

Chapter 12. Qualification of Welders and Welding Operators

Welding Performance Qualification

Welder, welding operator, and tack welder qualification tests determine the ability of those tested to produce acceptably sound welds with the process, materials, and procedure called for in the test. Qualification tests are not intended to be used as a guide for welding during actual construction, but rather to assess whether an individual has a certain minimum level of skill. They do not tell what an individual normally will or can do in production. For this reason, complete reliance should not be placed on qualification testing of welders. The quality of all production welds should be determined by inspection during and following completion of the actual welding.

Various codes (such as AWS D1.1, Structural Welding Code), specifications, and governing rules generally prescribe similar though frequently somewhat different methods or details for qualifying welders, welding operators, and tackers. The applicable or required code or document should be consulted for specific details and requirements. The types of tests that are most frequently required are described below.

Performance Qualification Requirements

The qualification requirements for welding pressure vessels, piping systems, and structures usually state that every welder or welding operator shall make one or more test welds using a qualified welding procedure. Each qual-

ification weld is tested in a specific manner (i.e., radiography or bend tests). In addition, essential variables that influence the welding are usually limited to certain ranges, such as the thicknesses of material and the test positions that will qualify for welding on different thicknesses and in different positions. Some variables pertinent to qualification testing and the extent of qualification are the groove type, with or without a backing, and the direction of welding in depositing vertical position welds.

Qualification requirements for welding pressure pipe differ from those for welding plate and structural members chiefly in the type of test assemblies used. The test positions may also differ to some extent. As a rule, the test requires use of pipe assemblies instead of flat plate. Space restrictions may also be included as a qualification factor if the production work involves welding in restricted spaces.

Essential Variables: Since it is impractical to test a welder for all the possible variables to be met in production, most codes establish limitations or ranges within which these variables are assumed not to change the results. The variables cover such items as welding process, base material type and thickness, filler metal, shielding medium, position, and weld root technique. Following are examples of essential variables from the Structural Welding Code which require requalification of welder performance if changed:

- (1) Welding process.
- (2) Filler metal. Filler metals are divided

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into groups and assigned "F" numbers; the grouping of electrodes and welding rods is based essentially on the usability characteristics that fundamentally determine the ability of a welder to make satisfactory welds with a given electrode.

(3) Welding position. Positions are classified differently for plate and pipe. A change in position may require requalification. For pipe welding, a change from rotated to fixed position requires requalification.

The tabulation of weld positions for groove and fillet welds as established by the American Welding Society is shown in Fig. 12.3A and B.

(4) Joint detail. A change in joint detail, such as omission of backing ring on joints welded from one side only.

(5) Plate thickness. Test plates are generally tested at two or three thicknesses: 3/8 in. (9.5 mm), 3/4 in. (19 mm), and 1 in. (25.4 mm). The 3/8 in. (9.5 mm) thickness is employed for qualifying a welder for limited thickness (less than 3/4 in. [19.05 mm]) and the 1 in. (25.4 mm) test plate for unlimited thickness.

(6) Technique. For example, in vertical position welding a change in direction of progression of welding requires requalification. Where

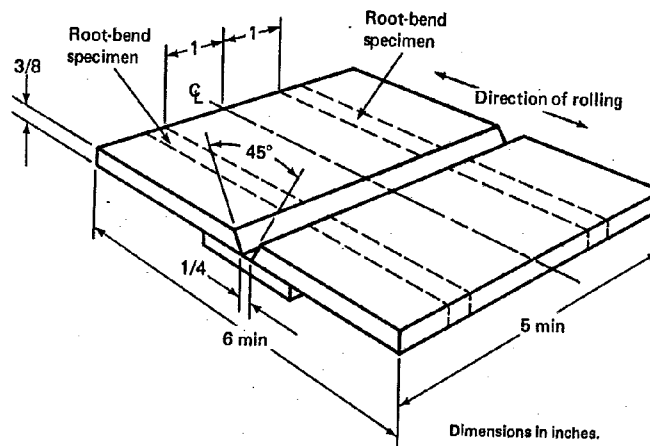
a combination of up and down progression is to be used in production, a welder may be qualified by a single test using the same combination as specified for production welding.

