

MIL-P-21415C (OS)
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 SUPERSEDING
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MILITARY SPECIFICATION
 PROTECTIVE FINISH AND PAINTING
 FOR POLARIS FLEET BALLISTIC MISSILE

*This specification has been approved by the Naval
 Ordnance Systems Command, Department of the Navy.*

1. SCOPE

1.1 This specification defines the requirements for protective finish and painting of fleet ballistic missile components.

2. APPLICABLE DOCUMENTS

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

SPECIFICATIONS

Federal

O-A-51	Acetone, Technical
O-T-620	Trichloroethane, 1-1-1, Technical, Inhibited (Methyl Chloroform)
QQ-A-250/4	Aluminum Alloy 2024, Plate and Sheet
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

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TT-C-490	Cleaning Methods and Pretreatment of Ferrous Surfaces for Organic Coatings
TT-E-489	Enamel, Alkyd, Gloss (For Exterior and Interior Surfaces)
TT-L-54	Lacquer; Spraying, Acid-Resistant (For Aluminum Surfaces Around Storage Batteries)
TT-P-28	Paint, Aluminum, Heat Resisting (1200° F)
TT-T-548	Toluene, Technical
UU-T-106	Tape, Pressure Sensitive Adhesive Masking Paper

Military

MIL-S-974	Surfacer, Sanding
MIL-M-3171	Magnesium Alloy, Processes for Pretreatment and Prevention of Corrosion on
MIL-S-5002	Surface Treatments and Metallic Coatings for Metal Surfaces of Weapons Systems
MIL-C-5541	Chemical Films and Chemical Film Materials for Aluminum and Aluminum Alloys
MIL-P-7962	Primer Coating, Cellulose Nitrate Modified Alkyd Type, Corrosion-Inhibiting, Fast Drying (For Spray Application Over Pretreatment Coating)
MIL-P-8116	Putty, Zinc-Chromate, General Purpose
MIL-C-8507	Coating, Wash Primer Pretreatment for Metals, Application of (For Aeronautical Use)
MIL-C-8514	Coating Compound, Metal Pretreatment, Resin-Acid
MIL-A-8625	Anodic Coatings, for Aluminum and Aluminum Alloys
MIL-C-8837	Coating, Cadmium (Vacuum Deposited)
MIL-T-10727	Tin Plating, Electrodeposited or Hot-Dipped for Ferrous and Non Ferrous Metals

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MIL-C-15705	Calking Compound (Liquid Polymer Polysulfide Synthetic Rubber, Formula No. 112, For Metal Enclosures)
MIL-P-15930	Primer Coating, Shipboard, Vinyl-Zinc Chromate (Formula No. 120 - For Hot Spray)
MIL-C-16173	Corrosion Preventive Compound, Solvent Cutback, Cold-Application
MIL-C-16232	Phosphate Coating, Heavy, Manganese or Zinc Base (For Ferrous Metals)
MIL-E-16738	Enamel, Exterior, White, Vinyl-Alkyd (Formula No. 122-82)
MIL-L-19537	Lacquer, Acrylic-Nitrocellulose, (For Aircraft Use)
MIL-L-19538	Lacquer, Acrylic-Nitrocellulose, Camouflage (For Aircraft Use)
MIL-P-23377	Primer Coating, Epoxy-Polyamide, Chemical and Solvent Resistant
MIL-C-26074	Coating, Electroless Nickel, Requirements for
MIL-M-26075	Magnesium Alloy Sheet and Plate (HK 31A)
MIL-P-26915	Primer Coating, Zinc Dust Pigmented, for Steel Surfaces
MIL-C-27227	Coating, Polyurethane, For Aircraft Application
MIL-M-45202	Magnesium Alloy, Anodic Treatment of
MIL-G-45204	Gold Plating, Electrodeposited

STANDARDS

Federal

FED-STD-151	Metals; Test Methods
FED-STD-595	Colors

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Military

MIL-STD-889 Dissimilar Metals

(Copies of specifications, standards, drawings, and publications required by suppliers in connection with specific procurement functions should be obtained from the procuring activity or as directed by the contracting officer.)

*2.2 Other publications. The following documents form a part of this specification to the extent specified herein. Unless otherwise indicated, the issue in effect on date of invitation for bids or request for proposal shall apply.

American Society for Testing and Materials (ASTM)

B 254 Electrodeposited Coatings on Steel

(Copies may be obtained from the American Society for Testing and Materials, 1916 Race Street, Philadelphia, Pa. 19103.)

Society for Automotive Engineers

AMS 2416 Nickel Cadmium Plating

AMS 2418 Copper Plating

(Application for copies should be addressed to the Society of Automotive Engineers, Inc., Two Pennsylvania Plaza, New York, N. Y. 10001.)

3. REQUIREMENTS

3.1 General. Requirements specified herein are applicable to internal and external surfaces of the fleet ballistic missile.

3.1.1 Precedence. The engineering drawing shall take precedence over this specification in case of any conflict and for applications not specified herein.

3.2 Application. Tables I, II, III, IV, and V identify the applicability of treatments and finishes, unless otherwise specified on the engineering drawing.

