MIL-C-81562B
30 June 1983
SUPERSEDING
MIL-C-81562A
28 September 1973

MILITARY SPECIFICATION

COATINGS, CADMIUM, TIN-CADMIUM AND ZINC (MECHANICALLY DEPOSITED)

This specification is approved for use by all Departments and Agencies of the Department of Defense.

1. SCOPE

1.1 Scope. This specification covers the requirements for three types and three classes of mechanically deposited cadmium, tin-cadmium or zinc coatings on metallic surfaces by impacting (peen plating).

1.2 Classification. The coatings, cadmium, tin-cadmium and zinc shall be of the following types and classes, as specified (see 6.2.1).

1.2 Types.

Type I - As coated
Type II - With supplementary chromate treatment (see 3.2.9 and 6.1.2)
Type III - With supplementary phosphate treatment (see 3.2.10)

1.2.1 Materials and classes.

Material of coating	Classes (thickness - inch)					
	1	2	3	4	5	6
C - cadmium	0.0005	0.0003	0.0002	-	-	-
T - tin-cadmium	0.0005	0.0003	0.0002	-	-	-
Z - zinc	0.003	0.002	0.0017	0.001	0.0005	0.0003

2. APPLICABLE DOCUMENTS

2.1 Government documents.

2.1.1 Specifications, standards, and handbooks. Unless otherwise specified, the following specifications, standards, and handbooks of the issue listed in that issue of the Department of Defense index of Specifications and Standards (DoDISS) specified in the solicitation form a part of this specification to the extent specified herein.

Beneficial comments (recomendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: Engineering Specifications and Standards Department (Code 93), Naval Air Engineering Center, Lakehurst, NJ 08733, by using the self-addressed Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

SPECIFICATIONS

FEDERAL

TT-C-490	-	Cleaning Method and Pretreatment of Ferrous Surfaces for Organic Coatings.
ZZ-E-661	-	Eraser, Rubber and Rubber Substitute.
NNN-P-40	-	Paper, Lens.

MILITARY

MIL-S-5000	-	Steel, Chrome-Nickel-Molybdenum (E4340), Bars and Reforging Stock.
MIL-S-5002	-	Surface Treatments and Inorganic Coatings for Metal Surfaces of Weapons Systems.
MIL-L-7808	-	Lubricating Oil, Aircraft Turbine Engine, Synthetic Base.

STANDARDS

FEDERAL

FED-STD-141	-	Paint, Varnish, Lacquer and Related Materials, Methods of Inspection, Sampling and Testing.
FED-STD-151	-	Metals; Test Methods.

MILITARY

MIL-STD-105	-	Sampling Procedures and Tables for Inspection by Attributes.
MIL-STD-1312	-	Fasteners, Test Methods.

(Copies of specifications, standards, handbooks, drawings, and publications required by manufacturers in connection with specific acquisition functions should be obtained from the contracting activity or as directed by the contracting officer.)

2.2 Other publications. The following documents form a part of this specification to the extent specified herein. The issues of the documents which are indicated as DoD adopted shall be the issue listed in the current DoDISS and the supplement thereto, if applicable.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM B 117	-	Salt Spray (Fog) Testing.
ASTM B 244	-	Thickness of Anodic Coatings on Aluminum and of Other Non-conductive Coatings on Nonmagnetic Basis Metal with Eddy-Current Instruments, Measurement of.
ASTM B 487	-	Metal and Oxide Coating Thicknesses by Microscopic Examination of a Cross Section, Measurement of.
ASTM B 499	-	Coating Thickness by the Magnetic Method: Nonmagnetic Coatings on Magnetic Basis Metal, Measurement of.

ASTM B 567 - Coating Thickness by the Beta-Backscatter Method, Measurement of.
ASTM B 568 - Coating Thickness by X-Ray Spectrometry, Measurement of.

(Application for copies should be addressed to the American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103.)

(Industry association specifications and standards are generally available for reference from libraries. They are also distributed among technical groups and using Federal agencies.)

2.3 Order of precedence. In the event of a conflict between the text of this specification and the references cited herein, the text of this specification shall take precedence.

3. REQUIREMENTS

3.1 Materials. The materials used shall be such as to produce coatings of cadmium, tin-cadmium or zinc, as specified (see 6.2.1), which meet the requirements of this specification.

3.1.1 Tin-cadmium composition. The composition of the material for the tin-cadmium coating shall contain 25 to 55 percent tin by weight and the remainder shall be cadmium (see 6.10).

3.2 General requirements.

3.2.1 Stress relief treatment. All steel parts having an ultimate tensile strength of 180,000 pounds per square inch (psi) and above, which are machined, ground, cold formed or cold straightened, shall be given a heat treatment at a minimum of 191° ± 14°C (375° ± 25°F) for three hours or more, prior to cleaning and coating for the relief of damaging residual tensile stresses. Carburized parts shall be baked at 135° ± 14°C (275° ± 25°F) for five to eight hours.

