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INTERNATIONAL
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AEROSPACE MATERIAL SPECIFICATION

SAE AMS 3166B

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Superseding AMS 3166A

Submitted for recognition as an American National Standard

(R)

Solvents, Cleaning
Cleaning Prior to Application of Sealing Compounds

FOREWORD

This document is being reissued to reflect the proper revision letter.

1. SCOPE:

1.1 Form:

This specification covers liquid cleaning solvents.

1.2 Application:

These solvents are used typically to cleaning aircraft primary and secondary structural surfaces prior to application of adhesion promoters and/or sealing materials, but usage is not limited to such applications.

1.3 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.

2. APPLICABLE DOCUMENTS:

The following publications form a part of this specification to the extent specified herein. The latest issue of SAE publications shall apply. The applicable issue of other publications shall be the issue in effect on the date of the purchase order.

QUESTIONS REGARDING THIS DOCUMENT: (724) 772-7161 FAX: (724) 776-0243
TO PLACE A DOCUMENT ORDER: (724) 776-4970 FAX: (724) 776-0790
SAE WEB ADDRESS: http://www.sae.org

2.1 SAE Publications:

Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001.

AMS 2473	Chemical Treatment for Aluminum Alloys, General Purpose Coating
AMS 2629	Fluid, Jet Reference
AMS 3276	Sealing Compound, Integral Fuel Tanks and General Purpose, Intermittent Use to 360 °F (182 °C)
AMS 3100	Adhesion Promoter for Polysulfide Sealing Compounds
AMS 3375	Adhesive/Sealant, Fluorosilicone, Aromatic Fuel Resistant, One-Part, Room Temperature Vulcanizing
AMS 3819	Cloths, Cleaning, for Aircraft Primary and Secondary Structural Surfaces
AMS 4101	Aluminum Alloy Plate, 4.4Cu - 1.5Mg - 0.60Mn (2124-T851) Solution Heat Treated, Stretched, and Precipitation Heat Treated
AMS 4202	Aluminum Alloy Plate, 5.7Zn - 2.2Mg - 1.6Cu - 0.22Cr, (7475-T7351) Solution Heat Treated, Stress Relieved by Stretching, and Precipitation Heat Treated
AMS 6419	Steel Bars, Forgings, and Tubing, 1.6Si - 0.82Cr - 1.8Ni - 0.40Mo - 0.08V (0.40-0.45C), Consumable Electrode Vacuum Remelted
AMS-QQ-A-250/4	Aluminum Alloy, 2024, Plate and Sheet

2.2 ASTM Publications:

Available from ASTM, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959.

ASTM D 740	Methyl Ethyl Ketone
ASTM D 1193	Reagent Water
ASTM D 1218	Refractive Index and Refractive Dispersion of Hydrocarbon Liquids
ASTM D 1296	Odor of Volatile Solvents and Diluents
ASTM D 1364	Water in Volatile Solvents (Fischer Reagent Titration Method)
ASTM D 1475	Density of Paint, Varnish, Lacquer, and Related Products
ASTM D 1613	Acidity in Volatile Solvents and Chemical Intermediates Used in Paint, Varnish, Lacquer, and Related Products
ASTM D 3278	Flash Point of Liquids by Setaflash-Closed-Cup Apparatus
ASTM D 3545	Alcohol Content and Purity of Acetate Esters by Gas Chromatography
ASTM D 3960	Determining Volatile Organic Compound (VOC) Content of Paints and Related Coatings
ASTM D 4420	Aromatics in Light Napthas, and Aviation Gasolines by Gas Chromatography
ASTM G 38	Making and Using C-Ring Stress-Corrosion Cracking Test Specimens

2.3 U.S. Government Publications:

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

CCC-C-419	Cloth, Duck, Unbleached, Plied Yarns, Army and Numbered
A-A-58054	Abrasive Mats, Non-Woven, Non-Metallic
MIL-PRF-23377	Primer Coatings: Epoxy, High Solids
MIL-C-27725	Coating, Corrosion Preventive, for Aircraft Integral Fuel Tanks
MIL-PRF-85582	Primer Coatings, Epoxy, Water Borne
MIL-STD-290	Packaging of Petroleum and Related Products
TT-E-751	Ethyl Acetate, Technical
TT-I-735	Isopropyl Alcohol
TT-N-97	Naptha, Aromatic
FED-STD-1313	Material Safety Data Sheets, Preparation of

3. TECHNICAL REQUIREMENTS:

3.1 Material:

The cleaning solvent shall be a liquid formulated to meet the requirements of 3.2 and 3.3. Purchaser shall specify requirements for vapor pressure and volatile organic compound (VOC) content as required to meet local air quality requirements.

