

MIL-P-23408B
23 August 1983
SUPERSEDING
MIL-P-23408A
19 July 1967

MILITARY SPECIFICATION

PLATING: TIN-CADMIUM (ELECTRODEPOSITED)

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 classes of tin-cadmium alloy plating.

1.2 Classification. Tin-cadmium plating shall be of the following classes, as specified (see 6.2.1):

<u>Class</u>	<u>Thickness, inch (minimum)</u>
1	0.0005
2	0.0003
3	0.0002

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.

STANDARDS

FEDERAL

FED-STD-151 - Metals, 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.)

Beneficial comments (recommendations, 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.

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2.2 Other publications. The following document forms a part of this specification to the extent specified herein. The issues of the document 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.

(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 tin-cadmium coatings which meet the requirements of this specification.

3.1.1 Composition. The plating shall contain 25 to 50 percent tin by weight and the remainder shall be cadmium.

3.2 Workmanship.

3.2.1 Basis metal. The basis metal shall be free from defects that will be detrimental to the appearance or the protective value of the plating. The basis metal shall be subjected to such cleaning, pickling and plating procedures as necessary to yield deposits as herein specified.

3.2.2 Plating. The basis metal shall be either plated with tin and cadmium in two consecutive layers and subjected to a diffusion treatment or plated with tin-cadmium alloy. The tin-cadmium plating shall be smooth, fine grained, adherent, continuous, free from visible blisters, pits, nodules, indications of burning, excessive edge build-up and other defects. Superficial staining which has been demonstrated as resulting from rinsing, or slight discoloration resulting from baking, as specified below (see 3.3.3), shall not be cause for rejection. All details of workmanship shall conform to the best practice for high quality plating.

3.3 General requirements.

3.3.1 Application. Unless otherwise specified, the plating shall be applied after all machining, brazing, welding, forming and perforating of the article have been completed.

3.3.2 Stress-relief heat treatment. Unless otherwise specified, all steel parts having an ultimate tensile strength of 150,000 psi and above, which are machined, ground, cold formed or cold straightened after heat treatment, shall be baked at a

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minimum of $191^{\circ} \pm 14^{\circ}\text{C}$ ($375^{\circ} \pm 25^{\circ}\text{F}$) for three hours or more prior to cleaning and plating for the relief of damaging residual tensile stresses.

3.3.3 Baking. All steel parts having a Rockwell hardness of C 40 and higher shall be baked at $168^{\circ} \pm 6^{\circ}\text{C}$ ($335^{\circ} \pm 10^{\circ}\text{F}$) for three or more hours within eight hours after plating to provide embrittlement relief (see 4.4.2.5). Plated springs or other parts subject to flexure shall not be flexed prior to baking operations (see 6.4). Carburized parts shall be baked at $135^{\circ} \pm 14^{\circ}\text{C}$ ($275^{\circ} \pm 25^{\circ}\text{F}$).

3.3.4 Diffusion treatment. All steel parts plated with tin and cadmium as discrete layers shall be given a diffusion treatment at $168^{\circ} \pm 6^{\circ}\text{C}$ ($335^{\circ} \pm 10^{\circ}\text{F}$) for 30 to 45 minutes, except when baking is required for embrittlement relief (see 3.3.3). In that case, the baking treatment is considered equivalent to the diffusion treatment.

3.3.5 Deposition. Unless otherwise specified, tin-cadmium shall be deposited directly on the basis metal without a preliminary plating of other metal.

3.4 Detail requirements.

3.4.1 Thickness of plating. The thickness of the tin-cadmium shall be as specified in Table I on all visible surfaces which can be touched by a ball 0.75 inch in diameter. Where Class 1 is specified, all other visible surfaces shall be Class 2 minimum thickness. Where Class 2 is specified, all other visible surfaces shall be Class 3 minimum thickness. Where Class 3 is specified, all other visible surfaces shall be 0.00015 inch minimum thickness.

3.4.1.1 Thickness. Tin-cadmium plating shall be Class 1 thickness, unless otherwise specified or controlled by the following exceptions (see 6.5):

- a. Bolts, studs, washers and articles with portions externally threaded. These parts shall have a minimum of Class 2 thickness.
- b. Holes and other openings and internal threads from which the external environment is completely excluded, where a controlled deposit can not be normally obtained, shall not be subject to a thickness requirement.

3.4.2 Adhesion. The adhesion of the plating shall be such, that when examined at a magnification of approximately 4 diameters, it does not show separation from the basis metal at the interface when subjected to the test described in 4.5.3. The interface between the tin-cadmium and the basis metal is the surface of the basis metal before plating. The formation of cracks in the plate caused by rupture of the basis metal which do not result in flaking, peeling, or blistering of the plate shall not be considered as nonconformance to this requirement.

3.4.3 Corrosion resistance. Plated specimens shall show no basis metal corrosion products at the end of 168 hours when tested by continuous exposure to salt spray as specified in 4.5.4.