3.2.2 Cleaning. All ferrous parts shall be cleaned in accordance with MIL-S-5002. Those parts having a Rockwell hardness of C 33 and higher shall be cleaned using materials which have no damaging effects on the metal, such as pitting, intergranual attack, significant etching and hydrogen embrittlement. Oxides on steel used for parts shall be removed by mechanical means such as glass bead blasting or vapor blasting, or by electrolytical alkali cleaning. Acid pickling or cathodic cleaning shall not be used. Other basis metals shall be cleaned by methods which shall not damage the substrate and shall not interfere with adhesion of the coating.

3.2.3 Coating application. The coating shall be applied after all basis metal heat treatments and mechanical operation, such as machining, brazing, welding, forming and perforating of the article, have been completed.

3.2.4 Undercoating. The coating may be deposited directly on the basis metal without a preliminary coating except that a flash undercoat of copper or other suitable metal may be applied mechanically or by immersion to improve adhesion.

3.2.5 Coverage. Unless otherwise specified, the coating shall cover all surfaces as stated in 3.3.1, 3.3.1.1 and 3.3.1.2 including roots of threads, thread peaks, corners and recesses (see 6.2.1).

3.2.6 Finish. Unless otherwise specified, either a light matte or semi-satin finish will be acceptable (see 6.2.1).

3.2.7 Embrittlement relief. Before application of any load or being used, all steel parts shall be held for a minimum of forty-eight (48) hours at room temperature after coating. Such conditioned parts, when tested in accordance with 4.5.6, shall not crack or fail by fracture.

3.2.8 Supplementary treatments. The chromate treatment (see 3.2.9) or the phosphate treatment (see 3.2.10) shall be applied directly after the coating operation to parts specified to be supplementary treated.

3.2.9 Chromate treatment (Type II). Unless otherwise specified (see 6.2.1), the chromate treatment required for conversion to Type II 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 and yellow with the cadmium and zinc materials. The tin-cadmium material shall be acceptable even if the typical yellow or iridescent color is not evident. The articles so treated shall be thoroughly rinsed and dried in accordance with the process used. Type II coating shall be similar in appearance and adhesion to coatings on separate specimens which are capable of passing the saltspray test (see 3.3.5.1, 4.4.3.3, 4.4.4.2 and 4.5.4). Usual chromic acid and nitric acid bright dips are not chromate treatments.

3.2.10 Phosphate treatment (Type III). Unless otherwise specified (see 6.2.1), 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. Unless otherwise specified (see 6.2.1), the coating thickness, as specified in the contract, purchase order or applicable drawing, on significant surfaces for each class of coating shall be as detailed in Table I. Significant surfaces shall be all visible surfaces of the article which can be touched by a sphere 0.75 inch (19 mm) in diameter plus additional functional surfaces specified (see 6.2.1). Where Class 1 is specified, all other visible surfaces shall be Class 2 minimum thickness. If the maximum thickness for Class 1 is not specified in the contract, order or applicable drawing, the thickness for C and T coatings shall not exceed 0.0008 inch (20 microns). Where Class 2 is specified, all other visible surfaces shall be Class 3 minimum thickness, and for Z coatings, the minimum thickness for all other visible surfaces of Class 4 coatings shall be Class 5. The minimum thickness for all other visible surfaces of Class 3 C and T coatings shall be 0.00015 inch (4 microns) and 0.0002 inch (5 microns) for Class 5 Z coatings.

3.3.1.1 The coatings shall be Class 1 thickness, unless otherwise specified in the contract, order or controlled by the following exception (see 6.2.1):

a. Bolts, studs, washers and articles with portions externally threaded shall have a minimum of Class 2 thickness on the threaded portions except for fine-threaded zinc coated parts which shall have a minimum of 0.0003 inch (8 microns).

b. Holes, other openings and articles with internal threads from which the external environment is completely excluded, shall not be subjected to a thickness requirement but shall show evidence of coating. There shall be no bare areas.

3.3.1.2 Undercoat. When an undercoat is used (see 3.2.4), the thickness of the copper or other suitable metal shall be less than 10 percent of the total coating thickness. The thickness of the undercoat shall not be included in the determination of the coating thickness

3.3.2 Types. Unless otherwise specified (see 6.2.1), coating shall be Type II. For use on surfaces to be painted, the coating shall be either Type II or Type III (see 6.1.1 and 6.1.2).

3.3.3 Adhesion. The adhesion of the coating shall be such that when examined at a magnification of approximately 4X diameters, the coating shall not show separation from the basis metal or from any undercoating at the interface, nor shall any undercoat show separation from the basis metal at the interface when subjected to the tests described in 4.5.2. The interface between the coating and either the basis metal or the undercoat is the surface before coating. The interface between the undercoat and the basis metal is the surface before undercoating. The formation of cracks in the coating caused by rupture of the basis metal, the undercoat or combination of both which do not result in flaking, peeling or blistering of the coating shall not be considered as nonconformance to this requirement.

