

AEROSPACE MATERIAL SPECIFICATION



AMS-STD-1595A

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Superseded by AWS D17.1
Superseding AMS-STD-1595

Qualification of Aircraft, Missile
and Aerospace Fusion Welders

CANCELLATION NOTICE

This specification has been "CANCELLED" by the Aerospace Materials Division, SAE, as of September, 2002, and has been superseded by AWS D17.1, Specification for Fusion Welding for Aerospace Applications. The requirements of the latest issue of AWS D17.1 shall be fulfilled whenever reference is made to the cancelled AMS-STD-1595. By this action, this document will remain listed in the Numerical Section of the Index of Aerospace Material Specifications, noting that it is superseded by AWS D17.1.

Cancelled specifications are available from SAE. Copies of AWS D17.1 are available from AWS, 550 NW LeJeune Road, Miami, FL 33126, or URL www.aws.org.

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1. SCOPE:

1.1 Purpose:

This standard establishes the procedure for qualification of welders and welding operators engaged in the welding of aircraft, missiles, other aerospace equipment, and their parts and accessories by fusion welding processes. This standard is applicable to aircraft, missile, and aerospace ground support equipment or other welding, when included in the contracting documents or when invoked in the absence of a specified welder qualification document.

1.2 Welder and welding operator assignments:

1.2.1 Welder: Welders may weld all joints by manual and semi-automatic welding for which they are qualified by producing acceptable test welds, as defined in Sections 4 and 5. In addition, welders may weld all joints by machine and automatic welding within the same limitations as for the acquired welder qualification.

1.2.2 Welding operator: Welding operators may weld all joints by machine and automatic welding for which they are qualified by producing acceptable test welds, as defined in Sections 4 and 5.

2. APPLICABLE DOCUMENTS:

The following publications, of the issue in effect on the date of invitation for bids or request for proposal, form a part of this specification to the extent specified herein.

2.1 U.S. Government Publications:

Available from DODSSP, Subscription Services Desk, Building 4D, 700 Robbins Avenue, Philadelphia, PA 19111-5094.

MIL-STD-410 Nondestructive Testing Personnel Qualification and Certification
MIL-STD-453 Inspection, Radiographic

2.2 ASTM Publications:

Available from ASTM, 100 Barr Harbor, West Conshohocken, PA 19428-2959.

ASTM DS-56 Unified Numbering System for Metals and Alloys (Same as SAE HS1086)

2.3 SAE Publications:

Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001.

SAE HS1086 Unified Numbering System for Metals and Alloys (Same as ASTM DS-56)

2.4 AWS Publications:

Available from American Welding Society, 550 N.W. LaJeune Road, Miami, FL 33126.

AWS A3.0	Welding Terms and Definitions
AWS B3.0	Welding Procedure and Performance Qualification
AWS D1.1	Structural Welding Code
AWS D10.9	Qualification of Welding Procedures and Welders for Piping and Tubing

3. DEFINITIONS:

3.1 Welding terminology:

The welding terminology of "Welding Terms and Definitions" AWS A3.0, shall be used in the interpretation of this standard. Some of these items and additional terms are defined below.

- 3.1.1 As-welded: The condition of weld metal, welded joints, and weldments after welding but prior to any subsequent thermal, mechanical, or chemical treatments.
- 3.1.2 Automatic welding: Welding with equipment which performs the welding operation without adjustment of the controls of a welding operator. The equipment may or may not perform the loading and unloading of the work.
- 3.1.3 Backing: A material (base metal, weld metal, carbon, or granular material) placed at the root of a weld joint for the purpose of supporting molten weld metal.
- 3.1.4 Base metal: The metal to be welded, soldered, or cut.
- 3.1.5 Blank: Part of a test weld removed for the preparation of a bend test specimen or a metallographic specimen.
- 3.1.6 Butt joint: A joint between two members aligned approximately in the same plane.
- 3.1.7 Complete fusion: Fusion that has occurred over the entire base metal surfaces intended for welding and between all layers and weld beads.
- 3.1.8 Complete joint penetration: Joint penetration in which the weld metal completely fills the groove and is fused to the base metal throughout its total thickness.
- 3.1.9 Defect: A discontinuity or discontinuities which by nature or accumulated effect render a part or product unable to meet minimum applicable acceptance standards or specifications. This term designated rejectability.
- 3.1.10 Depth of fusion: The distance that fusion extends into the base metal or previous pass from the surface melted during welding.
- 3.1.11 Discontinuity: An interruption of the typical structure of a weldment, such as a lack of homogeneity in the mechanical, metallurgical, or physical characteristics of the material or weldment. A

discontinuity is not necessarily a defect.

