

INCH-POUND

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## MILITARY SPECIFICATION

### ANODIC COATING FOR ZINC AND ZINC ALLOYS

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 electrolytically formed anodic coatings on wrought or die cast zinc parts, on electrodeposited, on mechanically deposited and on hot dipped steel, or over thermal sprayed zinc.

1.2 Classification. Anodic coating for zinc and zinc alloys shall be of the following classes as specified (see 6.2b):

- Class 1 - APCF (Green)
- Class 2 - SSC (Light Gray)
- Class 3 - SSCV (Dark Gray)
- Class 4 - SSCMn (Brown)

#### 2. APPLICABLE DOCUMENTS

##### 2.1 Government documents.

\* 2.1.1 Specifications and standards. The following specifications and standards 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 6.2c).

Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: Commanding Officer, Naval Air Warfare Center Aircraft Division Lakehurst, Systems Requirements Department, Code SR3, Lakehurst, NJ 08733-5100, by using the self addressed Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

AMSC N/A

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## SPECIFICATIONS

## FEDERAL

O-A-451	Ammonium Hydroxide, Technical
O-C-303	Chromium Trioxide, Technical
O-H-795	Hydrofluoric Acid, Technical
O-S-605	Sodium Silicate Solution
O-O-670	Orthophosphoric (Phosphoric) Acid, Technical
O-S-642	Sodium Phosphate, Tribasic, Anhydrous, Dodecahydrate and Monohydrate, Technical
P-D-220	Detergent, General Purpose
P-D-1800	Dishwashing Compound, Machine (Granular, Bead or Flake)
TT-L-26	Lacquer, Cellulose Nitrate, Brushing, Gloss
TT-L-32	Lacquer, Cellulose Nitrate, Gloss, For Aircraft Use

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MIL-L-7808	Lubricating Oil, Aircraft Turbine Engine Synthetic Base, NATO Code Number 0-148
MIL-L-19537	Lacquer, Acrylic-Nitrocellulose Gloss (For Aircraft Use)
MIL-C-83286	Coating, Urethane, Aliphatic Isocyanate, For Aerospace Applications

## STANDARDS

## FEDERAL

Fed. Test Method Paint, Varnish, Lacquer and Related Materials:  
Std. No. 141 Methods of Inspection, Sampling and Testing

Fed. Test Method Metal, Test Methods  
Std. No. 151

## MILITARY

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

(Unless otherwise indicated, copies of federal and military specifications, and standards are available from the DODSSP - Customer Service, Standardization Documents Order Desk, Building 4D, 700 Robbins Avenue, Philadelphia, PA 19111-5094.)

\* 2.2 Non-Government publications. The following documents form a part of this document 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 6.2c).

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AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

- B 117 Salt Spray (Fog) Testing
- B 287 Acetic Acid-Salt Spray (Fog) Testing
- B 368 Cooper-Accelerated Acetic Acid-Salt Spray (Fog) Testing  
(CASS Test)
- B 487 Metal and Oxide Coating Thickness by Microscopical Examination of  
a Cross Section, Measurement of
- B 529 Measurement of Coating Thickness by Eddy Current Test Method:  
Nonconductive Coatings on Nonmagnetic Basis Metals

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

(Non-Government standards and other publications are normally available from the organizations that prepare or distribute the documents. These documents also may be available in or through libraries or other informational services.)

\* 2.3 Order of precedence. In the event of a conflict between the text of this document and the references cited herein (except for associated detail specifications, specification sheets or MS standards), 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 First article. When specified (see 6.2i), a sample shall be subjected to first article inspection (see 6.3) in accordance with 4.3.

#### 3.2 Materials

3.2.1 Coating materials. The materials used for coating baths shall be so formulated as to produce finished which meet the requirements specified herein.

3.2.2 Basis metal. The basis metal or the substrate shall be sufficiently free from surface defects caused by machining, cutting, scratching, deforming, polishing, buffing, roughening, bending, stretching, rolling, sandblasting, vaporblasting and inclusions which will be detrimental to the functional use of the coating. It shall be subjected to such cleaning, anodizing and sealing procedures as are necessary to yield coatings meeting all requirements of this specification.

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3.3 Equipment and processes. The equipment and processes employed shall be such as to produce coatings which meet the requirements of this specification (see 3.5). Unless otherwise specified (see 6.2d), the process operating conditions shall be at the option of the supplier.

3.3.1 Material and property control. Prior to production, controls shall be established to assure that the coatings conform to the requirements of this specification. When processing practices have been so established, the procedures shall not be changed without approval of the procuring activity.

### 3.4 General requirements.

3.4.1 Handling. Parts shall be so handled during all pretreatment, anodizing and post treatment operations that mechanical damage or contamination will be avoided.

