MILITARY SPECIFICATION

COATING, INORGANICALLY BONDED ALUMINUM (ELECTROPHORETICALLY DEPOSITED)

This specification has been approved by the Naval Air Systems Command, Department of the Navy

1. SCOPE

1.1 Scope - This specification covers the requirements of inorganically bonded aluminum coatings, electrophoretically deposited, to provide corrosion and oxidation protection of ferrous alloys and other metallic substrates.

1.2 Classification - Inorganically bonded aluminum coatings shall be furnished in the following classes as specified (see 6.2):

Class 1 - Coating cured at 650 ±25° F
Class 2 - Coating cured at 650 ±25° F and post treated at elevated temperature.

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-E-760	Ethyl Alcohol (Ethanol), Denatured Alcohol, and Proprietary Solvent
O-T-236	Tetrachloroethylene (Perchloroethylene), Technical Grade
O-T-634	Trichloroethylene, Technical
TT-C-490	Cleaning Methods and Pretreatment of Ferrous Surfaces for Organic Coatings
TT-I-735	Isopropyl Alcohol

FSC MFFP

SPECIFICATIONS (Continued)

Military

MIL-S-5002	Surface Treatments and Metallic Coatings for Metal Surfaces of Weapons Systems
MIL-L-7808	Lubricating Oil, Aircraft Turbine Engine, Synthetic Base
MIL-T-81533	Trichloroethane, 1, 1, 1, (Methyl Chloroform) Inhibited, Vapor Degreasing

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

(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 National Standards Institute Publication

B46.1	Surface Texture

(Application for copies of ANSI standards should be addressed to the American National Standards Institute, 1430 Broadway, New York, N. Y. 10018.)

American Society for Testing and Materials Publication

B117	Method of Salt Spray (Fog) Testing
B487	Method for Measuring Metal and Oxide Coating Thicknesses by Microscopical Examination
B499	Method for Measurement of Coating Thickness by the Magnetic Method: Nonmagnetic Coatings on Magnetic Basis Metals

American Society for Testing and Materials Publication (Continued)

B504	Method of Test for Measurement of the Thickness of Metallic Coatings by the Coulometric Method
B529	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 inorganically bonded aluminum coatings, electrophoretically deposited, 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 metals 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 - The materials shall be so formulated as to produce inorganically bonded aluminum coatings which meet the requirements specified herein.

3.2.1 Nonvolatile contents - All ingredients used in the formulation of the nonvolatile contents of the coating material shall be inorganic, consisting of aluminum powder and binder materials.

3.2.2 Solvent contents - The volatile contents of the coating material shall consist of one or more solvents. Solvents shall be any nonaqueous materials such as hydrocarbons, alcohols, esters, ethers, ketones, etc. Where Air Pollution Regulations apply, the volatile contents of the coating material shall consist of a nonphotochemically reactive solvent blend. Water shall not be used as a solvent for admixing or thinning of the coating material.

3.2.3 Toxicity - The supplier shall certify that the materials contain no substance of known toxicity under normal conditions of usage.

3.3 Equipment and processes - The equipment and processes employed to accomplish electrophoretical deposition of aluminum coatings shall be approved by the procuring activity.

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.

3.3.2 Application processing -

3.3.2.1 Preparation - Surfaces to be coated shall be free from all contamination (see 3.4.3) prior to roughening by dry grit blasting or wet vapor blasting with 100 to 250 mesh silica, silica carbide, or alumina grit in accordance with Method I of TT-C-490. The grit used for blasting shall be new. Residual grit shall be removed from parts by blasting with clean oil-free dry air. The surfaces after blasting shall conform to the surface roughness requirements specified in the contract, order or applicable drawing.

3.3.2.2 Application - The coating shall be applied to the parts by electrophoretical deposition. Under no circumstances shall water be introduced to the coating bath consisting of the material detailed above (see 3.2.2). After application and humidification treatment (see 6.3), parts shall be dried at 175 ±25° F (80 ±14° C) for a minimum of 15 minutes. Parts shall then be cured at 650 ±25° F (343 ±14° C) for a minimum of 15 minutes after the parts have reached the specified temperatures. As a substitution for the curing at the specified temperature, with the approval of the procuring activity, a curing heat treatment at 375 ±25° F (191 ±14° C) for a minimum of 24 hours may be used. If subsequent coatings are required, parts shall be at room temperature prior to application.

