METRIC

MIL-F-14072D(ER)
4 October 1990
SUPERSEDING
MIL-F-14072C
16 August 1984

MILITARY SPECIFICATION

FINISHES FOR GROUND BASED ELECTRONIC EQUIPMENT

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

1. SCOPE

1.1 Scope. This specification covers requirements for finishes necessary to protect ground electronic equipment from the deteriorating effects of climatic conditions encountered in military use. Selection of materials, processes and finishes shall be in accordance with this document and all federal, state and local environmental regulations.

1.2 Conditions of applicability. When it is felt that the finish requirements of this document may compromise the performance of the equipment, the designer shall consider other possibilities, such as the use of compatible, inherently corrosion-resistant materials. For example, heat dissipation requirements of equipment may require special consideration to provide for optimum thermal conductivity. In such a case, the use of castings, welded pieces, clad metals, etc., which reduce the number of interfaces, may be satisfactory. A prudent choice of materials in the design stage will result in fewer finishing, corrosion, and environmental problems.

1.3 Classification. For application of finishes to ground electronic equipment, surfaces are classified by exposure as follows:

Type I (Exposed). Type I surfaces are areas, either exposed to view when equipment is in operating or traveling condition, or areas not exposed to view but subject to combined direct action of climatic elements. Climatic elements include temperature extremes, humidity extremes, rain, hail, snow, sleet,

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AMSC N/A
FSC MFFP-A437
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salt-laden air, industrial atmospheres, direct solar radiation, dust, and wind blown sand. For example, the outside surfaces of any equipment are Type I areas; the inside surfaces of an open frame motor are Type I areas.

Type II (Sheltered). Type II surfaces are areas not exposed to view during equipment operation and not subject to direct action of rain, hail, snow, sleet, direct solar radiation, and sand. For example, the interior surfaces of a radio receiver or switchboard are considered Type II areas.

Any Type I finish is adequate protection for Type II exposures.

2. APPLICABLE DOCUMENTS

2.1 Government documents

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

SPECIFICATIONS

FEDERAL

TT-P-28	- Paint, Aluminum, Heat Resisting (649 Deg C).
QQ-C-320	- Chromium Plating (Electrodeposited).
QQ-N-290	- Nickel Plating (Electrodeposited).
QQ-P-416	- Plating, Cadmium (Electrodeposited).
QQ-S-365	- Silver Plating, Electrodeposited, General Requirements for.
QQ-S-571	- Solder, Tin-Alloy; Tin-Lead Alloy; and Lead Alloy.
TT-C-490	- Cleaning Methods and Pretreatment of Ferrous Surfaces for Organic Coatings.
TT-E-485	- Enamel, Semi-Gloss, Rust-Inhibiting.
TT-E-489	- Enamel, Alkyd, Gloss (for Exterior and Interior Surfaces).
TT-E-527	- Enamel, Alkyd, Lusterless.
TT-E-529	- Enamel, Alkyd, Semi-Gloss.
TT-P-664	- Primer Coating, Alkyd, Corrosion-Inhibiting, Lead and Chromate Free, VOC-Compliant.
TT-P-1757	- Primer Coating, Zinc Chromate, Low Moisture Sensitivity.

MILITARY

MIL-F-495	- Finish, Chemical, Black, for Copper Alloys.
MIL-T-704	- Treatment and Painting of Material.
MIL-M-3171	- Magnesium Alloy, Processes for Pretreatment and prevention of Corrosion on.

MIL-C-5541	- Chemical Conversion Coatings on Aluminum and Aluminum Alloys.
MIL-A-8625	- Anodic Coatings, for Aluminum and Aluminum Alloys.
MIL-S-8802	- Sealing Compound, Temperature Resistant, Integral Fuel Tanks and Fuel Cell Cavities, High Adhesion.
MIL-C-10578	- Corrosion Removing and Metal Conditioning Compound (Phosphoric Acid Base).
MIL-T-10727	- Tin Plating, Electrodeposited or Hot-Dipped for Ferrous and nonferrous Metals.
MIL-T-12879	- Treatments, Chemical, Prepaint and Corrosion Inhibitive, for Zinc Surfaces.
MIL-L-13808	- Lead Plating (Electrodeposited).
MIL-P-14105	- Paint, Heat-Resisting (For Steel Surfaces).
MIL-C-14550	- Copper Plating (Electrodeposited).
MIL-E-15090	- Enamel, Equipment, Light-Gray (Formula No. 111).
DOD-P-15328	- Primer (Wash), Pretreatment (Formula No. 117 for Metals).
MIL-P-15930	- Primer Coating, Shipboard, Vinyl-Zinc Chromate (Formula No. 120 for Hot Spray).
DOD-P-16232	- Phosphate Coatings, Heavy, Manganese or Zinc Base (For Ferrous Metals).
MIL-T-22361	- Thread Compound; Antiseize, Zinc-Dust-Petrolatum.
MIL-C-22750	- Coating, Epoxy Polyamide.
MIL-T-23142	- Tape, Pressure Sensitive Adhesive, for Dissimilar Metal Separation.
MIL-P-23377	- Primer Coating, Epoxy Polyamide, Chemical and Solvent Resistant.
MIL-C-26074	- Coating, Electroless Nickel, Requirements for.
MIL-C-43616	- Cleaning Compound, Aircraft Surface.
MIL-M-45202	- Magnesium Alloys, Anodic Treatment of.
MIL-G-45204	- Gold Plating, Electrodeposited.
MIL-R-46085	- Rhodium Plating, Electrodeposited.
MIL-P-46105	- Primer Coating; Weld-Through, Zinc-Rich.
MIL-C-46168	- Coating, Aliphatic Polyurethane, Chemical Agent Resistant.
MIL-P-53022	- Primer, Epoxy Coating, Corrosion Inhibiting, Lead & Chromate Free.
MIL-P-53030	- Primer Coating, Epoxy, Water Reducible, Lead & Chromate Free.
MIL-C-53039	- Coating, Aliphatic Polyurethane, Single Component, Chemical Agent Resistant.
MIL-P-53084	- Primer, Cathodic Electrodeposition, Chemical Agent Resistant (Lead & Hexavalent Chromate Free).
MIL-R-81294	- Remover, Paint, Epoxy, Polysulfide and Polyurethane Systems.
MIL-P-81728	- Plating, Tin Lead (Electrodeposited).
MIL-S-81733	- Sealing & Coating Compound Corrosion Inhibitive.
MIL-S-83430	- Sealing Compound, Integral Fuel Tank & Fuel Cell Cavities, Intermittent Use to 360 Deg F.
MIL-P-85582	- Primer Coatings: Epoxy, Waterborne (Non Polluting).
MIL-C-87115	- Coating, Immersion Zinc Flake/Chromate Dispersion.

STANDARDS

FEDERAL

FED-STD-313 - Material Safety Data Sheets, Preparation and the submission of.
FED-STD-595 - Colors.

MILITARY

MIL-STD-1500 - Cadmium-titanium Plating, Low Embrittlement, Electrodeposition.
MIL-STD-1501 - Chromium Plating, Low Embrittlement, Electrodeposition.

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

2.1.2 Other Government documents, drawings, and publications. The following other Government documents, drawings, and publications form a part of this document to the extent specified herein. Unless otherwise specified, the issues are those cited in the solicitation.

DoD SD-6 - Provisions Governing Qualification.

(Application for copies should be address to Commanding Officer, Naval Publications and Forms Center, Standardization Documents Order Desk, Building 4D, 700 Robbins Avenue, Philadelphia, PA 19111-5094).

2.2 Non-Government publications. The following document(s) 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.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A123 - Zinc (Hot Dip Galvanized) Coatings on Iron & Steel Products, Standard Specification For.
ASTM A153 - Zinc Coating (Hot Dip) on Iron and Steel Hardware.
ASTM B253 - Practice for Preparation of Aluminum Alloys for Electroplating.
ASTM A380 - Practice for Cleaning and Descaling Stainless Steel Parts, Equipment and Systems.
ASTM B545 - Tin, Electrodeposited Coatings Of.
ASTM B579 - Alloy, Tin-lead (Solder Plate) Electrodeposited Coatings Of.
ASTM B633 - Zinc On Iron & Steel, Electrodeposited Coatings Of.
ASTM G15 - Corrosion & Corrosion Testing, Terms Relating To, Standard Definitions Of.

(Application for copies should be addressed to the American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103-1187.)

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

3. REQUIREMENTS

3.1 General. Selection of finishes shall be in accordance with the requirements contained herein. Finishes selected shall conform to the specified thickness and shall not interfere with the performance requirements of the equipment. Finishes, applied in accordance with this specification, will inhibit the corrosion of metals and deterioration of wood. In the event of conflict between the requirements of this document and finish requirements contained in specifications or drawings covering specific equipments, the specific equipment document requirements shall govern.

3.2 First article. The contractor shall furnish a sample unit(s) for first article inspection of finishes as specified in the part or equipment document.

3.3 Materials. Finishing materials shall be in accordance with the specifications listed in Section 2. The contractor shall have in his possession, for examination by the contracting officer or his duly authorized representative, satisfactory evidence that materials used on the order comply with the applicable specifications.

3.4 Substitution for specified finishes, processes, or materials. If, due to special conditions of service or design, the contractor considers that finishes, processes, or materials other than those specified herein are necessary or more suitable, such finishes, processes, or materials shall be used only upon receipt of prior approval from the contracting officer. At the discretion of the contracting officer, samples may be required to demonstrate the suitability of proposed substitutes.

3.4.1 "P" finishes on ferrous alloys. Table I permits finishes on ferrous alloys (other than corrosion-resistant steels) when tank phosphating is not practical. Phosphating in a tank may not be practical due to size, shape, or part fabrication method such as welding. Prior to using these finishes, the contractor shall prove, to the satisfaction of the contracting officer, that tank phosphating is not practical.

3.4.2 Plating of holes and recesses. When it is not practicable to meet specific thickness requirements for finishes in holes or other recesses, the contractor shall submit a proposal for finishing such holes and recesses for review and approval by the contracting officer .

3.5 Operations prior to application of finishes.

3.5.1 Cut edges. The edges of all metals in exterior locations shall be rounded to promote adhesion and an adequate thickness of subsequently applied paint. This is not possible over sharp edges. After rounding of edges, applicable pretreatment coats shall be applied (Table I). Rounding to a radius of approximately 3.18 mm shall be accomplished prior to electroplating to improve plating at edge areas.

3.5.2 Defect repair. The use of any material(s) for the purpose of filling or sealing nicks, dents, gouges and poor joints is prohibited.

3.5.3 Masking. Prior to painting base metal parts containing areas specifically intended for electrical contact or heat transmission, these areas shall be masked off or otherwise protected during finishing. Unless otherwise specified, plastics, rubber, fabrics and working parts of machinery shall also be masked off or otherwise protected. When masking tape is used, it shall be a type which will not adversely affect the finish or the equipment.

3.5.4. Preparatory cleaning. Prior to application of any finish, all surfaces shall be precleaned to remove dirt, grease, oil, solder flux, welding flux, sand, visible rust, scale or oxides and all other contaminants that might interfere with the adhesion of the surface treatment, underplate or final finish. Cleaning shall be done immediately before the finishing operation. If this is not feasible, suitable precautions shall be taken to insure cleanliness during the period between cleaning, plating or other finishing process. Multiple cleaning methods may be required to maximize adhesion properties.

3.5.4.1 Blasting. If an abrasive blasting is necessary to clean near critical areas having a special surface finish requirement, such areas must be protected from the abrasive. Blasting shall not be used on surfaces which might be damaged, i.e. machine parts and sheet metal thinner than 1.59mm (16 gage).

3.5.4.2 Cleaning of aluminum shelters. Aluminum shelters shall be cleaned in accordance with MIL-C-43616.

3.5.4.3 Cleaning of welded sections. Black iron oxide formed by welding operation shall be removed by blasting. Any residual blasting material shall be removed and the metal surface treated with a phosphoric acid etch per MIL-C-10578. This will remove and neutralize residual alkaline weld flux slags.

3.5.4.4 Use of steel wool. Steel wool shall not be used under any circumstances to clean aluminum or magnesium surfaces. Residual steel particles can become entrapped resulting in the formation of corrosion sites which may damage finish integrity and/or the basis metal. Use of emery or garnet abrasives on aluminum or magnesium is preferred.

3.6 Fabricated parts. Parts formed or fabricated by means of lock seams, lap joints, or by a means other than soldering, brazing, welding, or die forming, shall be plated, passivated, or both, prior to forming and fabricating operations. As an alternate, the design shall be such that plating, passivating, and/or neutralizing solutions will drain from the part. For example, aluminum to be lap-seamed and riveted should be anodized prior to the riveting operation.

