MILITARY SPECIFICATION

COATING SYSTEM, POLYURETHANE, ALIPHATIC, WEATHER RESISTANT: PROCESS FOR APPLICATION OF

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

1. SCOPE

1.1 Scope. This specification covers procedures for the application of polyurethane coating systems on interior and exterior surfaces of weapons systems or military equipment.

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-T-620	Trichloroethane-1, 1, 1, Technical, Inhibited (Methyl Chloroform)
BB-A-1034	Air, Compressed, For Breathing Purposes
TT-E-489	Enamel, Alkyd, Gloss (For Exterior and Interior Surfaces)
TT-E-527	Enamel, Alkyd, Lustreless
TT-L-20	Lacquer, Camouflage
TT-L-32	Lacquer, Cellulose Nitrate, Gloss, for Aircraft Use

SPECIFICATIONS

Federal (Continued)

TT-M-261	Methyl-ethyl-Ketone (For Use in Organic Coatings)
TT-P-320	Pigment, Aluminum, Powder and Paste, for Paint

Military

MIL-F-7179	Finishes and Coatings, General Specification for Protection of Aerospace Weapons Systems, Structures and Parts
MIL-L-7808	Lubricating Oil, Aircraft Turbine Engine, Synthetic Base
MIL-F-18264	Finishes, Organic, Weapons System, Application and Control of
MIL-T-19544	Thinner, Acrylic-Nitrocellulose Lacquer
MIL-T-19588	Toluene-Methyl Isobutyl Ketone Mixture
MIL-C-22751	Coating System, Epoxy-Polyamide, Chemical and Solvent Resistant: Process For Application of
MIL-P-23377	Primer Coating, Epoxy Polyamide, Chemical and Solvent Resistant
MIL-L-23699	Lubricating Oil, Aircraft Turbine Engines, Synthetic Base
MIL-P-38477	Plastic Material, Pressure Sensitive, For Aircraft Identification and Marking
MIL-M-43719	Marking Materials and Markers, Adhesive, Elastomeric, Pigmented; General Specification for
MIL-R-81294	Remover, Paint, Epoxy Systems
MIL-L-81352	Lacquer, Acrylic (for Naval Weapons Systems)
MIL-T-81772	Thinner, Aliphatic Polyurethane Coating

SPECIFICATIONS

Military (Continued)

MIL-C-81773	Coating, Polyurethane, Aliphatic, Weather Resistant

PUBLICATIONS

Naval Air Systems Command

NAVAIR 07-1-503	Cleaning Materials for Naval Air Systems Maintenance and Overhaul Operations

(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.

Pamphlet G-7	Compressed Air for Human Respiration
Specification G-7.1	Commodity Specification for Air

(Application for copies should be addressed to the Compressed Gas Association, 500 Fifth Avenue, New York, N.Y. 10036.)

3. MATERIAL AND EQUIPMENT

3.1 Polyurethane paint system. The polyurethane paint system shall consist of epoxy-polyamide primer conforming to MIL-P-23377, and aliphatic polyurethane topcoat conforming to MIL-C-81773. Paint materials shall be brought to room temperature (65 to 95° F) before use.

3.2 Primer (Mixing and thinning instructions). Epoxy-polyamide primer, MIL-P-23377, consists of two components, Component I, the pigmented portion, and Component II, the clear hardener. Each component shall be thoroughly stirred or shaken until uniformly mixed before combining. When mixing both components, Component II shall always be added to Component I in equal volume ratios. Add approximately 1-1/2 volumes of MIL-T-19588 thinner (equal volumes of methyl-isobutyl-Ketone and toluol) or MIL-T-19544 thinner for every two volumes of primer to an approximate viscosity of 16 to 19 seconds in a No. 2 Zahn cup. The mixture shall be thoroughly stirred, strained to remove coarse particles, and then allowed to stand at room temperature for one hour before use.