3.3.3 Coating classes -

3.3.3.1 Class 1 - Class 1 coatings are nonconductive and require no further treatment after final curing at 650 ±25° F.

3.3.3.2 Class 2 - Class 2 coatings are conductive and are developed by heating the parts at elevated temperatures after final curing at 650 ±25° F. After reaching the required temperature, the coated parts should be held at this temperature for a sufficient time to develop specified properties. Temperatures and times for post heat treatment are given in Table I.

TABLE I

TIME FOR POST HEAT TREATMENT FOR CLASS 2 COATINGS

Temperature Range - ° F	Heat Time - Minutes
1090 to 1110	10
990 to 1010	90
940 to 960	240

3.4 General requirements -

3.4.1 Basis metal - Carburized ferrous metals or other metallic substrates affected by temperatures below 650 ±25° F shall not be used. The basis metal shall be free from visible defects which will be detrimental to the appearance or protective value of the coating. The coating shall be applied after all basis metal heat treatments, except for those maraging steels where curing of applied coating can be substituted for aging heat treatment, and mechanical operations such as machining, brazing, welding and perforating of the articles have been completed. The basis metal shall be subjected to such cleaning and coating procedures as necessary to yield coatings as herein specified.

3.4.2 Stress relief treatment - All steel parts shall be given a stress relief heat treatment at a minimum of 375 ±25° F (191 ±14° C) for three hours or more prior to cleaning if they contain or are suspected of having residual tensile stresses caused by machining, grinding or cold forming operations. Parts which are cold straightened are considered to contain damaging residual tensile stresses (see 6.4). The temperature and time at temperature shall be such that maximum stress relief is obtained without reduction in hardness to less than the specified minimum.

3.4.3 Cleaning - All steel parts having a hardness Rockwell C33 and higher shall be cleaned using materials which will have no damaging effects on the metal, including freedom from pits, intergranular attack, etching, and hydrogen embrittlement. Steel parts having a hardness of less than Rockwell C33 which have been exposed to hydrogen contamination processes such as cathodic cleaning, pickling, and etching shall be heat treated at a minimum of 375 ±25° F (191 ±14° C) for three hours or more prior to surface preparation and blasting. Other basis metals shall be cleaned in accordance with MIL-S-5002. Prior to coating, cleaned steel parts shall be treated in accordance with Method II of TT-C-490 with a suitable solvent such as trichloroethylene, O-T-634; perchloroethylene, O-T-236; or 1,1,1 trichloroethane, MIL-T-81533. Titanium alloys shall not be degreased in chlorinated hydrocarbon solvents to prevent stress corrosion cracking.

3.4.4 Undercoating - The aluminum coating shall be deposited directly on the basis metal without a preliminary coating of other metals or materials.

3.4.5 Coverage - The coating shall completely cover all visible surfaces where the coating is functionally required.

3.5 Detail requirements -

3.5.1 Thickness - Unless otherwise specified in the contract, order or applicable drawing, the total thickness of the coating shall not be less than 0.0005 inch (0.5 mil) nor greater than 0.0017 inch (1.7 mil). 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 subject to a thickness requirement. However the coating on such surfaces shall be of sufficient thickness to ensure coating continuity and uniform appearance (see 4.6.1).

3.5.2 Surface roughness - The surface finish of the cured coating shall not exceed 63 RMS (root mean square) micro inches when tested as specified (see 4.6.2).

3.5.3 Curing - No part or any portion of the area covered with the coating shall be undercured when tested as specified (see 4.6.3).

3.5.4 Adhesion (bending) - The adhesion of the coating shall be such that when examined at a magnification of approximately 4 diameters, 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 tested as specified (see 4.6.4). The interface between the coating and basis metal is the surface of the basis metal before coating. The formation of cracks in the coating caused by rupture of the basis metal which does not result in flaking, peeling, or blistering of the coating shall not be considered as nonconformance to this requirement.

3.5.5 Adhesion (tape) - The adhesion of the coating shall be such that when tested as specified (see 4.6.5), the coating shall exhibit no removal from the basis metal nor shall any separately applied coats show separation from each other. The coating shall show no blistering or other defects.

