SECTION F-4 CONTENTS

FORMS

1 Scope

This procedure provides guidance for the qualification of welders, the qualification of welding procedures and the general welding operations performed on the Gas Department's natural gas system.

1.1 References

U.S. Department of Transportation (DOT)

[1] §192.221 Scope

[2] §192.225 Welding Procedures

[3] §192.227 Qualification of Welders

[4] §192.229 Limitations on Welders

[5] §192.231 Protection from Weather

[6] §192.235 Preparation for Welding

[7] §192.241 Inspection and Test of Welds

[8] §192.243 Nondestructive Testing

[9] §192.245 Repair or Removal of Defects

1.2 Definitions

Definitions relevant to this section:

API abbreviation for American Petroleum Institute.

Bevel means beveled pipe ends for welding purposes. Pipe that is cut at an inclination so that the two ends form an angle other than a right angle.

Butt-Weld means the joining of two pieces of pipe or other material by full penetration welds.

Destructive Testing means a method of testing strength or mechanical integrity of a piece of equipment by destroying the item being tested.

Dye Penetrant Weld Examination means a method for inspecting for surface defects of welds by using a dye and developer applied to the weld.

Hoop Stress means the tensile stress, usually in pounds per square inch (psi), acting on the pipe along the circumferential direction of the pipe wall when the pipe contains gas or liquid under pressure.

Joint, Welded means a connection made by the joining of metal parts in the plastic or molten state.

Nondestructive Testing means a method of testing strength or mechanical integrity of a piece of equipment without damaging the item being tested. Examples are radiography, ultrasonic testing, and acoustic emissions testing.

Pipe means any pipe or tubing used in the transportation of gas, including pipe-type holders.

Pipeline (*or Pipeline System*) means all parts of those physical facilities through which gas moves in transportation including, but not limited to, pipe, valves, and other appurtenances attached to pipe, compressor units, metering stations, regulator stations, holders and fabricated assemblies.

Specified Minimum Yield Strength (*abbreviation SMYS)* means specified minimum yield strength is:

(1) For steel pipe manufactured in accordance with a listed specification, the yield strength specified as a minimum in that specification; or

(2) For steel pipe manufactured in accordance with an unknown or unlisted specification, the yield strength determined in accordance with §192.107(b).

Wall Thickness means specified wall thickness of pipe without adding an allowance to compensate for the under-thickness tolerances permitted in approved specifications.

Welder means a person who performs manual or semi-automatic welding.

Welding Operator means a person who operates machine or automatic welding equipment.

1.3 Responsibility

The following GUC personnel, offices or their designees shall have the primary responsibility for compliance with the requirements of this section:

Qualification of Personnel:	*Gas Distribution Engineer*
Welding Operations:	*Gas Systems Supervisor*
Visual Inspection of Joints:	*Gas Systems Supervisor*
Non-Destructive Inspection of Joints:	*3rd Party Contractor*

Destructive Inspection of Joints: *3rd Party Contractor*

2 Requirements

The Gas Department is required to have qualified welding procedures for joining steel pipe and use personnel with proven experience to perform the welds. Welds performed on the system are subject to both destructive and nondestructive testing.

3 Qualification of Personnel

Prior to performing welding of steel pipe on the Gas Department's natural gas system, personnel responsible for joining steel pipe by welding shall be qualified. All qualification tests shall be conducted under the supervision and direction of a qualified Gas Department welder or a qualified testing company as approved by the *Gas Distribution Engineer*.

3.1 Initial Qualification

3.1.1 Gas Department Welders

Gas Department welders or welding operators shall be qualified in accordance with the procedures listed in Section 6, Section 12, Appendix A or Appendix B of the API Standard 1104 or Section IX of the ASME Boiler and Pressure Vessel Code, "Welding and Brazing Qualifications". Welds made for the initial qualification shall satisfy destructive or nondestructive test requirements. There are two levels of qualification for Gas Department Welders - Low Stress and High Stress.

High Stress

This welder classification is qualified to Fillet and butt weld on pipe of any diameter, wall thickness, and grade using downhill and uphill SMAW processes.

To Qualify the welder must complete the three welds below:

(1) The welder shall butt weld, using API-5L Grade X52, 12.75" OD, .250" WT steel pipe, with the pipe axis in the 45 degree fixed position using Welding procedure GUCWPS-5. This weld shall be destructively tested by cutting into six coupons: two subject to tensile testing, two subject to root bend testing, and two subject to nick-break testing.

