

1 0 SCOPE

This standard establishes the limits of acceptability for non-destructive inspection (except visual inspection) of production welding and for destructive and non-destructive testing for welders. It also covers procedures for preparing test specimens for destructive testing and the testing of the specimens.

2 0 STANDARD OF ACCEPTABILITY - NON-DESTRUCTIVE TESTING

2 1 Introduction

- 2 1 1 These standards of acceptability are applicable to the determination of the size and type of defects located by radiography and other non-destructive test methods including visual inspection.
- 2 1 2 Any defect exceeding the limits outlined classify the weld as unacceptable.
- 2 1 3 The visual inspection requirements of Paragraph 2 2 apply only to welder qualification test welds. Refer to Gas Standard D-40 for visual inspection requirements for production welding.
- 2 1 4 Welds which are to be destructively tested should not be subjected to non-destructive testing other than the visual inspection requirements of Paragraph 2 2.
- 2 1 5 Radiographic procedure shall be as outlined in Standard D-33. Radiography is not normally used on lines smaller than 6'.
- 2 1 6 Since radiographic test methods give two dimensional results only, the Company may reject welds which appear to meet these standards of acceptability if in the opinion of the inspector the depth of the defect may be detrimental to the strength of the weld.

2 2 Visual - Welder Qualifications Test Welds Only (See Standard D-40 for production welds)

The weld must be free of cracks, inadequate penetration, unrepaired burn through, and other defects, and must present a neat workman-like appearance. External undercut shall not exceed 1/32" depth or 12-1/2 percent of the pipe wall thickness whichever is smaller, and there shall not be more than 2 inches of undercutting in any continuous 12' of weld. (Also see Par 2 10) Any weld not meeting these requirements shall be failed without further testing.

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BY		PIPING - DATA SHEET STANDARDS OF ACCEPTABILITY NON-DESTRUCTIVE & DESTRUCTIVE TESTING GAS STANDARD PACIFIC GAS AND ELECTRIC COMPANY			SUPERSEDES 084508		
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2 3 Inadequate Penetration

Inadequate penetration is the incomplete filling of the weld root with weld metal. Types of inadequate penetration are as follows:

2 3 1 Inadequate Penetration of Weld Root

Inadequate penetration without high-low present is the incomplete filling of the weld root. A schematic representation of this condition is given on page 11 (Drawing 085177 (A)). Any individual condition due to this type of inadequate penetration shall not exceed 1 inch. The total length of such condition in any continuous 12-Inch length of weld shall not exceed 1 inch. If the weld is less than 12 inches long, then the total length of such condition shall not exceed 8 percent of the weld length.

2 3 2 Inadequate Penetration Due to High-Low

High-low is a condition where the pipe and/or fitting surfaces are misaligned. This situation is represented schematically on page 11 (Drawing 085177 (B) and (C)). High-low is not objectionable provided that the end preparation meets the requirements on Drawing 084033 (page 8 of Standard D-22) and the root of adjacent pipe and/or fitting joints is completely tied in (bonded) by weld metal (Drawing 085177 Item (C)). When one edge of the root is exposed (or unbonded), the length of this condition shall not exceed 2 inches at individual locations or 3 inches in any continuous 12-Inch length of weld (Drawing 085177 (B)).

2 3 3 Internal Concavity

Internal concavity as used in this standard shall mean a bead which is properly fused to and completely penetrates the pipe wall thickness along both sides of the bevel, but the center of the bead is less than flush with the inside surface of the pipe wall. Internal concavity is associated with a continuously deposited weld bead and it differs from burn-through areas which are associated with intermittently deposited weld metal. The magnitude of concavity shall be defined as the perpendicular distance between an axial extension of the pipe wall surface and the lowest weld bead surface point. It is shown schematically on page 11 (Drawing 085177 (D)).

Internal concavity is allowable provided the density of the radiographic image does not exceed that of the adjacent base metal. If the density exceeds that of the base metal, dimensions of such areas shall not exceed those specified for burn-through in sections 2 5 1 and 2 5 2.

	PG & E CO	DRAWING NUMBER	REV
	SHEET 2 OF 10 SHEETS	086433	0
		MICROFILM	

2 4 Incomplete Fusion

2 4 1 Incomplete fusion is the lack of bond between beads or between weld metal and base metal. Incomplete fusion at the root of the joint or at the top of the joint between the weld and the base metal (see page 11 Drawing 085177 (E)) shall not exceed 1 inch in length. The total length of such conditions in any 12-inch length of weld metal shall not exceed 1 inch. If the weld is less than 12 inches long, then the total length of such conditions shall not exceed 8 percent of the weld length.