The Test Specimen

A typical qualification test plate for unlimited thickness is shown in Fig. 12.1A. The plate is 1 in. (25.4 mm) thick with a 45° groove angle and a 1/4 in. (6.35 mm) root opening.

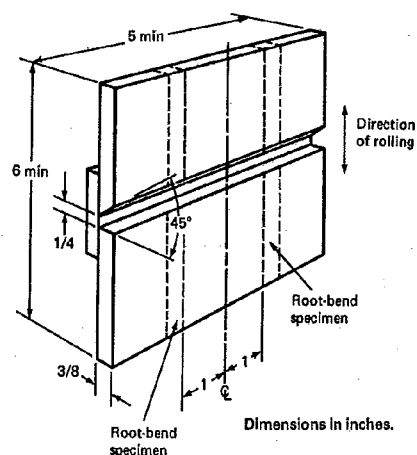
The groove weld plate for limited thickness (<3/4 in. [19.05 mm]) qualification is essentially the same as the plate shown in Fig. 12.1A and B except for the thickness. The plate thickness is 3/8 in. (9.5 mm).

Joint detail for groove weld qualification tests for butt joints on pipe or square or rectangular tubing should be in accordance with a qualified welding procedure specification for a single-welded pipe butt joint. As an alternative, the following joint details are frequently used: pipe diameter-wall thickness as required, single-V-groove, 60 degree included angle, 1/8 in. (3.2 mm) max root face and root opening without backing strip (see Fig. 12.2A) or single-V-groove, 60 degree included angle and suitable root opening with backing (see Fig. 12.2B).



Note: When radiography is used for testing, no tack welds shall be in the test area.

Fig. 12.1A—Test plate for unlimited thickness, welder qualification



Note: When radiography is used for testing, no tack welds shall be in the test area.

Fig. 12.1B—Optional test plate for unlimited thickness, horizontal position, welder qualification

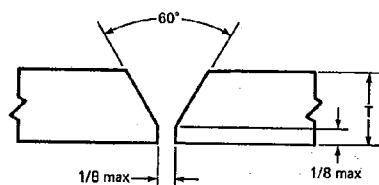


Fig. 12.2A—Plate and pipe butt joint, welder qualification, without backing

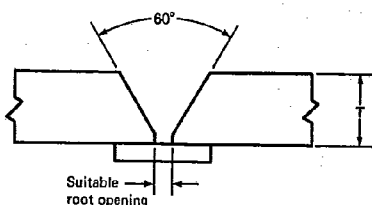


Fig. 12.2B—Pipe test butt joint, welder qualification, with backing

The above are examples of test samples required by various codes. Consideration by some codes is also given to other joint designs such as T, K, or Y connections in pipe, and fillet and tack welds.

Codes and specifications nearly always require that welder qualification tests be made in one or more of the most difficult positions to be encountered in production (e.g., vertical, horizontal, or overhead) if the production work involves other than flat position welding. In most cases, qualification in a more difficult position qualifies for welding in less difficult positions (e.g., qualification in the vertical, horizontal, or overhead position is usually considered adequate for welding in the flat position).

Figures 12.4 through 12.7 illustrate welding positions for groove and fillet welds in test samples for both plate and tubular shapes.

