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AERONAUTICAL DESIGN STANDARD

PERFORMANCE SPECIFICATION

FOR

ARMY AIRCRAFT CLEANERS, AQUEOUS AND SOLVENT

AMSC N/A

ADS-61A-PRF

AERONAUTICAL DESIGN STANDARD

PERFORMANCE SPECIFICATION

CLEANERS, AQUEOUS AND SOLVENT, FOR ARMY AIRCRAFT

UNITED STATES ARMY AVIATION AND MISSILE COMMAND

AVIATION ENGINEERING DIRECTORATE

REDSTONE ARSENAL, ALABAMA

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Certification Record

Board Date:

Document Identifier and Title:

ADS-61A-PRF, Aeronautical Design Standard, Performance Specification, Cleaners, Aqueous and Solvent, for Army Aircraft

Rationale for Certification:

Decision:

General Type	**Decision** (√)	**Certification**
Specification		Performance
		Detail
Standard		Interface Standard
		Standard Practice
		Design Standard
		Test Method Standard
		Process Standard
Handbook		Handbook (non-mandatory use)
Alternative Action		

	Concur	Nonconcur	Date
Division Chief, Structures and Materials Kevin M. Rotenberger			
AMCOM Standardization Branch Chief William J. Smith			
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1. SCOPE

1.1 Scope. This specification covers the requirements for cleaners used on Army aircraft.

1.2 Classification. Aircraft cleaners covered by this specification are classified by the following types.

Type 1	- Water soluble cleaners
Type 2	- Organic solvents
Type 2A	- Halogenated organic solvents

2. APPLICABLE DOCUMENTS

2.1 General. The documents listed in this section are specified in sections 3 and 4 of this specification. This section does not include documents cited in other sections of this specification or recommended for additional information or as examples. While every effort has been made to ensure the completeness of this list, document users are cautioned that they must meet all specified requirements documents cited in sections 3 and 4 of this specification, whether or not they are listed.

2.2 Government documents.

2.2.1 Specifications, standards, and handbooks. The following specifications, standards, and handbooks form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those listed in the latest issue of the Department of Defense Index of Specifications and Standards (DoDISS) and supplement thereto.

FEDERAL SPECIFICATIONS

A-A-58054	Abrasive Mats, Non-Woven, Non-Metallic
O-M-232	Methanol (Methyl Alcohol)

DEPARTMENT OF DEFENSE SPECIFICATIONS

MIL-C-5541	Chemical Conversions Coatings on Aluminum and Aluminum Alloys
MIL-A-8625	Anodic Coatings for Aluminum and Aluminum Alloys
MIL-P-14105	Paint, Heat-Resisting (For Steel Surfaces)
MIL-PRF-22750	Coating, Epoxy, High-Solids
MIL-PRF-23377	Primer Coatings: Epoxy, High-Solids
MIL-C-46168	Coating, Aliphatic Polyurethane, Chemical Agent Resistant
MIL-PRF-81322	Grease, Aircraft, General Purpose, Wide Temperature Range
MIL-DTL-81381	Wire, Electric, Polyimide-Insulated, Copper or Copper Alloy
MIL-PRF-81733	Sealing and Coating Compound, Corrosion Inhibitive
MIL-PRF-83282	Hydraulic Fluid, Fire Resistant, Synthetic Hydrocarbon Base, Metric, NATO Code Number H-537
MIL-PRF-85285	Coating: Polyurethane, High-Solids
MIL-PRF-85582	Primer Coatings: Epoxy, Waterborne

FEDERAL STANDARDS

FED-STD-141	Paint, Varnish, Lacquer and Related Materials: Methods of Inspection, Sampling and Testing

(Application for copies should be addressed to the Standardization Document Order Desk, 700 Robbins Avenue, Building 4D, Philadelphia, PA 19111-5094.)

