Society of Automotive Engineers, Inc.
TWO PENNSYLVANIA PLAZA, NEW YORK, N.Y. 10000

# AEROSPACE MATERIAL SPECIFICATION

AMS 2416E
Superseding AMS 2416D
Issued 8-15-55
Revised 11-1-68

## NICKEL-CADMIUM PLATING, DIFFUSED

1. ACKNOWLEDGMENT: A vendor shall mention this specification number and its revision letter in all quotations and when acknowledging purchase orders.

2. APPLICATION: Primarily to prevent corrosion of carbon and low alloy steel parts which may operate at temperatures up to 900 F (482 C). 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 would be reduced below drawing requirements by heating at 640 F (338 C).

3. PREPARATION:

3.1 All brazing or welding shall be completed before parts or assemblies are plated.

3.2 Unless otherwise specified, parts having hardness higher than Rockwell C 40 and which have been ground after heat treatment shall be suitably stress relieved before cleaning for plating. Temperatures to which parts are heated shall be such that maximum stress relief is obtained without reducing hardness of parts below drawing limits.

3.3 Before placing parts in plating solutions, they shall have chemically clean surfaces, prepared with minimum abrasion, erosion, or pitting.

4. PROCEDURE:

4.1 Nickel Plating: Shall be performed by electrodeposition of nickel from a sulfamate solution containing no addition agents (including stress-reducing agents) which might have a detrimental effect on properties of the plate or the basis metal, except that when permitted by purchaser, other nickel plating solutions may be used.

4.1.1 After being nickel plated, parts shall be rinsed, neutralized in alkaline solution, and transferred directly to the cadmium plating solution. Parts to be used for determining thickness of the nickel plate by nondestructive methods shall be rinsed after neutralization in alkaline solution and dried, and then cadmium plated as soon as possible after determination of nickel plate thickness. Specimens to be used for determining nickel plate thickness or for determining stress in the nickel plate shall be processed in the same manner as specified for parts to be used for determining nickel plate thickness.

4.2 Cadmium Plating: Consists of electrodeposition of cadmium from a cadmium cyanide solution. The cadmium shall be deposited directly on the nickel plate. Parts shall then be rinsed. Extreme care shall be exercised to avoid deposition of cadmium on any area not previously covered by nickel.

4.2.1 Parts which have been used for determination of nickel plate thickness by nondestructive methods shall be cleaned and the nickel reactivated prior to cadmium plating.

4.3 Chromate Treatment: After rinsing following cadmium plating, and without drying, parts may be treated by an approved chromate process which will prevent fingerprinting and staining. Parts shall then be rinsed.

4.3.1 If parts are not chromate treated, they shall be marked with a dye which will change color during the diffusion treatment.

4.4 Heating: After rinsing following marking with dye, or following chromate treatment when used, parts shall be dried and then shall be heated to 630 F ± 10 (332.2 C ± 5.6) in air, preferably in a circulating air furnace, held at heat for not less than 30 min., and cooled in air.

5. TECHNICAL REQUIREMENTS:

5.1 Thickness:

5.1.1 Nickel Plate: Shall, except as specified in 5.1.1.1, be 0.0002 - 0.0004 in. thick on significant surfaces of parts and not less than 0.00005 in. thick on surfaces of parts on which a controlled deposit cannot be maintained, such as holes, grooves, recesses, etc; nickel plate thickness greater than 0.0004 in. will be permitted in high current density areas. Unless otherwise specified, uncontrolled plate thickness areas are defined as those areas which can not be touched by a 0.75 in. diameter sphere. Thickness of nickel plate shall be determined on representative parts, or on separate specimens representing parts and plated either simultaneously with parts or separately but in a similar manner, by microscopic method, micrometer measurement, magnetic test, drop test, or electrostrip method, before parts or specimens are cadmium plated.

5.1.1.1 If nickel plate thickness greater than 0.0002 - 0.0004 in. thick is desired, this may be specified by this specification number followed by a dash and a number indicating the minimum nickel plate thickness in ten-thousandths of an inch; a tolerance of +0.0002 in will be permitted when the minimum thickness is 0.0003 in. and +0.0003 in. will be permitted when the minimum thickness is 0.0004 in. or more. Thus, AMS 2416-3 indicates nickel plate thickness of 0.0003 - 0.0005 in. and AMS 2416-5 indicates nickel plate thickness of 0.0005 - 0.0008 inch.

5.1.2 Cadmium Plate: Shall be approximately 0.0001 - 0.0002 in. thick. Routine determination of cadmium plate thickness will not be required; the process of plating shall be controlled to produce the specified thickness.

5.2 Nickel Plate Stress: Shall be in the range of 0 - 15,000 psi in tension as determined on specimens having nickel plate thickness of 0.0003 in.; stress shall be calculated from spiral contractometer reading (Ref. 35th Annual Proceedings, American Electroplaters Society, p. 53 - 89) or other instrument agreed upon by purchaser and vendor. This requirement does not apply if plating solutions other than sulfamate are used.

5.3 Bonding:

5.3.1 Nickel Plate: Shall be firmly and continuously bonded to the basis metal and shall be smooth, uniform in appearance on areas of equivalent hardness and surface finish, and free from frosty areas, pin holes, nodules, blisters, and other harmful imperfections.

5.3.2 Cadmium Plate: Shall be firmly and continuously bonded to the nickel plate, and shall be uniform in appearance, and free from pin holes, blisters, nodules, pits, and other harmful imperfections.

5.4 Color and Appearance: Finished plate after heating as in 4.4 shall have dull matte finish, shall be free from balling when examined under magnification up to 10X, and shall be smooth to the touch. Color of chromate treated parts may vary from olive drab through gray to black. Color need not be uniform on any one part but mottled, blotched, or sharply streaked areas will be cause for rejection. Color of dye marking shall be characteristic of the dye used.

5.5 Heat Resistance: Plate on parts, or on specimens representing parts and processed through the complete cleaning, plating, and heating cycle, shall be capable of being heated in air, preferably in a circulating air furnace, as specified in 5.5.1 and 5.5.2 without blistering or cracking on significant surfaces. The presence of weakly adhering oxidation products shall not be cause for rejection. Only the test of 5.5.1 will be required in routine inspection.

5.5.1 Heat at 700 F ± 10 (371.1 C ± 5.6) for 2 hr; transfer, without intentional cooling, to a furnace at 1000 F ± 10 (537.8 C ± 5.6) for 2 hours.