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Table I
PROTECTIVE SYSTEM

Material	Plating or chemical treatment	Organic treatment ¹	
		Interior	Exterior
Aluminum	Table II	No paint required unless otherwise specified on the drawing.	Table V, operations C-11 and C-17.
Magnesium	Table II	Two coats of acceptable primer, table V, operation C-4. ²	Table V, operations C-11 and C-17.
Copper and copper alloy	Table II	No paint required unless otherwise specified on the drawing.	Table V, operations C-11 and C-17.
Steel (except corrosion-resistant steel)	Table II	Parts which are plated or oiled require no further organic treatment. Parts which have no previous protective treatment and require protection shall be treated as follows: one coat pretreatment primer per table V, operation C-1, two coats of primer per operation C-4.	Table V, operations C-1, C-11, and C-17. Areas requiring adhesive bonding to painted surfaces (e.g., conduit bonding) shall also be given C-1, C-11, and C-17.
Corrosion-resistant steel	Table II	- ¹	Table V, operations C-1 and C-17. Optional schedule C-1, C-11, and C-17.
Titanium alloys	Table II	- ¹	Table V, operations C-1, C-11, and C-17
Beryllium	Table II	- ¹	Table V, operations C-1, C-11, and C-17.

See footnotes at end of table.

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Table I (contd)

Material	Plating or chemical treatment	Organic treatment ¹	
		Interior	Exterior
Nonmetallics (rubber, structural plastics, molded plastics, ceramics, graphite)	None	None required unless otherwise specified on drawings.	Table V, operations C-11 and C-17 for structural plastics, and C-17 only for untinted rubber surfaces. (For surfaces of rubber and plastic laminates, also see 3.3.1 and 3.3.2.1.)

¹ Areas requiring color and air drying use appropriate primers plus table V, operation C-17 for exterior surfaces, and appropriate primers plus operation C-13 for interior surfaces. See also 3.4.2.1.

² For abrasion resistance on interior surfaces, table V, operation C-17, shall be used in addition to the appropriate primers and pretreatments.

Table II

PLATING OR CHEMICAL TREATMENTS¹

Material	Plating or treatment	Remarks
Aluminum (chemical-film treatment shall not be used above 350° F)	1100, 300, 5052, 6061, Clad 2017, Clad 2024, Clad 7075.	Operation C-1, table V, is equivalent to table IV, T-1, T-2, or T-7 on surfaces to be primed or painted within 4 hours after operation C-1.
	All other alloys	

See footnote at end of table.

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Table II (contd)

Material	Plating or treatment	Remarks
Magnesium	Dichromate for moderate protection, table IV, operation T-9. Chrome-pickle or equivalent for electrical bonding, table IV, operation T-8. For maximum corrosion protection and abrasion resistance, anodizing shall be used, table IV, operation T-10. (See 3.7.1 and 3.7.2.)	All of these treatments require, in addition, an organic finish (see 3.7).
Copper and copper alloys	Cadmium (maximum temperature is 500° F, see 3.8.4). Table III, operations P-1 through P-4.	See 3.8.5 to 3.8.11 for other plating. See 3.8.2 for exemption.
Steel (except corrosion-resistant steel)	Cadmium (maximum temperature is 500° F, see 3.8.4). Table III, operations P-1 through P-4. Painting shall be applied over types II or III cadmium plate or, on table V, operation C-1 for type I or bare steel surfaces.	See 3.8.5 to 3.8.11 for other plating. See 3.8.2 for springs. See 3.5.1.2 and table I for parts to be painted. Zinc dust pigment primer is acceptable on hard steel surfaces where cadmium is not practicable.
Corrosion-resistant steel	Pickle or passivate, see 3.5.1.3 and 3.9. Table IV, operation T-15.	-
Titanium alloys	None required unless otherwise specified on detail or assembly drawings.	Vehicle exterior surfaces are covered in table I. For cleaning before painting, see 3.5.1.5.

See footnote at end of table.

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Table II (contd)

Material	Plating or treatment	Remarks
Beryllium	None required unless otherwise specified on detail or assembly drawings.	Vehicle exterior surfaces are covered in table I. For cleaning before painting, see 3.5.1.5.

¹The metallic surfaces obtained by plating or chemical treatment according to this table may require additional finish according to table I.

Table III

OPERATION P, METALLIC COATINGS

P-1	Cadmium plate 0.0003 inch thick minimum (bright) without chromate treatment, in accordance with the requirements of QQ-P-416, class 2, type I.
P-2	Cadmium plate 0.0003 inch thick minimum (bright) with iridescent chromate treatment, in accordance with the requirements of QQ-P-416, class 2, type II.
P-3	Cadmium plate 0.0002 inch thick minimum (bright) without chromate treatment, in accordance with the requirements of QQ-P-416, class 3, type I. Note: To be used only when external threads are to be plated.
P-4	Cadmium plate 0.0002 inch thick minimum (bright) with iridescent chromate treatment, in accordance with the requirements of QQ-P-416, class 3, type II. Note: To be used only when external threads are to be plated.
P-5	Nickel plate 0.001 inch thick minimum (bright), in accordance with the requirements of QQ-N-290, type II, class 1. Note: This is applicable for ferrous metals.
P-6	Nickel plate 0.0005 inch thick minimum (bright), in accordance with the requirements of QQ-N-290, type V, class 1. Note: This is applicable for nonferrous metals.
P-7	Nickel plate 0.003 inch thick minimum (bright), in accordance with the requirements of QQ-N-290, class 2. Note: Engineering plating; plated to specified dimensions or processed to specified dimensions after plating.

