

NOT MEASUREMENT SENSITIVE

MIL-T-10727C
 30 June 1989
 SUPERSEDING
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MILITARY SPECIFICATION

TIN PLATING: ELECTRODEPOSITED OR HOT-DIPPED,
 FOR FERROUS AND NONFERROUS METALS

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

1. SCOPE AND CLASSIFICATION

1.1 Scope. This specification covers the requirements for
 electrodeposited tin and hot-dipped tin coatings on ferrous and nonferrous
 metals.

1.2 Classification. The tin plating covered by this specification shall
 be of the following types, as specified (see 6.1):

Type I - Electrodeposited. Use ASTM B545 Standard Specification
 for Electrodeposited Coatings of Tin
 Type II - Hot-dipped

2. APPLICABLE DOCUMENTS

2.1 Government documents.

2.1.1 Specifications, standards, and handbooks. The following
 specifications, standards, and handbooks form a part of this document to the
 extent specified herein. Unless otherwise specified, the issues of these
 documents are those listed in the issue of the Department of Defense Index of
 Specifications and Standards (DODISS) and supplement thereto, cited in the
 solicitation (see 6.2).

SPECIFICATIONS

FEDERAL

QQ-S-571 - Solder, Tin Alloy: Tin-Lead Alloy; and Lead Alloy
 QQ-T-371 - Tin; Pig

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MIL-F-14256 - Flux, Soldering, Liquid (Rosin Base)

Beneficial comments (recommendations, additions, deletions) and any pertinent
 data which may be of use in improving this document should be addressed to:
 Director, U.S. Army Laboratory Command, Materials Technology Laboratory,
 ATTN: SLCMT-MEE, Watertown, MA 02172-0001 by using the Standardization
 Document Improvement Proposal (DD Form 1426) appearing at the end of this
 document or by letter.

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STANDARDS

MILITARY

MIL-STD-105 - Sampling Procedures and Tables for Inspection by
Attributes

(Unless otherwise indicated, copies of federal and military specifications, standards, and handbooks are available from the Naval Publications and Forms Center, (ATTN: NPODS), 5801 Tabor Avenue, Philadelphia, PA 19120-5099.)

2.2 Non-Government publications. The following documents form a part of this specification to the extent specified herein. Unless otherwise specified, the issues of the documents which are DoD adopted are those listed in the issue of the DODISS cited in the solicitation. Unless otherwise specified, the issues of documents not listed in the DODISS are the issues of the documents cited in the solicitation (see 6.2).

ASTM (AMERICAN SOCIETY FOR TESTING AND MATERIALS)

- ASTM B 117 - Method of Salt Spray (Fog) Testing
- ASTM B 322 - Cleaning Metals Prior to Electroplating
- ASTM B 487 - Measurement of Coating Thicknesses by Microscopical Examination of a Cross Section
- ASTM B 499 - Measurement of Coating Thickness by the Magnetic Method
- ASTM B 504 - Measurement of Thickness of Metallic Coatings by the Coulometric Method
- ASTM B 545 - Electrodeposited Coatings of Tin
- ASTM B 567 - Measurement of Coating Thickness by the Beta Back Scatter Method
- ASTM B 568 - Measurement of Coating Thickness by X-Ray Spectrometry

(Application for copies should be addressed to ASTM, 1916 Race Street, Philadelphia, Pennsylvania 19103.)

2.3 Order of precedence. In the event of a conflict between the text of this document and the references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

3. REQUIREMENTS

3.1 Tin coating. Coating shall be either electrodeposited (type I) or hot-dipped (type II) as specified. The hot-dip tin bath shall be not less than 99.8 percent tin, in accordance with QQ-T-371. Electrodeposited tin (type I) shall conform to the requirements set forth in the ASTM standard specification for Electrodeposited Coatings of Tin: ASTM B545 (see 4.5.1).

3.1.1 Alloying for special purposes. When specified, electrodeposited tin coatings conforming to the requirements outlined for type I coatings may sometimes deliberately be alloyed for special purposes, such as prevention of whisker growth. Special design considerations may mandate a codeposit of tin with another alloying element such as lead. Tin coatings are not necessarily

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advocated for use on electronic equipment designed for low voltage where components are closely spaced. Codeposition with a minimum of 2% lead with the tin has been described for coatings applied on or near miniaturized low voltage electronics (see ASTM B545 X7.3, X7.3.1, 7.3.2 and 7.3.4.3).

3.2 Basis metal. The basis metal shall be free from flaws or defects that will be detrimental to the appearance or the performance of the coating. Components or parts shall be subjected to such cleaning, pickling, and pretreatment procedures as are necessary to yield adherent deposits.