3.7 Potential problems to be considered prior to the specification of cadmium or zinc coatings.

a. Chromate-treated zinc-coatings, cadmium-plated, or zinc-base alloy

parts shall not be used when such parts may be exposed to ambient temperatures above 71°C while in service. This does not apply to baking temperatures in excess of 71°C which may be required to cure paint during the finish process. In lieu of cadmium or zinc coating for items to be subjected in service to higher temperature conditions than 71°C, MIL-P-53022 (softens at about 120°C) or MIL-C-87115, in conjunction with a suitable top coat finish as recommended in cited specifications prior to final finishing, should be applied. Mil-P-14105 is a high temperature paint option where applicable.

b. Unpainted cadmium, zinc-plated and zinc-base alloy parts shall not be used in assemblies where they would be in confined unventilated spaces and subject to vapors emanating from phenolic insulating varnishes, phenolic encapsulating compounds, uncured phenolic materials, or air drying alkyd paints (e.g., TT-E-527; TT-E-529, Class A; TT-E-489, Class A; and MIL-E-15090) as severe corrosion problems are likely to occur.

3.8. Use of sealants and anti-seize compounds.

3.8.1 Threaded parts for aluminum and magnesium alloys. Prior to assembly, all externally threaded parts for use in aluminum and magnesium alloys shall be coated with anti-seize compound in accordance with MIL-T-22361. For magnesium alloys, an equal weight mixture of zinc chromate pigment and petrolatum is also acceptable.

3.8.2 Openings. To preclude unnecessary finish requirements for the interiors of equipments exposed to Type I environmental conditions, openings not required for an electronic system's operation shall be sealed to prevent fluid entry or direct exposure to exterior environment. Sealing around access plates shall be provided in a configuration that will allow removal of access plates without damaging the sealant or surrounding metal.

3.8.3 Sealing. Unless otherwise specified in the end item specification, sealing of the interiors of gear cases or similar compartments and reservoirs shall be in accordance with the applicable sealant specification. The sealer shall be applied prior to assembly and shall be capable of withstanding immersion in lubrication oil, hydraulic fluids, and cutting compounds for the operating temperatures and atmospheric conditions specified for the end item, without wrinkling, blistering, peeling, or loss of adhesion.

3.8.4 Press fits. Press fitting of parts not permanently housed in oil or grease shall be accomplished with sealing and coating compound conforming to MIL-S-81733, primer coating epoxyamide conforming to MIL-P-23377, or sealing compound conforming to MIL-S-8802. Where exposure to lead or chromate pigments is prohibited, MIL-P-53022 may be used in place of MIL-P-23377. The complete assembly shall then be finished as specified in Table I. Press fit(s) for parts to be permanently housed in oil or grease shall be accomplished with oil or grease similar to that to be used in their housing environment.

3.8.5 Slipfits. Slipfits of dissimilar metals exposed to corrosive conditions shall be assembled using a sealing and coating compound conforming to MIL-S-81733, primer coating epoxy conforming to MIL-P-23377, or sealing compound conforming to MIL-S-8802. Where exposure to lead or chromate pigments is prohibited, MIL-P-53022 may be used in place of MIL-P-23377.

3.9 Paint finishes. Paint finishes to be applied on equipment(s) or parts thereof shall be in accordance with the requirements of Tables I and II. Compatible paint coating system(s) shall be selected with regard to classification of the surface to be protected. For example, Type I or Type II. Table I calls out basic paint finishes by P numbers. A basic paint finish is a system involving steps 1 through 3 of Table I and requires only the final film, step 4 of Table II, for a complete finish designation. With the exception of Basic Finish Number P215, step 4 of "Finish Process" of all finishes of Table I shall be considered to specify finish with compatible final film per Table II. Table II provides the final film requirements by letter designation thus a complete gray paint system for a ferrous alloy may be called out as P211.1E. Either the basic designation or the final film designation may be called out independently. For example, piece part drawings might specify a P211.1 basic paint finish, in which case the assembly drawings would call for a final film such as Final Film E.

3.9.1 Basic paint finishes, P. The basic finish process, P, shall be in accordance with Table I. The primers listed in Step 3 shall be applied as a single coat, except as noted in Table I, to yield a dry film thickness as required by the primer specification. To prevent adhesion problems, primer application should be completed as soon as possible after the surface has been prepared. No more than 24 hours should be allowed to elapse between the two steps. The dry film thickness of each final film shall be as specified in Table II, unless stated otherwise in the basic paint specification.

3.9.2 Final paint film. The final paint film, Step 4 of the finish process, shall be in accordance with Table II. The final paint film shall normally be applied within 24 hours after the primer has been cured. In the case of some of the fast drying epoxy primers, 24 hours drying prior to the top coat application may be too long. To compensate, a shorter time between coats or a light sanding may be necessary. Previous coats of paint shall be fully cured before subsequent coats are applied. When finish selection (see 3.4) permits application of basic finishes only (steps 1 through 3 of Table I) to piece parts, the final film (Table II) shall be applied to all exposed surfaces of the parts after they have been mounted or assembled. When piece parts have been finished with complete paint finishes (steps 1 through 4 of Tables I and II), fixed assemblies shall be touched up in order to provide a continuous film(s) across the interfaces. This requirement does not apply to hairline joints between mating parts, gasketed joints, or where moving parts such as hinges or catches are present. Touch-up paint used shall provide a reasonable color match with that of all other assembled parts.

3.9.2.1 Epoxies. Where extreme resistance to solvents, alkalies and abrasion and outstanding adhesion is required, the use of MIL-C-22750 instead of MIL-P-23377 primer is recommended for all metals. It is excellent for magnesium. The process for application of epoxy-polyamide coating systems shall be as specified by the manufacturer.

3.9.2.2 Film designation "AM". Film designation "AM" or "AE" is to be applied to interior surfaces of vans or shelters.

3.9.3 Color selection of final paint film. Unless otherwise specified in the applicable equipment document, Type I surfaces shall have final films of

the colors specified as follows:

a. Large tactical equipment such as radars, vans, etc. - Green 383 (Film AG) Chemical Agent Resistant (CARC).

b. Small tactical equipment such as field radio sets, vehicular radio sets, switchboards, etc. - Green 383 (Film AG) Chemical Agent Resistant (CARC).

c. Communications equipment installed at fixed facilities such as radio station equipment, and telephone central office sets - Green 383 (Film AG) as specified in the applicable equipment document, or Lusterless Gray No. 36118 (Film X).

d. Electronics test equipment - Semi-gloss Gray No. 26307 (Film E or P).

e. Automatic data processing - Green 383 (Film AG) as specified in the applicable equipment document, or Lusterless Gray No. 36118 (Film X).

f. The CARC (three color) camouflage pattern colors are AG, AH, and AI for wooded and other green vegetated areas; AR, AH and AI for winter/snow conditions, and AP for all three pattern colors for the desert.

3.9.3.1 Unspecified colors. The use of colors other than those specified in Table II or the equipment specification shall require the prior approval of the contracting officer.

3.9.4 Final paint film selection. Paints shall be selected in accordance with the following requirements:

a. Bake-drying and epoxy films. Except as noted in "b" below, only baking type or epoxy base coatings shall be used for the painting of metallic parts. When bake type coatings are used, the minimum baking temperature shall be 121°C for not less than 45 minutes, or 149°C for not less than 20 minutes. In no case shall assemblies containing plastic parts be baked at a temperature in excess of 121°C.

b. Air-drying films. Air-drying enamels shall be employed for touch-up and field repair, for parts too large to be baked, where the baking temperatures used adversely affect the required performance of the finished part, or for painting wood, plastics, or other materials which might be damaged by specified baking temperatures. Air-drying enamels shall not be used for touch-ups and field repairs on CARC or lacquer finishes.

c. Engines and other heated areas. Engines shall be cleaned and treated as specified herein and painted in accordance with the applicable engine specification. When cleaning and painting of exhaust manifolds, exhaust pipes, mufflers, and other parts subject to temperatures in excess of 204°C is specified in the applicable engine specification, the paint shall conform to MIL-P-14105 or TT-P-28, as applicable.

3.9.5 Painting conditions and methods. Painting shall be done in a well lighted, ventilated, protected area that is clean and dry. All painting

equipment shall be properly maintained and kept free of oil, dirt, scum, residues, etc. and shall be free of moisture just prior to painting. All finishing materials shall be thoroughly mixed. There shall be no stratification or separation of materials during painting operations. Materials shall have the proper consistency in accordance with the applicable specification(s) and be suitable for brush, spray, dip, roll or other methods of application being used such as electrocoating of CARC primer per MIL-P-53084.

3.9.6. Welding, soldering and brazing. Unless otherwise specified, welding, soldering and brazing shall not be permitted on an assembly after it has been painted with CARC finish(es). If it is necessary to perform one of these procedures after an item is coated, the finish must be completely removed to the base metal in all areas which will reach 204°C or higher. For the same conditions, this procedure must be followed for the backside if it is CARC painted. Three recommended methods for removal are plastic media blasting, the use of a paint remover such as MIL-R-81294, Type I, or the use of a surface grinder and wire brush combination. After the procedure is finished, the stripped surfaces shall be cleaned, pretreated and repainted.

3.10 Plated finishes. Plated finishes shall be in accordance with Table III. The plating process shall provide a continuous flaw free deposit. Specific finishes shall be selected with due regard to surface classification (Type I or II) and the basis metal to be protected. Plated finishes are designated by the letter M followed by a number. For example, M212 is a plated nickel finish for use on iron or iron-base alloy parts to be subjected to a Type I exposure. As specified in Table III, Finish M212 consists of 0.0152mm minimum nickel over 0.0127mm minimum copper undercoat over the basis metal.

3.10.1 Plating thickness substitution. If dimensionally acceptable, any plating thickness specified for Type I surfaces may be used in lieu of the thickness required for Type II surfaces. For example, a part extending in assembly from an unsheltered zone to a sheltered zone would be finished (as applicable) with a Type I plate. Similarly, Type II platings may be used on basis metals in unsheltered zones provided the surfaces extending to and exposed to Type I conditions are painted with an applicable paint system.

3.10.2 Hydrogen-embrittlement relief. Hydrogen embrittlement of hardened, plated steel parts intended for resilient or high stress service, such as a spring or fastener, can be a serious problem. No visual or chemical inspection method to reveal this defect is known. Designers are, therefore, cautioned to avoid the use of hardened ferrous alloys requiring plating whenever possible. When this is not feasible, steels employed should be of the lowest carbon content and lowest hardness which will provide the necessary mechanical performance of the part. The microstructure of such steels should be essentially tempered martensite. The use of sharp bends in the part should be avoided, particularly if the part is to be hardened after forming. Plating baths and pre-plate cleaning processes shall be adjusted and operated in a mode designed to prevent hydrogen embrittlement. Oxide and scale removal shall be conducted by tumbling or other mechanical means wherever possible. A brief dip in an acid containing an inhibitor may be used if necessary. Cleaning should be accomplished by means of soaking or anodic treatment in alkaline cleaners. All temper-hardened parts shall be stress relieved by

baking at 25°C below draw temperature for one hour per square inch of cross section area. All hardened steel parts subject to hydrogen embrittlement shall be treated in accordance with Finish E200 (See Table IV). Finish requirements, when specified on drawings or other pertinent documentation, shall include that finish designation. Thus the finish for a Type I cadmium plated steel spring would be called out on drawings at "M225 and E200."

3.10.3 High strength steel (i.e. 16.87 kg/sq cm and up). Special finishing methods, such as those specified in MIL-STD-1500, MIL-STD-1501, and MIL-C-87115, are required for materials in this class to reduce the risk of hydrogen embrittlement.

3.11 Finishes or processes other than painting or plating (E). Finishes or processes other than paintings or platings shall be in accordance with Table IV. Specific finishes shall be selected with respect to surface classification (Type I or Type II) and the basis metal to be protected. Table IV calls out finishes by the letter E followed by a number. Thus E513 is a chemical-film finish for use on aluminum or aluminum base parts to be subjected to Type II exposure.

3.12 Electrical conductivity of passivated finishes. Table V contains information on the electrical conductivity of passivated finishes. Designers specifying a passivated finish(es) for coating electronic equipment enclosures, mounting racks or associated structural framework should consider the following characteristics prior to making a selection from Table V:

1. The equipment conducting frequency mechanism i.e. Power or RF.
2. The requirement for the chassis mounting points to access, or be isolated from, any or all potential grounding points.

