

FEDERAL SPECIFICATION
ZINC COATING, ELECTRODEPOSITED,
REQUIREMENTS FOR

This specification was approved by the Commissioner, Federal Supply Service, General Services Administration, for use of all Federal agencies.

1. SCOPE AND CLASSIFICATION

1.1 Scope. This specification covers the requirements for electrodeposited zinc coatings. The terms "coating" and "plating" are used interchangeably throughout the specification.

1.1.1 Federal specifications do not include all types, classes, grades, and sizes of the commodities indicated by the titles of the specifications, or which are commercially available, but are intended to cover the types, etc., which are suitable for Federal Government requirements.

1.2 Classification.

1.2.1 Types. Zinc plating covered by this specification shall be of the following types, as specified (see 6.2):

- Type I - Without supplementary chromate or phosphate treatment.
- Type II - With supplementary chromate treatment (see 3.3.2 and 6.1.1).
- Type III - With supplementary phosphate treatment (see 3.3.3 and 6.1.2).

1.2.2 Classes. Zinc plating covered by this specification shall be of the following classes, as specified (see 6.2):

- Class 1 - 0.0010 inch thick.
- Class 2 - 0.00050 inch thick.
- Class 3 - 0.00020 inch thick.

2. APPLICABLE DOCUMENTS

2.1 The following documents of the issue in effect on date of invitation for bids or request for proposal, form a part of the specification to the extent specified herein.

Military Specification:

MIL-H-6875 - Heat Treatment of Steels (Aircraft Practice), Process for.

Military Standards:

MIL-STD-105 - Sampling Procedures for Inspection by Attributes.
MIL-STD-1312 - Fastener, Test Method.

(Copies of Military Specifications and Standards required by suppliers in connection with specific procurement functions should be obtained from the procuring 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. Unless otherwise indicated, the issue in effect on date of invitation for bids or request for proposal shall apply.

American Society for Testing and Materials (ASTM) Standards:

- B 117 - Salt Spray (Fog) Testing.
- B 487 - Metal and Oxide Coating Thicknesses by Microscopical Examination of a Cross Section, Measurement of.
- B 499 - Coating Thicknesses by the Magnetic Method: Nonmagnetic Coatings on Magnetic Basis Metals, Measurement of.
- B 504 - Thickness of Metallic Coatings by the Coulometric Method, Measurement of the.
- E 8 - Tension Testing of Metallic Materials.

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

3. REQUIREMENTS

3.1 Materials. The materials used shall be such as to produce coatings which meet the requirements of this specification. Anodes or baths containing mercury shall not be used for zinc plating.

3.2 Workmanship.

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

3.2.2 Plating. The zinc deposit shall be smooth, fine grained, adherent, uniform in appearance, and free from blisters, pits, nodules, indications of burning, and other defects. Superficial staining which has been demonstrated as resulting from rinsing or light discoloration resulting from baking as specified hereinafter, shall not be cause for rejection. All details of workmanship shall conform to the best practice for high-quality plating.

3.2.3 Type II plating shall be capable of passing the salt spray test (see 3.4.2, 4.3.2.2, and 4.5.3).

3.3 General requirements.

3.3.1 Unless otherwise specified (see 6.2), the plating shall be applied after all machining, brazing, welding, forming, and perforating on the article have been completed.

3.3.2 Unless otherwise specified (see 6.2), the chromate treatment required for conversion to type II shall be a chemical treatment in an aqueous solution of salts, acids, or both, and containing hexavalent chromium and activating acid radical(s) to produce a continuous smooth, protective film, distinctly colored iridescent bronze to brown, including olive-drab, and yellow. The articles so treated shall be thoroughly rinsed and dried according to requirements for the particular chemical process used.

3.3.3 Unless otherwise specified (see 6.2), the phosphate treatment required for conversion to type III shall be a chemical treatment comprising suitable aqueous solution containing phosphoric acid, phosphate, and accelerating chemicals to produce a tightly adherent film conforming to 4.5.2.

3.3.4 All steel parts having a hardness of Rockwell C-40 or higher (approximately 180,000 pounds per square inch (lb/in²) ultimate tensile strength or above) which are ground, cold formed, or cold straightened shall be stress relieved in accordance with MIL-H-6875 prior to cleaning and plating.

3.3.5 All steel parts having a hardness of Rockwell C-40 and higher shall be baked at a minimum of 375°F plus or minus 25°F (191°C plus or minus 14°C) for a minimum of three hours within four hours after plating to provide hydrogen embrittlement relief. Plated springs shall not be flexed prior to the baking operation. In the case of type II and type III parts, the heat treatment shall be given prior to the application of the supplementary coatings. Zinc surfaces passivated as a result of the baking operation shall be reactivated prior to receiving type II supplementary chromate treatment.

