

Rings, Flash Welded
Carbon and Low-Alloy Steels

RATIONALE

This document has been reaffirmed to comply with the SAE 5-year Review policy.

1. SCOPE:

1.1 Form:

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

1.2 Application:

This product has been used typically for parts such as flanges and rings, but usage is not limited to such 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.

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2.1 SAE Publications:

Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001 or www.sae.org.

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

2.2 ASTM Publications:

Available from ASTM, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959 or www.astm.org.

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| 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 |

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:

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 to 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 (50.8 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 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 accordance with 3.2.5.1.

3.3.1.1 Rings Having Specified Maximum Hardness Up to 241 HB, Incl, or Equivalent: Shall be as shown in Table 1.

TABLE 1 – Minimum Tensile Properties

| Property | Value |
|------------------|--|
| Tensile Strength | 90% of parent metal in same ring |
| Elongation in 4D | 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: Shall be as shown in Table 2.

TABLE 2 – Minimum Tensile Properties

| Property | Value |
|------------------|----------------------------------|
| Tensile Strength | 90% of parent metal in same ring |
| Elongation in 4D | 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 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 (See 8.2), determined in accordance with ASTM E 10.

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

3.4 Quality:

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

3.4.2 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 for vendor's tests and shall be responsible for the performance of all required tests. Purchaser reserves the right to sample and to perform any confirmatory testing deemed necessary to ensure that the rings conform to specified requirements.

4.2 Classification of Tests:

All technical requirements are 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.

4.3 Sampling and Testing:

Shall be in accordance with AMS 2370.

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.