

**COPPER FURNACE BRAZING
Corrosion and Heat Resistant Steels and Alloys**

1. SCOPE:

1.1 Purpose: This specification covers the engineering requirements for producing brazed joints using metallic copper as the brazing filler metal.

1.2 Application: For joining corrosion and heat resistant steels and alloys. Not recommended for use on parts which will operate in service over 1000°F (540°C) or requiring high strength joints for service over 700°F (370°C), or on materials subject to carbide precipitation during cooling from the brazing operation.

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 3430 - Paste, Copper Brazing, Water Thinning

AMS 4500 - Copper Sheet, Strip, and Plate, Soft Annealed (CDA 110)

AMS 4501 - Copper Sheet, Strip, and Plate, Oxygen-Free, Light Cold Rolled (CDA 102)

AMS 4701 - Copper Wire, 99.95(Cu + Ag), (CDA 102), Annealed

2.2 U.S. Government Publications: Available from Commanding Officer, Naval Publications and Forms Center, 5801 Tabor Avenue, Philadelphia, PA 19120.

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2.2.1 Military Standards:

MIL-STD-794 - Parts and Equipment, Procedures for Packaging and Packing of

3. TECHNICAL REQUIREMENTS:

3.1 Materials:

3.1.1 Filler Metal: Shall be copper conforming to AMS 4500, AMS 4501, or AMS 4701. When permitted by purchaser, a suitable copper paste such as AMS 3430 or copper applied by electroplating may be used.

3.1.2 Flux: Paste or liquid fluxes shall not be used, unless otherwise permitted by purchaser.

3.2 Equipment: Furnaces with suitable protective atmosphere as defined in 3.3 shall be used for brazing. Alternatively, induction heating, using a protective atmosphere in a jacket surrounding the work, may be used.

3.3 Atmospheres: Except as specified in 3.3.1 and 3.3.2, the furnace atmosphere for brazing shall be hydrogen of not less than 99.94% purity and dew point not higher than -25°F (-30°C), determined on gas being exhausted from the furnace or retort work zone.

3.3.1 If scale and visible oxides are removed from joint surfaces prior to placing parts 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:

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

3.3.1.2 Mixtures of argon and hydrogen in any proportions, the hydrogen purity being as specified in 3.3, the argon purity being as specified in 3.3.1.1, and the dew point of the mixture being not higher than -35°F (-37°C).

3.3.1.3 Vacuum of 5 - 20 μ m of Hg; the specified partial pressure may be maintained by back-filling with an inert atmosphere as in 3.3.1.1 or 3.3.1.2 before the furnace temperature exceeds 1600°F (870°C).

3.3.2 Atmospheres other than those listed in 3.3 and 3.3.1 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.

3.4 Preparation:

- 3.4.1 Surface Condition:** The surfaces to be joined shall be clean prior to assembly.
- 3.4.2 Fluxing:** When use of flux is permitted, flux shall be applied to the joint areas of parts.
- 3.4.3 Assembly:** The parts to be joined shall be assembled so that clearances between mating surfaces are within the specified tolerances. The assembly should be supported so that the parts will be in proper alignment after brazing. Sufficient copper shall be placed within, or in close proximity to, the joint. In the case of blind joints, the copper shall be preplaced within the joint; in such cases, use of AMS 3430 or other suitable copper paste or copper applied by electroplating is permitted.

3.5 Procedure:

- 3.5.1 Joining:** Parts shall be heated, in equipment defined in 3.2 using an atmosphere defined in 3.3, to a selected temperature within the range 2000° - 2150°F (1095° - 1175°C), held at the selected temperature within $\pm 25^\circ\text{F}$ ($\pm 15^\circ\text{C}$) until the copper melts and the joint is formed. Further heating shall be held to a minimum.
- 3.5.2 Cooling:** After brazing, assemblies shall be cooled in such a manner as to prevent cracks and minimize internal stress, distortion, scaling, and decarburization. Cooling from the brazing temperature to below the scaling temperature shall be done 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, 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 hardness is specified for the brazed assembly and heat treatment is required, such heat treatment shall follow the brazing operation.

3.7 Properties: Brazed parts shall conform to the following requirements:

- 3.7.1 Appearance:** Visual examination of joints shall show a complete line or ring of copper between component parts at the end of the joint at which the copper was introduced and, when practical, shall show at least a metallic stain of copper at the opposite end of the joint to indicate complete penetration of copper through the joint.

3.7.2 Coverage: Unless otherwise specified, the area joined by copper 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.

3.7.2.1 Surfaces of parts shall be free of excessive copper.

3.7.3 Proof Test: When specified, any part from a lot shall pass a proof test. Standards for acceptance and method of test shall be as agreed upon by purchaser and vendor.

3.8 Quality: Brazed joints shall be sound, clean, and free from foreign materials and from imperfections detrimental to performance of assemblies.

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 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 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 and shall be performed prior to or on the initial shipment of brazed parts to a purchaser, when a change in material or processing, or both requires reapproval as in 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, the contracting officer, or the request for procurement.

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 vendor's inspection at one time:

4.3.1 Coverage: Three assemblies per lot.

4.3.2 Proof Test: One assembly per lot, when specified.

4.4 Approval: