AEROSPACE MATERIAL SPECIFICATION

AMS2680™	REV. D

Issued 1981-04
Reaffirmed 2019-01
Revised 2025-04

Superseding AMS2680C

Electron-Beam Welding For Fatigue Critical Applications

RATIONALE

AMS2680D results from a Five-Year Review and update of this specification with changes to Ordering Information, Authority (see 1.2.2), Surface Preparation (see 3.3.4.2), Weld Schedule Certification (see 3.4.2.4), Finishing (see 3.5.1), Fatigue Testing (see 3.6.2), Maximum Defect Area (see 3.7.2.3.2), and Maximum Aligned Defect Area (see 3.7.2.3.3).

NOTICE

ORDERING INFORMATION: The following information shall be provided to the welding processor by the purchaser.

The purchase order shall specify not less than the following:

- AMS2680D
- Part number or assembly number of parts to be welded
- Quantity of parts to be welded
- Fatigue specimen shape and weld configuration, if required (see 3.6.2)

Parts manufacturing operations such as heat treating, forming, and media finishing can affect the condition of the substrate for welding or, if performed after welding, could adversely affect the welded part. The sequencing of these types of operations should be specified by the cognizant engineering organization or the purchaser and is not controlled by this specification.

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.

TO PLACE A DOCUMENT ORDER: **Tel: 877-606-7323 (inside USA and Canada)**
Tel: +1 724-776-4970 (outside USA)
Fax: 724-776-0790
Email: CustomerService@sae.org
SAE WEB ADDRESS: **http://www.sae.org**

For more information on this standard, visit
https://www.sae.org/standards/content/AMS2680D/

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

1.2.2 Authority

The cognizant engineering organization may impose requirements or approve allowances that supersede the requirements in this AMS.

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 cancelled and no superseding document has been specified, the last published issue of that document shall apply.

2.1 SAE Publications

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or +1 724-776-4970 (outside USA), www.sae.org.

AMS2630 Inspection, Ultrasonic, Product Over 0.5 Inch (12.7 mm) Thick

AMS2631 Ultrasonic Inspection, Titanium and Titanium Alloy Bar, Billet, and Plate

AMS2632 Inspection, Ultrasonic, of Thin Materials, 0.5 Inch (12.7 mm) and Under in Cross-Sectional Thickness

ARP1333 Nondestructive Testing of Electron Beam Welded Joints in Titanium-Base Alloys

AS7766 Terms Used in Aerospace Metals Specifications

2.2 ASTM Publications

Available from ASTM International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959, Tel: 610-832-9585, www.astm.org.

ASTM E8/E8M Tension Testing of Metallic Materials

ASTM E466 Conducting Force Controlled Constant Amplitude Axial Fatigue Tests of Metallic Materials

ASTM E606 Strain-Controlled Fatigue Testing

ASTM E1417 Liquid Penetrant Testing

ASTM E1444 Magnetic Particle Testing for Aerospace

ASTM E1742 Radiographic Examination

2.3 ANSI Accredited Publications

Copies of these documents are available online at https://webstore.ansi.org/.

ANSI B46.1 Surface Texture (Surface Roughness, Waviness, Lay)

2.4 AIA Publications

Available from Aerospace Industries Association, 1000 Wilson Boulevard, Suite 1700, Arlington, VA 22209-3928, Tel: 703-358-1000, www.aia-aerospace.org.

NAS 976 Electron Beam Welding Machine - High Vacuum

2.5 AWS Publications

Available from American Welding Society, 8669 NW 36 Street, #130, Miami, FL 33166-6672, Tel: 1-800-443-9353 or 305-443-9353, www.aws.org.

AWS A3.0 Standard Welding Terms and Definitions; Including Terms for Adhesive Bonding, Brazing, Soldering, Thermal Cutting, and Thermal Spraying

AWS D17.1 Fusion Welding for Aerospace Applications

2.6 Definitions

Terms used in AMS are defined in AS7766.

Welding defect definitions shall conform to standard definitions stated in AWS A3.0.

3. TECHNICAL REQUIREMENTS

3.1 Materials

3.1.1 Parent Materials

Parent materials shall be as specified.

3.1.2 Filler Materials

When required, filler metal shall be as specified.

3.1.3 Cleaning Materials

Cleaning materials, chemical solvents, or etching solutions shall be as specified or stated in the certified welding schedule.

