

MIL-C-85285A(AS)

7 July 1987

SUPERSEDING

MIL-C-85285(AS)

4 December 1978

MILITARY SPECIFICATION

COATING: POLYURETHANE, HIGH-SOLIDS

This specification is approved for use within the Naval Air Systems Command, Department of the Navy, and is available for use by all Departments and Agencies of the Department of Defense.

1. SCOPE

1.1 Scope. This specification covers the requirements for a two-component, flexible, weather-resistant, aliphatic polyurethane coating with a maximum volatile organic compounds (VOC) content of 420 grams/liter as applied. The coating shall be furnished as a kit.

1.2 Classification.

1.2.1 Part numbers. Part numbers for cataloging purposes under this specification are coded as follows:

M85285	XXXXX	-X
Applicable specification identifier	Color (See 1.2.2)	Size of kit (See 1.2.3)

Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: Naval Air Engineering Center, Systems Engineering and Standardization Department (Code 93), Lakehurst, NJ 08733-5100, by using the self-addressed Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

AMSC N/A

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FSC 8010

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1.2.2 Colors. The coating shall be furnished in any color and gloss specified by the procuring activity. The part number designation is the FED-STD-595 color number. The following colors are required most frequently:

	<u>FED-STD-595 Color</u>	<u>Name</u>
Gloss colors:	11136	Red
	13538	Orange-yellow
	16440	Light grey
	17925	Untinted white
Camouflage colors:	34095	Field green
	35237	Blue-grey
	36320	Dark grey
	36375	Medium grey
	36440	Light grey
	36495	Aircraft grey

1.2.3 Kit size. The coating covered by this specification should be purchased by volume as a kit. Each kit shall consist of two containers of equal volume. One container shall contain component A and the other shall contain component B (see 3.4). The kit size shall be identified in accordance with the following:

<u>Kit Size</u>	<u>Part Number Designation</u>
2 quart (1.89L)	1
2 gallon (7.57L)	2
10 gallon (37.85L)	3
110 gallon (416.35L)	4

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 specification 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

QQ-A-250/4	Aluminum Alloy 2024, Plate and Sheet
TT-P-343	Pigment, Carbon-Black, Dry
TT-P-346	Pigment, Chrome-Yellow and Chrome-Orange, Dry
TT-P-350	Pigment, Lampblack, Dry
UU-T-106	Tape, Pressure Sensitive Adhesive, Masking, Paper
PPP-P-1892	Paint: Varnish, Lacquer, and Related Materials, Packaging, Packing and Marking of

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SPECIFICATIONS (Continued)

MILITARY

MIL-C-5541	Chemical Conversion Coatings on Aluminum and Aluminum Alloys
MIL-A-8625	Anodic Coatings, for Aluminum and Aluminum Alloys
MIL-G-21164	Grease, Aircraft, Synthetic, Molybdenum Disulfide
MIL-P-23377	Primer Coatings, Epoxy Polyamide, Chemical and Solvent Resistant
MIL-L-23699	Lubricating Oil, Aircraft Turbine Engine, Synthetic Base
MIL-C-81706	Chemical Conversion Materials for Coating Aluminum and Aluminum Alloys
MIL-T-81772	Thinner, Aircraft Coating
MIL-C-81907	Coating System, Polyurethane, Aliphatic, Weather Resistant, Process for Application of
MIL-H-83282	Hydraulic Fluid, Fire Resistant, Synthetic Hydrocarbon Base, Aircraft
MIL-P-85582	Primer Coatings, Epoxy, VOC Compliant, Chemical and Solvent Resistant

STANDARDS

FEDERAL

FED-STD-141	Paint, Varnish, Lacquer and Related Materials, Methods of Inspection, Sampling and Testing
FED-STD-313	Material Safety Data Sheets; Preparation and Submission of
FED-STD-595	Colors

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MIL-STD-105	Sampling Procedures and Tables for Inspection by Attributes
MIL-STD-129	Marking for Shipment and Storage

2.1.2 Other Government documents, drawings, and publications. The following other Government documents, drawings, and publications form a part of this specification to the extent specified herein. Unless otherwise specified, the issues shall be those in effect on the date of the solicitation.

BUREAU OF MEDICINE AND SURGERY

BUMEDINST 6260.16	Polyurethane Paints and Other Substances Containing Isocyanates; Measures of Control of Health Hazards Related to
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(Application for copies should be addressed to: Commander, Naval Publications and Forms Center, 5801 Tabor Avenue, Philadelphia, PA 19120. Orders should cite the latest edition and supplements thereto.)

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CODE OF FEDERAL REGULATIONS (CFR)

- | | |
|------------------|------------------------------------------------------------------------------------------------------------------------------------|
| 49 CFR 171-178 | Department of Transportation (DOT) Regulations for the Transportation of Explosives and Other Dangerous Articles by Land and Water |
| 49 CFR 1910.1200 | Material Safety Data Sheet; Preparation and Submission Of |

(Application for copies should be addressed to: Superintendent of Documents, Government Printing Office, Washington, DC 20402. Orders should cite the latest edition and supplements thereto.)

(Copies of specifications, standards, handbooks, drawings, publications and other Government documents required by contractors in connection with specific acquisition functions should be obtained from the contracting activity or as directed by the contracting activity.)

2.2 Other publications. The following documents form a part of this specification to the extent specified herein. Unless otherwise specified, the issues of the documents which are DOD adopted shall be those listed in the issue of the DODISS specified in the solicitation. Unless otherwise specified, the issues of documents not listed in the DODISS shall be the issue of the nongovernment documents which is current on the date of the solicitation.