Testing of Qualification Welds

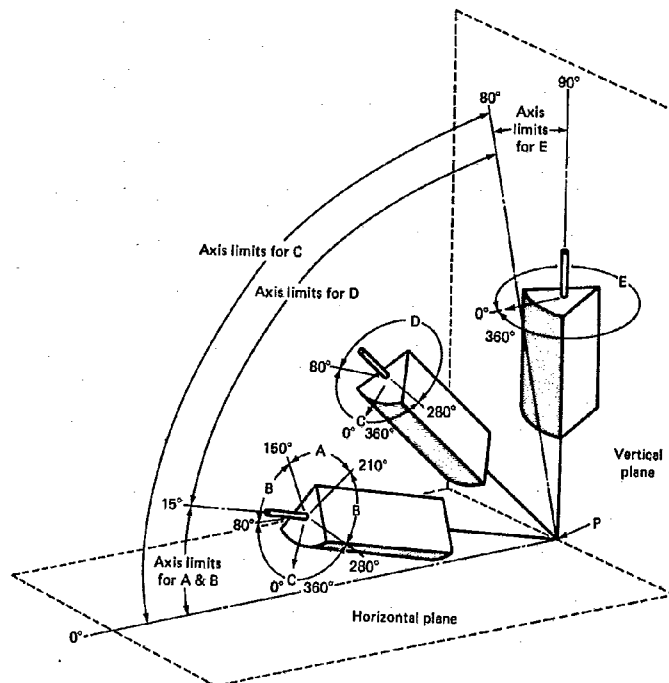
All codes and specifications have definite rules for testing qualification welds to determine compliance with the requirements. Most frequently required for groove welds are mechanical bend tests of specimens cut from specific locations in the welds. Fillet welds do not readily lend themselves to mechanical bend tests. In such cases, fillet weld break tests or macroetch tests or both may be required. For a description of these tests, see Chapter 14.

Radiographic testing is also sometimes allowed as an alternative to mechanical or other tests. Liquid penetrant examination is also frequently required on welds, especially those in nonferrous and other nonmagnetic materials. Usually, the primary requirement is that the test welds be sound and thoroughly fused to the base metal. Welders who make test welds that meet the prescribed requirements are considered to be qualified to apply the process and weld with filler metals and procedures similar within prescribed limits to those used in testing.

Qualification Records

Records of both the tests made for the qualification of welders and welding operators and of their usage of the process for which they were qualified are essential. An illustrative record

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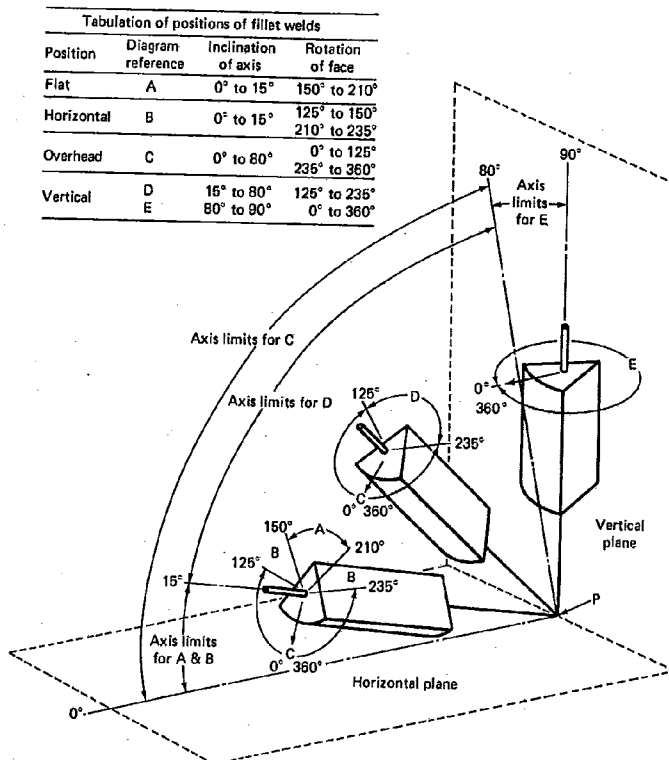


Tabulation of positions of groove welds			
Position	Diagram reference	Inclination of axis	Rotation of face
Flat	A	0° to 15°	150° to 210°
Horizontal	B	0° to 15°	80° to 150° 210° to 280°
Overhead	C	0° to 80°	0° to 80° 280° to 360°
Vertical	D	15° to 80°	80° to 280°
	E	80° to 90°	0° to 360°

Notes:

1. The horizontal reference plane is always taken to lie below the weld under consideration.
2. The inclination of axis is measured from the horizontal reference plane toward the vertical reference plane.
3. The angle of rotation of the face is determined by a line perpendicular to the theoretical face of the weld which passes through the axis of the weld. The reference position (0°) of rotation of the face invariably points in the direction opposite to that in which the axis angle increases. When looking at point P, the angle of rotation of the face of the weld is measured in a clockwise direction from the reference position (0°).