3.2 Properties:

The cleaning solvent shall conform to the requirements shown in Table 1.

TABLE 1 - Properties

Paragraph	Property	Requirement	Test Method
3.2.1	Composition	Same as data determined on preproduction test sample	4.5.6
3.2.2	Odor	Characteristic of solvents, used, not offensive to users, no residual odor	ASTM D 1296
3.2.3	Refractive Index	Preproduction value ±2%	ASTM D 1218
3.2.4	Density	Preproduction value ±2%	ASTM D 1475
3.2.5	Acidity	0.05% maximum, expressed as acetic acid	ASTM D 1613
3.2.6	Vapor Pressure, mm Hg	To be specified by purchaser	4.5.7
3.2.7	VOC, grams/L	To be specified by purchaser	4.5.8
3.2.8	Flash Point	100 °F (38 °C) minimum	ASTM D 3278
3.2.9	Visible Dry Residue	No more residual contamination and/or streaking than the control solvent	4.5.9
3.2.10	Stress Corrosion	No corrosion	4.5.10
3.2.11	Cleaning Prior to Sealing	20 pounds force per inch (3502 N/m) width, 100% cohesive failure for AMS 3276 sealant 8 pounds force per inch (1401 N/m) width, 100% cohesive failure for AMS 3375 sealant	4.5.11.1
3.2.12	Removal of Uncured Sealant	Sealant removal same as control solvent	4.5.11.2
3.2.13	Removal of A MS 3100 Adhesion Promoter	Promoter removal same as control solvent	4.5.11.3
3.2.14	Appearance	All components shall be miscible	4.5.12

3.3 Quality:

The cleaning solvent, as received by purchaser, shall be uniform in quality and condition, and free from foreign materials and from other contaminants detrimental to usage of the product.

4. QUALITY ASSURANCE PROVISIONS:

4.1 Responsibility for Inspection:

The manufacturer of the cleaning solvent shall supply all samples for supplier's tests and shall be responsible for performance of all required tests. Purchaser reserves the right to sample and to perform any confirmatory testing deemed necessary to ensure that the product conforms to the requirements of this specification.

4.2 Classification of Tests:

4.2.1 Acceptance Tests: Tests for requirements shown in Table 2 are acceptance tests and shall be performed on each lot.

TABLE 2

Requirement	Reference Paragraph
Composition	3.2.1
Refractive Index	3.2.3
Density	3.2.4
Acidity	3.2.5
Vapor Pressure	3.2.6
Visible Dry Residue	3.2.9

4.2.2 Preproduction Tests: All technical requirements are preproduction tests and shall be performed prior to or on the initial shipment of cleaning solvent to a purchaser, when a change in ingredients and/or processing requires reapproval as in 4.4.2, and when purchaser deems confirmatory testing to be required.

4.2.2.1 For direct U.S. Military procurement and for procurement for use on U.S. Military contracts, material shall be a product which has been tested, has passed the qualification tests of 4.2.2 (See 8.2), and has been listed or approved for listing on the applicable U.S. Military qualified products list (QPL).

4.3 Sampling and Testing:

Shall be as follows:

4.3.1 For Acceptance Tests: Sufficient cleaning solvent 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 the applicable test procedure or, if not specified therein, not less than three.

4.3.1.1 A lot shall be all cleaning solvent produced in a single production run from the same batch of raw materials under the same fixed conditions and presented for vendor's inspection at one time. A lot cleaning solvent shall not exceed 10,000 gallons (37,850 L).

4.3.1.2 When a statistical sampling plan has been agreed upon by purchaser and supplier, sampling shall be in accordance with such plan in lieu of sampling as in 4.3.1 and the report of 4.6 shall state that such plan was used.

4.3.2 For Preproduction Tests: As agreed upon by purchaser and supplier.

4.4 Approval:

4.4.1 Preproduction sample of cleaning solvent shall be approved by purchaser before cleaning solvent for production use is supplied, unless such approval be waived by purchaser. Results of tests on production cleaning solvent shall be essentially equivalent to those on the approved sample.

4.4.1.1 For direct U.S. Military procurement and for procurement for use on U.S. Military contracts, the material shall be listed, or approved for listing, on the applicable U.S. Military qualified products list (QPL).

4.4.2 Manufacturer shall use ingredients, manufacturing procedures, processes, and methods of inspection on production cleaning solvent which are essentially the same as those used on the approved sample. If necessary to make any change in ingredients, in type of equipment for processing, or in manufacturing procedures, manufacturer shall submit for reapproval a statement of the proposed changes in ingredients and/or processing and, when requested, a sample of cleaning solvent. Production cleaning solvent made by the revised procedure shall not be shipped prior to receipt of reapproval.

