

<b>AEROSPACE MATERIAL SPECIFICATION</b>	<b>AMS2680™</b>	<b>REV. C</b>
	Issued 1981-04 Revised 2001-06 Reaffirmed 2019-01  Superseding AMS2680B	
Electron-Beam Welding For Fatigue Critical Applications		

1. SCOPE:

1.1 Purpose:

This specification defines the procedures and requirements for joining metals and alloys using the electron beam welding process.

1.2 Application:

These procedures are used typically for high quality, electron-beam welding of aerospace components, the failure of which could cause loss of the aerospace vehicle or one of its major components, loss of control, or significant injury to occupants of a manned aerospace vehicle, but usage is not limited to such applications.

1.2.1 The procedure covered by this specification is recommended for square groove and square scarf-but joints for fatigue critical applications.:

2. APPLICABLE DOCUMENTS:

The issue of the following documents in effect on the date of the purchase order forms a part of this specification to the extent specified herein. The supplier may work to a subsequent revision of a document unless a specific document issue is specified. When the referenced document has been canceled and no superseding document has been specified, the last published issue of that document shall apply.

2.1 SAE Publications:

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

AMS 2630	Ultrasonic Inspection, Product Over 0.5 Inch (12.5 mm) Thick
AMS 2631	Ultrasonic Inspection, Titanium and Titanium Alloy Bar and Billet
AMS 2632	Ultrasonic Inspection of Thin Materials, 0.5 Inch (13 mm) and Thinner
AMS-STD-1595	Qualification of Aircraft, Missile and Aerospace Fusion Welders

ARP1333	Nondestructive Testing of Electron Beam Welded Joints in Titanium-Base Alloys
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## 2.2 ASTM Publications:

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

ASTM E 8	Tension Testing of Metallic Materials
ASTM E 8M	Tension Testing of Metallic Materials (Metric)
ASTM E 1444	Magnetic Particle Examination
ASTM E 1417	Liquid Penetrant Examination
ASTM E 1742	Radiographic Examination

## 2.3 ANSI Publications:

Available from American National Standards Institute, Inc., 1430 Broadway, New York, NY 10018.

ANSI B46.1 Surface Texture

## 2.4 AIA Publications:

Available from National Standards Association, Inc., 5161 River Road, Bethesda, MD 20812.

NAS 976 Electron Beam Welding Machine

## 3. TECHNICAL REQUIREMENTS:

### 3.1 Materials:

3.1.1 Parent Materials: Shall be as specified on the applicable part drawing.

3.1.2 Filler Materials: When required, filler metal shall be as specified on the part drawing.

3.1.3 Cleaning Materials: Cleaning materials, chemical solvents, or etching solutions shall be as specified on the part drawing or in the certified welding procedure.

### 3.2 Equipment:

3.2.1 Electron-Beam Welding Equipment: Shall be capable of producing welds meeting the requirements of 3.6 and 3.7. Equipment conforming to NAS 976 is accepted as meeting this requirement.

3.2.2 Jigs and Fixtures: All holding fixtures shall be capable of maintaining the desired configuration and tolerances during welding, providing back-up as required, and allowing required work space between the work piece and the electron gun. Back-up material used to deflect or absorb residual electron-beam energy shall be of the same alloy as the part being welded except that alternate back-up materials may be used when approved by procedure certification as in 3.4.2. Tooling within 6 inches (152 mm) of the weld joint shall be made from nonmagnetic materials or be degaussed to acceptable limits (See 3.2.3).

3.2.3 Degaussing: Ferromagnetic materials and tooling shall, prior to welding, be demagnetized to a level established by procedure certification (3.4.2) which prevents electron beam deflections while welding the joint.

### 3.3 Preparation:

Joint and surface preparation, prior to welding, shall be as follows and shall be included as part of the approved procedure certification:

3.3.1 Joint Preparation: Joints shall be prepared to conform to requirements specified on the part drawing.

3.3.2 Edge Preparation: Edges shall be machined square and parallel to ensure proper fit-up. Joints shall have no rounded-off edges, but shall be deburred after machining. Unless otherwise specified, faying surfaces of joints shall have a surface texture not greater than 125 microinches (3.2  $\mu\text{m}$ ), determined in accordance with ANSI B46.1. Witness lines, when specified, shall be applied in accordance with part drawing requirements (See ARP1333 for guidelines). Dry machining is recommended for edge preparation of reactive metals.