3.3 Top coat (Mixing and thinning instructions). Aliphatic polyurethane topcoat, MIL-C-81773, is a two component material consisting of 4 volumes of a pigmented portion, Component I, and one volume of a clear hardener, Component II. Thoroughly stir or shake each component vigorously until uniformly mixed. Then, slowly add Component II to Component I with thorough stirring and allow to stand 20 to 30 minutes; then adjust the viscosity with solvent conforming to MIL-T-81772 to a No. 2 Zahn viscosity of approximately 16 to 18 seconds at 70° F (See 3.3.3) when using conventional airspray equipment. Strain the admixture to remove coarse particles. Additional MIL-T-81772 thinner may be used to reduce the viscosity further for spraying in warm and humid weather (about 80° F or higher). Under higher heat and humid conditions, 25 percent of MIL-T-81772 thinner should be replaced with cellosolve acetate (Urethane Grade) to promote better flow. In addition, if needed, for still better flow, a maximum of 8 ounces (1/4 quart) of cyclohexanone replacing an equal volume of the cellosolve acetate per gallon of the mixed thinned coating may be used. The viscosity of the admixture when used with airless spray equipment should be adjusted as recommended by the equipment manufacturer.

3.3.1 Preparation of aluminum polyurethane coating. Prepare a mixture of eleven ounces by weight of aluminum powder conforming to TT-P-320, Type I, Class A in 5 fluid ounces of thinner conforming to MIL-T-81772 and incorporate in 1 gallon of clear admixed polyurethane coating.

3.3.2 Precautions.

1. Safety goggles should be worn when opening shipping cartons and cans. Excessive moisture in Component II cans will produce CO_2 and the contents may be under pressure.

2. Remove any bulged cans from the cartons with caution.

3. Discard Component II if can is bulged (do not open) or material is not clear or homogeneous.

4. Open Component II cautiously with the face away from the lid.

5. Mix only that amount which can be used immediately to avoid gelation in the pot.

6. Components are not interchangeable: For example, Component II hardener from one manufacturer may not be used with Component I from a different manufacturer even though both components have the same color number. Likewise, a Component II hardener of one color shall not be used with a different color Component I even though they are from the same manufacturer.

7. Do not contaminate Components I and II with alcohol or water.

8. Keep containers closed when not in use.

9. Wash hands before eating and smoking.

10. Allow materials to come to room temperature before using.

3.3.3 Comparison of equivalent viscosities and cups. The following comparison is intended only as a guide for use in the thinning operation of the coating system.

Cup	Viscosity (Seconds) at 70-75°F
Zahn No. 2	16-18
Zahn No. 1	30-40
Ford No. 3	16-22
Ford No. 4	11-14

3.4 Pot life.

3.4.1 Epoxy-primer. The primer is a reactive material which slowly increases in viscosity with time. Therefore, only necessary quantities for production needs should be mixed to minimize waste.

3.4.2 Polyurethane topcoat. It is recommended that only enough topcoat be admixed for immediate use, preferably for less than 4 hours. A lower gloss may result with admixed coating which has been allowed to age more than 4 hours even when the material is still within spray viscosity. Note that the viscosity will increase more rapidly at higher temperatures. To minimize this temperature-rate effect, the lowest practicable spraying viscosity will be found helpful.

3.5 Spray equipment. Spray guns, air or airless, accessories, and lines shall be kept clean. Equipment for polyurethane topcoat should be thoroughly cleaned before and after use with methyl-ethyl-ketone conforming to TT-M-261, or if not available, thinner conforming to MIL-T-81772 may be used. Foreign matter in spray equipment may cause polyurethane to crater. Cleanliness must be exercised at all times since once cured, the polyurethane system becomes difficult to dissolve. Equipment used with primer should be cleaned out with the applicable thinner after use. The use of airless spray will reduce overspray and thereby reduce the quantity of material used.

4. PROCEDURES AND OPERATIONS

4.1 Preparation of metal surfaces. Unless otherwise specified, metal surfaces shall have been surface treated before assembly and shall have received the requisite primer and insulating coatings between faying surfaces in accordance with the requirements of MIL-F-7179. Final treatment prior to painting with the polyurethane paint system shall be in accordance with the requirements of MIL-F-18264 and related Naval Air Systems Command Chart NAVAIR-07-1-503. Procedures for masking, cleaning, water-break test, and the treatment of aluminum, magnesium, and corrosion resistant steel surfaces necessary for the application of the epoxy primer, are specified in MIL-C-22751.