\* 3.4.2 Cleaning. Zinc and zinc based alloys shall be cleaned before subsequent anodic treatment. Grease or oil shall be removed by means of vapor degreasing, ultrasonic cleaning, solvent cleaning or by emulsion cleaning. Degreasing or precleaning operations shall be followed by cleaning the parts in an alkaline cleaner. The basis metal shall be rinsed thoroughly with water after the alkaline cleaning and prior to the application of the anodic coating. Soiled coated parts shall be cleaned with materials which will remove the soil without damaging the part of the coating.

3.4.3 Anodizing application. Parts and assemblies shall be anodized after all heat treatments, machining, welding, forming and perforating have been completed. Parts or assemblies which are bimetallic and which would be attacked by chemical cleaners or anodizing solutions or would prevent uniform formation of the anodic coatings on the surfaces or cause attack of the zinc alloy shall not be anodized as assemblies, unless the non-zinc surfaces are masked or electrically insulated in a manner which produces satisfactory anodized parts. When authorized by the contract, order or applicable drawings, zinc pieces with aluminum, brass, copper, nickel-plated, and steel inserts may be anodized. Anodic coatings shall not be applied to assemblies which will entrap the electrolyte in joint or recesses. Anodic coatings shall not be used for assemblies where the electrolyte cannot be removed. When authorized by the contract, order or applicable drawings, edges of assemblies shall be masked to prevent electrolyte entry. Spot welding assemblies are examples of assemblies requiring edge masking. Residual electrolytes will engender corrosion of zinc and zinc based alloys. Where coating of assemblies is not authorized, parts of assemblies shall be anodic coated before assembling.

3.5 Coatings. Anodic coatings, as specified in the contract, order or applicable drawing, shall be prepared by the applicable process or operation (see 3.5.1) to produce the specified deposit on the metal surface. The coating shall completely cover all visible surfaces where the coating is functionally required. The applied anodic coating shall be uniform in appearance, free from breaks, scratches or other defects which will reduce the serviceability of the anodized parts or assemblies (see 3.8).

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3.5.1 Processing. Coating shall be the result of treating zinc and zinc alloys electrolytically in a bath as specified herein. For Class 1 (APCF), the bath shall be composed of such materials as ammonium hydroxide (O-A-451), chromic acid (O-C-303), phosphoric acid (O-O-670), hydrofluoric acid (O-H-795), or ammonium fluoride. For Class 2 (SSC), the bath shall be a sodium silicate-chromate electrolyte, whereas for Class 3 (SSCV), the bath shall be sodium silicate-chromate-vanadate electrolyte. Class 4 (SSCMn), shall be produced from sodium silicate-chromate-manganate electrolyte. At the option of the supplier, other electrolytes of the above type formulated from phosphates, silicates or aluminates with chromates, vanadates, molybdates and tungstates, etc., may be used provided the coatings obtained are equivalent to those detailed herein with respect to thickness, color, corrosion resistance, wear and other functional characteristics. The process shall use an externally applied voltage (AC or DC to 200 volts) to form the protective coating. Recommended operation conditions are shown in table I.

\* 3.5.2 Sealing. Unless otherwise specified in the contract, order or applicable drawings (see 6.2e), all anodic coatings shall be completely sealed. Sealing shall be accomplished by immersion in a sealing medium such as a hot 10 percent (by volume) solution of sodium silicate (O-S-605, Class 1) followed by air drying or other suitable chemical solutions. Sealing (or painting by brush, spray or immersion) with organic finished, lacquers or enamels such as MIL-C-83286, MIL-L-19537, TT-L-26, and TT-L-32 shall also be permitted to enhance abrasion resistance and appearance along with corrosion control. Such sealing finished shall be specified in the contract, order or applicable drawings.

TABLE I. Fine anodizing process.

Class	1 - APCF	2 - SSC	3 - SSCV	4 - SSCMn
Terminal voltage	200	105	90	105
Current density (amperage per square foot)				
Direct current	125-150	125-150	125-150	125-150
Alternating current	40-50	40-50	40-50	40-50
Minimum operating Temperature - °F	140	140	176	158
Processing time - Minutes	7	9	10	9
Thickness - nominal				
Inch	0.00125	0.0016	0.0016	0.0015
Mil	1.25	1.6	1.6	1.5
Micrometer (micron) 1/	32	41	41	38
Color	Green	Light gray	Dark gray	Brown

1/ Approximate equivalent thickness where 0.001 inch or 1 mil equals 25.4 micrometers (microns).

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3.6 Detail requirements.

