AEROSPACE MATERIAL SPECIFICATION

AMS-QQ-P-416™	REV. F
Issued 2000-07 Revised 2021-03 Superseding AMS-QQ-P-416E	

(R) Plating, Cadmium (Electrodeposited)

RATIONALE

AMS-QQ-P-416F results from a Five-Year Review and complete revision of this specification.

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:

- AMS-QQ-P-416F
- Type (see 1.3.1)
- Class (see 1.3.2)
- Thickness of plating (see 3.3.1)
- Quantity of pieces to be plated
- Lot hydrogen embrittlement testing if required and sampling (see 4.4.2.3)
- Basis metal to be plated
- Tensile strength or hardness of the basis metal (see 5.2.5)
- Preplate stress relief to be performed by plating processor (time and temperature) if different from 3.2.1
- Stress and embrittlement relief temperature if the upper operating temperature is less than 275 °F (135 °C) (see 3.2.1.6 and 3.2.7.1)
- Special features, geometry, or processing present on components that requires special attention by the plating processor
- Hydrogen embrittlement relief to be performed by plating processor (parameters or reference document) if different from 3.3.4
- If steel components were machined, ground, cold formed or cold straightened after heat treatment (see 3.2.1)

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/AMSQQP416F

- Statement that all heat treatments and mechanical operations such as machining, brazing, welding, forming, and perforating have been completed prior to plating (see 3.2.3)
- Optional: Fixture/electrical contact locations, when not specified (see 3.2.5)
- Optional: Hydrogen embrittlement relief testing of each lot (see 4.4.2.3)
- Optional: Process approval requirement (see 4.7.1)
- Optional: Processing records requirement (see 4.7.2)

2. Components 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 component. 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 requirements for electrodeposited cadmium plating.

1.2 Application

The electrodeposited cadmium platings covered by this specification are intended for use as corrosion protective coatings. Unless otherwise specified, components heat treated to an ultimate tensile strength greater than 200 ksi (1379 MPa) or harder than 43 HRC should not be plated in accordance with this specification. Section 5 contains more information about the appropriateness of this process and the coating material. It also describes alternatives to cadmium plating.

1.3 Classification

Cadmium plating shall be of the following types and classes, as specified (see ordering information):

1.3.1 Types

I - As plated
II - With supplementary chromate treatment (see 3.2.9.1 and 3.2.9.2)
Grade A - Hexavalent chromate treatment, maximum service temperature 250 °F (121 °C)
Grade B - Hexavalent chrome free treatment, maximum service temperature 375 °F (191 °C)
III - With supplementary phosphate treatment (see 3.2.9.3)

1.3.1.1 For Type II plating, if no grade is specified, Grade A shall be supplied. Processors shall have the option to use Grade B if permitted by the cognizant engineering organization.

1.3.1.2 Type II, Grade A may be listed as Type IIA and Type II Grade B may be listed as Type IIB; the terms are equivalent.

1.3.2 Classes

1 - 0.0005 inch (0.0127 mm), minimum
2 - 0.0003 inch (0.0076 mm), minimum
3 - 0.0002 inch (0.0051 mm), minimum

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 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 +1 724-776-4970 (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 B117	Operating Salt Spray (Fog) Apparatus
ASTM B244	Measurement of Thickness of Anodic Coatings on Aluminum and of other Nonconductive Coatings on Nonmagnetic Basis Metals with Eddy-Current Instruments
ASTM B487	Measurement of Metal and Oxide Coating Thicknesses by Microscopical Examination of 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 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 E29	Using Significant Digits in Test Data to Determine Conformance with Specifications
ASTM E376	Measuring Coating Thickness by Magnetic-Field or Eddy Current (Electromagnetic) Testing Methods
ASTM F519	Mechanical Hydrogen Embrittlement Evaluation of Plating/Coating Processes and Service Environments

2.3 U.S. Government Publications

Copies of these documents are available online at https://quicksearch.dla.mil.