3.2 Equipment

3.2.1 Electron-Beam Welding Equipment

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 backup as required, and allowing required workspace between the workpiece and the electron gun. Backup material used to deflect or absorb residual electron-beam energy shall be of the same alloy as the part being welded except that alternate backup materials may be used when approved by schedule certification 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 schedule certification (see 3.4.2) that 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 schedule certification:

3.3.1 Joint Preparation

Joints shall be prepared to conform to specified requirements.

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. Faying surfaces of joints shall have a surface texture not greater than 125 microinches (3.2 µm), determined in accordance with ANSI B46.1. Witness lines, when specified, shall be applied in accordance with specified requirements (refer to 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

3.3.4.1 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 3.3.4.2). Welding shall commence within 40 hours after surface preparation.

3.3.4.2 Immediately prior to assembly for welding, joint edges may be additionally prepared, depending on the alloy being welded, by either alkaline cleaning, acid pickling, solvent cleaning (nonhalogenated for titanium alloys), wire brushing with a stainless steel brush and solvent cleaning (nonhalogenated for titanium alloys), or, for aluminum alloys, scraping of joint faying surfaces.

3.3.4.3 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 setup, 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 schedule 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 the cognizant quality organization (CQO).

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 CQO. 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 preestablished schedule as part of the test. If the operator successfully qualifies, the weld schedule shall be considered certified. All parameters (see Table 1) used for welding the certification plate shall be recorded in the weld schedule.

3.4.1.3 Operators certified in accordance with AWS D17.1 (as applicable to electron-beam welding) shall be considered qualified to weld in accordance with this specification.

3.4.2 Weld Schedule 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 schedule. 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 schedule shall be established using actual or simulated parts as agreed upon by the CEO and processor.

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 schedule and submitted for metallurgical examination in accordance with 3.6.3.2. Cosmetic-pass configurations shall be made as a bead-on previously deposited full-penetration weld. The cosmetic-pass configuration test specimen may also be taken from a simulated or actual part as specified by the CEO.

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 (see Figure 2) a cosmetic-pass weld, the weld schedule shall be submitted to the CQO/CEO for approval as required in 4.4.

3.4.2.5 Tacking/Locking Passes

A tacking pass may be used to restrict relative motion in the weld assembly prior to the first full-penetration pass. Weld schedule certification of a tacking pass is not required provided all evidence of the tack welding is obliterated by the actual weld through fusion.

3.4.2.5.1 A tacking pass, other than a full-penetration pass, made with a power density setting substantially reduced from the certified settings may be used over any portion of the weld joint up to and including the full length of the weld.

3.4.2.5.2 A full-penetration tacking pass using certified parameters may be utilized but shall not exceed 10% of the weld joint length. This locking pass shall terminate in the starting or stopping tabs, when applicable.

3.4.2.6 Cosmetic Pass

Cosmetic passes for the purpose of correcting unacceptable underfill conditions may be applied at any time after completion of the initial full-penetration pass. Cosmetic passes, if used, shall be certified in accordance with 3.4.2.2.

3.4.3 Weld Schedule Recertification

Recertification of weld schedules shall be required for failed test welds and when any change is made to any of the following parameters:

3.4.3.1 When a change is made in base metal composition or a change is made in thickness in excess of ±10% (not applicable to cosmetic-pass-weld configuration).

3.4.3.2 When a change is made in joint design (not applicable to cosmetic-pass-weld configuration) but not necessarily after changes in length of diameter of joint.

3.4.3.3 When the welding position (relationship between the gun angle and the work angle) is changed in excess of 10 degrees.

3.4.3.4 When a change is made in any one of the machine settings (see item 12 and items 14 through 20 of Table 1) or in the energy input (see item 23 of Table 1).

3.4.3.4.1 The use of the beam-deflection switch (see item 19 of Table 1) need not be considered when used for the purpose of scanning or beam alignment.

3.4.3.5 When the weld machine, weld gun, or filament shape are different from that used to certify the welding schedule.

3.4.4 Production Welding

Production parts shall be welded in accordance with the parameters established in the weld schedule certification of 3.4.2.

3.4.4.1 Welding Environment

Electron-beam welding shall be performed in a vacuum at a partial pressure not higher than 1 x 10^{-4} mm of mercury. Venting of the chamber after welding shall not occur less than 2 minutes after completion of welding, unless otherwise established in the weld schedule certification.

