MILITARY SPECIFICATION

ANODIC COATINGS FOR ZINC AND ZINC ALLOYS

This specification is mandatory 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 coatings for zinc and zinc alloys shall be of the following classes as specified (see 6.2):

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

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:

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

SPECIFICATIONS

Federal (Continued)

O-O-670	Orthophosphoric (Phosphoric) Acid, Technical
O-S-642	Sodium Phosphate, Tribasic, Technical, Anhydrous, Dodecahydrate and Monohydrate
O-T-236	Tetrachloroethylene (Perchloroethylene), Technical Grade
O-T-634	Trichloroethylene, Technical
P-D-220	Detergent, General Purpose
P-D-425	Dishwashing Compound, Machine
TT-L-26	Lacquer, Cellulose Nitrate, Brushing, Gloss
TT-L-31	Lacquer, Cellulose Nitrate, Gloss

Military

MIL-L-7808	Lubricating Oil, Aircraft Turbine Engine, Synthetic Base
MIL-L-19537	Lacquer, Acrylic-Nitrocellulose Gloss (For Aircraft Use)
MIL-T-81533	Trichloroethane, 1, 1, 1, (Methyl Chloroform) Inhibited, Vapor Degreasing
MIL-C-81773	Coating, Polyurethane, Aliphatic, Weather Resistant

STANDARDS

Federal

Fed. Test Method Std. No. 141	Paint, Varnish, Lacquer and Related Materials, Methods of Inspection, Sampling and Testing
Fed. Test Method Std. No. 151	Metal, Test Methods

STANDARDS

Military

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

(Copies of specifications, standards, drawings, and publications 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	Method of Salt Spray (Fog) Testing
B 287	Method of Acetic Acid-Salt Spray (Fog) Testing
B 368	Method of Copper-Accelerated Acetic Acid-Salt Spray (Fog) Testing (CASS Test)
B 487	Method for Measuring Metal and Oxide Coating Thickness by Microscopic Examination
B 529	Method for the Measurement of Coating Thickness by the Eddy Current Test Method: Nonconductive Coatings on Nonmagnetic Basis Metals

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

3. REQUIREMENTS

3.1 First article samples. First article samples of the anodized coatings, electrolytically deposited on zinc and zinc based alloys, shall be processed using materials, methods and processes proposed for production. The samples are for the purpose of determining that the processor's materials and processes will produce coatings on basis materials that will meet the requirements of this specification. These samples shall be inspected as specified in Section 4 and shall be submitted as directed by the procuring activity for examination and written approval.

3.2 Materials.

3.2.1 Coating materials. The materials used for coating baths shall be so formulated as to produce finishes 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.

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 6.2), 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. Suitable solvents such as trichloroethylene (O-T-634), perchloroethylene (O-T-236), or 1, 1, 1 trichloroethane (MIL-T-81533) may be used. 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 or 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 joints 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 welded 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).

3.5.1 Processing. Coatings 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 a sodium silicate-chromate-vanadate electrolyte. Class 4 (SSCMn) shall be produced from a sodium silicate-chromate-manganate electrolyte. At the option of the supplier, other electrolytes of the above types 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, 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 finishes, lacquers or enamels such as MIL-C-81773, MIL-L-19537, TT-L-26 and TT-L-31 shall also be permitted to enhance abrasion resistance and appearance along with corrosion control. Such sealing finishes shall be specified in the contract, order or applicable drawings.

TABLE I

ZINC ANODIZING PROCESSING

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	8
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).

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 coating shall be as 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 any wrinkling, 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.

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 (O-S-642) when tested as specified in 4.6.7.

3.6.8 Corrosion resistance (salt spray). The unsealed 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 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.

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 (CASS). 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.

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 the abrasion resistance 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 ±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, discontinuities such as breaks or scratches, or other damage. The size and number 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 a reasonably close approximation to that of a sample consisting 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 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 Classification of inspection. The examination and testing of anodic coatings shall be classified as follows:

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

(b) Quality conformance inspection (see 4.5)

4.3 First article inspection sampling.

4.3.1 Sampling for first article inspection. Except as specified in 4.3.4 as soon as possible after the 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 processes 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 also 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 metal 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 castings 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 measurements, 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.