AMERICAN NATIONAL STANDARD INSTITUTE

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|--------------|---------------------------------------------------------------------------------------------|
| ANSI Z 129.1 | American National Standard for the Precautionary Labeling of Hazardous Industrial Chemicals |
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AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

- | | |
|-------------|--------------------------------------------------------------------------------------------|
| ASTM D 185 | Coarse Particles in Pigments, Pastes and Paints |
| ASTM D 217 | Cone Penetration of Lubricating Grease |
| ASTM D 476 | Titanium Dioxide Pigments |
| ASTM D 523 | Specular Gloss |
| ASTM D 1200 | Viscosity of Paints, Varnishes and Lacquers by Ford Viscosity Cup |
| ASTM D 1210 | Fineness of Dispersion of Pigment-Vehicle Systems |
| ASTM D 1364 | Water in Volatile Solvents (Fischer Reagent Titration Method) |
| ASTM D 1544 | Color of Transparent Liquids (Gardner Color Scale) |
| ASTM D 1640 | Drying, Curing or Film Formation of Organic Coatings at Room Temperature |
| ASTM D 2197 | Adhesion of Organic Coatings |
| ASTM D 2572 | Isocyanate Groups in Urethane Materials of Pre-polymers |
| ASTM D 3335 | Low Concentrations of Lead, Cadmium, and Cobalt in Paint by Atomic Absorption Spectroscopy |
| ASTM D 3960 | Volatile Organic Content (VOC) of Paints and Related Coatings |
| ASTM G 7 | Atmospheric Environmental Exposure Testing of Nonmetallic Materials |

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AMERICAN SOCIETY FOR TESTING AND MATERIALS (Continued)

ASTM G 26

Light-and-Water-Exposure Apparatus (Xenon-Arc Type) for Exposure of Nonmetallic Materials, Recommended Practice for Operating

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

2.3 Order of precedence. In the event of a conflict between the text of this specification and the references cited herein (except for associated detail specifications, specification sheets or MS standards), the text of this specification shall take precedence. Nothing in this specification, however, shall supersede applicable laws and regulations unless a specific exemption has been obtained.

3. REQUIREMENTS

3.1 Qualification. The coatings furnished under this specification shall be products which are authorized by the qualifying activity for listing on the applicable qualified products list at the time set for opening of bids (see 4.3 and 6.6). Any change in the formulation of a qualified product will necessitate its requalification. The material supplied under contract shall be identical, within manufacturing tolerances, to the product receiving qualification.

3.2 Materials. The specified materials shall be of sufficient quality to produce coatings conforming to specification requirements.

3.3 Toxicity. The manufacturer shall certify that the materials shall have no adverse effect on the health of personnel when used for its intended purpose and under the precautions of 5.2.1 and BUMEDINST 6260.16. Material Safety Data Sheets shall be prepared and submitted in accordance with FED-STD-313 and shall meet the requirements of 29 CFR 1910.1200. When FED-STD-313 is at variance with the CFR, 29 CFR 1910.1200 shall take precedence, modify and supplement FED-STD-313. One copy shall accompany the samples being submitted to the qualifying activity for testing (see 4.3.2). Questions pertinent to this effect shall be referred by the contracting activity to the appropriate departmental medical service who will act as an advisor to the contracting agency (see 4.1.1 and 6.3). The total free isocyanate in the admixed coating shall not exceed 1.0 percent by weight (see 4.6.1). The formulation of this coating shall preclude the use of lead (see 4.6).

3.4 Composition. The aliphatic polyurethane coating shall consist of two components. Component A shall be pigmented and contain the polyester resins and solvents. Component B shall contain the clear aliphatic isocyanate resin and solvents and act as the hardener or curing agent for component A. These shall be packaged separately and furnished in kit form so that, when mixing, -1 volume of component B is added to 1 volume of component A.

3.4.1 Pigments. The pigments shall have proven outdoor durability. They shall be sufficiently insoluble to prevent leaching during immersion. Only lead-free pigments shall be used (see 4.6).

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3.4.2 Volatile content. The solvents used in manufacturing and thinning prior to application shall conform to the following requirements by volume when tested as specified in 4.6. The maximum volatile organic compounds (VOC) content shall be 420 grams/liter as applied (see 4.6). Solvents should be urethane grade and contain a minimum of alcohol in accordance with the best commercial practice (see 6.4). Halogenated solvents (e.g. 1,1,1-trichloroethane) shall not be used in the formulation of this product.

3.4.3 Thinner. The admixed coating shall be compatible with any thinner meeting MIL-T-81772, Type I. Caution must be taken when reducing the admixed coating not to exceed the maximum VOC content of 420 grams/liter in areas where air pollution regulations are enforced.

3.5 Component properties.

3.5.1 Condition in container. Component A, which has been allowed to stand without agitation for at least 14 days in a closed container, shall be capable of being easily mixed by hand with a paddle to a smooth, homogeneous, pourable condition. The material shall be free from grit, seeds, lumps, abnormal thickening or livering and shall not show pigment floatation or excessive settling which cannot be easily reincorporated to a smooth, homogeneous state. Component B shall be homogeneous, clear, free from gelation or detectable particulate matter either suspended in solution or settled on the inner surface of the container. The container shall not show evidence of excessive pressure or be deformed by gassing.

3.5.2 Storage stability. The previously unopened packaged product shall meet all the requirements specified herein for a period of one year. The daily temperature of the ambient air at the storage locations shall fall within the range of 1.7°-46°C (35°-115°F).

3.5.3 Accelerated stability (Component B). A full unopened can of Component B when exposed as specified in 4.6.2 shall not show excessive pressure buildup or distortion of the can. The material shall exhibit no trace of gelation or particulate matter, either suspended in solution or settled on the inner surface of the container.

3.5.4 Moisture content. Component A shall contain no more than 1.0 percent by weight of water (see 4.6).

3.6 Liquid properties.

3.6.1 Fineness of grind. The fineness of grind on the Hegman scale shall be a minimum of 7 for gloss colors and 5 for camouflage colors when tested 1 hour after mixing (see 4.6).

3.6.2 Coarse particles. Coarse particles retained on a No. 325 sieve shall be no more than 0.5 percent by weight of the admixed material (see 4.6).

3.6.3 Odor. The odor of the admixed coating, wet or dry, shall not be obnoxious. An air-dried film shall retain no residual odor 48 hours after application.

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3.6.4 Viscosity. The viscosity of the admixed coating (no thinner added), within 30 minutes after mixing, shall be in the range of 14 to 22 seconds through a No. 4 Ford cup (see 4.6).

3.6.5 Pot life. The viscosity of the admixed coating, when thinned initially to 14 seconds through a No. 4 Ford cup, shall not exceed 25 seconds after 4 hours in a closed container. The admixed coating shall not gel within seven hours after mixing (see 4.6).

3.7 Film properties.

3.7.1 Drying time. The film, after application to a panel, shall dry hard within a maximum time of eight hours (see 4.6).

3.7.2 Surface appearance. The paint film shall dry to a uniform smooth surface free from runs, sags, bubbling, streaking, hazing, seeding, dusting, floating, mottling or other film defects.