3.4.5 Rework

A rework shall be a full or partial electron-beam penetration weld accomplished subsequent to the full-penetration weld. Rework of imperfections, such as cosmetic passes for correction of underfill or bead appearance improvement as well as full-penetration passes for correction of a missed joint, and other defects may be accomplished by electron-beam welding in accordance with a certified welding schedule. Restarting the electron beam after an arc-out shall not be classified as a rework, but the reason, location, and method shall be recorded. Only one reweld is permitted.

3.5 Post-Treatment

3.5.1 Finishing

Post-weld machining of face and/or root surfaces shall be as specified. Post-weld blending shall not decrease the parent material by more than 10% of the joint thickness for full-penetration welds or more than 5% of the maximum depth of penetration for partial-penetration welds.

3.5.2 Heat Treatment

Weldments requiring heat treatment shall be processed as specified.

3.6 Properties

Specimens taken from test plates, actual parts, or simulated parts produced for schedule certification as in 3.4.2.1 and 3.4.2.2 shall conform to the following requirements:

3.6.1 Tensile Strength

When required, specimens shall conform to and be tested in accordance with ASTM E8/E8M. The weld is acceptable when failure occurs at a stress equal to or greater than the minimum tensile strength specified. Specimens failing at the bond line of the weld or in the weld metal are acceptable only when examination of the fracture surface at 15X magnification reveals it to be free of defects.

3.6.2 Fatigue Testing

When specified, fatigue testing shall be conducted in accordance with ASTM E466 or ASTM E606. Specimen shape and weld configuration for fatigue testing shall be specified.

3.6.3 Metallurgical Examination for Soundness and Bead Shape

3.6.3.1 Macrosections of the weld shall conform to the requirements of 3.7. Sections shall be taken transverse to the weld direction and shall be examined at 3 to 10X magnification. When required, witness line acceptance criteria for scarf joints shall also be noted for full-penetration welds.

3.6.3.2 Microsections of cosmetic welds, examined at not less than 100X magnification, shall meet the acceptance criteria of 3.7. Sections shall be taken parallel to and transverse to the weld direction.

3.6.4 Special Properties

When special tests are required to establish nondestructive acceptance criteria as in 3.7.2, the tests and specimens shall be established as agreed upon by the CEO and processor and shall apply to both weld certification test pieces and parts.

3.7 Quality

Electron-beam welds shall conform to the following requirements (refer to AWS A3.0 for defect definitions):

3.7.1 Visual Inspection

All weldments, examined at 10X magnification or greater, shall meet the following:

3.7.1.1 Color

The weld bead and adjacent parent metal shall have a color similar to that of the unwelded parent material. In the case of titanium, this color shall have a bright silver or light straw-colored appearance; blue-gray or gray discoloration or the presence of loose scale is not acceptable. Discoloration due to vapor deposition is acceptable. Cosmetic passes shall not be used to change color.

3.7.1.2 Penetration

Joints shall have complete penetration unless a partial-penetration weld is specified. When specified, complete penetration may be achieved by post-weld machining.

3.7.1.3 Incomplete Fusion

Incomplete fusion of full-penetration joints, insufficient penetration of partial-penetration welds, and missed joints are not acceptable.

3.7.1.4 Cracks

Cracks are not acceptable in the weld, weld-heat-affected zone, or adjacent parent metal except where micro-fissuring is specifically permitted (see 3.7.2.1).

3.7.1.5 Voids and Pores

Voids and pores open to the surface are not acceptable unless they are subsequently to be removed by machining or blending.

3.7.1.6 Underfill and Concave Root Surface

The cumulative depths of underfill on face and root surfaces shall not exceed the post-weld machining allowances specified on the part drawing. The allowable underfill for each surface not machined after welding shall be 10% of the joint thickness or as specified.

3.7.1.7 Undercut and Root Notches

Where permissible, undercut and root notches shall not exceed specified tolerances. When not specifically noted, undercut or root notches shall not exceed 10% of material thickness total and shall be blended to have not less than 0.06-inch (1.5-mm) root radius.

3.7.1.8 Mismatch

For plate over 0.250 inch (6.35 mm) in nominal thickness, mismatch shall not exceed 10% of the joint thickness or 0.030 inch (0.76 mm), whichever is less. For sheet and plate over 0.150 inch (3.81 mm) and up to 0.250 inch (6.35 mm) in nominal thickness, mismatch shall not exceed 10% or 0.020 inch (0.51 mm), whichever is less. For sheet and plate up to 0.150 inch (3.81 mm) in nominal thickness, mismatch shall not exceed 10% or 0.010 inch (0.25 mm), whichever is less.