2.3 Non-Government publications. The following documents form a part of this document to the extent specified herein. Unless otherwise specified, the issues of the documents that are DoD adopted are those listed in the latest issue of the DoDISS and supplement thereto.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM D-740	Standard Specification for Methyl Ethyl Ketone
ASTM D-1193	Standard Test Method for Reagent Water
ASTM D-1353	Standard Test Method for Nonvolatile Matter in Volatile Solvents for Use in Paint, Varnish, Lacquer, and Related Products
ASTM D-2109	Standard Test Method for Nonvolatile Matter in Halogenated Organic Solvents and Their Admixtures
ASTM D-2240	Standard Test Method for Rubber Property - Durometer Hardness
ASTM D-3167	Standard Test Method for Floating Roller Peel Resistance of Adhesives
ASTM D-4080	Standard Specification for Trichloroethylene, Technical and Vapor-Degreasing Grade
ASTM D-4376	Standard Specification for Vapor-Degreasing Grade Perchloroethylene
ASTM E-1210	Standard Test Method for Fluorescent Liquid Penetrant Examination Using the Hydrophilic Post-Emulsification Process
ASTM E-1219	Standard Test Method for Fluorescent Liquid Penetrant Examination Using the Solvent-Removable Process
ASTM E-1417	Standard Practice for Liquid Penetrant Inspection
ASTM F-483	Standard Test Method for Total Immersion Corrosion Test for Aircraft Maintenance Chemicals
ASTM F-484	Standard Test Method for Stress Crazing of Acrylic Plastics in Contact with Liquid or Semi-Liquid Compounds
ASTM F-485	Standard Test Method for Effects of Cleaners on Unpainted Aircraft Surfaces
ASTM F-502	Standard Test Method for Effects of Cleaning and Chemical Maintenance Materials on Painted Aircraft Surfaces
ASTM F-519	Standard Test Method for Mechanical Hydrogen Embrittlement Testing of Plating Processes and Aircraft Maintenance Chemicals
ASTM F-945	Standard Test Method for Stress-Corrosion of Titanium Alloys by Aircraft Engine Cleaning Materials
ASTM F-1110	Standard Test Method for Sandwich Corrosion Test
ASTM F-1111	Standard Test Method for Corrosion of Low-Embrittling Cadmium Plate by Aircraft Maintenance Chemicals
ASTM G-30	Standard Practice for Making and Using U-Bend Stress-Corrosion Test Specimens
ASTM G-44	Standard Practice for Evaluating Stress Corrosion Cracking Resistance of Metals and Alloys by Alternate Immersion in 3.5% Sodium Chloride Solution

(Application for copies should be addressed to American Society for Testing and Materials, 100 Barr Harbor Drive, West Conshohocken, PA. 19428-2959)

SOCIETY OF AUTOMOTIVE ENGINEERS (SAE)

AMS 2629	Fluid, Jet Reference
AMS 2644	Inspection Materials, Penetrants
AMS-M-3171	Magnesium Alloy, Processes for Pretreatment and Prevention of Corrosion on
AMS 4377	Magnesium Alloy, Sheet & Plate, 3.01A-1.0ZN (AZ31B-H24)
AMS 5046	Sheet, Strip and Plate, Carbon Steel (SAE 1020 and 1025), Annealed
AMS-P-83310	Plastic Sheet, Polycarbonate, Transparent
ARP 1755	Effect of Cleaning Agents on Aircraft Engine Materials Stock Loss Test Method
AMS-S-8802	Sealing Compound, Temperature-Resistant, Integral Fuel Tanks and Fuel Cell Cavities, High Adhesion

(Application for copies should be addressed to Society of Automotive Engineers, Inc., 400 Commonwealth Drive, Warrendale, PA 15096.)

2.4 Order of precedence. In the event of a conflict between the text of this document and the references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

3. REQUIREMENTS

3.1 First article. Unless otherwise specified (see 6.2), a sample shall be subjected to first article inspection in accordance with 4.3.

3.2 Toxicity. The cleaning compound shall not have an adverse effect on the health of personnel when used for its intended purpose. Use of the cleaner shall conform to local regulations for industrial hygiene and air pollution. The cleaner shall not contain known or suspected human carcinogens, heavy metals, or Total Toxic Organic (TTO) compounds.

