

Submitted for recognition as an American National Standard

(R)

**Protective Film, High Performance, Polymeric
Pressure Sensitive Adhesive, for
Aircraft Exterior Applications**

1. SCOPE:

1.1 Form:

This specification covers adhesive-backed polymeric protective film, pigmented or clear, for aircraft exterior applications.

1.2 Application:

This film is used typically as a replacement for polyurethane paint topcoats on military and commercial exterior aircraft surfaces. The film has been designed to meet air pollution regulations with zero emission of volatile organic compounds (VOC)/organic hazardous air pollutants (HAP).

1.3 Classification:

Types: The polymeric protective film material shall be of the following types:

Type 1 - For commercial applications

Type 2 - For military applications

Unless otherwise specified, the requirements of this specification are applicable for Types 1 and 2.

1.4 Safety - Hazardous Materials:

While the materials, methods, applications, and processes described or referenced in this specification may involve the use of hazardous materials, this specification does not address the hazards which may be involved in such use. It is the sole responsibility of the user to ensure familiarity with the safe and proper use of any hazardous materials and to take necessary precautionary measures to ensure the health and safety of all personnel involved.

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2. APPLICABLE DOCUMENTS:

The issue of the following documents in effect on the date of the purchase order form a part of this specification to the extent specified herein. The supplier may work to a subsequent revision of a document unless a specific document issue is specified. When the referenced document has been canceled and no superseding document has been specified, the last published issue of that document shall apply.

2.1 SAE Publications:

Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001 or www.sae.org.

AMS-QQ-A-250/4 Aluminum Alloy 2024, Plate and Sheet
 AMS-QQ-A-250/5 Aluminum Alloy, Alclad 2024, Plate and Sheet
 AMS 2629 Fluid, Jet Reference
 AMS 2825 Material Safety Data Sheets

AS1241 Fire Resistant Hydraulic Fluid for Aircraft

2.2 ASTM Publications:

Available from ASTM, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959 or www.astm.org.

ASTM B 117 Operating Salt Spray (Fog) Testing Apparatus
 ASTM D 217 Test Method for Cone Penetration of Lubricating Grease
 ASTM D 471 Rubber Property - Effect of Liquids
 ASTM D 522 Mandrel Bend Test of Attached Organic Coatings
 ASTM D 523 Specular Gloss
 ASTM D 1193 Reagent Water
 ASTM D 2197 Adhesion of Organic Coatings by Scrape Adhesion
 ASTM D 2244 Calculation of Color Differences from Instrumentally Measured Color Coordinates
 ASTM D 2247 Water Resistance of Coatings in 100% Relative Humidity
 ASTM D 2370 Tensile Properties of Organic Coatings
 ASTM D 2805 Hiding Power of Paints by Reflectometry
 ASTM D 3363 Film Hardness by Pencil Test
 ASTM G 53 Operating Light- and Water-Exposure Apparatus (Fluorescent UV-Condensation Type) for Exposure of Nonmetallic Materials
 ASTM G 85 Modified Salt Spray (Fog) Testing

2.3 U.S. Government Publications:

Available from DODSSP, Subscription Services Desk, Building 4D, 700 Robbins Avenue, Philadelphia, PA 19111-5094.

FED-STD-141	Paints, Varnish, Lacquer and Related Materials, Methods of Inspection, Sampling and Testing
TT-P-2756	Polyurethane Coating: Self-priming Topcoat, Low Volatile Organic Compounds (VOC) Content
TT-P-2760	Primer Coating: Polyurethane, Elastomeric, High-Solids
MIL-A-8625	Anodic Coatings for Aluminum and Aluminum Alloys
MIL-C-5541	Chemical Conversion Coatings on Aluminum and Aluminum Alloys
MIL-PRF-5606	Hydraulic Fluid, Petroleum Base, Aircraft Missile and Ordinance
MIL-P-25421	Plastic Materials, Glass Fiber Base Epoxy Resin, Low Pressure Laminated
MIL-PRF-7808	Lubricating Oil, Aircraft Turbine Engine, Synthetic Base
MIL-PRF-23377	Primer Coatings: Epoxy, High Solids
MIL-PRF-23699	Lubricating Oil, Aircraft Turbine Engine, Synthetic Base, NATO Code Number 0-156
MIL-PRF-83282	Hydraulic Fluid, Fire Resistant, Synthetic Hydrocarbon Base, Aircraft, Metric, NATO Code Number H-537
MIL-PRF-85285	Coating: Polyurethane, High Solids
MIL-PRF-85582	Primer Coatings, Epoxy, Waterborne

3. TECHNICAL REQUIREMENTS:

3.1 General:

- 3.1.1 Material: The material shall consist of clear or pigmented polymeric film, with a pressure sensitive adhesive applied to one side. The adhesive backing shall have a suitable protective liner which shall be easily removed without the use of solvents or water and without distortion of the film. The film and adhesive system shall be free of constituents which may have corrosive effects on substrates under normal operating conditions.
- 3.1.2 Odor: The material odor shall not be obnoxious or cause discomfort to personnel during the application.
- 3.1.3 Toxicity: The manufacturer shall certify that the film material furnished under this specification will have no adverse effect on the health of personnel, when used for its intended purpose.