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Table III (contd)

P-9	Chromium plate 0.00002 inch thick minimum, in accordance with the requirements of QQ-C-320, class 1, type I. Note: This chromium plating shall be applied over a nickel and copper underplating. Nickel and copper (total thickness of 0.0075 inch minimum).
P-10	Chromium plate 0.002 to 0.004 inch thick, in accordance with the requirements of QQ-C-320, class 2. Note: Engineering plating; plated to specified dimensions or processed to specified dimensions after plating.
P-11	Silver plate, a flash (approximately 0.0001 inch thick) in accordance with the requirements of QQ-S-365, type III (bright), grade B (without supplementary tarnish-resistant treatment). Corrosion-resistant steel shall be activated and plated with an initial undercoat of nickel in accordance with notes 7(e), (1) and (2) of ASTM B 254. Note: This is to prevent galling and seizing of metal surfaces.
P-12	Silver plate 0.0003 inch thick minimum, in accordance with the requirements of QQ-S-365, type III (bright), grade A (with tarnish-resistant chromate treatment). This is for articles to be soldered.
P-13	Silver plate 0.0003 inch thick minimum, in accordance with the requirements of QQ-S-365, type III (bright), grade A (with tarnish-resistant chromate treatment). This silver plating shall be applied over a copper strike. (See operation P-16.) Note: This is for articles to be soldered.
P-14	Silver plate 0.001 inch thick minimum, in accordance with the requirements of QQ-S-365, type III (bright), grade A (with tarnish-resistant chromate treatment) applicable to the finished product. Note: Engineering plating; this is for increasing electrical conductivity, solderability, and for plating to specified dimensions or processing to specified dimensions after plating.
P-15	Copper plate 0.0005 to 0.0006 inch thick, in accordance with the requirements of AMS 2418.
P-16	Copper plate 0.0002 to 0.0003 inch thick minimum, in accordance with the requirements of AMS 2418. Note: To be used only when external threads are to be plated.
P-17	Electroless nickel plate 0.0004 to 0.0006 inch thick, in accordance with the requirements of MIL-C-26074, class 1. Note: This is for plating aluminum and aluminum alloys for solderability.

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Table III (contd)

P-18	Electroless nickel plate 0.0005 to 0.0007 inch thick, in accordance with the requirements of MIL-C-26074, class 1. Note: This is applicable for ferrous metals. This thickness shall not be specified for external threads.
P-19	Electroless nickel plate 0.0002 to 0.0003 inch thick, in accordance with the requirements of MIL-C-26074, class 1. Note: To be used only when external threads are to be plated.
P-20	Chromium plate, 0.001 inch thick minimum, in accordance with the requirements of QQ-C-320, class 2, over nickel plate, 0.001 to 0.002 inch thick, in accordance with the requirements of QQ-N-290, class 2. This coating is intended as protection against severe corrosion.

Table IV

OPERATION T, TREATMENTS (CHEMICAL)

T-1	Anodize, chromic-acid coating, in accordance with the requirements of MIL-A-8625, type I.
T-2	Anodize, sulfuric-acid coating, in accordance with the requirements of MIL-A-8625, type II.
T-3	Anodize, sulfuric-acid coating, in accordance with the requirements of MIL-A-8625, type II. Dyes shall be specified in similar colors as defined by FED-STD-595.
T-7	Chemical-film treatment, in accordance with the requirements of MIL-C-5541.
T-8	Chrome-pickle treatment, in accordance with the requirements of MIL-M-3171, type I. Treatment in accordance with 3.7.1 shall be equivalent for touchup or electrical bonding.
T-9	Dichromate treatment in accordance with the requirements of MIL-M-3171, type III.

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Table IV (contd)

T-10	Processed in accordance with the anodizing procedures, paragraph 6, of MIL-M-45202, type I, class C, to produce a coating of 0.0001 to 0.0005 inch thickness. The bath composition and time in table V of MIL-M-45202 shall be considered nominal values and shall be subject to practical operating tolerances inherent in normal operation. Preparation of magnesium for anodizing shall be in accordance with MIL-M-3171. Coating properties, touchup, and performance requirements are specified in 3.7.1 and 3.7.2.
T-12	Phosphate treatment, in accordance with the requirements of TT-C-490, grade I. Note: Treatment requires organic finish.
T-13	Phosphate treatment, in accordance with the requirements of MIL-P-16232, type M, class 1. Note: This treatment is applicable on bearing surfaces.
T-14	Phosphate treatment, in accordance with the requirements of MIL-P-16232, type Z, class 1. Note: This treatment is applicable on surfaces of nonmoving parts.
T-15	Pickling and passivation treatment for corrosion-resistant steel, in accordance with the requirements of MIL-S-5002: (a) Pickled after forming, if formed on a soft die (b) Passivated after abrasive cleaning (c) Passivated after final machining (see 3.5.1.3).

Table V

OPERATION C, ORGANIC COATINGS

C-1	One pretreatment coating (MIL-C-8514), applied in accordance with the requirements of MIL-C-8507. Dry film thickness 0.2 to 0.3 mil.
C-2	Use operation C-11 on parts which receive no further organic coating or on parts to be finished per operations C-14, C-15, C-16, or C-17. Either operation C-10 or C-11 shall be used on parts to be finished per operations C-12 or C-13.
C-3	Operation C-2 shall be used.
C-4	Operation C-2 shall be used.
C-5	Operation C-6 shall be used.