3.2.1 Preparation of basis metal.

3.2.1.1 Type I (electrodeposited coatings). All basis metal shall be cleaned as outlined in ASTM B322.

3.2.1.2 Type II (hot-dip coatings). Basis metal shall be given a 2 to 5 minute treatment in a cold 15 percent (by volume) aqueous sulfuric acid solution containing 2 percent (by volume) nitric acid. After pickling and rinsing, all items shall be dipped in a flux solution composed of 3 pounds of zinc chloride and 0.3 pound of ammonium chloride per gallon of water.

3.2.1.3 Type I or Type II brass or bronze basis metal. An acid dip is not always effective for removal of all stains.

3.3 Significant surfaces with respect to minimum thickness of coating. The minimum thickness on significant surfaces (see 6.4) of the finished items shall be as specified on the drawings, or in the contract or purchase order. Significant surfaces are those visible surfaces or parts of the surface which can be touched with a sphere 0.75 inch (19.1mm) in diameter. The plating on other surfaces shall ensure plating continuity which is essential to the appearance and serviceability of the assembled article (see 6.1 and 6.2).

3.3.1 Type I electrodeposited tin coating. See ASTM B545 and section 6.1 of this specification.

3.3.2 Type II hot-dipped tin plate. For a pore-free corrosion resistant coating, a minimum coating thickness of 0.0007 in (18 μ m) tin is required (see 6.5).

3.4 Adhesion of coating. The coating shall be examined at a magnification of 4 diameters and shall not show separation from the basis metal at the common interface when subjected to the test specified in 4.6.2. Cracks in the basis metal which do not result in flaking, peeling, or blistering shall not be considered as nonconformance with this requirement.

3.4.1 Alternative adhesion test. When specified in the contract or order (see 6.2), adhesion shall be determined by the heat test specified in 4.6.2.2. Test specimens shall show no evidence of blistering or delamination of the plating subsequent to the heat test. Discoloration due to baking shall not be cause for rejection.

3.5 Preservation. When specified, Type I electrodeposited contacts or items used for electrical terminals to be soldered shall be given a protective coating or dip. Parts shall be dipped or coated immediately after plating at room temperature, 70°F (21°C), and then spun dried.

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3.5.1 Preservative coating. The preservative shall be composed of 1 ounce of stearic acid (commercial) dissolved in 1 gallon of xylol (commercial) (see 6.7).

3.6 Solderability. When a soldering test is specified, the finished item which requires soldering shall be easily coated with solder when tested as specified in 4.6.3. The solder shall adhere to the hot-dipped plate evenly (without lumps) and firmly. The coating shall not be capable of being lifted with a sharp-edged instrument.

3.7 Salt spray resistance. When specified in the contract or order (see 6.2), heavy resistant coatings required for corrosion protection shall be subjected to the salt spray test in accordance with 4.6.4. At completion of the test, the coating shall show no more corrosion of the basis metal than specified in 3.7.1.

3.7.1 Finish. The appearance of more than six corroded areas that are visible to the unaided eye per square foot of surface, or of any corroded areas larger than 0.063 inch (1.59mm) in diameter, shall be cause for rejection. For purpose of this requirement, a corroded area is defined as exposure or corrosion of the basis metal.

3.8 Workmanship. The coating shall be lustrous, smooth, fine-grained, adherent, and free from blisters, pits, nodules, indications of burning and other defects.

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 (examinations and tests) 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 this specification where such inspections are deemed necessary to ensure supplies and services conform to prescribed requirements.

4.1.1 Responsibility for compliance. All items shall meet all requirements of sections 3 and 5. The inspection set forth in this specification shall become a part of the contractor's overall inspection system or quality program. The absence of any inspection requirements in the specification shall not relieve the contractor of the responsibility of ensuring that all products or supplies submitted to the Government for acceptance comply with all requirements of the contract. Sampling inspection, as part of manufacturing operations, is an acceptable practice to ascertain conformance to requirements, however, this does not authorize submission of known defective material, either indicated or actual, nor does it commit the Government to accept defective material.

4.2 Classification of inspections. The inspection requirements specified herein are classified as quality conformance inspection (see 4.3).

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4.3 Quality conformance inspection.

4.3.1 Lot. A lot shall consist of plated articles of the same type and of approximately the same size, form and shape, of the same specified thickness of coating, plated under similar conditions, and submitted for inspection at one time.

4.4 Sampling.

4.4.1 Separate specimens. When plated articles are of such form as to be not readily adaptable to the tests described in 4.6, separate specimens plated concurrently with articles represented may be used. Sheet, strip, or wire test specimens shall be essentially of the same composition basis metal, heat treatment, condition, and surface finish of the articles represented, prior to plating.

4.4.1.1 Type I specimens. For type I (electrodeposited) tin plating, specimens shall be introduced into a lot at regular intervals prior to the cleaning operations preliminary to plating, and shall not be separated therefrom until after completion of the processing. Conditions affecting the plating of the specimens, including the spacing and positioning with respect to anodes and to other objects being plated, shall correspond as nearly as possible to those affecting the significant surfaces of the articles represented.

