NOTICE OF
ADOPTION

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AEROSPACE MATERIAL SPECIFICATION

SAE AMS 2417E

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Superseding AMS 2417D

Submitted for recognition as an American National Standard

PLATING, ZINC-NICKEL ALLOY

1. SCOPE:

1.1 Purpose:

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

1.2 Application:

This plating process has been used typically to provide corrosion resistance to steel parts which may operate up to 900 °F (482 °C) (Type 1), or up to 350 °F (177 °C) (Type 2), and requiring essential freedom from hydrogen embrittlement, but usage is not limited to such applications.

1.3 Classification:

Plating covered by this specification is classified as follows:

Type 1 - As-plated without supplementary treatment
Type 2 - As-plated with supplementary chromate treatment

1.3.1 Unless a specific type is specified, Type 1 shall be supplied.

1.4 Safety - Hazardous Materials:

While the materials, methods, applications, and processes described or referenced in this specification may involve the use of hazardous materials, this specification does not address the hazards which may be involved in such use. It is the sole responsibility of the user to ensure familiarity with the safe and proper use of any hazardous materials and to take necessary precautionary measures to ensure the health and safety of all personnel involved.

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 2759 Heat Treatment, Steel Parts, General Requirements

2.2 ASTM Publications:

Available from ASTM, 1916 Race Street, Philadelphia, PA 19103-1187.

ASTM B 117 Salt Spray (Fog) Testing
ASTM B 487 Measurement of Metal and Oxide Coating Thicknesses by Microscopical Examination of a Cross Section
ASTM B 499 Measurement of Coating Thicknesses by the Magnetic Method: Nonmagnetic Coatings on Magnetic Basis Metals
ASTM B 504 Measurement of Thickness of Metallic Coatings by the Coulometric Method
ASTM B 568 Measurement of Coating Thickness by X-Ray Spectrometry
ASTM E 290 Semi-Guided Bend Test for Ductility of Metallic Materials
ASTM E 376 Measuring Coating Thickness by Magnetic-Field or Eddy-Current (Electromagnetic) Test Methods
ASTM F 519 Mechanical Hydrogen Embrittlement Testing of Plating Processes and Aircraft Maintenance Materials

2.3 U.S. Government Publications:

Available from Standardization Documents Order Desk, Building 4D, 700 Robbins Avenue, Philadelphia, PA 19111-5094.

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

3. TECHNICAL REQUIREMENTS:

3.1 Preparation:

3.1.1 All fabrication-type processes such as forming, machining, shot peening, heat treating, brazing, and welding shall be completed before parts are plated.

3.1.2 (R) Steel parts having hardness of 40 HRC or higher and which have been straightened, formed, or ground after heat treatment shall be suitably stress-relieved in accordance with AMS 2759 before cleaning for plating.

3.1.3 (R) Parts shall have clean surfaces free of water break prior to immersion in the plating solution.

3.1.4 (R) Parts having hardness of 33 HRC or higher and parts roll threaded after heat treatment shall not be cleaned with inorganic acids, such as hydrochloric or sulfuric, greater than 3% concentration by weight. Duration of cleaning in weak inorganic acids (3% or less concentration) shall be limited to 30 seconds or five seconds after the onset of gassing.

3.1.5 Electrical contacts between the parts and power source shall be made to ensure that neither chemical or immersion deposition nor electrical arcing or overheating will occur. If parts are to be plated all over, the location of contact points shall be optional unless 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.

3.1.6 (R) Prior to deposition of the zinc-nickel alloy, parts may be given an electrodeposited nickel strike, or may be dry or wet abrasive blasted. Mechanical finishing shall be completed prior to application of a nickel strike, and shall be accomplished in a manner that will not affect the appearance or quality of the finished part.

3.2 Procedure:

3.2.1 (R) Zinc-Nickel Alloy Plating: The zinc-nickel alloy plate shall be electrodeposited from a suitable electrolyte. Stress-reducing agents shall not be used unless specifically authorized by purchaser.

3.2.2 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 post-treated as in 3.3.1, 3.3.2, 3.3.3, or 3.3.4, as applicable, with heating commencing within four hours after removal from plating, unless otherwise permitted by purchaser; heating shall be in air, preferably in a circulating-air furnace.

3.3.1 (R) Springs and other parts having hardness of 45 HRC or higher shall be heated to 450 °F ± 15 (232 °C ± 8) and held at temperature for not less than three hours, unless otherwise specified by purchaser.

3.3.2 Parts cold worked after heat-treatment, including roll-threaded parts; parts having hardness of 33 HRC or higher but less than 45 HRC: and springs and other parts having hardness of 45 HRC or higher which will be deleteriously affected by heating to 450 °F (232 °C) shall be heated to 375 °F ± 15 (191 °C ± 8) and held at temperature for not less than three hours.

3.3.3 (R) Parts, including carburized parts, which will be deleteriously affected by heating to 375 °F (191 °C) shall be heated to 275 °F ± 15 (135 °C ± 8) and held at heat for not less than five hours.

