AWS D17.1:2001
An American National Standard

# Specification for Fusion Welding for Aerospace Applications

American Welding Society

Approved American National Standard
ANSI

**Key Words**—Aerospace, aircraft, design, fabrication, factor of safety, fusion welding, flight hardware, inspection, qualification, repair, support equipment, weld classifications

**AWS D17.1:2001**
**An American National Standard**

**Approved by**
**American National Standards Institute**
**January 19, 2001**

# Specification for Fusion Welding for Aerospace Applications

Prepared by
AWS D17 Committee on Welding in the Aircraft and Aerospace Industries

Under the Direction of
AWS Technical Activities Committee

Approved by
AWS Board of Directors

## Abstract

This specification provides the general welding requirements for welding aircraft and space hardware. It includes but is not limited to the fusion welding of aluminum-based, nickel-based, iron-based, cobalt-based, magnesium-based, and titanium-based alloys using electric arc and high energy beam processes. There are requirements for welding design, personnel and procedure qualification, inspection, and acceptance criteria for aerospace, support and non-flight hardware. Additional requirements cover repair welding of existing hardware. A commentary for the specification is included.

**American Welding Society**
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# Foreword

(This Foreword is not a part of AWS D17.1:2001, *Specification for Fusion Welding for Aerospace Applications,* but is included for information purposes only.)

Aviation welding specifications were primarily dependent on government standards for contract purposes and were based on welding technology from the 1950s. Those specifications were MIL-W-8611 (steel), MIL-W-8604 (aluminum), MIL-W-18326 (magnesium) and MIL-T-5021 for welder performance. In 1977 the aviation and aerospace industry and government moved to update some of these standards by consolidating the welder's performance of MIL-T-5021 into MIL-STD-1595. MIL-STD-1595 was issued as a supplement to the ASME *Boiler and Pressure Vessel Code*, Section IX, in 1977. It was subsequently revised and superseded by MIL-STD-1595A in 1983. The first update to the 1950's welding process specifications came with the release of MIL-W-8604A in 1982, almost 30 years after its initial release. The material welding specifications MIL-W-8604, MIL-W-8611, and MIL-W-18326 were consolidated into MIL-STD-2219 in 1988 and represent the most significant change to aviation welding standards in more than 30 years.

After two unsuccessful attempts to change the military standards, the American Welding Society contacted the industry and proposed a meeting to develop a national specification. Interested welding personnel from the aviation industry gathered together in the autumn of 1993 to lay the foundation for a national aviation and aerospace specification for fusion welding to replace MIL-STD-1595A and MIL-STD-2219. This meeting led to the formation of AWS D17, *Committee on Welding in the Aircraft and Aerospace Industries*. The overriding theme the welding committee members brought to the table was that the aviation industry had changed. Those changes affected the welding processes and procedures, base metal and filler metal types, quality and the inspection equipment, just to name a few.

Since the 1950s the welding specifications had not completely kept pace during the revision process to reflect those technology changes. The writing of this specification was a prime opportunity for the industry and government to create a document to include those changes. Through an industrial effort and committee consensus, this specification represents several years of work, bringing the aviation and aerospace industry together to acknowledge the technological advances of welding and materials. Included in this document is weld repair technology to enable the use of weld repair beyond those areas originally designated for a weld.

In keeping with the welding and material technology advancements, this committee is committed to produce additional welding specifications as necessary, including Resistance Welding (RW) and Friction Stir Welding (FSW), to meet the demands of the ever-changing aviation and aerospace welding industry.

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# Specification for Fusion Welding for Aerospace Applications

## 1. General Requirements

**1.1 Scope.** This specification contains requirements for fusion welding of aerospace hardware. It is to be used in conjunction with the Engineering Authority's design handbooks or their accepted data. When conformance to this specification is stipulated in contract documents, all provisions of this specification shall be complied with, except for those provisions that the Engineering Authority or contract documents specifically exempt or those optional provisions that shall be applied when specified by the contract documents.

The following is a summary of the specification sections:

Section 1. **General Requirements:** basic information on the scope and provisions of this specification.

Section 2. **Applicable Documents:** a listing of the documents referenced in the text of this specification.

Section 3. **Design of Welded Connections:** requirements and guidance information for the design of welded connections.

Section 4. **Welding Performance and Procedure Qualification:** qualification requirements for welders, welding operators and welding procedures.

Section 5. **Fabrication:** requirements for preparation, assembly and workmanship when welding aerospace hardware.

Section 6. **Inspection:** criteria for inspector qualification, responsibilities of inspectors, acceptance of production welds, and standard requirements for performing visual inspection and nondestructive examination (NDE).

Section 7. **Repair of Existing Structures:** requirements for repair of existing aerospace hardware.

Section 8. **Welding of Nonflight Hardware:** requirements for welding nonflight hardware.

**1.1.1 Flight Hardware.** The fundamental premise of this specification is to provide general requirements for currently recognized aerospace fusion welding processes and materials. However, this specification provides for the application of new materials, new welding processes, or acceptance criteria for production welds differing from those defined in this specification. These new applications shall be documented by the proposer and approved by the Engineering Authority.

**1.1.1.1 Aircraft, Rotorcraft, and Engines Subject to FAA Regulation.** When applying welding in the design, construction and repair of aircraft, rotorcraft, or engines subject to FAA Regulation, the Engineering Authority must perform the appropriate design analyses and impose process control measures that will ensure compliance with the applicable requirements of the Code of Federal Regulations, Title 14.

**1.1.2 Nonflight Hardware.** Nonflight hardware, tooling, ground support equipment and related nonconventional aerospace facilities shall be designed and welded in accordance with the requirements of Section 8.

**1.2 Classification.** All welds produced in accordance with this specification shall be classified on the engineering drawings. Weld classifications shall be as follows: Class A, Class B, or Class C. These classifications refer to the level of inspection required and to the acceptance criteria. Alternate acceptance criteria and inspection methods may be applied if specified on the engineering drawing. The Engineering Authority shall also determine the weld procedure qualification requirements (see Commentary).

**1.2.1 Determining Classifications.** The Engineering Authority must consider material and process aspects that affect mission or systems requirements. A weld joint may be zoned with multiple classifications.

**1.2.2 Criteria.** The Engineering Authority shall determine the weld procedure qualification requirements for