AEROSPACE MATERIAL SPECIFICATION

AMS2403™	REV. P

Issued 1948-11
Reaffirmed 2009-06
Revised 2020-12

Superseding AMS2403N

Plating, Nickel General Purpose

RATIONALE

AMS2403P results from a Five-Year Review and update of this specification with changes to ordering information, fixture/electrical contact locations reworded (3.1.3), procedure clarified and adding that spotting in is not allowed (3.2.1, 3.2.1.1, 3.2.2), thickness changed to allow direct measurement (3.4.1, 3.4.1.3, 3.1.1.3, 3.4.1.4), adhesion test clarification (3.4.2.1, 3.4.2.2, 3.4.2.2), heat resistance test clarification (3.4.3), corrosion resistance (3.4.4), hydrogen embrittlement (3.4.5), quality clarification (3.5), acceptance tests (4.2.1.1), sampling and testing lot standard wording and standard specimen size (4.3, 4.3.2, 4.3.3), approval clarification (4.4.1, 4.4.3), resampling and retesting (4.6), rejections (Section 7), and notes added (8.7, 8.8).

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:

   - AMS2403P
   - Plating thickness desired (see 3.4.1)
   - Basis metal to be plated
   - Tensile strength or hardness of the basis metal
   - If pre-plate stress relief is to be performed by plating processor and if different from 3.1.1, time and temperature are to be specified
   - 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 3.3.1
   - Minimum thickness on internal surfaces, if required (see 3.4.1.2)
   - Quantity of pieces to be plated

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**

For more information on this standard, visit
https://www.sae.org/standards/content/AMS2403P

- Optional: Fixture/electrical contact locations, when not specified (3.1.3)
- If steel parts were machined, ground, cold formed or cold straightened after heat treat (3.1.1.1)
- If steel parts have been shot peened, specify if required stress relief has been completed (3.1.1.1.3)

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.

1. SCOPE

1.1 Purpose

This specification covers the engineering requirements for electrodeposition of nickel and the properties of the deposit.

1.2 Application

This process has been used typically to provide moderate corrosion and oxidation resistance to metal parts but without control of other characteristics, and for the buildup of surfaces, but usage is not limited to such applications. If a hard plate is required, AMS2423 should be used; if a low-stressed plate is required, AMS2424 should be used.

1.3 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 issues 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 International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or +1 724-776-4970 (outside USA), www.sae.org.

AMS2423	Plating, Nickel, Hard Deposit
AMS2424	Plating, Nickel, Low Stressed Deposit
AMS2750	Pyrometry
AMS2759/9	Hydrogen Embrittlement Relief (Baking) of Steel Parts
ARP1917	Clarifications of Terms Used in Aerospace Metals Specifications
ARP4992	Periodic Test Plan for Process Solutions
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 B117 Operating Salt Spray (Fog) Apparatus

ASTM B374 Terminology Relating to Electroplating

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 B530 Measurement of Coating Thicknesses by the Magnetic Method: Electrodeposited Nickel Coatings on Magnetic and Nonmagnetic Substrates

ASTM B567 Measurement of Coating Thickness by the Beta Backscatter Method

ASTM B568 Measurement of Coating Thickness by X-Ray Spectrometry

ASTM B571 Qualitative Adhesion Testing of Metallic Coatings

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

ASTM F519 Mechanical Hydrogen Embrittlement Evaluation of Plating/Coating Processes and Service Environments

3. TECHNICAL REQUIREMENTS

3.1 Preparation

3.1.1 Stress Relief Treatment

3.1.1.1 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 electroplating.) Furnaces used for stress relief shall be controlled per AMS2750; the minimum requirements shall be Class 5, with Type D Instrumentation. 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:

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

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

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

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

3.1.3 Fixture/Electrical Contact Locations

3.1.3.1 Except for barrel plating, for parts that are to be electroplated/coated all over, and contact locations are not specified, contact locations shall be at the discretion of the processor.

3.1.3.2 For parts that are not to be electroplated/coated all over, and contact locations are not specified, locations shall be in areas on which coating is not required.

3.2 Procedure

3.2.1 Nickel shall be electrodeposited from a suitable plating solution. Additives are permitted only if they do not have a detrimental effect on the properties of the plate or the basis metal; stress-reducing agents shall not be used unless specifically authorized by cognizant engineering organization. The addition of organic wetting agents for the purpose of lowering surface tension and to avoid gas-pitting is permitted. Except as specified in 3.2.1.1, nickel shall be deposited directly on the basis metal without a prior strike of metal other than nickel.

3.2.1.1 A preliminary chemical coating, immersion plate, and/or strike is permissible on aluminum, magnesium, beryllium, titanium, and their alloys.

3.2.2 Spotting in is not permitted.

3.3 Hydrogen Embrittlement Relief

After plating, rinsing, and drying, steel parts shall be treated in accordance with AMS2759/9. Parts, if plated as an aid to brazing, and if brazed within four hours after completion of plating, do not require hydrogen embrittlement relief.

3.4 Properties

3.4.1 Thickness

Thickness shall be as specified on the drawing determined in accordance with any of the following methods as applicable: ASTM B487, ASTM B499, ASTM B504, ASTM B530, ASTM B567, ASTM B568, ASTM E376, direct dimensional inspection provided the resolution of the measuring instrument is ten times more precise than the attribute being measured or other method acceptable to cognizant engineering organization.