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Table V (contd)

C-6	Surfaces coated with rust preventive compound, MIL-C-16173, grade 1.
C-7	Two coats of black acid-resistant lacquer, TT-L-54. The normal thickness of a single, dried coat shall be 0.5 to 0.75 mil.
C-8	Surfaces shall be sealed with zinc-chromate putty, MIL-P-8116.
C-9	One coat primer, operation C-1. Two coats vinyl-zinc chromate primer, MIL-P-15930. One coat gray, vinyl, alkali-resistant paint, MIL-P-16738. Total nominal thickness, 2.5 mils.
C-10	One coat of lacquer-type primer (MIL-P-7962), air dried 1 hour minimum and 24 hours maximum when topcoated with operation C-13. Nominal dry-film thickness shall be 0.4 mil in accordance with 3.8.3.
C-11	One coat of epoxy-polyamide primer conforming to the requirements of MIL-P-23377. This primer shall have a dry-film thickness of 0.0006 to 0.0009 inch.
C-12	One coat of acrylic-nitrocellulose lacquer (MIL-L-19538). The nominal dry-film thickness shall be 0.8 mil per coat. Colors per 3.8.3.2.3.
C-13	One coat of acrylic-nitrocellulose lacquer (MIL-L-19537). The nominal dry-film thickness shall be 0.8 mil per coat, in accordance with 3.8.3. Colors per 3.8.3.2.3.
C-14	One coat of heat-resistant aluminum paint, TT-P-28. The normal thickness of a single, dried coat shall be 0.5 to 1.2 mils.
C-15	One brush or spray coat of TT-E-489, type I enamel (air drying). The coating shall be air dried at least 8 hours before handling.
C-16	One spray coat of TT-E-489, type II, enamel (low-temperature baking). The coating shall be air dried 30 minutes, followed by a 2-hour bake at 170° to 180° F.

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Table V (contd)

C-17	<p>One coat of polyurethane coating meeting the coating properties of MIL-C-27227, paragraphs 3.1, 3.2, 3.5 through 3.5.3, and 3.5.6 through 3.6; and in lieu of paragraph 3.5.4 thereof, colors are to be per FED-STD-595 as specified on the engineering drawing. All performance tests are to be performed on aluminum alloy panels conforming to QQ-A-250/4 finished per operations T-7 and C-11. The above information is to appear on all purchase orders to procure the polyurethane coating. Total thickness of exterior organic coatings aft of the equipment section shall not exceed 5.0 mils even for multiple coats resulting from touchup. Total thickness of exterior organic coatings forward of the second-stage motor case shall not exceed 3.0 mils nor cause an overweight condition in the case of the plastic-glass nose fairing. For pretreatments and primers, see tables I and II.</p>
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3.3 Application of paint-type coatings to nonmetallic surfaces.

3.3.1 Rubber surfaces of the vehicle interior and exterior surfaces of rubber which are pigmented similar to the operation C-17 finish shall not be painted unless otherwise specified.

3.3.1.1 Vehicle exterior surfaces of unpigmented rubber, other than silicone rubber, shall be carefully hand cleaned with a solvent, such as solvent conforming to O-T-620, followed by the operations given in table I. Silicone rubber on exterior surfaces shall be coated as specified by the procuring activity or shall otherwise be left bare.

3.3.2 Plastic laminates. Structural plastic parts need not be painted unless otherwise specified on the engineering drawing.

3.3.2.1 Vehicle exterior surfaces of structural plastics shall be cleaned with an effective solvent, such as solvent conforming to O-A-51 or O-T-620, wherever safety from toxicity and from flammability are required. Satisfactory aerodynamic smoothness shall be produced by the use of a sanding surfacer such as that conforming to MIL-S-974, used in accordance with recommendations of the surfacer manufacturer. Several coats shall be satisfactory if they are carefully wetsanded to smoothness and followed immediately by the operations given in table I. Constant-diameter exterior surfaces not subject to excessive skin friction shall not be required to be smoothed with surfacer, unless specified on the engineering drawing.

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3.3.3 Plastics and ceramics. Molded plastics and ceramics need not be painted, unless otherwise specified. Unless electrical or other functional reasons prohibit painting, exterior surfaces of molded plastics and ceramics shall be solvent wiped using a suitable solvent such as solvent conforming to O-T-620, followed by painting in accordance with table I. Teflon and silicone-plastic exterior surfaces need not be painted.

3.4 General precautions.3.4.1 Faying surfaces, joints, and seams.

3.4.1.1 Surfaces of similar metals. In general, faying surfaces of similar metals need not be further protected. In addition, the following surfaces shall not be painted prior to assembly:

- (a) Welded faying surfaces
- (b) Faying surfaces in assemblies which are surface treated as assemblies
- (c) Faying surfaces of seams filled with sealing compounds.

3.4.1.2 Surfaces of dissimilar metals. Provisions for further protection against electrolytic corrosion are contained in 3.4.2.1.

3.4.2 Definition of dissimilar metals. For purposes of the corrosion-protection requirements of this specification, the groupings of the more commonly used metals shall be as established by MIL-STD-889. Beryllium shall be considered as a group II metal in MIL-STD-889.

3.4.2.1 Protection against electrolytic corrosion. Where dissimilar metals are used in contact, the following methods or combinations of methods shall be employed for the alleviation of electrolytic corrosion, unless electrical considerations preclude the employment of such methods:

- (a) Interposition of a material compatible to each in order to decrease the electrolytic-potential differences (e.g., cadmium plate on steel in contact with aluminum)
- (b) Interposition of an inert material between the dissimilar metals to act as a mechanical insulating barrier (e.g., plastic gaskets between nickel-plated brass and aluminum)

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(c) Application of organic coatings to the contact faces of each of the dissimilar metals (e.g., coats of paint on steel and aluminum surfaces in contact)

(d) Application of corrosion inhibitors to the faces of each dissimilar metal (e.g., zinc-chromate paste on brass parts in contact with aluminum, and complete potting of permanent electrical bonding joints)

(e) Limitation of amount of air and moisture reaching the dissimilar metal faces (e.g., steel bolts in aluminum with all surfaces of contact sealed with zinc-dust primer, plastic films, calking compound, or equivalent)

(f) Field joints between the motor cases and mating equipment section and interstage section should be completely sealed with an effective compound such as that conforming to MIL-C-15705 and smoothed out to a distance of no less than one-fourth inch from the joint and no more than one-eighth inch thick from the outside diameter of the missile outward. Calked seams should be touched up with matching paint by use of aerosol or equivalent.

