Prepared by: KG/JZB1

ARC WELDING PROCEDURE REQUIREMENT ALL STRESS LEVELS

D-22

Department:	Gas System Maintenance and Technical Support	**Section:** System Integrity	**Date:** 05-04-99
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Rev. #00: This document replaces PG&E Drawings 086432, 084033, 284361, 284363 and 283263.
For a description of the changes, see Page 13.

Purpose and Scope

This gas standard shall be included as a part of all welding procedure specifications used on natural gas facilities governed by 49 CFR Part 192 (latest revision), subpart E, and API Standard 1104. Changes to these welding standards shall be approved by Gas System Maintenance and Technical Support.

Acronyms

API:	American Petroleum Institute
ASME:	American Society of Mechanical Engineers
ASTM:	American Society for Testing and Materials
AWS:	American Welding Society
CE:	carbon equivalent
CFR:	Code of Federal Regulations
FCAW:	flux cored arc welding
GMAW:	gas metal arc welding
GTAW:	gas tungsten arc welding
MAOP:	maximum allowable operating pressure
OD:	outside diameter
psi:	pounds per square inch
psig:	pounds per square inch gauge
SAW:	submerged arc welding
SMAW:	shielded metal arc welding
SMYS:	specified minimum yield strength

References

	Gas Standard
Gas Main Welding Sleeves	A-60
Repairing Steel Pipeline Defects	A-65
Oxy-acetylene Weld Procedure	D-20
Welder Qualification for Under 20% of SMYS	D-30
Oxy-acetylene Welder Qualification for Over 20% of SMYS	D-30.1
Arc Welder Qualification for Working on Pipelines that Operate at Over 20% of SMYS	D-30.2

Welding Specifications

1. Materials to be welded using the procedures in this gas standard include the following. Any exceptions shall be noted in the particular welding procedure specification.

   A. Pipes

   - API 5L, Grade B and A-25
   - API 5LX, Grade X-42 up to and including X-65
   - ASTM A-53, Grade B
   - ASTM A-106, Grade B

   B. Fittings

   - ASTM A-516, Grade 70

- ASTM A-242
- ASTM A-441
- ASTM A-633, Grade E
- ASTM A-234, Grade WPB
- ASTM A-105

2. All welding on pipe and fittings that is not under pressure shall be completed using detailed procedure specifications established, qualified and recorded in accordance with 49 CFR Part 192 and the API 1104.

3. Weld Procedure Selection

A. Before welding pipe or fittings, the welder must first identify the pipe size, type of material that is to be welded SMYS, and stress level for which the pipe is designed to operate. The appropriate welding process and procedure shall be determined from Paragraphs 3B through 3F below.

B. All piping, fittings and appurtenances designed to operate at 20% or more of the pipe SMYS, regardless of size, shall be welded by using one or a combination of the following processes.

(1) SMAW (See Gas Standard D-30.2 for qualification procedure)

(2) GMAW

(3) FCAW

(4) GTAW

(5) SAW

C. This gas standard covers the SMAW process using cellulose and low-hydrogen electrodes and GMAW for all stress levels.

D. SMAW and GMAW shall be the preferred welding processes used for all piping larger than 2" nominal diameter with a wall thickness greater than 0.154" and designed to be operated at over 20% SMYS.

E. Oxy-acetylene gas welding, in accordance with Gas Standard D-20, may be used instead of SMAW or GMAW under the conditions listed in Paragraphs 2.1.1. and 2.1.2 of Gas Standard D-20.

F. Piping designed to operate at less than 20% SMYS may be welded using any of the arc welding processes listed in Paragraph 3B above.

G. GMAW is the preferred process for making branch connection welds. If the SMAW process is performed, the procedure for welding branch connections shall be to use cellulose electrodes for the first and second passes followed by low-hydrogen electrodes for the filler and cover passes.

H. When welding on pipe greater than 12" in diameter (nominal), a minimum of two welders shall work simultaneously on opposite sides of the pipe. If this is not possible, the single welder shall weld one quadrant (1/4 of the circumference) at a time, moving to the opposite quadrant after each pass, and welding the opposite quadrant to offset expansion/contraction stresses due to welding.

4. Weld Preparation

A. Welding electrodes shall conform to AWS Specifications A-5.1, A-5.5 or A-5.18. Refer to "Welding with Cellulose-coated and Wire Electrodes" and Table 2 on Page 9, Table 3 on Page 10, Figure 9 and Figure 10 on Page 10, "Welding with Low-hydrogen Electrodes" and Figure 11 and Figure 12 on Page 11.

B. All tools and equipment used for welding shall be of a capacity suited to the work to be performed.

C. The welding operation must be protected (shielded) from weather conditions (rain, snow, ice or high winds) that would impair the quality of the completed weld.

D. Before welding, the weld groove and the adjacent surfaces 1" from it shall be cleaned and kept free of all dirt, paint, rust, scale, moisture, oil, grease or other foreign material harmful to welding. Clean by filing, hand or power wire brushing or grinding, and by using approved solvents. Acceptable solvents for cleaning and drying are alcohol (methanol or ethanol) or acetone. Do not expose these solvents or their fumes to open flame, arcs or hot surfaces.

E. Before sections of pipe and fittings are assembled for welding, all rust, scale, slag, dirt, liquids or other foreign matter shall be removed from the inside surface of the pipe by swabbing with clean rags or by other

acceptable methods. The responsible person (people) on the job shall ensure compliance with this requirement.