3.2 Properties:

The film when applied in accordance with the manufacturer's instructions shall conform to the following requirements, and in accordance with test methods in Table 1.

TABLE 1 - Material Requirements

PROPERTY	Type 1 Requirements	Type 2 Requirements	Test Requirements
Odor	3.1.2	3.1.2	***
Toxicity	3.1.3	3.1.3	***
Cleanability	3.2.1	3.2.1	4.5.2
Thickness	3.2.2	3.2.2	4.5.3
Color	3.2.3	3.2.3	4.5.4
Infrared Reflectance	***	3.2.3.1	4.5.4.1
Gloss	3.2.3.2	3.2.3.2	4.5.4.2
Hiding Power	3.2.4	3.2.4	4.5.5
Perforations	3.2.5	3.2.5	***
Hardness	3.2.6	3.2.6	4.5.6
Conformability	3.2.7	3.2.7	4.5.7
Shrinkage	3.2.8	3.2.8	4.5.8
Abrasion	3.2.9	3.2.9	4.5.9
Flexibility			
Impact Elongation	3.2.10.1	3.2.10.1	4.5.10.1
Low Temperature	3.2.10.2	3.2.10.2	4.5.10.2
Free Film Elongation	3.2.10.3	3.2.10.3	4.5.10.3
Adhesion			
Room Temperature	3.2.11.1	3.2.11.1	4.5.11.1
Low Temperature	3.2.11.2	3.2.11.2	4.5.11.2
High Temperature	3.2.11.3	3.2.11.3	4.5.11.3
Scrape Adhesion	3.2.11.4	3.2.11.4	4.5.11.4
Wet Tape Test	3.2.11.5	3.2.11.5	4.5.11.5
Adhesion After Aging	3.2.11.6	3.2.11.6	4.5.11.1
Compatibility			
With Primers	3.2.12.1a	3.2.12.1b	4.5.12.1
With Topcoats	3.2.12.2a	3.2.12.2b	4.5.12.2
Film Adhesion to Itself	3.2.12.3	3.2.12.3	4.5.12.3
Paint Adhesion on Film	3.2.12.4	3.2.12.4	4.5.12.4

TABLE 1 - Material Requirements (Continued)

PROPERTY	Type 1 Requirements	Type 2 Requirements	Test Requirements
Fluid resistance			
AS1241/MIL-PRF-83282	3.2.13a-1	***	4.5.13
Oil MIL-PRF-7808	3.2.13a-2	***	4.5.13
Hydraulic Fluid			
MIL-PRF-5606	3.2.13a-3	***	4.5.13
Reference Fuel B	3.2.13a-4	***	4.5.13
ASTM D 471			
Lubricating Oil	***	3.2.13b-1	4.5.13
MIL-PRF-23699			
Hydraulic Fluid	***	3.2.13b-2	4.5.13
Mil-PRF-83282			
Humidity Resistance	3.2.14	3.2.14	4.5.14
Heat Resistance	3.2.15	3.2.15	4.5.15
Weather resistance			
Xenon-Arc	3.2.16.1a	3.2.16.1a	4.5.16a
Atlas UVCON or equivalent	3.2.16.1b	***	4.5.16b
Corrosion Resistance			
Salt Spray	3.2.17.1a,b	3.2.17.1c	4.5.17
Filiform	3.2.17.2	3.2.17.2	4.5.18
Sulfur Dioxide/Salt			
Spray	***	3.2.17.3	4.5.19
Rain Erosion Resistance	3.2.18	3.2.18	4.5.20
Strippability	3.2.19	3.2.19	4.5.21
Shelf Life	3.2.20	3.2.20	***

- 3.2.1 Cleanability: The film shall have 90% minimum cleaning efficiency when tested in accordance with 4.5.2.
- 3.2.2 Thickness: The film thickness, including the adhesive, shall not exceed 0.13 mm (0.005 inch). The thickness shall be tested in accordance with 4.5.3.
- 3.2.3 Color: The protective film shall be furnished in the color specified by the procuring activity with good visual match to the specified color chip in daylight. The maximum deviation from the specified color chip shall be Delta E value of 1 when tested in accordance with paragraph 4.5.4.
- 3.2.3.1 Infrared Reflectance (for Type 2 only): The infrared reflectance of lusterless colors, when specified by the procuring activity, shall be tested per 4.5.4.1 and shall conform to the limits in Table 2:

TABLE 2 - Infrared Reflectance

Wavelength (nm)	Maximum Reflectance (%)
450-500	8
500-600	10
600-2700	8

- 3.2.3.2 Gloss: The specular gloss of the film at a 60° angle of incidence when tested per 4.5.4.2 shall be as follows in Table 3:

TABLE 3 - Specular Gloss

Specular Gloss	Requirement
Gloss Colors	Minimum of 90
Semi-Gloss	15-45
Lusterless (Flat)	Maximum of 3

- 3.2.4 Hiding Power: The applied film material shall have the following minimum contrast ratios in Table 4 at the required film thickness, less than 0.13 mm (0.005 inch), when tested in accordance with 4.5.5:

TABLE 4 - Hiding Power

Film Color	Contrast Ratio
Light Colors	0.96 minimum
Dark Colors	1.00 minimum

- 3.2.5 Perforations: When the film is perforated, the perforation shall not adversely affect the performance of the film as required by this specification. The perforated and non-perforated film material shall pass all qualification requirements of this specification.
- 3.2.6 Hardness: The minimum film hardness shall be HB when tested in accordance with 4.5.6.
- 3.2.7 Conformability: The film, when tested in accordance with 4.5.7, shall be smooth, free from wrinkles, air bubbles, tenting (forming a tent over a rivet head), and any other irregularities. The maximum non-conformability of the filmed area shall be no more than 1% of the total film area.
- 3.2.8 Shrinkage: The film material tested in accordance with 4.5.8 shall not exceed 0.40 mm (0.016 inch) shrinkage in any one direction.
- 3.2.9 Abrasion: The film when tested per 4.5.9 shall be capable of withstanding 750 revolutions without wearing through to the adhesive.

3.2.10 Flexibility:

3.2.10.1 Impact Elongation: The protective film shall exhibit a minimum impact elongation of 60% at room temperature, when tested in accordance with 4.5.10.1, without cracking, crazing, flaking or any adhesion failure when examined under 10X magnification.

3.2.10.2 Low Temperature Flexibility: The protective film shall not exhibit any cracking or delamination under 10X examination when bent over a mandrel in accordance with 4.5.10.2.

3.2.10.3 Free Film Elongation: The free film elongation shall be 50% minimum when tested in accordance with 4.5.10.3.

3.2.11 Adhesion:

3.2.11.1 Adhesion at Standard Room Conditions: The film shall have a minimum of 0.438 N/mm (40 oz/in) adhesion when tested in accordance with 4.5.11.1 at standard room temperature.

3.2.11.2 Adhesion at Low Temperature: The film shall have a minimum of 0.383 N/mm (35 oz/in) adhesion when tested in accordance with 4.5.11.2. The testing shall be performed in the cold chamber after conditioning the specimens for 24 hours at $-50\text{ }^{\circ}\text{C} \pm 3$ ($-60\text{ }^{\circ}\text{F} \pm 5$).

3.2.11.3 Adhesion at High Temperature: The film shall be capable of withstanding 8 hours at $149\text{ }^{\circ}\text{C} \pm 3$ ($300\text{ }^{\circ}\text{F} \pm 5$) with no separation of adhesive from the substrate when tested in accordance with 4.5.11.3.

3.2.11.4 Scrape Adhesion Test: The protective film shall resist removal from the substrate when tested with a 3 kg (6.62 lb) weight in accordance with 4.5.11.4.

3.2.11.5 Wet Tape Test: The protective film shall not peel away from the substrate when tested in accordance with 4.5.11.5.

3.2.11.6 Adhesion After Aging: There shall be no loss of adhesion after aging in accordance with 3.2.17.1 and tested in accordance with 4.5.11.1.

3.2.12 Compatibility:

3.2.12.1 Compatibility with Primers: The film shall pass the adhesion requirements of 3.2.11.1 and 3.2.11.5 when tested in accordance with 4.5.12.1. Unless otherwise specified by the purchaser (See 8.1), the following primers shall be tested:

- a. For Type 1 Film only - BMS 10-79, and DMS 2104
- b. For Type 2 Film only - MIL-PRF-23377, MIL-PRF-85582, TT-P-2760.