(2) The welder shall layout, cut, fit, and weld a branch connection that extends vertically downward from the run of pipe in the horizontal position. The branch and run shall be API 5L Grade X52, 12.75" OD, 0.250" WT Steel pipe. A full size hole shall be cut into the run pipe prior to welding the branch. The Welder shall use Welding Procedure GUCWPS-10. This weld shall be destructively tested by cutting into four coupons all subject to nick-break tests.

(3) The welder shall layout, cut, fit, and weld a 12.75" OD patch on 12.75" OD pipe as shown in Appendix B, Figure B2 of the latest edition of API-1104. The pipe shall be at an angle of 45 Degrees. The pipe and patch shall be API-5L Grade X52, 12.75 OD, 0.250" WT steel pipe. The welder shall used Welding Procedure GUCWPS-M1. This weld shall be destructively tested by cutting into four

coupons, one subject to tensile testing, one subject to root bend testing, one subject to face bend testing, and one subject to nick-break testing.

Low Stress

Welders completing this test successfully shall be qualified to fillet and butt weld on pipe operating at less than 20% SMYS on pipe outside diameter 12.75" or less, any wall thickness, any grade, using the downhill SMAW process and qualified to weld on live distribution piping using the downhill SMAW process. All welds made for the test shall be destructively tested.

(1) Using API 5L Grade X52, 6.625" OD, .250" wt (0.188", 0.219", & 0.280" wt is acceptable) steel pipe, the welder shall make a butt weld with the pipe axis in the 45 degree fixed position using the Welding Procedure GUCWPS-2. This weld shall be destructively tested by cutting into four coupons requiring three coupons to pass the root bend test.

(2) The welder shall perform a filet weld on a ¾" or 1" tapping tee onto 6" or larger base pipe with the pipe axis in the horizontal fixed position using GUCWPS-7. This weld shall be destructively tested by impact testing to verify the subject did not break in the weld.

For the High Stress qualification procedure, if any of the weld samples fails the destructive test, the welder is not qualified to perform welds on the Gas Department's natural gas system. Low Stress qualificiation procedure allows for the failure of one root bend test, if more than one coupon fails the root bend the welder is not qualified to perform welds on the Gas Department's natural gas system. Following the successful welder qualification of Gas Department Personnel and contract personnel, Form II.F-4.1 shall be completed and submitted to the *Gas Distribution Engineer*.

3.1.2 Contract Welders

Contract welders shall provide evidence of being qualified in accordance with the procedures listed in Section 6, Section 12, Appendix A or Appendix B of the API Standard 1104 or Section IX of the ASME Boiler and Pressure Vessel Code, "Welding and Brazing Qualifications". Welds made for the initial qualification shall satisfy destructive test requirements.

(1) The Gas Department may require contract welders or welding operators to qualify specifically for welding on the Gas Department's facilities. If so, all testing and qualification requirements shall match the requirements of Section 3.1.1.

3.2 Requalification

3.2.1 Gas Department Welders

After the initial test, a Gas Department welder or welding operator shall maintain qualification to perform welding operations by the following:

High Stress

This welder classification will be requalified to Fillet and butt weld on pipe of any diameter, wall thickness, and grade using downhill and uphill SMAW processes.

(1) With intervals not to exceed 7 1/2 months and at least twice each calendar year; each Gas Department welder or welding operator shall requalify having their welds destructivly tested, and found acceptable in accordance with Section 6, Section 12, Appendix A or Appendix B of the API Standard 1104 or Section IX of the ASME Boiler and Pressure Vessel Code, "Welding and Brazing Qualifications.

The welder shall perform the weld below to requalify:

(1) The welder shall butt weld, using API-5L Grade X52, 12.75" OD, .250" WT steel pipe, with the pipe axis in the 45 degree fixed position using Welding procedure GUCWPS-5. This weld shall be destructively tested by cutting into six coupons: two subject to tensile testing, two subject to root bend testing, and two subject to nick-break testing.

Low Stress

This Welder classification will be requalified to fillet and butt weld on pipe operating at less than 20% SMYS on pipe outside diameter 12.75" or less, any wall thickness, any grade, using the downhill SMAW process and qualified to weld on live distribution piping using the downhill SMAW process. All welds made for the test shall be destructively tested.

(1) With intervals not to exceed 15 months and at least once each calendar year; each Gas Department welder or welding operator shall requalify having their welds destructivly tested, and found acceptable in accordance with Section 6, Section 12, Appendix A or Appendix B of the API Standard 1104 or Section IX of the ASME Boiler and Pressure Vessel Code, "Welding and Brazing Qualifications.

