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

AEROSPACE MATERIAL SPECIFICATION

AMS 2666C
Superseding AMS 2666B
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SILVER BRAZING
High Temperature

1. SCOPE:

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

1.2 Application: Primarily for use where joints having high strength up to 800 F (427 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 4772 - Brazing Filler Metal, Silver, 54Ag, - 40Cu - 5.0Zn - 1.0Ni

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 3411 except that flux conforming to AMS 3410 may be used in furnace brazing in hydrogen atmosphere when permitted by purchaser.

3.1.2 Filler Metal: 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.

3.3 Procedure:

3.3.1 Fluxing: Unless parts are to be brazed in a protective atmosphere as defined in 3.3.3.1, 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 are within the 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, unless a specific method of heating is specified. Furnace brazing shall be performed in a suitable protective atmosphere as defined in 3.3.3.1. Parts shall be heated until the filler metal melts and the joint is formed. Further heating shall be held to a minimum. The temperature to which joint areas are heated will vary with the method of heating and the flux used but should be not higher than 1725 F (941 C). Furnace brazing and immersion brazing may be used only when hardness of the detail parts will not be reduced below drawing limits.

3.3.3.1 Except as specified in 3.3.3.1.1 and 3.3.3.1.2, 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) as determined on gas being exhausted from the furnace or retort work zone.

3.3.3.1.1 If all scale and all visible oxides are removed from all 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:

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

3.3.3.1.1.2 Mixtures of argon and hydrogen in any proportions, the hydrogen purity being as specified in 3.3.3.1, the argon purity being as specified in 3.3.3.1.1.1, and the dew point of the mixture being not higher than -35 F (-37 C).

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

3.3.3.1.2 Atmospheres other than those listed in 3.3.3.1 and 3.3.3.1.1 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.

3.3.4 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:

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 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 cm^3 of hot (approximately 180 F (82 C)) deionized or distilled water. Collect rinse water in a 100 cm^3 beaker and add 3 - 5 drops of concentrated nitric acid (sp gr 1.42) and 2 - 3 cm^3 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 cm^3 of hot (approximately 180 F (82 C)) deionized or distilled water. Collect the rinse water in a 250 cm^3 beaker. Using two 100 cm^3 Nessler or equivalent color comparison tubes, pour 100 cm^3 of the rinsings into one tube and 100 cm^3 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 (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 Proof 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.