- 3.2.12.2 Compatibility with Topcoats: The film shall pass the adhesion requirements of 3.2.11.1 and 3.2.11.5 when tested in accordance with 4.5.12.2. Unless otherwise specified by the purchaser (See 8.1), the following topcoats shall be tested:
- For Type 1 Film only - BMS 10-79/BMS 10-60 system, and DMS 2104/DMS 2112 system.
 - For Type 2 Film only - MIL-PRF-23377/MIL-PRF-85285 system, TT-P-2756.
- 3.2.12.3 Film Adhesion to Itself: The film shall pass the adhesion requirements of 3.2.11.1 when tested in accordance with 4.5.12.3.
- 3.2.12.4 Paint Adhesion on Film: The paint topcoats, MIL-PRF-85285 and BMS 10-60, shall pass the adhesion requirements of 3.2.11.4 when tested in accordance with 4.5.12.4.
- 3.2.13 Fluid Resistance: When tested in accordance with 4.5.13, the film shall withstand immersion in the fluids and conditions listed below without any failures such as blistering, cracking, peeling, or softening more than one pencil hardness decrease.
- For Type 1 only:
 - Hydraulic Fluids, AS1241, and MIL-PRF-83282: 30 days 24 °C ± 3 (75 °F ± 5)
 - Lubricating Oil MIL-PRF-7808, Grade 3: 14 days at 24 °C ± 3 (75 °F ± 5)
 - Hydraulic Fluid MIL-H-5606: 14 days at 24 °C ± 3 (75 °F ± 5)
 - Reference Fuel B, ASTM D 471: 14 days at 24 °C ± 3 (75 °F ± 5)
 - Fluid, Jet Reference, AMS 2629 Type I: 14 days at 24 °C ± 3 (75 °F ± 5)
 - For Type 2 only:
 - Lubricating Oil, MIL-PRF-23699: 24 hours at 121 °C ± 3 (250 °F ± 5)
 - Hydraulic Fluid, MIL-PRF-83282: 24 hours at 65 °C ± 3 (150 °F ± 5)
- 3.2.14 Humidity Resistance: The film shall not blister, soften, or peel after exposure for 30 days in a humidity chamber at 95% ± 5 relative humidity and 49 °C ± 3 (120 °F ± 5) when tested in accordance with 4.5.14.
- 3.2.15 Heat Resistance: After 1 hour heat exposure at 121 °C ± 3 (250 °F ± 5), the color change of the film shall not exceed a Delta E value of 1 when tested in accordance with 4.5.15. Also, the film shall exhibit no loss of adhesion, blistering, softening, or other defects.

3.2.16 Weather Resistance:

3.2.16.1 Accelerated Aging: When the film is exposed to the accelerated aging tests specified below, the specular gloss at 60° angle of incidence shall be a minimum of 80 for gloss colors, a minimum of 15 for semi-gloss colors and a maximum of 3 for lusterless colors. The maximum color change shall be a Delta E value of 1 or less, and there shall be no loss of adhesion when tested in accordance with 4.5.11.1.

- a. For Types 1 and 2: The film shall be exposed for 500 hours in a 6000 watt Xenon-arc Weatherometer in accordance with 4.5.16a. At the end of the test the film shall meet the requirements specified in this paragraph.
- b. For Type 1 only: The film when tested per 4.5.16b shall be exposed for 300 hours in Atlas UVCON Weathering Device or equivalent. At the end of this test the film shall meet the requirements of this paragraph.

3.2.17 Corrosion Resistance:

3.2.17.1 Salt Spray: The scribed film when tested in accordance with 4.5.17 for the time specified below shall show no corrosion, blistering, or lifting of the coating system beyond the edge of the scribe line.

- a. Type 1 only: 3000 hours (on specimens B with 1 coat urethane compatible primer such as BMS 10-79 and the film, see 8.1).
- b. Type 1 only: 500 hours (on specimens B and the film).
- c. Type 2 only: 2000 hours (on specimens A with 1 coat of MIL-PRF-23377 Type I, Class C and the film).

3.2.17.2 Filiform: The film shall show no corrosion extending more than 3.2 mm (0.125 inch) from the scribe line when tested in accordance with 4.5.18.

3.2.17.3 Sulfur Dioxide/Salt Spray (Type 2 only): The film shall withstand exposure for 500 hours, when tested in accordance with 4.5.19, without corrosion or loss of adhesion beyond 3.2 mm (0.125 inch) from the scribe line.

3.2.18 Rain Erosion Resistance: The film shall have maximum peel of 6.4 mm (0.25 inch) from the edge and shall have no erosion to substrate when tested in accordance with 4.5.20.

3.2.19 Strippability: The film shall transfer no adhesive to the substrate and the substrate shall be tack free upon removal of the film when tested in accordance with 4.5.21. There shall be no tearing of the film during removal.

3.2.20 Shelf Life: The film material, in its original packaged condition, shall meet all the requirements in this specification for a minimum of one year from date of manufacture when stored in a temperature range of 4 to 33 °C (40 to 90 °F).