In addition to a statement, either "yes" or "no", regarding electrical conductivity at power frequencies and radio frequencies, Table V contains a remark column which gives data concerning the use of each listed finish.

3.13 Intermetallic-couples. The finishing of metallic areas to be placed in contact presents a special problem. Intermetallic contact of dissimilar metals will result in electrolytic couples. If precautions are not taken, these sites may promote corrosion through galvanic action. Table VI shall be used in determining the need for or degree of protection to be applied to couple members. This depends on the relative position of the coupled members in the galvanic series. Table VI shows metals and alloys (or platings) by groups which have common electro-motive forces (EMF) within 0.05 volt when coupled with a saturated calomel electrode in sea-water at room temperature. All members of a group regardless of metallurgical similarity or dissimilarity are considered compatible. Compatible couples between groups have been specified in Table VI based on a potential difference of 0.25 volt maximum. Permissible couple series are shown in Table VI by the graphs at the right. Member of groups connected by lines will form permissible couples. An "o" indicates the most cathodic member of each series, "o" an anodic member, the arrow the anodic direction. Table VI shows, in addition the EMF against a calomel electrode, a derived "anodic index" with Group 1 (gold, etc.) as 0 and Group 18 (magnesium, etc.) as 175. Subtraction of one group anodic index from another gives the EMF difference in hundredths of a volt. To provide the

corrosion protection required in ground electronic equipment, intermetallic couples should be restricted, where possible, to those permitted in Table VI having a minimal tendency to galvanically interact.

3.13.1 Use of compatible couples. The following should be considered in the selection and application of compatible couples:

a. Passivated coatings. For a compatible couple selection, passivated coatings specified herein shall be ignored and only the plating or basis metal considered. For example, all chromate or phosphate treatments of zinc or cadmium specified in Tables III and IV shall be ignored in making couple selections and only zinc or cadmium considered as acting in galvanic corrosion. Hard anodic films on aluminum-base alloys are impervious nonconductors and, therefore, contact may be made with any dissimilar metal.

b. Surface area of contacting metals. In intermetallic couples, the member with the higher anodic index is anodic to the member with the lower anodic index. It will therefore be susceptible to corrosion in the presence of an electrolytic cell or media. If the surface area of the cathodic part is significantly greater than that of the anodic part, the corrosive attack on the contact area of the anodic part may be greatly accelerated. Material selection for intermetallic contact parts should therefore establish the smaller part as the cathodic member of the couple.

c. Platings. For couple selection only the contacting metallic surfaces shall be considered for compatibility. For example, when a plated part is intended for assembly with aluminum, the compatibility of the plating, not the basis metal, with aluminum shall be considered. Likewise, when two plated parts are intended to be coupled, the compatibility of the platings not the basis metals is to be considered.

3.13.2 Exceptions to Table VI. The following exceptions apply to the selection of compatible couples in accordance with Table VI:

a. Special service conditions. Table VI shall be employed for ground based parts and electronic equipment(s) to be subjected to the variables of exposure(s) expected under military service conditions. For special conditions or considerations, Table VI may not be applicable. These may include factors such as operational temperature differences between parts, plating thickness(es), longevity, polarity reversals, multiple contacts, etc. Zinc, for example, may become cathodic to iron in hot tap water, and tin anodic to iron in tap water at ordinary temperatures. Both of these, as isolated cases, vary from the general experience reflected by the compatibility graphs of Table VI. In isolated cases, where couples are not exposed to weather or salt-laden air but are subjected to wide temperature and humidity variation with possible moisture condensation, restriction of couple members to those shown in Table VI might serve to provide a part life abnormally longer than the functional requirements of the equipment. In such cases, finish needs may be met by extending the anodic index differences to 50. Generally, couple selection should be governed by previous experience with such special conditions.

b. Sealed members. The requirements specified above do not apply to intermetallic contact members which, in a clean and dry condition, are permanently sealed in noncorrosive embedding or encapsulating materials, or hermetically sealed containers that are protected from ambient atmospheric conditions.

c. Magnesium. Table VI does not permit intermetallic contact between magnesium and any other metal. If the use of magnesium in contact with a dissimilar metal is required, the metals shall be separated by a tape in accordance with MIL-T-23142. The tape shall extend at least 0.32 cm beyond the periphery of the joint. The use of cloth supported tapes is prohibited.

d. Fasteners for magnesium. Although not permitted by Table VI, the use of aluminum alloy 5056-H32 rivets and aluminum alloys 5052, 5056, 6053 and 6063 washers and shims are allowed for assembly of magnesuim alloy members. Bolts and nuts shall be restricted to anodized 6061 aluminum alloy coated with one of the following sealers: MIL-S-8802, MIL-S-81733, MIL-S-83430, or epoxy primer MIL-P-23377.

3.14 Finish selection. Unless otherwise instructed by the contracting officer, finishes applied to equipment shall be one of those specified by Tables I, III, or IV. Insofar as possible, selection of finishes for all applications shall be made in accordance with Table VII. All restrictive conditions applicable to finish selection not appearing in Table VII must be considered prior to making a choice of finish. In this connection, it may be noted that Tables I through V contain finish selection requirements applicable to particular finishes. Paragraphs 3.14.1, 3.14.2 and 3.14.3 regarding finishes covered by this document, apply to finish selection and shall be used in conjunction with Table VII.

3.14.1 Finishing of Type I surfaces. The following requirements apply to finishing Type I surfaces:

a. Surfaces exposed to view. All Type I surfaces exposed to view when equipment is in transit or operational shall be painted for protection and or the purpose of camouflage. Parts fabricated from metals or alloys in Groups 6 through 18 of Table VI and copper shall be painted for protection. Those fabricated from materials listed in Groups 1 through 5 and hot-dip zinc coated parts shall be painted for camouflage purposes. The only exceptions to these painting requirements are as follows:

(1) Small copper-base alloy parts (except screws, bolts, nuts and washers) hooks, eyelets, bead-chain, etc. finished by using chemical blackening finish E311.

(2) Small parts finished with Type I, dull nickel plating, or hot-dip-zinc.

(3) Assemblies requiring a sliding electrical contact surface(s) finished with dull nickel plating.

b. Surfaces not exposed to view. Type I surfaces not exposed to view when equipment is in either transit or operating condition shall be painted or plated. Exceptions to this plating or painting requirement are as follows:

(1) Magnesium-alloy parts shall be painted.

(2) Parts fabricated from metals or alloys listed in Groups I through 5 of Table VI (except copper) require no further finishing.

(3) Screws, nuts, bolts, and washers fabricated from ferrous alloys and plated with cadmium shall be painted on all surfaces exposed after incorporation of these parts in assemblies.

(4) Machined or welded corrosion-resistant steel parts shall be passivated with the finish designated as E300.

3.14.2 Finishing of Type II surfaces. Surfaces of parts fabricated from metals or alloys listed in Groups 1 through 11 of Table VI require no further finishing. All other parts except magnesium and magnesium alloys shall be finished with any applicable Type I or Type II finish specified in Tables I, III, or IV. Magnesium and magnesium alloys shall be painted in accordance with the requirements of Table I.

3.14.3 Conditions restricting allowable finishes. In addition to the foregoing requirements, the selection of finishes shall be limited as follows:

a. Dissimilar metal contacts involving magnesium alloys. All parts shall be painted prior to assembly. The magnesium alloys shall be painted and a tape conforming to MIL-T-23142 shall be interposed between the two surfaces. The tape shall extend to at least 0.32 cm beyond the periphery of the joint. All exposed edges, in addition to the tape, shall be sealed with a material conforming to MIL-S-8802, MIL-S-81733, or MIL-S-83430. Butt joints shall be protected by grooving the seam to a width of not less than 0.32 cm and filling with sealing compound conforming to MIL-S-8802, MIL-S-81733, or MIL-S-83430. The depth of the groove shall be sufficient to retain the sealing compound. After application, the compound shall be smoothed to be flush with the surface(s) of adjacent dissimilar metals. The use of cloth supported tapes is prohibited.

b. Dissimilar metal contacts (except those involving magnesium and magnesium alloys). When using basis metal parts intended for intermetallic contact that may form couples not allowed by Table VI, the following shall govern:

(1) Galvanically incompatible basis metals shall be plated in order to reduce the difference in potential to that allowed by Table VI. All such platings shall be Type I regardless of the exposure condition when assembled in equipment(s). For example, chromium plated parts intended for assembly with aluminum in a Type II environment shall have Type I chromium platings. Whenever possible, plating to permit dissimilar basis metal contact shall be selected in order to provide a small cathodic part in contact with a larger anodic piece (see paragraph 3.13.1.b).

(2) Dissimilar metal contacts not permitted by Table VI will be allowed provided that at least one of the contacting surfaces, preferably the cathodic or more noble metal, is finished with a complete "P" finish (includes Final Film) or those "P" finishes which include primers per MIL-P-23377 (without Final Film).

(3) Dissimilar metal contacts not permitted by Table VI will be allowed provided that both contact surfaces are finished with a basic "P" finish (step 1 through 3 per Table I).

3.15 Workmanship. Finishes shall be applied to all surfaces, as required, to form an even, adherent, protective film. Finished surfaces shall be smooth and free from foreign debris. They shall not exhibit burnt areas, blisters, gouge marks, peeling, flaking, checks, pits, nodules, or other significant defects. To help prevent corrosion, finished parts shall be dry and free from all residual traces of processing chemicals. Failure to meet these requirements and/or evidence of any major defect(s) as specified in Table IX shall be cause for rejection and immediate corrective action. Minor defects, as specified in Table IX, shall also be cause for immediate corrective action. At the discretion of the Government, minor defects may be acceptable provided that the defect(s) will not be visible after assembly.

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 as specified herein. Except as otherwise specified in the contract or purchase order, the contractor may use in-house or any other facilities suitable for the performance of the inspection requirements specified herein, unless such facility is 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.

4.1.1 Responsibility for compliance. All items shall meet all requirements of sections 3 and 4. 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 from the responsibiity of ensuring that all products or supplies submitted to the Government for acceptance comply with all requirements of the contract. Sampling inspection, as part of manufacturing operations, is an acceptable practice to ascertain conformance to requirements. However, this does not authorize submission of known defective material, nor does it commit the Government to accept defective material.

4.1.2 Certificates. The prime contractor shall have in possession certification that all materials and processes used to finish parts meet the applicable requirements of this specification. At the discretion of the Government, materials and test specimens, with applied finishes, may be required for verification testing. These shall be furnished by the contractor. All certification shall include data regarding materials, cleaning, passivation, plating, paint film thicknesses, baking temperatures, etc. All certification shall be made available to the Government on request.

4.2 Classification of inspections. The inspections specified herein are classified as follows:

a. Surveillance inspection (see 4.3).

b. First article inspection (see 4.4)

c. Quality conformance inspection (see 4.5)

4.3 Surveillance inspection. The materials and finish processes used in finishing shall be subject to periodic inspection by the Government.

4.4 First article requirements.

4.4.1 First article inspection. When first article inspection is required in the part or equipment specification, the finishes shall be inspected for compliance with Tables VIII and IX and with equipment performance requirements.

4.4.2 Inspections to be performed. The sample will be subjected to the tests specified in 4.6. The Government may also require testing to assure conformance to any or all of the applicable requirements of this specification.

4.4.3 Rejection of first article samples. If any sample fails to comply with any of the applicable requirements, the first article quantity shall be rejected. The Government reserves the right to terminate its inspection upon failure of any sample to comply with any of the stated requirements.

4.5 Quality conformance inspection. Quality conformance inspection of parts and equipment for finishes shall be in accordance with Tables VIII and IX.

4.6 Methods of inspection.

4.6.1 Color. The color conformance of the specified paint film shall be verified by comparison with an appropriate FED-STD-595 color chip. CARC paints may require batch verification depending on the paint specificatiion requirements (see para 6.2.5.1).

4.6.2 Adhesion of paint. At the discretion of the Government, a representative, though inconspicuous, portion of the painted surface of the sample unit, or a piece of scrap finished at the same time and in the same manner, shall be scraped with a sharp knife. The paint shall peel evenly from the surface rather than chip or flake. In addition, it shall be difficult to nick through the paint film to the substrate with a thumbnail. Failure to pass this test shall be considered a major defect in accordance with Table VIII. Acceptable units subjected to this test may be delivered on contract after all visible damage to the painted surface is repaired to the satisfaction of the Government.