3.4.2.2 Press fits. Press fits shall be assembled using wet, zinc-chromate primer. After pressing, the edges shall be sealed with zinc-chromate primer, zinc-chromate putty compound, or other approved sealers.

3.4.3 Tubing.

3.4.3.1 Plumbing lines. No paint coating shall be applied to the interior surfaces of plumbing lines. Paint coatings shall be omitted from exterior surfaces of plumbing lines for a distance of 3 inches from each fitting.

3.4.3.2 Copper corrosion- and heat-resistant alloys. Interior and exterior surfaces of copper corrosion- and heat-resistant alloy tubing need not be painted, except as required for dissimilar-metal contact and color matching.

3.4.3.3 Steel tubing. Interior surfaces of steel tubular assemblies not entirely closed by welding shall be protected in accordance with the general schedule (tables I and II) for interior surfaces of the missile, insofar as practicable. Assemblies completely closed by welding or to which application of primer is not practicable or effective (e.g., crimped-end tubing not closed by welding or tubing heat-treated after

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assembly) shall be treated after assembly with corrosion-preventive compound conforming to MIL-C-16173, grade 1, in lieu of zinc-chromate primer coats. The compound shall be applied by forcing it into a hollow member under pressure, through holes drilled therein, or by immersing the part in a bath of the compound. The members shall be thoroughly drained after treatment and all exterior surfaces wiped free of corrosion-preventive compound. All accessible holes drilled in the member shall be closed by cadmium or zinc-plated, self-tapping screws, or equivalent.

3.4.3.4 Aluminum-alloy and magnesium-alloy tubing. Interior surfaces of structural aluminum-alloy and magnesium-alloy tubing shall be protected in accordance with the general schedule (tables I and II) for interior surfaces of the missile, insofar as practicable. The interior of the tubing sealed by welding shall be coated by corrosion-preventive compound, conforming to MIL-C-16173, grade 1, applied through appropriately drilled holes. The compound shall be applied by forcing it into a hollow member under pressure through holes drilled therein or by immersing the part in a bath of the compound. The members shall be thoroughly drained after treatment and all exterior surfaces wiped free of corrosion-preventive compound. All accessible holes drilled in the member shall be closed with cadmium or zinc-plated, self-tapping screws, or equivalent.

3.5 Preparation of metal surfaces prior to the surface treatment.

3.5.1 Special cleaning requirements.

3.5.1.1 Aluminum and its alloys. The use of uninhibited alkaline materials, such as sodium-hydroxide solutions, and the use of abrasives which accelerate corrosion of aluminum alloys, such as iron-oxide rouge or steel wool, shall be prohibited.

3.5.1.2 Carbon and low-alloy steel. Steel parts to be painted shall be cleaned and treated in accordance with TT-C-490. Exterior surfaces to be painted shall not be treated in accordance with grade I of TT-C-490, but shall be processed in accordance with tables I and II.

3.5.1.3 Corrosion- and heat-resistant alloys. The surfaces of alloy parts shall be free of scale, iron salts, foreign metals, and other contaminants that have a deleterious effect on corrosion resistance or strength properties. To accomplish this cleaning, these alloys shall be pickled or passivated in accordance with the requirements of MIL-S-5002.

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3.5.1.4 Magnesium and its alloys. Magnesium and its alloys shall be cleaned in accordance with MIL-M-3171.

3.5.1.5 Exterior metallic surfaces. Unless otherwise specified on the final assembly drawing, surfaces shall be cleaned of contaminants, using a suitable solvent, such as solvent conforming to O-T-620, immediately before priming for the final finish system. Wash primer, MIL-C-8514, shall be further primed with MIL-P-23377 epoxy primer sometime between 1 and 4 hours after application of the wash primer. Epoxy primer which has stood overnight or shows visible overspray shall be tack-ragged before final top coating; otherwise, the provisions of table V shall prevail for preparation and application of primers.

3.6 Surface treatment of aluminum and aluminum alloys.

3.6.1 Surface-treatment requirements. All aluminum and aluminum alloys to be painted shall be anodized or shall receive chemical-film treatment in accordance with table IV. All aluminum alloys except 1100, 3003, 5052, 6061, clad 2017, clad 2024, and clad 7075 shall be anodized or receive chemical-film treatment if they are to be left unpainted.

3.6.2 Nonaluminum inserts. Aluminum-alloy parts with integral non-aluminum inserts shall receive a chemical-film treatment in accordance with the requirements of MIL-C-5541.

3.6.3 Electrical parts. Only chemical film in accordance with the requirements of MIL-C-5541 shall be applied to such parts as electrical shields or chassis in which electrical conductivity over the entire surface is required up to 350° F. Aluminum parts fabricated from 1100, 3003, 5052, 6061, clad 2017, clad 2024, and clad 7075 need not be treated. All other aluminum alloys for use above 350° F and requiring conductivity shall receive a metallic coating (e.g., electroless nickel).