4.5 Test Methods:

4.5.1 Standard Conditions: Standard laboratory conditions are 77 °F ± 2 (25 °C ± 1) and 50% ± 5 relative humidity. All test specimens shall be prepared and cured under these conditions. In addition, all uncured property tests shall be conducted under these conditions. Other tests may be conducted at 77 °F ± 5 (25 °C ± 3) with no control on humidity.

4.5.2 Standard Cure: Except as otherwise specified herein, all reference to a standard cure shall be 14-days under the standard conditions specified in 4.5.1.

4.5.3 Control Cleaning Solvent: The control solvent shall be composed as shown in Table 3:

TABLE 3

Component	Specification	Percent by Volume
Aromatic Naptha	TT-N-97 Type I, Grade B	50.0 ± 2.0
Ethyl Acetate	TT-E-751	20.0 ± 1.0
Methyl Ethyl Ketone	ASTM D 740	20.0 ± 1.0
Isopropanol	TT-I-735	10.0 ± 1.0

4.5.4 Standard Contaminant: Standard contaminant shall be formulated as shown in Table 4.

TABLE 4 - Standard Contaminant

Ingredient	Parts by Weight
Glycerol Monosterate	3.0
Glycerol Trioleate	9.0
Caprylic Acid	3.0
Lauryl Alcohol	1.3
Cholesterol	1.2
Mineral Oil	2.7
Petrolatum	3.0
Lecithin	0.3
Water	70.0

Notes: Heat and blend and add 0.5 parts by weight lamp black.
Do not heat above 200 °F (93 °C)

4.5.5 Test Substrates: Test substrates as required shall be as specified below. Test panel sizes shall be nominally 0.040 x 2.75 x 6 inches (1.02 x 69.8 x 152 mm). Aluminum alloy panels shall conform to AMS-QQ-A-250/4, -T81 or -T3 with chemical film applied in accordance with AMS 2473.

4.5.5.1 MIL-C-27725 Coating: Aluminum alloy panels as in 4.5.5 shall be coated with MIL-C-27725 corrosion preventive coating, in accordance with manufacturer's instructions, to produce a dry film thickness of 0.0008 to 0.0015 inch (20 to 38.1 µm) or (0.020 to 0.038 mm) and cured for not less than 14 days at standard conditions.

4.5.5.2 MIL-PRF-23377 Primer: Aluminum alloy panels as in 4.5.5 shall be coated with MIL-PRF-23377 epoxy primer, in accordance with manufacturer's instructions, to produce a dry film thickness of 0.0006 to 0.0009 inch (15 to 23 µm) or (0.015 to 0.023 mm) and cured for not less than 14 days at standard conditions.

4.5.5.3 MIL-PRF-85582 Primer: Aluminum alloy panels as in 4.5.5 shall be coated with MIL-P-85582 epoxy primer, in accordance with manufacturer's instructions, to produce a dry film thickness of 0.0006 to 0.0009 inch (15 to 23 µm) or (0.015 to 0.023 mm) and cured for not less than 14 days at standard conditions.

4.5.5.4 Graphite Epoxy: Graphite epoxy panels shall be fabricated using eight plies of Hercules Epoxy-Graphite AS 4/3501-6, unidirectional tape laid (0,45,90,135) symmetrical. Cure shall be as follows.

4.5.5.4.1 Install peel ply to plate surface of laminate. Nylon peel ply is acceptable. Install peel ply to bag surface of laminate. Apply not less than 28 inches (711 mm) Hg vacuum and 85 psi ± 5 (586 kPa ± 34) pressure. Heat to 225 °F ± 5 (107 °C ± 3) at 1 to 4 F (0.6 to 2 C) degrees per minute. Hold at 225 °F ± 5 (107 °C ± 3) for 60 minutes ± 5. Heat to 350 °F ± 10 (177 °C ± 6) at 1 to 4 F (0.6 to 2 C) degrees per minute. Hold at 350 °F ± 10 (177 °C ± 6) for 120 ± 5 minutes. Cool to 150 °F ± 5 (66 °C ± 3) while maintaining vacuum and pressure. Return to atmospheric pressure and allow to cool to room temperature.