3.7.1.9 Overlaps

Overlaps are not acceptable.

3.7.1.10 Peaking

Distortion, usually in sheet metal in thin configurations, which causes the weld, measured from each weld toe or edge, to move out of the plane of the parent metal by more than 30% of the parent metal thickness, is unacceptable.

3.7.1.11 Witness Lines

When specified, witness lines shall be applied to the face and root sides of the weld joint (refer to ARP1333 for procedure).

3.7.1.11.1 Face Side

The joint interface (seam), as established by witness lines, shall fall within the central one-third of the weld bead. If the face side witness line examination indicates that the joint interface does not fall within the central one-third of the weld bead, the witness line data shall be evaluated for acceptance by the CEO/CQO to ensure compliance with 3.7.1.3.

3.7.1.11.2 Root Side

The joint interface (seam), as established by witness lines, shall fall at least one-half space within the weld bead width. In addition, the difference between unmelted witness line spaces on each side of the weld bead shall be one space or less. Weld bead locations that show a difference of more than one space (0.030-inch [0.76-mm] displacement) shall be evaluated for acceptance to ensure compliance with 3.7.1.3.

3.7.1.11.3 Witness line joint interface locations on the weld face shall be evaluated and accepted before any cosmetic passes are made.

3.7.1.11.4 For scarf joints, the requirements of 3.7.1.11.1 and 3.7.1.11.2 shall apply. Witness line acceptance criteria for all scarf joints shall be as specified.

3.7.1.12 Welder's Identification

Each individual weld shall be positively identifiable or traceable to the weld operator who made that weld, and the date welded, using the stamp or symbol provided in 3.4.1.1.

3.7.1.13 The method for applying the welder's identification and date shall be as specified. The method selected should ensure that the identification cannot be lost or obliterated during subsequent processing. When approved by the cognizant engineering organization (CEO), the source may maintain traceability of the welded parts to the individual who performed the welding and the date welded using systems other than part marking, such as routings, signed off and dated by the operator, which indicate the parts that the individual welded.

3.7.2 Radiographic Inspection

All welds shall be radiographically inspected in accordance with ASTM E1742 to determine conformance to the following acceptance standards. In addition, radiographic inspection shall be used as the referee technique for identifying, locating, and determining the size of indications disclosed by ultrasonic inspection as in 3.7.3.

3.7.2.1 Cracks

The presence of cracks as a result of welding in the weld metal, weld-heat-affected zone, or adjacent parent metal are not acceptable. Should micro-fissuring be acceptable in any specific alloy (e.g., precipitation-hardenable nickel alloys), acceptance criteria shall be specified.

3.7.2.2 Porosity, Voids, and Inclusions

Weld discontinuities, such as porosity, voids, and inclusions (metallic and nonmetallic), within the weld metal or immediately adjacent in the parent metal shall be restricted and sized as follows:

3.7.2.2.1 The size of internal porosity, cavities, voids, and inclusions shall be determined by its largest dimension.

3.7.2.2.2 Inclusions (metallic or nonmetallic) shall be treated the same as porosity.

3.7.2.2.3 Interconnected porosity, inclusions, and cavities (voids) shall be considered as one single pore for sizing purposes.

3.7.2.2.4 Pores and voids identified with the welding operation are acceptable provided they do not exceed the limits of 3.7.2.3.

3.7.2.3 Internal Discontinuity Limits

3.7.2.3.1 Maximum Pore Diameter

Two or more adjacent discontinuities, other than aligned (see 3.7.2.3.3), shall be treated as a single discontinuity (excluding the space between them) when the spacing between them is less than three times the greatest dimension of the smaller adjacent discontinuity. The allowable limits for various parent metal thicknesses are established in Table 2, Column B-2, for aluminum alloys and in Table 2, Column B-1, for all other materials covered by this specification.

3.7.2.3.2 Maximum Defect Area

The maximum defect area shall be the sum of the areas of the pores totally within a 1.0-inch (25-mm) length of weld not to exceed the limits of Table 2, Column C-2, for aluminum alloys and Table 2, Column C-1, for all other materials. The effective area of discontinuities is established in Table 3.

3.7.2.3.2.1 Pores under 0.010 inch (0.25 mm) shall not be considered in calculating total defect area for thicknesses 0.25 inch (6.4 mm) or over.