3.1.12 Filler metal: The metal to be added in making a welded, brazed, or soldered joint.

3.1.13 Fusion zone: The areas of base metal melted as determined on the cross section of a weld.

3.1.14 Heat-affected zone: That portion of the base metal which has not been melted, but whose mechanical properties or microstructure have been altered by the heat of welding, brazing, soldering, or cutting.

3.1.15 Joint: The junction of members or the edges of members which are to be joined or have been joined.

3.1.16 Machine welding: Welding with equipment which performs the welding operation under the constant observation and control of a welding operator. The equipment may or may not perform the loading and unloading of the work.

3.1.17 Manual welding: A welding operation performed and controlled completely by hand.

3.1.18 Semiautomatic arc welding: Arc welding with equipment which controls only the filler metal feed. The advance of the welding is manually controlled.

3.1.19 Test weld: A joint made by a welder for purposes of welder qualification.

3.1.20 Welder: One who performs a manual or semiautomatic welding operation.

3.1.21 Welder certification: Certification in writing that a welder has produced welds meeting prescribed standards.

3.1.22 Welding machine: Equipment used to perform the welding operation. For example, spot welding machine, arc welding machine, seam welding machine, etc.

3.1.23 Welding operator: One who operates machine or automatic welding equipment.

3.2 Symbols and terms:

- a. Sheet refers to both sheet and plate, where appropriate.
- b. Tube refers to both tube and pipe, where appropriate.
- c. The lower case letter, t, indicates base metal thickness for either sheet or tube wall.
- d. Mathematical symbols used before numbers mean:

- < less than
- > more than
- ≤ equal to or less than
- ≥ equal to or more than.

4. GENERAL REQUIREMENTS:

4.1 Qualification requirements:

To achieve qualified status, welders and welding operators shall demonstrate their skill by producing acceptable test welds in accordance with 4.1.1. No test welds are required for those welds which will not be required in production welding.

4.1.1 Welders: The correlation between test welds and production welds shall be based on the following factors.

- a. Welding process (see 5.1).
- b. Base metal composition (see 5.2).
- c. Base metal thickness (see 5.3).
- d. Welding position (see 5.4).
- e. Base metal form, sheet or tube (see 5.5).
- f. Type of weld, groove or fillet (see 5.5).
- g. Other welding conditions (see 5.6).

4.1.2 Welding operators: The correlation between test welds and production welds shall be based on only the first three factors given in 4.1.1.

4.2. Minimum requirements:

The requirements of this standard are minimum. Other requirements may be added by the contractor, but may not be substituted for the requirements of this standard.

4.3 Physical requirements:

The contractor shall establish reasonable and appropriate physical requirements for welders and welding operators. It will be accepted that those whose corrected vision in each eye for long distance is better than 20/30 and for 16 inches distance permits reading of Joeger No. 2 type will ordinarily satisfy vision needs for welding.

4.4 Identification:

The contractor shall assign a unique number or other identification to each welder or welding operator upon qualification.

4.5 Test records:

The contractor shall complete a test record containing the essential information required as evidence of the welder or welding operator qualification. These records shall be retained for the period of time specified in the contract or, if no retention time is specified, the period of record retention shall be for the duration of qualification.