3.3 Performance requirements. The cleaning compound shall conform to Table I.

TABLE I. Performance and requirements paragraphs /1

Characteristic	Type 1 Requirement	Type 2 Requirement	Type 2A Requirement	Conformance Paragraph
Non-volatile Residue	<10 mg/100ml	<2.5 mg/100ml	<2.5 mg/100ml	4.5.3
Low Temperature Stability at 0 ± 2°F	No separation			4.5.4
Effects on Unpainted Surfaces	No streaking, staining not easily removed by hand pressure and water			4.5.5
Total Immersion Corrosion	No staining, etching, pitting, no weight change exceeding Table II limits			4.5.6
Elevated Temperature Corrosion (not to exceed 205°F and only for cleaners used in heated process)	No corrosion, no pitting, no intergranular corrosion, no stock loss exceeding Table III limits			4.5.7
Low-Embrittling Cadmium Plate Corrosion	No weight change > 0.14 $mg/cm^2/24$ hrs			4.5.8
Sandwich Corrosion	No corrosion rating greater than reagent water			4.5.9
Hydrogen Embrittlement	No failures after 150 hours immersed			4.5.10
Stress Corrosion	No cracks in Table II alloys		No cracks in titanium alloy (6Al-4V)	4.5.11
Effects on Painted Surfaces	No discoloration or decrease >1 pencil hardness	No discoloration or decrease >1 pencil hardness	No discoloration or decrease >1 pencil hardness	4.5.12
Effect on Polysulfide Sealants	No change ± 5 Shore A units	No change ± 5 Shore A units	No change ± 5 Shore A units	4.5.13

TABLE I. Performance requirements and conformance paragraphs - Continued

Characteristic	Type 1 Requirement	Type 2 Requirement	Type 2A Requirement	Conformance Paragraph
Effects on Acrylic	No crazing or staining			4.5.14
Effects on Polycarbonate	No crazing or staining			4.5.15
Effects on Polyimide - Insulated Wire	No dissolution, cracking, or dielectric breakdown greater than wire exposed to de-ionized water			4.5.16
Sealant Adhesion	100% cohesive failure, minimum 3.5kN/m (20lb$_f$/in)	100% cohesive failure, minimum 3.5kN/m (20lb$_f$/in)	100% cohesive failure, minimum 3.5kN/m (20lb$_f$/in)	4.5.17
Adhesive Bonding	Peel strength and % cohesive failure shall meet or exceed bond specimens cleaned with control cleaner	Peel strength and % cohesive failure shall meet or exceed bond specimens cleaned with control cleaner	Peel strength and % cohesive failure shall meet or exceed bond specimens cleaned with control cleaner	4.5.18
Paint Adhesion	No separation of primer to substrates	No separation of primer to substrates	No separation of primer to substrates	4.5.19
Fluorescent Penetrant Inspection	All cracks identified, brightness intensity ≥ to control cleaner	All cracks identified, brightness intensity ≥ to control cleaner	All cracks identified, brightness intensity ≥ to control cleaner	4.5.20

1/ Testing shall be performed in the sequence provided.

TABLE II. Alloys[1] and total immersion corrosion requirements

ALLOY	MAXIMUM WEIGHT LOSS[2] (mg/cm^2/168 hours)
AM-355 CRT (for 14 mil material, approx. UTS 220 KSI)	0.49
PH 13-8 Mo (H1000 condition, UTS approx. 205 KSI)	0.49
Maraging C-250 (aged 480°C/900°F for 3 hrs, approx. UTS 260 KSI)	0.49
Magnesium AZ31B-H24[3] (UTS approx. 42 KSI)	0.70
Al 7075-T6 (Bare, UTS approx. 83 KSI)	0.49
Ti 6Al-4V (Solution treated and aged. UTS approx. 160 KSI)	0.35
Steel 4340 (Oil quench from 800°C/1425°F, tempered 595/1100°F, UTS approx. 260 KSI	0.49

[1] Materials strength levels are for all tests using these alloys.
[2] Average of three panels.
[3] AMS 4377 surface treated in accordance with AMS-M-3171 Type III