3.7.2.3.3 Maximum Aligned Defect Area

The maximum aligned defect area shall be any group of five or more individual pores within a 1.0-inch (25-mm) length of weld whose images can be intersected by a straight line (regardless of orientation within the weld) and the distance between adjacent discontinuities within the group being considered is less than four times the longest dimension of the smaller adjacent discontinuity. The limits of aligned defects are established in Table 2, Column C-4, for aluminum alloys and in Table 2, Column C-3, for all other materials (see 3.1.1). The effective area of discontinuities is established in Table 3.

3.7.3 Ultrasonic Inspection

When specified, all welds, including weld schedule certification tests, shall be ultrasonically inspected in accordance with AMS2630, AMS2632, or AMS2631 for titanium and titanium alloys. Acceptance criteria shall be as specified in 3.7.2.1 and 3.7.2.2.

3.7.3.1 Discontinuities or isolated ultrasonic responses compliant with 3.7.2.1 and 3.7.2.2, which by a reanalysis of witness line data and reinspection are shown not to be missed joints, shall be acceptable. Discontinuities that cannot be confirmed by radiographic inspection as in 3.7.2 in the area of the ultrasonic indication shall be referred to the CEO for disposition.

3.7.4 Fluorescent Penetrant Inspection

All welds, including weld schedule certification tests, of nonmagnetic materials shall be fluorescent penetrant inspected in accordance with ASTM E1417 to locate imperfections open to the surface. No defects are permissible except as permitted by 3.7.1.5.

3.7.5 Magnetic Particle Inspection

All welds, including weld schedule certification tests, of magnetic materials shall be magnetic particle inspected in accordance with ASTM E1444. No defects are permissible.

4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for Inspection

The welding processor shall be responsible for the performance of all required tests. The purchaser reserves the right to sample and to perform any confirmatory testing deemed necessary to ensure that welded assemblies conform to the requirements of this specification.

4.2 Classification of Tests

4.2.1 Acceptance Tests

Quality (see 3.7) is an acceptance test and shall be performed on each weld.

4.2.2 Preproduction Tests

Weld schedule certification (see 3.4.2) and properties (see 3.6 and 3.7) are preproduction tests and shall be performed on the first-article shipment of a welded part to a purchaser, when a change in processing requires reapproval of the welded part as in 4.4.2, and when the CEO deems confirmatory testing to be required.

4.3 Sampling and Testing

Sampling and testing shall be as follows; a lot shall be all parts or assemblies of the same alloy(s) of one configuration processed at one time in sequence and presented for the processor's inspection at one time:

4.3.1 For Acceptance Tests

For acceptance tests, all production weldments shall be tested.

4.3.2 For Preproduction Tests

For preproduction tests, not less than three welds for procedure certification (see 3.4.2) representative of each joint in the part or assembly using production facilities or facilities representative of those to be used in production shall be tested. When preproduction test welds are made on actual or simulated hardware, the number and location of test specimens shall be specified by the CEO.

4.4 Approval

4.4.1 The CQO shall approve the processor's facilities, inspection methods, and process controls before production parts are supplied, and these shall be available for the purchaser's inspection during the period of production part manufacture.

4.4.2 When specified, sample parts and the weld schedule shall be approved by the CEO before welded parts for production use are supplied. If necessary to make any change in procedures or methods of inspection, the welding processor shall submit for reapproval details of proposed changes and, when requested, sample welded parts.

4.5 Reports

The processor of welded parts shall furnish with each shipment a report showing the results of tests on each lot to determine conformance to the acceptance test requirements and stating that the parts have been processed in accordance with the certified welding schedule by certified welding operators. This report shall include the purchase order number, AMS2680D, part or assembly number, and quantity.

5. PREPARATION FOR DELIVERY

5.1 Identification

Welded parts shall be identified as specified or as agreed upon by the CEO and processor.

5.2 Protective Treatment

When required, welded parts shall be given a suitable protective treatment as specified.

5.3 Packaging

5.3.1 Welded parts shall be handled and packaged to ensure that the required physical characteristics of the parts are preserved.

5.3.2 Packages of parts shall be prepared for shipment in accordance with commercial practice and in compliance with applicable rules and regulations pertaining to the handling, packaging, and transportation of the parts to ensure carrier acceptance and safe delivery.

6. ACKNOWLEDGMENT

A processor shall mention this specification number and its revision letter in all quotations and when acknowledging purchase orders.

7. REJECTIONS

Parts not welded in accordance with this specification, or with modifications authorized by the CEO, will be subject to rejection.

