AEROSPACE MATERIAL SPECIFICATION

AMS2417	REV. J
Issued 1960-06 Revised 2013-09 Superseding AMS2417H	

Plating, Zinc-Nickel Alloy

RATIONALE

AMS2417J is issued to add control of stress relief heat treatment furnace equipment in accordance with AMS2750.

NOTICE

ORDERING INFORMATION: The following information shall be provided to the plating processor by the purchaser.

1. Purchase order shall specify not less than the following:

   - AMS2417J
   - Plating thickness, if other than specified in 3.4.2.3.
   - Type and Grade designation. See 1.3.
   - Basis metal to be plated
   - Tensile strength or hardness of the basis metal
   - Pre-plate stress relief to be performed by plating processor (time and temperature) if different from 3.1.1
   - Special features, geometry or processing present on parts that requires special attention by the plating processor
   - Hydrogen embrittlement relief to be performed by plating processor (parameters or reference document) if different from 3.3
   - Minimum thickness on internal surfaces, if required. See 3.4.2.1.
   - Optional: Periodic testing frequency (4.2.2) and sample quantity (4.3.2)
   - Quantity of pieces to be plated

2. Parts manufacturing operations such as heat treating, forming, joining and media finishing can affect the condition of the substrate for plating, or if performed after plating, could adversely affect the plated part. The sequencing of these types of operations should be specified by the cognizant engineering organization or purchaser and is not controlled by this specification.

TO PLACE A DOCUMENT ORDER: **Tel: 877-606-7323 (inside USA and Canada)**
Tel: +1 724-776-4970 (outside USA)
Fax: 724-776-0790
Email: CustomerService@sae.org
SAE WEB ADDRESS: **http://www.sae.org**

SAE values your input. To provide feedback on this Technical Report, please visit
http://www.sae.org/technical/standards/AMS2417J

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

Zinc-nickel plating has been used typically to provide corrosion resistance to steel parts that may operate at elevated temperatures (See 1.3) 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, service temperature 500 °F (260 °C) max.

Type 2 As-plated with supplementary chromate treatment

Grade A Hexavalent chromate treatment, service temperature 250 °F (121 °C) max.

Grade B Trivalent chromium treatment, service temperature 375 °F (191 °C) max.

Type 3 As-plated with supplementary phosphate treatment (Adhesion base for primer/paint), service temperature 350 °F (177 °C) max.

1.3.1 Unless a type is specified, Type 2 shall be supplied.

1.3.2 For Type 2 plating, if no grade is specified, Grade A 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.

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 cancelled and no superseding document has been specified, the last published issue of that document shall apply.

2.1 SAE Publications

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or 724-776-4970 (outside USA), www.sae.org.

AMS2750 Pyrometry

AMS2759/9 Hydrogen Embrittlement Relief (Baking) of Steel Parts

AS2390 Chemical Process Test Specimen Material

2.2 ASTM Publications

Available from ASTM International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959, Tel: 610-832-9585, 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 Stress Relief Treatment

3.1.1.1 Furnaces used for stress relief shall be controlled per AMS2750. The minimum requirements shall be Class 5, with Type D Instrumentation.

3.1.1.2 All steel parts having a hardness of 40 HRC and above and that are machined, ground, cold formed or cold straightened after heat treatment shall be cleaned to remove surface contamination and thermally stress relieved before plating. (Residual tensile stresses have been found to be damaging during electrofinishing.) Temperatures to which parts are heated shall be such that stress relief is obtained while still maintaining hardness of parts within drawing limits. Unless otherwise specified, the following treatment temperatures and times shall be used:

3.1.1.2.1 For parts, excluding nitrided parts, having a hardness of 55 HRC and above, including carburized and induction hardened parts, stress relieve at 275 °F ± 25 (135 °C ± 14) for 5 to 10 hours.

3.1.1.2.2 For parts having a hardness less than 55 HRC, and all nitrided parts, stress relieve at 375 °F ± 25 (191 °C ± 14) for a minimum of 4 hours. Higher temperatures may be used only when specified or approved by the cognizant engineering organization.

3.1.1.2.3 For peened parts: If stress relief temperatures above 375 °F (191 °C) are elected, the stress relief shall be performed prior to peening or the cognizant engineering organization shall be consulted and shall approve the stress relief temperature.

3.1.2 The plating shall be applied over a surface free from water breaks. The cleaning procedure shall not produce pitting or intergranular attack of the basis metal and shall preserve dimensional requirements.