3.7.3 Color. The color of the polyurethane film after drying 24 hours shall be a good visual match with the specified color chip in FED-STD-595.

3.7.4 Infrared reflectance. The infrared reflectance of FED-STD-595 Color 34095 shall conform to the following limits when tested relative to barium sulfate (see 4.6.3):

<u>Wavelength (nanometers)</u>	<u>Maximum Reflectance (percent)</u>
450-500	8
500-600	10
600-2700	8

3.7.5 Gloss. The specular gloss of the coating at a 60° angle of incidence shall be a minimum of 90 for gloss colors and a maximum of 3 for camouflage colors (see 4.6).

3.7.6 Hiding power. The contrast ratio of the coating cast on a black and white hiding power chart at a specified dry-film thickness shall be a minimum of 0.9 (see 4.6).

3.7.7 Adhesion. After immersion in water, the coating shall not peel away from the primer during the tape test. In addition, the coating shall resist removal from the primer by a 3 kg weight when subjected to the scrape test (see 4.6).

3.7.8 Flexibility. The coating shall exhibit a minimum impact elongation of 60 percent when tested at room temperature. At a temperature of $-51 \pm 3^{\circ}\text{C}$ ($-60 \pm 5^{\circ}\text{F}$), the coating shall exhibit no cracking when bent, coated side away, over a one-inch mandrel (see 4.6.4).

3.8 Resistance properties.

3.8.1 Fluid resistance. The coating shall withstand immersion for 24 hours in the following fluids and temperatures: MIL-L-23699 lubricating oil

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at $121 \pm 3^\circ\text{C}$ ($250 \pm 5^\circ\text{F}$) and MIL-H-83282 hydraulic fluid at $66 \pm 3^\circ\text{C}$ ($150 \pm 5^\circ\text{F}$). Four hours after removal, the film shall not exhibit any blistering, softening, dark staining, or other film defects (see 4.6.5).

3.8.2 Weather resistance. After 500 hours of exposure to a 6000 watt Xenon-arc weatherometer, the specular gloss of the coating at a 60° angle of incidence shall be a minimum of 80 for gloss colors and a maximum of 3 for camouflage colors. There shall be no evidence of film cracking or color fading after exposure; and the coating shall exhibit a minimum impact elongation of 20 percent when tested at room temperature (see 4.6.6).

3.8.3 Heat resistance. After 1 hour at 121°C (250°F), the color and appearance of the coating shall remain unchanged; and the coating shall exhibit a minimum impact elongation of 20 percent when tested at room temperature (see 4.6).

3.8.4 Solvent resistance (cure). The coating shall withstand repeated rubbing by a cloth rag soaked in methyl ethyl ketone solvent (see 4.6.7).

3.8.5 Tape resistance. There shall be no evidence of permanent marring caused by masking tape applied to the coating after eight hours air-dry (see 4.6.8).

3.9 Working properties.

3.9.1 Mixing. Component B shall mix readily with the pigmented component A to a smooth homogeneous product.

3.9.2 Application. When Components A and B are mixed and reduced for spraying with thinner conforming to MIL-T-81772, Type I, the material shall be homogeneous and, when sprayed, shall yield a smooth, uniform film. Caution must be taken when reducing the admixed coating not to exceed the maximum VOC content of 420 grams/liter in areas where air pollution regulations are enforced.

3.9.3 Cleanability. The coating shall have a 90 percent minimum cleaning efficiency in removing soils A, B and C (see 4.6.9).

3.9.4 Strippability. At least 90 percent of the coating shall be stripped in 60 minutes with the use of MIL-R-81294, Type I, Class 1 paint remover (see 4.6.10).

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 his own or any other facilities suitable for the performance of the inspection requirements specified herein, unless disapproved by the Government. The Government reserves the right to perform any of the inspections set forth in the specification where such inspections are deemed necessary to assure supplies and services conform to prescribed requirements.

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4.1.1 Responsibility for compliance. All items must meet all requirements of Sections 3 and 5. 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 of the responsibility of assuring that all products or supplies submitted to the Government for acceptance comply with all requirements of the contract. Sampling in quality conformance does not authorize submission of known defective material, either indicated or actual, nor does it commit the Government to acceptance of defective material. The contractor shall furnish to the contracting activity the toxicological data and formulations required to evaluate the safety of the material for the proposed use through the submission of the Material Safety Data Sheet detailed in FED-STD-313.

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

- a. Qualification inspection (see 4.3).
- b. Quality conformance inspection (see 4.4).

4.3 Qualification inspection. Qualification inspection shall consist of all the tests specified in Section 3.

4.3.1 Qualification samples. The test samples shall consist of one gallon of each component of the coating material in FED-STD-595 colors 17925, 34095 and 36375. The material shall be furnished in containers of the type to be used in filling contract orders. Samples shall be identified as follows and forwarded to the laboratory designated in the letter of authorization (see 6.6).

- Qualification test samples.
- Specification MIL-C-85285A(AS); Color _____.
- Coating, Polyurethane, High-Solids.
- Manufacturer's name and product number.
- Submitted by (name and date) for qualification testing in accordance with authorization (reference authorizing letter).

4.3.2 Test report. In addition to the qualification test samples, the manufacturer shall furnish a test report showing that the material satisfactorily conforms to the requirements of this specification. Material Safety Data Sheets shall be prepared and submitted in accordance with FED-STD-313 and 29 CFR 1910.1200.

4.3.3 Retention of qualification. In order to retain qualification of products approved for listing on the Qualified Products List (QPL), the manufacturer shall verify by certification to the qualifying activity that his product(s) comply with the requirements of this specification. Unless otherwise specified by the qualifying activity, the time of periodic verification by certification shall be in two-year intervals from the date of original qualification and shall be initiated by the qualifying activity.

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4.4 Quality conformance inspection.

4.4.1 Lot formation. A lot shall consist of all polyurethane coating of the same color, manufactured at one time from one batch, forming part of one contract, and submitted for acceptance. A batch shall consist of all coating material manufactured during one continuous operation and forming part of one contract or order for delivery.

4.4.2 Retention sample. At least one quart of each component of the coating material shall be selected at random from each batch by an authorized government representative and forwarded to the laboratory designated by the purchasing activity.

4.4.2.1 Batch data. With each sample, the manufacturer shall furnish a certified test report showing that the material satisfactorily meets the quality conformance requirements (4.4). In addition, the manufacturers shall certify that there has been no formulation or process change from that which resulted in the production of the qualification inspection sample. Each ingredient material shall be identified with the name of its manufacturer and that manufacturer's trade name and formula number.