3.6.1 Thickness. Thickness of the coating shall be as specified in the contract, order or applicable drawing. If a definite thickness is not specified in the contract, order or applicable drawing, the nominal thickness of the coating shall be as specified in Table I. The thickness shall not vary by more than plus or minus ten percent. Surfaces on which the specified thickness cannot be readily controlled, such as holes, deep recesses, bases of angles and internal threads from which the external environment is completely excluded and where a controlled deposit cannot be normally obtained, shall not be subjected to a thickness requirement. However, the coating on such surfaces shall be of sufficient thickness to ensure coating continuity and uniform appearance.

3.6.2 Color. The color of the coating shall be uniform. The color for each class of the coating shall be specified in Table I. The standards for the colors shall be as specified in the contract, order or applicable drawings.

3.6.3 Impact resistance. The unsealed anodized coating shall have good resistance against impact. The item or separate specimen shall be subject to the test specified in 4.6.3. The coating shall not show separation from the basis metal at the interface, nor shall any separately applied coats show separation from each other when examined at a magnification of approximately 4 diameters. The interface between the coating and the basis metal or substrate is the surface before coating. The formation of cracks in the coating which does not result in flaking or peeling of the coating, as well as deformation of relatively thin test specimens, shall not be considered as nonconformance to this requirement.

3.6.4 Lubricating oil resistance. The unsealed coating on items or separate specimens shall withstand immersion in oil at a temperature of 250°F (121°C) for 24 hours without showing, blistering, pitting or other surface defects when subject to the test specified in 4.6.4. Upon cooling to room temperature, the coating shall not exhibit removal from the basis metal when tested as specified in 4.6.5.

3.6.5 Adhesion (tape). The adhesion of the coating shall be such that the anodized coating shall exhibit no removal from the basis metal nor shall any separately applied coats show separation from each other when tested as specified in accordance with 4.6.5. The coating shall not show blistering or other defects.

3.6.6 Detergent corrosion. When tested as specified in accordance with 4.6.6, unsealed coating on items or separate specimens shall not be discolored or etched, nor shall a dense white film be formed on the surfaces. Slight dulling of the surface or formation of a faint white film on the items or separate specimens shall not be interpreted as evidence of nonconformity with this requirement.



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3.6.7 Deleterious action. A 0.2 percent (by weight) solution of detergent cleaning compound, conforming to P-D-220, shall not cause greater than one-half the loss of 60 degree specular gloss of unsealed coating on items or separate specimens caused by a 0.2 percent solution of trisodium phosphate (0-S-642) when tested as specified in 4.6.7.

3.6.8 Corrosion resistance (salt spray). The unsalted anodic coating on items or separate specimens, when tested in accordance with 4.6.8 by continuous exposure to 5 percent salt spray, shall show no blistering, softening, separation from the basis metal, corrosion products or other coating failure at the end of the test period stated in table II. Minor staining shall not be considered as nonconformance of this requirement if pits are not observed except in those areas within 1/16 inch from identification markings and electrode contact markings remaining after processing.

3.6.9 Corrosion resistance (accelerated salt spray). The unsealed anodic coating on items or separate specimens, when tested in accordance with 4.6.9 by continuous exposure to accelerated acetic acid-salt spray, shall show no blistering, softening, separation, from the basis metal, corrosion products or other coating failure at the end of the test period stated in Table II. Minor staining shall not be considered as nonconformance to this requirement if pits are not observed except in those areas within 1/16 inch from identification markings and electrode contact markings remaining after processing.

TABLE II. Coating properties.

Properties	Reference Paragraph	Class			
		1-APCF	2-SSC	3-SSCV	4-SSCMn
Corrosion resistance - hours Salt spray	3.6.8	1,000	1,000	1,000	1,000
Accelerated salt spray	3.6.9	176	240	336	224
CASS	3.6.10	32	32	32	32
Abrasion resistance (Taber)- wear cycles	3.6.11	1,000	1,200	2,000	2,000
Abrasion resistance (jet abrader) - minutes	3.6.12	8	13	17	14

3.6.10 Corrosion resistance. The unsealed anodic coating on items or separate specimens, when tested in accordance with 4.6.10 by continuous exposure to copper-accelerated acetic acid-salt spray, shall show no blistering, softening, separation from basis metal, corrosion products or other coating failure at the end of the test period stated in Table II. Minor staining shall not be considered as nonconformance to this requirement if pits are not observed except in those areas within 1/16 inch from identification markings and electrode contact markings remaining after processing.

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3.6.11 Abrasion resistance (Taber). The unsealed anodized coating shall have a hard abrasion resistant finish. The items or separate specimens shall be subject to the abrasion test specified in 4.6.11. The unsealed coating shall withstand more than the number of wear cycles shown in Table II.

3.6.12 Abrasion resistance (jet abrader). The items or separate specimens shall be subject to abrasion test specified in 4.6.12. The unsealed coating shall withstand more than the number of minutes stated in Table II to abrade through the coating to the substrate. The abrasive flow shall be  $5 \pm 0.2$  grams per minute.