- 4.5.1 Test record forms: Suggested test record forms are given in Figure 1 and in the following documents.
- a. Structural Welding Code, AWS D1.1
 - b. Qualification of Welding Procedures and Welders for Piping and Tubing, AWS D10.9.
- 4.6 Requalification: A welder or welding operator shall be requalified every five years to the same requirements as an original qualification. Requalification is also required when either of the following two conditions are present.
- 4.6.1 A welder or welding operator has not welded with a given welding process for a period of three months; except that this period shall be extended to six months if the welder has welded with another process of Table I.
- 4.6.2 There is a specific reason to question the ability of a welder or welding operator to meet the requirements for qualification in a given welding process.
- 4.7 Alternate requalification: As an alternate to the requirements of 4.6.1, requalification to the same requirements as an original qualification may be accomplished at two year intervals, in lieu of the three month and six month restrictions.
5. DETAILED REQUIREMENTS:
- 5.1 Welding process: For welders and welding operators, a test weld made with a given welding process of Table I qualifies only that welding process. This standard does not apply to welding processes not included in Table I.
- 5.2 Base metals: For welders and welding operators, a test weld made in a base metal included in one of the ten base metal groups of Table II qualifies only that base metal group, except as modified by 5.2.1 and 5.2.2 and as illustrated in Table III. The specific base metals included in each of the base metal groups of Table II, are given in the Appendix of this standard. Since the base metal groups are intended only for the purpose of qualification, some of the base metal groups contain base metals whose composition does not conform to the nominal description of the base metal group.

QUALIFICATION TEST RECORD

Name _____ Id. _____ SS No. _____
 Joint welding procedure _____ Welder ☐ Welding operator ☐

TEST WELD

Base metal description _____ Group No. _____
 Welding process _____ Single weld ☐ Double weld ☐
 Current AC ☐ DC ☐ Backing Yes ☐ No ☐
 Vertical Down ☐ Up ☐ Penetration Complete ☐ Partial ☐

	Position				Dimension, inch	
Sheet groove	1G ☐	2G ☐	3G ☐	4G ☐	t	_____
Tube groove	1G ☐	2G ☐	5G ☐		O. D.	t _____
Sheet fillet	1F ☐	2F ☐	3F ☐	4F ☐	t	_____
Tube fillet	1F ☐	2F ☐	4F ☐	5F ☐	O. D.	t _____

TEST RESULTS

Visual Pass ☐ Fail ☐
 Radiographic NA ☐ Pass ☐ Fail ☐
 Bend NA ☐ Pass ☐ Fail ☐
 Metallographic NA ☐ Pass ☐ Fail ☐

QUALIFIED

Base Metal Group No. _____ Single weld ☐ Double weld ☐
 Current AC ☐ DC ☐ Backing With ☐ Without ☐
 Vertical Down ☐ Up ☐ Penetration Complete ☐ Partial ☐

	Position				t, inch		O. D., inch	
					Min.	Max.	Min.	Max.
Sheet groove	1G ☐	2G ☐	3G ☐	4G ☐	_____	_____	_____	_____
Tube groove	1G ☐	2G ☐	5G ☐		_____	_____	_____	_____
Sheet fillet	1F ☐	2F ☐	3F ☐	4F ☐	_____	_____	_____	_____
Tube fillet	1F ☐	2F ☐	4F ☐	5F ☐	_____	_____	_____	_____

The above named individual is qualified in accordance with MIL-STD-1595A within the above limits for the welding process used for this test weld.

Date of test weld _____ Signed by _____
 Qualifier

FIGURE 1. Suggested test record form.

TABLE I. Fusion welding processes.

Oxyfuel welding (OFW)
Shielded metal arc welding (SMAW)
Submerged arc welding (SAW)
Gas tungsten arc welding (GTAW)
Gas metal arc welding (GMAW)
Flux cored arc welding (FCAW)
Plasma arc welding (PAW)
Electron beam welding (EBW)

TABLE II. Base metal groups.

Group	Nominal description
Ia	Carbon and low alloy steels
Ib	Alloy steels
IIa	Stainless steels
IIb	Precipitation hardening stainless steels
IIIa	Nickel and nickel-base alloys
IIIb	Precipitation hardening nickel-base alloys
IV	Aluminum and aluminum-base alloys
V	Magnesium-base alloys
VI	Titanium and titanium-base alloys
VII	Cobalt-base alloys

- 5.2.1 Qualification in a base metal group with a “b” designator also qualifies for base metal numbers with the same roman numeral designator and an “a” designator. See Table III.