DD Form 1423

DI-NDTI-80809B

DOD FAR Supplement 215.470

MIL-DTL-5002 Surface Treatments and Inorganic Coatings for Metal Surfaces of Weapons Systems

MIL-STD-1916 DoD Preferred Methods for Acceptance of Product

TT-C-490 Chemical Conversion Coatings and Pretreatments for Metallic Substrates (Base for Organic Coatings)

2.4 AIA Publications

Available from Aerospace Industries Association, 1000 Wilson Boulevard, Suite 1700, Arlington, VA 22209-3928, Tel: 703-358-1000, www.aia-aerospace.org.

NASM1312-1 Fastener Test Methods - Method 1, Salt Spray

NASM1312-5 Fastener Test Methods - Method 5, Stress Durability

NASM1312-12 Fastener Test Methods - Method 12, Thickness of Metallic Coatings

NASM1312-14 Fastener Test Methods - Method 14, Stress Durability, Internally Threaded

3. REQUIREMENTS

3.1 Materials

The materials used shall be such as to produce platings that meet the requirements of this specification.

3.1.1 Inventory

Items in inventory that were plated prior to the issuance of this revision may be used until the supply is exhausted.

3.2 General Requirements

3.2.1 Preplate Stress Relief

Steel components having a hardness of 34 HRC and higher that have been machined, ground, cold-formed, or cold-straightened after heat treatment, shall be cleaned as required to remove surface contamination and thermally stress relieved prior to plating. Stress relief is optional for components with hardness below 34 HRC (see 5.10).

3.2.1.1 All components having a hardness from 34 to 55 HRC, including nitrided components, shall be thermally stress relieved at 375 °F ± 25 °F (191 °C ± 14 °C) for 4 to 10 hours prior to plating.

3.2.1.2 Carburized components and components with hardness higher than 55 HRC shall be stress relieved at 275 °F ± 25 °F (135 °C ± 14 °C) for 5 to 10 hours prior to plating.

3.2.1.3 Stress relief shall precede shot peening, cleaning, and plating for relief of damaging residual tensile stresses.

3.2.1.4 For components being overhauled, previously shot peened surfaces may be stress relieved but shall not be baked at temperatures above 375 °F ± 25 °F (191 °C ± 14 °C) for components up to 55 HRC or 275 °F ± 25 °F (135 °C ± 14 °C) for components heat treated above 55 HRC.

3.2.1.5 Furnaces used for stress relief shall be controlled per AMS2750; the minimum requirements shall be Class 5 and Type D instrumentation.

3.2.1.6 Components with upper operating temperature limits of less than 275 °F (135 °C) shall be stress relieved at a specified temperature for not less than 5 hours (see ordering information).

3.2.1.7 Stress relief is not required for fasteners if all cold working is limited to cold working of the head-to-shank fillet and thread rolling after heat treatment.

3.2.2 Cleaning

All components shall be cleaned in accordance with MIL-DTL-5002. Fasteners heat treated to 160 ksi (1103 MPa) tensile strength or 36 HRC, or higher, shall be cleaned in accordance with MIL-DTL-5002 and the following:

a. Abrasive cleaning shall be used for removal of heat treat scale and oxidation as applicable. Acid pickling is not permitted.

b. Alkaline cleaning shall be used as applicable with anodic (reverse) current or no current. Cathodic (direct) current cleaning with the component serving as the cathode shall not be used.

c. A clean water rinse shall be used as applicable following each cleaning or plating operation.

d. Surface activation of the component in an inhibited acid is acceptable for purposes of plating adhesion.

3.2.3 Plating Application

The plating shall be applied after all basis metal heat treatments and mechanical operations such as machining, brazing, welding, forming, and perforating of the article, have been completed. It is the responsibility of the customer to ensure that all basis metal heat treatments and mechanical operations such as machining, brazing, welding, forming, and perforating have been completed prior to plating. The basis metal shall be free from visible defects that will be detrimental to the appearance or protective value of the plating.

3.2.4 Strike

Cadmium shall be deposited on the basis metal without a strike of other metal, except in the case of components made of corrosion resistant alloys on which a strike of nickel or copper may be necessary, or on components made of aluminum on which a preliminary treatment, such as the zincate process or a strike of copper or electroless nickel, may be necessary.

3.2.5 Fixture/Electrical Contact Locations

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

3.2.5.2 For components that are not to be electroplated all over, and contact locations are not specified, locations shall be in areas on which coating is not required.