F. Pipe and/or fittings joined by welding shall be aligned to minimize any offset (high-low) of pipe wall surfaces around the circumference of the pipe. For joining pipe and/or fittings of the same nominal wall thickness, the internal offset shall not exceed 1/16". If the pipe or fitting ends are defective or damaged (scratches, gouges, dents, etc.), the ends shall be rebeveled. For joining pipe of unequal wall thickness, the internal offset shall not exceed 3/32". If this value is exceeded, refer to Figure 2 through Figure 8 on Page 8 of this gas standard. External offset shall be limited to the out-of-roundness and pipe and fitting end diameter tolerances given in the material specifications.

G. All hammers used for aligning pipe and fittings must be bronze or brass faced. Avoid denting, gouging or scratching the pipe and/or fittings.

H. When aligning abutting lengths of the pipe for welding, the longitudinal seams shall be staggered (no closer than 3") within the top quadrant (10 to 2 o'clock).

I. A lineup clamp shall be used on pipe with a nominal diameter 3" or larger. The lineup clamp shall be left in place until the stringer bead is at least 50% completed and equally deposited around the weld groove. No stress (movement) shall be placed on the weld groove until the stringer bead is completed (applicable only when piping meets both of the following criteria).

- Grade X52 or above
- 12.750" OD or larger

(1) The minimum separation between any two circumferential welds, wherever possible, shall be as follows.

(a) One pipe diameter for welds on pipelines other than station piping but never less than 3" (except as allowed by Paragraph (c) below).

(b) 6" for station piping or fabricated assemblies 6" nominal OD and larger; one pipe diameter for piping smaller than 6" nominal OD.

(c) 1", as measured along the inside arc radius of any welding elbow and transverse segments of this elbow 2" or more in nominal diameter (GO 112, latest revision, paragraph 192.313 c).

(2) Adequate working clearance shall be provided and maintained around the pipe and/or fittings at all points to be welded so that the work can be performed safely.

(3) Branch connection welds, including reinforcing member welds, shall be located at least 3" away from circumferential welds whenever possible.

5. Preheating

A. A preheat of 200°F minimum to 400°F maximum must be achieved and maintained at the weld location until completion of welding when any of the following conditions exist.

- When pipe or fitting wall thickness (regardless of pipe grade) is greater than 0.5".
- When the pipe or fitting surface temperature at the weld area is less than 50°F.
- When the pipe mill heat analysis shows a carbon content in excess of 0.32%.
- When CE exceeds 0.65% (CE% = carbon % + 1/4 manganese %).

  Pipe material meeting API 5L, 5LX and ASTM A-53 or A-106, Grade B specifications, does not exceed the chemical limits required for preheat that are shown above. Certain fitting materials may exceed the limits and therefore would require preheat.

- When weld defects are being repaired.

B. The preheated area shall be at least 6" wide, centered about the weld, and shall extend around the entire circumference of the pipe or fitting.

C. Preheat temperature shall be checked with temperature-sensitive crayons, such as "Tempilstick", or contact pyrometer, at the weld area outside of the weld groove.

D. If welding is interrupted, the weld area shall be preheated before welding is resumed.

E. Interpass temperature is the temperature of the weld area between depositing weld beads. The minimum interpass temperature shall comply with the minimum preheat temperature requirements given in preceding.

6. Stress Relieving

A. Stress relieving shall be required under the following conditions.

(1) When the carbon content of the pipe fitting material by heat analysis exceeds 0.32% or the CE exceeds 0.65%. (Pipe meeting API specifications 5L or 5LX and ASTM A-53 or A-106, Grade B, does not exceed these limits. Certain fitting materials may exceed these limits and therefore would require stress relieving.)

(2) When the wall thickness of the pipe or fitting being welded is 0.750" or greater, unless low hydrogen or GMAW welding processes are used. Stress relieving is mandatory for all thickness 1-1/4" or greater.

(3) When couplings, weldolets, or socket-weld fittings larger than 2" are welded to a header wall with a thickness 0.750" or greater, unless low hydrogen or GMAW welding processes are used. Stress relieving is mandatory for all header wall thickness 1-1/4" or greater.

B. Stress Relieving Temperature

(1) For welding being performed under API specifications as in this standard, heating to stress relieving temperatures shall be done uniformly at a rate suitable to the type of equipment being used. For welds to ASME specifications, heat uniformly at a rate not to exceed 600°F per hour below 600°F, and not to exceed 400°F per hour above 600°F.

(2) The weld being stress relieved shall be held in the range of 1,100°F-1,200°F for a period of one hour per inch of wall thickness, but in no case less than 45 minutes.

(3) After stress relieving is completed, the weld shall be cooled to 600°F at a cooling rate not to exceed 500°F per hour. From 600°F, the weld may be cooled in still air. Accelerated cooling is not allowed.

(4) The minimum width of the area to be stress relieved on each side of the weld shall be equal to four times the wall thickness, or 2", whichever is greater.

C. Equipment for Local Stress Relieving

(1) Stress relieving may be accomplished by electric induction, electric resistance, oxy-fuel-fired ring burners, exothermic chemical reactions, or other suitable means of heating in compliance with Paragraph 6B above.

(2) The stress relieving temperature shall be checked by using recording thermocouple pyrometers. Recording charts shall be properly identified and become part of the job records.