4.2 Application of primer. After the surface has been properly prepared and masked as required in 4.1, apply the epoxy primer to a dry film thickness of 0.6 to 0.9 mil (exclusive of wash primer if used) and allow to air dry for about one hour. The temperature of the surface to be painted and the ambient temperature should be between 65° and 95° F. For temperatures below 70° F, allow the primer coat to air dry approximately 2 hours. If necessary, sand lightly with 400 - grit sandpaper or Kraft paper to remove roughness or overspray, otherwise the rough surface of the primer may result in a marginal gloss of the polyurethane topcoat. Wipe the area with a suitable tack rag to remove sanding dust.

4.3 Application of polyurethane topcoat. Apply a thin wet coat approximately 0.6 mil and allow to air dry for 15-45 minutes (preferably 45). Do not apply a dry mist coat since it will cause a final low gloss due to the rough surface. Follow with a wet coat to form a total dry topcoat film thickness of 1.0 to 1.5 mil (total dry film thickness of 2.0-2.4 mils for the coating system). For Insignia White, a topcoat film thickness of 2.0 mils may be necessary to obtain good hiding.

4.3.1 Leading edges. In order to increase erosion resistance on leading edges, about 4-5 mils thickness of topcoat should be applied. To avoid the possibility of formation of blisters and bubbles in the thicker coatings particularly when applied under hot, humid conditions, the drying time between coats should be increased as necessary. Application of the extra coats before the regular paint coats will avoid overspray on the balance of the aircraft.

4.3.2 Drying time. The appropriate drying time of the polyurethane finish is shown in Table I. Wet tape adhesion tests shall be made in accordance with MIL-F-18264 to assure the maintenance of a satisfactory level of adhesion.

TABLE I. DRYING TIME 3/

1/ 2/	Hours at 70° F
Dust Free 2/	1/2
Dry to tape 2/	6
Dry hard 2/	8
Water resistant	24
Oil resistant	72
Aircraft ready for outdoors	48-72

1/ Drying time may be accelerated by holding in a warm atmosphere (90 to 100° F)

2/ Flat colors usually dry 25-50 percent faster than gloss colors.

3/ Below 50° F, drying times may be more than doubled.

4.3.3 Precautions. In addition to the precautions specified in 3.3.1, personnel should comply with the following precautions in applying the material:

a. Containers should be closed when not in use. Partially used containers more than several days old should be discarded.

b. Clean spray equipment thoroughly before and after using polyurethane paint with methyl-ethyl-ketone conforming to TT-M-261. When MEK is not available, use thinner conforming to MIL-T-81772.

c. Polyurethane paint left in any spray equipment overnight may solidify.

d. Polyurethane overspray is greater than with epoxy-polyamide topcoat. Airless spray is recommended to reduce overspray. Protective measures should be taken for surfaces already painted.

e. Good housekeeping to minimize airborne particles is essential since surface contamination is more evident in the extremely high gloss polyurethane.

4.4 Toxicity. Vapors from Component II and the overspray from the admixed polyurethane paint are irritating to the membranes of the eyes, nose and throat. They may also produce an allergic sensitization characterized by breathing difficulty, non-productive cough and shortness of breath. Painters experiencing any of these symptoms should be removed from the job and referred to competent medical authority. When industrial hygiene personnel are available, polyurethane

application shall be accomplished using the protective equipment and precautionary measures prescribed by the Industrial Hygienist. When industrial hygiene personnel are not available, the following measures shall be enforced:

a. Isolate the spray painting operations to prevent exposure of unprotected personnel to overspray and solvent vapor. Ensure that spray mist and vapors do not drift into adjacent work areas or spaces. Allow a 20 minute period following termination of the spray painting operation before unprotected personnel are permitted to re-enter the isolation area. Forced ventilation spaces should be vented away from work areas or pedestrian traffic areas.

b. Painters when mixing and spraying polyurethane paints shall wear a U.S. Bureau of Mines approved continuous flow class air-line respirator with full face piece. In addition, close attention shall be given to the quality of the compressed air used for breathing. The quality of compressed air for breathing purposes is established by BB-A-1034 and recommended safety guide lines are contained in Compressed Gas Association Specification G-7.1 and pamphlet G-7. Safety precautions for utilization of industrial compressed air systems for supplying air for breathing purposes are specified in 4.4.1.