8. NOTES

8.1 Revision Indicator

A change bar (I) located in the left margin is for the convenience of the user in locating areas where technical revisions, not editorial changes, have been made to the previous issue of this document. An (R) symbol to the left of the document title indicates a complete revision of the document, including technical revisions. Change bars and (R) are not used in original publications, nor in documents that contain editorial changes only.

8.2 Dimensions and properties in inch/pound units and the Fahrenheit temperatures are primary; dimensions and properties in SI units and the Celsius temperatures are shown as the approximate equivalents of the primary units and are presented only for information.

8.3 Purchase documents should specify not less than the following:

AMS2680D
Part or assembly number of parts to be welded
Quantity of parts to be welded

Table 1 - Minimum parameters to be recorded in welding schedule

1.	Applicable Electron-Beam Certification Number
2.	Parent Metal
3.	Parent Metal Thickness
4.	Pre-Weld Cleaning Procedure, Applicable Cleaning Specification, or Both
5.	Surface Preparation at Weld Joint
6.	Filler Metal Type, Specification, or Both
7.	Automatically Fed Filler Metal Diameter
8.	Filler Wire Feed Speed (±10%)
9.	Operator and ID Stamp
10.	Welding Speed, inches/minute (mm/s) (±5%)
11.	Sketch of Setup, Including All Angles (±0.5 degree)
12.	Distance of Gun to Work (±1/8 inch [±3.2 mm])
13.	Beam Current (±5%)
14.	High Voltage (±5%)
15.	Focusing Current (±5%)
16.	Vacuum Level
17.	Welding Schedule
18.	Tacking/Locking Passes
19.	Beam Deflection __ On/Off __ Type or Shape __; Amplitude __ Frequency
20.	Cathode to Anode Spacer
21.	Witnessing Inspector’s Name and Stamp
22.	Quality Control Certification
23.	Maximum Residual Magnetism, gauss
24.	Weld Machine Identification
25.	Weld Gun Identification
26.	Filament Type

Table 2A - Internal discontinuity limits, inch/pound units

Final Weld Thickness Inch	Maximum Pore Diameter (3.7.2.3.1) Inch	Maximum Pore Diameter (3.7.2.3.1) Inch	Plan Area of Image Square Inches x 10000 (3.7.2.3.2) Total Discontinuities	Plan Area of Image Square Inches x 10000 (3.7.2.3.2) Total Discontinuities	Plan Area of Image Square Inches x 10000 (3.7.2.3.3) Total Discontinuities	Plan Area of Image Square Inches x 10000 (3.7.2.3.3) Total Discontinuities
Column A	B-1	B-2	C-1	C-2	C-3	C-4
0.010	0.0010	0.0025	3	7	1	3
0.025	0.0025	0.0063	8	16	3	6
0.050	0.0050	0.0125	15	32	5	13
0.075	0.0075	0.0188	18	47	8	18
0.100	0.010	0.025	25	63	10	25
0.125	0.013	0.031	31	78	13	31
0.150	0.015	0.038	37	94	15	38
0.175	0.018	0.044	43	109	18	44
0.200	0.020	0.050	50	125	20	50
0.225	0.023	0.056	56	125	23	56
0.250	0.025	0.063	62	125	25	63
0.500	0.050	0.063	125	125	50	63
0.750 & over	0.050	0.063	125	125	63	63

1. Interpolate between final weld thicknesses where necessary.
2. The effective image areas for various discontinuities are shown in Table 3A.
3. Example for use of Table 2A:
   a) For final weld thickness of 0.500 inch in titanium.
   b) Radiograph indicates that the greatest concentration and magnitude of internal discontinuities in any 1 linear inch of weld includes:
      1 discontinuity 0.041 to 0.050 inch diameter
      4 discontinuities 0.031 to 0.040 inch diameter
      5 discontinuities 0.010 to 0.020 inch diameter
   c) Calculate the sum of the areas of the discontinuities using the factors in Table 3A.
      1 x 20 = 20
      4 x 10 = 40
      5 x 2 = 10
      Sum = 70
   d) From Table 2, column C-1, the acceptable area of total discontinuities in titanium is 125; because the calculated area was 70, the weld is acceptable from the standpoint of total discontinuities.
   e) If, however, the discontinuities were so aligned that they could be intersected by a straight line (see 3.7.2.3.3), the allowable limit for the titanium example weld (column C-3) is 50 while the calculated area was 70 and the weld would not be acceptable.