The welder shall perform the weld below to requalify:

(1) Using API 5L Grade X52, 6.625" OD, .250" wt (0.188", 0.219", & 0.280" wt is acceptable) steel pipe, the welder shall make a butt weld with the pipe axis in the 45 degree fixed position using the Welding Procedure GUCWPS-2. This weld shall be destructively tested by cutting into four coupons requiring three coupons to pass the root bend test.

3.2.2 Contract Welders

Requalification of contract welders or welding operators shall be in accordance with the requirements of Section 3.2.1.

4 Welding Procedure

Welding shall be performed by a qualified welder or welding operator in accordance with welding procedures that are qualified under Section 5, Section 12, Appendix A or Appendix B of API Std 1104, or Section IX of the ASME Boiler and Pressure Vessel Code to produce welds meeting the requirements of this subpart. The quality of the test welds used to qualify welding procedures shall be determined by destructive testing in accordance with the applicable welding standard(s).

4.1 Procedures

The Gas Department's welding procedure is as shown in Form II.F-4.2. The standard welding procedure specifications for shielded metal arc-welding (SMAW) of carbon steel pipes, valves, fittings and flanges are as follows:

(1) Process: Manual shielded metal arc-welding.

(2) Base metal: The base material shall conform to the specifications of API Standard 5L pipe and applicable ASTM standards.

(3) Filler metal: The filler metal shall conform to the ASW-ASTM Classifications listed in API 1104, Section 4.2.2.1. Shelf life shall not be exceeded. Heater boxes are recommended for low hydrogen electrodes.

(4) Position: As specified by the qualified procedure.

(5) Preparation of Base Material: All surfaces to be welded shall be clean and free of material that may be detrimental to the weld. The pipe ends at all welded joints shall be beveled. Bevels shall be made by machine or an appropriate oxygen cutting machine/guide.

(6) Electrical Characteristics: Direct Current reverse polarity.

(7) Welding Layers: The welding current and manner of depositing the weld metal shall be such that the layers of welding as deposited shall have a neat appearance. Each completed weld shall be free of overlaps, undercuts, excessive convexity and concavity, scale, oxides, pin holes, non-metallic inclusions, air pockets or any other defect. The size of electrode for each pass on each size of pipe shall be as shown in the procedure. Each bead shall be applied completely around the pipe and shall be thoroughly cleaned of all scale, slag, or other foreign material before the next bead is started. The stringer beads will be placed in the same fashion. Welding procedure specifications shall be followed for reinforcement heights and widths and bevel dimensions.

(8) Cleaning: All slag or flux remaining on any bead of welding shall be removed before laying down the next successive bead. To increase weld quality, tacks, high spots, and starts and stops should be ground.

(9) Defects: Any cracks or burn through that appear on the surface of any bead of welding shall be removed by grinding before depositing the next successive bead of welding to ensure a quality weld.

(10) Preheating: Preheating is not required above 32˚F. If welding is done below 32˚F, the pipe joint shall be heated to procedure specifications before welding is started. Moisture shall be removed from the pipe prior to performing welds. A torch with a heating tip may be used to remove frost and/or moisture.

(11) Post heating: Post heating is conducted if required by the procedure.

(12) Cooling: Cooling of welds by using any substance other than air shall not be permitted. The pipe shall not be moved until the weld is below 600˚F.

(13) Alignment: External and/or internal lineup clamps must be used in accordance with the requirements of the procedure specification. Lineup clamps may be removed after tacking or after fifty (50) percent of the root bead when there is danger of pipe movement or undue stress

on the weld. In some instances alternate devices may have to be used to align and hold fittings in place, the alignment must be preserved during the root pass.

(14) Vertical Welding Technique: The second pass (hot pass) shall be supplied immediately after the root pass is complete. Stripper pass may be required at the 2 o'clock to 4 o'clock and 10 o'clock to 8 o'clock positions in the pipe just before applying the O.D. reinforcement pass. For downhill welding, all passes except the stripper passes will start at the 12 o'clock position and stop at the 6 o'clock position with overlap of the one-fourth (1/4) inch to one-half (1/2) inch back from the end of the previous weld. The Stripper pass will start at the downhill point and move to the upper point.

(15) Transition Welds: Welds that transition between different grades of steel are to be made following the procedure for the higher grade material.

(16) On pipe greater than twelve (12) inch, the technique of using more than one welder (one on each side) should be used.