c. Solvent resistant gauntlet style gloves shall be worn by personnel engaged in the mixing and application of polyurethane paint. Spray painters shall be fully clothed with collars buttoned and sleeves taped at the wrists.

d. Personnel applying unthinned polyurethane coatings with a brush or roller to small areas for touch-up purposes where spray application is not indicated, may wear an organic vapor cartridge respirator in lieu of the air-line respirator.

4.4.1 Safety precautions for industrial compressed air systems. The safety precautions, procedures and equipment required on industrial compressed air systems supplying air for breathing purposes shall be as follows:

a. Locate all compressor air intakes where fumes, exhaust gases and other air contaminants will not enter the compressor.

b. Install continuous carbon monoxide detection equipment in output headers or accumulator tanks of all compressor plants. The detection device shall be installed to sound an alarm, shut down the compressor plant, and vent the system to atmosphere when the air supply has an unacceptable concentration of carbon monoxide. The alarm setting of the detection device shall not exceed 50PPM. An acceptable CO alarm is Mine Safety Appliances (MSA Model-701).

c. Install high temperature air detector device in the discharge header of oil-lubricated compressors to shut down compressor and sound an alarm should the air temperature exceed 275° F.

d. Install inspection plates in discharge headers to facilitate regular inspections for accumulation of impurities.

e. Install appropriate trap and filter in the air supply line ahead of the mask to separate water, oil, scale or other extraneous matter from the air stream.

f. Install a pressure relief valve and gauge in the line to prevent high pressure air from reaching the user, should the pressure regulator fail.

g. Maintain minimum rate of oil feed to cylinders consistent with equipment requirements.

h. Establish regular and frequent inspection and cleaning schedules for all lines, with particular emphasis on low sections or pockets which cannot be eliminated by piping changes.

i. Establish regular and frequent laboratory or field analysis of air samples from compressors and representative use points in the air system for conformance with BB-A-1034.

j. Encourage the selection of axial compressors for equipment replacement or system expansions.

k. Aftercoolers or condensers should have the capacity to cool the compressed air to a temperature at or very near any minimum anticipated air line temperature to prevent additional condensation of water and oil vapors throughout the distribution system.

l. In special hazardous areas, it is desirable that blasters and painters be equipped with two-way communications face masks to provide contact with people outside the immediate work area.

m. At all times, there shall be an experienced, competent and reliable person on duty at the air control valves as a guage tender to insure the proper supply of air to hazardous working areas.

5. GENERAL PROCEDURES AND OPERATIONS

5.1 Identification of coating system. The paint system applied shall be identified in accordance with MIL-F-18264 for aircraft. Items other than aircraft shall be marked as required by the procuring activity.

5.2 Insignia and marking applications.

5.2.1 Decals. Decals made from plastic material conforming to MIL-P-38477 may be applied either over primer or polyurethane topcoat. Decals made from MIL-P-38477 are resistant to diester lubricants. Decals made of Type I, Class 1 material conforming to MIL-M-43719 are applied only over the polyurethane finish. These decals are not resistant to diester lubricants.

5.2.2 Alkyd enamels. Enamels conforming to TT-E-489 or TT-E-527 may be applied on polyurethane finish. These enamels are moderately resistant to diester lubricants.

5.2.3 Polyurethane paint. Polyurethane paint conforming to MIL-C-81773, in addition to being used as the paint finish, may be used for insignia and markings. It may be applied over the epoxy-polyamide primer or over the polyurethane finish coat. Polyurethane paint is resistant to diester lubricants.

5.2.4 Acrylic lacquer. Acrylic lacquer conforming to MIL-L-81352 is applied only over a thin tie coat of primer, MIL-P-23377 on the polyurethane finish. This lacquer is resistant to diester lubricants.

5.2.5 Cellulose nitrate lacquers. Gloss lacquer conforming to TT-L-32 and camouflage lacquer conforming to TT-L-20 can be applied to surfaces which have been recently painted (2-3 days). Neither lacquer is resistant to diester lubricants.

