SAE Aerospace
An SAE International Group

AEROSPACE MATERIAL SPECIFICATION

SAE AMS 2417G

Issued JUN 1960
Revised JUL 2004

Superseding AMS 2417F

Plating, Zinc-Nickel Alloy

1. SCOPE:

1.1 Purpose:

This specification covers the 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 500 °F (260 °C) (Type 1), up to 250 °F (121 °C) (Type 2), or up to 350 °F (177 °C) (Type 3), but usage is not limited to such applications (See 8.9 and 8.10).

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
Type 3 As-plated with supplementary phosphate treatment (Adhesion base for primer/paint)

1.3.1 Unless a type is specified, Type 2 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 that 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 the necessary precautionary measures to ensure the health and safety of all personnel involved.

TO PLACE A DOCUMENT ORDER: **Tel: 877-606-7323 (inside USA and Canada)**
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SAE WEB ADDRESS: **http://www.sae.org**

2. APPLICABLE DOCUMENTS:

The issue of the following documents in effect on the date of the purchase order forms a part of this specification to the extent specified herein. The supplier may work to a subsequent revision of a document unless a specific document issue is specified. When the referenced document has been canceled and no superseding document has been specified, the last published issue of that document shall apply.

2.1 SAE Publications:

Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001 or www.sae.org.

AMS 2759/9	Hydrogen Embrittlement Relief (Baking) of Steel Parts

2.2 ASTM Publications:

Available from ASTM, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959 or www.astm.org.

ASTM B 117	Practice for Operating Salt Spray (Fog) Apparatus
ASTM B 253	Guide for Preparation of Aluminum Alloys for Electroplating
ASTM B 487	Test Method for Measurement of Metal and Oxide Coating Thicknesses by Microscopical Examination of a CrossSection
ASTM B 499	Test Method for Measurement of Coating Thicknesses by the Magnetic Method: Nonmagnetic Coatings on Magnetic Basis Metals
ASTM B 504	Test Method for Measurement of Thickness of Metallic Coatings by the Coulometric Method
ASTM B 568	Test Method for Measurement of Coating Thickness by X-Ray Spectrometry
ASTM B 571	Test Methods for Adhesion of Metallic Coatings
ASTM E 376	Practice for Measuring Coating Thickness by Magnetic-Field or Eddy-Current (Electromagnetic) Examination Methods
ASTM F 519	Test Method for Mechanical Hydrogen Embrittlement Evaluation of Plating Processes and Service Environments

3. TECHNICAL REQUIREMENTS:

3.1 Preparation:

3.1.1 Steel parts having a hardness of 40 HRC or higher and which have been straightened, formed, or ground after heat treatment shall be suitably stress relieved before cleaning and plating. Temperatures to which parts are heated shall be such that maximum stress relief is obtained without reducing hardness of parts below drawing limits, but, unless otherwise specified, not less than 275 °F ± 10 (135 °C ± 6) for not less than five hours for parts 55 HRC or greater, or 375 °F ± 25 (191 °C ± 14) for not less than four hours for other parts.

3.1.2 Parts shall have clean surfaces free of water break prior to immersion in the plating solution.

3.1.3 Electrical contact between the parts and power source shall be made to prevent chemical or immersion deposition, electrical arcing, and overheating. If parts are to be plated all over, contact points shall be located where specified or where agreed upon by purchaser and processor. If parts are not required to be plated all over, contact points shall be located on areas on which plating is not required or is optional.

3.1.4 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, if employed, shall be completed prior to application of a nickel strike, when used, 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 The zinc-nickel alloy plate shall be electrodeposited from a suitable electrolyte. Stress-reducing agents shall not be used unless approved by purchaser.

3.2.1.1 Aluminum alloys may be zincate treated in accordance with ASTM B 253 before plating.

3.2.1.2 Parts which specify Type 2 plating shall be given a supplementary chromate conversion coating, which will meet the requirements of 3.4.4.2. Any post thermal treatment shall be done prior to application of the chromate conversion treatment. Steel parts requiring a post thermal treatment as in 3.3 may require reactivation prior to application of the conversion coating.

3.2.1.3 Parts which specify Type 3 plating shall, after hydrogen embrittlement relief baking, be given a supplementary zinc phosphate conversion coating, which meets the requirements of 3.4.4.3. Steel parts requiring post thermal treatment as in 3.3 may require reactivation prior to application of the conversion coating.

3.3 Hydrogen Embrittlement Relief:

Treatment of steel parts shall be in accordance with AMS 2759/9.

3.4 Properties:

Zinc-nickel alloy plate shall conform to the following requirements. (Composition and thickness for Types 2 and 3 apply prior to conversion coating).

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

3.4.2 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 (See 8.3).

3.4.2.1 Nickel Strike: When applied, shall be 0.0001 inch (2.5 µm) maximum.

3.4.2.2 Zinc-Nickel Alloy Plate:

3.4.2.2.1 Parts Without External Threads (other than washers): 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 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 Adhesion: Shall meet the requirements of ASTM B 571 for zinc plating.

3.4.4 Corrosion Resistance:

3.4.4.1 Type 1 plated 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 red corrosion on 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 (See 4.3.1.3).

3.4.4.2 Type 2 plated 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 white corrosion product after 96 hours and no evidence of red corrosion on the basis metal in controlled thickness areas after 500 hours, determined by exposure to salt spray corrosion testing in accordance with ASTM B 117. (See 4.3.1.3).

3.4.4.3 Type 3 plated parts or representative specimens, which have received a supplementary Type 3 phosphate conversion coating shall be uniform in texture, evenly deposited, and medium gray to black in color. The coating shall not show smut, powder, or white stains. Corrosion test not required; visual requirement only.