3.5.6 Lubricating oil resistance - The coating shall withstand immersion in oil at a temperature of 250° F (121° C) for twenty-four hours without showing any wrinkling, blistering, pitting or other surface defects. The adhesion of the coating shall be satisfactory. Upon cooling to room temperature, the coating shall not exhibit flaking when bent over a mandrel (see 4.6.6).

3.5.7 Thermal shock resistance - The coating shall show no blistering, softening, separation from the basis metal or other coating failure when tested by heating at the temperature which the part will be exposed in service as indicated in the applicable drawing, contract or purchase order (see 6.2) for 4 hours and thermal shocked by quenching in water. Where the service temperature is not indicated, the coating shall be subjected to a temperature of 1175 ±25° F (635 ±14° C) (see 4.6.7).

3.5.8 Corrosion resistance - The coating shall show no blistering, softening, separation from the basis metal, corrosion products or other coating failure at the end of 336 hours when tested as specified by continuous exposure to 5 percent salt spray. Minor staining shall not be considered as nonconformance to this requirement if pits are not observed (see 4.6.8).

3.5.9 Sacrificial corrosion protection resistance - Materials with the Class 2 coating shall show protection of uncoated areas from blistering, corrosion products or other coating failure at the end of 1000 hours when tested by continuous exposure to 5 percent salt spray (see 4.6.9).

3.5.10 Electrical resistance properties - Materials with the Class 2 coating shall have a maximum electrical resistance of 15 ohms per inch when tested as specified herein (see 4.6.10).

3.6 Workmanship - The cured coating shall be uniformly light grey in color, smooth, adherent, free from blisters, pits, nodules, beads, drips, edge build-up and other irregularities of surface. All details of workmanship shall conform to the best practices for high quality coating.

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 tests - The inspection and testing of metallic-ceramic coatings shall be classified as follows:

(a) First article tests

(b) Quality conformance tests

4.3 First article tests -

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 coated 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 coated 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 forging or casting separate test specimens, hot-rolled specimens may be used to represent forged and cast articles. The separate specimens may also be cut from scrap castings when alloy castings are being coated. These specimens shall be introduced into a lot at regular intervals prior to the cleaning operations preliminary to coating and shall not be separated therefrom until after completion of coating. Conditions affecting the coating of specimens including the spacing and positioning in respect to treatments and to other objects being coated 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, surface roughness, curing, adhesion and lubricating oil resistance - If separate specimens for thickness, surface roughness, curing, adhesion and lubricating oil resistance are required, they shall be strips approximately 6 inches long, 3 inches wide and 0.04 inch thick. These panels may be coated on one side only.

4.3.2.2 Specimens for thermal shock resistance, corrosion resistance and sacrificial corrosion protection resistance - If separate specimens for thermal shock resistance, corrosion resistance and sacrificial corrosion protection resistance are required, they shall be strips approximately 6 inches long, 3 inches wide and 0.04 inch thick. These test panels shall have all surfaces protected with the electrophoretically deposited aluminum coating.

4.3.2.3 Specimens for electrical resistance - If separate specimens for electrical resistance are required, they shall be strips approximately 8 inches long, 3 inches wide and 0.04 inch thick. These specimens may be coated on one side only.

4.3.2.4 The first article samples shall consist of at least the number of specimens coated in accordance with Table II.

4.3.3 Further production - Further production of the electrophoretically deposited aluminum coating of 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.

TABLE II

SAMPLING PREPARATION FOR FIRST ARTICLE TESTING

Test	Minimum Number of Specimens Required	Specimen Reference Paragraph	Test Reference Paragraph	Conforming to Paragraph
Thickness	3 1/	4.3.2 and 4.3.2.1	4.6.1	3.5.1
Surface roughness	3 1/	4.3.2 and 4.3.2.1	4.6.2	3.5.2
Curing	3 1/	4.3.2 and 4.3.2.1	4.6.3	3.5.3
Adhesion (bending)	3	4.3.2 and 4.3.2.1	4.6.4	3.5.4
Adhesion (tape)	3	4.3.2 and 4.3.2.1	4.6.5	3.5.5
Lubricating oil resistance	4 2/	4.3.2 and 4.3.2.1	4.6.6	3.5.6
Thermal shock resistance	3	4.3.2 and 4.3.2.2	4.6.7	3.5.7
Corrosion resistance	3	4.3.2 and 4.3.2.2	4.6.8	3.5.8
Sacrificial corrosion protection resistance	3 3/	4.3.2 and 4.3.2.2	4.6.9	3.5.9
Electrical resistance	3 3/	4.3.2 and 4.3.2.3	4.6.10	3.5.10

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

2/ Retain one specimen for unexposed comparison.