4.4.1.2 Type II specimens. Type II (hot-dipped plating) specimens shall be securely attached to the articles prior to the cleaning operations preliminary to coating and shall not be separated therefrom until after completion of the processing. Unless the necessity for separate specimens has been demonstrated for thickness measurements they shall not be allowed. Separate specimens with dimensions of approximately 25mm wide, 100mm long and 1mm thick (1 inch x 4 inches x 0.04 inches) are standard.

4.4.2 Sampling for visual examination and nondestructive tests. Sampling for visual examination and nondestructive tests shall be conducted in accordance with MIL-STD-105. A sample of coated parts or articles shall be selected at random from each lot in accordance with MIL-STD-105. 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 plating thickness (nondestructive tests) at the acceptable quality level (AQL) of 2.5 percent defective.

4.4.2.1 Visual examination. Samples selected in accordance with 4.4.2 shall be examined for compliance with the requirements of 3.7 after plating. If the number of nonconforming articles exceeds the acceptance number for the sample, the lot represented by the sample shall be rejected.

4.4.2.2 Thickness of plating (nondestructive tests). Samples selected in accordance with 4.4.2 shall be inspected and the plating thickness measured by the applicable tests detailed in 4.6.1. 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.

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4.4.3 Sampling for destructive tests (thickness, adhesion, solderability and salt spray resistance). A sample of four items shall be selected at random from each lot or four separately plated specimens shall be prepared as specified in 4.4.1 to represent the lot. If the items in a lot are four or less, the number of items in the sample shall be determined by the procuring activity. Specimens may be used for more than one test where applicable.

4.5 Inspection conditions. Unless otherwise specified, all inspections shall be performed in accordance with the test conditions specified in ASTM B545 or the applicable paragraphs in section 4.

4.5.1 Examination for compliance with 3.1 and 3.2. The process and parts shall be examined for compliance with the requirements of 3.1 and 3.2. Should the process or parts fail to meet the requirements specified, the final product shall be rejected and the process discontinued until corrective action has been taken.

4.5.2 Examination of finished items. Samples selected as specified in 4.4.2 shall be examined for compliance with 3.8 and 5.1. Any item in the sample having any defects shall be considered defective, and if the number of defective items in any sample exceeds the acceptance number of the appropriate sampling plan of MIL-STD-105, the lot represented by the sample shall be rejected. Rejected lots may be resubmitted for acceptance tests provided the contractor has removed or reworked all nonconforming products.

4.5.3 Testing. Unless otherwise specified, sampling shall be in accordance with 4.4.3 and the items shall be tested in accordance with 4.6. If any item in the sample fails to pass any test, the lot which the sample represents shall be considered defective, and shall be cause for rejection of the lot. Rejected lots may be reprocessed and resubmitted for acceptable tests.

4.6 Tests.

4.6.1 Thickness. Separate specimens (see 4.4.1) shall not be used for thickness measurements unless a need for such specimens has been shown. Thickness measurements may be made by any method that determines the coating thickness within plus or minus 10 percent of its true thickness. The following test methods for thickness are used as applicable: ASTM B487 (microscopical), ASTM B504 (coulometric), ASTM B499 (magnetic), ASTM B567 (beta radiation backscatter), or ASTM B568 (X-ray spectrometry). Measurements on threaded fasteners shall be made on the shank or other smooth surface as close to the threads as possible. The method or instrument used for determining the coating thickness shall be of a type approved by the procuring activity.

4.6.1.1 Nondestructive tests for thickness. Each item in the sample selected in accordance with 4.4.2 shall be measured for plating thickness. The measurements shall be made in representative locations on each item and the item shall be considered defective if one or more of the measurements fail to meet the specified minimum thickness.

4.6.1.2 Destructive tests for thickness. Each item selected in accordance with 4.4.3 shall be tested in representative locations by one of

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the destructive test methods for thickness. If the plating thickness at any one place on any one item is less than the specified minimum, the lot shall be rejected.

4.6.2 Adhesion. Each item selected in accordance with 4.4.3 shall be tested for adhesion. The items used for the thickness test of 4.6.1 may be used for the adhesion test if the items are of suitable size and form. When specified (see 6.2), an alternate adhesion test may be used.

4.6.2.1 Method of test. The test specimens shall be bent repeatedly through an angle of 180 degrees on a diameter equal to the thickness of the specimen until fracture of the basis metal occurs. Following fracture of the basis metal, it shall not be possible to detach any areas of the coatings with a sharp instrument. When the plated articles are not readily adaptable to the bend test, adhesion may be determined on the plated article by cutting the plating from the basis metal at the interface in a continuous path, and examining at four diameters magnification to determine whether removal has been caused by the cutting away of an adherent plate or by the lifting of a nonadherent plate.