4.4.3 Examinations.

4.4.3.1 Tests. The examination shall consist of all the tests specified in Section 3, with the exception of storage stability (3.5.2). There shall be no failures. Samples for tests shall consist of one complete unopened kit selected at random from each batch. Containers shall only be opened when being tested.

4.4.3.2 Visual inspection of filled containers. Samples selected at random for examination in accordance with 4.4.3.3 shall be examined for proper filling and weight.

4.4.3.3 Examination of packaging and marking. An examination shall be made to determine that packaging, packing and marking comply with the requirements of Section 5 of this specification. Defects shall be scored in accordance with the list below. The sample unit for this examination shall be one shipping container fully prepared for delivery except that it shall not be palletized and need not be sealed. Shipping containers fully prepared for delivery that have not been palletized shall be examined for defects of closure. The lot size shall be the number of shipping containers in the end item inspection lot. The samples for this examination shall be selected at random in accordance with MIL-STD-105, inspection level S-2 and acceptable quality level (AQL) 4.0 defects per hundred units.

<u>Examine</u>	<u>Defect</u>
Packaging	Container not as specified, closures not accomplished by specified or required methods or materials. Leakage or seepage of contents. Non-conforming component, component missing, damaged or otherwise defective. Bulged or distorted container.

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Markings

Data, including directions for use, omitted, illegible, incorrect, incomplete, or not in accordance with contract requirements.

4.4.3.4 Examination for palletization. An examination shall be made to determine that palletization complies with the requirements of Section 5 of this specification. Defects shall be scored in accordance with the list below. The sample unit shall be one palletized unit load fully prepared for delivery. The lot size shall be the number of palletized unit loads in the end item inspection lot. The samples for this examination shall be selected at random in accordance with MIL-STD-105, inspection level S-1 and acceptable quality level (AQL) 6.5 defects per hundred units.

<u>Examine</u>	<u>Defect</u>
Finished dimension	Length, width, or height exceeds specified maximum requirement.
Palletization	Not as specified. Pallet pattern not as specified. Interlocking of loads not as specified. Load not bonded with required straps as specified.
Weight	Exceeds maximum load limits.
Marking	Omitted, incorrect, illegible, of improper size, location, sequence or method of application.

4.4.4 Rejection and retest. Failure in any quality conformance test shall result in rejection of that batch and shall constitute sufficient justification for removal from the qualified products list. Rejected material shall not be resubmitted for acceptance without written approval from the Naval Air Development Center, Code 6062, Warminster, PA 18974. The application for resubmission shall contain full particulars concerning previous rejections and measures taken to correct these deficiencies. Samples for retest shall be randomly selected as in 4.4.2 and forwarded to the testing activity.

4.5 Test panels. Panels shall be prepared under laboratory testing conditions. All panels used for test purposes shall be aluminum alloy conforming to QQ-A-250/4 (T3 temper) and shall be 0.020 by 3 by 6 inches in size.

4.5.1 Panel preparation. With the exception of the flexibility (4.6.4) and weather resistance (4.6.6) tests, the panels shall be treated with materials conforming to Form I, Method C (Immersion), Class 1A of MIL-C-81706 to produce coatings conforming to MIL-C-5541.

4.5.2 Application of finish scheme. The following finish scheme shall be applied: Spray panels with one cross-coat of MIL-P-23377 or MIL-P-85582 epoxy-polyamide primer and air-dry one hour. The dry film thickness of the

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primer shall be 0.0006 to 0.0009 inches (0.6 to 0.9 mils). The admixed polyurethane topcoat may be reduced with MIL-T-81772, Type I thinner to spray viscosity and allowed to stand 30 minutes before using. Apply a mist coat of the reduced paint and air-dry for 15 minutes. Apply a second coat until the total dry film thickness of topcoat is 0.0017 to 0.0023 inches (1.7 to 2.3 mils). The panels shall be allowed at least seven days air-dry before testing. More detailed application instructions are available in MIL-C-81907.

4.6 Test methods. The tests of this specification shall be conducted in accordance with Table I and the subparagraph of 4.6, and the panels used prepared as specified in 4.5 and subparagraphs of 4.6 as specified. The laboratory testing conditions shall be in accordance with the applicable test method described herein.

TABLE I. Test methods.

Requirements Paragraph	Test	FED-STD-141 Test Method No.	ASTM Method No.
3.3, 3.4.1	Lead content		D 3335
3.4.2	Volatile organic compound (VOC) content		D 3960
3.5.4	Moisture content		D 1364
3.6.1	Fineness of grind		D 1210
3.6.2	Coarse particles		D 185
3.6.4, 3.6.5	Viscosity, Pot-life		D 1200
3.7.1	Drying time		D 1640
3.7.5	Gloss		D 523
3.7.6	Hiding power		D 2805
3.7.7	Adhesion, Tape test	6301	
3.7.7	Adhesion, Scrape test		D 2197 <u>1/</u>
3.8.3	Heat resistance	6051	

1/ Method A

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4.6.1 Determination of free isocyanate content. Unreacted hexamethylene diisocyanate is removed from the sample by vacuum distillation after the addition of a carrier solvent. The distillate is diluted with carbon tetrachloride and its spectrum is obtained in the wavelength region of 2480-2000 cm^{-1} . The absorption band at 2265 cm^{-1} is measured and the value obtained is converted to concentration of free hexamethylene diisocyanate with the aid of a calibration curve.

4.6.1.1 Apparatus.

- a. Double beam infrared spectrometer, Perkin Elmer Model 225 or equivalent.
- b. Two matched NaCl cuvettes, 0.9 mm path length.
- c. Distillation apparatus (see Figure 1).
- d. Volumetric flasks, 100 ml, 10 ml.
- e. Analytical balance.
- f. Oil bath (600 ml beaker with mineral oil and equipped with beaker mantle or hot plate for heating).
- g. Vacuum pump, manometer, Dewar flask and safety shield.

4.6.1.2 Reagents.

- a. Purified hexamethylene diisocyanate.
- b. Carbon tetrachloride, spectral grade.
- c. Cellosolve acetate* (ethylene glycol monoethyl ether acetate) - diphenyl ether. Purify the cellosolve acetate by refluxing 4 liters over 200 ml of TDI (Toluene diisocyanate) for 1 hour. Mix equal volumes of diphenyl ether and purified cellosolve acetate. Add approximately 25g of silica gel (type 08, 12-18 mesh) for every 100 ml of the mixed solvent. Shake and allow to stand overnight before using.