3.4.1.1 Where "nickel flash" is specified, plate thickness shall be approximately 0.0001 inch (2.5 µm).

3.4.1.2 For surfaces that will not be machined after plating, the plate shall be substantially uniform in thickness on significant surfaces except that slight buildup on exterior corners or edges will be permitted provided finished drawing dimensions are met.

3.4.1.3 For selective plating, specific areas to be plated shall be as specified on the engineering drawing. Otherwise, all surfaces of the part, except those that 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.

3.4.1.4 If internal surfaces are required to be plated to meet a thickness requirement, the drawing shall so specify.

3.4.2 Adhesion

3.4.2.1 Specimens

Adhesion shall be tested for in accordance with the ASTM B571 multiple bend test method with the specimens, as in 4.3.3, bent repeatedly back and forth through an angle of 180 degrees until failure of the basis metal occurs (see 8.8). Examine the region at low magnification for separation, for example, 4X, for separation or peeling of the coating. Formation of cracks that do not result in flaking or blistering of the plate is acceptable. Other adhesion test methods specified in ASTM B571 may be used when permitted by the cognizant engineering organization.

3.4.2.2 Machined Plating

Adhesion of plating after finish machining of the plating will be considered acceptable evidence of plating adhesion in lieu of testing per ASTM B571 and is not subject to periodic testing in 4.2.2.

3.4.2.3 Parts

When specified by the cognizant engineering organization, there shall be no blisters or other evidence of poor adhesion when parts are subjected to the heat-quench test of ASTM B571.

3.4.3 Heat Resistance

Specimens as in 4.3.3, except alloys of aluminum, copper, titanium, and magnesium, shall show no cracks or blisters in the plate after being heated to 1000 °F ± 25 °F (538 °C ± 14 °C), held at heat for not less than 2 hours, and cooled; heating shall be in a circulating-air furnace.

3.4.4 Corrosion Resistance

Carbon and low-alloy steel parts (except as provided in 3.4.1.3) when required by cognizant engineering organization, or test specimens, excluding those parts plated to aid in brazing or where plating is used for dimensional restoration, shall show no visual evidence of corrosion after being subjected for not less than 48 hours to a continuous salt spray corrosion test conducted in accordance with ASTM B117 when plate is in the following conditions:

3.4.4.1 When specified minimum plate thickness is 0.002 inch (51 µm) or greater, parts or panels shall withstand the test either after embrittlement relief as in 3.3 or after the heat resistance test of 3.4.3 following embrittlement relief as in 3.3.

3.4.4.2 When specified minimum plate thickness is 0.0005 inch (12.7 µm) or greater but less than 0.002 inch (51 µm), parts or panels shall withstand the test only after the heat resistance test of 3.4.3 following embrittlement relief as in 3.3.

3.4.5 Hydrogen Embrittlement

The plating process shall not cause hydrogen embrittlement in ferrous metals. Testing in accordance with the requirements of ASTM F519 Type 1A using notched round specimens, unless a different specimen type is specified by the cognizant engineering organization, stressed in tension under t sustained load, is required only when parts 40 HRC or higher are plated. For test purposes, plating thickness shall be not less than 0.002 inch (51 µm), measured on the smooth section of the specimen, but with visual plating at the root of the notch. Testing beyond the 200 hour test period is not required.

3.5 Quality

Plating, as received by purchaser, shall be smooth, continuous, adherent to the basis metal, and uniform in appearance and shall be visually free from frosty areas, pin holes, porosity, blisters, nodules, pits, and other imperfections detrimental to usage of the plating. If the nickel is to be machined these conditions apply after machining. Slight staining or discoloration is permissible. There shall be no evidence of double plating or spotting-in after plating.

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. Where actual parts are to be tested, such parts shall be supplied by purchaser. 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

Thickness (3.4.1) and quality (3.5) are acceptance tests and shall be performed to represent each lot.

4.2.1.1 If the nickel plate is used for brazing preparation, acceptance test requirements for thickness and adhesion may be modified with the approval of the cognizant engineering organization.

4.2.2 Periodic Tests

Heat resistance (3.4.3), corrosion resistance (3.4.4), and embrittlement (3.4.5) are periodic tests and shall be performed at least monthly unless frequency of testing is specified by the cognizant engineering organization. Adhesion (3.4.2) 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. Tests of cleaning and plating solutions (see 8.5) to ensure that the deposited metal will conform to this specification.

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 is a group of parts, all of the same part number, processed through the same chemical solutions in the same tanks under the same conditions, which have completed the chemical processing within a period of 24 hours of each other and are presented to inspection at the same time.

4.3.1 For Acceptance Tests

Test samples shall be selected randomly from all parts in the lot. The minimum number of samples shall be as shown in Table 1.

Table 1 - Sampling for acceptance tests

Number of Parts in Lot	Quality	Thickness
Up to 7	All	3
8 to 15	7	4
16 to 40	10	4
41 to 110	15	5
111 to 300	25	6
301 to 500	35	7
Over 500	50	8

4.3.2 Periodic Tests

Sample quantity and frequency of testing shall be at the discretion of the processor unless a test frequency is specified by the cognizant engineering organization. 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.