The Gas Department will accept welding procedures provided by contractors contingent upon documentation that demonstrates proper qualification of the procedure. The procedure shall be included in the permanent project file that is maintained by *Engineering*.

Neither Gas Department nor contract welders or welding operators may weld with a particular welding process unless, within the preceding 6 calendar months, the welder or welding operator was engaged in welding with that process.

4.2 Inservice Welding

Particular consideration should be given to the fillet weld used to join a sleeve to a carrier pipe because the fillet weld is prone to underbead or delayed hydrogen cracking. With Welds on pressurized and flowing piping systems, success has been achieved using low-hydrogen welding process. The cracking process is related to the hydrogen absorbed by the hot weldment. A slow cooling rate is necessary to permit diffusion and elimination of hydrogen. Proper attention should be given to fit up and to the carbon equivalent factor and chemical composition of both the sleeve and carrier pipe. The use of low hydrogen electrodes requires that special attention be given to electrode care and handling. Low hydrogen electrodes are highly susceptible to absorbing moisture from the air. This moisture turns into hydrogen during the welding process and may cause hydrogen cracking during the cooling process. Immediatley after opening a new container, low hydrogen electrodes shall be placed into a rod oven or rod warmer. These electrodes shall remain in a heated state until either used or discarded. Questionable low hydrogen electrodes shall not be used to weld on pipe facilities.

5 Inspection and Testing of Field Welds

Visual, nondestructive and destructive inspection standards may be used to determine quality of the field welds. The Gas Department has the right to inspect any weld by nondestructive means or by removing

welds and subjecting them to mechanical tests. Inspections and testing must be performed by individuals qualified by appropriate training and experience to ensure that:

(1) The weld is performed in accordance with the qualified welding procedure
(2) The weld is acceptable as described in §192.241(c).

5.1 General Inspection

Prior to welding on steel pipe the *Gas Systems Supervisor* shall:

(1) Review and verify that welders on the job site are qualified.
(2) Visually inspect each length of pipe and/or component to ensure that it has not sustained damage (gouges, grooves, dents, scratches, notches, etc.) that could impair its serviceability. The surface, beveled ends and body shall be examined.
(3) Ensure all pipe joints are properly aligned prior to welding.
(4) Use a combustible gas indicator or other leak detection device to verify the absence of a combustible gas-air mixture before and during welding procedures involving active gas pipelines.

5.2 Visual Inspection Requirements

Welders shall perform visual inspection of all welds that they make. All welds shall be visually inspected in accordance with the following:

(1) Conduct visual inspection to ensure that welding is performed in accordance with the welding procedure.
(2) Inspect the stringer (root) bead before subsequent beads are applied, and determine that all scale, slag, or dirt is removed from each weld prior to application of each succeeding bead.
(3) After completion of welding, the weld and area adjacent to the weld are to be visually examined. Discontinuities not meeting applicable standards must be repaired before other non-destructive testing is performed.
(4) Observe the removal of weld slag from pipe surfaces after final weld.
(5) The final weld surface shall meet the visual acceptance criteria imposed by API 1104 and the contour and finish requirements applicable to the specified non-destructive examination method. Grinding may be used to remove surface irregularities which could cause non-relevant indications to appear during non-destructive testing.
(6) The *Supervisor* is to check for proper weld reinforcement height on groove welds and see that minimum overlap is met.
(7) Fillet welds are to be inspected for size and appearance. The edges where the fillet legs blend into the base metal is to be inspected carefully for undercut.

5.2.1 Visual Inspection Criteria

(1) At no point shall the weld face be below the surface of the base material, nor shall it be raised more than 1/16” above the parent metal.
(2) The weld face shall be no greater than 1/8” wider than the original groove.
(3) The visual acceptance criteria for Incomplete Fusion (IF), Inadequate Penetration (IP), Porosity (P) and Burn-thru (BT) shall be the same as the radiographic acceptance criteria set down in API-1104.
(4) Arc strikes (burns) must be prepared by following the repair procedure.

(5) Undercut adjacent to the toes of the root pass on the inside, or the toes of the final bead on the outside of the pipe shall not be greater than 1/32" deep or twelve and one-half (12.5) percent of the pipe wall thickness, whichever is smaller, and there shall not be more than two (2) inches of undercut in any continuous twelve (12) inches of weld.

5.3 Nondestructive Testing

Nondestructive testing may be accomplished by radiographic, ultrasonic, liquid dye penetrant, magnetic particle or other approved methods. The testing shall be performed to clearly indicate defects that may affect the integrity of the welds.