3.1.3 Except for barrel plating, electrical contact points shall be as follows. For parts which are to be plated all over, locations shall be acceptable to the purchaser. For parts which are not to be plated all over, locations shall be in areas on which plating is not required, or locations shall be specified or approved by the cognizant engineering organization.

3.1.4 Mechanical surface preparation, such as a dry or wet abrasive blast, if employed, shall be completed prior to application of a strike such as nickel, copper or zinc, when used, and shall be accomplished in a manner that will not have a detrimental effect on the appearance or quality of the finished part.

3.2 Procedure

3.2.1 Parts shall be plated by electrodeposition of a zinc-nickel alloy plating onto a properly prepared surface. See 8.5.1.

3.2.1.1 Aluminum alloys shall be zincate treated in accordance with ASTM B 253 or other method permitted by the cognizant engineering organization prior to plating.

3.2.1.2 Parts for which Type 2 plating is specified shall be given a supplementary chromate conversion coating and 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 for which Type 3 plating is specified shall, after hydrogen embrittlement relief baking, be given a supplementary zinc phosphate conversion coating and meet 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.

3.2.1.4 Parts for which Type 2 Grade B plating is specified shall be given a supplementary trivalent chromium conversion coating and meet the requirements of 3.4.4.4. Any post thermal treatment shall be done after application of the trivalent chromium conversion treatment.

3.2.2 Spotting-in and double plating are prohibited. See 8.2.1.

3.3 Hydrogen Embrittlement Relief

Treatment of steel parts shall be in accordance with AMS2759/9.

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 acceptable to purchaser. Composition testing for Types 2 and 3 apply prior to conversion coating.

3.4.2 Thickness shall be determined on representative parts or test panels in accordance with any of the following methods as applicable: ASTM B 487, ASTM B 499, ASTM B 504, ASTM B 568, ASTM E 376, or other method permitted by the cognizant engineering organization. Thickness requirements for Types 2 and 3 apply prior to conversion coating.

3.4.2.1 All surfaces of the part, except those which cannot be touched by a sphere 0.75 inch (19 mm) in diameter, shall be plated to the specified thickness. Unless otherwise specified, surfaces such as holes, recesses, threads and other areas where a controlled deposit cannot be obtained under normal plating conditions, may be under the specified limit provided they show visual plating coverage.

3.4.2.2 Strike

When applied, shall be 0.0001 inch (2.5 µm) maximum. See 8.5.1.

3.4.2.3 Zinc-nickel alloy plate, unless otherwise specified

3.4.2.3.1 Parts without external threads (other than washers) shall have total plate thickness of 0.0003 to 0.0007 inch (8 to 18 µm).

3.4.2.3.2 Washers and parts with external threads shall have total plate thickness of 0.0002 to 0.0004 inch (5 to 10 µm).

3.4.3 Adhesion shall meet the requirements of ASTM B 571 by the Bend Test method using a 4T mandrel.

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 after exposure for 500 hours to salt spray corrosion test conducted in accordance with ASTM B 117. See 4.3.3.2.

3.4.4.2 Type 2, Grade A-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 after exposure to salt spray corrosion testing in accordance with ASTM B 117. See 4.3.3.2.

3.4.4.3 Type 3-plated parts (or representative specimens) that have received a supplementary coating shall not show smut, powder, or white stains. (Corrosion test not required; visual requirement only. See 3.5 and 4.2.2.)

3.4.4.4 Type 2, Grade B-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 after exposure to salt spray corrosion testing in accordance with ASTM B 117. See 4.3.3.2.

3.4.5 Hydrogen Embrittlement

The plating process after baking shall not cause hydrogen embrittlement in steel parts 36 HRC and over, determined in accordance with 4.3.3.3.

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. Type 3 phosphate conversion coating shall be uniform in texture, evenly deposited, and medium gray to black in color.

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. When parts are to be tested, the parts shall be supplied by purchaser. The cognizant engineering organization 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) and quality (3.5) are acceptance tests and shall be performed on parts, or specimens representing parts when permitted herein from each lot. See 4.3.3.

4.2.2 Periodic Tests

Composition (3.4.1) is a periodic test and shall be performed at least quarterly unless frequency of testing is specified by the cognizant engineering organization. Adhesion (3.4.3) is a periodic test that shall be performed no less than daily for each generic class of alloy as defined by AS2390 processed during that day. Corrosion resistance (white corrosion product only) (3.4.4.2 or 3.4.4.4) is a periodic test and shall be performed at least monthly unless frequency of testing is specified by the cognizant engineering organization. Corrosion resistance (red corrosion) (3.4.4.1, 3.4.4.2, or 3.4.4.4) is a periodic test and shall be performed at least annually unless frequency of test is specified by the cognizant engineering organization. Hydrogen embrittlement (3.4.5) is a periodic test and shall be performed at least once in each month that steel parts 36 HRC and over are plated unless frequency of testing is specified by the cognizant engineering organization. Tests of cleaning and plating solutions are periodic tests and shall be performed at a frequency established by the processor unless frequency of testing is specified by the cognizant engineering organization. See 4.3.2.