7. Horizontal and Vertical Fixed-position Welding; Cellulose-type Electrode or Wire-type Electrode for GMAW

Horizontal and vertical fixed position shielded metal-arc welding with cellulose-covered electrodes (AWS E6010, E7010 or E8010) or wire electrode (ER70S-6) shall be performed by the "downhill" method. Refer to Figure 10 on Page 10 for the proper electrode to use with specific materials.

A. Depositing Stringer Bead and Hot Pass

(1) The amount of root opening (gap) shall fall within the range given in Figure 9 on Page 10 for the welding process used, and should suit the preference of the welder responsible for the integrity of the stringer bead. During alignment and tacking, the joint is held together by a lineup clamp. Care must be taken during joint alignment and preparation to ensure full penetration and complete fusion during stringer bead (root pass) deposit.

(2) Strike the arc in the weld groove only. The stringer bead for SMAW is made using a drag technique (electrode coating resting on the bevel as the electrode is dragged downhill). Thoroughly clean the stringer before applying hot pass (second bead). Disc grinding is used to remove bumpy starts and slag, improve bead contour or remove excessive wagon tracks (see Figure 1 on Page 5) before applying the hot pass.

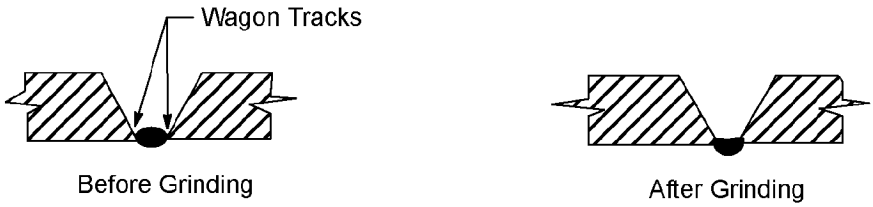


Figure 1
Wagon Tracks – Slag Filled Crevices on Either Side of Stringer Bead

(3) Applying the hot pass with sufficient heat (amperage) will melt out shallow wagon tracks and float any remaining slag to the surface. Use a slight up and down whipping motion. Start the hot pass immediately after completion of the stringer bead - within five minutes.

B. Filler and Cover Passes

(1) A side-to-side weave motion is used when applying the filler passes. Filler metal shall be added to any concave portion of the filler passes, before applying the cover pass.

(2) On heavy wall pipe and fittings (greater than schedule 40) where the welding groove is wide, more than one bead per layer shall be used for filling in the "downhill" direction (does not apply to low-hydrogen electrodes - see Paragraph 8H(2) below).

(3) Strip capping shall be used for making the cover pass when welding in the vertical fixed position. Wash passes are not acceptable when welding in this position.

(4) Filler and cover passes made using the weave motion when welding downhill on horizontally fixed pipe and fittings shall be no wider than four times the electrode diameter. Welds shall be uniform and without undercutting.

(5) Two beads shall be started at the same location. The face of the completed weld should be approximately 1/8" greater than the width of the original groove. At no point shall the crown surface be below the outside surface of the pipe, nor should it be raised above the parent metal more than 1/16".

(6) The completed weld shall be thoroughly brushed and cleaned.

8. Horizontal and Vertical Fixed Position Welding – Low-hydrogen Electrodes (See Note 4 on Page 11 for recommended use)

A. To perform properly, low-hydrogen electrodes must be stored and handled in a manner which will prevent absorption of moisture. These electrodes shall either be stored in their manufacturer's unopened containers, or once opened, in holding ovens. Electrodes in unopened sealed containers remain dry indefinitely under good storage conditions. The storage area should be enclosed, clean, dry and have adequate facilities for safe storage to prevent deterioration.

B. If used immediately, low-hydrogen electrodes may be issued for use directly from freshly-opened, hermetically sealed containers. The remaining electrodes shall be removed from their containers and placed in an electric holding oven or portable rod warmer and held at a temperature of 250°F to 350°F.

C. Electrodes shall be withdrawn from the holding oven or portable rod warmer in small quantities and used immediately.

D. The electric holding oven or portable rod warmer shall be powered by a reliable electric source.

E. Electrodes shall not be exposed to moisture. They shall not be used after having been removed from their sealed containers or holding oven for a period exceeding four hours. If the low-hydrogen electrode container is punctured and exposed to air for a few days, or stored sealed for long susperiods of time in areas of high humidity, weld quality will be adversely affected.

F. Electrodes subjected to the conditions described in Paragraph 8E must be dried or discarded. Electrodes are dried by baking them in an electric oven at 700°F to 800°F for a minimum of one hour. They should then be transferred to a holding oven and held there until used. Discard any electrodes whose coating becomes fragile and discard any electrodes that flake or break off while welding or that develop a noticeable difference in handling or arc characteristics.

G. All welders who become qualified to use low-hydrogen electrodes shall be thoroughly instructed in storage and handling requirements and be equipped with an electric heater or portable electrode warmer. Low-hydrogen electrodes shall always be issued in portable rod warmers, or the electrodes shall be returned to the heated storage oven within the time specified in Paragraph 8E.

H. Welding Technique with Low-hydrogen Electrodes (refer to Figure 13 through Figure 20 on Page 12)

(1) The stringer bead and hot pass shall be made using shielded metal-arc welding with E6010(5P), E7010(HYP) or E8010(70+) electrodes, welding downhill, on horizontally fixed pipe and fittings.

