SAE Aerospace
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# AEROSPACE MATERIAL SPECIFICATION

SAE AMS2673 REV. E

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Superseding AMS2673D

## Brazing, Aluminum and Aluminum Alloys Molten Flux (Dip)

RATIONALE

AMS2673E results from a Five Year Review and update of this specification.

1. SCOPE

1.1 Purpose

This specification covers the requirements for producing brazed joints of aluminum and aluminum alloys by immersion in a molten flux bath.

1.2 Application

This process has been used typically for joining aluminum and selected aluminum alloys.

1.3 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 that 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.

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 cancelled and no superseding document has been specified, the last published issue of that document shall apply.





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**http://www.sae.org/technical/standards/AMS2673E**

2.1 SAE Publications

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or 724-776-4970 (outside USA), www.sae.org.

AMS3415 Flux, Aluminum Dip Brazing, 1030 °F (554 °C) or Lower Liquidus

AMS4063 Aluminum Alloy, Clad One Side, Sheet, 1.25Mn - 0.12Cu (No. 11-0 Brazing Sheet), Annealed

AMS4064 Aluminum Alloy, Clad Two Sides Sheet, 1.25Mn - 0.12Cu (No. 12-0 Brazing Sheet), Annealed

AMS4185 Filler Metal, Aluminum Brazing, 12Si (4047)

AMS4255 Aluminum Alloy, Clad One Side Sheet, 0.6Mg - 0.35Si - 0.28Cu (No. 21 Brazing Sheet), as Fabricated

AMS4256 Aluminum Alloy, Clad Two Sides Sheet, 0.6Mg - 0.35Si - 0.28Cu (No. 22 Brazing Sheet), As Fabricated

2.2 ASTM Publications

Available from ASTM International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959, Tel: 610-832-9585, www.astm.org.

ASTM D 1179 Fluoride Ion in Water

ASTM D 1193 Reagent Water

3. TECHNICAL REQUIREMENTS

3.1 Materials

3.1.1 Filler metal shall be aluminum brazing alloy conforming to AMS4185 except as specified in 3.3.2.

3.1.2 Flux shall conform to AMS3415 or other suitable flux.

3.2 Equipment

3.2.1 Preheat furnace shall be maintained within the range 900 to 1050 °F (482 to 566 °C).

3.2.2 Salt-bath furnace shall be a ceramic-type maintained within ±10 °F (±6 °C) of a selected temperature within the range 1050 to 1200 °F (566 to 649 °C).

3.3 Preparation

3.3.1 Surface Condition

Surfaces to be joined shall be free from water breaks prior to assembly. See 8.2.

3.3.2 Assembly

Clearances between mating surfaces of detail parts to be brazed shall be held within specified tolerances. The assembly shall be supported so that the parts will be in proper alignment throughout brazing. Jigs, fixtures, and clamps shall be fabricated from material that will not significantly contaminate the flux bath. Stop-off may be used provided it does not contaminate the molten flux bath. On closed assemblies, vent holes shall be provided as specified. Except when parts are fabricated from clad brazing sheet such as AMS4063, AMS4064, AMS4255, or AMS4256, the filler metal shall be positioned at one end of the joint. Filler metal shall be placed at the blind end of each blind joint when accessible. When specified, filler metal may be placed within the joint prior to assembly for brazing. When parts are made from clad sheet, the clad surface shall be in contact with the intended mating surfaces.

3.3.3 Tack welding shall be used only when specified or permitted by purchaser.

3.4 Joining

Assembled details shall be preheated in a furnace to an established temperature within the range 900 to 1050 °F (482 to 566 °C) and transferred immediately into the molten flux bath. Temperature of the flux bath shall be maintained within 10 Fahrenheit (6 Celsius) degrees of a temperature established so as to preclude incipient melting, excessive alloying of the joint, and distortion in excess of dimensional requirements. Time in flux bath should be established using a pilot assembly in order to ensure complete filler metal penetration through the joint and limiting excessive alloying or erosion.

3.4.1 Cooling

After brazing, assemblies shall be cooled in a manner that prevents cracks and minimizes internal stress, distortion, scaling, and oxidation. If solution heat treatment is to be performed in conjunction with brazing, cooling procedures may be revised accordingly.

3.5 Flux Removal

After brazing and cooling, flux shall be removed by a method that is not injurious to the surface finish and that will not remove metal below the drawing tolerances. The test of 3.6.5 shall be used to determine that flux has been adequately removed.

3.6 Properties

Brazed assemblies shall conform to the following requirements:

3.6.1 Appearance

Examination of the visible joint edges shall show a complete line or ring of filler metal between component parts at both ends of the joint.

3.6.1.1 The total accumulated length of any pinhole, void (within braze filler), or filler metal skip (no presence of braze filler), extending into the joint, shall not exceed 10% of the total length of the fillet. Individual pinholes, voids, or filler metal skips shall not exceed 3/32 inch (2.4 mm).