4.5.5.5 AMS 3276 Sealant Coating: Aluminum alloy panels as in 4.5.5.1 shall be cleaned by scrubbing and rinsing with the control solvent (4.5.3) using AMS 3819, Grade A cleaning cloths. After cleaning with the control solvent, panel surfaces shall be wiped dry with clean AMS 3819, Grade A, cleaning cloth and allowed to dry for not less than 30 minutes at standard conditions. The panel shall then be coated with AMS 3276 manganese dioxide curing sealant to an approximate thickness of 0.125 inch (3.18 mm) and cured for not less than 14 days at standard conditions.

4.5.5.6 AMS 3375 Fluorosilicone Sealant Coating: Aluminum alloy panels as in 4.5.5.1 shall be cleaned by scrubbing and rinsing with the control solvent (4.5.3) using AMS 3819, Grade A cleaning cloths. After cleaning with the control solvent, panel surfaces shall be wiped dry with clean AMS 3819, Grade A, cleaning cloth and allowed to dry for not less than 30 minutes at standard conditions. The panel shall be primed with AMS 3375 primer and coated with AMS 3375 fluorosilicone sealant to an approximate thickness of 0.125 inch (3.18 mm) and cured for not less than 14 days at standard conditions.

4.5.6 Composition: Determine the composition of the cleaning solvent in accordance with ASTM D 3545 modified to apply to the solvent used in the material. Use a 10% FFAP Chromasorb 10 foot (30.5 m) column or equivalent. Determine the water content in accordance with ASTM D 1364.

4.5.7 Vapor Pressure: The vapor pressure of the volatile organic compounds (VOC) in the solvent at 68 °F (20 °C) shall be calculated from Equation 1.

$$P_{voc} = \frac{\sum_{i=1}^{n} \left(\frac{P_i \times W_i}{M_i}\right)}{\sum_{i=1}^{n} \left(\frac{W_i}{M_i}\right) + \sum_{j=1}^{m} \left(\frac{W_i}{M_i}\right)} \qquad \text{(Eq. 1)}$$

Basis: 68 °F (20 °C), consistent units

where:

P_{voc} = Calculated composite vapor pressure of volatile organic compounds (VOC) in the cleaning solvent at 68 °F (20 °C)
P_i = Vapor pressure of the pure “i” th component at 68 °F (20 °C)
$W_{i,j}$ = Weight in grams of the “i” th or “j” th component
$M_{i,j}$ = Molecular weight of the “i” th or “j” th component
i = Indicates VOC components in the cleaning solvent
j = Indicates exempt components in the cleaning solvent as defined by appropriate Federal, state, and local regulations
n = Number of VOC components
m = Number of exempt components

4.5.8 VOC Content: VOC content shall be calculated in accordance with ASTM D 3960 and expressed in grams per liter.

4.5.9 Visible Dry Residue: Clean two AMS-QQ-A-250/4 -T81 or -T3 aluminum alloy panels with the control solvent (4.5.3) using AMS 3819, Grade A, cloth. Apply 5 mL of the solvent cleaner under test to a pad 2 x 2 inches (51 x 51 mm) made with eight layers of AMS 3819, Grade A, cloth. Immediately clean one of the precleaned panels using gentle finger pressure and vigorous wiping speed for fifteen seconds. Clean the second precleaned panel, using a new pad, and the control solvent (4.5.3). Examine both panels visually for residual contamination and/or streaking.

4.5.10 Stress Corrosion: C-ring stress corrosion test shall be conducted in accordance with ASTM G 38 using AMS 4101 aluminum alloy, AMS 4202 aluminum alloy, and AMS 6419 steel stressed to 75% of yield strength. Exposure shall be 2000 hours immersed in the cleaning solvent.

4.5.11 Cleaning Efficiency:

4.5.11.1 Cleaning Prior to Sealing:

4.5.11.1.1 Apply standard contaminant (4.5.4) to test substrates 4.5.5.1, 4.5.5.2, 4.5.5.3, 4.5.5.4, 4.5.5.5, and 4.5.5.6 and expose to 120 °F ± 2 (49 °C ± 1) for 24 hours. Cool to room temperature and wipe panel surface to remove gross contaminant with AMS 3819, Grade A, cleaning cloth. Wet a clean AMS 3819, Grade A, cleaning cloth with candidate cleaning solvent and wipe panel surfaces five times using a clean wet cloth each time. Substrate 4.5.5.3 shall be additionally scuff sanded with abrasive mats conforming to A-A-53054, Type I, Class I, Grade A, followed by solvent cleaning using AMS 3819, Grade A, cloth in the manner described above. Air dry panels not less than 30 minutes at standard conditions.

