

**AEROSPACE
MATERIAL
SPECIFICATION**

AMS 2417D
Superseding AMS 2417C

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NICKEL-ZINC ALLOY PLATING

1. SCOPE:

1.1 Purpose: This specification covers the engineering requirements for electrodeposition of a nickel-zinc alloy and the properties of the deposit.

1.2 Application: Primarily to prevent corrosion of steel parts which may operate in service up to 900°F (480°C). No diffusion heat treatment of the coating is 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 SAE, 400 Commonwealth Drive, Warrendale, PA 15096.

2.1.1 Aerospace Material Specifications:

AMS 2350 - Standards and Test Methods

2.2 ASTM Publications: Available from American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103.

ASTM B117 - Salt Spray (Fog) Testing

ASTM B487 - Measurement of Metal and Oxide Coating Thicknesses by Microscopical Examination of a Cross Section

ASTM B499 - Measurement of Coating Thicknesses by the Magnetic Method: Nonmagnetic Coatings on Magnetic Basis Metals

ASTM B504 - Measurement of Thickness of Metallic Coatings by the Coulometric Method

ASTM E290 - Semi-Guided Bend Test for Ductility of Metallic Materials

ASTM E376 - Measuring Coating Thickness by Magnetic-Field or Eddy-Current (Electromagnetic) Test Methods

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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 Preparation:

- 3.1.1 All forming, machining, heat treating, brazing, and welding shall be completed before parts are plated.
- 3.1.2 Parts having hardness of 40 HRC or higher and which have been ground after heat treatment shall be suitably stress-relieved before cleaning for plating. Temperature to which parts are heated shall be such that maximum stress relief is obtained without reducing the hardness of the parts below drawing limits.
- 3.1.3 Parts shall have chemically clean surfaces, prepared with minimum abrasion, erosion, or pitting prior to immersion in the plating solution.
- 3.1.4 Parts having hardness of 33 HRC or higher and parts roll threaded after heat treatment shall not be cleaned with inorganic acids (hydrochloric or sulfuric) unless specifically approved by purchaser. Cleaning of other parts with inorganic acids is not prohibited but permission to use such method on a particular part shall first be obtained from purchaser. In either case, a momentary dip in acid after alkaline cleaning is permissible.
- 3.1.5 Electrical contacts between the parts and power source shall be made in such a manner as will ensure that neither chemical or immersion deposition nor electrical arcing or overheating will occur. If parts are to be plated all over, contact points shall be located where specified or where agreed upon by purchaser and vendor. If parts are not required to be plated all over, contact points shall be located in areas on which plating is not required or is optional.

3.2 Procedure:

- 3.2.1 Nickel Strike: Prior to electrodeposition of the alloy plate, parts shall be given an electrodeposited nickel strike.

- 3.2.2 Nickel-Zinc Alloy Plating: The nickel-zinc alloy plate shall be electrodeposited over the nickel strike from a suitable electrolyte containing no addition agents which might have a detrimental effect on the properties of the deposited alloy or the basis metal. Stress-reducing agents shall not be used unless specifically authorized by purchaser.
- 3.2.3 The plated parts shall be removed from the plating solution, thoroughly rinsed, and dried.
- 3.3 Post Treatment: After plating, rinsing, and drying, steel parts shall be
Ø post treated as in 3.3.1, 3.3.2, 3.3.3, or 3.3.4, as applicable, unless otherwise permitted by purchaser, to remove hydrogen embrittlement; heating shall be in air, preferably in a circulating-air furnace.
- 3.3.1 Springs and other parts having hardness of 45 HRC or higher shall be
Ø heated to $450^{\circ}\text{F} \pm 15$ ($235^{\circ}\text{C} \pm 8$) and held at heat for not less than 2 hours.
- 3.3.2 Parts, including roll-threaded parts, cold worked after being heat treated by hardening and tempering; parts having hardness of 33 HRC or higher but less than 45 HRC; and springs and other parts having hardness of 45 HRC
Ø or higher which will decrease in hardness or be otherwise deleteriously affected by heating to 450°F (230°C) shall be heated to $375^{\circ}\text{F} \pm 15$ ($190^{\circ}\text{C} \pm 8$) and held at heat for not less than 3 hours.
- 3.3.3 Parts, including carburized parts, which will decrease in hardness or be
Ø otherwise deleteriously affected by heating to 375°F (190°C) shall be heated to $275^{\circ}\text{F} \pm 15$ ($135^{\circ}\text{C} \pm 8$) and held at heat for not less than 5 hours.
- 3.3.4 Parts requiring special handling shall be post treated as agreed upon by
Ø purchaser and vendor.
- 3.4 Properties: Nickel-zinc alloy plate shall conform to the following requirements:
- 3.4.1 Composition: The nickel-zinc alloy plate shall contain 16 - 30% nickel and the balance zinc, determined by a method agreed upon by purchaser and vendor.
- 3.4.2 Thickness: Shall be as follows, unless otherwise specified, determined on
Ø representative parts or test panels in accordance with ASTM B487, ASTM B499, ASTM B504, ASTM E376, or other suitable method, as agreed upon by purchaser and vendor.
- 3.4.2.1 Nickel Strike: Shall have thickness not less than 0.00005 in. (1.3 μm).
- 3.4.2.2 Nickel-Zinc Alloy Plate:

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- 3.4.2.2.1 Parts Other Than Washers and Parts With External Threads: Shall have plate thickness of 0.0003 - 0.0007 in. (8 - 18 μm).
- 3.4.2.2.2 Washers and Parts With External Threads: Shall have plate thickness of 0.0002 - 0.0004 in. (5 - 10 μm).
- 3.4.2.2.3 No requirements are established for minimum plating thickness on surfaces of holes, recesses, internal threads, contact areas of parts plated all over, and other areas where a controlled deposit cannot be obtained under normal plating conditions, but such areas shall not be masked to prevent plating. Unless otherwise specified, the resultant thickness shall be considered only when such surfaces of parts can be touched by a sphere 0.75 in. (19 mm) in diameter.
- 3.4.3 Adhesion: Specimens as in 4.3.3 shall not show separation of the plating from the basis metal, when examined at up to 6X magnification, after being bent rapidly at room temperature, in accordance with ASTM E290, through an angle of 180 deg around a diameter equal to the thickness of the specimen. Formation of cracks which do not result in flaking or blistering of the plating is acceptable.
- 3.4.4 Corrosion Resistance: Parts or representative test panels, plated to a thickness of 0.0002 - 0.0004 in. (5 - 10 μm) shall show no visual evidence of corrosion of significant surfaces after being subjected for not less than 48 hr to continuous salt spray corrosion test conducted in accordance with ASTM B117.
- 3.5 Quality: Plated nickel-zinc shall be smooth, continuous, adherent to basis metal, uniform in appearance, and not coarsely crystalline and shall be essentially free from pin holes, porosity, blisters, nodules, pits, and other imperfections detrimental to performance of parts. Slight staining or discoloration is permissible. Standards for acceptance shall be as agreed upon by purchaser and vendor.
- 3.5.1 Double plating and spotting-in after plating are not permitted, unless otherwise specified.

4. QUALITY ASSURANCE PROVISIONS:

- 4.1 Responsibility for Inspection: The processing vendor 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 requirements for composition (3.4.1), thickness (3.4.2.1 and 3.4.2.2), and quality (3.5) are classified as acceptance tests and shall be performed to represent each lot.
- 4.2.2 Periodic Tests: Tests to determine conformance to requirements for adhesion (3.4.3) and corrosion resistance (3.4.4) and tests of cleaning and plating solutions to ensure that the deposited metal will conform to the requirements of this specification are classified as 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 to determine conformance to all technical requirements of this specification are classified as preproduction tests and shall be performed on the initial shipment of plated parts to a purchaser, when a change in material and/or processing requires reapproval as in 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, the contracting officer, or the request for procurement.
- 4.3 Sampling: Shall be not less than the following; a lot shall be all parts made of the same steel or alloy, heat treated to essentially the same hardness or tensile strength level, plated to the same range of plate thicknesses in the same solutions in each consecutive 8-hr period of operation, and presented for vendor's inspection at one time:
- 4.3.1 For Acceptance Tests:
- 4.3.1.1 Composition: One part for each 8 hr of operation of each nickel-zinc alloy plating tank.
- 4.3.1.2 Thickness: Three parts from each lot.
- 4.3.1.3 Coverage and Appearance: All parts in lot.
- 4.3.1.4 Adhesion and Corrosion: Three specimens per lot.
- 4.3.2 For Periodic Tests and Preproduction Tests: As agreed upon by purchaser and vendor.
- 4.3.3 When plated parts are of such configuration or size as to be not readily adaptable to the specified tests, separate test specimens cleaned and plated with the parts they represent may be used. For adhesion and corrosion tests, specimens shall be strip of the same type of alloy as the parts being plated approximately 0.040 x 4 x 1 in. (1 x 100 x 25 mm) and for thickness and quality tests shall be panels of the same size and type or shall be bars approximately 0.5 in. (15 mm) in diameter and 4 in. (100 mm) long.