(2) Filler and cover passes shall be made using E7016 or E7018 electrodes for all grades of pipe through X-60, and E8016 or E8018 electrodes for X-65 pipe, welding uphill, on horizontally fixed pipe and fittings.

(3) On heavy wall pipe or fittings (greater than schedule 40) where the welding groove is wide, more than one filler and/or cover pass per layer shall be used.

(4) Filler and cover passes made using the weave motion welding uphill on horizontally fixed pipe and fittings shall be no wider than 5/8" using 3/32" diameter rod and 1" using 1/8" diameter rod.

(5) On pipe or fittings in the vertical fixed position, each weld layer shall be deposited with multiple passes in the horizontal plane. Wash passes shall not be permitted.

9. Roll Welding

Roll or flat welding is where the welding arc is struck on the top of the pipe or fitting and held there to deposit the bead as the pipe or fitting is steadily revolved. When applicable, roll welding will be permitted, providing alignment and support is maintained by roll-type positioners.

10. Fillet Weld

The bead shape of all fillet welds shall be flat or slightly convex with the length of each weld leg equal. All attachments using fillet welds shall be in accordance with the Figure 13 through Figure 20 on Page 12 of this gas standard.

Circumferential fillet welds on sleeves shall be made using all low-hydrogen electrodes or GMAW if the preheat temperature specified in Paragraph 5A cannot be maintained (e.g. flow cannot be made static). If the preheat temperature specified in Paragraph 5A can be maintained, then circumferential fillet welds shall be made using the procedure described in Paragraph 8H above or using a qualified GMAW process.

A. When welding slip-on flanges to pipe, the inside weld joining the pipe end to the flange's inside diameter bore surface shall be completed first, followed by the weld at the outside of the flange to the outside circumference of the pipe as shown in Figure 16 on Page 12.

B. Fillet welds attaching supports and other non-pressure attachments to pressure piping are limited to piping and fitting materials with less than 46,000 psi SMYS operating under 50% of SMYS and shall not exceed 3/8" leg size and 2" in weld length. It is not recommended to weld supports of other non-pressure attachments directly to pressure piping.

11. Back-Welding

A. Back-welding and end preparation when joining unequal wall thickness shall be performed as specified on Page 8 of this standard. Before back-welding, disc grind or wire buff loose scale from the backside of the weld groove.

B. When valves and fittings are welded to each other or to pipe, the joint shall have a two pass weld on the inside in addition to the outside weld. This requirement applies to all diameters when practical. Back-welding is not required if valves and fittings are supplied shop welded to pipe of the same wall thickness as the line pipe.

C. Back-welding shall be done using SMAW welding with E6010, E7010 or E8010 electrodes. Use a small weave to penetrate and fuse the backside of the weld groove. Back-weld bead width and height should exceed minimum requirements shown in Figure 2 through Figure 8 on Page 8 by as small a margin as practical. If a second fill pass is needed, this pass should form a smooth transition from one side of the pipe to the other. Do not overweld.

12. Repair or Removal of Defects and Cracks

A. Repair welds shall be performed using a written, qualified weld repair procedure.

(1) Before welding, the surfaces to be welded shall be cleaned and prepared in accordance with the requirements given in this standard.

(2) With the exception of shallow crater cracks, no weld containing cracks, regardless of size or location, shall be acceptable. All welds containing cracks and other unacceptable defects that are detected during or after welding shall be repaired or removed. Cracks in circumferential or branch connection welds that are more than 8% of the weld length must be repaired by replacing a pipe segment. Cracks of any length in longitudinal welds in pipe operating with an MAOP of 20% or more of SMYS or 500 psig or greater, must be repaired by replacing a pipe segment. Cracks in longitudinal welds in pipe operating with an MAOP below 20% of SMYS or 500 psig may be repaired using the patching, sleeving or canning repair methods given in Gas Standard A-65.

(3) If a longitudinal or branch connection weld has a crack that is 8% or less of the weld length, the weld may be repaired by grinding, filing or machining the repair cavity to bright, clean base metal, and fill welding. Refer to Gas Standard A-65 for other permissible repair methods. Oxy-fuel gas gouging (flame gouging), air carbon-arc gouging, and chipping are acceptable methods for removing cracks and other defects, except only grinding or chipping should be used on pressurized lines. After removing defect(s), other than cracks, the area shall be examined visually to verify that the defect(s) have been completely removed. After removing crack(s), the repair groove must be examined by a magnetic particle or dye penetrant test to ensure complete removal of the crack(s). The surface of the fill weld must conform to the surface of the adjacent original weld.

B. A replacement segment of pipe must be installed with the minimum separation between welds.

C. Preheating the segment(s) to be repaired is required if conditions exist which would adversely affect the quality of the weld repair. Post-weld heat treatment and nondestructive examination shall be the same as required for the original weld joint.

D. Repairing a crack, or any defect in a previously repaired area, must be in accordance with written weld repair procedures that have been qualified under Gas Standards D-30, D-30.1 or D-30.2. Repair procedures must provide that the minimum mechanical properties specified for the welding procedure used to make the original weld are met on completion of the final weld repair.