Fig. 12.3A—Positions of groove welds



FOR GROOVE WELDS IN PIPE THE FOLLOWING DEFINITIONS SHALL APPLY:

HORIZONTAL FIXED POSITION: When the axis of the pipe does not deviate by more than 30° from the horizontal plane and the pipe is not rotated during welding.

HORIZONTAL ROLLED POSITION: When the axis of the pipe does not deviate by more than 30° from the horizontal plane, the pipe is rotated during welding, and the weld metal is deposited within an arc not to exceed 15° on either side of a vertical plane passing through the axis of the pipe.

VERTICAL POSITION: When the axis of the pipe does not deviate by more than 10° from the vertical position. (The pipe may or may not be rotated during welding.)*

*Positions in which the axis of the pipe deviates by more than 10° and less than 60° from the vertical shall be considered intermediate.

Fig. 12.3B—Positions of fillet welds

form for welder or welding operator qualification testing is shown in Fig. 12.8.

Standardization of Tests

The objective of welder and welding operator qualification tests is to determine whether this person has the ability to deposit sound weld metal. Examination of specimen welds helps determine this; yet, the specimen welds required

for qualification do not usually correspond in detail to all those that will be encountered in production welding. The reason for this is that too many variations exist in normal production welding, and to cover all details would require far too many tests. In addition, it has been found that additional tests add little to the information about a welder's or welding operator's ability. For this reason, welder or welding operator

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qualification tests have been standardized considerably to eliminate the need for additional qualification tests every time a procedure or production application detail is altered slightly.

Naturally, separate qualification tests are required whenever radically different procedures or production conditions are involved. In addition, for some critical production welding applications, in-process performance tests are sometimes required.

Relation of Qualification Tests to Welder or Welding Operator Training

As previously noted, the welds required for qualification are not usually identical to those a welder or welding operator will be required to make during his normal production work. For that reason, it is not enough to train a welder or welding operator only to the extent necessary to pass the prescribed qualification tests. Training should be broader and more extensive,

sufficient to cover all procedures and joint details that will be encountered in actual production. This training is the responsibility of the fabricator.

Retests

Retesting of welders, welding operators, or tackers may be required under certain circumstances, some of which are:

- (1) In case of failure of the initial test welds
- (2) In case of a significant change in welding procedure
- (3) In case a welder has not been engaged in arc welding or has not used the process for an extended period (usually six months; the time is three months under U.S. Navy MIL-STD-248)
- (4) In case there is reason for the inspector to question a welder's or welding operator's ability; i.e., his welds have a high reject rate

Reference should be made to the applicable code or specification for provisions governing such retests.

