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INTERNATIONAL
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AEROSPACE MATERIAL SPECIFICATION

SAE AMS 2675F

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Submitted for recognition as an American National Standard

(R) NICKEL ALLOY BRAZING

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 nickel alloy filler metal.

1.2 Application:

This process has been used typically for joints requiring high strength and corrosion and oxidation resistance up to 1200 °F (649 °C), but usage is not limited to such applications.

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 2403 Nickel Plating, General Purpose
AMS 2424 Nickel Plating, Low-Stressed Deposit
AMS 2750 Pyrometry
AMS 4775 Brazing Filler Metal, Nickel Alloy, 73Ni - 0.75C - 4.5Si - 14Cr - 3.1B - 4.5Fe, 1790 - 1970 °F (977 - 1077 °C) Solidus-Liquidus Range

2.2 U.S. Government Publications:

Available from DODSSP, Subscription Services Desk, Building 4D, 700 Robbins Avenue, Philadelphia, PA 19111-5094.

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

2.3 ANSI Publications:

Available from American National Standards Institute, 11 West 42nd Street, New York, NY 10036.

ANSI B46.1 Surface Texture

3. TECHNICAL REQUIREMENTS:

3.1 Materials:

3.1.1 Filler Metal: Shall conform to AMS 4775, unless otherwise specified. (See 8.2).

3.1.2 Flux: Paste or liquid fluxes shall not be used, unless otherwise agreed upon by purchaser and vendor.

3.2 Equipment:

Furnaces, with suitable protective atmospheres as defined in 3.3, shall be used for brazing unless electrical induction, electrical resistance heating, or other method is permitted by purchaser. Where brazing is concurrent with heat treatment, the pyrometry requirements of the applicable heat treatment specification shall be applied. Otherwise, pyrometry shall be in accordance with AMS 2750.

3.3 Atmospheres:

Unless otherwise agreed upon by purchaser and vendor, the furnace atmospheres for brazing shall be as follows:

3.3.1 Hydrogen of not less than 99.99% purity and dew point not higher than -25 °F (-32 °C).

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

3.3.3 Mixtures of argon and hydrogen in any proportions, the hydrogen purity being as specified in 3.3.1, the argon purity being as specified in 3.3.2, and the dew point of the mixture being not higher than -35 °F (-37 °C).

3.3.4 Vacuum of 5 x 10^{-3} Torr or better (lower pressure). Back-fill to a higher pressure may be achieved with a non-oxidizing atmosphere (See 3.3.2 or 3.3.3).

3.4 Preparation:

3.4.1 Surface Condition: The surfaces to be joined shall be clean prior to assembly. For joints not prepared by nickel plating, a surface roughness of 32 to 125 microinches (0.8 to 3.2 µm) determined in accordance with ANSI B46.1, is recommended but not required.

3.4.2 Nickel Plating: Unless otherwise specified, joints shall be prepared as Noted in Table 1 by nickel plating in accordance with AMS 2403 or AMS 2424

TABLE 1 - Nickel Plating Thickness Requirements for Furnace Atmosphere

Alloy	Nickel Plating Thickness Inch (µm) Vacuum	Nickel Plating Thickness Inch (µm) Non-Oxidizing Gas
Precipitation Hardenable Iron Alloys	0.0001 to 0.0006 (2.5 to 15)	0.0004 to 0.0006 (10 to 15)
Precipitation Hardenable Nickel Alloys		
(a) Ti + Al content under 4% nominal	0.0001 to 0.0006 (2.5 to 15)	0.0004 to 0.0006 (10 to 15)
(b) Ti + Al content 4% nominal or greater	0.0001 to 0.0006 (2.5 to 15)	0.0008 to 0.0012 (20 to 30)
Non-precipitation Hardenable Nickel Alloys with Ti + Al content under 1% nominal	Optional to 0.0006 (15), max	0.0001 to 0.0006 (2.5 to 15)
All other Alloys	Optional to 0.0006 (15), max	Optional to 0.0006 (15), max

3.4.2.1 Unless otherwise specified, nickel plating on areas other than the faying surface and adjacent fillet is optional and may be incomplete.

3.4.3 Assembly: The parts to be joined shall be assembled so that the clearances between mating surfaces are within specified tolerances. When joint tolerances are not specified, the joint clearance shall be 0.001 to 0.004 inch (25 to 102 µm), (See 8.2). When agreed upon by purchaser and vendor, tack welding may be used to facilitate assembly. The assembly shall be supported so that the parts will be in proper alignment throughout the brazing process. Sufficient filler metal shall be placed at one end of the joint. In the case of blind joints, the filler metal shall be preplaced at the blind end of the joint.

