SAE The Engineering Society For Advancing Mobility Land Sea Air and Space®
INTERNATIONAL
400 Commonwealth Drive, Warrendale, PA 15096-0001

AEROSPACE MATERIAL SPECIFICATION

An American National Standard

SAE AMS 2667E

Issued JUL 1956
Revised APR 1996

Superseding AMS 2667D

BRAZING, SILVER
For Small Pressurized Fittings

1. SCOPE:

1.1 Purpose:

This specification covers the engineering requirements for producing brazed joints in parts fabricated from austenitic corrosion and heat resistant steels, but may also be used on carbon or low-alloy steels or copper alloys, and the properties of such joints.

1.2 Application:

This process has been used typically for producing joints brazed between flexible metal hose, pressure fillings, pipe and tube joints, and similar parts, such as bellows and rigid end fittings where one end of the joint is not accessible for inspection, but usage is not limited to such applications.

1.3 Classification:

The brazing procedure is classified by the maximum service temperature as follows:

Type 1 600 OF (316 ºC) service temperature
Type 2 400 OF (204 ºC) service temperature
Type 3 800 OF (427 ºC) service temperature

1.3.1 If a type is not specified, Type 1 shall be supplied.

1.3.2 Maximum operating pressures will vary with part geometry and should be specified by purchaser.

1

1.4 Safety - Hazardous Materials:

While the materials, methods, applications, and processes described or referenced in this specification may involve the use of hazardous materials, this specification does not address the hazards which may be involved in such use. It is the sole responsibility of the user to ensure familiarity with the safe and proper use of any hazardous materials and to take necessary precautionary measures to ensure the health and safety of all personnel involved.

1.4.1 Warning: Numerous scientific studies have determined that cadmium, which is used in some brazing alloys, presents a health hazard to persons who are exposed to it.

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.

AMS 3410 Flux, Silver Brazing
AMS 3411 Flux, Silver Brazing, High Temperature
AMS 4768 Silver Alloy Brazing Filler Metal, 35Ag - 26Cu - 21Zn - 18Cd, 1125 to 1295 ºF (607 to 702 ºC) Solidus-Liquidus Range
AMS 4769 Silver Alloy Brazing Filler Metal, 45Ag - 24Cd - 16Zn - 15Cu, 1125 to 1145 ºF (607 to 618 ºC) Soldus-Liquidus Range
AMS 4770 Silver Alloy Brazing Filler Metal, 50Ag - 18Cd - 16.5Zn - 15.5Cu, 1160 to 1175 ºF (627 to 635 ºC) Solidus-Liquidus Range
AMS 4771 Silver Alloy Brazing Filler Metal, 50Ag - 16Cd - 15.5Zn - 15.5Cu - 3.ONi, 1170 to 1270 ºF (632 to 688 ºC) Soliclus-Liquidus Range
AMS 4772 Silver Alloy Brazing Filler Metal, 54Ag - 40Cu - 5.OZn - 1.ONi, 1325 to 1575 ºF (718 to 857 ºC) Solidus-Liquidus Range
AMS 4773 Silver Alloy Brazing Filler Metal, 60Ag - 30Cu - 1 OSn, 1115 to 1325 ºF (602 to 718 ºC), Solidus-Liquidus Range
AMS 4774 Silver Alloy Brazing Filler Metal, 63Ag - 28.5Cu - 6.OSn - 2.5Ni, 1275 to 1475 ºF (690 to 802 ºC) Solidus-Liquidus Range
AMS 4788 Silver Alloy Brazing Filler Metal, 50Ag - 28Zn - 20Cu - 2.ONi, 1220 to 1305 ºF (660 to 707 ºC) Solidus-Liquidus Range

2.2 ASTM Publications:

Available from ASTM, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959.

ASTM D 1179 Fluoride Ion in Water
ASTM D 1193 Reagent Water

2.3 U.S. Government Publications:

Available from DODSSP, Subscription Services Desk, 700 Robbins Avenue, Philadelphia, PA 19111-5094.

MIL-STD-2073-1 DOD Materiel, Procedures for Development and Application of Packaging Requirements

3. TECHNICAL REQUIREMENTS:

3.1 Materials:

3.1.1 Flux: For Types 1 and 2 brazed joints, flux shall conform to AMS 3410. For Type 3, flux shall conform to AMS 3411. Other fluxes may be used if approved by purchaser.

3.1.2 Filler Metal:

3.1.2.1 Type 1: Filler metal shall conform to AMS 4768 or AMS 4771. AMS 4771 shall be used for brazing austenitic corrosion and heat resisting steels.

3.1.2.2 Type 2: Filler metal shall conform to AMS 4769, AMS 4770, or AMS 4771. For austenitic corrosion resistant steels, AMS 4771 shall be used.

3.1.2.3 Type 3: Filler metal shall conform to AMS 4772.

3.1.2.4 (R) For Type 1 and Type 2 processing, where purchaser specifies or permits the use of cadmium free filler metal, AMS 4773 or AMS 4788 may be used, except that AMS 4788 shall be used for corrosion and heat resistant steels.

3.2 (R) Preparation:

The surfaces to be joined shall be clean prior to assembly. Surfaces shall not be 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. Flux should not be used on hose covered with wire braid or wire cloth because of the wicking action of the cloth or braid and the resulting difficulty of removal. Where this is unavoidable by part design, fluxes used shall be free from chlorides and fluorides.