3.3.3 Weld Start and Run-Off Tabs: Tabs, when used, shall be of the same alloy as the detail parts being welded and shall be cleaned in the same manner as the parts. Tabs shall be integral with the part, either being machined in, or welded to, the part pieces prior to assembly.

3.3.4 Surface Preparation: Prior to welding surfaces of parts shall be prepared using a suitable cleaning agent and method consistent with the alloys being welded. If solvents are used on titanium alloys, they must be nonhalogenated (See 8.2). Welding shall commence within 40 hours after surface preparation, unless otherwise permitted or restricted by purchaser.

3.3.4.1 Parts, after surface preparation, shall be handled in the joint area with clean, lint-free gloves and shall be covered or otherwise protected to prevent contamination, except during set-up, welding, and inspection.

3.3.5 Accessory Equipment Preparation: Jigs, fixtures, and measuring devices shall be free of scale, grease, protective coatings, oxides, dust, oil, and other foreign material detrimental to the welding process.

3.3.5.1 Cleaned surfaces shall be handled only with clean, lint-free gloves.

3.3.6 Pre-Weld Fit-Up: Gaps for production welding shall not exceed gap distance used for procedure certification as in 3.4.2. For small diameter electron beams (high voltage guns), a suggested maximum allowable gap is 0.001 inch (0.03 mm). For larger diameter electron beams (low or medium voltage guns), the suggested maximum allowable gaps are 0.001 inch (0.03 mm) for material thicknesses up to 0.020 inch (0.51 mm) and 0.005 inch (0.13 mm) for thicker material.

### 3.4 Procedure:

- 3.4.1 Qualification of Welding Operators: Electron-beam welding shall be performed by certified operators, qualified in accordance with procedures approved by purchaser.
  - 3.4.1.1 Personnel performing welding in accordance with this specification shall be qualified under the cognizance and supervision of the designated welding activity and approved by the cognizant quality control activity. Qualified personnel shall be assigned a stamp with a number or symbol that shall be used to identify all weldments made by such personnel.
  - 3.4.1.2 An operator undergoing qualification testing may weld a certification plate in accordance with 3.4.2 according to a pre-established schedule as part of the test. If the operator successfully qualifies, the weld procedure shall be considered certified. All parameters used for welding the certification plate shall be recorded in the weld procedure, Table 1.
  - 3.4.1.3 Operators certified in accordance with AMS-STD-1595 (as applicable to electron beam welding) shall be considered qualified to weld in accordance with this specification.
- 3.4.2 Procedure Certification: Prior to production, a separate weld schedule shall be established for each joint and alloy or alloy combination to be welded. The schedule shall be prepared for each penetration weld joint configuration, and for each cosmetic pass configuration, if required, showing all applicable items listed in Table 1.
  - 3.4.2.1 For full penetration weld joints, a test plate conforming to Figure 1 shall be welded in accordance with the prepared weld procedure. Where the test plate of Figure 1 is not an appropriate representation of the parts to be welded, as in the case of forgings, castings, tubing, or other geometric considerations, the procedure shall be established on actual or simulated parts as agreed upon by purchaser and vendor.
  - 3.4.2.2 For any cosmetic pass configurations, a test plate conforming to Figure 2 shall be welded in accordance with the prepared weld procedure and submitted for metallurgical examination in accordance with 3.6.2.2. Cosmetic pass configurations shall be made as a bead-on-previously-deposited full-penetration weld. The cosmetic pass configuration test sample may also be taken from a simulated or actual part as specified by purchaser.
  - 3.4.2.3 Test Piece Preparation and Testing: The weld schedule certification test piece (either Figure 1, actual part, or simulated part) shall be of the same material and condition and shall be prepared and cleaned in the same manner as the production part. Welding shall be performed using the same welding position and joint configuration (thickness and angle) representative of that used on the production part. The welding operator's ID number shall be marked on each test piece welded for certification. Testing shall be accomplished in accordance with 3.6 and 3.7.
  - 3.4.2.4 Upon acceptance of the test piece(s) (either Figure 1, actual part, or simulated part) for either a full-penetration or (Figure 2) a cosmetic-pass weld, the cognizant quality control activity shall certify the weld procedure.