*Polyurethane grade. May be obtained from Union Carbide Chemicals Company.

4.6.1.3 Instrument settings.

Slit	Manual, 250
Gain	Manually set at 2260 cm^{-1}
Pen traverse time	10 seconds
Pen response	2
Scan speed	2
Scale selector	1
Range scanned	2480 - 2000 cm^{-1}

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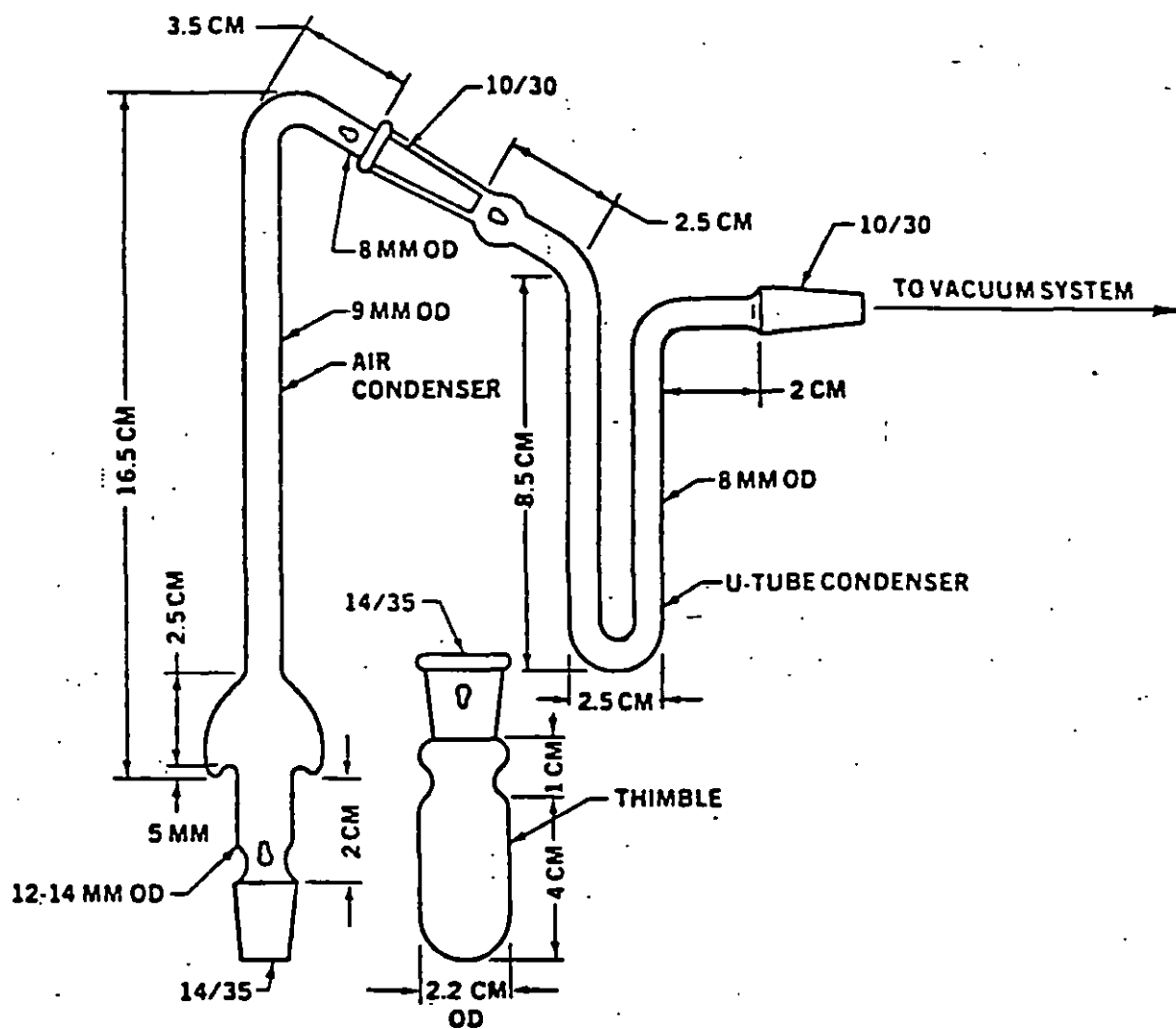


FIGURE 1. Miniature vacuum distillation apparatus.

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4.6.1.4 Standardization.

- a. Prepare five standard solutions having concentrations of 10 mg, 20 mg, 30 mg, 40 mg and 50 mg of hexamethylene diisocyanate in 100 ml of carbon tetrachloride.
- b. With the matched NaCl cuvettes, record the spectra of the standard solutions in the wavelength region of 2480 - 2000 cm^{-1} , using pure carbon tetrachloride in the reference beam.
- c. Draw a tangent through the absorption minima at 2450 cm^{-1} and 2100 cm^{-1} on each curve, then measure the peak height of the absorption maximum at 2265 cm^{-1} from this tangent line.
- d. Plot the absorption values for the standard solutions as a function of their concentrations expressed as mg/10 ml of carbon tetrachloride.

4.6.1.5 Procedure.

- a. Weigh approximately 1.0 g of sample accurately (± 0.1 mg) into a dry vial and add 1.0 g of mixed solvent weighed accurately (± 0.1 mg). Cap tightly with a polyethylene lined screw cap and completely dissolve by shaking.
- b. Weigh exactly 0.3 - 0.4 g of sample solution into the tared distillation thimble and stopper immediately.
- c. Attach the thimble to the distillation assembly and arrange the apparatus to immerse the U-tube condenser in the dry ice-acetone bath contained in a Dewar flask.
- d. Evacuate the system to 1 - 3mm Hg pressure and maintain this pressure for 5 minutes before proceeding.
- e. Gradually raise the oil bath which has previously been heated to $100 \pm 5^\circ\text{C}$ over the sample thimble and up to, but not touching, the bulbous portion of the air condenser. Maintain the temperature at $95 - 105^\circ\text{C}$ for 20 minutes ± 30 seconds.
- f. Lower the oil bath, release the vacuum and detach the distillation assembly while leaving the U-tube condenser in the dry ice-acetone bath. Wipe the oil from the inner joint of the air condenser. Hold the air condenser with the head joint upward and carefully rinse the head joint with carbon tetrachloride, taking care to avoid picking up portions of residual resin from the column. Quantitatively transfer the rinsings and the contents of the U-tube condenser to a 10 ml volumetric flask. Dilute to the mark with additional carbon tetrachloride.