E. Arc burns shall be either repaired by grinding or cut out. If a repair is made by grinding, the remaining wall thickness must at least be equal to either:

(1) The nominal wall thickness required for the design pressure of the pipeline, or

(2) The minimum wall thickness required by the tolerance in the specification to which the pipe was manufactured. The amount of allowable wall thickness reduction based on the manufactured pipe specifications is as follows:

12-1/2% for ASTM A-106 pipe

10% for API-5L pipe

8% for API-5LX pipe

12-1/2% for ASTM A-53 pipe

13. Identifying Welds

Where the number of welders makes identifying a welder's work difficult, the welder shall identify his work by marking it with his assigned number or initials using soapstone, yellow lumber crayon or other suitable marker.

Arc Welding Procedure Requirement
All Stress Levels

Notes

1. The joint design shown in Figure 3 is not for use where thicker pipe wall has lower yield strength. A joint of this type can be used where location class changes.
2. If materials being joined have different yield strengths, welding electrodes must be suitable for the highest yield material in each joint.
3. Below is a legend of values and symbols used in Figure 3 through Figure 8.

   t_D – Wall thickness required for design purposes for heavy wall pipe which is being joined to thinner pipe. The t_D value may not exceed 1.5 t.

   t_H – Actual wall thickness of heavier wall pipe.

   * – No minimum when materials joined have equal yield strength.

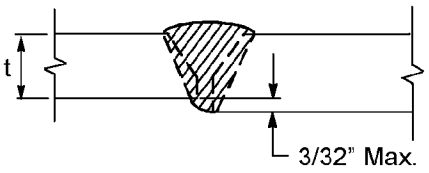


Figure 2

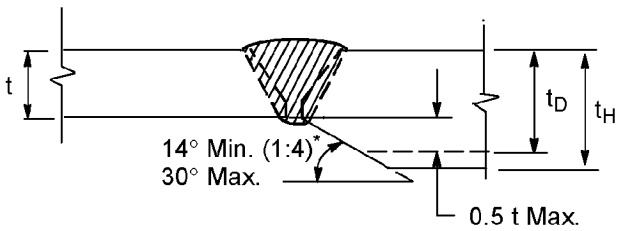


Figure 3

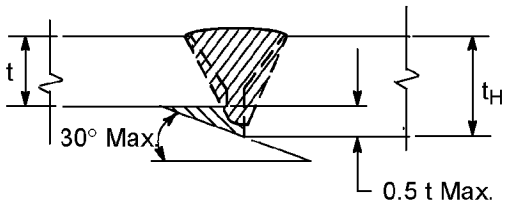


Figure 4

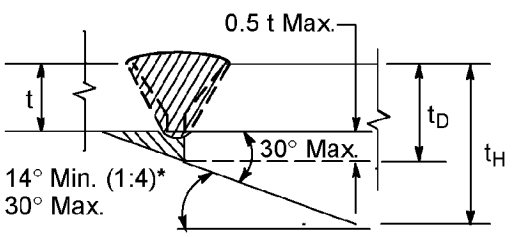


Figure 5

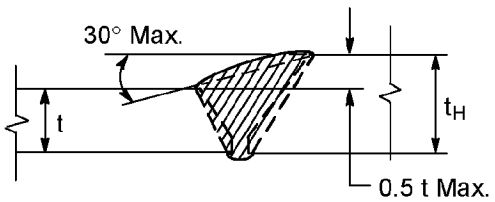


Figure 6

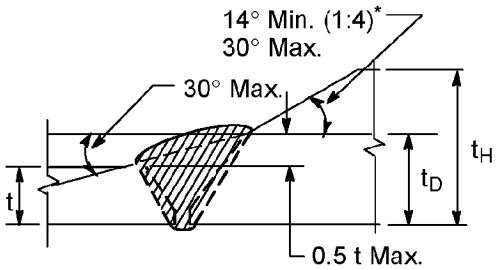


Figure 7

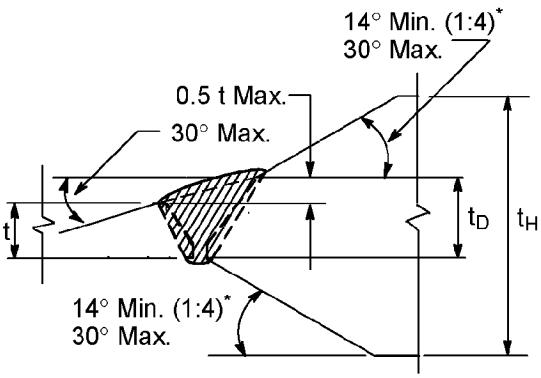


Figure 8

Arc Welding Procedure Requirement
All Stress Levels

Welding with Cellulose-coated and Wire Electrodes

1. All current shall be DC reverse polarity.
2. If backwelding, use "hot pass" techniques for the (first) backweld pass. Use conventional filler and cover techniques if multiple passes are required.
3. In some older pipeline installations, "PG&E Specified" pipe was installed. This pipe does not necessarily comply with API, ASTM or any other pipeline standard. Before welding on "PG&E Specified" pipe, consult Gas System Design for the proper welding procedures and electrode(s) to use.
4. Where fittings are to be welded in pipelines, and the suitable electrodes as given in Table 2 are different, use the high-strength electrodes (i.e., E7010 instead of E6010, or E8010 instead of E7010).