TABLE III. Base metal groups qualified by test weld.

Test weld	Qualified
Ia	Ia
Ib	Ia, Ib
IIa	IIa
IIb	IIa, IIb
IIIa	IIIa
IIIb	IIIa, IIIb
IV	IV
V	V
VI	VI
VII	VII

5.2.2 For welders and welding operators, a separate qualification is required for each base metal not included in the Appendix, except as modified in 5.2.2.1.

5.2.2.1 Exception: A base metal not included in the Appendix, with welding characteristics similar to a given base metal group of the Appendix, may be qualified with any base metal of the given base metal group. The preparing activity shall be notified by the organization qualifying a welder or welding operator under the provisions of this paragraph, with DD Form 1426 or a letter, of the two base metals involved and the chemical composition of the base metal not included in the Appendix.

5.3 Base metal thickness: The qualification limits, with regard to base metal thickness (sheet thickness or tube wall thickness), are given below for welders and welding operators. These limits apply to both groove welds and fillet welds.

5.3.1 A test weld with a base metal thickness of t shall qualify welds with a thickness range of $0.67t$ to $4t$; except that, when the test weld thickness is equal to or greater than 1 inch, the qualification range is $0.67t$ to unlimited.

5.3.2 Two test welds, each with members of equal thickness, shall qualify welds with all intermediate thicknesses, in addition to the thickness qualifications of 5.3.1.

5.4 Welding position:

5.4.1 Welders: The welding positions qualified by a given test weld position, to be found at the left of Table IV, are denoted by an X in the table. The welding positions are illustrated in Figures 2 through 5.

5.4.2 Welding operators: A test weld made in any welding position qualifies for all welding positions.

5.5 Base metal form and weld type:

5.5.1 Welders: The base metal forms and weld types qualified by a given test weld, to be found at the left of Table IV, are denoted by an X in the table, with the exceptions given below.

5.5.1.1 Qualification for fillet welds in base metal equal to or less than 0.063 inch in thickness requires a fillet test weld. Groove test welds do not qualify for fillet welds in this thickness range.

5.5.1.2 A tube test weld shall qualify only for tubes of an outside diameter equal to or greater than the outside diameter of the test weld.

5.5.2 Welding operators: A test weld of any base metal form and of any weld type shall qualify for all base metal forms and all weld types. A tube test weld of any outside diameter shall qualify for tubes of any outside diameter.

5.6 Other welding conditions: In addition to the welding process, base metal composition, base metal thickness, welding position, base metal form and type of weld; other welding conditions which require a correlation between the test weld and the production welds are given in Table V.

5.6.1 Welders: The welding conditions qualified by the given test weld conditions, to be found at the left of Table V, are denoted by an X in the table. The current type restrictions apply only to the GTAW process. For all other processes, a test weld made with either ac or dc current qualifies for welds made with either current type.

5.6.2 Welding operators: The welding condition restrictions of Table V do not apply to the qualification of welding operators.

5.7 Test welds: One test weld shall be required for each combination of welding conditions, given in 4.1.1 and 4.1.2, being qualified. Test welds shall be made in accordance with a written joint welding procedure.

5.7.1 Groove test weld in sheet: The test weld is a butt joint in sheet as described in Figure 6.

TABLE IV. Welding position, base metal form, and weld type qualified by test weld

Test Weld			Qualified position															
Form	Weld type	Position	Sheet								Tube							
			Groove				Fillet ^{1/}				Groove				Fillet ^{1/}			
			1G	2G	3G	4G	1F	2F	3F	4F	1G	2G	5G	6G	1F	2F	4F	5F
Sheet	Groove	1G	X				X	X			X				X			
		2G	X	X			X	X			X	X			X			
		3G	X		X		X	X	X		X				X			
		4G	X			X	X	X	X		X				X			
Sheet	Fillet	1F					X										X	
		2F					X	X							X	X		
		3F					X	X	X						X			
		4F					X	X		X					X	X	X	
Tube	Groove	1G	X				X	X			X				X	X		
		2G	X	X			X	X			X	X			X	X		
		5G	X		X	X	X		X	X	X		X		X		X	X
		6G	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Tube	Fillet	1F					X										X	
		2F					X	X							X	X		
		4F					X	X		X					X	X	X	
		5F					X	X	X	X					X	X	X	X

^{1/} A groove test weld does not qualify for fillet welds in base metal equal to or less than 0.063 inch in thickness (see 5.5.1.1).