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- g. The spectrum of the solution is recorded at 2480 - 2000 cm^{-1} , a baseline constructed as before and the peak at 2265 cm^{-1} is measured. (If the absorption is too strong, the sample can be diluted with additional carbon tetrachloride; however, this must be taken into account in the calculations specified in 4.6.1.6).

4.6.1.6 Calculations. Calculate the free monomer as follows:

$$\text{Percent hexamethylene diisocyanate monomer} = \frac{C}{W \times 10} \text{ where:}$$

C = mg/10 ml hexamethylene diisocyanate from the standard curve.

W = sample weight in grams used in the distillation procedure.

4.6.2 Accelerated stability (Component B). A full unopened can of Component B shall be stored in an oven at $57 \pm 3^\circ\text{C}$ ($135 \pm 5^\circ\text{F}$) for 24 hours and cooled to room temperature before being examined. The unopened can should be placed in a larger vented container in the oven to confine any splash that may occur, in the event the lid of the unopened can is blown off by gassing.

NOTE: Open cans cautiously, as they may be under pressure. Do not open deformed cans.

4.6.3 Infrared reflectance. The total reflectance (specular and diffuse) of the panel, when measured relative to barium sulfate using a Perkin-Elmer LAMBDA 9 spectrophotometer, shall conform to the limits specified in 3.7.4.

4.6.4 Flexibility. Test panels shall be aluminum alloy conforming to QQ-A-250/4 (O temper) and anodized in accordance with MIL-A-8625, Type I. Panels shall be 0.020 by 3 by 6 inches in size and prepared as specified in 4.5 without a primer. The panels shall be allowed at least seven days air-dry before testing (see 3.7.8).

4.6.4.1 Ambient flexibility. Two coated panels, prepared as in 4.6.4, shall be tested with a GE Impact-Flexibility Tester at a room temperature of $22 \pm 2^\circ\text{C}$ ($72 \pm 4^\circ\text{F}$). Place the coated panel, film downward, on the rubber pad at the bottom of the impacter guide. Drop the impacter on the panel, so that the impression of the entire rim of the impacter is made in the panel. Reverse the impacter ends; and drop it on the panel adjacent to the first area of impact. Use ten power magnification to detect fine surface cracking. Report the percent elongation corresponding to the largest spherical impression at which no cracking occurs.

4.6.4.2 Low temperature flexibility. Two coated panels, prepared as in 4.6.4, shall be tested in accordance with ASTM D 1737 at a temperature of $-51 \pm 3^\circ\text{C}$ ($-60^\circ \pm 5^\circ\text{F}$) using a one-inch mandrel.

4.6.5 Fluid resistance. Test panels, prepared as directed in 4.5, shall be separately immersed for 24 hours in MIL-L-23699 lubricating oil at a temperature of $121 \pm 3^\circ\text{C}$ ($250 \pm 5^\circ\text{F}$) and MIL-H-83282 hydraulic fluid at a temperature of $66 \pm 3^\circ\text{C}$ ($150 \pm 5^\circ\text{F}$). Four hours after removal, the various films shall be examined for conformity to the requirements of 3.8.1.

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4.6.6 Weather resistance. Test panels, prepared as directed in 4.5, shall be exposed for 500 hours in a 6000 watt Xenon-arc weatherometer (Atlas Electric Devices Company or equivalent) that is cycling between 102 minutes of light only and 18 minutes of light and waterspray. The following conditions shall apply when tested according to ASTM G 26, Type BH.

Black body temperature in cabinet:	$60 \pm 3^{\circ}\text{C}$ ($140 \pm 5^{\circ}\text{F}$)
Relative humidity in cabinet:	$50 \pm 5\%$
Intensity of xenon-arc:	0.3 to 0.4 watts/square meter at 340 nm wavelength

At the completion of this test, the specular gloss and ambient flexibility of the specimens shall be determined in accordance with FED-STD-141, Test Method Numbers 6101 and 6226; and the results shall be compared to the requirements of 3.8.2.

4.6.7 Solvent resistance (cure). Test panels shall be prepared as directed in 4.5. A cotton, terry-cloth rag shall be soaked in methyl ethyl ketone solvent and rubbed back and forth 25 times (50 passes) over the coating with firm finger pressure. Rubbing through to bare metal indicates failure due to improper cure.

4.6.8 Tape resistance. Test panels, prepared as specified in 4.5, shall be air-dried for six hours. A one-inch wide strip of masking tape (3M Company #250 or equivalent) shall be applied to each panel, adhesive side down, and pressed down with one pass of a 4-1/2 pound (2.04 kilogram) roller to adhere the tape to the panel. The tape shall remain in contact with the panel for one hour. Then remove the tape carefully and examine the test film for conformance with 3.8.5.

4.6.9 Cleanability.4.6.9.1 Apparatus.

- a. Test panels, 6 by 2.5 by 0.02 inch, cut from aluminum alloy, QQ-A-250/4.
- b. One quart (1L) wide-mouth, glass jars (one for each soil prepared).
- c. Balance, accurate to 0.1 g.
- d. High shear mixer, such as a Cowles dispersator or equivalent.
- e. Grease worker, mechanical (see ASTM D 217, Annex A 1.3).
- f. Acid brushes.
- g. Rubber roller, 5 lbs \pm 0.1 (2270 g \pm 50).
- h. Forced draft oven capable of $105 \pm 2^{\circ}\text{C}$ ($221 \pm 4^{\circ}\text{F}$).

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- i. Colorimeter, such as a McBeth Model MC-1010S, supplied by Kollmorgen Corporation, Newburgh, NY (optional) or equivalent.
- j. Wear tester, such as Cat. No. WG 6700 (Gardner Heavy Duty Wear Tester) supplied by Pacific Scientific, Bethesda, MD or equivalent.
- k. Hog bristle brushes, such as Cat. No. AG 8111 supplied by Pacific Scientific, Bethesda, MD or equivalent.
- l. Template for positioning panels on the wear tester (see Figure 2).
- m. Cellulose sponge backed with nylon web, such as Cat. No. 63 supplied by 3M Company, Minneapolis, MN or equivalent.