Tape Tests

Unless otherwise specified a minimum of two test specimens representative of

each day's production shall be run through all steps of the regular production process including painting. Adhesion by tape testing of the painted specimens should be determined within 24 hours drying for single coat applications. A two coat paint should be tested within a maximum of 72 hours drying time. If any test specimen fails any of the tape tests, all items processed since the last acceptance shall be rejected and corrective action taken.

Dry Tape Test

Press a 5.08 cm length of a somewhat longer piece of pressure sensitive adhesive tape firmly on a flat or cylindrical surface of the item removing all air bubbles under the tape.

Allow the tape to normalize for 10 seconds. Grasp a free end of the tape and with a rapid motion strip it from the test specimen by pulling the tape back upon itself at 180 degrees (in such manner that the tape is folded back on itself during the procedure). Observe the tested surface for areas where the paint is removed.

Disregard flecks of paint on the tape where the underlying metal, phosphate, chromate or primer coating is not exposed.

Wet Tape Test.

At the discretion of the Government, any or all of the following additional tests may be performed:

A piece of cloth shall be taped on the area under inspection. The cloth shall be kept soaked for a minimum of 24 hours with tap or distilled water. After 24 hours remove the wet cloth and immediately apply a 5.08 cm length of pressure sensitive tape to the painted surface, adhesive side down. Allow a sufficient additional length for gripping with fingers during testing. Using finger/hand pressure press the 5.08 cm test section of the tape firmly to the surface removing all air bubbles. Allow the tape to normalize for 10 seconds. In one abrupt motion remove the tape. Examine the tested area for damage to the coating system or exposure of the base metal.

Scribe Tape Test

a. Scribe four 25.4mm lines completely through the paint finish, 1.59 to 2.38mm apart.
b. Scribe another four 25.4mm lines, 1.59 to 2.38mm apart, 90 degrees to the first set of lines. The resulting pattern shall be nine squares.
c. Press a length of tape, longer than the scribed area, firmly over the scribed pattern, rubbing out all air pockets.
d. Wait ten seconds minimum. Grasp a free end of the tape and at a rapid speed strip it from the painted surface by pulling the tape back upon itself at 180 degrees. The removal of two of more squares of topcoat, topcoat primer, or topcoat primer-pretreatment coating constitutes test failure. Removal of overspray does not constitute test failure.

Tape Type.

The tape used for tape testing shall be 2.54 cm wide and have a minimum

adhesion rating of 502 g/cm (NOTE: 3M Co. Code 250 meets this requirement).

Adhesion Test Specimens.

Test specimens shall be prepared from actual production items or parts thereof. If size is prohibitive, use scrap parts of the same kind and finish (from the same manufacturing lot if possible) which have been rejected for causes other than phosphating, material composition or heat treatment. Standard test panels may be used when authorized.

4.6.3 Thickness. Except where the method of determining the thickness of finishes is covered in applicable subsidiary specifications referenced herein, thickness may be determined by any method acceptable to the Government. Dry paint film thickness shall be measured at several places on each sample unit. Plating thickness shall be measured at several places on each sample unit where a minimum plating thickness would be expected due to part shape, recesses, etc.

4.6.4 Hydrogen embrittlement. Plated hardened ferrous parts shall be tested to insure freedom from an embrittled condition. Sample units of parts shall be tested by stressing them statically in the same way they would be stressed in service at 90 percent of the yield strength of the base metal, for 24 hours. If one or more samples crack or break, the entire inspection lot shall be rejected. Inspection lots rejected for failure to pass the hydrogen embrittlement test shall not be delivered to the Government.

4.6.5 Surface condition. The finish shall be visually examined for defects listed in Table IX.

4.6.6 Spectral reflectance. Spectral reflectance of paint films listed in Table II are to be tested in accordance with the applicable paint specifications. Separate test specimens may be used.

5. PACKAGING

5.1 This section is not applicable to this specification.

6. NOTES

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

6.1 Intended use. This specification is intended for use as a subsidiary document to specifications and drawings covering ground based electronic equipment. It specifies required finishes in detail by finish numbers.

6.2 Cross reference between discontinued and superseding finishes.

6.2.1 Discontinued paint film designators. Cross references between discontinued letters and superseding letters are in accordance with Table X.

6.2.2 Discontinued plated, M finishes. Cross references between discontinued and superseding M numbers are in accordance with Table XI.

6.2.3 Discontinued finishes or processes other than painting or plating, E finishes. Cross references between discontinued and superseding E numbers are as indicated in Table XII.

6.2.4 Cross reference of basic paint finishes, P numbers. Revision A included, in many cases, multiple choice of treatments to be applied under the same P number. Revision B used a decimal system in these cases to assign a specific P number for each treatment. Table XIII is a cross reference for Revisions A, B, C and D. It includes continued, superseding, and discontinued P numbers.

6.2.5 CARC paints. The CARC paint specifications are based on pigment formulations to meet specific color and spectral reflectance requirements and not a visual color match. Therefore, each film is extremely flat in appearance and has a slight surface texture, the visual color will vary depending on the texture and type of substrate to which it has been applied, the orientation of the paint film and the direction from which the paint film is illuminated and observed. These paints will wear as a result of handling or rubbing, especially if the paint film has not been fully cured. The marring is due to the smearing of the pigments which are close to or at the surface of these paint films. Paint films AG, AH and AI afford better protection against exposure of the base metal since it is applied over an epoxy primer.

6.2.5.1 CARC color inspection. Since marring, orientation and illumination variations are characteristics of CARC paints, visual color matching should not be a singular cause for rejection of end items. Batch validation, not color chip matching, should be the inspection criteria (see the applicable paint specification for color matching requirements).

6.3 Antennas. Electrically functional elements of antennas shall not be painted, unless specified on equipment drawings or specific approval is obtained from the equipment design activity.

6.4 Corrosion and corrosion testing terms. Refer to ASTM G15 for standard definitions of terms relating to corrosion and corrosion testing.

6.5 Material Safety Data Sheets. Contracting Officers will identify those activities requiring copies of completed Material Safety Data Sheets prepared in accordance with FED-STD-313. The pertinent mailing addresses for submission of data are listed in appendix B of FED-STD-313.

6.6 Subject term (key word) listing.
Painting, metal finishing, plating, wood finishing.

Custodian:
Army - ER

Preparing activity:
Army - ER

Review Activities:
Army - AR, ME, MI, MR, AL, CR, GL, AT

Project: MFFP-A437

TABLE I. Basic paint finishes (P)

Finish Number	Type Exposure	Finish Process			
		Step 1 Preconditioning	Step 2 Passivation	Step 3 (see 3.9.1) Pretreatment	Primer
FOR USE ON FERROUS ALLOYS OTHER THAN CORROSION RESISTANT STEELS (TANK PHOSPHATING IS PRACTICAL)					
P210	I or II	----	TT-C-490, Type I	----	MIL-P-53022 1/,7/
P211.1	I or II	----	TT-C-490, Type I	----	TT-P-664 1/
P216	I or II	Clean per MIL-T-704	DOD-P-15328	TT-E-485	TT-E-485
P216.1	I or II	Clean per MIL-T-704	TT-C-490, Type I	TT-E-485	TT-E-485
P216.2	I or II	Clean per MIL-T-704	TT-C-490, Type II	TT-E-485	TT-E-485
P217	I or II	Clean per MIL-T-704	----	----	MIL-P-53030 1/,7/
P217.1	I or II	Clean per MIL-T-704	TT-C-490, Type I	----	MIL-P-53084 1/,7/
FOR USE ON FERROUS ALLOYS (TANK PHOSPHATING IS NOT PRACTICAL)					
P210.1	I or II	Sanding or abrasion or phosphoric acid etch per MIL-C-10578	----	DOD-P-15328	MIL-P-53030 1/,7/
P213.1	I or II	See P210.1	----	---	TT-P-664
P213.4	I or II	See P210.1	----	DOD-P-15328	TT-P-664
P216	I or II	For Finish Process See P216 above.			
P217	I or II	For Finish Process See P217 above.			

"TABLE I. Basic paint finishes (P) - Continued."

Finish Number	Type Exposure	Finish Process			
		Step 1 Preconditioning	Step 2 Passivation	Step 3 (see 3.9.1) Pretreatment	Step 3 (see 3.9.1) Primer
FOR USE ON INSIDE OF FERROUS TUBES					
P215	II	TT-C-490, Method VI.	Priming not required. Finish by filling, draining, and drying with one coat of TT-E-485, Type I. Final dry film thickness, 0.0254mm minimum. This is normally an end point (final) coating.		
FOR USE ON CORROSION RESISTANT STEELS, NICKEL BASE ALLOYS, COPPER AND COPPER BASE ALLOYS					
P210.1	I or II	For Finish Process see P210.1 above.			
P213.1	I or II	For Finish Process see P213.1 above.			
P213.4	I or II	For Finish Process see P213.4 above.			
P217	I or II	For Finish Process see P217 above.			
P218	I or II	Mil-T-704(For corrosion resistant steel)	Mil-T-704 (For corrosion resistant steel)	---	MIL-P-53030 1/,7/
P313	II	Sanding or abrasion or phosphoric acid etch per MIL-C-10578	----	DOD-P-15328	MIL-P-53030 1/,7/
FOR USE ON ALL PLATED SURFACES EXCEPT THOSE PLATED WITH CADMIUM OR ZINC					
P310	I or II	MIL-C-10578	----	DOD-P-15328	MIL-P-23377 1/,7/
P341.1	I or II	MIL-C-10578	----	---	TT-P-1757 1/
P341.2	I or II	MIL-C-10578	----	---	TT-P-664
P341.3	I or II	MIL-C-10578	----	DOD-P-15328	TT-P-1757 1/

"TABLE I. Basic paint finishes (P) - Continued."

Finish Number	Type Exposure	Finish Process			
		Step 1 Preconditioning	Step 2 Passivation	Step 3 (see 3.9.1) Pretreatment	Step 3 (see 3.9.1) Primer
FOR USE ON ALL PLATED SURFACES EXCEPT THOSE PLATED WITH CADMIUM OR ZINC - Continued					
P341.4	I or II	MIL-C-10578	---	DOD-P-15328	TT-P-664 9/
P343	II	MIL-C-10578	---	DOD-P-15328	
FOR USE ON CADMIUM OR ZINC PLATED SURFACES					
P310.1	I or II	---	MIL-T-12879, Type I, Class 1 or 2 for M228 plating (see Table III); other platings specified in Table III include passivation treatments.	----	MIL-P-23377 1/, 7/
P371.1	I or II	---	---	DOD-P-15328	TT-P-1757 1/
P371.2	I or II	---	---	DOD-P-15328	TT-P-664
P373	II	---	---	DOD-P-15328	9/
P374	I or II	For finish process see P218 above.			
FOR USE ON SILVER, SILVER BASE ALLOYS, LEAD AND TIN BASE ALLOYS INCLUDING SOLDER					
P310	I or II	For Finish Process see P310 above.			
P341.1	I or II	For Finish Process see P341.1 above.			
P341.2	I or II	For Finish Process see P341.2 above.			
P341.3	I or II	For Finish Process see P341.3 above.			
P341.4	I or II	For Finish Process see P341.4 above.			
P343	II	For Finish Process see P343 above.			
FOR USE ON ALUMINUM AND ALUMINUM BASE ALLOYS					
P510	I or II	---	MIL-A-8625 2/	----	MIL-P-23377 1/,7/
P510.2	I or II	---	MIL-C-5541	----	MIL-P-23377 1/,7/

"TABLE I. Basic paint finishes (P) - Continued."

Finish Number	Type Exposure	Finish Process			
		Step 1 Preconditioning	Step 2 Passivation	Step 3 (see 3.9.1) Pretreatment	Primer
FOR USE ON ALUMINUM AND ALUMINUM BASE ALLOYS - Continued					
P510.3	I or II	---	---	DOD-P-15328	MIL-P-23377 1/,7/
P511	I or II	---	MIL-A-8625	---	TT-P-1757 1/
P513.1	I or II	---	MIL-C-5541	---	TT-P-1757 1/
P513	I or II	---	---	DOD-P-15328	TT-P-1757 1/
P517	II	---	MIL-C-5541	---	9/
P518.1	I or II	---	MIL-A-8625	---	MIL-P-15930
P519.1	I or II	---	MIL-C-5541	---	MIL-P-15930
P519.2	I or II	---	---	DOD-P-15328	MIL-P-15930
P520	I or II	Clean per MIL-T-704	DOD-P-15328	TT-E-485	TT-E-485
P520.1	I or II	Clean per MIL-T-704	MIL-A-8625	TT-E-485	TT-E-485
P521	I or II	For Finish Process see P217 above.			
P522	I or II	Clean per MIL-T-704	---	---	---
P522.1	I or II	Clean per MIL-T-704	MIL-C-5541	---	MIL-P-53084 1/,7/
FOR USE ON ZINC BASE ALLOYS					
P610	I or II	---	MIL-T-12879, Type I, Class 2. 3/	DOD-P-15328	MIL-P-23377 1/,7/
P610.1	I or II	---	MIL-T-12879, Type I, Class 1.	DOD-P-15328	MIL-P-23377 1/,7/
P611.1	I or II	---	MIL-T-12879, Type I, Class 2. 3/	DOD-P-15328	TT-P-1757 1/
P611.2	I or II	---	MIL-T-12879, Type I, Class 2. 3/	DOD-P-15328	TT-P-664
P613.1	I or II	---	MIL-T-12879, Type I, Class 1.	DOD-P-15328	TT-P-1757 1/

"TABLE I. Basic paint finishes (P) - Continued."