3/ Post treat the specimens.

4.3.4 First article sample and inspection for a subsequent contract - If a contractor has previously delivered electrophoretically deposited aluminum coated 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 testing - First article testing 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 tests -

4.5.1 Lot - A lot shall consist of coated articles, of the same basis material and approximately the same size and shape, coated under the same conditions and submitted for inspection at one time.

4.5.2 Sampling -

4.5.2.1 For visual examination and nondestructive tests - Samples for visual examination and nondestructive tests shall be selected at random from each lot, in the number indicated in Table III. 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) 4.5.2.1.3 for surface roughness and in 4.5.2.1.4 for curing.

TABLE III

SAMPLES FOR VISUAL INSPECTION AND NONDESTRUCTIVE TESTS

Number of Items in Lot Inspection	Number of Items in Samples (Randomly Selected)	Acceptance Number (Maximum Number of Sample Items Nonconforming to any Test)
15 or less	7 1/	0
16 to 40	10	0
41 to 110	15	0
111 to 300	25	1
301 to 500	35	1
501 and over	50	2

1/ If the number of items in the inspection lot is less than 7, the number of items in the sample shall be equal to the number of items in the inspection lot.

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 3.4.1 before coating, when specified, of 3.6 after coating, and of 3.4.5 for coverage. If the number of nonconforming articles exceeds the acceptance number for that sample, as stated in Table III, 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 locations on each article as defined in 3.5.1 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, as stated in Table III, 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.

4.5.2.1.3 Surface roughness - Samples selected in accordance with 4.5.2.1 shall be inspected and the surface roughness measured by the test detailed in 4.6.2 for compliance with the requirements of 3.5.2. The articles shall be considered nonconforming if one or more measurements fail by exceeding the maximum specified. If the number of defective items in any sample exceeds the acceptance number for the specified sample, as stated in Table III, the lot represented by the sample shall be rejected. Separate specimens shall not be used for roughness measurement unless a need has been demonstrated.

4.5.2.1.4 Curing - Samples selected in accordance with 4.5.2.1 shall be examined for compliance with the requirements of 3.5.3 by the applicable test detailed in 4.6.3. The article shall be considered nonconforming if there is any indication of green coloration and the lot represented by the sample shall be rejected.

4.5.2.2 For destructive tests - A random sample of four coated parts or articles shall be taken from each lot or four 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 contracting agency.

4.5.2.2.1 Thickness of coating (Destructive tests) - If samples and testing for thickness of plating by nondestructive testing is not applicable, 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 each article as defined in 3.5.1 for compliance with the specified requirements. If the coating thickness at any place on any article or specimen fails to comply with the specified thickness, the lot shall be rejected. Separate specimens (see 4.3.2 and 4.3.2.1) shall not be used for thickness measurements unless a need has been demonstrated.

4.5.2.2.2 Surface roughness (Destructive tests) - The articles or specimens used for the destructive thickness test (see 4.5.2.2.1) may be used as specimens for the surface roughness test (see 4.6.2) to determine compliance with the requirements of 3.5.2. Failure of one or more of the test specimens shall constitute failure of the lot. Separate specimens (see 4.3.2 and 4.3.2.1) shall not be used for surface roughness unless a need has been demonstrated.

4.5.2.2.3 Curing (Destructive tests) - The articles or specimens used for the destructive thickness test (see 4.5.2.2.1) may be used as the specimens for the curing test (see 4.6.3) to determine compliance with the requirements of 3.5.3. Failure of one or more of the test specimens shall constitute failure of the lot.

4.5.2.2.4 Adhesion (Destructive tests) - The articles or specimens used for the destructive thickness test (see 4.5.2.2.1), if of suitable size and form, may be used as the specimens for the flexibility adhesion test (see 4.6.4) to determine compliance with the requirements of 3.5.4. Failure of one or more of the test specimens shall constitute failure of the lot.