3.2.6 Coverage

The plating shall cover all surfaces as stated in 3.3.1, including roots of threads, corners, and recesses.

3.2.7 Hydrogen Embrittlement Relief

All components shall be baked within 4 hours after the plating operation in accordance with AMS2759/9 except threaded fasteners between 150 ksi and 220 ksi (1034 MPa and 1517 MPa) tensile strength shall be baked for 23 hours minimum and steel components between 160 ksi and 180 ksi (1103 MPa and 1241 MPa) tensile strength shall be baked for 8 hours minimum. Components with hardness of 55 HRC and higher shall be baked for 23 hours minimum at 275 °F ± 25 °F (135 °C ± 14 °C). Plated springs and other components subject to flexure shall not be flexed prior to hydrogen embrittlement relief treatment. In the case of Type IIA, Type IIB, and Type III treated components which require baking, the baking treatment shall be done prior to the application of the supplementary coatings. Cadmium plated surfaces passivated as a result of the baking operation shall be reactivated prior to receiving the Type IIA or Type IIB supplementary treatment (see 5.5). The following alloys are not considered susceptible to hydrogen embrittlement from the cadmium plating process, and therefore do not require the hydrogen embrittlement relief or the hydrogen embrittlement relief test of 3.3.4:

a. UNS S66286, UNS N07718, UNS R30159, UNS R30035, UNS N04400, UNS N06600, UNS N07750

b. 300 series austenitic stainless steels

c. Aluminum and aluminum alloys

3.2.7.1 Components with upper operating temperature limits of less than 275 °F (135 °C) shall be baked at a specified temperature for not less than 5 hours (see ordering information).

3.2.7.2 Baking Procedure Control

The bake furnace pyrometry shall conform to AMS2750. All components shall be baked continuously at temperature, within the specified range. Interruptions for loading and unloading components shall be permitted provided the time between the opening of the furnace door, and the re-establishment of the specified baking temperature, is not used to determine the total cumulative bake time. The specified baking temperature shall be considered to be re-established when all control, indicating, and recording thermocouples reach the specified baking temperature.

3.2.7.3 If a power outage occurs that results in the component or oven dropping out of the required temperature range, the required bake shall be completed at the correct temperature as quickly as possible. The power outage details shall be documented, and the cognizant engineering organization shall be contacted for disposition of the components.

3.2.8 Luster

The use of brightening agents, or other additives which produce brightened deposits in the plating solution, is prohibited on components with a specified heat treatment that requires a 180 ksi (1241 MPa) minimum tensile strength or a minimum of 40 HRC, and higher except as permitted in paragraph 3.2.8.1. Either a bright (not caused by brightening agents) or dull luster is acceptable. Use of brighteners is allowed for those alloys listed in 3.2.7 that do not require embrittlement relief.

3.2.8.1 Use of Brighteners with Bearings

The use of brighteners is permitted for annular bearings. For rod end bearing bodies, track roller studs, and end washers of needle track roller bearings, the amount of brightener added to the plating bath shall be limited to 20% of the normal amount recommended by the manufacturer.

3.2.9 Supplementary Treatments

Unless otherwise specified the cadmium shall be given a Type II, Grade A (IIA) treatment.

3.2.9.1 Type II, Grade A Chromate Treatment

The chromate treatment required for conversion to Type II, Grade A shall be a treatment in or with an aqueous solution of salts, acids, or both, to produce a continuous smooth, distinct protective film, distinctly colored iridescent bronze to brown including olive drab, yellow, and forest green. The articles so treated shall be thoroughly rinsed and dried in accordance with the requirements of the process used (see 5.2.2.2). Usual chromic and nitric acid bright dips for cadmium are not chromate treatments.

3.2.9.2 Type II, Grade B Hexavalent Chrome Free Treatment

A hexavalent chrome free treatment for Type II, Grade B shall be an environmentally compliant treatment that does not employ hexavalent chromium compounds. Some Type II, Grade B treatments may not produce a distinct color change after the coating is applied.

3.2.9.3 Type III Phosphate Treatment

The phosphate treatment required for conversion to Type III shall produce a tightly adherent film conforming to Type I of TT-C-490.