3.7 Dimensions of coated articles. Articles or parts shall comply with the dimensional requirements of the applicable drawings after application of the anodic coating.

3.8 Workmanship. The anodic coating shall be continuous, smooth, adherent, uniform in appearance and shall be free from powdery areas, loose films, of contact marks shall be at a minimum consistent with good practice. The location of contact marks shall be in areas of minimum exposure to service environmental conditions when important to function of the part. The color shall be reasonably close approximation to that of a sample of treated pieces agreed upon as the standard range by the supplier and the procuring activity, if so agreed upon or specified in the contract or purchase order.

#### 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 the 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, it 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 inspection. The inspection requirements specified herein are classified as follows:

- (a) First article inspection (see 4.3 and 4.4)



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## (b) Quality conformance inspection (see 4.5)

4.3 First article inspection.

4.3.1 Sampling for first article inspection. Except as specified in 4.3.4 as soon as possible after award of contract, the contractor shall submit to a testing activity designated by the procuring activity the first articles or samples of coating. Whether or not first articles or samples are required the contractor shall supply a certified statement of prior tests which show the coating complies with the requirements of this specification. The statement shall also include the basis metal material, the material used to produce the coating and a general description of the process and post treatments for the fabrication of the submitted samples. Processes and non-proprietary control data information pertinent to the fabrication of articles with coatings shall be furnished.

4.3.2 Test sample preparation. When the anodized articles are of such form, shape, size and value as to prohibit use thereof, or are not readily adaptable to the test specified herein, or when destructive tests of small lot sizes are required, the test shall be made by the use of separate specimens anodized concurrently with the articles represented. The separate specimens shall be of the same basis metals as that of the articles represented. The same basis metal includes chemical composition, grade, heat-treated condition and finish of surface prior to coating. For example, a cold-rolled surface should not be used to represent a hot-rolled surface. Due to the impracticality of casting separate test specimens, hot-rolled specimens may be used to represent cast articles. The separate specimens may also be cut from scrap casting when alloy castings are being anodized. These specimens shall be introduced into a lot at regular intervals prior to the cleaning operations preliminary to anodizing and shall not be separated therefrom until after completion of anodizing. Conditions affecting the anodizing of specimens including the spacing and positioning in respect to treatments and to other objects being anodized shall correspond as nearly as possible to those affecting the significant surfaces of the articles represented. Separate specimens shall not be used for thickness measurement, however, unless the necessity for their use has been demonstrated.

4.3.2.1 Specimens for thickness, color, impact resistance, lubricating oil resistance, adhesion, deleterious action, and corrosion resistance. If separate specimens for thickness, color, impact resistance, lubricating oil resistance, adhesion, deleterious action and corrosion resistance are required, they shall be strips approximately 6 inches long, 3 inches wide and 1/16 inch thick.

4.3.2.2 Specimens for detergent corrosion. If separate specimens for detergent corrosion are required, they shall be strips approximately 3 inches long, 1 inch wide and 1/16 inch thick.

4.3.2.3 Specimens for abrasion resistance. If separate specimens for abrasion resistance are required, they shall be pieces approximately 4 inches by 4 inches and 1/16 inch thick. The test plates for the Taber abraser test shall have all corners rounded and a one-quarter inch center hole. They shall be uniform and level.

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4.3.2.4 First article specimens. The first article samples shall consist of at least the number of specimens coated in accordance with table III.

TABLE III. Sampling preparation for first article inspection.

Test	Minimum Number of Specimens Required	Specimen Reference Paragraph	Test Ref Para	Rqmt Para
Thickness	3 <u>1/</u> <u>2/</u>	4.3.2 and 4.3.2.1	4.6.1	3.6.1
Color	3 <u>1/</u>	4.3.2 and 4.3.2.1	4.6.2	3.6.2
Impact resistance	3 <u>2/</u>	4.3.2 and 4.3.2.1	4.6.3	3.6.3
Lubricating oil resistance	4 <u>3/</u> <u>4/</u>	4.3.2 and 4.3.2.1	4.6.4	3.6.4
Adhesion (tape)	3 <u>4/</u>	4.3.2 and 4.3.2.1	4.6.5	3.6.5
Detergent corrosion	2	4.3.2 and 4.3.2.1	4.6.6	3.6.6
Deleterious action	2	4.3.2 and 4.3.2.1	4.6.7	3.6.7
Corrosion resistance (salt spray)	3 <u>5/</u>	4.3.2 and 4.3.2.1	4.6.8	3.6.8
Corrosion resistance (accelerated salt spray)	3 <u>5/</u>	4.3.2 and 4.3.2.1	4.6.9	3.6.9
Corrosion resistance (CASS)	3 <u>5/</u>	4.3.2 and 4.3.2.1	4.6.10	3.6.10
Abrasion resistance (Taber)	3	4.3.2 and 4.3.2.3	4.6.11	3.6.11
Abrasion resistance (jet abrader)	3	4.3.2 and 4.3.2.3	4.6.12	3.6.12

1/These panels shall be prepared if destructive thickness measurements are conducted. The same specimens may be used for thickness and color as well as visual examination.