5.2.6 Squadron markings. After receipt of aircraft from the contractor or Naval Air Rework Facility, squadron markings may be applied as specified in 5.2.1 thru 5.2.5. The marking areas shall be thoroughly wet sanded with No. 400 sandpaper, dust removed, and cleaned with solvent before applying any of the above markings. The most convenient marking material for squadron markings is camouflage lacquer conforming to TT-L-20 or gloss lacquer conforming to TT-L-32. These materials should not be used on surface areas subject to spillage of diester lubricants since these lubricants will soften either lacquer.

5.3 Overpainting. The following procedure will apply to Weapon Systems which have been determined suitable for overpainting:

a. Clean exterior surfaces.

b. Remove all exterior decals and markings on areas which received touch-up and which show evidence of poor adhesion.

c. Sand all surfaces with No. 400 aluminum oxide paper or pads. Feather all irregularities of the old finish. Efforts should be made to remove as much loose, adherent or seriously deteriorated existing finish as possible, without exposing bare metal.

d. Remove sanded residue with tack rags and wash surfaces with a suitable solvent using lint free cloth. Apply chemical treatment to all bare metal surfaces. Prime all bare spots on the aircraft with epoxy primer MIL-C-23377.

e. Aircraft requiring extensive touch-up painting should have touch-up extended to the nearest seam to avoid a spotty appearance. Adjacent areas should be masked off to eliminate overspray.

f. Apply one even coat of epoxy-primer, MIL-P-23377, and allow to air dry for about one hour.

g. Apply a light even coat of polyurethane paint; allow this thin coat to dry for approximately 30 minutes and then apply a final full wet topcoat. Any residue left by masking shall be removed with safety solvent conforming to O-T-620.

5.4 Repairs. The following procedures are suggested for repairing minor paint damage before delivery:

a. Feather the edges of the damaged paint using 320 or finer abrasive paper or pads wet with toluene. Remove sanding residues.

b. If there is only a fine scratch in the top coat, apply the admixed but unthinned polyurethane paint with a fine brush. For scratches down to metal surfaces, surface treat and prime before topcoating.

c. If the damaged area is larger than a scratch, apply thinned coatings by spraying.

d. Following repair to the immediate damaged area, blend the repair by spraying polyurethane paint thinned with 90 percent thinner over a broader area surrounding the repair.

5.5 Practice panels. Prior to application of polyurethane paint to aircraft, it is necessary that trial applications be made to practice panels in order to familiarize personnel with characteristics of the supplier's paint; e.g., spraying properties, drying time, masking time, surface appearance and color. Panels should be coated with primer since some topcoats which have excellent appearance applied over smooth, inert surfaces have a definite loss in gloss and show irregularities when applied over primer.

5.6 Quality control. The final finish shall meet the adhesion and smoothness requirements of MIL-F-18264.

6. NOTES

6.1 Intended use. The polyurethane coating system is used primarily for the protection of exterior surfaces of naval aircraft. The paint system has excellent color and gloss retention, resists chalking after weathering and offers protection of areas exposed to chemicals and solvents. It is recommended for use on other military equipment exposed to similar conditions.

6.2 Stripping. Air dried polyurethane finishes can be stripped with paint remover conforming to MIL-R-81294. Polyurethane finish can also be removed with this compound provided the coating has not been subjected to temperatures over 250° F for prolonged periods. The substrate will also be a determining factor in the ease of stripping. Polyurethane finish on porous surfaces which afford good to excellent adhesion may be difficult to strip. In general, removal of the polyurethane topcoat should present no problem, however, some primer residues may remain on porous or previously heated areas, requiring multiple applications with scrubbing for more complete removal.

6.3 Diester lubricants. Polyurethane finishes afford good resistance to diester lubricants conforming to MIL-L-7808 or MIL-L-23699. However, prolonged contact by these lubricants may cause discoloration (darkening) of the surface. Resistance to phosphate ester lubricants is not, however, a requirement.

6.4 Numerical index. Applicable data and procedures referenced to appropriate paragraphs of this specification are outlined in Table II.

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