3.3.4 Adhesion of Type II supplementary film. The adhesion of a Type II supplementary film to the coating shall be such that, when tested as detailed in 4.5.3, the supplementary chromate film shall not be removed or worn through to the underlying mechanically-deposited coating.

3.3.5 Corrosion resistance.

3.3.5.1 Type II. Coatings with the Type II treatment shall show neither white corrosion products nor basis metal corrosion products at the end of the time periods shown in Table II, when tested by continuous exposure to the salt spray in accordance with 4.5.4. The appearance of corrosion products, visible to the unaided eye at normal reading distance, shall be cause for rejection, except that white corrosion products at the edges of specimens shall not constitute failure.

3.3.5.2 Types I and III. When specified in the contract or order (see 6.2.1), coatings with either the Type I or the Type III treatment shall show no corrosion products of the basis metal at the end of the time periods shown in Table II, when tested by continuous exposure to salt spray in accordance with 4.5.4. Any appearance of corrosion products of the basis metal shall be cause for rejection, except that corrosion products at the edges of specimens shall not constitute failure.

3.3.6 Lubricating oil resistance (applicable to material T only). The material T coating shall withstand immersion in oil at a temperature of 121° ± 3°C (250° ± 5°F) for 24 hours without any wrinkling, blistering, pitting or other surface defects. The adhesion of the coating shall be satisfactory. Upon cooling to room temperature, the coating shall not exhibit flaking when bent over a mandrel as described in 4.5.5.

3.4 Workmanship.

3.4.1 Basis metal. The basis metal shall be free from visible defects that will be detrimental to the appearance or protective value of the coating. The basis metal shall be subject to such precleaning and mechanical coating procedures as necessary to yield coatings herein specified. All other visible surfaces shall have not less than the minimum thickness listed in the next higher class, except Class 6, which shall be not less than 0.00015 inch minimum thickness.

3.4.1.1 Internally threaded parts. Internally threaded parts need not be retapped following the coating process, but should be oversized, prior to coating, to accommodate the coating mating part.

3.4.2 Coating. The coating shall be smooth, fine grained, adherent, uniform in appearance, free from blisters, pits, nodules, and other defects. Superficial staining, which has been demonstrated as resulting from rinsing, or slight discoloration resulting from any drying operation, shall not be cause for rejection. All details of workmanship shall conform to the best practice for high quality coating.

4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for inspection. Unless otherwise specified in the contract or purchase order, the contractor is responsible for the performance of all inspection requirements as specified herein. Except as otherwise specified in the contract or purchase order, the contractor may use his own or any other facilities suitable for the performance of the inspection requirements specified herein, unless disapproved by the Government. The Government reserves the right to perform any of the inspections set forth in the specification where such inspections are deemed necessary to assure supplies and services conform to prescribed requirements.

4.2 Classification of inspections. The inspection requirements specified herein are classified as quality conformance inspections and consists of the following:

a. Process control inspection (see 4.3).

b. Lot sampling inspection (see 4.4).

4.3 Process control inspection.

4.3.1 Control records. When specified in the contract or order (see 6.2.1), the processor shall maintain a record of the history of each processing barrel, showing all additional chemicals or treatment solutions to the unit, the results of all chemical analyses performed and the quantity of parts coated during operation. Upon request of the acquisition activity, such records, as well as reports of the

test results, shall be made available. These records shall be maintained for not less than one year after completion of the contract or purchase order.

4.3.2 Analytical inspection. The equipment, procedures and operations employed by the processor shall be capable of producing high quality mechanically deposited coatings or materials as specified in this document. Analytical inspections of the process shall be conducted in accordance with the recommended frequency and procedures of the material supplier as may be appropriate for the processing method. Upon request of the acquisition activity such capability shall be demonstrated by the supplier.

4.3.3 Process control tests.

4.3.3.1 Frequency of tests. To assure continuous control of the process, as required by MIL-S-5002, and to minimize the possible occurrence and acceptance of items with detrimental hydrogen embrittlement during production, specimens shall be prepared and tested in accordance with Table III. The test specimens shall be prepared in accordance with 4.4.4 through 4.4.4.3, as applicable, and from alloy steel, 4340, conforming to MIL-S-5000. The tested specimens shall conform to the requirements of this specification. These tests shall be conducted at least once a month or more frequently if required by the acquisition activity. These tests are conducted to determine conformance of the mechanically deposited coatings with the requirements of this specification and are acceptable as evidence of the properties being obtained with the equipment and procedures employed.