4.6.2.2 Alternate adhesion test. The test specimens shall be baked at a temperature of $420^{\circ} \pm 10^{\circ}\text{F}$ ($215 \pm 5^{\circ}\text{C}$) for a period of 30 minutes, to determine adhesion of the plating.

4.6.3 Solderability. When solderability is required each item in the sample of 4.4.3 shall be tested for solderability. The items used for the thickness and adhesion tests of 4.6.1 and 4.6.2 may be used for the solderability test if the items are of suitable size and form.

4.6.3.1 Method of test. Test specimens shall be fluxed in conformance with MIL-F-14256, type R (or as outlined in ASTM B 545, paragraph X6.2.2.3), and then immersed in a solder conforming to QQ-S-571. Unless otherwise specified, the solder shall conform to Sn60, Sn62 or Sn63 of QQ-S-571. Specimens shall be immersed for 3-5 seconds at a solder-pot temperature of $450 \pm 20^{\circ}\text{F}$ ($232 \pm 11^{\circ}\text{C}$), removed and shaken lightly to remove excess of solder. The solder coating shall be examined for compliance with 3.6.

4.6.4 Salt spray test. When specified (see 3.7 and 6.2), coated items shall be subjected to a 24 hour, 5 percent sodium chloride solution, salt spray test in accordance with ASTM B117, Salt Spray (Fog) Testing. After removal from the salt spray (fog) cabinet examine the items for compliance with 3.7.

5. PACKAGING

(This section is not applicable to this specification)

6. NOTES

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

6.1 Intended use. The following applications of various thicknesses of coating are submitted for information purposes only and are not to be construed as mandatory requirements in the use of this specification:

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- a. ASTM B545 outlines thicknesses for various service conditions in section 6, paragraph 6.1.
- b. 0.0001 to 0.00025 inch (2.5 to 6.4 μm) for "tin flashing" of articles to be soldered.
- c. 0.0002 to 0.0004 inch (5 to 10 μm) for articles to prevent galling or seizing.
- d. 0.0003 inch (7.6 μm) minimum for articles generally plated to prevent corrosion of basis metals.
- e. 0.0002 to 0.0006 inch (5 to 15 μm) for articles to prevent formation of case during nitriding.

6.2 Ordering data. Purchasers should select the preferred options permitted herein and include the following information in procurement documents:

- a. Title, number, and date of this specification.
- b. Type of tin plating (see 1.2).
- c. Thickness of tin plating (see 3.3 and 6.1).
- d. Whether alternate adhesion test is required (see 3.4.1).
- e. Whether the item is to be soldered (see 3.6).
- f. Whether salt spray tests are required (see 3.7).
- g. Administrative provisions for inspection records (see 4.1).
- h. Supplementary preservative coating if required (see 3.5.1).
- i. Other tests, including any of those specified in accordance with ASTM B545.
- j. Proper disposal of chemical solutions in accordance with state and federal requirements.
- k. Scheduling of procurements shall not permit a time lapse greater than 60 days between the time of plating and the time of soldering.

6.3 The manufacturer of the basis metal parts shall provide the plating facility with the following data:

- a. Hardness of steel parts.
- b. Whether heat treatment for stress relief has been performed or is required (ASTM B 242, Preparation of High-Carbon Steel for Electroplating).

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6.4 Significant surfaces. Significant surfaces (3.3) are those surfaces that are visible and subject to wear and corrosion.

6.5 Minimum coating thickness. Hot-dipped coatings less than 0.0005 in. (13 μ m) thick are not likely to be completely pore-free on normally commercially finished basis metals. When tin is specified, primarily for corrosion resistance, the common practice is to provide a minimum thickness of at least 0.001 in.

6.6 Disposal of materials. Caution should be taken during plating process. The contractor shall be responsible for the safe reutilization and disposal of all material generated by this process in accordance with ASTM A380, sections 8.2 and 8.7.

6.7 Material safety. Hazardous items include substances mixtures, and materials which may cause personal injury, property damage or environmental deterioration through transportation, use or disposal (see 6.2).

6.8 Material safety data sheets. Contracting officers will identify those activities requiring copies of completed material safety data sheets prepared in accordance with FED-STD-313. The pertinent government mailing addresses for submission of data are listed in appendix B of FED-STD-313.

6.9 Subject term (keyword) listing.

adhesion	preservative coating
basis metal	salt spray test
corrosion	solderability
electrodeposited	tin plating
electroplating	tin whisker
hot-dipped	

6.10 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.

Custodians:

Army - MR
Navy - OS
Air Force - 99

Preparing activity:

Army - MR

Project MFFP-0403

Review activities:

Army - MI, EA, AR, ER
Navy - EC
DLA - DH

User activity:

Army - ME

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