3.3.4 Parts requiring special handling shall be post treated as specified by purchaser.

3.3.5 (R) Chromate Coating (Type 2 only): Following hydrogen relief as in 3.3, parts shall be placed in a chromating bath for sufficient time to deposit approximately 40 mg per square foot (430 mg/m^2) of chromate, rinsed in water not over 160 °F (71 °C) for 1/2 to 2 minutes, and air dried.

3.4 Properties:

Zinc-nickel alloy plate shall conform to the following requirements:

3.4.1 Composition: The zinc-nickel alloy plate shall contain 6 to 20% nickel and the balance essentially zinc, determined by a method agreed upon by purchaser and vendor.

3.4.2 (R) Thickness: Shall be as follows, determined on representative parts or test panels in accordance with ASTM B 487, ASTM B 499, ASTM B 504, ASTM B 568, ASTM E 376, or other method acceptable to purchaser. When both parts and specimens are tested, the thickness of plating on parts shall govern.

3.4.2.1 (R) Nickel Strike: When applied, shall be not less than 0.00005 inch (1.3 μm) thick.

3.4.2.2 Zinc-Nickel Alloy Plate:

3.4.2.2.1 Parts Other Than Washers and Parts Without External Threads: Shall have total plate thickness of 0.0003 to 0.0007 inch (8 to 18 μm).

3.4.2.2.2 Washers and Parts With External Threads: Shall have total plate thickness of 0.0002 to 0.0004 inch (5 to 10 μm).

3.4.2.2.3 (R) Except for external threads, thickness shall be considered only where surfaces of parts can be touched by a sphere 0.75 inch (19 mm) in diameter. 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.

3.4.3 (R) Adhesion: Specimens as in 4.3.3 shall not show separation of the plating from the basis metal, when examined at up to 4X magnification after being bent at room temperature, in accordance with ASTM E 290, through an angle of 180 degrees around a diameter equal to the thickness of the specimen. When a larger bend ratio is permitted by the applicable base metal specification, requirement of the base metal specification shall apply. Formation of cracks which do not result in flaking or blistering of the plating is acceptable.

3.4.4 (R) Corrosion Resistance: Parts or representative specimens, plated to a thickness of 0.0004 to 0.0007 inch (10 to 18 μm) shall show no visual evidence of corrosion of the basis metal in controlled thickness areas, determined by exposure for 500 hours to salt spray corrosion test conducted in accordance with ASTM B 117.

3.4.4.1 (R) Type 2 parts shall show no evidence of zinc corrosion products after 96 hours and no evidence of basis metal corrosion after 500 hours exposure to salt spray corrosion test conducted in accordance with ASTM B 117.

3.4.5 (R) Hydrogen Embrittlement: The plating process shall be non-embrittling, determined in accordance with ASTM F 519, Type 1a, 1b, or 1c.

3.5 (R) Quality:

Plating, as received by purchaser, shall be smooth, continuous, adherent to the basis metal, and essentially free from porosity, blisters, nodules, pits, and other imperfections detrimental to performance of the plating. Staining or discoloration is permissible.

3.5.1 Double plating and spotting-in after plating are not permitted.

4. QUALITY ASSURANCE PROVISIONS:

4.1 (R) Responsibility for Inspection:

The processing vendor shall supply all samples for processor's tests and shall be responsible for performing all required tests. 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 (R) Acceptance Tests: Tests for thickness (3.4.2.1 and 3.4.2.2) and quality (3.5) are acceptance tests and shall be performed to represent each lot.

4.2.2 (R) Periodic Tests: Tests for composition (3.4.1), adhesion (3.4.3), corrosion resistance (3.4.4 and 3.4.4.1) hydrogen embrittlement (3.4.5), and tests of preparatory and plating solutions to ensure that the deposited metal will conform to specified requirements are periodic tests and shall be performed quarterly when the process is in use unless other 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 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, contracting officer, or request for procurement.

4.3 Sampling and Testing:
(R)

Shall be not less than specified in 4.3.1 and 4.3.2. A lot shall be all parts of the same part number plated to the same range of plate thicknesses in the same set of solutions in no more than eight consecutive hours of operation, and presented for processor's inspection at one time.

4.3.1 For Acceptance Tests:

4.3.1.1 Thickness: Three parts or 0.1% from each lot, whichever is greater.

4.3.1.2 Quality: Shall be in accordance with the sampling plan shown in
(R) Table 1:

TABLE 1 - Quality Sampling Plan

Number of Parts in Lot	Number of Parts to be Sampled
Up to 40, incl	All
Over 40 to 110, incl	15
Over 110 to 300, incl	25
Over 300 to 500, incl	35
Over 500	50

4.3.2 For Periodic Tests and Preproduction Tests: Quarterly, or as agreed upon
(R) by purchaser and vendor. Each sample submitted for composition (3.4.1), adhesion (3.4.3), corrosion resistance (3.4.4 and 3.4.4.1), and hydrogen embrittlement (3.4.5) shall consist of not less than three specimens.

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 thickness tests, specimens shall be a strip of the same alloy as the parts being plated, approximately 0.040 x 4 x 1 inch (1.02 x 102 x 25 mm). For corrosion tests, specimens shall be the same size except a low-alloy or carbon steel may be used.

4.4 Approval:

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