3.3.6 Unless otherwise specified (see 6.2), zinc shall be deposited directly on the basis metal without a preliminary plating of other metal, such as nickel, except in the case of parts made-of corrosion-resisting steel on which a preliminary plating of nickel is permissible.

3.3.7 Unless otherwise specified (6.2), either a bright or dull finish will be acceptable.

3.4 Detail requirements.

3.4.1 Thickness of plating. Unless otherwise specified (see 6.2) the thickness of zinc 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 not less than 0.00015 inch minimum thickness (see 6.1.1).

Table I - Thickness.

Class	Thickness, minimum	
	Inch	Millimeter
1-----	0.0010	0.025
2-----	0.00050	0.013
3-----	0.00020	0.005

3.4.1.1 Military activities. Zinc plating shall be type II, class 1 thickness unless otherwise specified in the contract or order (see 6.2) or controlled by the following exceptions (see 6.7):

- (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 shall not be subject to a thickness requirement but shall show evidence of coating.

3.4.2 Salt spray requirements.

3.4.2.1 Type II. Type II plating (supplementary chromate treatment) shall show neither white corrosion products of zinc nor basis metal corrosion products when test specimens are subjected to continuous exposure to the salt spray for 96 hours in accordance with 4.5.3. The appearance of corrosion products visible to the unaided eye at normal reading distance shall be cause for rejection, except that corrosion products at the edges of the article shall not constitute failure. The salt spray test is not required for fasteners.

3.4.2.2 Types I and III. When specified (see 6.2), type I and type III coatings shall show no corrosion products of the basis metal at the end of the periods of time shown in table II when tested by continuous exposure to the salt spray in accordance with 4.5.3. 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.

Table II - Salt-spray test requirements for type I and type III coatings.

Class	Test period for corrosion of basis metal
	Hours
1-----	192
2-----	96
3-----	36

3.4.3 Adhesion. The adhesion of the plating shall be such that when examined at a magnification of approximately four diameters, it does not show separation from the basis metal at the interface when subjected to the test specified in 4.5.2. The interface between the zinc and the basis metal is the surface of the basis metal before plating. Cracks in the plate which do not result in flaking, peeling, or blistering so as to separate at the interface, are considered acceptable.

4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for inspection. Unless otherwise specified in the contract or purchase order, the supplier is responsible for the performance of all inspection requirements as specified herein. Except as otherwise specified in the contract or order, the supplier 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 Separate specimens. When the plated articles are of such form as to be not readily adaptable to a test specified herein, the test may be made by the use of separate specimens plated 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 treated condition, and finish of surface prior to plating. For example, a smooth cold-rolled surface should not be employed for representing a hot-rolled surface (see 6.8.1). When available, test specimens shall be prepared from scrap parts of the same kind (from the same manufacturing lot if possible) which have been rejected for cause other than unacceptable plating, material composition, or heat treatment. Specimens for salt spray test need not be identical in shape or size but shall be stamped, etched, or otherwise indelibly marked for identification as a test specimen. The separate specimens may be strips approximately 1 inch wide, 4 inches long and up to 1/8 inch thick for adhesion tests, but shall be at least 4 inches wide, 6 inches long and up to 1/8 inch thick for all other tests except for hydrogen embrittlement relief. If separate specimens for hydrogen 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. The configuration shall be in accordance with figure 8 of ASTM E8 for rounded specimens. 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 V shall be approximately equal to half the area of the full cross section area of the specimen's reduced section. The V shall have a 0.010 inch plus or minus 0.0005 inch radius of curvature at the basis of the notch. These 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 in 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.

4.3 Sampling.

4.3.1 Lot. A lot shall consist of plated articles processed under the same condition, of approximately the same size and shape, having the same type and class of plating, and submitted for inspection at one time.

4.3.2 Sampling for tests. A representative sample shall be selected from each lot in accordance with MIL-STD-105 at special inspection level S-3. The lot shall be accepted or rejected in accordance with acceptable quality level (AQL) 2.5 percent.

4.3.2.1 Plating thickness Each sample selected in accordance with 4.3.2 shall be inspected and the plating thickness measured in several places on each sample at which the plating would be expected to be minimum (see 4.5.1). If the minimum plating thickness on any single article is less than 70 percent of the specified thickness, the lot shall be rejected. The minimum thickness measured on each article shall be recorded, and the average value of the minimum thickness computed by dividing the sum of the thicknesses by the number of articles in the sample. If the average minimum thickness is less than the specified value for the class given in table I, the lot shall be rejected. When plated articles are of such form as not to be adaptable to thickness determinations by methods specified herein, the thickness of plating shall be determined by the use of separate specimens plated in accordance with 4.2. The number of separate specimens shall be as specified in 4.3.2. Separate specimens shall not be used for thickness measurements, however, unless the necessity for their use has been demonstrated.