Finish Number	Type Exposure	Finish Process			
		Step 1 Preconditioning	Step 2 Passivation	Step 3 (see 3.9.1) Pretreatment	Primer
FOR USE ON ZINC BASE ALLOYS - Continued					
P613.2	I or II	----	MIL-T-12879, Type I, Class 1	----	TT-P-664
P615.1	II	----	MIL-T-12879, Type I, Class 2 3/	----	9/
P615.2	II	----	MIL-T-12879, Type I, Class 1	----	9/
P616	I or II	For Finish Process see P520 above.			
P617	I or II	For Finish Process see P217 above.			
FOR USE ON ZINC BEARING MAGNESIUM ALLOYS					
P710	I	MIL-M-3171	MIL-M-3171, Type III	----	MIL-P-23377 1/, 4/, 7/
P710.1	I	MIL-M-3171	MIL-M-45202, Type II, Class D 5/	----	MIL-P-23377 1/, 4/, 7/
P710.2	II	MIL-M-3171	MIL-M-3171, Type III	----	MIL-P-23377 7/
P710.3	II	MIL-M-3171	MIL-M-45202, Type I, Class C	----	MIL-P-23377 1/, 7/
P711.1	I	MIL-M-3171	MIL-M-3171, Type III	----	MIL-P-15930 4/
P712.1	I	MIL-M-3171	MIL-M-45202, Type II, Class D 5/	----	MIL-P-15930 4/
P713.1	II	MIL-M-3171	MIL-M-3171, Type III	----	MIL-P15930
P713.2	II	MIL-M-3171	MIL-M-45202, Type I, Class C	----	MIL-P15930
P718	I or II	Clean per MIL-M-3171	MIL-M-3171	----	---
P718.1	I	Clean per MIL-M-3171	----	DOD-P-15328	1/, 4/, 6/, 7/, 9/
P718.2	II	Clean per MIL-M-3171	----	DOD-P-15328	1/, 6/, 7/, 9/

"TABLE I. Basic paint finishes (P) - Continued."

Finish Number	Type Exposure	Finish Process			
		Step 1 Preconditioning	Step 2 Passivation	Step 3 (see 3.9.1) Pretreatment	Primer
FOR USE ON ZINC BEARING MAGNESIUM ALLOYS - Continued					
P719	I or II	For Finish Process see P217 above.			
FOR USE ON MAGNESIUM ALLOYS (EXCEPT PARTS SUBJECT TO FLEXING)					
P710.4	I	MIL-M-3171	MIL-M-45202, Type II, Class A, Grade 3, or Class D	----	MIL-P-23377 1/, 4/, 7/
P710.5	II	MIL-M-3171	MIL-M-45202, Type II, any Class or Grade	----	MIL-P-23377 1/, 7/
P714.1	I	MIL-M-3171	MIL-M-45202, Type II, Class A, Grade 3, or Class D	----	MIL-P-15930 4/
P715.1	II	MIL-M-3171	MIL-M-45202, Type II, any Class or Grade	----	MIL-P-15930
P719	I or II	For Finish Process see P217 above.			
P720	I or II	MIL-M-3171	MIL-M-3171, any Class or Grade	----	MIL-P-53030
FOR USE ON MAGNESIUIM ALLOYS EXCEPT THOSE CONTAINING ZINC					
P710.1	I	For Finish Process see P710.1 above.			
P710.6	I	MIL-M-3171	MIL-M-3171, Type IV	----	MIL-P-23377 1/, 4/, 7/
P710.7	II	MIL-M-3171	MIL-M-3171, Type IV	----	MIL-P-23377 1/, 7/
P710.8	II	MIL-M-3171	MIL-M-45202, Type I, any Class or Grade	----	MIL-P-23377 1/, 7/
P712.1	I	For Finish Process see P712.1 above.			
P716.1	I	MIL-M-3171	MIL-M-3171, Type IV	----	MIL-P-15930 4/
P717.1	II	MIL-M-3171	MIL-M-3171, Type IV	----	MIL-P-15930

"TABLE I. Basic paint finishes (P) - Continued"

Finish Number	Type Exposure	Finish Process			
		Step 1 Preconditioning	Step 2 Passivation	Step 3 (see 3.9.1) Pretreatment	Primer
FOR USE ON MAGNESIUM ALLOYS EXCEPT THOSE CONTAINING ZINC - Continued					
P717.2	II	MIL-M-3171	MIL-M-45202, Type I, any Class or Grade	----	MIL-P-15930
P719	I or II	For Finish Process see P217 above.			
P720	I or II	For Finish Process see P218 above.			
FOR USE ON WOOD					
P911	I or II	Sanding	----	MIL-T-704 8/	TT-P-664

1/ Alternate primers where lead or chromate pigments are prohibited are MIL-P-53022, MIL-P-53030 or MIL-P-85582. CARC primer MIL-P-53084 (lead and chromate free) is an option for use on ferrous alloys or aluminum (see Table I). It is applied by electrocoating (see paragraph 3.9.5). For low infrared reflectance (IR) use MIL-P-23377, Type II. Alternate primer for ferrous metals prior to spot welding is MIL-P-46105.

2/ When Type I (Chromic acid) or Type II (Sulfuric acid) anodic coating is used, coat per MIL-C-5541 applied prior to epoxy primer to improve adhesion of epoxy primer.

3/ Colored chromates as they normally occur in processing operations are desired. The use of clear or bleached chromates is prohibited.

4/ Apply two coats of primer.

5/ MIL-M-45202, Type II coatings (heavy) should not be applied to magnesium parts subject to flexing. On such parts, use Type I (light).

6/ Pretreatment coating per DOD-P-15328 for use on magnesium alloys should have the phosphoric acid content reduced by 50 percent of that specified in DOD-P-15328 (This dilution is required to prevent hydrogen evolution at magnesium surfaces).

7/ To ensure proper adhesion, only epoxy primers must be used prior to top coat finishing with CARC paints.

"TABLE I. Basic paint finishes (P) - Continued"

8/ Preservative treatments for wood. Preservative treatments are often required for both painted and unpainted material and must be used when specified. A non-pentachlorophenol preservative should be used for this purpose. Caution must be exercised in the use of preservative materials as some water based preservatives might cause objectionable swelling and/or a raised-grain in a high quality end use. When a preservative treatment is specified, the wood surface shall be dry and free from grease and other foreign matter before it is treated. Wood that is to be treated shall not have a moisture content exceeding 20 percent of its post oven drying weight. Where possible, wood parts shall be cut to final dimensions, planed or sanded smooth, and holes, rabbets, and the like, shall be made before treatments. In the event that it becomes necessary to make holes, rabbets, sawcuts, or the like, after treatment, preservative shall be applied liberally to surfaces exposed by these operations.

9/ Select a suitable primer compatible with the final paint film to be applied.

TABLE II. Final paint film (Step 4 of Finish Process).

FOR TYPE I (EXPOSED) APPLICATIONS

Film Designation	Color (FED-STD-595 No.)	Gloss	Dry Film Thickness (mm) (mm x 39.37=mils)	Applicable Paint Specification
B	Black (No. 37038)	Lusterless	0.0254-0.0381	TT-E-527
D	Black (No. 27038	Semi-gloss	0.0254-0.0381	TT-E-529
E	Gray (No. 26307)	Semi-gloss	0.0254-0.0381	MIL-E-15090, Class 2.
F	Gray (No. 26152)	Semi-gloss	0.0254-0.0381	TT-E-529
G	Gray (No. 16376)	Gloss	0.0254-0.0381	TT-E-489
K	Black (No. 17038)	Gloss	0.0254-0.0381	TT-E-489
N	Black (No. 37038)	Semi-gloss	0.0254-0.0381	MIL-C-22750
P	Gray (No. 26307)	Semi-gloss	0.0254-0.0381	MIL-C-22750
T	Black (No. 17038)	Gloss	0.0254-0.0381	MIL-C-22750
X	Gray (No. 36118)	Lusterless	0.0254-0.0381	TT-E-527
AE	White (No. 27875)	Semi-gloss	0.0254-0.0381	MIL-C-22750
AG	Green 383(#34094)	Lusterless	0.0457 minimum	MIL-C-46168*
AH	Brown 383(#30051)	Lusterless	0.0457 minimum	MIL-C-46168*
AI	Black (No. 37038)	Lusterless	0.0457 minimum	MIL-C-46168*
AP	Tan 686 (No.33446)	Lusterless	0.0457 minimum	MIL-C-46168*
AR	White (No. 37875)	Lusterless	0.0457 minimum	MIL-C-46168*

FOR TYPE II (SHELTERED) APPLICATIONS

Film Designation	Color of File (FED-STD-595 No.)	Gloss	Dry Film Thickness (mm) (mm x 39.37=mils)	Applicable Paint Specification
A	Olive Drab (No. 34087)	Lusterless	0.0254-0.0381	MIL-C-53039* MIL-C-46168*, or TT-E-527
H	Olive Drab (No. 14087)	Gloss	0.0254-0.0381	TT-E-489
M	Olive Drab (No. 24087)	Semi-gloss	0.0254-0.0381	MIL-C-22750
AL	Green (No. 24410)	Semi-gloss	0.0254-0.0381	TT-E-529
AM	Green (No. 24533)	Semi-gloss	0.0254-0.0381	MIL-C-22750

*CARC Finish - Alternate Single Component Finish (Also CARC) is MIL-C-53039

NOTE: Film designations AG, AH and AI are CARC, tricolor, camouflage. For wooded and other vegetated areas. For winter/snow conditions the colors are AR, AH and AI and for the desert only AP is used.

TABLE III . Plated finishes (M).

Finish Number	Type Exposure	Plate Description	Minimum Plating Thickness in mm (mm x 39.37 = mils)		Applicable Specifications
			Inter-mediate Plates	Final Plate	
FOR USE ON IRON OR IRON-BASE ALLOYS					
M211	I	Silver	0.0025 Nickel	0.0127 Silver	QQ-N-290 plus QQ-S-365, Grade A
M212	I	Nickel	0.0127 Copper	0.0152 Nickel	MIL-C-14550, Class 2, plus QQ-N-290, Class 1, Grade E (Bright finish)
M213	I	Dull Nickel	0.0127 Copper	0.0152 Nickel	MIL-C-14550, Class 2 plus QQ-N-290, Class 1, Grade E (Matte finish)
M214	I	Copper	None	0.0254 Copper	MIL-C-14550, Class 1
M216	I	Bright Chrome	0.0152 Nickel over 0.0127 Copper	0.0005 Chromium	MIL-C-14550, Class 2 plus QQ-N-290, Class 1, Grade E plus QQ-C-320, Type I, Class 1
M217	I	Hot-dip Tin	None	0.0127 Tin	MIL-T-10727, Type II
M220	I	Hot-dip Terneplate	None	0.0127 Terne	Best commercial practice
M221	I	Hot solder dip (40 to 60% tin)	None	0.0127 Solder	QQ-S-571

"TABLE III . Plated finishes (M) - Continued."

Finish Number	Type Exposure	Plate Description	Minimum Plating Thickness in mm (mm x 39.37 = mils)		Applicable Specifications
			Intermediate Plates	Final Plate	
FOR USE ON IRON OR IRON-BASE ALLOYS - Continued					
M222	I and II	Electroplated Tin-lead (50 to 70% tin) 1/	None	0.0076	MIL-P-81728
M223	I	Lead	0.0004 Copper	0.0381 Lead	MIL-L-13808, Type II 2/
M224	I	Passivated Cadmium (must be painted)	None	0.0127 Cadmium	QQ-P-416, Type III, Class 1
M225	I	Olive-drab Chromate Passivated Cadmium Do not paint 3/	None	0.0127 Cadmium	QQ-P-416, Type II Class 1
M226	I	Passivated Zinc (must be painted)	None	0.0127 Zinc	ASTM B633, Type II or III, Class 2
M227	I	Olive-drab Chromate Passivated Zinc	None	0.0127 Zinc	ASTM B633, Type II
M228	I	Hot-dip Zinc	None	---	ASTM A123, ASTM A153
M229	I	Chromate Passivated Hot-dip Zinc	None	---	ASTM A123, ASTM A153 plus MIL-T-12879, Type II
M251	II	Silver	0.0025 Nickel	0.0076 Silver	QQ-N-290, Grade C plus QQ-S-365, Grade A

"TABLE III . Plated finishes (M) - Continued."