3.4.5 Hydrogen Embrittlement: The plating process shall not cause hydrogen embrittlement in steel parts, after baking, determined in accordance with ASTM F 519 (See 4.3.1.4).

3.5 Quality:

Plating, as received by purchaser, shall be smooth, continuous, adherent to the basis metal, and visually free from porosity, blisters, nodules, pits, and other imperfections detrimental to performance of the plating. Slight staining or discoloration is permissible. There shall be no evidence of double plating or spotting-in.

4. QUALITY ASSURANCE PROVISIONS:

4.1 Responsibility for Inspection:

The processor shall supply all samples for processor's tests and shall be responsible for the performance of all required tests. Parts, if required for tests, shall be supplied by purchaser. Purchaser reserves the right to sample and to perform any confirmatory tests deemed necessary to ensure that processing conforms to the specified requirements.

4.2 Classification of Tests:

4.2.1 Acceptance Tests: Thickness (3.4.2), adhesion (3.4.3), and quality (3.5) are acceptance tests and shall be performed to represent each lot.

4.2.2 Periodic Tests: Composition (3.4.1), corrosion resistance (3.4.4.2) (white corrosion product only), hydrogen embrittlement (3.4.5), and tests of preparatory and plating solutions (See 8.7) to ensure that the deposited metal will conform to specified requirements are periodic tests and shall be performed at a frequency selected by the processor unless frequency of testing is specified by purchaser, except corrosion resistance (3.4.4.2), which shall be conducted not less than monthly.

4.2.3 Preproduction Tests: 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 by the cognizant engineering organization (See 4.4.2), and when purchaser deems confirmatory testing to be required.

4.3 Sampling and Testing:

Shall be not less than the following: A lot shall be all parts of the same material and part number or similar part configuration, plated to the same range of plate thickness using the same solutions, plated in a single, continuous plating cycle, not to exceed 16 hours, and presented for processor's inspection at one time.

4.3.1 Sample Configuration:

4.3.1.1 Nondestructive testing shall be performed wherever practical and authorized herein. Except as noted, actual parts shall be selected as samples for tests.

4.3.1.2 Thickness and Adhesion: Separate test panels of the same generic class of alloy and heat treat condition as the parts, distributed throughout the lot, cleaned, plated, and post treated with the parts represented shall be used when plated parts are of such configuration or size as to be not readily adaptable to the specified tests, when nondestructive testing is not practical on actual parts, or it is not economically acceptable to perform destructive tests on actual parts.

4.3.1.3 Corrosion Test: Panels shall be low carbon steel approximately 0.032 x 4 x 6 inches (0.8 x 102 x 153 mm) or bars approximately 0.5 inch (13 mm) in diameter and 4 inches (102 mm) long having a surface roughness not exceeding 40 microinches (1 µm).

4.3.1.4 Hydrogen Embrittlement Relief Test: Test specimens shall conform to ASTM F 519, Type 1a, notched round bars stressed in tension under constant load. For test purposes the specimens shall be prepared, plated, and post plate baked in accordance with this specification. The plate thickness shall be 0.0005 to 0.0007 inch (8 to 18 µm) on unnotched surfaces with visual evidence of plating at the root of the notch.

4.3.2 For Acceptance Tests: Test samples shall be selected from all parts in the lot, unless purchaser specifies a sampling plan; the minimum number of samples shall be as shown in Table 1:

TABLE 1 – Sampling for Acceptance Tests

Number of Parts in the Lot	Quality	Adhesion and Thickness
Up to 7	All	3
8 to 15	7	4
16 to 40	10	4
41 to 110	15	8
111 to 300	25	9
301 to 500	35	7
501 to 700	50	8
701 to 1200	75	10
Over 1200	125	15

4.3.2.1 Periodic Tests: Sample quantities and frequency of testing shall be at the discretion of the processor unless otherwise specified by purchaser, except for periodic white corrosion tests in 3.4.4.2, which shall be conducted.

4.4 Approval:

4.4.1 The process and control procedures, a preproduction sample part, or both, whichever is specified, 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 controls from those on which the approval was based, unless the change is approved by the cognizant engineering organization. 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 strike, if used
Plating bath composition and composition control limits
Type of supplementary coating, if used
Thermal pretreatment times and temperatures
Thermal post treatment times and temperatures
Method of testing plating thickness
Method of adhesion testing
Periodic test plan.

4.5 Reports:

The processor of plated parts shall furnish with each shipment a report stating that the parts have been processed and tested in accordance with the specified requirements and that they conform to acceptance test requirements. This report shall include the purchase order number, lot number, AMS 2417G, part number, and quantity.

4.6 Resampling and Retesting:

4.6.1 If the results of any acceptance test fails to meet the specified requirements, the parts represented may be stripped by a method acceptable to the purchaser that does not roughen, pit, or adversely affect part dimensions, pretreated, coated, supplementary treated, if specified, as defined herein, and tested. Alternatively, all parts in the lot may be inspected for the nonconforming attribute, and the nonconforming parts may be stripped by a method acceptable to purchaser that does not roughen, pit, or adversely affect part dimensions and treated as above.

4.6.2 If the results of any periodic test fails to meet the specified requirements, the process is nonconforming. No additional part shall be coated until the process is corrected and new specimens are coated and tested. Results of all tests shall be recorded, and, when requested, reported. Purchaser shall be notified of all parts coated since the last acceptable test.

5. PREPARATION FOR DELIVERY:

5.1 Plated parts shall be handled and packaged to ensure that the required physical characteristics and properties of the plate are preserved.

5.2 Packages of plated parts shall be prepared for shipment in accordance with commercial practice and in compliance with applicable rules and regulations pertaining to the handling, packaging, and transportation of the parts to ensure carrier acceptance and safe delivery.