3.3 Quality:

The film material, as received by the purchaser, shall be uniform in condition and quality, and free from blisters, foreign material, cracks, and other defects detrimental to the usage of the film.

4. QUALITY ASSURANCE PROVISIONS:

4.1. Responsibility for Inspection:

The manufacturer of the film material shall supply all samples for required tests and shall be responsible for performance of required tests. The purchaser reserves the right to sample and perform conformity testing necessary to ensure conformance to the requirements of this specification.

4.2 Classification of Tests:

4.2.1 Conformity Inspection: Conformity inspection shall consist of all requirements and tests specified in Section 3 and Table 1.

4.2.2 Acceptance Tests: Color (3.2.3), gloss (3.2.3.2), adhesion (3.2.11.1 and 3.2.11.5), are acceptance tests and shall be performed on each lot.

4.2.3 Preproduction Tests:

4.2.3.1 All technical requirements of Section 3 are preproduction tests and shall be performed prior to or on the initial shipment of the film to a purchaser, when a change in ingredients and/or processing requires reapproval as in 4.4.2, or purchaser deems confirmatory testing to be required.

4.3 Sampling and Testing:

Sampling and testing shall be performed as follows:

- 4.3.1 For Acceptance Tests: Sufficient film material shall be taken at random from each lot to perform all required tests. The number of determinations for each requirement shall be as specified in Table 5.

TABLE 5 - Sampling for Acceptance Tests

Requirement	Paragraph Reference	Number of Determinations
Color	3.2.3	1
Gloss	3.2.3.2	1
Adhesion	3.2.11.1	2
	3.2.11.5	2

- 4.3.1.1 A lot shall be all film material from the same batch of raw materials processed in one continuous run and presented for manufacturer's inspection at one time.
- 4.3.1.2 A statistical sampling plan, acceptable to purchaser, may be used in lieu of sampling as in 4.3.1.
- 4.3.2 For Preproduction Tests: Acceptable to purchaser.
- 4.4 Approval:
- 4.4.1 The film material shall be approved by the purchaser before the film material is supplied for production use, unless such approval is waived by the purchaser. Results of tests on production film material shall be essentially equivalent to those on the approved sample.
- 4.4.2 Manufacturer shall use ingredients and manufacturing processes on production film material which are essentially the same as those used on the approved sample. If necessary to make any change in ingredients or processing, manufacturer shall submit for reapproval a statement of the proposed changes in ingredients and/or processes and, when requested, sample film material. Production material made by the revised procedure shall not be shipped prior to receipt of reapproval.
- 4.5 Test Methods:
- 4.5.1 Preparation of Test Specimens:
- 4.5.1.1 Preparation of Test Panels: Test panels shall be prepared under laboratory conditions $25\text{ }^{\circ}\text{C} \pm 1$ ($77\text{ }^{\circ}\text{F} \pm 3$) unless otherwise specified in this specification. Unless otherwise specified test panels shall be fabricated of aluminum alloy with dimensions of $0.50\text{ mm} \times 76.2\text{ mm} \pm 3 \times 152.4\text{ mm} \pm 3$ ($0.020\text{ inch} \times 3\text{ inch} \pm 0.125 \times 6\text{ inch} \pm 0.125$) and shall be pretreated with chromate conversion coating in accordance with MIL-C-5541 Class 1A and primed with one coat of MIL-PRF-23377, thickness 0.18 to 0.23 mm (0.0007 to 0.0009 inch). Panel composition shall be in accordance with Table 6.

TABLE 6 - Test Panel Compositions

Panel	Substrate
A	AMS-QQ-A-250/4, T3 temper unless otherwise specified
B	AMS-QQ-A-250/5

4.5.1.2 Application of Film: Clean the surface of the test panel with isopropyl alcohol. Wipe the surface of the test panels dry with lint free paper or cloth. Remove the protective liner from the film. Apply film starting at one end of the panel, securing contact progressively toward the other end, avoiding wrinkling and air entrapment. Once in place, roll the film down with two passes from a rubber covered roller weighing 2.0 kg (4.5 lb). Do not try to move the film material after it has been rolled. The filmed test panels shall be conditioned for 24 hours at standard room conditions before testing.