4. QUALITY ASSURANCE PROVISIONS

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Responsibility for inspection. Unless otherwise specified in the contract 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 available 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 seemed necessary to assure supplies and services conform to prescribed requirements.

2. Classification of inspections. The inspections specified herein are classified as quality conformance inspections.

2.1 Separate specimens. When the plated articles are of such form, as to be readily adaptable to a test specified herein or are for destructive tests of small lot sizes, the test shall be made by the use of separate specimens plated concurrently with the articles represented. The separate specimens shall be of a metal equivalent to that of the articles represented. Equivalent basis includes chemical composition, grade, condition and finish of surface prior to plating. 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 small test specimens, hot-rolled steel specimens may be used to represent cold and cast-steel articles. The separate specimens shall be strips approximately 1 inch wide, 4 inches long and 0.04 inch thick for adhesion test; but shall be at least 4 inches wide, 6 inches long and approximately 0.04 inch thick for all other tests. These specimens shall be introduced into a lot at regular intervals from the cleaning operations preliminary to plating and shall not be separated from the lot until after completion of plating. Conditions affecting the plating of specimens including the spacing and positioning in respect to anodes and to other articles being plated 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.

3 Lot. A lot shall consist of plated articles of the same class plated under the same conditions, and approximately the same size and shape submitted for inspection at one time.

4 Sampling.

4.1 For visual examination and nondestructive tests. Samples for visual examination and nondestructive tests shall be selected at random from each lot. The number of articles shall be as indicated in Table II. The lot shall be accepted or rejected according to the procedures in 4.4.1.1 for visual examination and 4.4.1.2 for plating thickness (nondestructive tests).

4.1.1 Visual examination. Samples selected in accordance with 4.4.1 shall be examined for compliance with the requirements of 3.2.1 before plating, unless otherwise specified, and 3.2.2 after plating. If the number of nonconforming articles exceeds the acceptance number for that sample, as stated in Table II, the lot represented by the sample shall be rejected.

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4.4.1.2 Thickness of plating (nondestructive tests). Samples selected in accordance with 4.4.1 shall be inspected and the plating thickness measured at locations on each article as defined in 3.4.1 for compliance with the requirements. The 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, as stated in Table II, the lot represented by the sample shall be rejected. Separate specimens (see 4.2.1) shall not be used for thickness measurements unless a need has been demonstrated.

4.4.2 For destructive tests. A random sample of four plated parts or articles shall be taken from each lot or four separately plated specimens shall be prepared in accordance with 4.2.1 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 contracting agency (see 6.2.1).

4.4.2.1 Composition (destructive tests). Samples selected in accordance with 4.4.2 shall be tested for composition as specified in 3.1.1 (see 4.5.1).

4.4.2.2 Thickness of plating (destructive tests). Samples selected in accordance with 4.4.2 shall be measured for plating thickness at several locations on each article, as defined in 3.4.1, for compliance with the specified requirements. Measurements on threaded articles, such as screws, nuts, bolts and other fasteners shall be made on the shank or other smooth surfaces as close to the threads as possible. If the plating thickness at any place on any article or specimen is less than the specified minimum thickness, the lot shall be rejected. Separate specimens (see 4.2.1) shall not be used for thickness measurements unless a need has been demonstrated.

4.4.2.3 Adhesion (destructive tests). The articles or specimens used for the destructive thickness test (see 4.4.2.2), if of suitable size and form, may be used as the specimens for the adhesion test to determine compliance with the requirements of 3.4.2. Failure of one or more of the test specimens shall constitute failure of the lot.

4.4.2.4 Corrosion resistance (destructive tests). When specified, compliance with the requirements for corrosion resistance shall be determined (see 3.4.3). A set of four separate test specimens prepared in accordance with 4.2.1 shall be tested. Failure of one or more of the test specimens shall reject the lot.

4.4.2.5 Embrittlement relief (destructive tests). Unless otherwise specified, conformance to the requirements of 3.3.3 for embrittlement relief shall be determined. A random sample of four plated articles shall be taken from each lot. The samples shall be considered nonconforming if cracks are found after test or failure by fracture. Failure of one or more of the test specimens shall reject the lot (see 4.5.5).

4.5 Test methods.

4.5.1 Composition. Either Method 111 or 112 of FED-STD-151 may be used for determination of composition of the tin-cadmium plating.

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4.5.2 Thickness. Either Method 520, electronic test; Method 522, magnetic test; or Method 521, microscopic test of FED-STD-151 may be used for measuring the tin-cadmium plating thickness. However, for referee tests, the microscopic test method shall be used.

4.5.3 Adhesion. Adhesion may be determined by scraping the surface or shearing with a sharp edge, knife or razor through the plating down to the basis metal and parallel to surface of the basis metal and examining at four diameters magnification for evidence of nonadhesion. Alternately the article may be clamped in a vise and the projecting portion bent back and forth until rupture occurs. If the edge of the ruptured plate can be peeled back or if a separation between the plate and the basis metal can be seen at the point of rupture when examined at four diameters magnification, adhesion is not satisfactory.