3.6.4 Surface treatment of assemblies. Surface treatment shall be applied prior to assembly except that fusion-welded assemblies shall be treated after welding.

3.6.4.1 Spot-welded assemblies. Spot-welded assemblies shall be anodized by using chromic acid in accordance with the requirements of MIL-A-8625, type I, or a chemical-film treatment in accordance with the requirements of MIL-C-5541.

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3.6.4.2 Copper-bearing alloys. Chromic-acid anodizing shall not be applied to alloys with a nominal copper content in excess of 5 percent (2011, 112, 113, 122, 138, and 212). Sulfuric-acid anodizing in accordance with the requirements of MIL-A-8625, type II, or treatment, in accordance with MIL-C-5541, shall be used instead of chromic-acid anodizing when the above-mentioned condition exists.

3.6.4.3 Joints and recesses. Sulfuric-acid anodizing shall not be applied to parts or assemblies that contain joints or recesses in which the anodizing solution may be retained; chromic acid should be used instead. If this also is inapplicable, the part or assembly shall not be anodized, but a chemical-film treatment shall be given instead.

3.6.5 Precautions. When the film or treated material is cut or scratched through over an appreciable area, the exposed area shall be treated with a chemical film in accordance with the requirements of MIL-C-5541 prior to painting. This operation shall not be required in the case of drilled, punched, or machine counter-sunk holes. The ends of tubing cut after surface treatment shall not require this operation.

3.7 Surface treatment of magnesium alloys.

3.7.1 Surface treatment required. Magnesium alloys shall be treated for touching up scratched surfaces and for electrical-bonding applications in accordance with the following requirements:

- (a) Treatment according to MIL-M-3171, type I, or;
- (b) A brushed, dipped, or sprayed solution of the following nominal composition:

Chromic acid, technical	1-1/3 ounce per gallon
Calcium sulfate, technical	1 ounce per gallon
Water	Balance.

Treatment according to MIL-M-3171, type III, may be used under an epoxy primer on all magnesium alloys, except those containing a high percentage of manganese (M1), those containing thorium, zirconium, and rare earths (EK30, EK41, EZ33, HK31, and HM21), and where temperatures exceed 500° F. These exceptions, and applications requiring maximum environmental resistance, shall be anodized in accordance with MIL-M-45202, as modified in table IV, T-10, and as specified in 3.7.2 and 3.7.2.4.

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3.7.2 Anodized-coating properties. In addition to the requirements specified in MIL-M-45202, type I, class C, the anodized coating shall conform to the following requirements.

3.7.2.1 Thickness. The anodized coating thickness on individual parts shall be 0.0001 to 0.0005 inch. The coating weight, as determined on separate test specimens, shall be between 450 and 2,300 milligrams per square foot.

3.7.2.2 Anodic-coating adhesion. There shall be no lifting or other damage to the anodic coating when tested with pressure-sensitive tape.

3.7.2.3 Primer adhesion on anodic coatings. There shall be no lifting or other damage to epoxy primer coating.

3.7.2.4 Salt-spray resistance. No corrosion, except for a few scattered, isolated pits or corrosion adjacent to edges, impression marks, or contact points, shall be visible after 50 hours of exposure to the salt-spray test.

3.8 Carbon and low-alloy steels, brass, bronze, copper, and nickel alloys.

3.8.1 Surface-treatment requirement. Unless otherwise specified herein or on the engineering drawing, all carbon and low-alloy steel, brass, bronze, copper, and nickel-alloy parts shall be cadmium plated. See 3.8.2 for the exemptions to plating.

3.8.1.1 Threaded parts. Unless otherwise specified on the engineering drawings, the minimum thickness of metallic coatings on externally threaded parts shall be 0.0002 inch.

3.8.2 Exemptions from electroplating requirements. The exemptions from electroplating requirements are as follows:

(a) Only those areas of brass, bronze, copper, and nickel-alloy parts that are to be in contact with aluminum, aluminum alloy, beryllium, or magnesium shall be plated.

(b) Sintered bearings of the oil-impregnated type shall not be plated.

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(c) Parts need not be plated when welded to a structure that is not to be plated.

(d) Parts that cannot be thoroughly cleaned to ensure removal of the plating solution shall not be plated.

(e) Cables and tinned wire shall not be plated after fabrication.

(f) No plating shall be required on portions of members that act as bearings or journals, or where plating would interfere with proper functioning of the part. If protection against corrosion is required, the surfaces shall be coated with preservative in accordance with the requirements of the engineering drawing.

(g) Parts to be enclosed in or operated in grease, lubrication oil, or hydraulic oil need not be plated.

(h) Parts on which other protective coatings, such as paints or oils, are to be applied, as noted herein, need not be cadmium plated.

(i) Springs that are closely coiled, thereby preventing the application of plating to internal surfaces, shall be coated with corrosion-preventive compound conforming to MIL-C-16173, grade 1.

3.8.3 Organic coatings. Unless otherwise specified herein or on the engineering drawing, parts which cannot be plated for corrosion protection because of their size, shape, cost, or function shall be given an organic coating (i.e., paints, greases, or corrosion-preventive compound). Surfaces shall be processed and painted in detail as specified herein, except that exterior surfaces of completed assemblies shall, and interior surfaces may, receive a finish coating after assembly. Thickness requirements for coatings listed under table V shall apply only to large, flat, or gently contoured surfaces on production hardware and to test panels, but these requirements shall not be invoked on small parts, corners, edges, sharply contoured surfaces, in holes, or other surfaces not normally tested for paint thickness by nondestructive methods. On the latter surfaces, paint and primer-coating thickness shall be held to a minimum consistent with complete coverage and best corrosion protection. For such irregular surfaces, only visual inspection for color matching and complete coverage of top coats shall be required.