Table 1 Codes for the Cellulose-coated and Wire Electrodes

Electrodes	Code
3/32" E6010 Fleetweld 5P or equal	159252
1/8" E6010 Fleetweld 5P or equal	159026
5/32" E6010 Fleetweld 5P or equal	159027
3/16" E6010 Fleetweld or equal	159028
1/8" E7010 Shield Arc Hyp or equal	159285
5/32" E7010 Shield Arc Hyp or equal	159286
3/16" E7010 Shield Arc Hyp or equal	159287
1/8" E8010 Shield Arc 70+ or equal	159405
5/32" E8010 Shield Arc 70+ or equal	159406
3/16" E8010 Shield Arc 70+ or equal	159407
0.035" ER70S-6 Lincoln L-56 or equal	Available from GC Headquarters in Manteca

Table 2 Electrodes Suitable for Welding Various Materials

Material		Electrode	
		AWS A-5.1 and 5.5 SMAW	AWS A-5.18 GMAW
Pipe (See Note 3)	API 5L, Grade B and A-25	E6010	ER70S-6
	API 5LX, Grade X-42 thru X-48	E6010	ER70S-6
	API 5LX, Grade X-52 thru X-60	E7010	ER70S-6
	API 5LX Grade X-65	E8010	–
	ASTM A-53, Grade B	E6010	ER70S-6
	ASTM A-106, Grade B	E6010	ER70S-6
Fittings	ASTM A-105	E6010	ER70S-6
	ASTM A-234, Grade WPB	E6010	ER70S-6
	ASTM A-242 and A-441	E6010	ER70S-6
	ASTM-A516, Grade 70	E6010	ER70S-6
	ASTM A-633, Grade E	E7010	ER70S-6

Table 3 Weld Detail for SMAW and GMAW with Cellulose-coated and Wire Electrodes

Weld Layer	Method		Electrode		Recommended	
	Horizontal Fixed Position	Vertical Fixed Position [1]	Class	Size	Amperes	Volts
First Pass	Downhill	Bead	Table 2	All	90-100 (GMAW) 100-170 (SMAW)	18-20 (GMAW) 26-28 (SMAW)
Hot Pass (See Note 2 on Page 9)	Downhill	Bead	Table 2	1/8" or 5/32"	120-160	24-28
Filler Passes	Downhill [2]	Bead	Table 2	All	140-180	24-28
Cover Pass	Downhill [2]	Bead	Table 2	All	140-180	24-28

[1] Wash passes shall not be acceptable in vertical fixed position.
[2] Exceptionally wide downhill wash passes shall not be permitted.

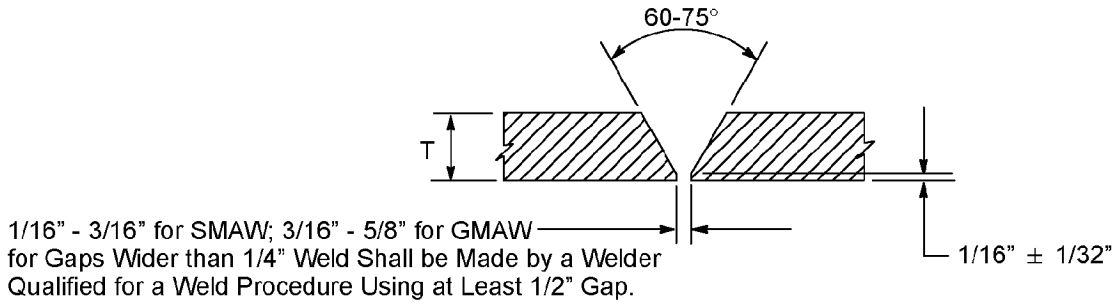
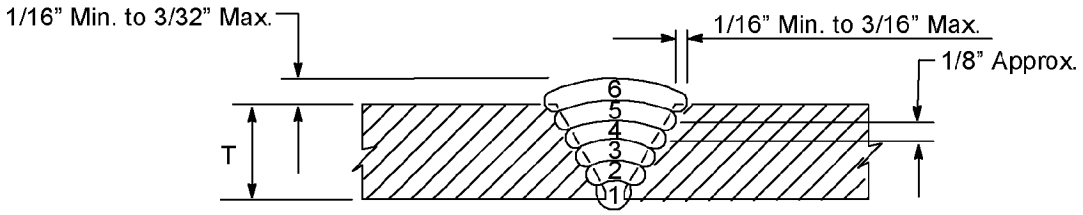


Figure 9
Weld Design with Cellulose Coated and Wire Electrodes



Sequence of Beads (Number Will Vary with Change in Wall Thickness, etc.)

Figure 10
Standard V Bevel Butt Joint

Arc Welding Procedure Requirement
All Stress Levels

Welding with Low-hydrogen Electrodes

1. All current shall be DC reverse polarity.
2. Electrodes specified are suitable for all API grades through X-60. For Grade X-65, use E8016 or E8018 (3/32" or 1/8" diameter) electrode for filler and cover passes.
3. Handling instructions and weld technique in "Welding Specifications," Paragraph 8 must be followed.
4. A low-hydrogen electrode is recommended for high yield, heavy wall pipe for station piping, river crossings or other locations where vibration or external loading may occur. It should also be used when the preheat temperature cannot be maintained (refer to "Welding Specifications," Paragraph 10). It produces a ductile high-strength weld which gives superior notch strength. However, the low-hydrogen electrode (E7016 or E7018) is more time consuming than the conventional cellulose electrode (E6010, E7010 or E8010). Contact the Gas System Design Department if more information is required.
5. For first pass and hot pass, use electrodes as shown in Figure 9 and Figure 10 on Page 10.
6. Low-hydrogen Electrodes: 1/8" E7018 (Alt: E7016) Hobart, Airco, Alloy Rods or Lincoln, use Code 159194.