4.6.9.2 Preparation of artificial soils.

- a. Place $50 \text{ g} \pm 0.5$ of carbon black (such as Raven 1040 supplied by Columbian Chemical Company, New York, NY or equivalent) and $500 \text{ g} \pm 1$ of one of the following fluids in a one quart (1L) jar:

Soil A - Hydraulic fluid conforming to MIL-H-83282
 Soil B - Lubricating oil conforming to MIL-L-23699
 Soil C - Grease conforming to MIL-G-21164

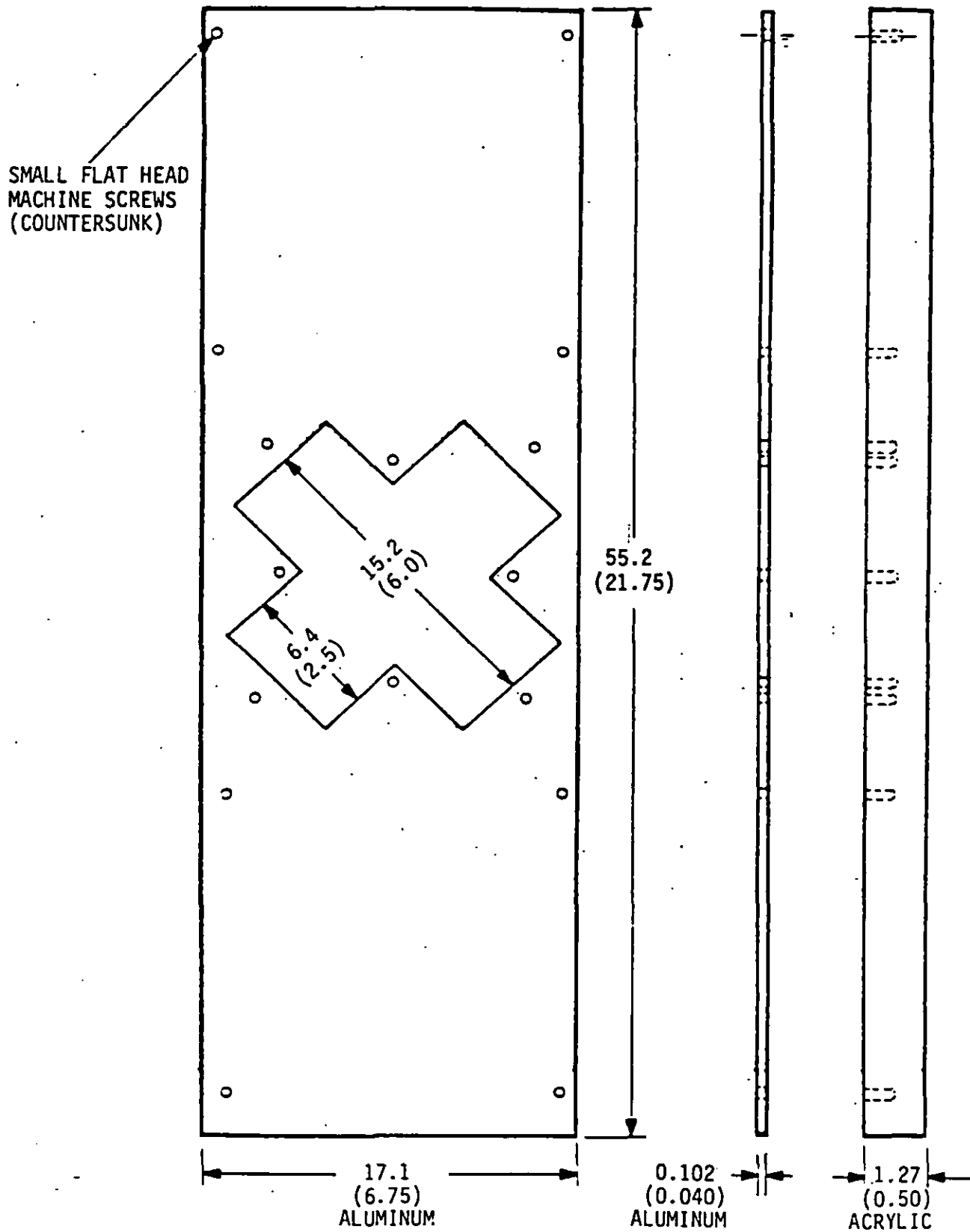
- b. Homogenize Soils A and B using a high shear mixer for 15 minutes ± 1 . Prior to each application of the soil, stir or shake the mixture by hand. Homogenize Soil C using a grease worker for 15 minutes ± 1 .

4.6.9.3 Preparation of control formula cleaner. Blend by combining the mixture of the first four ingredients with the mixture of the last two ingredients and mix thoroughly.

<u>Formula:</u>	<u>Composition by weight (%)</u>
Witconate 1260 <u>1/</u>	5.0
Igepal CO-630 <u>2/</u>	10.0
Sodium xylene sulfonate (40% active)	5.0
Diethylene glycol mono-butyl ether	5.0
Tetrapotassium pyrophosphate	5.0
Reagent water	70.0

- 1/ Witconate 1260 supplied by Witco Chemical Corporation of New York, NY or equivalent.
- 2/ Igepal CO-630 supplied by GAF Corporation of Wayne, NJ or equivalent.

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DIMENSIONS IN CENTIMETERS (INCHES).

FIGURE 2. Template.

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4.6.9.4 Preparation of test panels. Using a clean, hog bristle brush, lightly scrub the paint surface of each panel with a 1.0 percent (by weight) solution of Alconox detergent (Alconox Detergent supplied by Alconox, Inc., New York, NY or equivalent) in reagent water. Rinse each panel thoroughly three times using reagent water. Dry for 18 hours at $49 \pm 2^\circ\text{C}$ ($120 \pm 4^\circ\text{F}$). Measure the lightness value (L-value in the L-a-b color system) of the test panel paint surface and record this value as A, the L-value for the unsoiled test panel.

Using a soft-bristle acid brush, coat the painted surface of a test panel with the desired soil. Remove excess soil by covering the test panel surface with folded absorbent tissue and exerting pressure by rolling the tissue with the 5-lb rubber roller. Repeat this blotting procedure twice. Brush the soiled surface in one direction only and parallel to the long dimension of the test panel, using 10 strokes of the hog bristle brush. Bake the test panel at $105 \pm 2^\circ\text{C}$ ($221 \pm 4^\circ\text{F}$) for 60 minutes ± 1 . Measure the lightness value of the cleaned paint surface and record this value as B, the L-value for the soiled test panel.

