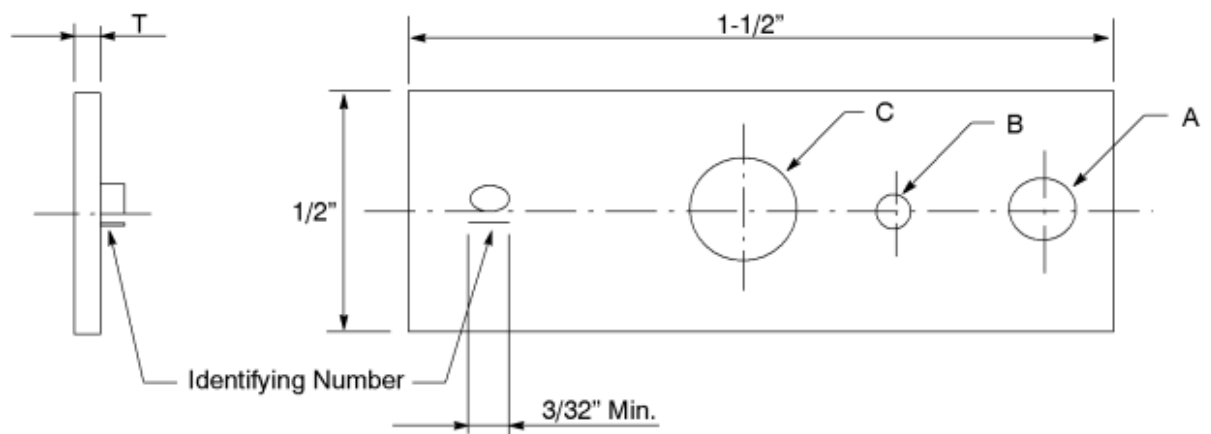
C - Diameter = 4 T

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**