4.5.2 Cleanability:

4.5.2.1 Apparatus:

- a. Test panels A of Table 6.
- b. One quart (1 liter) wide-mouth, glass jars (one for each soil prepared).
- c. Balance, accurate to 0.1 g.
- d. High shear mixer, such as Cowles dispersator.
- e. Grease worker, mechanical (see ASTM D 217, Annex A 1.3).
- f. Acid brushes.
- g. Rubber roller, 2270 g \pm 50 (5 lb \pm 0.1).
- h. Forced draft oven capable of 105 °C \pm 2 (221 °F \pm 4).
- i. Colorimeter, such as a McBeth Model, MC-1010S, supplied by Kollmorgen Corporation, Newburgh, NY.
- j. Wear tester, such as Cat. No. WG 6700 (Gardner Heavy Duty Wear Tester) supplied by Pacific Scientific, Bethesda, MD.
- k. Hog bristle brushes, such as Cat. No. AG 8111 supplied by Pacific Scientific, Bethesda, MD.
- l. Template for positioning panels on the wear tester (see Figure 1).
- m. Cellulose sponge backed with nylon web, such as Cat. No. 63 supplied by 3M Company, Minneapolis, MN.

4.5.2.2 Preparation of Artificial Soil: Place 50 g \pm 0.5 of carbon black (such as Raven 1040 supplied by Columbian Chemical Company, New York, NY or equivalent) and 500 g \pm 1 of MIL-PRF-83282 hydraulic fluid in a one quart jar. Homogenize the soil using a high-shear mixer for 15 minutes. Stir or shake the mixture by hand prior to each application of the soil.

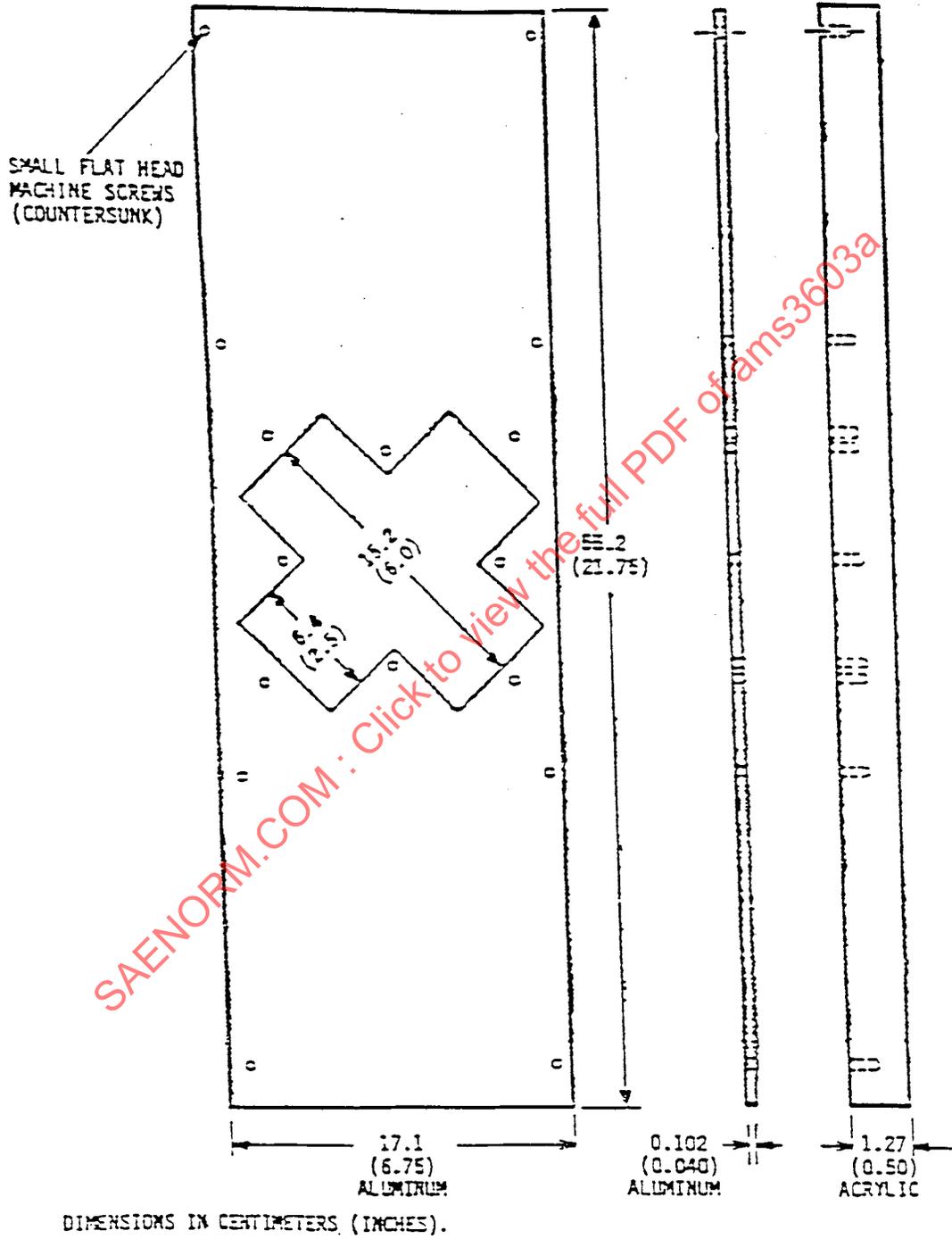


FIGURE 1 - Template for the Wear Tester

- 4.5.2.3 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 (See Table 7).