TABLE III. Allowable corrosion stock loss

ALLOYS	STOCK LOSS μm/8 hrs.[1]	STOCK LOSS mils/year
Maraging C-250	1.160	50
AM-355 CRT	0.116	5
PH 13-8 Mo	1.160	50
Steel 4340	1.160	50
Titanium 6Al-4V	0.464	20
Al 7075-T6 (non-clad)	1.160	50
Magnesium (AZ31B-H24)[2]	1.160	50

[1] Average of three panels.
[2] AMS 4377 surface treated in accordance with AMS-M-3171 Type III

4.0 VERIFICATION

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

a. First article inspection (see 4.3)

b. Conformance inspection (see 4.4)

4.2 Inspection conditions. Unless otherwise specified, all inspections shall be performed in accordance with the conformance inspection paragraphs specified in Table I.

4.3 First article inspection. The first article inspection shall consist of all tests specified in Table I. An infrared spectrum of the non-volatile matter for Type 1, and a spectrum of 2 and 2A solvents shall be recorded using an infrared spectrometer with a minimum resolution of 4 wavenumbers. Results shall be expressed as percentage transmittance in the range of 4,000 to 400 wavenumbers. First time suppliers to this specification shall perform the first article inspection (see 6.3).

4.3.1 First article sample.

4.3.1.1 Laboratory test sample. The laboratory test sample shall consist of five gallons of the aircraft cleaning compound. Samples shall be identified as follows:

a. Aircraft cleaning compound, aqueous and solvent, type
b. First article test samples
c. Manufacturer's name and product number
d. Submitted by (name and date) for first article testing in accordance with authorization (reference authorizing letter)
e. Manufacturer's recommendation dilution

4.4 Conformance inspection. Each lot shall be inspected to verify conformance to the following requirements: For Type 1 cleaners, infrared spectrograms of the non-volatiles and total immersion corrosion run on Aluminum 7075 and 4340 Steel are required. For Type 2 and 2A cleaners, non-volatile residue and infrared spectrograms of the cleaners shall be required. Samples shall be taken at random from selected drums of a lot. An infrared spectrum of the non-volatile matter for Type 1, and a spectrum of 2 and 2A solvents shall be recorded using an infrared spectrometer with a minimum resolution of 4 wavenumbers. Results shall be expressed as percentage transmittance in the range of 4,000 to 400 wavenumbers. There shall be no difference more than ±1.5 percentage points when comparing the qualifying material spectra with the conformance spectra. IR Spectra shall have no new or missing peaks.

4.5 Test Methods. The tests of this specification shall be conducted in accordance with the conformance inspection paragraphs listed in Table I and 4.5.1 through 4.5.20

4.5.1 Standard contaminant. The standard contaminant shall be prepared by mixing two parts by weight of hydraulic fluid (MIL-PRF-83282 or equivalent), one part by weight lubricating grease (MIL-PRF-81322 or equivalent), and one-tenth by weight of carbon black. This mixture shall be applied to panels, baked for two hours at 55°C (130°F), and cooled to room temperature.

4.5.2 General method. When dilution of Type I cleaner is required, de-ionized water shall be used for dilution (ASTM D-1193, Type IV).

4.5.3 Non-volatile residue. Type 2A cleaners non-volatile residue shall be verified per ASTM D-2109. Types 1 and 2 cleaners non-volatile residue shall be verified per ASTM D-1353, with the following exception: For cleaners that may polymerize or react at 100° C, e.g., cleaners containing d-limonene or terpenes, the cleaner may be dried in a vacuum chamber at room temperature to evaporate the cleaner, instead of using a 100°C steam bath as called out by ASTM D-1353.

4.5.4 Low temperature stability. Low temperature stability shall be verified by the procedure given in this paragraph. Pour approximately 50 ml of the concentrated, as-received cleaner into a test tube of suitable size and cool to 0 ± 2°F in a cold box. Keep the sample at this temperature for one hour. Remove the sample from the cold box and allow the temperature to rise to room

temperature. Invert the test tube five times and examine the content for homogeneity.