4.3.3.2 Test specimens. The test specimens for the process control inspection shall be prepared in accordance with 4.4.4 through 4.4.4.3, as applicable, for the thickness, adhesion, corrosion resistance and lubricating oil resistance tests specified in Table III. Specimens for the process control embrittlement relief tests shall be either four round notched steel specimens of alloy steel 4340 conforming to MIL-S-5000 (see 4.4.4 and 4.4.4.3) heat treated from 260 to 280 ksi (1795 to 1930 MPa) tensile strength, from one or more heats, or four articles selected from four individual lots (see 4.4.1) for a total of 16 articles. Reliability of equipment and production control shall be demonstrated by showing each selected specimen or article to be free from hydrogen embrittlement when tested in accordance with 4.3.3.1, 4.4.4.3 and 4.5.6.

4.4 Lot sampling inspection.

4.4.1 Lot. A lot shall consist of articles of the same basis metal composition, coated and treated under the same conditions with the same material, to be of the same class and type and approximately the same size and shape submitted for inspection at one time.

4.4.2 Sampling for visual examination and nondestructive tests. Sampling for visual examination and nondestructive tests shall be conducted at the option of the supplier in accordance with MIL-STD-105 or using Table IV. A sample of coated parts or articles shall be drawn by taking at random from each lot the number of items in accordance with MIL-STD-105, Inspection Level II, Acceptable Quality Level (AQL) 1.5 percent defective or as indicated in Table IV. The lot shall be accepted or rejected according to the procedures in 4.4.2.1 for visual examination and 4.4.2.2 for coating thickness (nondestructive test).

4.4.2.1 Visual examination. Samples selected in accordance with 4.4.2 shall be examined for compliance with coverage (3.2.5), finish (3.2.6) and coating (3.4.2) after coating. If the number of nonconforming items exceeds the acceptance number for the sample, the lot represented by the sample shall be rejected.

4.4.2.2 Thickness of coating (nondestructive test). Samples selected in accordance with 4.4.2 shall be inspected and the coating thickness measured by the applicable test detailed in 4.5.1 at several locations on each article as defined in 3.3.1 and 3.3.1.1, as applicable, for compliance with the requirements. On fastener hardware, measurements shall be made at locations defined in MIL-STD-1312, Test 12. The part or article shall be considered nonconforming if one or more measurements fail to meet the specified minimum thickness. If the number of defective items in any sample exceeds the acceptance number for the specified sample, the lot represented by the sample shall be rejected. Separate specimens (see 4.4.4.1) shall not be used for thickness measurements unless a need has been demonstrated.

4.4.3 Sampling for destructive tests. A random sample of four coated parts or articles shall be taken from each lot for each destructive test or separately coated specimens shall be prepared in accordance with 4.4.4, 4.4.4.1, 4.4.4.2 and 4.4.4.3 to represent each lot. If the number of articles in the lot is four or less, the number of articles in the sample shall be specified by the acquiring activity (see 6.2.1).

4.4.3.1 Thickness of coating (destructive tests). If sampling and testing for thickness of coating by nondestructive testing is not the option of the supplier, samples selected in accordance with 4.4.3 shall be measured for coating thickness by the applicable tests detailed in 4.5.1, at several locations on each article as defined in 3.3.1 and 3.3.1.1 for compliance with the requirements. On fastener hardware, measurements shall be made at locations defined in MIL-STD-1312, Test 12. If the coating thickness, at any place on any article or specimen, is less than the specified minimum thickness, the lot shall be rejected. Separate specimens (see 4.4.4.1) shall not be used for thickness measurements, unless a need has been demonstrated.

4.4.3.2 Adhesion (destructive tests). The articles or specimens used for the destructive thickness test (see 4.4.3.1), if of suitable size and form, may be used as the test pieces for the adhesion tests to determine compliance with the requirement of 3.3.3 and 3.3.4 if applicable.

4.4.3.3 Corrosion resistance (destructive tests). When specified in the contract or purchase order, compliance with the requirements for corrosion resistance shall be determined (see 6.2.1). A set of four separate test specimens, prepared in accordance with 4.4.4 and 4.4.4.2 in lieu of the coated articles, shall be used to determine compliance with the requirements for corrosion resistance (see 3.3.5, 3.3.5.1 and 3.3.5.2). Failure of one or more of the test specimens shall reject the lot.

4.4.3.4 Lubricating oil resistance (destructive tests). When specified in the contract or purchase order, compliance with the requirements for lubricating oil resistance of material T coated articles shall be determined (see 6.2.1). A set of four separate test specimens, prepared in accordance with 4.4.4 and 4.4.4.2 in lieu

of the coated articles, shall be used to determine compliance with the requirements for lubricating oil resistance (see 3.3.6). Failure of one or more of the test specimens shall reject the lot.