Table 4 Weld Detail with Low-hydrogen Electrodes

Weld Layer	Method		Electrode		Recommended	
	Horizontal Fixed Position	Vertical Fixed Position [1]	Class	Size	Amps	Volts
First Pass	Downhill	Bead	Note 5	All	100-170	26-28
Hot Pass [2]	Downhill	Bead	Note 5	1/8" or 5/32"	120-160	24-28
Filler Passes	Uphill	Bead	E7016 or E7018	3/32" or 1/8"	100-150	22-25
Cover Pass	Uphill	Bead	E7016 or E7018	3/32" or 1/8"	100-150	22-25

[1] Wash passed shall not be acceptable in vertical fixed position.
[2] If backwelding, use hot pass techniques for (first) backweld pass. Use conventional filler and cover techniques if multiple passes are required.

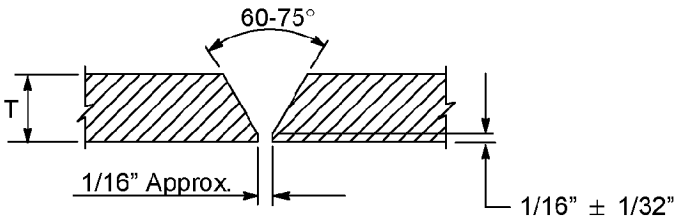
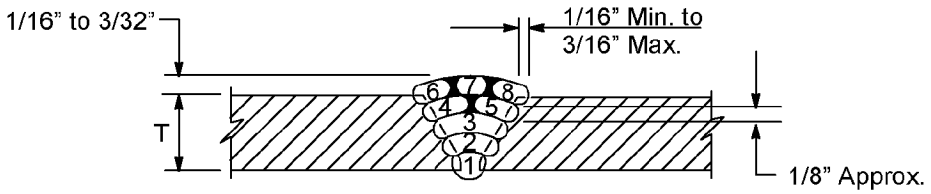


Figure 11
Weld Design with Low-hydrogen Electrodes



Sequence of Beads
(Number and position will vary with change in wall thickness, etc.)

Figure 12
Standard V Bevel Butt Joint

Arc Welding Procedure Requirement
All Stress Levels

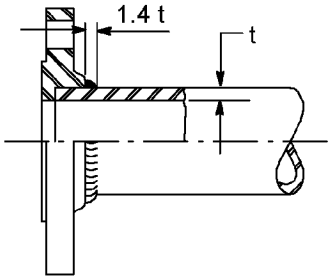


Figure 13
Socket Welding Flange

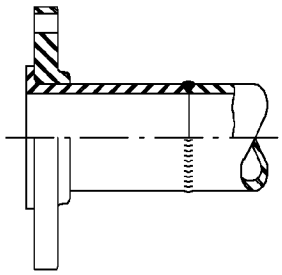


Figure 14
Lap Joint Flange

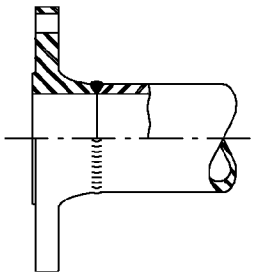
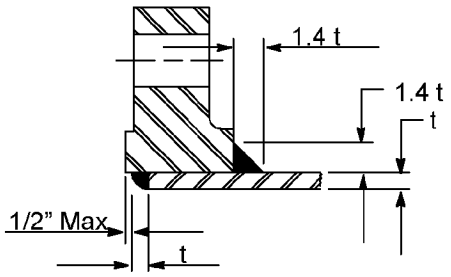
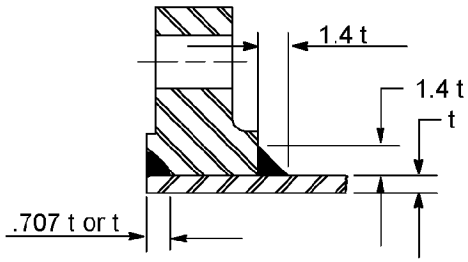


Figure 15
Butt Welding Flange



Front and Back Weld



Face and Back Weld

Figure 16
Slip-on Flanges

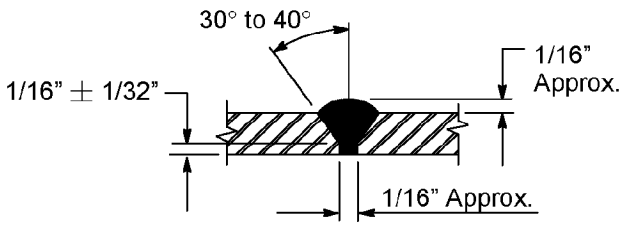
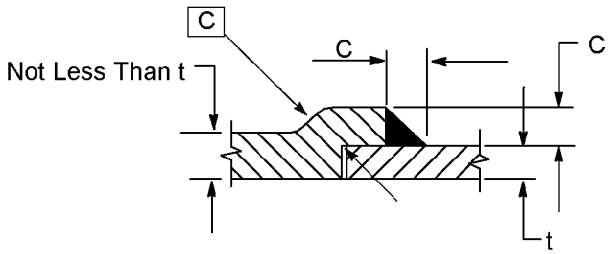