TABLE 7 - Control Formula Cleaner

Ingredients	Composition by Weight (%)
Witconate 1260 ¹	5.0
Igepal CO-630 ²	10.0
Sodium Xylene Sulfonate (40% active)	5.0
Diethylene Glycol Mono-Butyl Ether	5.0
Tetrapotassium Pyrophosphate	5.0
Reagent Water, ASTM D 1193	70.0

¹Witconate 1260 supplied by Witco Chemical Corporation of New York, NY

²Igepal CO-630 supplied by GAF Corporation of Wayne, NJ

- 4.5.2.4 Preparation of Test Panels: Using a clean, hog bristle brush, lightly scrub the film surface of each test panel with a 1.0% (by weight) solution of Alconox detergent (Alconox detergent supplied by Alconox, Inc., New York, NY), or equivalent in reagent water ASTM D 1193, Type IV, less than 50 ppm total solids. Rinse each test panel thoroughly three times using reagent water. Dry for 18 hours at $49\text{ }^{\circ}\text{C} \pm 2$ ($120\text{ }^{\circ}\text{F} \pm 4$). Measure the lightness value (L-value in L-a-b color system) of the test panel film surface and record this value as A (average of minimum of 3 readings), the L-value for the unsoiled test panel. Using a soft-bristle acid brush, coat the film surface of a test panel with the soil. Remove excess soil by covering the test panel surface with folded absorbent tissue and exerting pressure by rolling the tissue with a 4.5 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 $105\text{ }^{\circ}\text{C} \pm 2$ ($221\text{ }^{\circ}\text{F} \pm 4$) for 60 ± 1 minutes. Measure the lightness value of the soiled film surface and record this value as B (average of a minimum of 3 readings), the L-value for the soiled test film.
- 4.5.2.5 Procedure: Dilute the cleaner as required using reagent water ASTM D 1193, Type IV, 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 90 mm (3.5 inches) and the width is 70 mm (2.75 inches). When the dry sponge is attached to the cleaning head of the wear tester, the combined weight shall be no less than 1350 grams and no more than 1400 grams. (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 a 45° angle (see Figure 1). Saturate the sponge and cover the test panel with the diluted cleaner. After 60 ± 5 seconds, 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 film surface and record this value as C (average of a minimum of 3 readings), the L-value for the cleaned test panel film.