3.6.1.2 Cracks in filler metal or parent metal are not acceptable.

3.6.1.3 Overheating resulting in blisters on the base metal or eutectic melting is not acceptable.

3.6.1.4 Residual flux is not permissible on surfaces of the assembly.

3.6.2 Coverage

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 acceptable to purchaser.

3.6.3 Proof Pressure Test

When specified, any part from a lot shall pass a proof pressure test. Standards for acceptance and method of test shall be specified by purchaser.

3.6.4 Melting or erosion shall not cause thinning of the parent metal surface adjacent to the brazed joint in excess of 5 percent of the parent metal thickness and 15 percent cumulative of the braze length.

3.6.5 Halide Test

Testing shall be conducted to ensure that residual flux has been removed. If the test indicates flux residue, the assemblies shall be subjected to additional cleaning and testing until flux removal is complete. In case of dispute, the procedure of 3.6.5.1 and/or 3.6.5.2 shall be used.

3.6.5.1 Chlorides

Rinse the test area with 40 to 50 mL of hot [approximately 180 °F (82 °C)] reagent water (8.3). Collect rinse water in a 100 mL beaker and add 3 to 5 drops of concentrated nitric acid (specific gravity 1.42) and 2 to 3 mL of 10 percent silver nitrate solution. Stir the contents of the beaker and allow to stand for 5 to 10 minutes. A resultant solution as clear as a blank of reagent 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.

3.6.5.2 Fluorides

Rinse the test area with approximately 200 mL of hot [approximately 180 °F (82 °C)] ASTM D 1193, Type IV, water. Collect rinse water in a 250 mL beaker. Use approximately 200 mL of ASTM D 1193, Type IV, water as a blank or comparison sample. Both samples shall be tested in accordance with ASTM D 1179. A higher concentration of fluoride in the rinse water than in the blank or comparison sample indicates the presence of fluoride-containing residual flux.

3.7 Quality

Brazed joints shall be sound, clean, free of unmelted filler metal in the joint, and free from other imperfections detrimental to performance of brazed joints. Filler metal in excess of that required for the joint is acceptable provided it does not interfere with form, fit, or function of the completed assembly.

4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for Inspection

The processor of brazed assemblies shall supply all test specimens for processor's tests and shall be responsible for performing all required tests. Parts, when required for test, 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

Flux removal (3.5), appearance (3.6.1), coverage (3.6.2), and quality (3.7) are acceptance tests and shall be performed on brazed assemblies sampled from each lot. See 4.3.1.

4.2.2 Periodic Tests

Proof pressure testing when specified (3.6.3), destructive coverage testing when agreed upon by purchaser and processor when there exists a lot size of 40 or less (3.6.2), and melting or erosion (3.6.4) are periodic tests and shall be performed at a frequency established by the processor unless frequency of testing is specified by purchaser.

4.2.3 Preproduction Tests

All property verification tests (3.6) are preproduction tests and shall be performed prior to or on the initial shipment of brazed assemblies to the purchaser and when purchaser requires confirmatory testing.

4.3 Sampling for Testing

4.3.1 Acceptance Tests

Acceptance test samples shall be randomly selected from all parts or assemblies in the lot. A lot shall be all assemblies of the same part number brazed in a continuous operation and presented for processor's inspection at one time. Unless the cognizant engineering organization provides a sampling plan, the minimum number of samples shall be as shown in Table 1.

TABLE 1 - SAMPLING FOR ACCEPTANCE TESTING

| Number of Parts in Lot | Quantity and Appearance | Coverage Non-Destructive Tests | Coverage Destructive Tests |
|---|---|---|---|
| 1 to 6 | All | 3 or all* | 0 |
| 7 to 15 | All | 4 | 0 |
| 16 to 40 | All | 4 | 0 |
| 41 to 110 | All | 5 | 1 |
| 111 to 300 | All | 6 | 2 |
| 301 to 500 | All | 7 | 3 |
| 501 to 700 | All | 8 | 5 |
| 701 to 1200 | All | 10 | 7 |
| Over 1200 | All | 15 | 10 |

*Whichever is less



4.3.2 Periodic Tests

Sample quantities shall be selected at the discretion of the processor, unless otherwise specified by the cognizant engineering organization.

4.3.3 Preproduction Tests

One joint shall be destructively examined for braze coverage and for evidence of overheating or other deleterious effects.

4.4 Approval

4.4.1 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 If the processor makes a change to any material, process, or control factor from that which was used for approval, all preproduction tests shall be performed and the results submitted to the cognizant engineering organization for process reapproval unless the change is approved by the cognizant engineering organization. A significant change is one that, in the judgment of the cognizant engineering organization could affect the properties or performance of the brazed parts.

4.4.2.1 Control factors include, but are not limited to, the following:

Method of cleaning
Brazing flux used
Braze filler metal
Placement of filler metal
Preheat temperature and time
Brazing cycle
Method of flux removal
Periodic test plan.