Finish Number	Type Exposure	Plate Description	Minimum Plating Thickness in mm (mm x 39.37 = mils)		Applicable Specifications
			Inter-mediate Plates	Final Plate	
FOR USE ON IRON OR IRON-BASE ALLOYS - Continued					
M252	II	Nickel	0.0051 Copper	0.0102 Nickel	MIL-C-14550, Class 3 plus QQ-N-290, Grade F (Bright finish)
M253	II	Dull Nickel	0.0051 Copper	0.0102 Nickel	MIL-C-14550, Class 3 plus QQ-N-290, Grade F (Matte finish)
M254	II	Copper	None	0.0127 Copper	MIL-C-14550, Class 2
M255	II	Bright Chrome	0.0102 Nickel over 0.0051 Copper	0.0005 Chromium	QQ-N-290, Grade F plus MIL-C-14550, Class 3, plus QQ-C-320
M256	II	Hot-dip Tin	None	0.0076 Tin	MIL-T-10727, Type II
M258	II	Hot solder dip (40 to 60% tin)	None	0.0076 Solder	QQ-S-571
M260	II	Lead	0.0004 Copper	0.0254 Lead	MIL-L-13808, Type II, Class 1
M261	II	Passivated Cadmium (must be painted)	None	0.0076 Cadmium	QQ-P-416, Type III, Class 2
M262	II	Unbleached Chromate passivated Cadmium. Do not paint. 3/	None	0.0076 Cadmium	QQ-P-416, Type II, Class 2

"TABLE III . Plated finishes (M) - Continued."

Finish Number	Type Exposure	Plate Description	Minimum Plating Thickness in mm (mm x 39.37=mils)		Applicable Specifications
			Inter-mediate Plates	Final Plate	
FOR USE ON IRON OR IRON-BASE ALLOYS - Continued					
M263	II	Passivated Zinc (must be painted)	None	0.0076 Zinc	ASTM B633, Type III
M264	II	Unbleached Chromate Passivated Zinc 3/	None	0.0076 Zinc	ASTM B633, Type II
M265	I and II	Electroless Nickel	None	0.0254 Electroless Nickel	MIL-C-26074, Grade A
FOR USE ON COPPER OR COPPER-BASE ALLOYS CONTAINING LESS THAN 40% ZINC					
M221	I	Hot solder dip	See M221 above for details.		
M225	I	Olive-drab Chromate Passivated Cadmium	See M225 above for details.		
M230	I and II	Electroplated Tin-Lead (50 to 70% tin) 1/	0.0025 Copper	0.0076 Tin-Lead	MIL-C-14550, Class 4 plus MIL-P-81728.
M258	II	Hot solder dip	See M258 above for details.		
M262	II	Unbleached Chromate Passivated Cadmium 3/	See M262 above for details.		

"TABLE III . Plated finishes (M) - Continued."

Finish Number	Type Exposure	Plate Description	Minimum Plating Thickness in mm (mm x 39.37=mils)		Applicable Specifications
			Inter-mediate Plates	Final Plate	
FOR USE ON COPPER OR COPPER BASE ALLOYS CONTAINING LESS THAN 40% ZINC					
M310	I	Gold	0.0254	0.0254 Gold	QQ-N-290 Grade C plus MIL-G-45204, Class 4/
M311	I	Silver	0.0254 Nickel	0.0127 Silver	QQ-N-290, Grade C plus QQ-S-365, Grade A
M312	I	Nickel	None	0.0152 Dull Nickel	QQ-N-290, Grade E (Bright finish)
M313	I	Dull Nickel	None	0.0152 Dull Nickel	QQ-N-290, Grade E (Matte finish)
M316	I	Bright Chrome	0.0152 Nickel	0.0005 Chromium	QQ-N-290, Grade E plus QQ-C-320
M317	I	Hot-dip Tin	None	0.0178 Tin	MIL-T-10727, Type II
M323	I	Lead	None	0.0381 Lead	MIL-L-13808, Type I
M350	II	Gold	0.0152 Nickel	0.0127 Gold	QQ-N-290 Grade E plus MIL-G-45204, Class 1
M351	II	Silver	0.0254 Nickel	0.0254 Silver	QQ-N-290 Grade C plus QQ-S-365 Grade A
M355	II	Bright Chrome	0.0102 Nickel	0.0005 Chromium	QQ-N-290 Grade F plus QQ-C-320
M356	II	Lead	None	0.0254 Lead	MIL-L-13808, Type 1, Class 1

"TABLE III . Plated finishes (M) - Continued."

Finish Number	Type Exposure	Plate Description	Minimum Plating Thickness in mm (mm x 39.37=mils)		Applicable Specifications
			Inter-mediate Plates	Final Plate	
FOR USE ON COPPER OR COPPER-BASE ALLOYS CONTAINING LESS THAN 40% ZINC - Continued					
M357	I and II	Electroless Nickel	None	0.0127 Electroless Nickel	MIL-C-26074, Grade B
M358	I and II	Rhodium	0.0127 Silver	0.0005 Rhodium	QQ-S-365, Grade B plus MIL-R-46085, Class 3
M359	I and II	Rhodium	0.0051 Nickel	0.0005 Rhodium	QQ-N-290, Grade G plus MIL-R-46085, Class 3
M362	II	Nickel	None	0.0102 Nickel	QQ-N-290, Grade F
FOR USE ON COPPER-BASE ALLOYS CONTAINING 40% ZINC OR MORE					
M221	I	Hot solder dip	See M221 above for details.		
M225	I	Olive-drab Chromate Passivated Cadmium	See M225 above for details.		
M230	I and II	Electroplated Tin-Lead (50 to 70% tin) 1/	See M230 above for details.		
M258	II	Hot solder dip	See M258 above for details.		

"TABLE III . Plated finishes (M) - Continued."

Finish Number	Type Exposure	Plate Description	Minimum Plating Thickness in mm (mm x 39.37=mils)		Applicable Specifications
			Inter-mediate Plates	Final Plate	
FOR USE ON COPPER-BASE ALLOYS CONTAINING 40% ZINC OR MORE - Continued					
M262	II	Unbleached Chromate Passivated Cadmium 3/	See M262 above for details.		
M310	I	Gold	See M310 above for details.		
M311	I	Silver	See M311 above for details.		
M317	I	Hot-dip Tin	See M317 above for details.		
M323	I	Lead	See M323 above for details.		
M351	II	Silver	See M351 above for details.		
M356	II	Lead	See M356 above for details.		
M412	I	Nickel	0.0051 Copper	0.0152 Nickel	MIL-C-14550, Class 3 plus QQ-N-290, Grade E plus QQ-C-320
M413	I	Dull Nickel	0.0051 Copper	0.0152 Nickel	MIL-C-14550, Class 3 plus QQ-N-290, Grade E plus QQ-C-320
M416	I	Bright Chrome	0.0152 Nickel over 0.0051 Copper	0.0005 Chrome	MIL-C-14550, Class 3 plus QQ-N-290 Grade E plus QQ-C-320

"TABLE III . Plated finishes (M) - Continued."

Finish Number	Type Exposure	Plate Description	Minimum Plating Thickness in mm (mm x 39.37=mils)		Applicable Specifications
			Inter-mediate Plates	Final Plate	
FOR USE ON COPPER-BASE ALLOYS CONTAINING 40% ZINC OR MORE - Continued					
M417	I and II	Electroless Nickel	0.0051 Copper	0.0127 Electroless Nickel	MIL-C-14550, Class 3 plus MIL-C-26074, Grade B
M418	I and II	Rhodium	0.0127 Silver 0.0025 Copper	0.0005 Rhodium	MIL-C-14550, Class 4 plus QQ-S-365, Grade G plus MIL-R-46085, Class 3
M419	I and II	Rhodium	0.0051 Nickel over 0.0025 Copper	0.0005 Rhodium	MIL-C-14550, Class 4 plus QQ-N-290, Grade G plus MIL-R-46085, Class 3
M452	II	Nickel	0.0051 Copper	0.0102 Nickel	MIL-C-14550, Class 3 plus QQ-N-290, Grade F
M455	II	Bright Chrome	0.0102 Nickel over 0.0051 Copper	0.0005 Chrome	MIL-C-14550, Class 3 plus QQ-N-290, Grade F plus QQ-C-320
FOR USE ON ALUMINUM OR ALUMINUM-BASE ALLOYS 5/					
M212	I	Nickel	See M212 above and 6/ for details.		
M213	I	Dull Nickel	See M213 above and 6/ for details.		
M216	I	Bright Chrome	See M216 above and 6/ for details.		

"TABLE III . Plated finishes (M) - Continued."

Finish Number	Type Exposure	Plate Description	Minimum Plating Thickness in mm (mm x 39.37=mils)		Applicable Specifications
			Inter-mediate Plates	Final Plate	
FOR USE ON ALUMINUM OR ALUMINUM-BASE ALLOYS 5/ - Continued					
M252	II	Nickel	See M252 above and 6/ for details.		
FOR USE ON ZINC-BASE ALLOYS					
M611	----	Nickel	0.0051 Copper	0.0152 Nickel	MIL-C-14550, Class 3 plus QQ-N-290, Grade E

1/ Electroplated Tin-Lead is be be reflowed to provide improved coverage and protection of the basis metal.

2/ Lead plating shall be applied in accordance with MIL-L-13808 except the thickness shall be as specified herein.

3/ Colored chromates as they normally occur in processing operations are desired. The use of clear or bleached chromates is prohibited. Paint does not adhere to chromate-passivated cadmium. If cadmium is to be painted, use M261 only.

4/ The type and grade are to be specified.

5/ Use of nickel or copper/nickel on aluminum for Type I exposures is a questionable practice. Any porosity in the coating can lead to severe corrosion. Therefore, any such applications should be carefully weighed and avoided whenever possible.

6/ The aluminum alloys require pretreatment prior to plating. All surfaces shall be treated in accordance with ASTM B253 or given a sodium carbonate anodize in accordance with the pretreatment process for aluminum alloys.

TABLE IV. Finishes or processes other than painting or plating (E).

For Use On	Type Exposure	Finish Number	Finish Process
Plated ferrous alloys (other than corrosion-resistant steel) having a Rockwell hardness greater than C-40.	I or II	E200	1) Prior to cleaning and plating, and after forming and hardening, parts shall be stress-relieved by baking at 149°C to 260°C for 30 minutes. The baking temperature employed will depend on the amount of residual stress required by the part. 2) Immediately after plating and prior to any passivation treatment, parts shall be baked at 177°C to 204°C for 5 hours. Parts shall not be flexed prior to baking. NOTE: Parts heat treated at less than 191°C including carburized parts shall be treated by a method having prior approval of the contracting officer.
Ferrous alloys other than corrosion-resistant steel (Wearing parts lubricated in service).	II	E211	1) Preconditioning not required. 2) Passivate with phosphate film per DOD-P-16232, Type M, Class 2.
Ferrous alloys other than corrosion-resistant steel (nonwearing parts not lubricated in service).	II	E212	1) Preconditioning not required. 2) Passivate with phosphate film per DOD-P-16232, Type Z, Class 2.
Ferrous alloys other than corrosion-resistant steel (wearing parts lubricated in service; and maximum corrosion resistance required; can be dyed to specific color).	II	E213	1) Preconditioning not required. 2) Passivate with phosphate film per DOD-P-16232, Type M, Class 4 plus supplementary treatment.
Ferrous alloys other than corrosion-resistant steel (non-wearing parts not lubricated in service and maximum corrosion resistance required; can be dyed to specific color).	II	E214	1) Preconditioning not required. 2) Passivate with phosphate film per DOD-P-16232, Type Z, Class 4 plus supplementary treatment.

"TABLE IV. Finishes or processes other than painting or plating (E) - Continued."