2 4 2 Incomplete Fusion Due to Cold Lap

Incomplete fusion due to cold lap is a discontinuity between two adjacent weld beads or between a weld bead and the base metal. For the purposes of this standard incomplete fusion due to cold lap is a subsurface discontinuity and thus it differs from incomplete fusion referred to in Par 2 5 1. Incomplete fusion due to cold lap is depicted schematically on page 11 (Drawing 085177 (F)). Individual incomplete fusion due to cold lap discontinuities shall not exceed 2 inches in length. The total length of incomplete fusion due to cold lap in any continuous 12-inch length of weld shall not exceed 2 inches.

2 5 Burn-Through

A burn-through is that portion of the root bead where excessive penetration has caused the weld puddle to be blown into the pipe. This is usually caused by too much space in fit-up.

2 5 1 For Pipe 2-3/8 Inches O D and Larger

Any unrepaired burn-through shall not exceed 1/4 inch or the thickness of the pipe wall whichever is smaller in any dimension. The sum of the maximum dimensions of separate unrepaired burn-through in any continuous 12 inch length of weld shall not exceed 1/2 inch.

2 5 2 For Pipe Less Than 2-3/8 Inches O D

No more than one unrepaired burn-through is acceptable and it shall not exceed 1/4 inch or the thickness of the pipe wall, whichever is the smaller, in any dimension.

2 5 3 Radiographs of repaired burn-throughs shall show that these have been properly repaired. Burn-through shall be considered to have been acceptably repaired if the density of the radiographic image of the burn-through does not exceed that of the adjacent base metal.

	PG & E CO	DRAWING NUMBER	REV
	SHEET 3 OF 10 SHEETS	086433	0
		MICROFILM	

2 6 Slag Inclusions

A slag inclusion is a nonmetallic solid entrapped in weld metal, or between the weld metal and the pipe metal. Elongated slag inclusions are usually found at the fusion zone. Isolated slag inclusions are irregularly shaped inclusions and may be located anywhere in the weld.

2 6 1 Elongated Slag Inclusions (Wagon Tracks)

2 6 1 1 For Pipe 2-3/8 Inches O D and Larger

Any elongated slag inclusions shall not exceed 2 inches in length or 1/16 inch in width. The total length of elongated slag inclusions in any continuous 12 inch length of weld shall not exceed 2 inches. Parallel slag lines shall be considered as separate conditions if the width of either exceeds 1/32 inch.

2 6 1 2 For Pipe Less Than 2-3/8 Inch O D

Individual elongated slag inclusions shall not exceed 1/16 inch in width or three times the nominal wall thickness in length. Parallel slag lines shall be considered as separate conditions if the width of either one of them exceeds 1/32 inch.

2 6 2 Isolated Slag Inclusions

2 6 2 1 For Pipe 2-3/8 Inch O D and Larger

The maximum width of any isolated slag inclusions shall not exceed 1/8 inch. The total length of isolated slag inclusions in any continuous 12 inch length of the weld shall not exceed 1/2 inch nor shall there be more than four isolated slag inclusions of the maximum width of 1/8 inch in this length.

2 6 2 2 For Pipe Less Than 2-3/8 Inches O D

The maximum width of any isolated slag inclusions shall not exceed 1/2 the nominal wall thickness and the total length of such inclusions shall not exceed twice the nominal wall thickness.

2 7 Porosity or Gas Pockets

Porosity or gas pockets are voids occurring in the weld metal.

	PG & E CO	DRAWING NUMBER	REV
	SHEET 4 OF 10 SHEETS	086433	0
		MICROFILM	

2 7 1 Spherical Porosity

The maximum dimension of any individual spherical gas pocket shall not exceed 1/8 inch or 25 percent of the pipe wall thickness whichever is the lesser. The maximum distribution of spherical porosity shall not exceed that shown in Drawing 084025 and 084026 (page 17 and 16 of this Standard)

2 7 2 Cluster Porosity

Cluster porosity which occurs in the finish pass shall not exceed an area of 1/2 inch in diameter with the maximum dimensions of any individual gas pocket within the cluster not to exceed 1/16 inch. The total length of cluster porosity in any continuous 12-inch length of weld shall not exceed 1/2 inch. Cluster porosity occurring in all other passes shall comply with Paragraph 2 7 1