4.6 Test methods -

4.6.1 Thickness - The magnetic test method, ASTM B499, or the electronic test method, Method 520 of Fed. Test Method Std. No. 151 or ASTM B529, shall be used for nondestructive measuring of coating thickness. For destructive measuring of the coating thickness, the microscopic test procedure in accordance with ASTM B487 or the coulometric method, ASTM B504, shall be used. At the option of the supplier, instruments which use the principle of beta-radiation back scatter may also be used (see 3.5.1).

4.6.2 Surface roughness - Surface roughness shall be determined by comparing the surfaces of the coated part or specimen with standard roughness blocks using a suitable electronic measuring instrument (profilometer) calibrated for root mean square microinches (RMS) in accordance with ANSI B46.1 for surface texture (see 3.5.2).

4.6.3 Curing - A cotton swab soaked in water or alcohol, conforming to either O-E-760 or TT-I-735 shall be applied to all surfaces of the coated part or to a portion of the coating area. An uncured surface can be detected by the appearance of green coloration on the coated surface or on the moistened swab (see 3.5.3).

4.6.4 Adhesion (bending) - Adhesion shall be determined in accordance with Fed. Test Method Std. No. 141, Method 6223 using a mandrel whose diameter is 14 times the basis metal thickness. The time of test shall be 2 seconds. If the edge of the ruptured coating can be peeled back or if separation between coating and the basis metal can be seen at the point of rupture when examined at four diameters magnification adhesion is not satisfactory (see 3.5.4).

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 coating or if there is separation between coating and the basis metal, adhesion is not satisfactory (see 3.5.5).

4.6.6 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

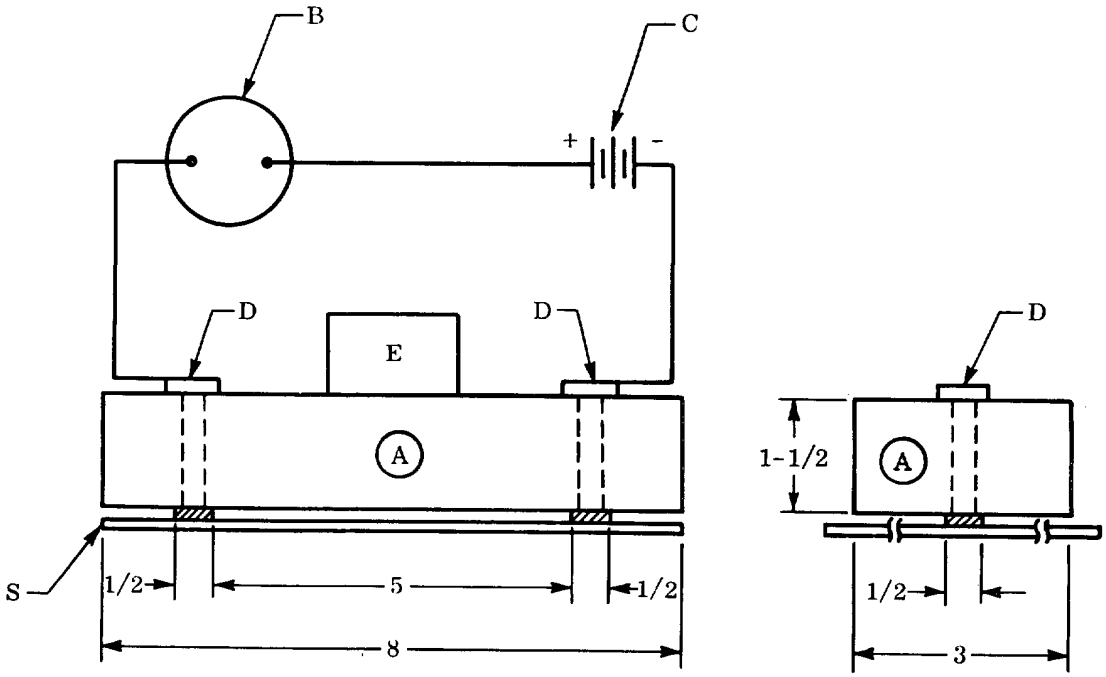
specimens or parts shall be cooled to room temperature, examined and compared with unexposed specimens or panels. Discoloration shall not be a cause for rejection. Specimens or parts shall then be subject to the test as detailed in 4.6.4 (see 3.5.4 and 3.5.6).

