

NOTICE OF
ADOPTION

ADOPTION NOTICE
20 December 1991
AMS 7496H
1 January 1991
SUPERSEDING
AMS 7496G
31 August 1978

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Title of Document: Rings, Flash Welded
Carbon and Low-Alloy Steels

Date of Specific Issue Adopted: 1 January 1991

Releasing Non-Government Standards Body: SAE

Custodians:

Air Force - 11
Army - MR
Navy - AS

Military Coordinating Activity
Air Force - 11

(Project No: 5365-0189)

FSC 5365

DISTRIBUTION STATEMENT A: Approved for public release; distribution is unlimited.

Submitted for recognition as an American National Standard

Issued 1951-06-01
Revised 1991-01-01
Superseding AMS-7496G

**RINGS, FLASH WELDED
Carbon and Low-Alloy Steels**

1. **SCOPE:**

1.1 **Form** This specification covers flash welded rings fabricated from carbon and low-alloy steels.

1.2 **Application:** Primarily for parts such as flanges and rings.

2. **APPLICABLE DOCUMENTS:** The following publications form a part of this specification to the extent specified herein. The latest issue of SAE publications shall apply. The applicable issue of other publications shall be the issue in effect on the date of the purchase order.

2.1 **SAE Publications:** Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001.

2.1.1 **Aerospace Material Specifications:**

- AMS-2370 - Quality Assurance Sampling of Carbon and Low-Alloy Steels, Wrought Products Except Forgings and Forging Stock
AMS-6302 - Steel Bars, Forgings, and Tubing, Low-Alloy, Heat Resistant, 0.65Si - 1.25Cr - 0.50Mn - 0.25V (0.28 - 0.33C)
AMS-6303 - Steel Bars and Forgings, Low-Alloy, Heat Resistant, 0.65Si - 1.25Cr - 0.50Mn - 0.85V (0.25 - 0.30C)
AMS-6412 - Steel Bars and Forgings, 0.80Cr - 1.8Ni - 0.25Mn (0.35 - 0.40C) (4337)

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2.2 **ASTM Publications:** Available from ASTM 1916 Race Street, Philadelphia, PA 19103-1187.

ASTM E 8 - Tension Testing of Metallic Materials
ASTM E 8M - Tension Testing of Metallic Materials (Metric)
ASTM E 10 - Brinell Hardness of Metallic Materials

2.3 **U.S. Government Publications:** Available from Standardization Documents Order Desk, Building 4D, 700 Robbins Avenue, Philadelphia, PA 19111-5094.

2.3.1 **Military Standards:**

ML-STD-794 - Parts and Equipment, Procedures for Packaging and Packing of

3. **TECHNICAL REQUIREMENTS:**

3.1 **Material:** Shall be as specified on the drawing.

3.2 **Fabrication:**

3.2.1 **Forming:** Rings shall be formed from suitably rolled, extruded, or forged shapes. Grain flow in the formed rings shall be substantially circumferential.

3.2.2 **Preparation for Welding:**

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3.2.2.1 Formed rings shall be clean and free from foreign materials in the area of electrode contact and at the surfaces to be welded.

3.2.2.2 Formed rings may be preheated, before welding, as agreed upon by purchaser and supplier.

3.2.3 **Welding:** The ends of the formed rings shall be flash butt-welded together; there shall be only one weld per ring. Welding shall be performed on a machine provided with accurate control of feed of joint during flashing, rate and distance of travel of sections to be welded, secondary voltage and current magnitude, and timing and current cut-off. The flash shall be maintained during the flashing interval of the welding operation. The amount of manual flashing, for purposes of preheating, shall be limited to 10% of total flashing distance. The machine shall be capable of repeating the sequence of operations independently of the skill of the operator. A record of all machine settings and sequence of operations for welding each different ring shall be kept by the vendor and be made available to purchaser.

3.2.4 **Heat Treatment:** The welded rings shall be normalized by heating to the appropriate temperature, holding at heat for not less than 1 hour, and cooling in air or other method acceptable to purchaser and tempered as necessary to produce the specified hardness. Steels, such as AMS-6302, AMS-6303, and AMS-6412, may be cycle annealed to produce the specified hardness. For rings under 0.188 inch (4.78 mm) in nominal thickness, time at normalizing heat may be reduced to 15 - 30 minutes.

3.2.4.1 For rings under 0.188 inch (4.78 mm) in nominal thickness, austenitizing and cooling are not normally required but, when required by purchaser, may be performed locally.

3.2.4.2 Other Heat Treatment: When the drawing or applicable material specification requires additional heat treatment after the heat treatment of 3.2.4, rings shall be so heat treated.

3.2.5 Proof Testing of Welds (Sizing): Each ring, after cooling to room temperature following heat treatment, shall be tested to determine the quality of the weld. Each ring shall have flash and excess metal at the weld removed to within +1/32 inch (+0.8 mm) of parent metal surface either before or after heat treatment as in 3.2.4 but before sizing. Preliminary sizing may be done before cooling but final sizing shall be done at room temperature. The stress applied for final sizing shall be sufficient to provide a permanent expansion of not less than 1% across a 2-inch (50-mm) gage length centered on the weld. Sizing shall be performed in such a way as to provide uniform stress distribution throughout the ring.