The Gas Department does not operate any pipeline segments at pressures that produces a hoop stress of more than twenty (20) percent of SMYS and therefore, is not required to perform non-destructive testing in accordance with the percentage testing guidelines provided in §192.243.

The following weld installations shall have one hundred (100) percent non-destructive testing of the welds on the Gas Department's natural gas system:

(1) Aerial (attached) or buried installations that cross major or navigable waterways (all joints between the outside abutment walls for aerial installations or all joints between the over bend on each side of the crossing for buried installations)
(2) Railroad crossing (all joints within railroad rights-of-way)

Engineering may require non-destructive inspections exceeding the requirements above or in locations other than those listed above.

If, during nondestructive testing, a weld is found to be unacceptable, the weld must be removed or repaired in accordance with Section II.F-10. A weld must be removed if it has a crack that is more than eight (8) percent of the weld length. Each weld that is repaired must have the defect preheated if conditions exist that would adversely affect the quality of the weld repair. After the repair, the segment of the weld that was repaired must be inspected to ensure the acceptability of the weld. Repair of a crack or of any defect in a previously repaired area must be in accordance with API 1104.

5.4 Destructive Testing

Destructive testing shall consist of removing the completed welds, cutting the specimen into sections, and examining the specimen's sections. The specimens shall be prepared and meet the applicable requirements of API Standard 1104, Section 2 or 3. The Gas Department does not conduct internal destructive testing, a third party is utilized to complete this testing.

6 Precautionary Notes

(1) Prior to welding on a steel pipeline that is cathodically protected by a rectifier system, the welder shall contact the *Gas System Supervisor* to have the rectifier system turned off. Upon completion of the welding operations, the welder shall contact the *Gas System Supervisor* to have the rectifier system turned on.

(2) Welding equipment shall be maintained in such condition as to insure acceptable welds and continuity of operation. Any equipment, which does not meet the requirements, shall be repaired or replaced immediately. Welding electrodes shall be kept dry and shall be checked by the Company Representative for proper size and type specified.

(3) Welding shall not be performed during rain, snow, excessive wind, etc., unless a weather screen is erected to protect the welding area and welder. If conditions necessitate the removal of the weather screen before the weld has cooled, a temporary covering shall be placed around the welded joint. The covering material shall be felt tar paper or equivalent. No liquid (water, snow, primer, etc.), shall touch the weld area until it has cooled to a hard hot condition (approximately 150 degrees). Welds, which do not cool normally; i.e., artificially cooled, shall be removed and replaced. The Gas Systems Supervisor has the right to suspend welding operations if in his judgment weather conditions exist which would impair the quality of completed welds.

(4) When pipe is welded above ground, the working clearance around the pipe at the weld should not be less than 16 inches. When the pipe is welded in the trench, clearance shall be sufficient to provide the welder ready access to the joint.

(5) Filler metals and welding rods shall be stored and handled so as to avoid damage to them and to the containers in which they are shipped. Those in opened containers shall be protected from deterioration, and filler metals, which are coated, shall be protected from excessive moisture changes. Filler metals and fluxes, which show signs of damage or deterioration, shall not be used.

7 Reporting

Destructive and nondestructive test reports shall be provided by the testing individual or company.

Form II.F-4.1 and Form II.F-4.2 shall be completed for each individual that is qualified for welding on the Gas Department's natural gas system.

7.1 Maintenance of Records

The records of destructive and nondestructive testing results shall be maintained on file in the *Engineering Section* for the life of the pipeline.

The records of welding qualification as recorded on Form II.F-4.1 and Form II.F-4.2 shall be maintained on file in *Engineering* for a long as the individual is qualified to perform welding operations on the Gas Department's natural gas system.

WELDER QUALIFICATION RECORD

Customer Greenville Utilities Commission **File No.** _____

Test Date _____ **Procedure** _____

Welder's Name _____ **Stamp No.** _____

Welding Process _____ **Manual** _____ **Semi-Automatic** _____ **Machine** _____

Welding Position _____ **Uphill** _____ **Downhill** _____

Material Specification _____ **Pipe** _____ **Plate** _____

Pipe Size _____ **Wall Thickness** _____ **Plate Thickness** _____

FILLER METAL

Specification _____ **Classifications** _____ **F-Group** _____

Filler Metal Diameter _____ **Trade Name** _____

Shielding Gas _____ **Flux** _____

GUIDED BEND TEST

SAMPLE NO.	TYPE	RESULTS	COMMENTS

We, the undersigned, certify that the statements in this record are correct and that the welds were prepared and tested in accordance with the requirements of API 1104.