2/When these panels are prepared for destructive thickness measurements, the same specimens may be used for impact resistance.

3/Retain one specimen for unexposed comparison.

4/The same specimens shall be used for adhesion.

5/Another specimen may be prepared to be used for comparison after exposure.

4.3.3 Further production. Further production of the anodic coated zinc and zinc based alloys parts, items or articles by the contractor prior to approval of the procuring activity or completion of inspection of the first article sample shall be at the contractor's risk.

4.3.4 First article sample and inspection for a subsequent contract. If a contractor has previously delivered anodic coated zinc and zinc based alloys parts, items or articles in accordance with the requirements of this specification and his product has been found satisfactory, the requirements for a first article sample and its submittal in accordance with 4.3.1 for any subsequent contract or order may be waived at the discretion of the procuring

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activity (see 6.2i).

4.4 First article inspection. First article inspection of coating shall consist of all tests specified in 4.5 and all tests described under Test Methods (see 4.6). The responsibility for the performance of the first article testing shall be as specified in the contract or order (see 3.1 and 6.2). Failure of any specimen to conform to any of the requirements of this specification shall be cause for rejection of the lot represented.

4.5 Quality conformance inspection.

4.5.1 Lot. A lot shall consist of all articles, items, parts or components with anodic coating of the same class, of the same basis material and approximately the same size, shape, thickness and color, submitted for inspection at one time. The lot size shall not exceed the number of parts, articles, items or components resulting from one daily production.

4.5.2 Sampling.

4.5.2.1 For visual examination and nondestructive tests. Samples for visual examination and nondestructive tests shall be selected from each lot of coated parts and articles in accordance with the provisions of MIL-STD-105. Acceptance criteria shall be Inspection Level II, Acceptable Quality Level (AQL) 1.0 percent defective. The lot shall be accepted or rejected according to the procedures in 4.5.2.1.1 for visual examination, and in 4.5.2.1.2 for coating thickness (nondestructive tests).

4.5.2.1.1 Visual examination. Samples selected in accordance with 4.5.2.1 shall be examined for compliance with the requirements of 3.5, 3.6.2 and 3.8 for coverage, color and workmanship. If the number of nonconforming articles exceeds the acceptance number for that sample, the lot represented by the sample shall be rejected.

4.5.2.1.2 Thickness of coating (nondestructive tests). Samples selected in accordance with 4.5.2.1 shall be inspected and the coating thickness measured by the applicable tests detailed in 4.6.1 at several locations on the significant surfaces of each article as defined in 3.6.1 for compliance with the requirements. The article shall be considered nonconforming if one or more measurements fail to meet the specified 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 4.3.2) shall not be used for thickness measurements unless a need has been demonstrated.

4.5.2.2 For destructive tests. A random sample of six coated parts or articles shall be taken from each lot or six separately coated specimens shall be prepared in accordance with 4.3.2 and 4.3.2.1 to represent each lot.

4.5.2.2.1 Thickness of coating (destructive test). If samples and testing for thickness of coating by nondestructive testing is not applicable, three samples selected in accordance with 4.5.2.2 shall be measured for coating thickness by the applicable tests detailed in 4.6.1 at several location son the significant surfaces of each article as defined in 3.5.1 for

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compliance with the specified requirements. If the coating thickness at any place on any article fails to comply with the specified thickness, the lot shall be rejected. Separate specimens shall not be used for thickness measurements unless a need has been demonstrated.

4.5.2.2.2 Impact resistance. The article, if of suitable size and form, or specimens used for the destructive thickness test (see 4.5.2.2.1) may be used as specimens for the impact resistance test (see 4.6.3) to determine compliance with the requirements of 3.6.3. Failure of one or more of the test pieces shall constitute failure of the lot.

4.5.2.2.3 Corrosion resistance (CASS). Three of the articles, if of suitable size and form, or specimens, selected in accordance with 4.5.2.2, shall be used as test pieces for the CASS corrosion resistance test (see 4.6.10) to determine compliance with the requirements of 3.6.10. Failure of one or more of the test pieces shall constitute failure of the lot.

#### 4.6 Test methods.

4.6.1 Thickness. The electronic test method, Method 520 of Fed. Test Method Std. No. 151 or ASTM B 529 shall be used for nondestructive measuring of coating thickness. For destructive thickness measurements, the microscopic test procedure in accordance with ASTM B 487 shall be used (see 3.6.1).