4.4.3.5 Hydrogen embrittlement relief (destructive test). When specified in the contract or purchase order, conformance to the requirements of 3.2.7 for hydrogen embrittlement relief shall be determined for those parts having a tensile strength of, or heat treated to a tensile strength level of 180,000 psi and higher and which will be subject to a sustained tensile load in use (see 6.2.1). A random sample of four coated articles shall be taken from each lot or four specimens prepared in accordance with 4.4.4 and 4.4.4.3 shall be used to represent the lot. When tested as specified in 4.5.6, cracks or failure by fracture shall be cause for rejection. Failure of one or more of the test pieces shall reject the lot.

4.4.4 Specimen preparation. When the coated articles are of such form, shape, size and 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 coated concurrently with the articles represented. The separate specimens shall be of a basis metal equivalent to that of the articles represented. "Equivalent" basis metal includes chemical composition, grade, heat treat condition and finish of surface, prior to coating. For example, a cold-rolled steel surface should not be used to represent a hot-rolled steel surface. Due to the impracticality of forging or casting separate test specimens, hot-rolled steel specimens may be used to represent forged and cast-steel articles. The separate specimens may be also cut from scrap castings when ferrous alloy castings are being coated. These separate specimens shall be introduced into a lot at regular intervals, prior to the cleaning operations preliminary to coating and shall not be separated therefrom until after completion of coating. Conditions affecting the coating of specimens including the spacing and coating media in respect to other objects being coated shall correspond as nearly as possible to those affecting the significant surfaces of the articles represented. Separate specimens shall not be used for thickness measurements, however, unless the necessity for their use has been demonstrated.

4.4.4.1 Specimens for thickness and adhesion tests. If separate specimens for thickness and adhesion are required, they shall be rounded rods not less than 3 inches in length and 1/4 inch in diameter.

4.4.4.2 Specimens for corrosion and lubricating oil resistance tests. If separate specimens for corrosion resistance and lubricating oil resistance tests are required, they shall be ferrous alloy panels not less than 6 inches in length, 3 inches in width and approximately 0.04 inch thick. For the lubricating oil resistance test, the ferrous alloy shall be of such composition and hardness that the specimen will withstand deformation without cracking or fracture.

4.4.4.3 Specimens for embrittlement relief. If separate specimens for embrittlement relief test are required, they shall be round notched specimens with the axis of the specimen (load direction) perpendicular to the short transverse grain flow direction. Specimens shall have a 60 degree V-notch located approximately at the center of the gage length. The cross section area at the root of the vee shall be approximately equal to half the area of the full cross section area of the specimen's reduced section. The vee shall have a 0.010 ± 0.0005 radius of curvature at the base of the notch.

4.5 Tests.

4.5.1 Thickness. For nondestructive measuring of coating thickness, procedures in accordance with FED-STD-151, Method 520 (electronic test), ASTM B 499 (magnetic test), ASTM B 244 (eddy current), ASTM B 567 (beta radiation backscatter principle) or ASTM B 568 (X-ray spectrometry) may be used. For destructive measuring of coating thickness, procedures in accordance with ASTM B 487 (microscopic) may be used. In addition to the above, the other procedures embodied in MIL-STD-1312, Test 12, may be used for thickness measurement of coated fastener hardware. Thickness measurements of mechanically deposited coatings, Types II and III, shall be made after application of the supplementary treatments.

4.5.2 Adhesion. Adhesion may be determined by scraping the surface or shearing with a sharp edge, knife or razor through the coating to the basis metal and examining at 4X diameters magnification for evidence of non-adhesion. Alternately, the article or specimen may be clamped in a vise and the projecting portion bent back and forth until rupture occurs. If the edge of the ruptured coating can be peeled back or if separation between the coating and basis metal can be seen at the point of rupture when examined at 4X diameter magnification, adhesion is not satisfactory.

4.5.3 Adhesion of Type II supplementary film. Adhesion of the Type II supplementary film may be determined by rubbing the chromated surface with a soft white tissue paper, such as lens paper conforming to NNN-P-40, or less preferably with a gritless soft gum eraser (art-gum) conforming to ZZ-E-661 for a few seconds by hand (about 10 strokes) using normal pressure and a stroke about 2 inches long. The film must be adherent, nonpowdery and abrasion resistant.

4.5.4 Corrosion resistance. Corrosion resistance shall be conducted in accordance with ASTM B 117 (salt spray test) for the minimum number of hours detailed in Table II according to the material, class and type. To secure uniformity of results, Type II supplementary coatings shall be aged at room temperature for 24 hours before subjection to the salt spray test.

4.5.5 Lubricating oil resistance. Lubricating oil resistance shall be determined by immersing parts or specimens in diester lubricating oil conforming to MIL-L-7808 at a temperature of $121^{\circ} \pm 3^{\circ}C$ ($250^{\circ} \pm 5^{\circ}F$) for 24 hours. After removal, parts or specimens shall be cooled to room temperature, examined and compared with unexposed parts or specimens. Discoloration shall not be cause for rejection. The part or specimen shall then be tested in accordance with FED-STD-141, Method 6223 using a mandrel whose diameter is 14 times the basis metal thickness. The time of test shall be 2 seconds. If the edge of the ruptured coating can be peeled back, or if separation of the coating from the basis metal can be seen at the point of rupture when examined at 4X diameter magnification, adhesion is not satisfactory due to poor resistance to lubricating oil.