4.6.7 Thermal shock resistance - Specimens or parts shall be placed in a precision controlled circulating oven or furnace at the temperature specified for service (see 6.2) and left in for a period of 4 hours. Specimens or parts shall be supported horizontally on a rack. No part of the test pieces shall be in direct contact with the bottom or sides of the heating unit. If the service temperature is not indicated, the test temperature shall be 1175 ±25° F (635 ±14° C). The test pieces shall be removed from the oven and quenched immediately in a tank of cold running water so that the maximum quench delay time, when the oven door is opened and the last corner of the test piece is immersed in the water tank, does not exceed 5 seconds. Upon removal from the water tank the test specimens or parts shall be visually examined for defects (see 3.5.7).

4.6.8 Corrosion resistance - Coated specimens or parts shall be subjected to a 5 percent salt spray for 336 continuous hours in accordance with Fed. Test Method Std. No. 141, Method 6061, or ASTM B117, Test pieces shall be supported or suspended 15 degrees from the vertical. 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 3.5.8).

4.6.9 Sacrificial corrosion protective resistance - Coated specimens or parts shall have a 3/8 inch diameter hole drilled through the test piece, leaving the hole fully uncoated. At the option of the supplier, specimens or parts may be selected prior to coating. These test pieces shall have a 3/8 inch diameter area marked off where no coating shall be applied during processing. Test pieces shall be subjected to a 5 percent salt spray for 1000 continuous hours in accordance with Fed. Test Method Std. No. 141, Method 6061, or ASTM B117. Test pieces shall be supported or suspended 15 degrees from the vertical. 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 3.5.9).

4.6.10 Electrical resistance - The coating on the specimen or parts shall be tested for electrical resistance by means of a Wheatstone bridge or a suitable direct reading ohm-meter operated on direct current, using the apparatus shown in Figure 1. The brass electrodes shall be 1/2 inch square, spaced with their inner edges parallel and 5 inches apart. The specimen under test shall be supported on an insulated surface such as a glass plate, with coated surface uppermost and the test fixture placed on it, with the additional 5-pound weight added. Three readings, at various positions on the specimen, shall be made. No reading shall be more than the specified maximum (see 3.5.10).



S - Coated Specimen
A - Dry Wood Block
B - Ohm-Meter
C - Power Supply
D - Brass Electrodes
E - Weight (5 Pounds)

All Dimensions In Inches.

Figure 1. Test Fixture For Electrical Resistance.

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 shipment and handling.

6. NOTES

6.1 Intended use - The multi-electrophoretically deposited, inorganically bonded aluminum coating (from two or more deposition applications and curing) is intended to be used for the prevention of heat sealing, oxidation, salt water corrosion, and for protection from corrosion due to other corrosive environments. The coating material may be applied to jet engine parts. There may be an unfavorable effect upon the fatigue strength of basis materials beginning about 1000° F (538° C) due to diffusion of the coating into the basis metals.

6.1.1 Class 1 - The Class 1 coating is intended to provide oxidation corrosion protection of parts up to temperature of 1200° F (649° C) and to marine atmosphere corrosion protection where coated parts are exposed to elevated operating temperatures for time periods as stated in Table I which would render the coating conductive. This class coating is also intended to be used where the nature of the basis material of the part limits curing and post treatment temperatures to 650° F (343° C).

6.1.2 Class 2 - The Class 2 coating is intended to provide oxidation corrosion protection, galvanic corrosion protection and marine atmosphere corrosion protection of ferrous alloys, titanium and titanium alloys and other metallic substrates. The coating also has current carrying capacity for static charges. The post curing treatment at 950° to 1100° F (510° to 593° C) as recommended in Table I provides for the sacrificial anodic corrosion protection at the lowest processing cost. This class coating, because of these coating characteristics, is recommended to be used for parts wherever possible.

6.1.3 The requirements of this specification are not applicable to electrocoating deposits when primers and topcoats of organic paint finishing systems such as epoxys and acrylics are used.