4.3.2.2 Salt spray. For type I and type III coatings, the samples selected in accordance with 4.3.2 shall be subjected to the salt spray test of 4.5.3. For type II coatings, inspection shall be conducted on plated parts wherever practicable. A set of three plated parts or separate specimens in lieu of the number in 4.3.2 shall be tested. These tests shall be made periodically or when there is reason to believe that the type II supplementary treatment solution might not be operating properly.

4.3.2.3 Adhesion. Separate strip specimens, prepared as specified in 4.2, may be used for the adhesion test of 4.5.2. The number of specimens tested shall be equal to the number of plated articles taken as a sample for other tests in accordance with 4.3.2.

4.3.3 Sampling for visual examination. Sample plated pieces shall be selected from each lot in accordance with MIL-STD-105 at general inspection level II for the examination specified in 4.4. Any piece having one or more defects shall be rejected (see 3.2.2). Lots shall be accepted or rejected in accordance with AQL 2.5 percent.

4.4 Visual examination. The articles shall be carefully examined to determine compliance with 3.2.

4.5 Test methods.

4.5.1 Thickness. For nondestructive measuring of the plating thickness, procedures in accordance with ASTM B 499 may be used. For destructive measuring of plating thickness, procedures in accordance with ASTM B 487 or ASTM B 504 may be used. In addition to the above, other procedures embodied in test 12 of MIL-STD-1312 may be used for thickness measurement of plated fastener hardware. At the option of the supplier, other instruments, such as those employing the principle of beta-radiation back scatter or x-ray spectrometry, may be used. When the coulometric test is used, the thickness measurement of the zinc in type II and type III coatings shall be made after application and removal of the supplementary coating. The chromate film may be removed from type II plating by using a very mild abrasive (a paste of levigated alumina rubbed on with the finger). The phosphate coating may be removed from type III plating by a concentrated (28 percent) ammonia solution which quickly dissolves the phosphate coating but does not attack the underlying zinc.

4.5.2 Adhesion (bend test). Specimens may be of the same size and form and shall be prepared in the same manner as the separate strip specimens specified in 4.2; and shall simulate as closely as practicable the composition and surface condition of the article. To determine the adhesion of the plating, the test specimens shall be bent through an angle of 180 degrees on a diameter equal to the thickness of the specimen and then carefully examined at four diameters magnification for evidence of nonadhesion. If the above specimens are not practically available, adhesion may be determined by scraping the surface of the plated article to expose the basis metal 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.

4.5.3 Salt spray test. The salt spray test shall be made in accordance with ASTM B 117. To secure uniformity of results, type II supplementary coatings shall be aged for 24 hours before subjection to the salt spray.

4.5.4 Embrittlement relief. Conformance to the requirements of 3.3.5 for hydrogen embrittlement relief shall be determined on those parts which will be subjected to a sustained tensile load in use. A random sample of four plated articles shall be taken from each lot. 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 part. The selected samples shall be subjected to a sustained tensile load, equal to 115 percent of the maximum design load for which the part was designed. Parts which require special fixtures, extreme loads to comply with the above requirements or where the maximum design load is not known, may be represented by separate specimens prepared in accordance with 4.2. The notched specimens shall be subjected to a sustained tensile load equal to 75 percent of the ultimate notch tensile strength of the material. Unless otherwise specified, the articles, parts or specimens shall be held under load for at least 200 hours, and then examined for cracks or fracture. The samples shall be considered nonconforming if cracks are found after test or fail by fracture. Failure of one or more of the test specimens shall reject the lot.

5. PREPARATION FOR DELIVERY

5.1 This section is not applicable to this specification.

6. NOTES

6.1 Intended use. The electrodeposited coating of zinc covered by this specification is intended for use as a protective coating on ferrous parts (see 6.4).

6.1.1 Type II treatment. The primary purpose of chromate finishes is to retard or prevent the formation of white corrosion products on surfaces exposed to stagnant water, high humidity atmosphere, salt water, marine atmospheres, or exposed to cyclic condensation and drying. Some types of chromate coatings have proved satisfactory as a base for paint. The surface of zinc plate is attacked by supplementary chromate treatment, thereby diminishing the amount of metallic zinc present. Therefore, additional thickness of zinc plating must be applied to insure that the minimum zinc plate thicknesses are met after supplementary chromate treatment.