3.3 Detail Requirements

3.3.1 Thickness of Plating

The finished thickness shall be as specified and shall be determined on components. Measurement methods shall meet the requirements of 4.6.1. Other methods may be used if permitted by the cognizant engineering organization.

a. For surfaces that can be touched by a sphere 0.75 inch (19 mm) in diameter, including external threads, the minimum thickness of cadmium plating shall be as specified for each class in 1.3.2. If not specified, the maximum shall be the minimum plus 0.0003 inch (0.0076 mm), except in high cathode current density areas, such as corners and edges. The cadmium shall be substantially uniform in thickness on significant surfaces except that slight build-up on exterior corners or edges is permitted provided finished drawing dimensions are met.

b. For internally threaded components, a maximum limit of 0.0005 inch (0.0127 mm) above the minimum shall be allowed on the external surfaces.

c. For surfaces that cannot be touched by a 0.75 inch (19 mm) sphere, including internal threads, no plating thickness is required, but such areas shall show evidence of plating. There shall be no bare areas, except for areas beyond a hole depth of 2.5 times the hole diameter (see 5.2.1.1.2).

d. Any strike that is used shall be considered part of the cadmium plating thickness requirement.

3.3.2 Adhesion

The adhesion of the plating shall be such that when examined at a magnification of 4 to 10X, the plating shall not show separation from the basis metal nor from any strike at the interface, nor shall any strike show separation from the basis metal at the interface when subjected to the tests described in 4.6.2 and Table 2. The interface between the strike and the basis metal is the surface before plating. The formation of cracks in the plating caused by rupture of the basis metal, the strike or combination of both which do not result in flaking, peeling, or blistering of the plating shall not be considered as nonconformance to this requirement.

3.3.3 Corrosion Resistance

Type IIA and Type IIB areas required to be plated (see 3.3.1) on test production components or test specimens shall not show white corrosion products of cadmium, pitting, or basis metal corrosion products at the end of 96 hours when tested by continuous exposure to the salt spray in accordance with 4.6.3 and Table 1. The appearance of corrosion products visible to the unaided eye shall be cause for rejection, except that white corrosion products at the edges of specimens (see 4.5.2) are to be accepted.

3.3.4 Hydrogen Embrittlement Relief Test

Hydrogen embrittlement testing is required for components heat treated to 160 ksi (1103 MPa) tensile strength and higher or 36 HRC, and higher. This includes rod end bearing bodies, track roller bearing studs, and end washers on needle track roller bearings, but does not include other bearings. Unless otherwise specified, testing shall be in accordance with 4.6.4 as stated in 4.4.2.3 and 4.4.3. Rod end bearing bodies, track roller bearing studs and end washers of needle track roller bearings shall be tested in accordance with 4.6.4.3.

3.4 Environmental Requirements

All cadmium plating facilities and equipment shall comply with all local environmental and safety regulations. Cadmium plating may be restricted or banned in many countries or areas due to environmental and health concerns.

3.5 Workmanship

3.5.1 Appearance

The cadmium plating shall be smooth, adherent, uniform in appearance, free from blisters, pits, nodules, burning, and other defects when examined visually without magnification. The plating shall show no indication of contamination or improper operation of equipment used to produce the cadmium deposit, such as excessively powdered or darkened plating. Superficial staining, which has been demonstrated as resulting from rinsing, or slight discoloration resulting from any drying or baking operations as specified shall not be cause for rejection.

3.5.1.1 Appearance after application of supplementary treatments shall be essentially uniform in color and appearance. Superficial staining, which has been demonstrated as resulting from rinsing, or slight discoloration resulting from any drying or baking operations shall not be cause for rejection.

4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for Inspection

The processor is responsible for the performance of all inspection requirements, examinations and tests as specified herein. Except as otherwise specified, the processor may use his own or any other facilities suitable for the performance of the inspection requirements. The purchaser reserves the right to perform any of the inspections set forth in this specification where such inspections are deemed necessary to ensure supplies and services conform to prescribed requirements.

4.2 Classification of Inspections

The inspection requirements specified herein are classified as quality conformance inspections and tests (see 4.4).

4.3 Inspection Conditions

All inspections shall be performed in accordance with the test conditions stated in the applicable test method or applicable paragraph in this specification.