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) Curing temperature, if other than 650 ±25° F (see 3.3.2.2).

(d) Thickness of plating, if other than specified (see 3.5.1).

(e) Service temperature (see 3.5.7 and 4.6.7).

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

(g) Responsibility for first article testing (see 4.4).

6.3 Recommended coating procedures - The following procedures are recommended for obtaining electrophoretically deposited inorganically aluminum bonded coatings.

6.3.1 Surface preparation - Parts shall be processed and cleaned in accordance with 3.4.1, 3.4.2 and 3.4.3. Following degreasing, roughening and dry air blasting (see 3.3.2.1), parts should not be handled with bare hands. Clean lint-free or disposable polyethylene gloves should be used to avoid contamination. If parts are not to be coated within several hours after grit blasting, they should be stored in clean, sealed polyethylene bags or envelopes to prevent corrosion of the prepared surfaces.

6.3.2 Application - The cleaned parts should be installed in jigs, clamps, supports or fixtures prior to reaching the coating area. Any areas of parts which are not to be coated should be masked. Jigs, fixtures and clamps should be of non-contaminative materials which are insoluble in the coating bath as well as the maskents. Negatively charged electrodes (cathodes) should then be attached to the part in locations related to the electrical distance from the anode (metal of the dip tank). Normally troublesome areas may require placement of additional electrodes to shorten the current path and achieve the full potential of coating thickness uniformity. The fixtured parts should be carried, by conveyor, into the dip tank for total immersion. The coating operation should be performed in a glass-enclosed room, air-conditioned, with a relative humidity not greater than 50 percent. All surfaces to be coated must be in contact with the bath. The tank and auxiliary electrodes constitute the positively charged anodes. Available voltage power supply, capable of providing 5 or more amperes of direct current ranging from 0 to 200 volts, ormore, should be provided. Coating deposit thickness depends basically on the amount of current, voltage and duration of immersion. Exact control of required thickness is possible through adjustment of these factors by the processor. Upon leaving the bath, parts should be removed from the jigs or fixtures and dipped in a suitable solvent, such as those used in 3.4.3 for vapor degreasing. This should remove any residual bath particles. As the coating is relatively fragile, care should be exercised to prevent damage by careless handling and by contact of coated parts with each other.

6.3.3 Humidification - Upon leaving the rinsing tank, parts should be air-dried. An air blast may be used to remove any adherent coating material which

might mar the coating during subsequent operations. Parts should then be preheated in a recirculating air furnace at 140 ±10° F for 10 minutes. The preheated parts should then be inserted in a humidification chamber maintained at a dry bulb temperature of 135 ±2° F and a relative humidity of 67 ±1 percent for a minimum of 10 minutes. The humidified coating, upon removal should be in conformance with the requirements of 3.4.5 and 3.6 except for color. This should be light green.

6.3.4 Drying and curing - After the humidification treatment, the parts shall be dried and cured as detailed in 3.3.2.2. It is recommended that parts be multicoated as a single coating may be porous due to nature of the deposit.

6.4 Stress relief - There is a hazard that cold-worked or cold-straightened steel parts of hardness Rockwell C40 or below may crack during cleaning and plating. Such parts should have a suitable heat treatment for stress relief prior to cleaning and coating (see 3.4.2).

6.5 Humidity effects - The color characteristics of the coating may be affected by weather conditions during application. Humidity and temperature fluctuations during operation may change the matte gray cured coating to a darker shade with tints of brown or green coloration without affecting the properties of the coating.

Preparing activity:
Navy - AS
Project No. MFFP-N032

U.S. GOVERNMENT PRINTING OFFICE: 1970-433-692/8461

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-C-81797 (AS) — COATING, INORGANICALLY BONDED ALUMINUM (ELECTROPHORETICALLY DEPOSITED)

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.

FOLD

DEPARTMENT OF THE NAVY
Naval Air Engineering Center
Philadelphia, Pennsylvania 19112

POSTAGE AND FEES PAID
NAVY DEPARTMENT

OFFICIAL BUSINESS

Weapons Engineering Standardization Office (Code X)
Naval Air Engineering Center
Philadelphia, Pennsylvania 19112

FOLD