3.2.5.1 For rings made from steel under 0.188 inch (4.78 mm) in nominal thickness, flash removal may reduce thickness below that of parent metal provided that the finished weld blends smoothly into adjacent metal and provided that thickness is not reduced below the minimum specified on the drawing for the parent metal; proof testing of such rings will be waived if welding precedes a final forming operation which involves an expansion of the weld equivalent to or exceeding that required by 3.2.5.

3.2.5.2 When permitted by purchaser, statistical data developed for each part/process combination may be used to substantiate proof testing in lieu of actual measurements taken on the weld.

3.2.6 When the drawing or applicable material specification requires additional heat treatment, rings shall be so heat treated after sizing.

3.2.7 Restoration to Shape: If it is necessary to restore shape of rings following sizing or following final heat treatment when specified, such operation shall be done on suitable presses and not by localizing blows as from a hammer. Except as specified in 3.2.7.1, rings may be reheated for such operation but shall not be heated to a temperature higher than any prior tempering temperature.

3.2.7.1 When permitted by purchaser, restoration to shape may be performed in conjunction with cooling from a heat treatment operation by placing the ring on a press which will produce slight (approximately 1/4%) expansion or compression of the ring diameter and flattening of the ring.

3.3 Properties: Rings shall conform to the following requirements:

3.3.1 Tensile Properties: Shall be as follows, determined in accordance with
 0 ASTM E 8 or ASTM E 8M on specimens cut, after final heat treatment of the lot, from welded rings processed to this specification. When permitted by purchaser, rings to be supplied with additional heat treatment after the heat treatment of 3.2.4 may be tested in the normalized and tempered or the cycle annealed condition by the vendor, but the final basis for acceptance shall be tests made on fully heat treated rings. Tensile testing will not be required on rings made from steel under 0.188 inch (4.78 mm) in nominal thickness for which proof testing is waived in 3.2.5.1.

3.3.1.1 Rings Having Specified Maximum Hardness Up to 241 HB, Incl, or Equivalent:

Tensile Strength, minimum	90% of parent metal in same ring
Elongation in 4D, minimum	60% of parent metal in same ring but not less than 15%

3.3.1.2 Rings Having Specified Maximum Hardness Higher than 241 HB or Equivalent:

Tensile Strength, minimum	90% of parent metal in same ring
Elongation in 4D, minimum	50% of parent metal in same ring

3.3.1.3 When permitted by purchaser, rings not conforming to 3.3.1 will be considered acceptable if the tensile properties through the welded area, determined after final heat treatment, are not lower than the minimum requirements of the material specification or part drawing.

3.3.1.4
 0 When permitted on the part drawing, representative weld test segments may be used in lieu of rings. The weld test segments shall be welded utilizing the same size, shape, type of stock, and welder set-up at the same time as production and with the same current shunt, and shall be heat treated with the production lot.

3.3.2 Hardness: Shall be not higher than 241 HB, or equivalent, determined in accordance with ASTM E 10.

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3.3.3 Microstructure: When required, shall conform to standards agreed upon by
 0 purchaser and vendor.

3.4 Quality:

3.4.1 Rings, as received by purchaser, shall be uniform in quality and condition, sound, and free from foreign materials and from imperfections detrimental to usage of the rings.

3.4.1.1 Any controlled grain size requirement shall be as agreed upon by purchaser and vendor.

3.4.2
 0 Parts shall be subjected to nondestructive testing. Method of test and standards for acceptance shall be as agreed upon by purchaser and vendor.

4. QUALITY ASSURANCE PROVISIONS:

4.1 Responsibility for Inspection: The vendor of rings shall supply all samples
0 for vendor's tests and shall be responsible for performing all required tests. Purchaser reserves the right to sample and to perform any confirmatory testing deemed necessary to ensure that the rings conform to the requirements of this specification.

4.2 Classification of Tests: Tests for all technical requirements are
0 acceptance tests and preproduction tests, and shall be performed prior to or on the initial shipment of a ring to a purchaser, on each lot, when a change in material and/or processing requires reapproval as in 4.4.3, and when purchaser deems confirmatory testing to be required.

4.2.1 For direct U.S. Military procurement, substantiating test data shall be
0 submitted to the cognizant agency as directed by the procuring activity, contracting officer, or request for procurement.

4.3 Sampling and Testing: Shall be in accordance with AMS-2370.
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4.4 Approval:

4.4.1 Sample parts shall be approved by purchaser as in 4.4.2, unless such
approval be waived by purchaser.

4.4.2 When a new vendor is being considered, new welding equipment is being
placed in operation, settings on an old machine are changed, or changes in joint size or shape are made, the welding procedure shall be approved in the following manner: One or more rings from the first shipment of each size ring shall be selected at random. The ring or rings shall be subjected to tensile tests, hardness determinations, and examination of structure. If the requirements of 3.3.1 and 3.3.2 are met and the structure of the weld is satisfactory, the equipment and procedure will be considered satisfactory for making the weld.

4.4.3 Vendor shall use the same size, type, and shape of stock (within specified
0 tolerances), type of forming equipment, heating cycles for forming and preheating welding schedule (except that current settings may be changed by $\pm 10\%$), heating and cooling procedures and atmospheres for heat treatment, cleaning operations, and methods of inspection for production rings as for approved sample rings. If necessary to make any change in any of these factors, vendor shall submit for reapproval a statement of the proposed changes in processing and, when requested, sample rings produced by the revised procedure. Production rings incorporating the revised operations shall not be shipped prior to receipt of reapproval.

4.4.4 Reapproval may be waived by purchaser or parts may be reapproved by
0 following the approval procedure of 4.4.2.