4.6.2 Color. Color shall be determined by comparing the surfaces of coated parts or specimens with the agreed standard in accordance with Fed. Test Method Std. No. 141, Method 4250 (see 3.6.2).

4.6.3 Impact resistance. Impact resistance shall be determined by placing the specimens or parts on a flat surface. A round tube (brass, aluminum or copper)  $72 \pm 0.5$  inches long, with an internal diameter of 1.15 to 1.35 inches shall be placed perpendicular to the coated surface, with its center 1-1/2 inches from each inside edge of the test piece so that the impact is delivered near a corner of the piece. If the corners are unfit for testing, the tube may be placed in an adjacent position with its center about 3-1/2 inches from one edge but still 1-1/2 inches from the outer edge. A steel ball, weighing  $67.5 \pm 5$  grams and  $1 \pm 0.02$  inch diameter, shall be dropped down the tube to strike the coating. If the coating cracks or breaks, it denotes brittleness. Two areas of the test piece shall be tested (see 3.6.3).

4.6.4 Lubricating oil resistance. Lubricating oil resistance shall be determined by immersing specimens or parts in diester lubricating oil conforming to MIL-L-7808 at a temperature of 250°F (121°C) for 24 hours. After removal, specimens or parts shall be cooled to room temperature, examined and compared with unexposed specimens or panels. Discoloration shall not be a cause for rejection. Specimens or parts shall then be subjected to the test as detailed in 4.6.5 (see 3.6.4 and 3.6.5).

4.6.5 Adhesion (tape). Adhesion shall be determined in accordance with Fed. Test Method Std. No. 141, Method 6301. If there is any damage to the anodic coating or if there is separation between coating and substrate, adhesion is not satisfactory (see 3.6.5).

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4.6.6 Detergent corrosion. Specimens or parts shall be totally immersed for 5 hours at 180°F (82°C) in 250 ml. solution of dishwashing compound, P-D-1800, Type I, prepared as specified in 4.6.6.1. The solution level shall be maintained with distilled water. After exposure, the test pieces shall be removed, rinsed with distilled water and dried. The pieces shall be examined for discoloration, etching or formation of a white film on the surface (see 3.6.6).

4.6.6.1 Test solution. A solution of the dishwashing compound shall be prepared by dissolving 50.0 grams in CO<sub>2</sub>-free distilled water at 131° to 149°F (55° to 65°C). The solution shall be cooled to 68° ± 2°F (20° ± 1°C), then made up to exactly 1 liter with water and mixed thoroughly. The solution shall be allowed to stand for not more than 1 hour to allow any insoluble matter to settle. Approximately 500 ml. of the clear supernatant solution shall be decanted into a clean dry glass-stoppered bottle. If the solution does not settle rapidly, it may be filtered through a dry filter, the first 100 ml. of the filtrate discarded, and the next 500 ml. collected in the bottle. Transfer 20 ml. of the solution into a 250 ml. volumetric flask and adjust to 68° ± 2°F (20° ± 1°C). Then dilute to mark with distilled water and thoroughly mix.

4.6.7 Deleterious action. The specular gloss of two specimens or parts shall be determined in accordance with Fed. Test Method Std. No. 141, Method 6101. One of the specimens or parts shall then be totally immersed in each of the solutions, prepared as specified in 4.6.7.1, for one hour at room temperature, 70° to 85°F (21° to 29°C). After exposure, the test pieces shall be removed, rinsed thoroughly with distilled water and dried for at least one hour at room temperature. The specular gloss of each piece shall be remeasured. The percent decrease in gloss of the immersed portion of the piece shall be compared with the gloss of the same piece before immersion and shall be reported both for the detergent and for the trisodium phosphate (see 3.6.7).

4.6.7.1 Test solution. Solutions of detergent cleaning compound, conforming to P-D-220 and trisodium phosphate (sodium phosphate, tribasic), conforming to O-S-642, Type II, shall be prepared by dissolving 2.00 grams in distilled water. The solution shall be cooled to 68° ± 2°F (20° ± 1°C), then made up to exactly one liter with water and mixed thoroughly.

4.6.8 Corrosion resistance (salt spray). Unsealed coated specimens or parts shall be subjected to a 5 percent salt spray for 1,000 continuous hours in accordance with Fed. Test Method Std. No. 141, Method 6061 or ASTM B 117. Upon removal after completion of the test period, all traces of salt residue shall be removed from the test piece by washing in clear running water. Pieces shall be examined visually for any evidence of defects (see 3.6.8).