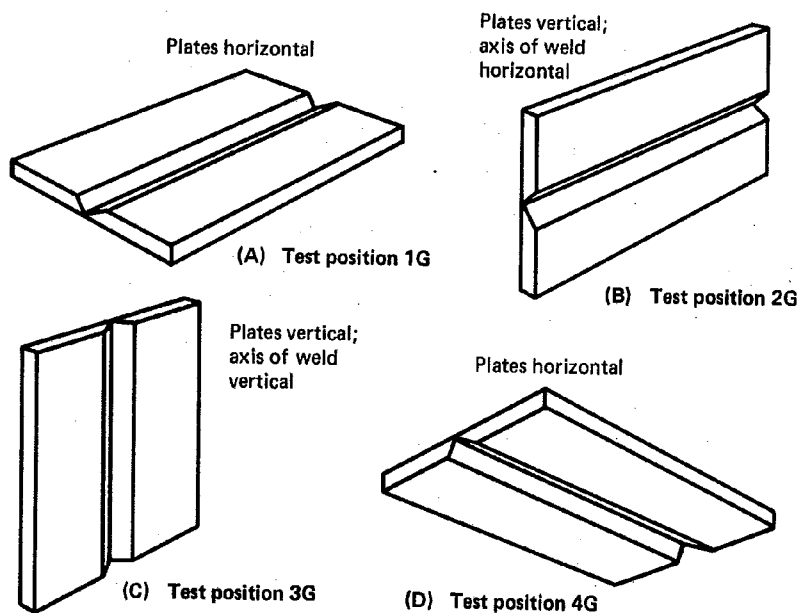


Fig. 12.4—Positions of test plates for groove welds

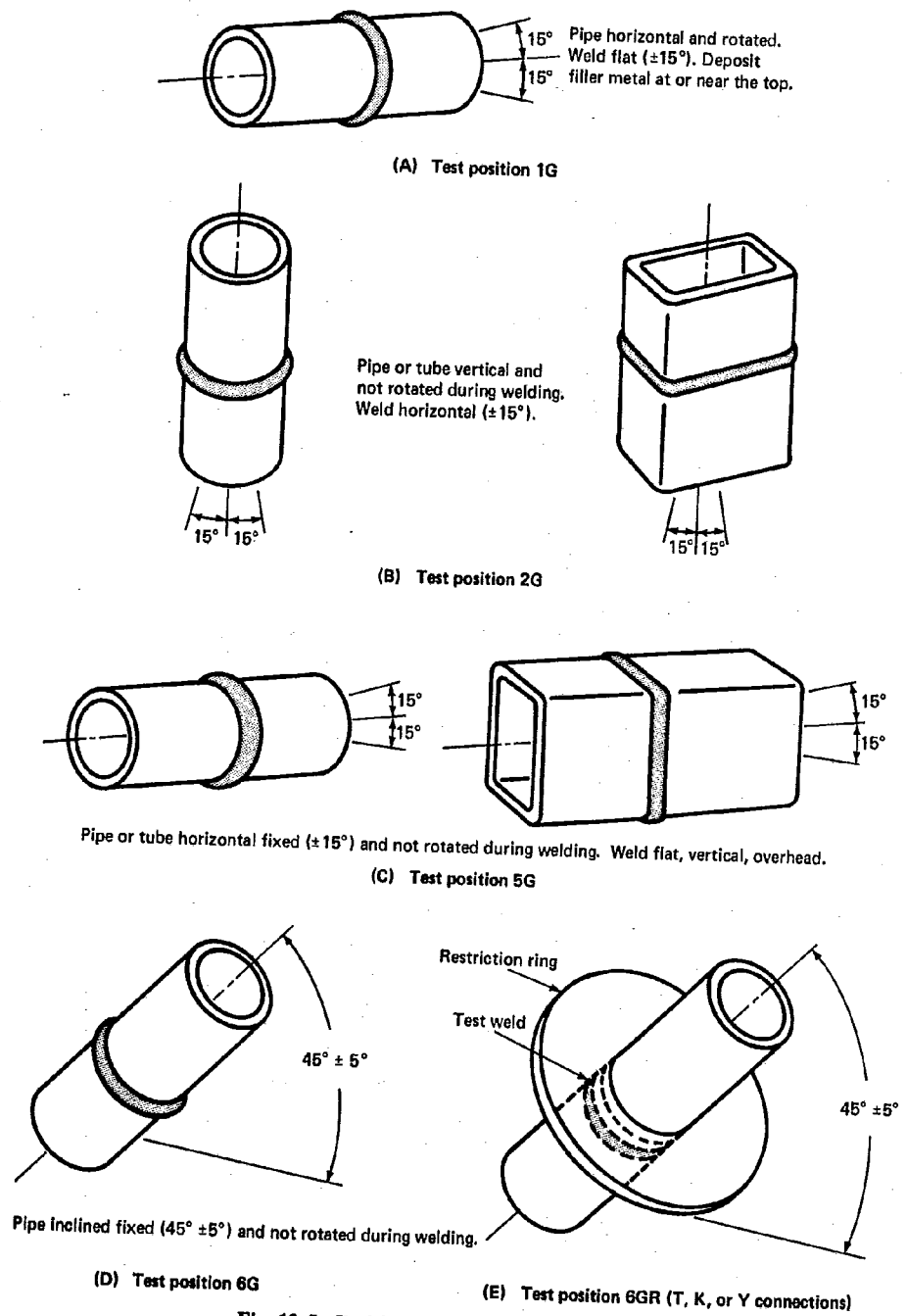