4.5.5 Effects on unpainted surface. The alloys listed in Table II shall be verified per ASTM F-485. The maximum intended use concentration of the cleaner shall be used when testing dictates use concentration.

4.5.6 Total immersion corrosion. The test procedure in ASTM F-483 shall verify the cleaner's effect of total immersion corrosion. The alloys listed in Table II shall be used, except that the maximum intended use concentration of the cleaner shall be used when the procedure calls for testing at the recommended use concentration.

4.5.7 Elevated temperature corrosion. For the alloys listed in Table III, the cleaner's effect on stock loss corrosion shall be verified per SAE ARP 1755, with the following exceptions: 1) Test duration shall be 8 hours, 2) Test temperature shall be the maximum use temperature plus 25°F, not to exceed 205°F, 3) Concentration shall be the maximum recommended plus 10. The following shall be recorded: any visual general corrosion, preferential grain boundary attack, pitting corrosion or stock loss (in units of micrometers or mils as shown in Table III) and the cleaner concentration, temperature, and processing time utilized. Preferential grain boundary attack, pitting corrosion or stock loss above the allowable limit provided shall be cause for rejection.

4.5.8 Low-embrittling cadmium plate corrosion. The cleaner's effect on low-embrittling cadmium plate corrosion shall be verified per ASTM F-1111. The maximum intended use concentration of the cleaner shall be used when testing dictates use concentration.

4.5.9 Sandwich corrosion. The sandwich corrosion for alloys listed in Table II shall be verified per ASTM F-1110. The maximum intended use concentration of the cleaner shall be used when testing dictates use concentration.

4.5.10 Hydrogen embrittlement. Hydrogen embrittlement of the cleaner shall be verified per ASTM F-519, using Type 1d specimens.

4.5.11 Stress corrosion. The following procedures shall be used to verify the effects of the cleaner with regard to stress corrosion. 4.5.12.a shall be used for Type 1 cleaners, and 4.5.12.b shall be used for Type 2A cleaners.

a. Procedures for Type 1 cleaners. Test the alloys listed in Table II except aluminum 2024-T6 (non-clad) shall be tested in lieu of aluminum 7075-T6. For titanium follow the procedure given in ASTM F-945 using Method A heat treatment. For the other alloys in Table II follow the procedure described below: Fabricate six U-bend specimens for each alloy per ASTM G-30 Type (a). Wash the test specimens with acetone until visibly clean, and allow to air-dry. Leave three specimens untreated to establish validity of the sheet material. Run stress corrosion test with the remaining three specimens by cycling method per ASTM G-44 for 30 days, 24 hours per day, with the following exceptions: (1) Replace the 3.5% sodium chloride solution with the cleaning solution. (2) Replace the one-hour cycle with a two-hour cycle that includes a 20-minute period in the cleaning solution followed by a 100-minute period out of the solution. (3) Test at the maximum intended use

concentration and temperature. Maintain the test solution at the given concentration and temperature. Use sufficient solution to cover the stressed portion of the test specimens throughout the 20-minute immersion period.

b. Procedures for Type 2A cleaners. Using titanium alloy (6Al-4V) follow the procedure given in ASTM F-945 with the following exceptions: Exclude testing of three restrained test specimens in a 3% sodium chloride solution. That is, test with a minimum of six specimens instead of nine. Three specimens remain untreated after acid cleaning, and the other three specimens are tested in the candidate solvent. (2) Replace furnace heating Method A (900°F for 8 hours) or Method B (500°F for 168 hours), with the following: Place three test specimens in a 500 ml reaction flask fitted with multiple ports and closed with an o-ring seal. Add sufficient solvent to form a layer of solvent one-inch deep. Attach a reflux condenser, insert a thermometer or thermocouple, and heat over a light shielded 150 watt light bulb and reflux for 8 hours a day for 5 days. Record the temperature of the heated solvent during the testing. The bulb heating can be replaced by heating with a bath type apparatus where the bath temperature is controlled.