For Use On	Type Exposure	Finish Number	Finish Process
Ferrous alloys in lieu of chromate treated zinc or cadmium plated parts that will be subjected to ambient temperatures between 71°C and 343°C when in service (see 3.7 for alternate methods). High strength steel parts can be coated without subjecting them to possible affects of hydrogen embrittlement resulting from an electroplating process.	I or II	E215	Precondition clean surface per MIL-T-704. Apply immersion zinc/chromate coating per MIL-C-87115 followed by a primer coating per the specification. Apply a final paint finish coat selected from Table II or as specified on the master drawing.
Machined or welded corrosion resistant steel parts.	I or II	E300 1/	Passivate per ASTM A 380.
Small copper or copper alloy parts such as buckles, hooks, eyelets, etc.	I	E311	Finish with chemical black treatment per MIL-F-495.
Aluminum and aluminum base alloys.	I or II	E511 2/	1) Preconditioning not required. 2) Anodize per MIL-A-8625, Types I, II or III. 3/
Aluminum - alloys when Low Resistance Electrical Contacts are required; service temperatures not to exceed 60°C.	II	E512	1) Preconditioning not required. 2) Passivate with chemical film per MIL-C-5541, Class 3.
Aluminum and aluminum-base alloys, service temperatures not to exceed 60°C.	II	E513	1) Preconditioning not required. 2) Passivate with chemical film per MIL-C-5541, Class 1A.
Aluminum and aluminum-base alloys (for use on bearing surfaces when extreme wear resistance is necessary).	II	E514	Apply anodic hardcoat per MIL-A-8625, Type III. Better service in bearing applications can be provided by polytetrafluoroethylene dispersion sealing of hard anodized surfaces to reduce friction.

"TABLE IV. Finishes or processes other than painting or plating (E) - Continued."

For Use On	Type Exposure	Finish Number	Finish Process
Aluminum alloys in lieu of chromate treatment (see 3.7). This process has been classed as non-polluting. It is recommended for parts which, when in service, will be exposed to temperatures above 71°C and as an alternate to anodization if metal fatigue is a factor.	I or II	E517	Precondition cleaning of surface per MIL-T-704. Apply immersion zinc/chromate coating per MIL-C-87115. If parts require painting use MIL-P-53022 or other suitable primer per this specification. Apply a final paint film selected from Table II.
Zinc-base alloys, operating temperature not to exceed 71°C.	II	E611	1) Preconditioning not required. 2) Passivate with unbleached chromate film per MIL-T-12879, Type II. 4/
Zinc-base alloys (must be painted).	II	E612	1) Preconditioning not required. 2) Passivate with phosphate film per MIL-T-12879, Type I, Class 1.

1/ The primary purpose of this treatment is the removal of embedded iron, steel or other foreign metallic particles.

2/ Anodic films are satisfactory for Type I surfaces only on small unthreaded parts.

3/ Type II is the preferred anodic treatment; however, it should not be used on surfaces subject to stresses or surfaces containing lapped joints or crevices which could entrap the sulphuric acid anodization solution. Type I anodization should be used in these cases. Type III anodization is intended to provide greater wear characteristics, abrasion resistance and improved corrosion protection.

4/ Colored chromates as they normally occur in processing operations are desired. The use of clear or bleached chromate is prohibited.

TABLE V. Electrical conductivity of passivated finishes (see para 3.12).

Alloy Part	Type Exposure	Finish Number	Finish	Conducting Frequency		Remarks
				Power	RF	
Ferrous	I II	M225 M262	Chromate-passivated Cadmium	No	Yes	Electrical contact may require use of toothed type lockwashers. 1/
Ferrous	I II	M227 M264	Chromate-passivated Zinc	No	Yes	Electrical contact may require use of toothed type lockwashers. 1/
Ferrous	II II II	E211 E212 E213	Phosphate passivation	No	No	Since these finishes are porous, their use in contact with other metals must be restricted to those forming couples compatible with ferrous alloys (except corrosion-resistant steel).
Aluminum	II	E511	Anodize	No	No	May be used in contact with any dissimilar metal.
Aluminum	II	E512	Chemical	Yes	Yes	Electrical contact does not require use of toothed lockwashers.
Aluminum	II	E513	Chemical film	No	Yes	Electrical contact may require use of toothed type lockwashers. 2/
Aluminum	II	E514	Hard anodize	No	No	May be used in contact with any dissimilar metal.
Zinc-base	II	E611	Chromate passivation	No	Yes	Electrical contact may require use of toothed type lockwashers. 1/

"TABLE V. Electrical conductivity of passivated finishes - Continued."

Alloy Part	Type Exposure	Finish Number	Finish	Conducting Frequency		Remarks
				Power	RF	
Zinc-base	II	E612	Phosphate passivation	No	No	Since this finish is porous, its use in contact with other metals must be restricted to those forming couples compatible with zinc-base alloys.

1/ Chromate films, depending on thickness, have a relatively low electrical resistance from 0.0001 to 0.002 ohm (.1 to 2 milliohm) over a contact area of 6.45 cm^2 with contact pressure of 7.03 kg per cm^2.

2/ Touch up may be required around areas where toothed type lockwashers are located. Use additional chromate conversion coating (chemical film) applied via brush to seal outside surfaces of mechanical fasteners and all abraded areas.

TABLE VI. Compatible couples.

Group No.	Metallurgical Category	EMF (Volt)	Anodic Index (0.01 V)	Compatible Couples (see note below)
1	Gold, solid and plated; gold-platinum alloys; wrought platinum	+0.15	0	
2	Rhodium plated on silver-plated copper	+0.05	10	
3	Silver, solid or plated; high silver alloys	0	15	
4	Nickel, solid or plated; monel metal, high-nickel-copper alloys	-0.15	30	
5	Copper, solid or plated; low brasses or bronzes; silver solder; German silvery high copper-nickel alloys; nickel-chromium alloys; austenitic corrosion-resistant steels	-0.20	35	
6	Commercial yellow brasses and bronzes	-0.25	40	
7	High brasses and bronzes; naval brass; Muntz metal	-0.30	45	
8	18% chromium type corrosion-resistant steels	-0.35	50	
9	Chromium plated; tin plated; 12% chromium type corrosion-resistant steels	-0.45	60	
10	Tin-plate; terneplate; tin-lead solder	-0.50	65	
11	Lead, solid or plated; high lead alloys	-0.55	70	
12	Aluminum, wrought alloys of the 2000 Series	-0.60	75	
13	Iron, wrought, gray or malleable; plain carbon and low alloy steels, armco iron	-0.70	85	
14	Aluminum, wrought alloys other than 2000 Series aluminum, cast alloys of the silicon type	-0.75	90	
15	Aluminum, cast alloys other than silicon type; cadmium, plated and chromated	-0.80	95	
16	Hot-dip-zinc plate; galvanized steel	-1.05	120	
17	Zinc, wrought; zinc-base die-casting alloys; zinc plated	-1.10	125	
18	Magnesium & magnesium-base alloys, cast or wrought	-1.60	175	

Note: o indicates the most cathodic members of the series; ● indicates an anodic member; Arrows indicate the anodic direction.

TABLE VII. Finish selection

Class of Part	Conditions Affecting Finish Selection	Type Exposure	Applicable Finish 1/
FABRICATED FROM FERROUS ALLOYS OTHER THAN CORROSION RESISTANT STEELS			
Massive structural parts and assemblies, such as masts, tower sections, tower assemblies, van bodies, truck bodies, large brackets, gussets and assembly hardware.	Vat passivation is practical.	I	P210 thru P217.1
	Vat passivation is not practical.	I	P210.1 thru P217
	Parts have a prior hot-dip zinc (M228) and require painting for camouflage requirements.	I	P371.1 thru P373
Large bolts, nuts, washers, and similar type hardware for assembling of massive structures.	Parts will require painting after assembly	I	M224, M225, M226 M227, M228 or M229
	Parts will not require painting after assembly	I	M228 or M229
Lesser structural parts and assemblies such as racks, cases, castings, housings, panels, brackets, etc.	Vat passivation is practical.	I	P210 thru P217.1
	Vat passivation is not practical.	I	P210.1 thru P217
Ground rods, stakes, ground plates, etc.	Parts will be used in contact with soil.	I	M228 or M229
Hardened steel parts such as coil springs, flat springs, washers, etc. subject to hydrogen embrittlement.	Plating is required for protection due to equipment design.	I	Any Type I plating per Table III plus E200.
		II	Any Type II plating per Table III plus E200
Small hardware (except threaded parts) such as hinges, fasteners, catches, handles, truck corners, etc.	Parts will be exposed to view when assembled in equipment.	I	P211.1, P213.1 or P217.1
	Parts will not be exposed to view when assembled in equipment.	I	P211.1 thru P211.3 or P213.1 thru P217.1 or any Type I plating per Table III
	Parts will be painted after assembly.	I	M224, M226, or M227
	Parts will be exposed to view when assembled and cannot be painted.	I	M213

"TABLE VII. Finish selection - Continued"

Class of Part	Conditions Affecting Finish Selection	Type Exposure	Applicable Finish 1/
FABRICATED FROM FERROUS ALLOYS OTHER THAN CORROSION RESISTANT STEELS - Continued			
Small hardware (except threaded parts) such as hinges, fasteners, catches, handles, truck corners, etc. - Continued	Parts were finished with any plating, except cadmium or zinc, and require painting after assembly.	I	P341.1 thru P341.4
	Parts were plated with cadmium or zinc and require painting after assembly.	I	P371.1 or P371.2
Inside surfaces of open tubes.		I	P215
Any type of part (except threaded parts).	Parts will be subjected to temperatures in excess of 71°C and plating is desired.	I or II	Any Type I plating per Table III except cadmium or zinc
Screws, bolts, nuts and washers, and small specialty parts.	Prior to assembly in equipment.	I	Any Type I plating per Table III
	After assembly in equipment (parts were finished with any plating except cadmium or zinc) and will be exposed to view.	I	P341 thru P341.1
	After assembly in equipment (parts were plated with cadmium or zinc).	I	P371.1 or P371.2
	Parts will not be exposed to view after assembly.	I	Any Type I plating per Table III
	Parts will be exposed to view after assembly.	I	M213
Hardware such as hinges, catches, tube shield, clamps, brackets, clips screws, bolts, nuts, washers, etc.	Parts will be subjected to temperatures in excess of 71°C.	II	Any Type II plating per Table III except cadmium or zinc
	Parts will not be subjected to temperatures in excess of 71°C	II	Any Type II plating per Table III
	Parts will be in contact with uncured phenolics or subjected to phenolic vapors (see 3.7).	II	Any Type II plating per Table III except cadmium or zinc
Gears, cams, slides, etc.	Parts cannot be lubricated and will not be subjected to high bearing pressure	II	M262
	Parts cannot be lubricated and will be subjected to high bearing pressure	II	M252 or M255

"TABLE VII. Finish selection - Continued"

Class of Part	Conditions Affecting Finish Selection	Type Exposure	Applicable Finish 1/
FABRICATED FROM FERROUS ALLOYS OTHER THAN CORROSION RESISTANT STEELS - Continued			
Any type of part	An electrical conductive dissimilar metal contact is required	II	Any plating per Table III to meet Table VI
Wearing parts lubricated in service.	Parts will be oiled or greased but not during operation.	II	E211 or E213
	Parts will be splash or force-feed lubricated in operation.	II	E211 or E213
Sliding, wearing surfaces, such as guide rails, etc., requiring electrical conductivity.	Parts cannot be lubricated.	II	M252 or M255
FABRICATED FROM CORROSION-RESISTANT STEELS OR NICKEL-BASE ALLOYS			
Large parts	Parts will be exposed to view in assembled equipment.	I	P213.1 or P213.4
	Parts will not be exposed to view in assembled equipment.	I	No finish required
Small parts	Parts will be exposed to view in assembled equipment.	I	P213.1 or P213.4
	Parts will not be exposed to view in assembled equipment.	I	No finish required
Welded or machined parts made of corrosion-resistant steel.	Parts will not be exposed to view in assembled equipment	I or II	E300
Any type of part	-----	II	No finish required
FABRICATED FROM ALUMINUM-BASE ALLOYS			
Massive structural parts and assemblies such as masts, tower sections, tower assemblies, brackets, gussets, and assembly hardware.	Vat passivation is practical.	I	Any applicable paint finish per Table I
	Vat passivation is not practical.	I	P513.1, P517, P519.1 or P519.2
Smaller structural parts and assemblies such as racks, cases, castings, housings, panels, brackets, etc.	Vat passivation is practical.	I	Any applicable paint finish per Table I
	Vat passivation is not practical.	I	P513.1, P517, P519.1. or P519.2

"TABLE VII. Finish selection - Continued"