4.6.9 Corrosion resistance (accelerated salt spray). Unsealed coated specimens or parts shall be subjected to a 5 percent salt spray adjusted with acetic acid for the number of hours stated in Table II in accordance with ASTM B 287. Upon removal after completion of the test period, all traces of salt residue shall be removed from the test piece by washing in clear running



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water. Pieces shall be examined visually for any evidence of defects (see 3.6.9).

4.6.10 Corrosion resistance (CASS). Unsealed coated specimens or parts shall be subjected to a 5 percent salt spray adjusted with copper chloride ( $\text{CuCl}_2 \cdot 2\text{H}_2\text{O}$ ) and acetic acid for 32 continuous hours in accordance with ASTM B 368. Upon removal after completion of the test period, all traces of salt residue shall be removed from the test piece by washing in clear running water. Pieces shall be examined visually for any evidence of defects (see 3.6.10).

4.6.11 Abrasion resistance (Taber). Unsealed coated specimens or parts shall be tested in accordance with Fed. Test Method Std. No. 141, Method 6192, using CS-10 wheels with a 500 gram load. The wheels shall revolve on the anodic coating at a speed of 70 revolutions per minute (rpm) until the anodic coating is abraded through to the substrate surface. The number of cycles of abrasion shall be recorded as the wear cycle of the material (see 3.6.11).

4.6.12 Abrasion resistance (jet abrader). Unsealed coated specimens or parts shall be tested in accordance with Fed. Test Method Std. No. 141, Method 6193. The test shall be continued until the first show of bare substrate is evident by the abrupt change in color of the pinhole-size abrasion pit. The time required shall be recorded for abrading through the coating to the substrate (see 3.6.12).

## 5. PACKAGING

5.1 Preservation packaging, packing. The preservation, packaging and packing methods for coated parts of articles employed by a supplier shall be such as to preclude any physical damage during handling and shipment.

## 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 anodic coatings are intended to be used as high quality finishes with high corrosion resistance plus the decorative advantage of color. The anodizing can be applied to wrought or die cast zinc and zinc base alloy parts as well as those formed from electrodeposited, mechanically deposited and hot dipped steel, or thermal sprayed with zinc. Electrodeposited or mechanically deposited zinc should have a minimum coating thickness of 0.0007 inch (0.7 mil).

6.1.1 The anodizing techniques can be applied to impeller and housing assemblies exposed to detergents, bleach, sand and hot water. Trim and other parts for motor pumps may be coated to prevent corrosion, erosion and cavitation due to road salts and gravel impingement. Bulk gasoline tank closure fittings may be anodized to reduce or prevent corrosion due to pools of rain water, salt laden snow and sea water. Anodized galvanized steel may be used for items such as pole-kline hardware, electrical fittings, containers and storage tanks.



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6.1.2 Zinc anodizing produces a film of the barrier layer type, a porous structure overlaying an initial barrier layer. This is in contrast with the simple oxide formed when anodizing aluminum in accordance with MIL-A-8625. During the anodizing of zinc, a complex fritted compound (of fused particles) is formed by anodic spark discharge beginning at about 65 to 70 volts. The coating is hard, porous, absorbent, and has excellent masking properties. It is thicker, harder, and more corrosion resistant than zinc chromate (MIL-C-17711) or phosphate conversion coatings (MIL-P-16232). As the anodized coatings are porous and absorbent, they are very receptive as a base for paints, enamels, lacquers, etc. Further treatments are not generally needed because the anodizing restricts moisture penetration and prevents under-film corrosion.

6.1.3 The four classes, as detailed herein (see 1.2) permit anodizing in the four colors with each color denoting a distinct process exhibiting different thicknesses and property values. Sealing (see 3.5.2) will further improve corrosion resistance of the coating. Anodized coatings that are not sealed may be adversely affected by weak acids and moderately strong bases. They tend to dissolve the anodic coatings, penetrate to, and attack the basic metal or substrate, causing lifting of the coating.

\* 6.2 Acquisition requirements. Acquisition documents must specify the following:

- a. Title, number, and date of this specification.
- b. Class of coating (see 1.2).
- c. Issue of DODISS to be cited in the solicitation, and if required, the specific issue of individual documents referenced (see 2.1.1 and 2.2).
- d. Process operation conditions, if other than specified (see 3.3).
- e. Sealing not required (see 3.5.2).
- f. Sealants, to be specified (see 3.5.2).
- g. Thickness (see 3.6.1).
- h. Color standards (see 3.6.2).
- i. Whether first article is required (see 3.1 and 4.3).
- j. Responsibility for first article inspection (see 4.4)

\* 6.3 First article. When first article inspection is required, the contracting officer should provide specific guidance to offerors whether the item(s) should be a first article sample, a first production item, or a standard production item from the contractor's current inventory and the number of items to be tested as specified in 4.3. The contracting officer should include specific instructions in acquisition documents regarding arrangements for examinations, approval of first article test results and disposition of first articles. Invitations for bids should provide that the

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Government reserves the right to waive the requirement for samples for first article inspection to those bidders offering a product which has been previously acquired or tested by the Government, and that bidders offering such products, who wish to rely on such production or test, must furnish evidence with the bid that prior Government approval is presently appropriate for the pending contract.