4.2.2.1 Periodic testing may be suspended in any test period (e.g., month or quarter) when parts are not processed; however, preproduction testing may be required by the cognizant quality organization upon resumption of processing.

4.2.3 Preproduction Tests

All property verification tests (3.4) are preproduction tests and shall be performed prior to or on the initial shipment of plated parts to a purchaser and when the cognizant engineering organization requires confirmatory testing. All property verification tests (3.4) are preproduction tests and shall be performed prior to production and when the cognizant engineering organization requires confirmatory testing.

4.3 Sampling for Testing

4.3.1 Acceptance Tests

Test samples shall be randomly selected from all parts in the lot. 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 operation (3.2), not to exceed 16 hours, and presented for processor's inspection at one time. Unless the cognizant engineering organization provides 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	Thickness
Up to 7	All	3 or all*
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

*Whichever is less

4.3.2 Periodic Tests

Sample quantity shall be two for corrosion resistance. For adhesion tests, four test specimens of each generic class of alloy, as defined by AS2390, that have been be processed through the same cleaning and plating operations as the parts that they represent. These adhesion test specimens shall be processed prior to the first production lot of parts or with the first production lot of parts. For hydrogen embrittlement, sample size as specified in ASTM F 519 unless otherwise specified by the cognizant engineering organization. Sample quantities for other tests shall be at the discretion of the processor unless otherwise specified by the cognizant engineering organization.

4.3.3 Sample Configuration

Nondestructive testing shall be performed wherever practical. Except as noted, actual parts shall be selected as samples for tests. Since properties, such as thickness, may differ on panels, correlation with actual parts shall be established.

4.3.3.1 Representative test specimens in lieu of parts may be used under any one of the following circumstances: The plated parts are of such configuration or size as to be not readily adaptable to specified tests, nondestructive testing is not practical on actual parts, or it is not economically acceptable to perform destructive tests on actual parts. Except as specified below, acceptance test specimens shall be made of the same generic class of alloy as the parts, established in accordance with AS2390, distributed within the lot, cleaned, plated, and post treated with the parts represented.

4.3.3.2 Corrosion Testing

When ferrous alloy parts are processed within the test period (month), test panels shall be low carbon or low alloy steel 0.025 inch (0.6 mm) minimum thickness and not less than 4 x 6 inches (102 x 152 mm) or bars approximately 0.5 inch (13 mm) in diameter and 4 inches (102 mm) long having a surface roughness not to exceed 40 microinches (1 µm) AA. Aluminum alloy test panels (same panel size as for steel) made of either 2024-T3 or the same generic class of alloy as the parts processed within the test period when aluminum alloy parts are plated. Test panels, made of the predominant generic class of alloy as the parts plated within the test period may be used when permitted by the cognizant engineering organization. Alternative alloy or configuration may be used when permitted by the cognizant engineering organization. Plating thickness shall be in accordance with 3.4.2.

4.3.3.3 Hydrogen Embrittlement Test

Test shall be in accordance with the requirements of ASTM F 519 Type 1a.1 using round notched specimens, unless a different specimen is specified by the cognizant engineering organization, stressed in tension under constant load. For test purposes, the plating thickness shall be 0.0005 to 0.0007 inch (8 to 18 µm) measured on the smooth section of the specimen, but with visual evidence of plating at the root of the notch. Testing beyond the 200 hour test period is not required. The test samples shall be exposed to all steps of the documented plating process including stress relieve, surface preparation (reagent, electro-cleaning or abrasive blasting as applicable), electrodeposition of the zinc nickel onto the basis metal, and the prescribed baking schedule per AMS2759/9.

4.3.3.4 Adhesion Testing

Test specimens for adhesion testing shall be made of the same generic class of alloy as defined by AS2390 processed. The test specimens shall be 0.025 inch (0.6 mm) minimum thickness and not less than 1 x 4 inches (25 x 102 mm).

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 If the processor makes a significant change to any material, process, or control from that which was used for process approval, all preproduction tests shall be performed and the results submitted to the cognizant engineering organization for process reapproval 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. . Production parts plated by the revised procedure shall not be shipped prior to receipt of reapproval without authorization from the purchaser.

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 for cleaning and processing solutions. See 8.8.