4.6.9.5 Procedure. Dilute the cleaner as required using reagent water at room temperature. Control formulas shall always be diluted 1 part cleaner to 9 parts water (by volume). Clean the test panel within 4 hours using the wear tester as follows. Cut the sponge such that the dimension parallel to the cleaning stroke is 3.5 in. (90 mm) and the width is 2.75 in. (70 mm). When the dry sponge is attached to the cleaning head of the wear tester, the combined weight shall be no less than 1350 g and no more than 1400 g. (NOTE: Use Velcro-type strips on the cleaning head to attach the nylon web side of the sponge.) Place a soiled test panel in the template at $+45^\circ$ (see Figure 2). Saturate the sponge and cover the test panel with the diluted cleaner. After 60 seconds ± 5 , clean the test panel using 5 cycles of the wear tester, then immediately turn the test panel 90° in the template and clean for an additional 5 cycles. Rinse the test panel under a flowing stream of tap water at room temperature and allow to dry. Measure the lightness value of the cleaned paint surface and record this value as C, the L-value for the cleaned test panel.

4.6.9.6 Calculation. Calculate the cleaning efficiency achieved on each test panel as follows:

$$\text{cleaning efficiency (\%)} = \frac{C - B}{A - B} \times 100$$

4.6.10 Strippability. Test panels, prepared as directed in 4.5 and weathered for 500 hours as directed in 4.6.6, shall be placed on a rack at a 60° angle with the horizontal. Enough MIL-R-81294, Type I, Class I paint remover shall be poured along the upper edge of each panel to completely cover the coating surface. After 60 minutes exposure time, the loosened film shall be brushed off and the panels shall be rinsed while brushing under a stream of cool water. The amount of coating stripped in this manner is determined by the percentage of substrate surface area exposed.

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13. Personnel preparing or applying this material in a production-type operation shall wear whatever protective equipment is recommended as a result of an on-site industrial hygiene survey. In touch-up operations, personnel shall wear:
- a. A well-fitted air line respirator or double cartridge organic vapor respirator with fresh cartridges inserted daily.
 - b. Solvent-resistant gauntlet style gloves.
 - c. Safety goggles.
 - d. Full clothing with collar buttoned and sleeves taped at the wrist.

5.2.1.2 Lid (Component B only). Each lid of Component B material shall bear a red printed label with the following information:

"USE CAUTION
OPEN SLOWLY"

6. NOTES

6.1 Intended use This high-solids, polyurethane coating is intended for exterior use on aircraft, weapon systems and other applications. No additives other than the appropriate thinner to obtain the proper spray viscosity shall be added. The coating has been formulated to meet air pollution regulations requiring a maximum volatile organic compounds (VOC) content of 420 grams/liter as applied.

6.2. Ordering data.

6.2.1 Acquisition requirements. Acquisition documents should specify the following:

- a. Title, number and date of this specification.
- b. Kit desired, including the quantity and size of containers (see 1.2.3).
- c. Color number and name (see 1.2).
- d. Level of packaging and packing (see Section 5).
- e. Special marking (see 5.2).
- f. Toxicological data requirements (see 3.3 and 4.3.2).
- g. FAR clauses 23.303 and 52.223-3
- h. Specify if palletization is required.

6.3 Toxicity. Some free isocyanate is released during mixing and application. The free isocyanates released can produce a significant irrita-

tion of the skin, eyes and respiratory tract. They may also produce an allergic sensitization of personnel exposed, particularly if there is an inhalation of vapor and mist produced during spray application. Once sensitized, further exposure cannot be tolerated, hence the restriction on issue and use of this material. Additional information pertaining to protective equipment and other necessary precautions can be obtained from BUMEDINST 6260.16A.

6.4 Moisture. The polyurethane components should be kept dry. The presence of moisture degrades the quality of the coating. Packaging of the materials should be done in a dry atmosphere. Solvents and resins should be examined for evidence of contamination before they are incorporated, even though they are of "urethane grade." Urethane grade solvents or thinners may become contaminated with water in tank cars or storage tanks. The purchase of urethane grade solvents or thinners is no guarantee that excessive moisture is not present. It is therefore recommended that all users check for moisture contamination. The following suggested method may be used to determine the presence of water: Add one drop of aluminum secondary butoxide to 100 ml of the solvent in a stoppered flask and shake. An appreciable amount of turbidity indicates the presence of water.

6.5 Composition of Component B. It is suggested that no methyl ethyl ketone be used in Component B, as it may degrade the isocyanate portion of the resin.

6.6 Qualification. With respect to products requiring qualification, awards will be made only for products which are, at the time set for opening of bids, qualified for inclusion in the applicable Qualified Products List, whether or not such products have actually been so listed by that date. The attention of the suppliers is called to this requirement and manufacturers are urged to arrange to have the products that they propose to offer to the Federal Government tested for qualification, in order that they may be eligible to be awarded contracts or orders for the products covered by this specification. The activity responsible for the Qualified Products List is the Naval Air Development Center, Attn: Code 6062, Warminster, PA 18974; and information pertaining to qualification of products may be obtained from that activity. It is understood that the material furnished under this specification subsequent to final approval shall be of the same originally granted. In the event that the coating furnished under contract is found to deviate from the composition of the approved product or that the product fails to perform satisfactorily, approval of such products will be subject to immediate withdrawal from the Qualified Products List.

6.7 Subject term (key word) listing.

Aliphatic polyurethane
Coating
Exterior use
Flammable
Hazardous material
High-solids
Isocyanate
Low Infrared Reflectance

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Material Safety Data Sheets
Polyurethane, aliphatic
Qualification
Qualified Products List (QPL)
Toxic
VOC compliant
Weather resistant

6.8 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 and meeting the requirements of 29 CFR 1910.1200. When FED-STD-313 is at variance with the CFR, 29 CFR 1910.1200 shall take precedence, modify and supplement FED-STD-313. The pertinent government mailing addresses for submission of data are listed in Appendix B of FED-STD-313.

6.9 Changes from previous issue. Asterisks (or vertical lines) are not used in this revision to identify changes with respect to the previous issue due to the extensiveness of the changes.

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