4.4 Quality Conformance Inspection and Tests

The quality conformance inspection shall consist of the following:

a. Process records (4.4.1)

b. Lot sampling inspection (4.4.2)

c. Production control testing (4.4.3)

4.4.1 Process Records

The processor shall maintain a record of the history of each processing bath, showing all additions of chemicals or treatment solutions to the unit, and the results of all chemical analyses performed. The processor shall maintain a record of process control test results including adhesion, corrosion, and hydrogen embrittlement if applicable to the components being processed. Upon request of the purchaser, such records, as well as reports of the test results, shall be made available. These records shall be maintained for not less than 1 year after completion of the contract or purchase order.

4.4.2 Lot Sampling Inspection

The lot sampling inspection shall consist of the examinations and tests stated in 4.4.2.2.

4.4.2.1 Lot

A lot is a group of components, all of the same component 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.

4.4.2.2 Sampling for Visual Examination and Thickness of Plating

Sampling for visual examination and thickness of plating tests shall be conducted. A sample of plated components or articles, except for those barrel plated, shall be taken at random from each lot, the number of articles in accordance with MIL-STD-1916, VL = II, or as indicated in Table 2, or as specified by purchaser. Unless specified otherwise, the sampling chosen shall be the option of the plater. Barrel plated components or articles shall be sampled in accordance with MIL-STD-1916, VL = I, or as specified by purchaser. The lot shall be accepted or rejected according to the procedures in 4.4.2.2.1 for visual examination and 4.4.2.2.2 for plating thickness.

4.4.2.2.1 Visual Examination

Samples selected in accordance with 4.4.2.2 shall be examined for compliance with requirements of 3.5.2 after plating. If the number of nonconforming items exceeds the acceptance number for the sample, the lot represented by the sample shall be rejected. Separate specimens (4.5) shall not be used for visual examination tests.

4.4.2.2.2 Thickness of Plating

Samples selected in accordance with 4.4.2.2 shall be inspected and the plating thickness measured by the applicable test stated in 4.6.1 to verify compliance with the requirements of 3.3.1. Measurements on fastener hardware shall be made at locations defined in NASM1312-12. The component or article shall be considered nonconforming if one or more measurements fail to meet the specified minimum thickness. If the number of nonconforming components or articles in any sample exceeds the acceptance number for the specified sample, the lot represented by the sample shall be rejected. Separate specimens (see 4.5) shall not be used for thickness tests.

4.4.2.3 Hydrogen Embrittlement Relief Test (Lot Testing)

When specified (see ordering information), hydrogen embrittlement testing shall be performed on each lot. Sampling shall be as specified (see ordering information). Unless otherwise specified, the test method shall be in accordance with 4.6.4.

4.4.3 Production Control Tests

Production control tests shall consist of all the tests specified in Table 2. If hydrogen embrittlement relief testing is performed on each lot (4.4.2.3) and the lot size is such that the frequency of testing is greater than that stated in 4.4.3.2, the production control test for hydrogen embrittlement may be waived.

4.4.3.1 Sampling for Production Control Tests

Four plated components or prepared test specimens (see 4.5) for each of the required tests specified in Table 2 shall be sampled from production at the times specified in 4.4.3.2.

4.4.3.2 Frequency of Tests

The production control test schedule shall be as follows:

a. The first products or specimens plated at start of first, second and third week of production shall be tested.

b. The first products or specimens plated at start of fifth and seventh week of production and then at the start of production every month thereafter shall be tested.

c. Any failure shall immediately halt production. All components produced since the last acceptable test shall be considered suspect. The reason for failure shall be determined and corrected before production resumes. The lots of platings produced using the faulty procedure or material shall not be acceptable.

4.4.3.3 Procedure for Follow on Contracts

When a processor is in continuous production of plating from contract to contract and there have been no failures in production control tests, the processor may continue testing at the current frequency of test level to start a new contract.