2 7 3 Piping (Wormhole) Porosity

Piping (Wormhole) porosity is an elongated discontinuity which results when the gas rises through the solidifying weld metal. The maximum dimension of the radiographic image associated with wormhole porosity shall not exceed 1/8 inch or 25 percent of the pipe wall thickness whichever is the lesser. The maximum distribution for wormhole porosity shall not exceed that shown on pages 17 or 16 (Drawings 084025 and 084026). The orientation of this discontinuity will substantially affect the density of the radiographic image and when applying these limits consideration shall be given to the provisions of Par 2 1 6 (Right of Rejection)

2 7 4 Hollow Bead

Hollow bead is elongated linear porosity occurring in the root pass. The maximum length of this discontinuity shall not exceed 1/2 inch. The total length of hollow bead in any continuous 12-inch length of weld metal shall not exceed 2 inches, and individual adjacent discontinuity exceeding 1/4 inch in length shall be separated by at least 2 inches of sound weld metal.

2 8 Cracks

Shallow crater cracks or star cracks which are located at the stopping point of weld beads and which are the result of weld metal contraction during solidification are not considered injurious defects unless their length exceeds 5/32 inches. With the exception of these shallow crater cracks no weld containing cracks regardless of size or location shall be acceptable.

	PG & E CO	DRAWING NUMBER	REV
	SHEET 5 OF 10 SHEETS	086433	0
		MICROFILM	

2 9 Accumulation of Discontinuities

Excluding high-low condition any accumulation of discontinuities having a total length of more than 2 inches in a continuous weld length of 12 inches, or more than 8 percent of a continuous weld length if the total weld length is less than 12 inches is unacceptable. Any accumulation of discontinuities which total more than 8 percent of the weld length associated with an entire joint is unacceptable.

2 10 Undercutting

Undercutting is the burning away of the side walls of the welding groove at the edge of a layer of weld metal or the reduction in the thickness of the pipe wall adjacent to the weld and where it is fused to the surface of the pipe.

Undercutting adjacent to the cover bead on the outside of the pipe shall not be V-shaped and shall not exceed the following dimensions:

<u>Depth</u>	<u>Length</u>
1/32 In or 12-1/2 percent of the pipe wall thickness whichever is smaller	Not acceptable
Above 1/64 In to 1/32 In or 6 to 12-1/2 percent of the pipe wall thickness whichever is smaller	2 In or 1/6 the length of the weld whichever is smaller
1/64 In or 6 percent of the pipe wall thickness whichever is smaller	Acceptable regardless of length

Undercutting may be determined by visual, mechanical or non-destructive test methods.

Where there is evidence of internal undercutting adjacent to the root bead, the same standards of acceptability shall apply, except that the procedure outlined in Section 6.9 of the 13th Edition (1973) of API 1104 for the determination of the depth of internal undercutting solely by radiography using a comparator shim, is not to be used. The depth limitations for internal undercutting adjacent to the root bead apply only if:

- a) The depth is visually determined by use of a depth measuring device on all undercutting along the entire circumference of the weld and
- b) Visual determination of internal undercutting is made in all pipe of the same diameter in a pipeline except where impractical at tie-in welds.

	PG & E CO	DRAWING NUMBER	REV
	SHEET 6 OF 10 SHEETS	086433	0
		MICROFILM	

3 3 Nick-Break Test (Butt Welds)

3 3 1 Preparation

The specimens (Drawing 283709 page 14 of this Standard) shall be a minimum of 9" long and approximately 1 inch wide. They may be machine-cut or torch-cut. They shall be notched with a hacksaw on each side at the center of the weld. Each notch shall be approximately 1/8 inch deep.

Nick-break specimens prepared in this manner from welds made with certain automatic and semiautomatic process may fail through the pipe instead of the weld. When this occurs the external reinforcement may be notched to a depth not to exceed 1/16 inch measured from the original weld surface.

3 3 2 Method

The specimens shall be broken by pulling in a tensile machine or by supporting the ends and striking the center. The exposed area of the fracture shall be at least 3/4 inch wide.

3 3 3 Requirements

The exposed surfaces of each specimen shall show complete penetration and fusion and (a) there shall be no more than six gas pockets per square inch of surface area with the greatest dimension not to exceed 1/16 inch, (b) slag inclusions shall not be more than 1/32 inch in depth nor 1/8 inch or one-half the nominal wall thickness in length whichever is shorter and there shall be at least 1/2 inch of sound weld metal between adjacent inclusions. The dimensions should be measured as shown in Drawing 083976 (Page 15).