3.8.3.1 Exceptions from painting. The following parts shall be excepted from painting:

(a) Sintered bearings of the oil-impregnated type shall not be painted.

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(b) Cables and tinned wire shall not be painted after fabrication.

(c) No painting shall be required on portions of members that act as bearings or journals, or where paint would interfere with proper functioning of the part.

(d) Parts to be enclosed in or operating in grease, lubricating oil, or hydraulic oil need not be painted.

3.8.3.2 Special areas.

3.8.3.2.1 Acid spillage. Surfaces within 12 inches of storage batteries and subject to acid spillage or spray shall be painted with two coats of black acid-resistant lacquer, in accordance with the requirements of TT-L-54, applied over an epoxy primer, operations C-4 and C-7, table V.

3.8.3.2.2 Alkali spillage. Surfaces within 12 inches of storage batteries and subject to alkali spillage or spray shall be painted with one coat of alkali-resistant vinyl paint, in accordance with the requirements of MIL-P-16738, applied over vinyl zinc-chromate primer, operation C-9, table V.

3.8.3.2.3 Colors. Colors of organic coatings shall be as specified by the engineering drawings, in accordance with the definitions of FED-STD-595.

3.8.3.3 Touchup. Touchup painting should be held to a minimum consistent with good workmanship practices. All attaching parts and small damaged paint areas shall be touched up after installation and assembly using the general top-coat finish schedule (tables I and II). Top coats may be applied over primer for better color matching with adjacent surfaces. Aerosols containing the materials specified in tables I and II shall be an acceptable means of touchup over these small areas.

3.8.4 Cadmium plating. Cadmium plating shall be in accordance with the requirements of QQ-P-416. Cadmium plating shall not be used if the plated part is subjected to a temperature of 500° F or higher. Type II treatment (chromate treatment) on cadmium plating shall not be used if the plated part is subjected to a temperature of 300° F or higher. When the temperature encountered shall be above 300° F, type I (without chromate treatment) cadmium-plate treatment shall be specified. Zinc primer, MIL-P-26915, type I, on bare steel shall be an acceptable substitute for cadmium up to 200° F.

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3.8.4.1 All steels hardened to 220,000 pounds per square inch or above shall be processed to the requirements of MIL-C-8837.

3.8.5 Chromium plating. Chromium plating of surfaces shall be undertaken only where it is necessary to take advantage of the superior abrasion or wear resistance of chromium as compared with cadmium plating or to prevent soft solder from adhering. Where chromium plating is specified, it shall be such as to produce coatings in accordance with the requirements of QQ-C-320.

3.8.6 Nickel plating. Nickel plating shall be used for corrosion protection only in high-temperature applications where cadmium plating would not be suitable or to minimize the effect of dissimilar-metal contacts. Electroless nickel may be used if a uniform thickness of coating is required and on aluminum and aluminum alloys to provide solderability. Where nickel plating of parts or surfaces is specified, it shall be such as to produce coatings in accordance with the requirements of MIL-C-26074.

3.8.7 Tin plating. Tin plating shall be used only where the properties of the material present distinct advantages, for the purpose intended, as compared with the use of cadmium coating for the same application. A plating of tin should be used in lieu of cadmium on parts that are to be subsequently soldered. Where tin plating is specified, it shall be applied so as to produce coatings in accordance with the requirements of MIL-T-10727. On copper-base alloys, a 0.0003-inch minimum of tin shall be required where solder is to be applied.

3.8.8 Phosphate treatments. Phosphate treatment, in accordance with the requirements of MIL-P-16232, may be substituted for cadmium plating on those ferrous parts that are subsequently to be finished with non-drying petroleum oils containing corrosion inhibitors. Treatment in accordance with the requirements of TT-C-490 may be substituted for cadmium plating on those ferrous parts that are to be painted.

3.8.9 Silver plating. Silver plating shall be used on electrical contacts and in other applications where the electrical properties and solderability of silver are required. When silver plating is specified, it shall be such as to produce coatings in accordance with the requirements of QQ-S-365, including 3.4.4 therein. Tarnish-resistant, solder-through coatings shall be employed to preserve the bright silver finish, in addition to the wrapping or packaging required by the provisions of QQ-S-365, paragraph 6.5.

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3.8.10 Gold plating. Gold plating may be used on electrical contacts and other applications where the electrical, corrosion-resistance properties of gold are desired. When gold plating is employed, it shall be in accordance with an approved specification, such as MIL-G-45204, except that the composition requirements of paragraph 3.1 of MIL-G-45204 may be different if the other provisions of the specification are met.

3.8.11 Copper plating. Copper plating may be used on ferrous and nonferrous metals (except aluminum and magnesium), zinc-based die castings, and printed-circuit boards. Copper plating may be used for increasing the electrical conductivity of poor conductors, as a filler material in copper furnace brazing, and as a protective coat prior to heat treatment. When copper plating is specified, it shall be such as to produce coatings in accordance with the requirements of AMS 2418.

3.8.12 Nickel-cadmium diffused coating applied in accordance with AMS 2416 is acceptable for surfaces requiring corrosion protection and operating up to 1,000° F.

3.9 Finish for corrosion- and heat-resistant steels and alloys.

3.9.1 Surface treatment, plating. Corrosion- and heat-resistant alloys need not be plated unless it is necessary for the proper functioning of the part or for dissimilar-metals protection.