\* 6.4 Consideration of data requirements. The following data requirements should be considered when this specification is applied on a contract. The applicable Data Item Descriptions (DID's) should be reviewed in conjunction with the specific acquisition to ensure that only essential data are requested/provided and that the DID's are tailored to reflect the requirements of the specific acquisition. To ensure correct contractual application of the data requirements, a Contract Data Requirements List (DD Form 1423) must be prepared to obtain the data, except where DOD FAR Supplement 27.475-1 exempts the requirements for a DD Form 1423.

<u>Reference Paragraph</u>	<u>DID Number</u>	<u>DID Title</u>	<u>Suggested Tailoring</u>
4.3	DID-NDTI-80809A	Test/Inspection Report	

The above DID's were those cleared as of the date of this specification. The current issue of DOD 5010.12-L, Acquisition Management Systems and Data requirements Control List (AMSDL), must be researched to ensure that only current, cleared DID's are cited on the DD Form 1423.

6.5 Welding. Anodic coatings must be stripped at weld areas from zinc and zinc base alloy parts before welding operations can be performed. However, parts of anodized galvanized steel can be welded without the stripping operation since the anodized coating is affected by the heat for only a short distance from the joints.

6.6 Adhesion. Bending coated panels can cause flaking of all four classes of coating. Therefore, the processing operations should be applied only to zinc and zinc alloy die castings or performed parts that will not be subjected to extensive deformation after coating.

6.7 Color match. FED-STD-595 may be used as a guide for specifying color of anodic coatings. The color standards in FED-STD-595 are intended for paint finishes and should be used for approximately comparison only with anodic coatings.

\* 6.8 Subject term (key word) listing.

- Abrasion resistant
- Corrosion resistant
- Electrolytically deposited
- Finish
- Process for
- Sealing

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\* 6.9 Abrasion resistance with organic finishes. For information only, when an anodic coating is sealed with organic finishes (see 3.5.2), the sealed coating should be capable of withstanding more than the number of Taber wear cycles shown in Table IV when tested in accordance with 4.6.11. The sealed coating should be capable of withstanding more than the number of minutes stated in Table IV to abrade through the coatings to the substrate when tested in accordance with 4.6.12. For finishes other than listed in Table IV, the number of wear cycles and the minimum minutes for jet abrader resistance should be furnished by the procuring activity.

TABLE IV. Abrasion resistance properties with organic finishes.

Abrasion Resistance	Class			
	1-APCF	2-SSC	3-SSCV	4-SSCMn
Taber - wear cycles				
TT-L-26	1,390	1,780	2,580	2,580
TT-L-31	1,390	1,780	2,580	2,580
MIL-L-19537	1,390	1,780	2,580	2,580
MIL-C-83286	2,190	2,800	2,800	2,825
Jet abrader -minutes				
TT-L-26	9	15	21	16
TT-L-31	9	15	21	16
MIL-L-19537	9	15	21	16
MIL-C-83282	25	32	32	30

6.10 Changes from previous issue. The margins of this specification are marked with asterisks to indicate where changes (additions, modifications, corrections, deletions) from the previous issue were made. This was done as a convenience only and the Government assumes no liability whatsoever for any inaccuracies in these notations. Bidders and contractors are cautioned to evaluate the requirements of this document based on the entire content irrespective of the marginal notations and relationship to the last previous issue.

Custodians:  
 Army - MR  
 Navy - AS  
 Air Force - 11

Preparing activity:  
 Navy - AS  
 (Project No. MFFP-0531)

Review activities:  
 Army - GL, MI  
 Air Force - 99

User activities:  
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# STANDARDIZATION DOCUMENT IMPROVEMENT PROPOSAL

## INSTRUCTIONS

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1. DOCUMENT NUMBER  
MIL-A-81801A

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940112

### 3. DOCUMENT TITLE

ANODIC COATING FOR ZINC AND ZINC ALLOYS

### 4. NATURE OF CHANGE (Identify paragraph number and include proposed rewrite, if possible. Attach extra sheets as needed.)

### 5. REASON FOR RECOMMENDATION

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### 8. PREPARING ACTIVITY

a. NAME  
COMMANDING OFFICER, NAVAL AIR WARFARE CENTER  
AIRCRAFT DIVISION LAKEHURST (API) GROUP  
SYSTEMS REQUIREMENTS DEPARTMENT

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