3 4 Root and Face Bend Test (Butt Welds)

3 4 1 Preparation

The specimens (Drawing 283709 Page 14 of this Standard), shall be at least 9 inches long by 1 inch wide and the long edges shall be rounded. They may be machine-cut or torch-cut. The cover pass and root bead reinforcement shall be ground or machined flush with the surface of the specimen. These surfaces shall be smooth and any scratches which exist shall be light and transverse to the weld.

3 4 2 Method

The specimens shall be bent in a guided bend test jig similar to that shown in Drawing 084109 Standard M-26.

	PG & E CO	DRAWING NUMBER	REV
	SHEET 8 OF 10 SHEETS	086433	0
		MICROFILM	

Each specimen shall be placed on the die with the weld at the mid-span. Face bend specimens shall be placed with the face of the weld directed toward the gap and root bend specimens shall be placed with the root of the weld directed toward the gap. The plunger shall be forced into the gap until the curvature of the specimen is approximately U-shaped.

3 4 3 Requirements

The bend test shall be considered acceptable if no crack or other defect exceeding 1/8 inch or 1/2 the nominal wall thickness whichever is smaller in any direction is present in the weld or between the weld and the fusion zone after bending. Cracks which originate along the edges of the specimen during testing and which are less than 1/4 inch measured in any direction shall not be considered unless obvious defects are observed. Each specimen subjected to the bend test shall meet these requirements.

3 5 Side Bend Test (Butt Welds)

3 5 1 Preparation

The specimens (Drawing 283709 Page 14) shall be at least 9 inches long by 1/2 inch wide and the long edges shall be rounded. They shall be machine-cut or they may be torch-cut to approximately a 3/4 inch width and then machined or ground to the 1/2 inch width. The sides shall be smooth and parallel. The cover and root bead reinforcements shall be ground or machined flush with the surfaces of the specimen.

3 5 2 Method

The specimens shall be bent in a guided bend test jig, similar to that shown in Drawing 084109 (Standard M-26). Each specimen shall be placed on the die with the weld at mid-span and with the face of the weld at 90 degrees to the gap. The plunger shall be forced into the gap until the curvature of the specimen is approximately U-shaped.

3 5 3 Requirements

Each specimen shall meet the Face and Root Bend Test Requirement Paragraph 3 4 3.

4 0 DESTRUCTIVE TESTING OF WELDED JOINTS - BRANCH WELDS

4 1 Preparation

Specimens shall be cut from the joint at the locations shown in Drawing 086406 (Page 4 of Standard D-30 2). The minimum number of specimens are also given in Drawing 086406.

	PG & E CO	DRAWING NUMBER	REV
	SHEET 9 OF 10 SHEETS	086433	0
		MICROFILM	

4 2 Method

Prepare and break specimens as indicated on Drawing 084024
(Page 13 of this Standard)

5 0 REPAIR OR REMOVAL OF DEFECTS (FOR PRODUCTION WELDS)

Each weld that does not meet the Standards of Acceptability Section 2 of this Standard, shall be repaired or removed

For new construction a weld must be removed if it has a crack that is more than two inches or that penetrates either the root or second bead For operating lines see Standard A-65

Each weld that is repaired must have the defect removed down to clean metal and the segment to be repaired must be preheated After repair the segment of the weld that was repaired must be inspected to ensure its acceptability If the repair is not acceptable, the weld must be removed

6 0 RECORDS

6 1 Inspection and Test Reports for Pipeline Welds

6 1 1 Divisions are requested to arrange with the Gas Construction Department to handle all radiographic testing

6 1 2 Record of number of welds inspected must be retained for the life of the facility (See Standard D-40)

6 2 Employee Qualification and Requalification records must be retained for the entire period a welder is qualified Use forms as indicated in appropriate qualification standard or other approved forms

7 0 WELD INSPECTORS

7 1 All weld inspections shall be performed by persons qualified to inspect welds as stated in Standard D-40

7 2 Welder Qualification or Requalification tests shall be performed in the presence of a qualified welding inspector The inspector shall insure that these test welds meet visual inspection requirements of Paragraph 2 2 and that they are performed in accordance with the Welding Procedure

	PG & E CO	DRAWING NUMBER	REV
	SHEET 10 OF 10 SHEETS	086433	0
		MICROFILM	