4.3.2.4 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 Reference Paragraph	Conforming to Paragraph
Thickness	3 1/ 2/	4.3.2 and 4.3.2.1	4.6.1	3.6.1
Color	3 1/	4.3.2 and 4.3.2.1	4.6.2	3.6.2
Impact resistance	3 2/	4.3.2 and 4.3.2.1	4.6.3	3.6.3
Lubricating oil resistance	4 3/ 4/	4.3.2 and 4.3.2.1	4.6.4	3.6.4
Adhesion (tape)	3 4/	4.3.2 and 4.3.2.1	4.6.5	3.6.5
Detergent corrosion	2	4.3.2 and 4.3.2.2	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 5/	4.3.2 and 4.3.2.1	4.6.8	3.6.8
Corrosion resistance (accelerated salt spray)	3 5/	4.3.2 and 4.3.2.1	4.6.9	3.6.9
Corrosion resistance (CASS)	3 5/	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 activity (see 6.2).

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, 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. If the number of articles in the lot is four or less, the number of articles in the sample shall be specified by the procuring activity.

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 locations on the significant surfaces of each article as defined in 3.5.1 for 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 standards 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 ±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 ±5 grams and 1 ±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).

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-425, 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_2-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 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 ($CuCl_2 \cdot 2H_2O$) 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. PREPARATION FOR DELIVERY

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

6. NOTES

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-line hardware, electrical fittings, containers and storage tanks.

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 basis metal or substrate, causing lifting of the coating.

6.2 Ordering data. Purchasers should exercise any desired options offered herein, and the procurement documents should specify the following:

(a) Title, number and date of this specification.

(b) Class of coating (see 1.2).

(c) Process operating condition, if other than specified (see 3.3).

(d) Sealing not required (see 3.5.2).

(e) Sealants, to be specified (see 3.5.2).

(f) Thickness (see 3.6.1).

(g) Color standards (see 3.6.2).

(h) First article sampling (see 3.1, 4.3.1, 4.3.2, and 4.3.4).

(i) Responsibility for first article inspection (see 4.4)

6.3 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.

6.4 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 preformed parts that will not be subjected to extensive deformation after coating.

6.5 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 approximate comparison only with anodic coatings.

6.6 Toxicity. Anodic coated articles of zinc and zinc based alloys should not be used for food containers or as an item likely to come in contact with food or beverage. The coating contains chromium ions and zinc and zinc base alloys are soluble in the presence of acid foods.

6.7 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-81773	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-81773	25	32	32	30

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

Preparing activity:
Navy - AS
(Project No. MFFP-0043)

Review activities:
Army - MR, EL, MI, MU, WC, GL
Navy - AS
Air Force - 70, 71, 80

User activities:
Army - AT, AV, ME
Navy - SH, EC, OS, MC
Air Force - None

☆ U. S. GOVERNMENT PRINTING OFFICE: 1971 -433-695/8892

SPECIFICATION ANALYSIS SHEET

Form Approved
Budget Bureau No. 22-R255

INSTRUCTIONS: This sheet is to be filled out by personnel, either Government or contractor, involved in the use of the specification in procurement of products for ultimate use by the Department of Defense. This sheet is provided for obtaining information on the use of this specification which will insure that suitable products can be procured with a minimum amount of delay and at the least cost. Comments and the return of this form will be appreciated. Fold on lines on reverse side, staple in corner, and send to preparing activity. Comments and suggestions submitted on this form do not constitute or imply authorization to waive any portion of the referenced document(s) or serve to amend contractual requirements.

SPECIFICATION

MIL-A-81801 ANODIC COATINGS FOR ZINC AND ZINC ALLOYS

ORGANIZATION

CITY AND STATE

CONTRACT NUMBER

MATERIAL PROCURED UNDER A

☐ DIRECT GOVERNMENT CONTRACT ☐ SUBCONTRACT

1. HAS ANY PART OF THE SPECIFICATION CREATED PROBLEMS OR REQUIRED INTERPRETATION IN PROCUREMENT USE?

A. GIVE PARAGRAPH NUMBER AND WORDING.

B. RECOMMENDATIONS FOR CORRECTING THE DEFICIENCIES

2. COMMENTS ON ANY SPECIFICATION REQUIREMENT CONSIDERED TOO RIGID

3. IS THE SPECIFICATION RESTRICTIVE?

☐ YES ☐ NO *(If "yes", in what way?)*

4. REMARKS *(Attach any pertinent data which may be of use in improving this specification. If there are additional papers, attach to form and place both in an envelope addressed to preparing activity)*

SUBMITTED BY *(Printed or typed name and activity - Optional)*

DATE

DD FORM 1 JAN 66 1426

REPLACES EDITION OF 1 OCT 64 WHICH MAY BE USED.