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. Optimum joint clearances for silver brazing are in the range of 0.001 to 0.004 inch (0.025 to 0.10 mm). 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 neutral flame torch heating, unless a specific method of heating is specified. The method of heating for brazing should be selected 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. 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:

Brazed parts shall conform to the following requirements:

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. Surface and subsurface voids in the brazed joint are acceptable provided pressure and leak test requirements are met.

3.4.1.1 Parts shall be visibly free from flux residue.

3.4.1.2 The presence of unflowed filler metal is unacceptable.

3.4.2 Tests:

3.4.2.1 Proof Tests: When specified by purchaser, any part from a lot shall pass a proof test. Where a proof test procedure is not specified, the proof pressure of production parts shall be 75% of the average burst pressure of not less than three preproduction samples or as specified by purchaser. Proof pressure testing may be done pneumatically or hydrostatically at room temperature.

3.4.2.2 Burst Pressure Tests: When specified by purchaser, any part from a lot shall pass a burst pressure test. The burst pressure shall be the maximum pressure sustained without noticeable leakage.

3.4.2.3 Leak Tests: Any part from a lot shall sustain an internal pressure of not less than 90% of the proof pressure without leakage, unless another leak test pressure is specified by purchaser. Leak tests shall be done pneumatically with the assembly held under still, clear water for not less than five minutes.

3.4.3 Halide Tests: Test shall be conducted on brazed assemblies to ensure that residual halide containing flux has been removed. If the flux is known not to contain chlorides, tests for chloride need not be made; if the flux is known not to contain fluorides, the test for fluorides need not be made. If tests indicate the presence of halides, parts shall be subjected to additional cleaning and testing procedures until removal is complete. Test methods are not specified. Commercial chemicals are available for simple qualitative analysis for fluorides. However, in case of dispute, the following test methods shall apply.

3.4.3.1 Chlorides: Rinse the test area with 40 to 50 mL of hot (approximately 180 ºF (82 ºC)) ASTM D 1193, Type IV, water. Collect rinse water in a 100 mL beaker and add 3 to 5 drops of concentrated nitric acid (sp gr 1.42) and 2 to 3 mL of 10% silver nitrate solution. Stir the contents of the beaker and allow to stand 5 to 10 minutes. A solution as clear as a blank of ASTM D 1193, Type IV, 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 (R) Fluorides: Rinse the test area with approximately 200 mL of hot (approximately 180 ºF (82 ºC)) ASTM D 1193, Type IV, water. Collect the rinse water in a 250 mL beaker. Use approximately 200 mL of ASTM D 1193, Type IV, water as a comparison sample. Test both samples in accordance with ASTM D 1179. A higher concentration of fluoride in the rinse water than in the comparison sample indicates the presence of fluoride containing residual flux.

3.5 Quality:

3.5.1 Brazed joints shall be sound, clean, and free from foreign materials and from imperfections detrimental to usage of the brazed joints.

3.5.2 Surfaces of assemblies shall be free from pitting and burning and from excessive filler metal that interferes with form, fit, or function.

4. QUALITY ASSURANCE PROVISIONS:

4.1 Responsibility for Inspection:

The processor of brazed assemblies shall supply all samples for processor's tests and shall be responsible for the performance of all required tests. Parts, if required for tests, shall be supplied by purchaser. Purchaser reserves the right to sample and to perform any confirmatory testing deemed necessary to ensure that processing conforms to specified requirements.

4.2 Classification of Tests:

4.2.1 Acceptance Tests: All technical requirements, except burst pressure tests, are acceptance tests and shall be performed on each lot.

4.2.2 Preproduction Tests: All technical requirements are preproduction tests and shall be performed prior to or on the initial shipment of brazed parts to a purchaser, when a change in material and/or processing requires approval by the cognizant engineering organization (See 4.4.2), 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, contracting officer, or request for procurement.

4.3 Sampling and Testing:

(R) Shall be not less than shown in Table 1, with samples selected randomly from the lot, unless another sampling plan is specified by purchaser. A lot shall be all assemblies of the same part number, brazed by the same operator in the same shift, and presented for processor's inspection at one time.

TABLE 1 - Sampling and Testing

Parts in Lot		Quality (See 4.3.1)	Tests (See 4.3.2)
1 to	6	All	3
7 to	15	All	4
16 to	40	All	4
41 to	110	All	5
111 to	300	All	6
301 to	500	All	7
501 to	700	All	8
701 to	1200	All	10
Over	1200	All	15

4.3.1 (R) Quality includes close visual inspection of all joints for completeness of fillet and absence of visual residual flux.

4.3.2 Tests include proof pressure (3.4.2.1) and leak (3.4.2.3) tests, and, when halide-containing fluxes are used, tests for residual halides (3.4.3).

4.4 Approval:

4.4.1 (R) The process and control procedures, a preproduction sample brazed part, or both, whichever is specified, shall be approved by the cognizant engineering organization before production parts are supplied.

4.4.2 (R) Processor shall make no change to materials, processes, or controls from those on which approval was based, unless the change is approved by the cognizant engineering organization. A significant change is one which, in the judgment of the cognizant engineering organization, could affect the properties of the parts.