Class of Part	Conditions Affecting Finish Selection	Type Exposure	Applicable Finish 1/
FABRICATED FROM ALUMINUM-BASE ALLOYS - Continued			
Small hardware such as hinges, fasteners, catches handles, screws, nuts, bolts, washers, etc.	Parts will be exposed to view when assembled in the equipment.	I	P511 or P518.1
	Parts will be exposed to view when assembled and cannot be painted.	I	M213
	Parts will not be exposed to view when assembled in the equipment.	I	Any Type I plating per Table III or E511
Internal structural parts such as chassis, brackets, inside of panels, clamps, shields, clips, hinges, etc.	None	II	E511 or E513
	RF electrical conducting surface is required.	II	E513
	A nonconducting surface is required.	II	E511 or P517
	Plating is required for contact with dissimilar metals.	II	Any Type I plating to meet Table VI
Parts made from alloys, 1100,3003,5052, and 6061 only.	A power electrical conducting surface is required.	II	E512
Parts requiring high wear resistance such as gears, cams, slides, etc.	Parts will be subjected to high bearing pressure.	II	E514
FABRICATED FROM COPPER OR COPPER-BASE ALLOYS			
Structural parts, such as castings, housings, brackets, etc.	Parts will be exposed to view.	I	P213.1 or P213.4
	Parts will be exposed to view in assembles equipment and are made from alloys containing 40% zinc or more.	I	P213.1 or P213.4
	Parts will not be exposed to view and are made from alloys containing less than 40% zinc.	I	No finish required

"TABLE VII. Finish selection - Continued"

Class of Part	Conditions Affecting Finish Selection	Type Exposure	Applicable Finish 1/
FABRICATED FROM COPPER OR COPPER-BASE ALLOYS - Continued			
Small hardware such as hinges, springs, fasteners, catches, screws, bolts, nuts, washers, etc.	Parts will be exposed to view in assembled equipment.	I	P213.1 or P213.4
	Parts will be exposed to view in assembled equipment and painting is not practical.	I	M225, M313 or M413
	Parts will not be exposed to view in assembled equipment and are made from the alloys containing 40% zinc or more.	I	Any Type I plating per Table III
	Parts will not be exposed to view in assembled equipment and are made from alloys containing less than 40% zinc.	I	No finish required
Small specialty parts (except threaded parts) such as buckles, hooks, eyelets, bead chain, etc.	Painting is not practical	I	E311
Parts with sliding wearing surfaces that require electrical conductivity.	Part is exposed to view in assembled equipment.	I	M253
Internal parts such as chassis, brackets, inside of panels, clamps, shields, clips, hinges, springs, nuts, bolts, screws, washers, gears, cams, shafts, locks, slides, etc.	None	II	No finish required
	Painting is desired or required to provide a nonconducting surface.	II	P313, P213.1 or P213.4
	Plating is required to permit contact with a dissimilar metal.	II	Any Type I plating to meet Table VI
	Plating is required and part will be subjected to temperatures above 71°C or part will be exposed to phenolics or phenolic vapors.	II	Any Type II plating per Table III except cadmium or zinc
PLATED SURFACES REQUIRING PAINTING			
All parts	Plated with any metal except cadmium or zinc.	I	P341.1 thru P341.4
		II	P343
	Plated with cadmium or zinc.	I	P371.1 or P371.2
		II	P373

"TABLE VII. Finish selection - Continued"

Class of Part	Conditions Affecting Finish Selection	Type Exposure	Applicable Finish 1/
FABRICATED FROM ZINC-BASE ALLOYS			
All parts	None	I	P611.1, P611.2, P613.1 or P613.2
	Part is small and painting is not practical.	I	M611
	Painting is desired or required to provide a nonconducting surface.	II	P615.1, P615.2 +P611.1, P611.2, +P613.1 or +P613.2
	Parts will be subjected to temperatures in excess of 71°C.	II	M611 or any paint finish per Table I
	Parts will not be subjected to temperatures in excess of 71°C.	I	E611
	Parts will be painted after assembly.	I	E611 or E612
	Parts have prior finish (E611 or E612) and require painting.	I	P371.1 or P371.2
PARTS FABRICATED FROM MAGNESIUM-BASE ALLOYS			
All parts fabricated from zinc-bearing magnesium alloys.	None	I and II	See Table I.
All parts except those subject to flexing.	None	I and II	See Table I.
All parts except those containing zinc.	None	I and II	See Table I.
FABRICATED FROM WOOD			
All parts and assemblies	None	I or II	P911

1/ Allowable basic paint finishes (steps 1 through 3 of Table I) are prefixed with +, for example +P211. When no + is shown, it is understood that complete finishes (steps 1 through 4 of Table I) are required and finish call-out shall include the letter designation of the final film, for example P211A.

TABLE VIII. Inspection

Inspection	Requirement Paragraph	Test Paragraph
Paint Finishes		
Color	Table II	4.6.1
Type	Table II	4.1.1
Adhesion	3.15	4.6.2
Thickness	Tables I and II	4.6.3
Surface condition	3.15	4.6.5
Spectral reflectance of paint films	Table II	4.6.6
Plate Finishes		
Type	Table III	4.1.1
Thickness	Table III	4.6.3
Hydrogen embrittlement	3.10.2	4.6.4
Surface condition	3.15	4.6.5

TABLE IX. Classification of visual finish defects.

Classification	Defect
Major See Paragraph 3.15	Color of paint film not as specified. Paint film fails to pass adhesion test. Minimum total paint film thickness is 90 percent of the values specified in Tables I and II. Maximum total paint film thickness is 120 percent of the values specified in Tables I and II. Paint type not in accordance with applicable specification. Blisters, nodules, sags, orange peel, chalking, mud cracking or wrinkles in finished areas visible after assembly. Spectral reflectance out of limits. Plating metal not as specified. Plating less than 90 percent of thickness as specified in Table III. Plating peeling or flaking from underplate or basis metal. Hydrogen embrittlement of parts. Scratches, cuts, abrasions, etc. with exposure of bare metal. Gouge marks, checks, pits, burns with exposure of bare metal. Foreign debris where removal would expose bare metal.
Minor See Paragraph 3.15	Color of paint film as specified, but not within tolerance for shade, hue, or intensity (tolerance in accordance with applicable specification). Blisters, nodules, sags, orange peel, chalking, mud cracking or wrinkles in finished areas not visible after assembly.

TABLE X. Cross reference of paint film designators.

Discontinued Letters	Superseding Letters
AF	AG
C	M
F1	F
I	AG
J	AG
L	None
Q	Y
R	B
S	X
U,V,W	AG
Y	AG
Z	AI

TABLE XI. Cross reference of M Numbers.

Discontinued M Numbers	Superseding M Numbers
M215	(M218)*
M259	M222
M315	(M218)*
M415	(M218)*

* Cancelled - No Replacement

TABLE XII. Cross reference of E Numbers.

Discontinued E Number	Superseding E Number
E516	E514
E515	E514

TABLE XIII. Cross reference of P Numbers.

Amendment I	Revision A	Revision B	Revision C	Revision D
	211	211.1 thru 211.3		211.1
	212			
	213	213.1thru 213.6		213.1 or 213.4
	214			
	215J	215J		
	313	313		
	341	341.1 thru 341.4		
	342			
	343	343		
	371	371.1 or 371.2		
	373	373		
511	511	511		
	512			
513.1 or 513.3	513	513.1 or 513.2	513.1	
	514			
511 or 513.1	515	511 or 513.1		
	516			
	517	517		
510 or 518.1	518	510 or 518.1		
519.2 or 519.3	519	519.1		
510.2 or 510.3	519	510.1	510.2 or 510.3	
	611	611.1 or 611.2		
	612			
	613	613.1 or 613.2		
	614		522 Added	
	615	615.1 or 615.2		
	711	710 or 711.1		718.1 Added
	712	710.1, 710.2,		718.2 Added
		710.3, or 712.1		
	713	713.1 or 713.2		
	714	710.4 or 714.1		
	715	710.5 or 715.1		
	716	710.6, 710.7		
		710.8 or 716.1		
	717	717.1 or 717.2		
	911	911		
	912			

NUMERICAL INDEX

Paragraph		Page
SCOPE 1		
1.1	Scope	1
1.2	Conditions of applicability	1
1.3	Classification	1
2	APPLICABLE DOCUMENTS	2
2.1	Government documents	2
2.1.1	Specifications, standards, and handbooks	2
2.1.2	Other Government documents, drawings and publications	4
2.2	Non-government publications	4
2.3	Order of precedence	4
3	REQUIREMENTS	5
3.1	General	5
3.2	First article	5
3.3	Materials	5
3.4	Substitution for specified finishes, processes, or materials	5
3.4.1	"P" finishes of ferrous alloys	5
3.4.2	Plating of holes and recesses	5
3.5	Operations preparatory to application of finishes	5
3.5.1	Cut edges	5
3.5.2	Defect repair	6
3.5.3	Masking	6
3.5.4	Preparatory cleaning	6
3.5.4.1	Blasting	6
3.5.4.2	Cleaning of aluminum shelters	6
3.5.4.3	Cleaning of welded sections	6
3.5.4.4	Use of steel wool	6
3.6	Fabricated parts	6
3.7	Potential problems to be considered prior to specification of cadmium or zinc coatings	6
3.8	Use of sealants and anti-seize compounds	7
3.8.1	Threaded parts for aluminum and magnesium alloys	7
3.8.2	Openings	7
3.8.3	Sealing	7
3.8.4	Press fits	7
3.8.5	Slipfits	7
3.9	Paint finishes	8
3.9.1	Basic paint finishes, P	8
3.9.2	Final paint film	8
3.9.2.1	Epoxies	8
3.9.2.2	Film designation "AL"	8
3.9.3	Color selection of final paint film	8
3.9.3.1	Unspecified colors	9
3.9.4	Final paint film selection	9
3.9.5	Painting conditions	9
3.9.6	Welding, soldering and brazing	10
3.10	Plated finishes	10
3.10.1	Plating thickness substitution	10
3.10.2	Hydrogen-embrittlement relief	10

"NUMERICAL INDEX - Continued."

Paragraph		Page
3.10.3	High strength steel (i.e. 16.87 kg/cm^2 and up)	11
3.11	Finishes or processes other than painting or plating (E)	11
3.12	Electrical conductivity of passivated finishes	11
3.13	Intermetallic-couples	11
3.13.1	Use of compatible couples	12
3.13.2	Exceptions to Table VI	12
3.14	Finish Selection	13
3.14.1	Finishing of Type I surfaces	13
3.14.2	Finishing of Type II surfaces	14
3.14.3	Conditions restricting allowable finishes	14
3.15	Workmanship	15
4	QUALITY ASSURANCE PROVISIONS	15
4.1	Responsibility for inspection	15
4.1.1	Responsibility for compliance	15
4.1.2	Certificates	15
4.2	Classification of inspection	16
4.3	Surveillance inspection	16
4.4	First article requirements	16
4.4.1	First article inspection	16
4.4.2	Inspections to be performed	16
4.4.3	Rejection of first article samples	16
4.5	Quality conformance inspection	16
4.6	Methods of inspection	16
4.6.1	Color	16
4.6.2	Adhesion of paint	16
4.6.3	Thickness	18
4.6.4	Hydrogen embrittlement	18
4.6.5	Surface condition	18
4.6.6	Spectral reflectance	18
5	PACKAGING	18
5.1	This section is not applicable to this specification	18
6	NOTES	18
6.1	Intended use	18
6.2	Cross reference between discontinued and superseding finishes	18
6.2.1	Discontinued paint film designators	18
6.2.2	Discontinued plated, M finishes	19
6.2.3	Discontinued finishes or processes other than painting or plating, E finishes	19
6.2.4	Cross reference of basic paint finishes, P Numbers	19
6.2.5	CARC paints	19
6.2.5.1	CARC color inspection	19
6.3	Antennas	19
6.4	Corrosion and corrosion testing terms	19
6.5	Material Safety Data Sheets	19
6.6	Subject term (key word) listing	19

"NUMERICAL INDEX - Continued."

TABLES

I.	Basic paint finishes (P)	20
II.	Final paint film (step 4 of Finish Process)	28
III.	Plated finishes (M)	29
IV.	Finishes or processes other than painting or plating (E)	38
V.	Electrical conductivity of passivated finishes	41
VI.	Compatible couples	43
VII.	Finish selection	44
VIII.	Inspection	50
IX.	Classification of visual finish defects	50
X.	Cross reference of paint film designators	51
XI.	Cross reference of M Numbers	51
XII.	Cross reference of E Numbers	51
XIII.	Cross reference of P Numbers	52

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