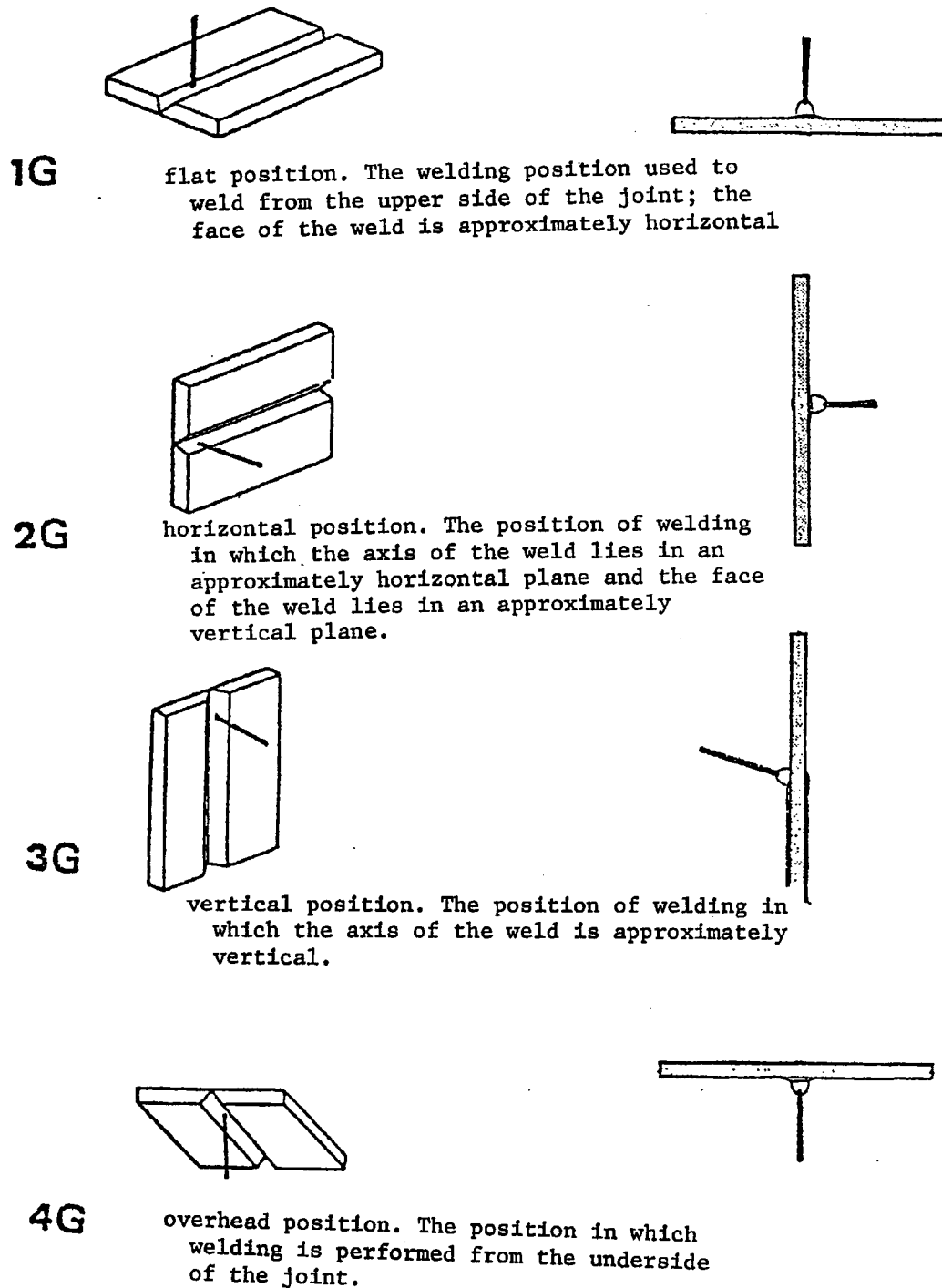
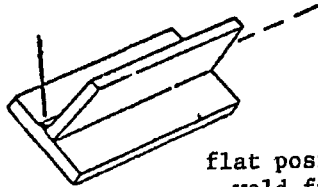
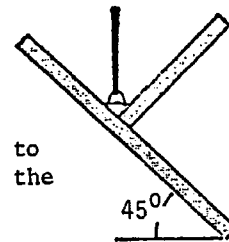


