



AEROSPACE MATERIAL SPECIFICATION

Society of Automotive Engineers, Inc.
TWO PENNSYLVANIA PLAZA, NEW YORK, N.Y. 10001

AMS 2667B
Superseding AMS 2667A

Issued 7-1-56
Revised 11-15-72

SILVER BRAZING

For Flexible Metal Hose, 600 F (316 C) Max Operating Temperature

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1. SCOPE:

1.1 Purpose: This specification covers the engineering requirements for production of brazed joints between flexible metal hose, and similar parts such as bellows, and rigid end fittings and the properties of such joints. Parts are usually made of austenitic corrosion and heat resistant steels but may be carbon or low-alloy steels.

1.2 Application: Primarily where joints having high strength up to 600 F (316 C) are required.

2. APPLICABLE DOCUMENTS: The following publications form a part of this specification to the extent specified herein. The latest issue of Aerospace Material Specifications (AMS) shall apply. The applicable issue of other documents shall be as specified in AMS 2350.

2.1 SAE Publications: Available from Society of Automotive Engineers, Inc., Two Pennsylvania Plaza, New York, New York 10001.

2.1.1 Aerospace Material Specifications:

AMS 2350 - Standards and Test Methods
AMS 3410 - Flux, Silver Brazing
AMS 3411 - Flux, Silver Brazing, High Temperature
AMS 4768 - Brazing Filler Metal, Silver, 35Ag - 26Cu - 21Zn - 18Cd

2.2 ASTM Publications: Available from American Society for Testing and Materials, 1916 Race Street, Philadelphia, Pennsylvania 19103.

ASTM D1179 - Fluoride Ion in Industrial Water and Industrial Waste Water

3. TECHNICAL REQUIREMENTS:

3.1 Materials:

3.1.1 Flux: Shall conform to AMS 3410 or AMS 3411.
3.1.2 Filler Metal: Shall conform to AMS 4768.

3.2 Preparation:

3.2.1 Surface Condition: The surfaces to be joined shall be clean prior to assembly. Surfaces shall not be highly polished.

3.3 Procedure:

3.3.1 Fluxing: Flux as specified in 3.1.1 shall be applied so that the surfaces to be joined are completely coated.

3.3.2 **Assembly:** The parts shall be assembled so that the clearances between mating surfaces will produce optimum coverage by filler metal without appreciable running on surfaces outside the boundaries of the joint area. Sufficient filler metal shall be placed within, or in close proximity to, the joint. The assembly should be supported so that the parts will be in proper alignment after brazing.

3.3.3 **Joining:** Shall be accomplished by electrical induction, molten, filler metal, or torch heating, unless a specific method of heating is specified. Parts shall be heated until the filler metal melts and the joint is formed. Further heating shall be held to a minimum. Overheating shall be avoided.

3.3.4 **Cooling:** After brazing but prior to handling, assemblies shall be cooled for sufficient time to allow the filler metal to solidify and in such a manner as to prevent cracks and minimize internal stress, distortion, and scaling.

3.3.5 **Flux Removal:** After brazing and cooling, flux shall be removed by a method not injurious to the specified surface finish. The tests of 3.4.3 shall be used to determine that flux has been adequately removed.

3.4 Properties:

3.4.1 **Coverage:** Visual examination of joints shall show an adequate fillet of filler metal at the end of the joint at which the filler metal was introduced.

3.4.2 **Pressure Test:** When a pressure test is specified on the drawing or is agreed upon by purchaser and vendor, any assembly from a lot shall pass that test. Voids in the brazed joint will not be cause for rejection if the pressure test requirement is met.

3.4.3 **Halide Tests:** The following tests shall be conducted on hose, bellows, and tube assemblies, and on other assemblies when specified, to assure that residual flux has been removed. If the flux is known not to contain chlorides, the test for chlorides need not be made and if the flux is known not to contain fluorides, the test for fluorides need not be made. If the washings indicate the presence of either chlorides or fluorides, assemblies shall be subjected to additional cleaning and testing operations until removal is complete.

