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400 COMMONWEALTH DRIVE, WARRENDALE, PA. 15096

AEROSPACE MATERIAL SPECIFICATION

AMS2664D
Superseding AMS 2664C

Issued 5-1-68
Revised 10-1-82

SILVER BRAZING
For Use Up to 800°F (425°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, and cobalt alloys by use of silver alloy filler metals and the properties of such joints.

1.2 Application: Primarily for joints requiring high strength up to 800°F (425°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 3411 - Flux, Silver Brazing, High Temperature
AMS 4765 - Brazing Filler Metal, Silver, 56Ag - 42Cu - 2.0Ni, 1420° - 1640°F (770° - 895°C) Solidus-Liquidus Range
AMS 4772 - Brazing Filler Metal, Silver, 54Ag - 40Cu - 5.0Zn - 1.0Ni, 1325° - 1575°F (720° - 855°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

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 3411 or equivalent as approved by the ø purchaser.

3.1.2 Filler Metal:

3.1.2.1 For Brazing in Protective Atmosphere: Shall conform to AMS 4765.

3.1.2.2 For Brazing with Flux: Shall conform to AMS 4772.

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 (Required for Induction and Furnace Brazing Without Flux): ø Joint surfaces on parts made of any steel or alloy having a specified titanium or aluminum content, either as a maximum or a range, shall be nickel plated in accordance with AMS 2403 or AMS 2424, except that plating will not be required on materials in which the specified maximum titanium content is not greater than 0.30% or the specified maximum aluminum content is not greater than 0.20% or the specified maximum sum of aluminum plus titanium contents is not greater than 0.40%; thickness of plating shall be 0.0001 - 0.0003 in. (2.5 - 7.5 µm) unless otherwise specified.

3.2.2.1 Nickel plating as in 3.2.2 may be used on steels and alloys not having a specified titanium or aluminum content when such parts are to be brazed in an atmosphere permitted in 3.3.3.2.

3.2.3 Post-Plating Diffusion Treatment: Prior to being assembled for brazing, all nickel plated parts shall be induction heated to 1825°F ± 50 (995°C ± 30) and held at heat for not less than 10 seconds. This requirement does not apply to parts to be furnace brazed.

3.3 Procedure:

3.3.1 Fluxing: Unless parts are to be brazed in a protective atmosphere as defined in 3.3.3.2, 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, after nickel plating when plating is used, 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 heating (See 8.2) in a protective atmosphere as defined in 3.3.3.2 or by induction heating with such an atmosphere surrounding the work or shall be accomplished by Ø furnace, induction, or torch heating using flux, 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. Brazing temperature shall not exceed 1900°F (1040°C).

3.3.3.1 When permitted by purchaser, resistance heating may be used for producing nonstructural joints, such as spacing collars on tubes, provided that the heating is accomplished by passing the current through one member of the joint, so that the resistance of the part rather than the resistance across the joint is the source of heating, and provided that brazing is accomplished in a protective atmosphere as defined in 3.3.3.2.

3.3.3.2 Except as specified in 3.3.3.2.1 and 3.3.3.2.2, the protective atmosphere for brazing shall be hydrogen of not less than 99.94% purity and dew point not higher than -25°F (-32°C), determined on gas being exhausted from the furnace or retort work zone.

3.3.3.2.1 If scale and visible oxides are removed from surfaces of parts before the parts are placed in the brazing furnace, one of the following atmospheres may be used; specified dew points apply to the gas being exhausted from the furnace or retort work zone:

3.3.3.2.1.1 Argon of not less than 99.99% purity and dew point not higher than -35°F (-37°C).

3.3.3.2.1.2 Mixtures of argon and hydrogen in any proportions, the hydrogen purity being as specified in 3.3.3.2, the argon purity being as specified in 3.3.2.1.1, and the dew point of the mixture being not higher than -35°F (-37°C).

3.3.3.2.1.3 Vacuum of 5 - 20 microns of Hg; when permitted by purchaser, higher vacuum (lower pressure) than 5 microns of Hg may be used.

3.3.3.2.2 Atmospheres other than those listed in 3.3.3.2 and 3.3.3.2.1 may be used when authorized in writing by purchaser; such authorization will be granted only after demonstration, to the satisfaction of the purchaser, that use of such atmospheres will not cause scaling, carburization, nitriding, or excessive decarburization of the basis metals and will produce joints which consistently meet all other technical requirements of this specification.

3.3.3.2.3 ø When induction brazing in a protective atmosphere using flux, dew point requirements are waived.

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, oxidation, decarburization, 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: ø 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 of 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, 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 for vendor's tests and shall be responsible for performing all Ø 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 Ø 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 Ø 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 reapproval as in 4.4.3, and when purchaser deems confirmatory testing to be required.