4.5 Separate Specimen Preparation

When the plated articles are of such form, shape, size, or value as to prohibit use thereof, or are not readily adaptable to a test specified herein, or when destructive tests of small lot sizes are required, the test shall be made by the use of separate specimens which may be plated concurrently with production components. If specimens are not plated concurrently with production components, they shall be plated using the same processing parameters (cleaning and preparation steps, process tanks, current density, plating time, rinse times, bake, conversion coating, etc.) as the production components they represent. When separate specimens are required by the purchaser to certify a lot, these specimens shall be plated within 1 calendar day of the beginning or end of lot processing. Periodic production control tests shall only represent production processed during the time frame that the test specimens were processed (see 4.4.3.2). The specimens shall be as stated in 4.5.1, 4.5.2, 4.5.3, and Table 1 and shall be distributed such that the tests are performed on each plating bath. When ferrous alloy castings are being plated, the separate specimens may be cut from scrap castings.

4.5.1 Specimens for Adhesion Tests

If separate specimens for adhesion tests are required, they shall be four strips approximately 1 inch (2.5 cm) wide, 4 inches long (10 cm), and 0.04 inch (1.0 mm) thick.

4.5.2 Specimens for Corrosion Resistance Tests

If separate specimens for corrosion resistance test are required, they shall be four panels not less than 6 inches (15 cm) in length, 4 inches (10 cm) in width, and approximately 0.04 inch (1.0 mm) thick.

4.5.3 Specimens for Embrittlement Relief Test

See 4.6.4.1.

4.6 Tests

4.6.1 Thickness (Lot by Lot Inspection)

4.6.1.1 Nondestructive measurement of plating thickness shall be determined in accordance with ASTM E376, ASTM B499, ASTM B244, ASTM B567, or ASTM B568. Destructive measurement of plating thickness shall be determined in accordance with ASTM B487 or ASTM B504. For measurement of plating thickness on fasteners, the procedure stated in NASM1312-12 may be used instead of the above.

4.6.1.2 Thickness measurements of cadmium platings, Type IIA, Type IIB, and Type III, may be made before or after application of the supplementary treatments. If thickness is measured before the application of supplementary treatments, the processor shall ensure that the process used to apply supplementary treatments does not reduce the thickness of the cadmium plating.

4.6.1.3 When the coulometric test is used, the supplementary treatment shall be removed prior to testing. The chromate film may be removed from the Type II coating by using a very mild abrasive (a paste of levigated alumina rubbed on with the finger). The phosphate coating may be removed from the Type III coating by immersing the specimen in a 10% solution of NaOH and scrubbing with a rubber policeman (usually takes from 10 to 15 minutes).

4.6.1.4 Direct dimensional inspection is permissible in lieu of the above provided the resolution of the measuring instrument is ten times more precise than the attribute being measured. For non-ferrous substrates, it is permissible to use “dimensional gauging” such as micrometers, verniers, pin gauges, dial bore gauges, height gauges, or coordinate measuring machines when permitted by the cognizant engineering organization. The dimensional gauges shall be maintained in accordance with ANSI/NCSL Z540.3. Resolution of the calibrated measuring instrument used, shall be not less than ten times more precise than the attribute being measured.

4.6.1.5 Measure Method

Measurement of plating thickness shall use the rounding method as specified in ASTM E29.

4.6.2 Adhesion (Production Control Test)

Adhesion shall be determined by scraping the surface or shearing with a sharp edge, knife, or razor through the plating to the basis metal and examining at 4 to 10X magnification for evidence of non-adhesion. Alternatively, the article or specimen may be tested in accordance with ASTM B571 bend test—no mandrel, clamped in a vise, and the projecting portion bent back and forth until rupture of the basis metal and/or plating occurs. If the edge of the ruptured plating can be peeled back or if separation between the plating and basis metal can be seen at the point of rupture when examined at 4 to 10X magnification, adhesion is not satisfactory. If adhesion is not satisfactory, the pre-plating, cleaning, and plating processes, as well as the materials, shall be evaluated and the cause of failure eliminated.

4.6.3 Corrosion Resistance (Production Control Test)

Corrosion resistance shall be conducted in accordance with ASTM B117 (salt spray test) for 96 hours or, for fastener hardware, in accordance with NASM1312-1. To secure uniformity of results, Type II or Type IIB supplementary coatings shall be aged by the processor at room temperature for 24 hours minimum before submittal for salt spray testing. Corrosion test specimens shall be plated to a Class 2 thickness.