3.4.3.1 **Chlorides:** Rinse the test area with 40 - 50 cm³ of hot (approximately 180 F (82 C)) deionized or distilled water. Collect rinse water in a 100 cm³ beaker and add 3 - 5 drops of concentrated nitric acid (sp gr 1.42) and 2 - 3 cm³ of 10% silver nitrate solution. Stir the contents of the beaker and allow to stand 5 - 10 minutes. A solution as clear as a blank of deionized or distilled water treated in the same manner as the rinsings indicates the absence of chlorides. A white-to-gray precipitate or turbidity indicates the presence of residual flux.

3.4.3.2 **Fluorides:** Rinse the test area with approximately 200 cm³ of hot (approximately 180 F (82 C)) deionized or distilled water. Collect the rinse water in a 250 cm³ beaker. Using two 100 cm³ Nessler or equivalent color comparison tubes, pour 100 cm³ of the rinsings into one tube and 100 cm³ of deionized or distilled water into the other as a blank. Treat the water in the two tubes in accordance with ASTM D1179, or use an equivalent (See 8.2) colorimetric method, and allow the color to develop. A color in the washings deeper than that of the blank indicates the presence of residual flux.

3.5 Quality:

3.5.1 Brazed joints shall be sound, clean, and free from foreign materials and from imperfections detrimental to performance of assemblies.

3.5.2 Surfaces of assemblies shall be free from pitting, burning, and excessive filler metal.

4. QUALITY ASSURANCE PROVISIONS:

4.1 **Responsibility for Inspection:** The vendor of brazed assemblies shall supply all samples and shall be responsible for performing all required tests. Purchaser reserves the right to perform such confirmatory testing as he deems necessary to assure that processing conforms to the requirements of this specification.

4.2 **Classification of Tests:** Tests to determine conformance to all technical requirements of this specification are classified as acceptance or routine control tests.

4.3 **Sampling:** Shall be not less than the following; a lot shall be all assemblies of the same part number brazed in a continuous operation and presented for inspection at one time:

4.3.1 **Coverage:** Three assemblies per lot.

4.3.2 **Pressure Test:** One assembly per lot.

4.3.3 **Halide Test:** As required to assure that all assemblies are free of residual flux but not less than once each working shift.

4.4 Approval:

4.4.1 To assure that a vendor has the capability to deliver consistently a satisfactory level of quality, sample assemblies brazed to this specification and the vendor's facilities and procedures shall be approved by purchaser before assemblies for production use are supplied, unless such approval be waived.

4.4.2 Silver brazing by torch method shall be performed only by operators who have been qualified, by a procedure acceptable to the purchaser, to braze the metals specified for each assembly.

4.4.3 Vendor shall use brazing process, filler metal placement, type of equipment, environment, brazing cycle, and methods of inspection for production assemblies which are essentially the same as those used on the approved sample assemblies. If any changes are necessary in type of equipment, processes, procedures, or methods of inspection, vendor shall submit for reapproval a detailed statement of the revised operations and, when requested, sample assemblies. No production assemblies fabricated by the revised procedure shall be shipped prior to receipt of reapproval.

4.5 **Resampling and Retesting:** If any specimen used in the above tests fails to meet the specified requirements, disposition of the assemblies may be based on the results of testing three additional specimens for each original nonconforming specimen. Failure of any retest specimen to meet the specified requirements shall be cause for rejection of the assemblies represented and no additional testing shall be permitted.

5. **PREPARATION FOR DELIVERY:** Not applicable.

6. **ACKNOWLEDGMENT:** A vendor shall mention this specification number and its revision letter in all quotations and when acknowledging purchase orders.

7. **REJECTIONS:** Assemblies not brazed in accordance with this specification or with authorized modifications will be subject to rejection.

8. NOTES:

8.1 **Precaution:** The method of heating for brazing should be selected with care to avoid damaging previously applied supplementary coatings; e.g., hose assemblies having silver plated coupling nuts should not be brazed by immersion in molten filler metal.