Figure 17
Butt Weld Joint



t = Wall Thickness Nominal
C $_{Minimum}$ = 1-1/4 t, But Not Less Than 5/32"

Figure 18
Socket Weld Joint

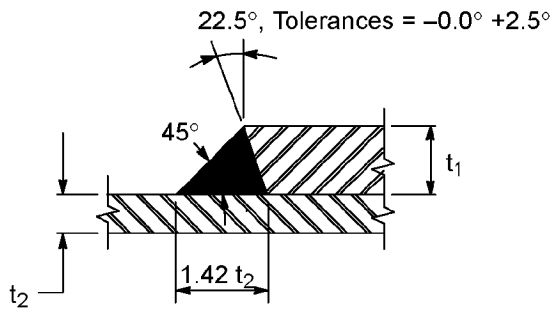


Figure 19
Welding Sleeve Attachments for any Pipe Diameter
(Must be used for 18" OD and larger pipe.
Refer to Gas Standard A-60 for weld details.)

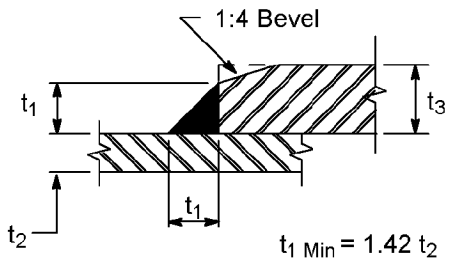


Figure 20
Weld Sleeve Attachments
for 16" OD and Smaller Pipe

Symbols for Figure 21 and Figure 22:
$W_{1\ Min.}$ = 3/8" B, But Not Less Than 1/4"
$W_{2\ Min.}$ = 1/2" M, But Not Less Than 1/4" or t, Whichever is Smaller
N = 1/16" Min., 1/8" Max.

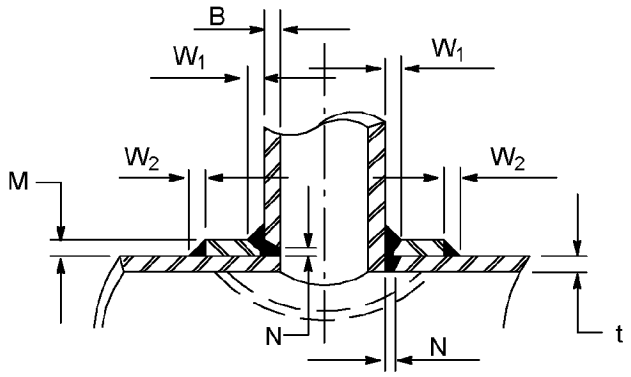


Figure 21
Pad-type Reinforcement

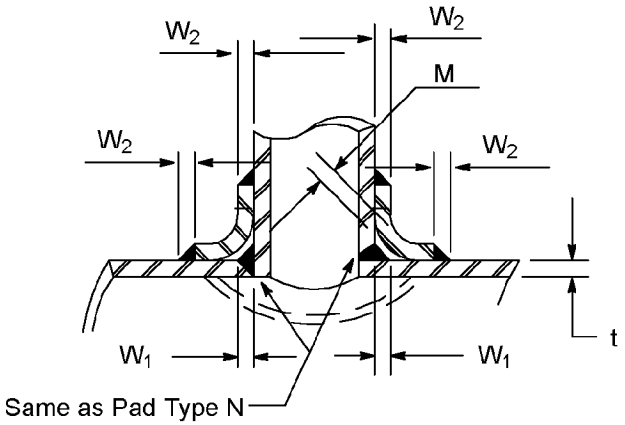
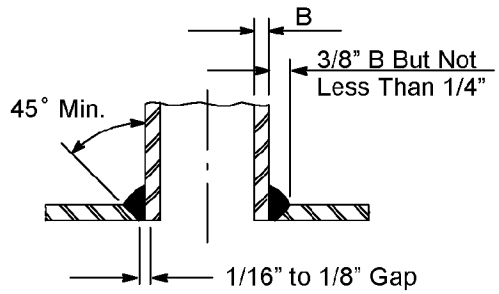
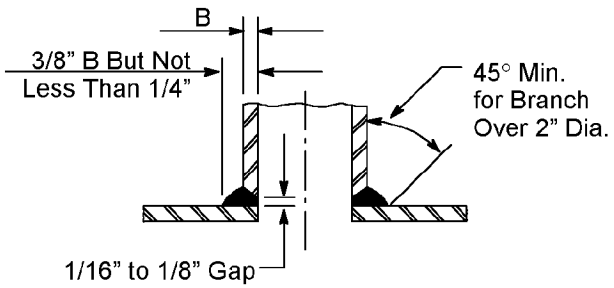


Figure 22
Saddle-type Reinforcement



Branch Cut into Header



Branch Abutting Header

Figure 23
Welding of Branch Connections Joint Design

Revision Notes

Revision 00 has the following changes:

1. Converted PG&E Drawings 086432, 084033, 284361, 284363 and 283263 to Gas Standard D-22.
2. Revised Notes on Page 8 and in Figure 19.
3. Added the "Acronyms" and "References" sections.
4. This document is part of Change 45.