4.6.4 Hydrogen Embrittlement Relief Test

4.6.4.1 Specimens

Testing shall be in accordance with the requirements of ASTM F519 Type 1a.1 using four round notched specimens, stressed in tension under sustained load. For test purposes the plating thickness shall be Class 1, 0.0005 inch (0.0127 mm) minimum measured on the smooth section of the specimen, but with visual evidence of plating at the root of the notch. The notch and 0.5 inch (13 mm) on both sides of the notch sample shall be plated. 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 and surface preparation (reagent, electro-cleaning, or abrasive blasting as applicable), bake, and post treatment. In lieu of the ASTM F519 required 260 to 280 ksi (1793 to 1931 MPa) heat treat strength level, specimens may be heat treated to the same tensile strength or higher than the components represented. Specimens representing a components lot (see 4.4.2) shall have the same supplementary treatment as the components.

4.6.4.2 Fasteners

Externally threaded or grooved fasteners that can be loaded in tension by an axial application of a load up to 20000 pounds (9072 kg) or reasonable load limits of test equipment, shall be tested as specified in NASM1312-5. When the load requirement is greater than the reasonable limits of the test equipment, the notched specimen procedure (4.6.4.1) shall be used. Internally threaded fasteners shall be tested as specified in NASM1312-14. The minimum test load shall be 85% of the minimum ultimate tension load specified in the end product specification. The load shall be sustained for not less than 72 hours. The fasteners shall be examined for conformance to 3.3.4.

4.6.4.3 Bearings

Test pieces for rod end bearing bodies, track roller bearing studs, and end washers of needle track roller bearings shall be either the plated bearing component or notched specimens, at the option of the bearing manufacturer. Notched specimens shall conform to 4.6.4.1 and shall be plated with the bearing components lot they represent. They shall be subjected to a sustained tensile load equal to 75% of its notched ultimate tensile strength. The bearing component shall be loaded in tension to produce a stress level of 75% of its ultimate tensile strength. Loads shall be maintained for not less than 72 hours and specimens or bearings shall be examined for compliance with 3.3.4. At the bearing manufacturer's option, end washers may be tested simultaneously with the needle bearing track roller stud.

4.6.4.4 Other Components or Articles

Components such as spring pins, lock rings, etc., which are installed in holes or rods, shall be similarly assembled using the applicable components specifications or drawing tolerances that impose the maximum sustained load on the plated component. The articles or components shall be subjected to the sustained load for not less than 200 hours then examined for conformance to 3.3.4.

4.7 Approval

4.7.1 Process Approval

4.7.1.1 When specified (see ordering information), the process and control factors and/or a preproduction component, whichever is specified, shall be approved by the cognizant engineering organization before production components are supplied.

4.7.1.1.1 If the processor makes a significant change to any material, process, or control factor from that which was used for process approval, all preproduction tests shall be performed, and the results submitted to the purchaser 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 components.

4.7.1.1.2 Control factors shall include, but not be limited to, the following:

Surface preparation and cleaning method
Plating bath composition and composition control limits
Use of brighteners
Plating bath temperature limits and controls
Plating duration
Thermal post treatment times and temperatures
Method for determining plating thickness
Stripping procedure, when applicable
Electrical contact locations, when required
Current density (amps per component or amps per total surface area of the components plated at one time in each tank)
Periodic test plan for cleaning and processing solutions (see 8.4)

4.7.2 Processing Records

4.7.2.1 When specified by the cognizant engineering or quality organization (see ordering information), the processor shall record the control factors used for each lot of components or every component as specified and provide this information with each shipped lot or every shipped component as applicable. Plating duration shall include the time of day.

5. NOTES

This section contains information of a general or explanatory nature that may be helpful, but is not mandatory.

NOTICE

This document references a component which contains cadmium as a plating material. Consult local safety and/or environmental officials if you have questions concerning cadmium's use.

NOTICE

This specification may reference the use of substances, products, or processes that are restricted or banned by local (regional) chemical substance regulations. Users of this specification should consider the implications of local legislation on the products, substances, and processes referred to within the document.

5.1 Revision Indicator

A change bar (I) located in the left margin is for the convenience of the user in locating areas where technical revisions, not editorial changes, have been made to the previous issue of this document. An (R) symbol to the left of the document title indicates a complete revision of the document, including technical revisions. Change bars and (R) are not used in original publications, nor in documents that contain editorial changes only.