4.5.11.1.2 Prepare peel strength specimens using substrates 4.5.5.1, 4.5.5.2, 4.5.5.3, and 4.5.5.4 by applying a 0.125 inch ± 0.016 (3.18 mm ± 0.41) thickness of AMS 3276, manganese dioxide curling sealant to the center 4 inches (102 mm) of the cleaned panel. Only a thin layer of sealant to wet the surface shall be applied to substrate 4.5.5.5. An optional configuration consists of coating the bottom approximate 5 inches (127 mm) of the panel with sealant (Figure 1). A 2.75 x 12 inch (69.8 x 305 mm) strip of aluminum woven wire screen, 15 to 20 mesh with wire diameter of 0.10 to 0.011 inch (0.25 to 0.28 mm) or cotton duck conforming to CCC-C-419, Type III, shall be impregnated with sealant so that approximately 4 inches (102 mm [5 inches (127 mm) for optional configuration] at one end is completely covered on both faces. The sealant shall be worked well into the screen or fabric. The sealant impregnated end of the screen or fabric shall be placed on the sealant coated panel and smoothed down on the layer of sealant, taking care not to trap air beneath the screen or fabric.

4.5.11.1.2.1 An additional approximately 0.125 inch (3.18 mm) thick coating of sealant shall be applied over the screen or fabric. Peel specimen configuration shall be as shown in Figure 1.

4.5.11.1.2.2 Substrate 4.5.5.6 shall be prepared the same as substrate 4.5.5.5 except the sealant used shall be AMS 3375.

4.5.11.1.3 Following standard cure, peel specimens prepared from substrate 4.5.5.1, 4.5.5.4, 4.5.5.5, and 4.5.5.6 shall be immersed in a covered glass vessel containing equal parts of AMS 2629 jet reference fluid and a 3% solution of salt water and exposed to 140 °F ± 2 (60 °C ± 1) for seven days. Substrates 4.5.5.2 and 4.5.5.3 shall be immersed in a covered glass vessel containing ASTM D 1193 Type IV, water at 140 °F ± 2 (60 °C ± 1) for seven days. Fluid to specimen ratio shall be approximately one panel per print (0.5 L) of fluid. Immersion in wide-mouth quart (liter) jars with two panels in each jar has been found suitable. After exposure, the specimens shall be cooled for 24 hours at room temperature in the fluid.

4.5.11.1.3.1 The peel strength of the condition panels shall be measured with 30 minutes after removal from the test fluid. Two one-inch (25 mm) wide sections shall be prepared by cutting completely through the sealant and fabric or screen to the panel, lengthwise, along the panel and continuing completely along the free end of the fabric. The specimens shall be stripped back at an angle of 180 degrees to the panel in a suitable tensile test machine. Jaw separation rate shall be two inches per minute (0.8 mm/s). During peel strength testing, three cuts shall be made through the sealant to the panel in an attempt to promote adhesive failure. The cuts shall be made at approximately one-inch (25-mm) intervals.

4.5.11.1.3.2 The peel strength for each specimen shall be the numerical average of the peak loads required to separate the strips of sealant from the test substrate or to cause cohesive failure of the sealant. Failure of the sealant to screen or fabric shall not be included in the peel strength values.

4.5.11.2 Removal of Uncured Sealant: Apply a thin coating, approximately 0.06 inch (1.5 mm), of AMS 3276, B2, sealant to a substrate in accordance with 4.5.5.1. Allow sealant to cure 2 hours ± 5 minutes at standard conditions (4.5.1), then clean the panel using AMS 3819, Grade A, cloth wet with cleaning solvent. Repeat test using control solvent (4.5.3).

4.5.11.3 Removal of AMS 3100 Adhesion Promoter: Apply AMS 3100/1 and AMS 3100/2 adhesion promoters to substrates in accordance with 4.5.5.1. Allow promoter films to dry 24 hours. Clean the panel using AMS 3819, Grade A, cloth wet with cleaning solvent. Repeat test using control solvent (4.5.3).

4.5.12 Appearance: The sample taken for acceptance tests as in 4.3.1 shall be visually examined and shall be free of separation or colloidal dispersion.

4.6 Reports:

The supplier of cleaning solvent shall furnish with each shipment a report from the manufacturer showing the results of tests to determine conformance to the acceptance test requirements and stating that the product conforms to the other technical requirements. This report shall include the purchase order number, lot number, AMS 3166A, manufacturer's name and product designation, date of manufacture, and quantity.

4.6.1 A material safety data sheet conforming to FED-STD-1313, or equivalent, shall be supplied to each purchaser prior to, or concurrent with, the report of preproduction test results or, if preproduction testing be waived by purchaser, concurrent with the first shipment of the product for production use. Each request for modification of product formulation shall be accompanied by a revised data sheet for the proposed formulation.