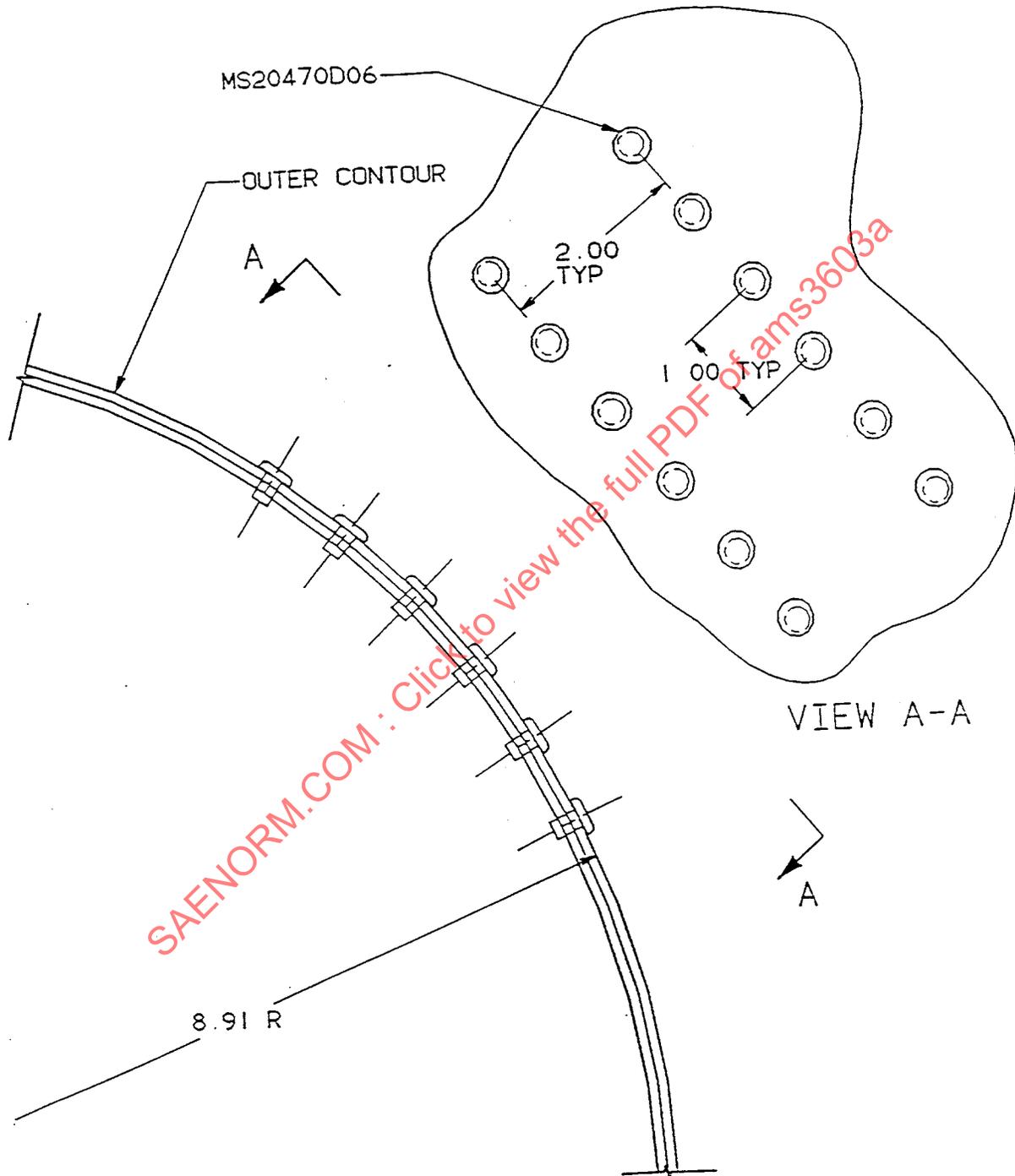


FIGURE 2 - Riveted Panel for the Conformity Test

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

$$\text{Cleaning efficiency (\%)} = \frac{C - B}{A - B} \times 100 \quad (\text{Eq. 1})$$

Where:

A = lightness value of unsoiled test panel (4.5.2.4)

B = lightness value of soiled test panel (4.5.2.4)

C = lightness value of cleaned test panel (4.5.2.5)

4.5.3 Thickness: Strips of the film, approximately 2.5 cm x 15 cm (1 inch x 6 inch), shall be cut from the roll or sheet. The protective liner shall be removed and the film applied to a 0.025 mm (0.001 inch) thick strip of aluminum foil of the same dimension. The film shall be rolled down firmly. Four micrometer (or equivalent instrument) readings at random locations on the film shall be taken from each strip. All the measurements shall be less than 0.127 mm (0.005 inch) after the subtraction of the aluminum foil thickness.

4.5.4 Color: The color shall be tested in accordance with ASTM D 2244 for conformance to the requirements of 3.2.3.

4.5.4.1 Infrared Reflectance: The total infrared reflectance (specular and diffuse) shall be determined relative to barium sulfate, using a spectrophotometer such as a Perkin-Elmer LAMBDA 9 for conformance to the requirements of 3.2.3.1.

4.5.4.2 Gloss: Five strips of the film material, each 7.5 cm x 15 cm (3 inch x 6 inch) shall be cut and stabilized at standard conditions for 24 hours. The gloss of the film on each strip shall be tested in accordance with ASTM D 523 and shall conform to the requirements of 3.2.3.2.

4.5.5 Hiding Power: The film shall be tested in accordance with ASTM D 2805 and shall conform to the requirements of 3.2.4.

4.5.6 Hardness: The test panels shall be prepared in accordance with 4.5.1 using Panel A as in Table 6. The film hardness shall be tested in accordance with ASTM D 3363 and conform to the requirements of 3.2.6.

4.5.7 Conformability: Apply film over a button head riveted Alclad 2024-0 (annealed) 0.040 inch gage panel (Figure 2) with contour in accordance with the application specification and inspect visually for conformance to the requirements of 3.2.7. The panel shall be chromate conversion coated and primed in accordance with 4.5.1.1 prior to film installation.

4.5.8 Shrinkage: A strip of film material 16.5 cm x 16.5 cm (6.5 inch x 6.5 inch) shall be applied over the entire surface of a 15 cm x 15 cm (6 inch x 6 inch) AMS-QQ-A-250/4 aluminum test panel in accordance with 4.5.1.2 and trimmed to the dimensions of the test panel. The test panels shall then be baked at 65 °C ± 3 (150 °F ± 5) for a period of 48 hours. Allow test panels to cool to room temperature and examine for shrinkage (contraction of the film from the edge of the panel and appearance of adhesive). Shrinkage shall conform to the requirements of 3.2.8.