

**AEROSPACE
MATERIAL
SPECIFICATION**

AMS 2665D
Superseding AMS 2665C

Issued 12-1-47
Revised 10-1-83

SILVER BRAZING
For Use Up to 400°F (205°C)

1. SCOPE:

1.1 Purpose: This specification covers the engineering requirements for producing brazed joints in parts made of steels, iron alloys, nickel alloys, cobalt alloys, and copper alloys by use of silver alloys and the properties of such joints.

1.2 Application: Primarily for joints requiring high strength up to 400°F (205°C).

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 SAE, 400 Commonwealth Drive, Warrendale, PA 15096.

2.1.1 Aerospace Material Specifications:

AMS 2350 - Standards and Test Methods

AMS 2403 - Nickel Plating, General Purpose

AMS 2424 - Nickel Plating, Low-Stressed Deposit

AMS 3410 - Flux, Silver Brazing

AMS 4770 - Brazing Filler Metal, Silver, 50Ag - 18Cd - 16.5Zn - 15.5Cu, 1160° - 1175°F (625° - 635°C) Solidus-Liquidus Range

AMS 4771 - Brazing Filler Metal, Silver, 50Ag - 16Cd - 15.5Zn - 15.5Cu - 3.0Ni, 1170° - 1270°F (630° - 690°C) Solidus-Liquidus Range

AMS 4774 - Brazing Filler Metal, Silver, 63Ag - 28.5Cu - 6.0Sn - 2.5Ni, 1275° - 1475°F (690° - 800°C) Solidus-Liquidus Range

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

ASTM D1179 - Fluoride Ion in Water

SAE Technical Board rules provide that: "All technical reports, including standards approved and practices recommended, are advisory only. Their use by anyone engaged in industry or trade or their use by governmental agencies is entirely voluntary. There is no agreement to adhere to any SAE standard or recommended practice, and no commitment to conform to or be guided by any technical report. In formulating and approving technical reports, the Board and its Committees will not investigate or consider patents which may apply to the subject matter. Prospective users of the report are responsible for protecting themselves against liability for infringement of patents."

AMS 2665D

2.3 U.S. Government Publications: Available from Commanding Officer, Naval Publications and Forms Center, 5801 Tabor Avenue, Philadelphia, PA 19120.

2.3.1 Military Standards:

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

3. TECHNICAL REQUIREMENTS:

3.1 Materials:

3.1.1 Flux: Shall conform to AMS 3410 or equivalent, as approved by purchaser.

3.1.2 Filler Metal: Shall conform to AMS 4770 except that AMS 4771 or AMS 4774 may be used when permitted by purchaser.

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.

3.2.2 Nickel Plating: Joint surfaces may be nickel plated in accordance with AMS 2403 or AMS 2424; thickness of plating shall be 0.0001 - 0.0003 in. (2.5 - 7.5 μ m) unless otherwise specified.

3.3 Procedure:

3.3.1 Fluxing: Flux 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 are within tolerances specified on the drawing. 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 furnace, electrical induction, electrical resistance, molten salt, molten filler metal, torch, or burner heating (See 8.2), unless a specific method of heating is specified. Furnace brazing shall be performed in a suitable protective atmosphere. Parts shall be heated until the filler metal melts and the joint is formed. Further heating shall be held to a minimum. For furnace heating, the furnace temperature during brazing shall be not higher than 1350°F (730°C). For immersion heating, the temperature of the immersion medium shall not exceed 1250°F (675°C). Furnace brazing and immersion brazing may be used only when hardness of the detail parts will not be reduced below drawing limits.

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: Brazed parts shall conform to the following requirements:

3.4.1 Coverage:

3.4.1.1 Visual examination of joints shall show a complete line or ring of filler metal between component parts at the end of the joint at which the filler metal was introduced and, when practical, shall show at least a metallic stain of filler metal at the opposite end of the joint, to indicate complete penetration of the filler metal in the joint.

3.4.1.2 Unless otherwise specified, the area joined by filler metal shall be not less than 80% of the area of the mating portions of the assembly, determined by a method agreed upon by purchaser and vendor.

3.4.2 Proof Test: When a proof test is specified on the drawing, any assembly from a lot shall pass that test.

3.4.3 Halide Tests: The following tests shall be conducted on tube, manifold, probe, bellows, thermocouple, and hose assemblies, and on other assemblies when specified to ensure 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. Other test methods may be used when approved by purchaser.

3.4.3.1 Chlorides: Rinse the test area with 40 - 50 mL of hot (approximately 180°F (80°C)) deionized or distilled water. Collect rinse water in a 100 mL beaker and add 3 - 5 drops of concentrated nitric acid (sp gr 1.42) and 2 - 3 mL 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 mL of hot (approximately 180°F (80°C)) deionized or distilled water. Collect the rinse water in a 250 mL beaker. Using two 100 mL Nessler or equivalent color comparison tubes, pour 100 mL of the rinsings into one tube and 100 mL deionized or distilled water into the other as a blank. Treat the water in the two tubes in accordance with ASTM D1179, Method B, or use an equivalent colorimetric method. 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 the brazed joints.

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 for vendor's tests and shall be responsible for performing all required tests. Results of such tests shall be reported to the purchaser as required by 4.5. Purchaser reserves the right to sample and to perform any confirmatory testing deemed necessary to ensure that processing conforms to the requirements of this specification.

4.2 Classification of Tests:

4.2.1 Acceptance Tests: Tests to determine conformance to all technical requirements of this specification are classified as acceptance tests and shall be performed on each lot.

4.2.2 Preproduction Tests: Tests to determine conformance to all technical requirements of this specification are classified as preproduction tests and shall be performed prior to or on the initial shipment of brazed parts to a purchaser, when a change in material or processing, or both, requires reapproval as in 4.4.3, and when purchaser deems confirmatory testing to be required.

4.2.2.1 For direct U.S. Military procurement, substantiating test data and, when requested, preproduction test material shall be submitted to the cognizant agency as directed by the procuring activity, the contracting officer, or the request for procurement.

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 vendor's inspection at one time:

4.3.1 Coverage: Three assemblies per lot.