4.5.6 Embrittlement relief. Compliance with 3.2.7 shall be determined with samples of coated parts taken as specified in 4.4.3.5. Parts such as spring pins, lock rings, etc., which are installed in holes or rods, shall be similarly assembled using the applicable parts specification or drawing tolerances which impose the maximum sustained tensile load on the coated part. The selected samples shall be subjected to a sustained tensile load equal to 115 percent of the maximum design yield load for which the part was designed. Fastener hardware, where the maximum

design yield load is not known or given, shall be tested in accordance with MIL-STD-1312, Test 5. Parts which require special fixtures, extreme loads to comply with the above requirements, or where the maximum design yield load is not known, may be represented by separate specimens prepared in accordance with 4.4.4.3. The notched specimens shall be subject to a sustained tensile load equal to 75 percent of the ultimate notch tensile strength of the material. The articles, parts or specimens shall be held under load for at least 200 hours and then be examined for cracks or fractures.

5. PACKAGING

5.1 Preservation-packaging and packing. Preservation-packaging and packing methods for mechanically deposited parts or articles employed by a supplier shall be such as to preclude damaging during shipment and handling (see 6.9).

6. NOTES

6.1 Intended use.

6.1.1 General usage. The mechanically deposited coatings of cadmium, tin-cadmium and zinc covered by this specification are intended for use as protective coatings on ferrous and other basis metal parts. Mechanically deposited coatings, often referred to as "peen platings", are formed without the use of electric current by impacting soft, ductile metal powders so that they will adhere onto the surface of parts.

6.1.2 Type II treatment. The prime purpose of chromate finishes (Type II) on mechanically deposited coatings is to retard or prevent the formation of white corrosion products on surfaces exposed to stagnant water, high humidity atmospheres, salt water, marine atmospheres or cyclic condensation and drying. Some types of chromate films have proved satisfactory as a base for paints. The surfaces of mechanically deposited coatings, particularly cadmium and zinc, are attacked by supplementary chromate treatment, thereby diminishing the amount of metallic coating present. With coatings of 0.0003 inch (0.3 mil) and greater, this reduction is insignificant, but it is significant with a 0.0002 inch (0.2 mil) thick coating. It is therefore recommended that supplementary chromate treatment not be applied to coatings having a nominal thickness of 0.0002 inch (0.2 mil) or less.

6.1.3 Type III treatment. The prime purpose of phosphate finishes (Type III) on mechanically deposited coatings is to form a paint base.

6.1.4 Application. The application of mechanically deposited coatings is a two part process: surface conditioning and coating. The surface conditioning step is designed to remove contaminations (minor soils), to produce a mildly etched surface (see 3.2.2), and to provide a flash coating which may be copper (see 3.2.4) to make the surface receptive to the subsequent coating operation. The coating operation is carried out in a tumbling barrel containing the part with a water-slurry of spherically shaped, fine metal powder or powders, glass beads as the impact media, and a chemical compound known as the "promoter". The temperature ranges from 18° to 27°C (65° to 80°F) and the coating is done in 15 to 60 minutes. Coating thickness is controlled by the amount of the metal powder materials used.

6.2 Ordering data.

6.2.1 Acquisition requirements. Acquisition documents should specify the following:

a. Title, number and date of this specification.

b. Material, class and type required (see 1.2.1, 1.2.2, 3.1 and 3.3.2).

c. Coverage of all surfaces, unless otherwise specified (see 3.2.5).

d. Finish required, if other than specified (see 3.2.6).

e. Type of chromate treatment required for conversion to Type II, if other than specified (see 3.2.9).

f. Type of phosphate treatment required for conversion to Type III, if other than specified (see 3.2.10).

g. Thickness of coating, if other than specified (see 3.3.1 and 3.3.1.1).

h. Whether Type I and Type III coatings are to be subject to corrosion resistance test (see 3.3.5.2 and 4.4.3.3).

i. Control record requirement (see 4.3.1).

j. Number of samples for destructive testing (see 4.4.3).

k. Whether corrosion resistance test is required for lot sampling inspection (see 4.4.3.3).

l. Whether lubricating oil resistance test is required for lot sampling inspection (see 4.4.3.4).

m. Whether hydrogen embrittlement relief test is required for lot sampling inspection (see 4.4.3.5).