6.1.2 Type III treatment. The primary purpose of phosphate finishes is to form a paint base.

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 and class required (see 1.2.1), 1.2.2, and 3.4.1.1).
- (c) When plating is to be applied if other than specified (see 3.3.1).
- (d) Type of chromate treatment required for conversion to type II, if other than specified (see 3.3.2).
- (e) Type of phosphate treatment required for conversion to type III if other than specified (see 3.3.3).
- (f) Special plating requirement (see 3.3.6).
- (g) Finish required, if other than specified (see 3.3.7).
- (h) Thickness of plating, if other than specified (see 3.4.1).
- (i) Whether types I and III zinc plating are to be subjected to the salt spray test (see 3.4.2.2 and 4.5.3).
- (j) Method of determining thickness (see 4.5.1).

6.3 When this specification is specified for articles to be surface finished with zinc, then mechanically deposited coatings of zinc, in accordance with MIL-C-81562 may be furnished at the option of the supplier, within limits of that document, and upon acceptance and approval of the procuring activity.

6.4 Zinc plating should not be used in the following applications:

6.4.1 All types:

- (a) Parts which in service reach a temperature of 500°F (260°C) or higher or come in contact with other parts which reach those temperatures.
- (b) Parts in contact with structural fabric surfaces.
- (c) Parts in functional contact where gouging or binding may be a factor or where corrosion might interfere with normal functioning.
- (d) Grounding contacts where the increased electrical resistance of zinc plated surfaces would be objectionable.
- (e) Surfaces where free circulation of air does not exist and condensation of moisture is likely to occur.

6.4.2 Type II. Supplementary chromate treatments should not be used on zinc plated parts which are continuously exposed to temperatures in excess of 150°F (66°C) or intermittently exposed for short periods to temperatures of approximately 300°F (149°C) or more. However, these treatments may be used to prevent finger marking and corrosion which may occur at room temperature during assembly and storage.

6.5 Supplementary chromate treatments (type II) which involve only dipping in chemical solutions normally require a sufficient period of drying to render the parts suitable for handling without damage to the coating while in gelatinous form; and it is important with such coatings that the workmanship be such that the coating is not excessively damaged while wet.

6.6 Surfaces of zinc plating intended for conversion to type II and which have become passive as a result of the heat treatment specified in 3.3.5 may be reactivated by brief immersion in dilute acid. If, for example, the chromating solution is acidified with sulphuric acid; then the reactivating solution should be one percent sulphuric acid (sp. gr. 1.83) by volume; or, for further example if the chromating solution is acidified with hydrochloric acid then the activating solution should be one percent hydrochloric acid (sp. gr. 1.16) by volume. The duration of immersion should be as brief as is consistent with the nature of the work. For example, a perforated container of barrel plated parts would be expected to be reactivated in approximately 15 seconds and separately racked items in approximately 5 seconds. The surfaces should be activated as soon as possible following heat treatment and should be handled carefully to avoid contamination by dirt or grease.

6.7 As heavier coatings than class 3 are required for satisfactory corrosion resistance, allowance should be made for dimensional tolerances necessary for coating build-up in the manufacture of most threaded articles, such as nuts, bolts and similar fasteners with complimentary threads. Certain recessed areas, such as root diameters of threads, have a tendency to exhibit lack of build-up with electrodeposited platings.

6.8 The performance of a zinc coating depends largely on its thickness and the kind of environment to which it is exposed. Without proof of satisfactory correlation, accelerated tests such as the salt spray tests cannot be relied upon to predict performance in other environments, nor will these serve as comparative measures of the corrosion protection afforded by different metals. Thus, the marked superiority shown by cadmium coatings over zinc coatings of equal thickness in the standard salt spray test cannot be construed as proof that this will hold true in all atmospheric environments.

6.8.1 The quality of an electrodeposit on one basis metal is not necessarily indicative of the quality of the same thickness on another basis metal. For example, coatings on castings and forgings are usually inferior to a similar deposit on cold rolled steel.

6.9 The manufacturer of the basis metal parts or prime contractor should provide the plating facility with the following data:

- (a) Whether heat treatment has been performed or is required for stress relief (see 3.3.4).
- (b) Hardness of part (see 3.3.4 and 3.3.5).
- (c) Ultimate use.
- (d) Tensile loads required for embrittlement relief test, if applicable (see 4.5.4).

Military Custodians:

Army - MR
 Navy - SH
 Air Force - 84

Review activities

Army - ME
 Navy - AS, OS, EC

Civil Agency Coordinating Activity:

GSA-FSS, PCD

Preparing activity:

Navy - SH

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