4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for inspection. Unless otherwise specified in the contract or purchase order, the supplier is responsible for the performance of all inspection requirements as specified herein. Except as otherwise specified in the contract or order, the supplier may use his own or any other facilities suitable for the performance of the inspection requirements specified herein, unless disapproved by the Government. The Government reserves the right to perform any of the inspections set forth in this specification where such inspections are deemed necessary to assure supplies and services conform to prescribed requirements.

4.2 Classification of tests on anodized magnesium.

4.2.1 Qualification. Anodized magnesium coatings, for the qualification of the process, shall be tested for thickness, salt-spray resistance, and adhesion, as specified herein.

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4.2.2 Process control. Process control, after qualification, shall consist of the thickness and coating-adhesion tests only as necessary for positive quality control. Salt-spray and paint-adhesion tests, after initial qualification requirements are met, shall be required only as necessary but in no event shall the interval between tests exceed 3 months.

4.3 Test methods.

4.3.1 Thickness. The coating thickness on individual parts shall be determined by nondestructive testing methods, using a properly calibrated instrument based on the eddy-current principle. The coating weight, as determined on separate test panels, may be substituted for thickness determinations. If the coating-weight method is used, weight determinations shall be made on an equivalent alloy, as necessary, processed concurrently with the production part.

4.3.2 Adhesion. The adhesion of anodized coatings shall be determined each day by tape testing of production parts. Tape, conforming to UU-T-106, type II, shall be firmly applied to a clean, anodized coating and then removed abruptly. The coating shall then be visually examined for damage.

4.3.3 Paint adhesion. Anodized surfaces to be examined for paint adhesion shall be coated with one coat of epoxy primer as specified in table V, operation C-2. The tape test shall be performed as specified in 4.3.2.

4.3.4 Salt-spray resistance. Salt-spray-resistance tests shall be conducted on anodized test panels of HK31 alloy, MIL-M-26075. The test shall be performed in accordance with FED-STD-151, method 811, except that the significant surface of exposure shall be approximately 6° from the vertical. Significant areas shall not include areas adjacent to edges, impression marks, or contact points.

4.4 Previous acceptance or approval of material in the course of manufacture shall in no case be construed as a guarantee of the acceptance of the finished product.

4.5 In-process control of organic-coating thickness shall be accomplished by the most appropriate of the following methods:

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(a) Color standards, properly prepared and calibrated for thickness versus color

(b) A nondestructive thickness tester, properly calibrated for reasonably similar base materials and coatings

(c) The difference in thickness from direct micrometer measurements.

4.5.1 Panels no smaller than 4 by 10 inches, when coated concurrently and under the same general conditions as used on hardware, shall be acceptable as test surfaces in lieu of the actual tactical surface.

5. PREPARATION FOR DELIVERY

5.1 To prevent damage to the coatings, finished surfaces shall not be packaged for shipment until satisfactorily cured.

6. NOTES

6.1 Hermetically sealed units. Materials or parts inside hermetically sealed units do not require surface protection; however, if protection is used, it shall be in accordance with this specification.

6.2 Definitions.

6.2.1 Exterior surfaces. Surfaces forming the exterior of the missile, after all doors, hatches, etc., are closed, shall be considered as exterior surfaces. The aft end is not considered part of the exterior surface for the purposes listed herein.

6.2.2 Nominal thickness. Nominal thickness for primers allows a tolerance of 0.3 mil and, for top coats, 0.4 mil per coat, unless otherwise specified herein.

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(Project No. MFFP-N 068)

SPECIFICATION ANALYSIS SHEET		Form Approved Budget Bureau No. 22-R255
<p>INSTRUCTIONS: This sheet is to be filled out by personnel, either Government or contractor, involved in the use of the specification in procurement of products for ultimate use by the Department of Defense. This sheet is provided for obtaining information on the use of this specification which will insure that suitable products can be procured with a minimum amount of delay and at the least cost. Comments and the return of this form will be appreciated. Fold on lines on reverse side, staple in corner, and send to preparing activity. Comments and suggestions submitted on this form do not constitute or imply authorization to waive any portion of the referenced document(s) or serve to amend contractual requirements.</p>		
<p>SPECIFICATION MIL-P-21415C (OS), Protective Finish and Painting for Polaris Fleet Ballistic Missile</p>		
ORGANIZATION		
CITY AND STATE		CONTRACT NUMBER
<p>MATERIAL PROCURED UNDER A <input type="checkbox"/> DIRECT GOVERNMENT CONTRACT <input type="checkbox"/> SUBCONTRACT</p>		
<p>1. HAS ANY PART OF THE SPECIFICATION CREATED PROBLEMS OR REQUIRED INTERPRETATION IN PROCUREMENT USE? A. GIVE PARAGRAPH NUMBER AND WORDING.</p>		
<p>B. RECOMMENDATIONS FOR CORRECTING THE DEFICIENCIES</p>		
<p>2. COMMENTS ON ANY SPECIFICATION REQUIREMENT CONSIDERED TOO RIGID</p>		
<p>3. IS THE SPECIFICATION RESTRICTIVE? <input type="checkbox"/> YES <input type="checkbox"/> NO (If "yes", in what way?)</p>		
<p>4. REMARKS (Attach any pertinent data which may be of use in improving this specification. If there are additional papers, attach to form and place both in an envelope addressed to preparing activity)</p>		
SUBMITTED BY (Printed or typed name and activity - Optional)		DATE

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