Fig. 12.5—Positions of test pipe for groove welds

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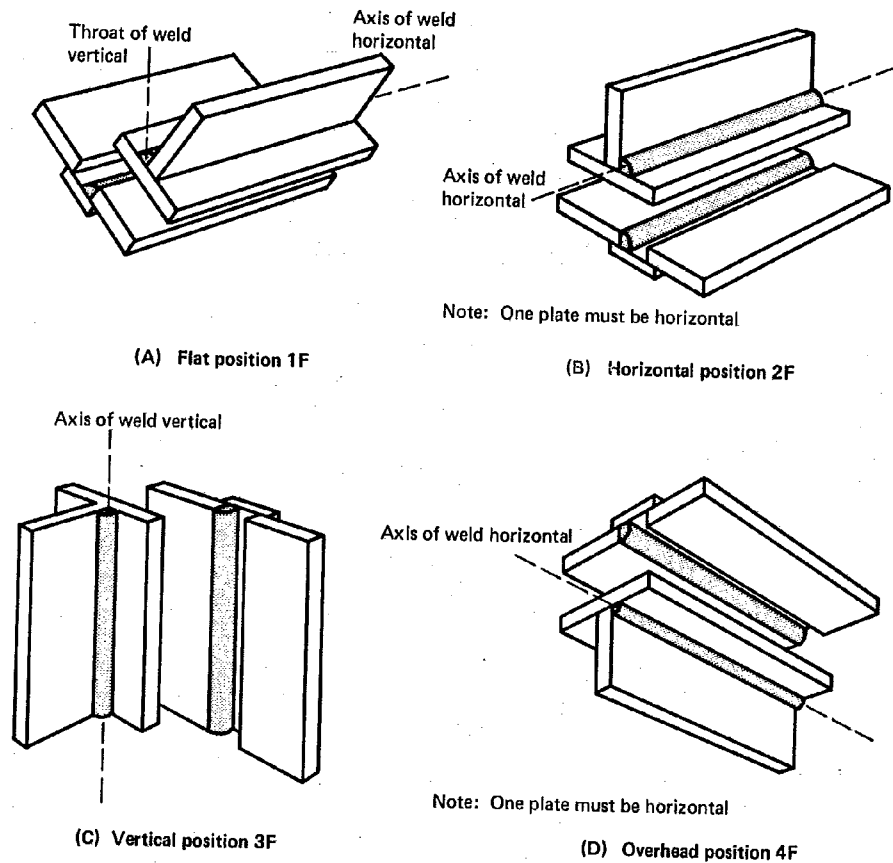