6.3 Limitations. Cadmium coatings should not be used on parts for space applications or on parts which in service reach a temperature of 233°C (450°F) or higher, or come in contact with other parts which reach those temperatures. Tin-cadmium coatings should not be used on parts which in service reach a temperature of 174°C (345°F) or higher or come in contact with other parts which reach those temperatures. Zinc coatings should not be used on parts which in service reach a temperature of 371°C (700°F) or higher and come in contact with other parts which reach those temperatures. MIL-S-5002 contains additional warning where the various coatings shall not be used.

6.4 Stress relief. There is a hazard that hardened and tempered cold-worked or cold-straightened steel parts having a Rockwell hardness of C 33 and below can crack during cleaning and coating. Such parts should have a suitable heat treatment for stress relief prior to cleaning and coating (see 3.2.1).

6.5 Threaded parts. As heavier coatings are required for satisfactory corrosion resistance than Class 3 for military use, allowance should be made in the manufacture of most threaded articles, such as nuts, bolts and similar fasteners with complementary threads for dimensional tolerances to obtain necessary coating build-up. Certain recessed areas, such as root diameters of threads, have a tendency to exhibit build-up with mechanically deposited coatings which is in direct contrast with electrodeposited plating as well as vacuum deposition.

6.6 Type II temperature limitations. Chromate treatments (Type II) should not be used on coated parts which will not be painted and which will be continuously exposed to temperatures in excess of 66°C (150°F) or intermittently exposed for short periods to temperatures of approxmately 131°C (300°F) or more. However, these treatments may be used to prevent finger marking and corrosion which may occur at room temperature during assembly and storage.

6.7 Type II handling precaution. Chromate treatments (Type II), which involve only dipping in chemical solutions, normally require a sufficient period of drying, approximately 24 hours at 21° to 32°C (70° to 90°F), to render the parts suitable for handling without damage to film while in gelatinous forms; and it is important with such films that the workmanship be such that the film is not excessively damaged while wet.

6.8 Toxicity. Cadmium and tin-cadmium, because of their toxicity, should not be employed as a coating for any object intended for use as a food container, cooking utensil or for any object likely to come in contact with food. Cadmium or tin-cadmium coated sheets or any other structural shapes which may be subjected to heat from welding, brazing or soldering operations should be so labeled because of the danger from poisonous vapors during operations. Zinc, because of its solubility in the presence of acid foods, should not be employed as a coating for any object that may contain or come in contact with food.

6.9 Packaging limitations. Unprotected cadmium and tin-cadmium coated articles should not be packed in non-ventilated containers, either together or in contact with electrical equipment, because of the danger of deleterious effect on cadmium coating from unstable organic electrical insulation. In addition to organic electrical insulation, phenolic resinous substances and others containing unsaturated carbon-to-carbon linkages, such as oil paint and impregnated paper, etc., cause an abnormal attack on cadmium by setting free, in the presence of moisture, formic acid, butyric acid, etc. Corrosion of cadmium coatings and steel basis metal has been noted when cadmium coated articles have been packaged in direct contact with container materials such as wood or cardboard. Corrosion has been especially severe if the container materials have become wet or have been stored under conditions of high humidity. Zinc coated articles should not be packaged in non-ventilated containers unless containers are dehydrated with a desiccant or the coated articles are treated with a corrosion-preventive compound.

6.10 Tin-cadmium contents. The composition for the tin-cadmium coating, stated in 3.1.1, indicates the mixture of tin and cadmium powders that should be used by the supplier. No simple method exists for determination of the tin-cadmium ratio in the coated article. MHowever, X-ray fluorescence or atomic absorption techniques can be used.

6.11 Changes from previous issues. Asterisks are not used in this revision to identify changes with respect to the previous issue due to the extensiveness of the changes.

Custodians:
Army - MR
Navy - AS
Air Force - 20

Review activities:
Army - AR, AV, MD, MI
Navy - OS
Air Force - 70, 71, 80, 82, 84, 99

User activities:
Army - AT, ME
Navy - SH

Preparing activity:
Navy - AS

(Project MFFP-0250)

TABLE I. Coating thickness.

Class	Thickness					
	Cadmium (material C) and tin-cadmium (material T)			Zinc (material Z)		
	Inch, minimum	Mil, minimum	Equivalent as micrometers (approximately) 1/	Inch, minimum	Mil, minimum	Equivalent as micrometers (approximately) 1/
1	0.00050	0.5	13	0.00300	3.0	76
2	0.00030	0.3	8	0.00200	2.0	51
3	0.00020	0.2	5	0.00170	1.7	43
4	-	-	-	0.00100	1.0	25
5	-	-	-	0.00050	0.5	13
6	-	-	-	0.00030	0.3	8

1/ 0.001 inch = 1 mil = 25.4 micrometers

TABLE II. Test periods for salt spray test requirements in hours.