4.5.4 Corrosion resistance. Corrosion resistance shall be conducted in accordance with ASTM B 117 (salt spray (fog) test). Test shall be continued for 168 hours.

4.5.5 Embrittlement relief. Unless otherwise specified, samples of coated parts taken as specified in 4.4.2.5 for determining compliance with 3.3.3 are those which will be subjected to a sustained tensile load in use. Parts such as spring pins, lock rings, etc., which are installed in holes or rods, shall be similarly assembled, using the applicable parts specifications or drawing tolerances which impose the maximum sustained tensile load on the plated parts. The selected samples shall be subjected to a sustained tensile load to within 15 percent of the yield load. The articles or parts shall be held under load for at least 200 hours, unless otherwise specified, and then examined for cracks. Parts which require special fixtures or extreme loads to comply with the above requirements, unless otherwise specified by the contracting agency, may be represented by separate test specimens. Four rounded, notched steel specimens with the axis perpendicular to the short grain flow direction shall be prepared as specified in 4.2.1 to represent each lot. The configuration shall be in accordance with Figure 2 of FED-STD-151, Method 211, for rounded specimens. Specimens shall have a 60 degree V-notch with cross section area at the root of the Vee approximately equal to half the area of the full cross section area of the specimens and shall have a 0.010 ± 0.0005 inch radius of curvature at the base of the notch.

4.6 Retests. Articles rejected or withdrawn because of defective or deficient plating may be resubmitted after stripping and replating or screening of the entire lot. Full particulars concerning the replating shall be furnished to the contracting agency. Where only insufficient thickness is involved, replating without stripping the existing coating may be permitted at the discretion of the contracting agency. All material having a Rockwell hardness of greater than C 40 shall be hydrogen-embrittlement relieved after replating in accordance with 3.3.3.

5. PACKAGING

5.1 Preservation and packing. Unless otherwise specified, preservation and packing methods for electrodeposited tin-cadmium parts or articles employed by the supplier shall be such as to preclude damaging during shipment and handling.

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6. NOTES

6.1 Intended use. The tin-cadmium plating covered in this specification is intended for use as a protective coating on metal parts used in weapons systems. Tin-cadmium coatings should not be used on parts which in service reach a temperature of 170°C (340°F) or higher or come in contact with other parts which reach those temperatures.

6.2 Ordering data.

6.2.1 Acquisition requirements. Acquisition documents should specify the following:

- a. Title, number and date of this specification.
- b. Class (thickness) required (see 1.2 and 3.4.1).
- c. Specified application procedures, if applicable (see 3.3.1, 3.3.2, 3.3.3 and 3.4).
- d. Corrosion resistance testing, if applicable (see 4.4.2.4).
- e. Embrittlement relief testing, if applicable (see 4.4.2.5).
- f. Sampling for destructive tests, if the lot is four or less (see 4.4.2).

6.3 Toxicity. Tin-cadmium, because of its toxicity, should not be employed as a coating for any object intended for use as a food container or cooking utensil or for any object likely to come in contact with food or beverages. Tin-cadmium coated sheets and any other structural shapes which may be subjected to heat from welding or soldering operations should be so labeled because of the damage from poisonous vapors during such operations.

6.4 Baking time. For higher strength materials it may be beneficial to extend the baking treatment to 23 hours (see 3.3.3) to insure complete hydrogen embrittlement relief.

6.5 Tolerances. The dimensional tolerances for threaded articles, such as nuts, bolts and similar fasteners with complementary threads do not permit the application of a coating thickness greater than Class 3. If heavier coatings are required for satisfactory corrosion resistance, allowance must be made in the manufacture of the threaded fasteners for tolerances necessary for plate build-up.

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

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Custodians:

Army - MR
 Navy - AS
 Air Force - 20

Preparing activity:

Navy - AS

(Project MFFP-0249)

Review activities:

Army - AR, CR
 Navy - OS
 DLA - IS(E)

User activities:

Navy - MC, SH

TABLE I. Thickness.

Class	Thickness, minimum (inch)
1	0.0005
2	0.0003
3	0.002

TABLE II. Samples for visual inspection and
nondestructive tests.

Number of items in lot inspection	Number of items in samples (randomly selected)	Acceptance number (maximum number of sample items noncon- forming to any test)
15 or less	7 <u>1/</u>	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 be equal to the number of items in the inspection lot.

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.

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STANDARDIZATION DOCUMENT IMPROVEMENT PROPOSAL*(See Instructions - Reverse Side)*

1. DOCUMENT NUMBER MIL-P-23408B		2. DOCUMENT TITLE Plating: Tin-Cadmium (Electrodeposited)					
3a. NAME OF SUBMITTING ORGANIZATION		4. TYPE OF ORGANIZATION (Mark one)					
b. ADDRESS (Street, City, State, ZIP Code)		<input type="checkbox"/> VENDOR					
		<input type="checkbox"/> USER					
		<input type="checkbox"/> MANUFACTURER					
		<input type="checkbox"/> 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)					