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| AEROSPACE MATERIAL SPECIFICATION | AMS2416™ | REV. M |
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| | Revised | 2018-06 |
| Superseding AMS2416L | | |
| Plating, Nickel-Cadmium Diffused | | |

RATIONALE

AMS2416M results from a Five-Year Review and update of this specification with changes to Ordering Information, 1.4 Warning, 3.1.1 Stress Relief Treatment, and 3.3.2, 3.3.2.1, 3.3.2.2 Heat Resistance.

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:

- AMS2416M
- Plating thickness desired (see 3.3.1)
- 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
- Minimum thickness on internal surfaces, if required (see 3.3.1.1).
- Optional: Periodic testing frequency (4.2.2) and sample quantity (4.3.3)
- Quantity of pieces to be plated
- Critical areas of nickel plating coverage to prevent cadmium liquid metal embrittlement (see 1.4, 3.2.2, and 8.7)

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.

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on this Technical Report, please visit
<http://standards.sae.org/AMS2416M>**

1. SCOPE

1.1 Purpose

This specification covers the requirements for an electrodeposit of cadmium diffused into an electrodeposit of nickel on carbon, low-alloy, and corrosion-resistant steels.

1.2 Application

This coating has been used typically to prevent corrosion of carbon, low-alloy, and corrosion resistant steel parts that may operate in service up to 900 °F (482 °C), but usage is not limited to such applications. This process is not suitable for use on parts of complex shape where minimum nickel plate thickness requirements cannot be met and on parts whose hardness or strength would be reduced below drawing or specification requirements by heating to 640 °F (338 °C).

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.

1.4 Warning

This document includes cadmium as a plating material. The use of cadmium has been restricted and/or banned for use in many countries due to environmental and health concerns. The user should consult with local officials on applicable health and environmental regulations regarding its use. Great care is necessary during this duplex plating process. Cadmium must only be plated directly onto the nickel plate, otherwise liquid cadmium metal embrittlement may occur in the base metal (see 8.6).

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.

| | |
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| AMS2750 | Pyrometry |
| ARP1917 | Clarification of Terms Used in Aerospace Metals Specifications |
| ARP4992 | Periodic Test for Processing 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.

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| 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 Cross Section |

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| 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 B636 | Measurement of Internal Stress of Plated Metallic Coatings with the Spiral Contractometer |
| ASTM E376 | Measuring Coating Thickness by Magnetic-Field or Eddy-Current (Electromagnetic) Testing Methods |

3. TECHNICAL REQUIREMENTS

3.1 Preparation

3.1.1 Stress Relief Treatment

All steel parts having hardness 40 HRC or 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 and 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 For parts, excluding nitrided parts, having a hardness of 55 HRC and above, and for carburized and induction hardened parts, stress relieve at $275\text{ °F} \pm 25\text{ °F}$ ($135\text{ °C} \pm 14\text{ °C}$) for 5 to 10 hours.
- 3.1.1.2 For parts having a hardness less than 55 HRC, and for nitrided parts, stress relieve at $375\text{ °F} \pm 25\text{ °F}$ ($191\text{ °C} \pm 14\text{ °C}$) for a minimum of 4 hours. Higher temperatures shall be used only when specified or approved by the cognizant engineering organization.
- 3.1.1.3 For peened parts, if stress relief temperatures above 375 °F (191 °C) are to be used, 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 cognizant engineering organization. For parts which are not to be plated all over, locations shall be in areas on which plating is not required.

3.2 Procedure

3.2.1 Nickel Plating

Nickel shall be electrodeposited from a sulfamate solution, or other plating bath acceptable to the cognizant engineering organization, containing no substances that might have a detrimental effect on the properties of the plate or the basis metal; stress-reducing agents shall not be used unless authorized by the cognizant engineering organization. The nickel plate shall be deposited directly on the basis metal. A preliminary strike or flash of nickel especially on corrosion-resistant steels or similarly passive materials is permissible. A strike or flash of any metal other than nickel is prohibited. Spotting-in is not permitted.

- 3.2.1.1 After being nickel plated, parts shall be thoroughly rinsed and transferred directly to the cadmium plating solution. Parts to be used for determining thickness of the nickel plate shall be rinsed after neutralization in alkaline solution and dried. Parts shall be reactivated and cadmium plated as soon as possible after determination of nickel plate thickness.