3.4.4 Fluxing: When use of paste or liquid flux is permitted, flux shall be applied to the joint areas of parts. Gaseous hydrogen fluoride pre-cleaning/fluxing may be performed, when agreed upon by purchaser and vendor

3.5 Procedure:

3.5.1 Joining: Parts shall be heated in equipment as in 3.2 using an atmosphere as in 3.3 until the filler metal melts and the joint is formed. The brazing temperature shall be from 25 to 200 F (14 to 111 C) degrees above the liquidus for the filler metal used. After the filler metal melts, heating may be prolonged to aid diffusion.

3.5.2 Cooling: After brazing, assemblies shall be cooled in a manner and at a rate that will prevent cracks and minimize internal stress, distortion, scaling, and decarburization. Cooling from the brazing temperature to below the scaling temperature shall be performed in one of the atmospheres described in 3.3. If hardening is to be executed in conjunction with brazing, cooling procedures may be revised accordingly.

3.6 Post Treatment:

3.6.1 Flux Removal: After brazing and cooling, the residues of paste or liquid fluxes, if used, shall be removed from the parts by a method not injurious to the specified surface finish.

3.6.2 Heat Treatment: Where heat treatment is required and the heat treatment temperature is below 1780 °F (971 °C), such heat treatment shall follow the brazing operations or, when acceptable to purchaser, may be performed during the post-braze cool down process.

3.7 Properties:

Brazed parts shall conform to the following requirements:

3.7.1 Appearance: Examination of visible joint edges shall show a complete line or ring of filler metal between component parts.

3.7.2 Coverage: The area joined by filler metal shall not be less than 80% of the area of the mating portions of the assembly, determined by a method acceptable to purchaser:

3.7.3 Proof Test: When specified, any part from a lot sha11 pass a proof test determined by a method acceptable to purchaser.

3.8 Quality:

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

3.8.1 Surfaces of parts shall be free from excessive filler metal that interfere with form, fit, or function.

3.8.2 The presence of un-melted filler metal is not acceptable.

3.8.3 Erosion of the base metal shall not exceed 20% of the thinnest member or 0.002 inch (51 µm), whichever is less.

3.8.4 Unless otherwise specified, the depth of diffusion of solid substitution alloying elements (i.e., chromium, nickel, cobalt, tungsten, etc) at the joint shall not exceed 0.004 inch (102 µm), measured from the original base metal surface.

4. QUALITY ASSURANCE PROVISIONS:

4.1 Responsibility for Inspection:

The brazing facility shall supply all samples for processor's tests and shall be responsible for performing all required tests. Where actual or simulated parts are required for processor's tests, such parts 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 the requirements of this specification.

4.2 Classification of Tests:

4.2.1 Acceptance Tests: Tests for all technical requirements with the exception of braze coverage (3.7.2) and depth of diffusion (3.8.4) are acceptance tests and shall be performed on each lot.

4.2.2 Periodic Tests: Destructive examination for braze coverage (3.7.2) and depth of diffusion (3.8.4) are periodic tests and shall be performed at a frequency selected by the vendor unless frequency of testing is specified by purchaser.

4.2.3 Preproduction Tests: Tests for all technical requirements are preproduction tests and shall be performed prior to or on the initial shipment of brazed parts to a purchaser, when any 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.

4.2.3.1 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:

Shall be not less than the following; a lot shall be all assemblies of the same part number brazed in the same equipment without breakdown of setup and presented for processor's inspection at one time:

4.3.1 For Acceptance Tests: Shall be as shown in Table 2.

TABLE 2 - Sampling far Acceptance Tests

Number of Parts in Lot	Quality and Appearance	Coverage
8 to 7	All	3
8 to 15	7	4
16 to 40	10	4
41 to 110	15	5
111 to 300	25	6
301 to 500	35	7
Over 500	50	8

4.3.1.2 Proof Test: As agreed upon by purchaser and vendor.

4.3.2 For Preproduction Tests: One or more joints shall be destructively examined for braze coverage, depth of diffusion, and for evidence of surface contamination, carburization, decarburization, or other deleterious effects.

4.4 Approval:

4.4.1 The process and control factors, or a preproduction sample, or both, whichever is specified by purchaser, shall be approved by the cognizant engineering organization before production parts are supplied.

4.4.2 The processor shall make no significant change to materials, processes, or control factors from those on which the approval was based, unless the change is approved by the cognizant engineering organization (See 4.2.3). A significant change is one which, in the judgment of the cognizant engineering organization, could affect the properties or performance of the parts.

4.4.3 Control factors shall include but not be limited to the following:

Surface preparation, including use of nickel plate
Brazing filler metal pre-placement, quantity, and form
Method of applying or attaching brazing filler metal
Type of heating equipment and atmosphere
Brazing temperature
Heating and cooling temperature profiles
Concurrent heat treatment, if performed
Periodic test plan