_____ **Date** _____

Certified Welding Inspector

WELDING PROCEDURE SPECIFICATION NO. GUWP-1

For: Manual Butt or Fillet **Welding of:** Carbon Steel Pipe and Fittings

Process: Manual Shielding Metal Arc Welding

Test Pipe Material Grade: SMYS of 42,000 PSI or less

Test Pipe Diameter and Wall Thickness: through 12.75" OD/nominal pipe wall thickness from 0.188" to 0.312"

Joint Design: Bevel angle 35˚ -5˚+ 2-1/2˚ with 1/16"± 1/32" root face for butt, or 45˚ minimum bevel angel, same root face for fillet

Filler Metal and No. of Beads: API Group 1 (see TABLE)

Electrical of Flame Characteristics: Direct Current, reverse polarity (see TABLE)

Position: Position welding only, horizontal or vertical

Direction of Welding: Shall be downhill

No. of Welders: N/A

Time Lapses Between Passes: Maximum time between beads shall be 5 minutes

Type and Removal of Lineup Clamps: External clamps are permitted, and shall be removed only when 50% of root bead is in place

Cleaning and/or Grinding: Power grinder shall be used. Grind all starts, stops and windows before restringing. Brush hot pass and fillers before next bead. Cap shall be brushed before leaving the weld.

Preheat/Stress Relief: Pre-heat to 60˚F if ambient temp is below 32˚F

Shielding Gas and Flow Rate: N/A

Shielding Flux: N/A

Speed of Travel: See Table Below

Plasma Gas Composition: N/A **Plasma Gas Flow Rate:** N/A

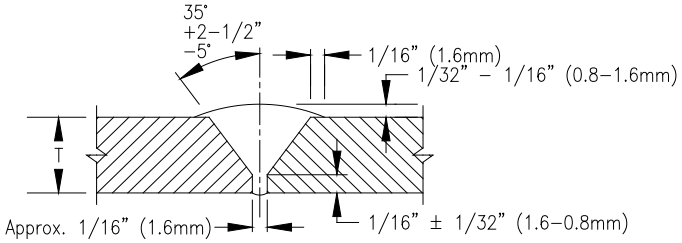
Plasma Gas Orifice Size: N/A

Sketches and Tabulations Attached: N/A

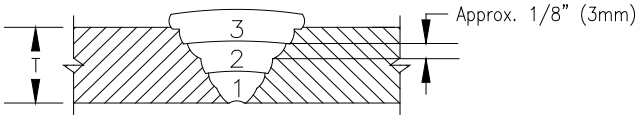
Tested: May 30, 2001 **Welder:** Barry Perry

Approved: May 30, 2001 **Welding Supervisor:**

Adopted: May 30, 2001 **Chief Engineer:**

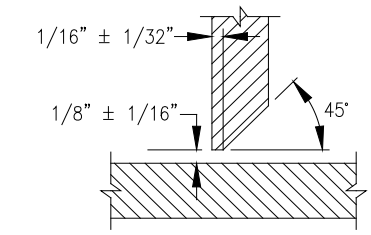


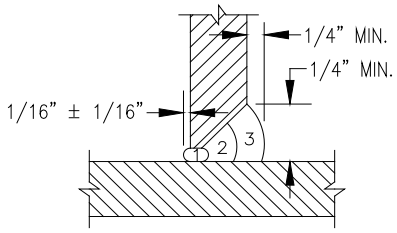
Standard V–Bevel Butt Joint



Sequence of Beads

Butt Weld Design





Fillet Weld Design

ELECTRODE SIZE, ELECTRICAL DATA AND SPEED				
Bead Number	Electrode Size and Type	Voltage	Amperage	Speed (ipm)
1 (Root)	1/8"-5/32", AWS Class A-5.1, E6010	24 -26	75 – 130 (1/8") 90 – 185 (5/32")	9 – 13
2 (Hot Pass)	1/8"-5/32", AWS Class A-5.1 –A5.5, E6010	24 -26	75 – 130 (1/8") 90 – 185 (5/32")	9 – 13
3 (Cap)	5/32"-3/16", AWS Class A-5.1 – A5.5, E6010	24 – 26 (5/32") 26 – 30 (3/16")	90 – 185 (5/32") 140 – 225 (3/16")	9 – 14 (5/32") 11 – 14 (3/16")