	Type I	Type II	Type III	Type I	Type II	Type III
Material	Class 1			Class 2		
C	144	98	144	96	96	96
T	144	168	144	120	168	120
Z	500	96	500	300	96	300
Material	Class 3			Class 4		
C	36	96	36	-	-	-
T	60	168	60	-	-	-
Z	250	96	250	192	96	192
Material	Class 5			Class 6		
C	-	-	-	-	-	-
T	-	-	-	-	-	-
Z	96	96	96	56	96	56

TABLE III. Lot sampling tests and specimens.

Test	For coating types	Paragraph		
		Requirement	Specimen prepration	Test
Thickness	I, II, III	3.3.1, 3.3.1.1 and 3.3.1.2	4.4.4 and 4.4.4.1 1/	4.5.1
Adhesion	I, II, III	3.3.3	4.4.4 and 4.4.4.1 1/	4.5.2
Coating adhesion	II	3.3.4	4.4.4 and 4.4.4.1 1/	4.5.3
Corrosion resistance	I, II, III	3.3.5, 3.3.5.1 and 3.3.5.2	4.4.4 and 4.4.4.2 1/	4.5.4
Lubricating oil resistance (material T only)	I, II, III	3.3.6	4.4.4 and 4.4.4.2 1/	4.5.5
Embrittlement relief	I, II, III	3.2.7	4.4.4 and 4.4.4.3	4.5.6

1/ Standard alloy steels shall be used for process control specimens. The selection shall be at the option of the supplier; however, alloy steels such as AISI or SAE numbers 4130, 4135, 4140, 4145, 4340, 8645 and 8740 conforming to MIL-S-5000 shall be used.

TABLE IV. Sampling for visual examination and nondestructive tests.

Numbers of items in lot inspections	Number of items in samples (randomly selected)	Acceptance number (maximum number of sample items nonconforming to any test)
15 or less	7 1/	0
16 to 40	10	0
41 to 110	15	0
111 to 300	25	1
301 to 500	35	1
501 and over	50	2

1/ If the number of items in the inspection lot is less than 7, the number of items in the sample shall equal the number of items in the inspection lot.

☆ U S GOVERNMENT PRINTING OFFICE 1983—605-034/3368

INSTRUCTIONS In a continuing effort to make our standardization documents better, the DoD provides this form for use in submitting comments and suggestions for improvements All users of military standardization documents are invited to provide suggestions This form may be detached, folded along the lines indicated, taped along the loose edge *(DO NOT STAPLE)*, and mailed In block 5, be as specific as possible about particular problem areas such as wording which required interpretation, was too rigid, restrictive, loose, ambiguous, or was incompatible, and give proposed wording changes which would alleviate the problems Enter in block 6 any remarks not related to a specific paragraph of the document If block 7 is filled out, an acknowledgement will be mailed to you within 30 days to let you know that your comments were received and are being considered

NOTE This form may not be used to request copies of documents, nor to request waivers, deviations, or clarification of specification requirements on current contracts Comments submitted on this form do not constitute or imply authorization to waive any portion of the referenced document*(s)* or to amend contractual requirements

(Fold along this line)

(Fold along this line)

DEPARTMENT OF THE NAVY
Commanding Officer
Naval Air Engineering Center
Engineering Specifications and Standards Department
(ESSD), Code 93
Lakehurst, NJ 08733

OFFICIAL BUSINESS
PENALTY FOR PRIVATE USE $300

NO POSTAGE NECESSARY IF MAILED IN THE UNITED STATES

BUSINESS REPLY MAIL
FIRST CLASS PERMIT NO 12503 WASHINGTON D C

POSTAGE WILL BE PAID BY THE DEPARTMENT OF THE NAVY

Commanding Officer
Naval Air Engineering Center
Engineering Specifications and Standards Dept.
(ESSD), Code 93
Lakehurst, NJ 08733

STANDARDIZATION DOCUMENT IMPROVEMENT PROPOSAL

(See Instructions - Reverse Side)

1 DOCUMENT NUMBER	2. DOCUMENT TITLE
MIL-C-81562B	Coatings, Cadmium, Tin-Cadmium and Zinc (Mechanically Deposited)

3a. NAME OF SUBMITTING ORGANIZATION	4 TYPE OF ORGANIZATION *(Mark one)*
	☐ VENDOR
b ADDRESS *(Street, City, State, ZIP Code)*	☐ USER
	☐ MANUFACTURER
	☐ OTHER *(Specify)* _____

5 PROBLEM AREAS

a. Paragraph Number and Wording

b. Recommended Wording

c Reason/Rationale for Recommendation

6 REMARKS

7a. NAME OF SUBMITTER *(Last, First, MI)* – Optional	b WORK TELEPHONE NUMBER *(Include Area Code)* – Optional
c MAILING ADDRESS *(Street, City, State, ZIP Code)* – Optional	8 DATE OF SUBMISSION *(YYMMDD)*

DD FORM 82 MAR 1426

PREVIOUS EDITION IS OBSOLETE