FIGURE 2. Groove weld in sheet: positions 1G, 2G, 3G, and 4G.

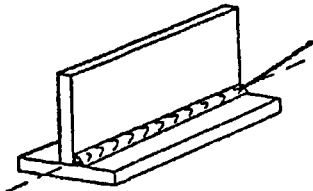
1F



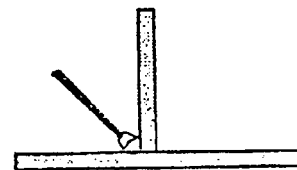
flat position. The welding position used to weld from the upper side of the joint; the face of the weld is approximately horizontal.



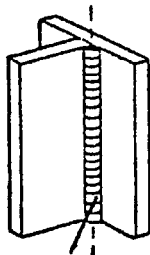
2F



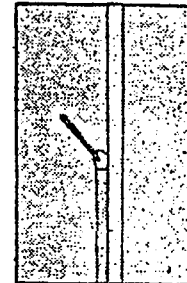
horizontal position. The position in which welding is performed on the upper side of an approximately horizontal surface and against an approximately vertical surface.



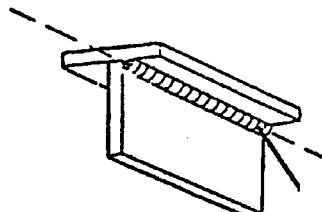
3F



vertical position. The position of welding in which the axis of the weld is approximately vertical.



4F



overhead position. The position in which welding is performed from the underside of the joint.

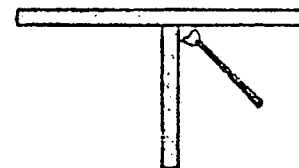
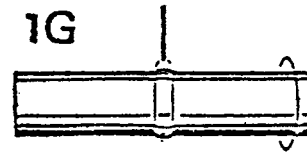
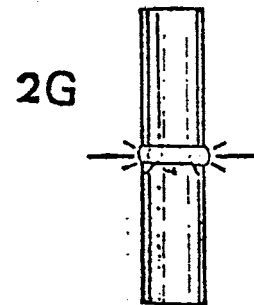


FIGURE 3. Fillet weld in sheet: positions 1F, 2F, 3F, and 4F.

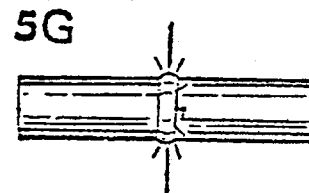
horizontal rolled position. The position of a pipe joint in which the axis of the pipe is approximately horizontal, and welding is performed in the flat position by rotating the pipe.



vertical position. The position of a pipe joint in which welding is performed in the horizontal position and the pipe is not rotated during welding.



horizontal fixed position. The position of a pipe joint in which the axis of the pipe is approximately horizontal and the pipe is not rotated during welding.



inclined position. The position of a pipe joint in which the axis of the pipe is approximately at an angle of 45° to the horizontal and the pipe is not rotated during welding.

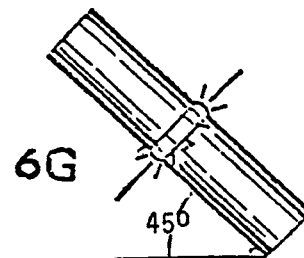


FIGURE 4. Groove weld in tube: positions 1G, 2G, 5G, and 6G.