Fig. 12.6—Positions of test plates for fillet welds

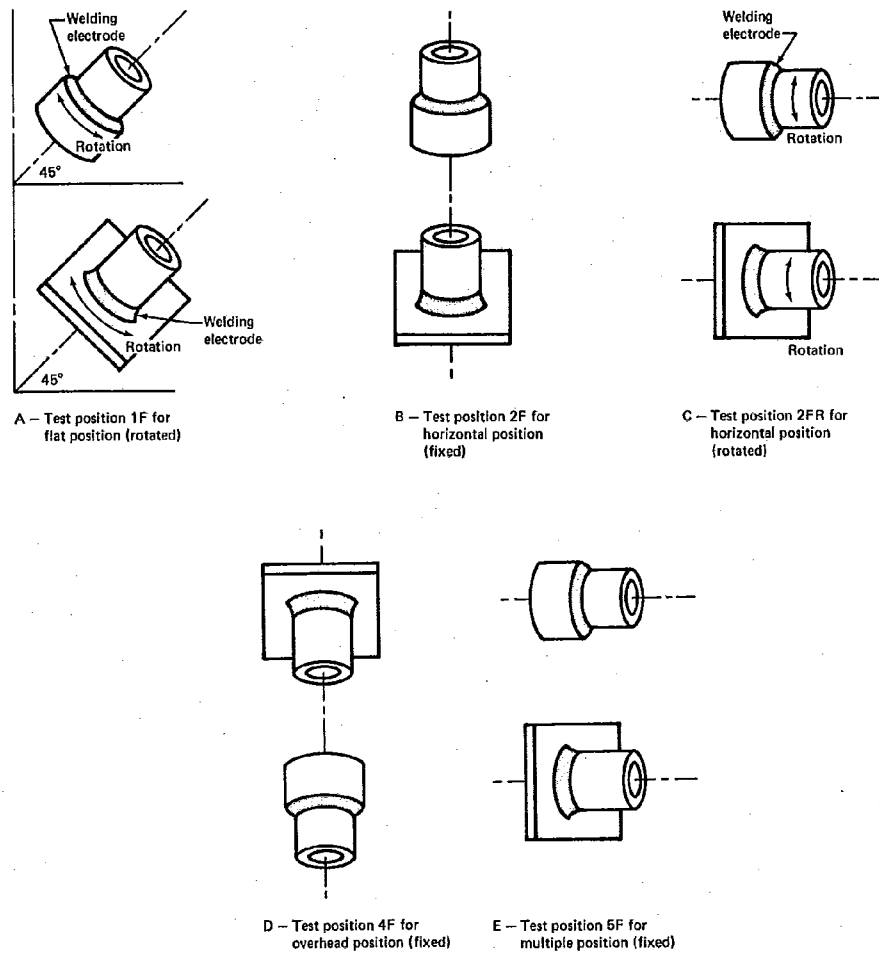


Fig. 12.7—Positions of test pipes for fillet welds

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WELDER AND WELDING OPERATOR QUALIFICATION TEST RECORD

Welder or welding operator's name _____ Identification no. _____
 Welding process _____ Manual _____ Semiautomatic _____ Machine _____
 Position _____
 (Flat, horizontal, overhead or vertical – if vertical, state whether upward or downward)
 In accordance with procedure specification no. _____
 Material specification _____
 Diameter and wall thickness (if pipe) – otherwise, joint thickness _____
 Thickness range this qualifies _____

FILLER METAL

Specification no. _____ Classification _____ F no. _____
 Describe filler metal (if not covered by AWS specification) _____
 Is backing strip used? _____
 Filler metal diameter and trade name _____ Flux for submerged arc or gas for gas metal arc or flux
 cored arc welding _____

Guided Bend Test Results

Type	Result	Type	Result

Test conducted by _____ Laboratory test no. _____
 per _____

Fillet Test Results

Appearance _____ Fillet size _____
 Fracture test root penetration _____ Macroetch _____
 (Describe the location, nature, and size of any crack or tearing of the specimen.)
 Test conducted by _____ Laboratory test no. _____
 per _____

RADIOGRAPHIC TEST RESULTS

Film identi- fication	Results	Remarks	Film identi- fication	Results	Remarks

Test witnessed by _____ Test no. _____
 per _____

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 5C or D of AWS D1.1, Structural Welding Code.

Manufacturer or contractor _____

Authorized by _____

Date _____

Form E-4

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Fig. 12.8—Sample welder qualification test record