4.5.12 Effects on painted surfaces. The cleaner's effect on painted surfaces shall be verified per ASTM F-502, for all paints listed in Table IV. The maximum intended use concentration of the cleaner shall be used when testing dictates use concentration. Aircraft green shall be considered a preferred color. All test panels shall be primed per MIL-PRF-23377, Type I, Class C.

TABLE IV. Paint systems for effects on painted surface tests

SPECIFICATION	DESCRIPTION
MIL-PRF-22750	Epoxy Topcoat
MIL-C-46168, Type IV	Aliphatic Polyurethane Topcoat
MIL-PRF-85285, Type I	Polyurethane, High Solids Topcoat
MIL-P-14105	Heat Resistant Paint

4.5.13 Effect on polysulfide sealants. The cleaner's effect on polysulfide sealants shall be verified by following the procedure described below:

a. Preparation of test specimens. Mix sealants MIL-PRF-81733, Class 1, Grade B Type II; and AMS-S-8802 Class B, as specified by their respective manufacturers and press into a 1/8 inch thick sheet mold. Use the standard cure of 14 days at 25 ±3 °C at 50% humidity, or 48 hours at 60 ±3 °C. This will be the sheet stock for each sealant, and the specimens shall be cut from the sheet stock.

b. Test procedure. Measure the Shore A hardness of each sealant per ASTM D-2240 before exposing them to cleaners. Immerse two specimens of each sealant in the cleaner at the maximum intended use concentration at room temperature for 30 minutes. Wipe off the cleaner, and test within 30 minutes for Shore A hardness.

4.5.14 Effects on acrylic plastic. Stress crazing of acrylic plastic shall be verified by ASTM F-484 (Types A, B, and C). The cleaner shall be tested at the maximum intended use concentration.

4.5.15 Effects on polycarbonate plastic. Stress crazing of polycarbonate plastic shall be verified by following the test procedure given in ASTM F-484, with the following exceptions. The acrylic plastic shall be replaced with polycarbonate plastic conforming to AMS-P-83310 and shall be stressed for 30 + 2 minutes to an outer fiber stress of 2000 psi. The cleaner shall be tested at the maximum intended use concentration.

4.5.16 Effects on polyimide-insulated wire. The procedure specified in this paragraph shall verify the effects of the cleaning solvent on polyimide-insulated wire. Coil two segments of MIL-DTL-81381/11-20 wire approximately 61 cm (24 in) and place into separate 118 ml (4 oz) wide mouth jars. To one jar add sufficient amount of the concentrated cleaner to completely cover the wire coil. To the other jar (control sample) add sufficient de-ionized water (ASTM D-1193, Type IV) to cover the wire coil. Cap both jars and store at room temperature (20 - 25°C) for 14 days. At the end of the storage period remove both coils, rinse thoroughly with de-ionized water and suspend to allow complete draining and drying. Uncoil the wires, examine each closely for dissolution, and report the results. The wire immersed in the cleaner shall perform as well as the wire immersed in de-ionized water. Both wires shall then be subjected to a double reverse wrap on a 0.3 cm (0.125 in) mandrel and examined for cracking. (Note: failure of the control sample here voids the test and must be repeated using new MIL-DTL-81381/11-20 material). Wire immersed in the cleaner shall then be examined for cracking. If cracking occurs results shall be reported and the test ended. Passing wire shall then withstand a one-minute dielectric test of 2,500 volts (rms). Using a Hypot model number 4045 or equivalent, and examined for breakdown and/or leakage. Wire immersed in the cleaner shall perform equally well as the control wire immersed in de-ionized water.

4.5.17 Sealant adhesion. Sealant adhesion shall be verified by following the peel test procedure described below, using aluminum 2024-T3 test panels with dimensions of 1 x 70 x 150 mm (0.04 x 2.75 x 6 inches):

a. Apply MIL-P-23377 primer to eight (8) suitably prepared test panels. Apply MIL-PRF-85582 primer to another set of eight (8) test panels. Scuff sand the panels primed with MIL-PRF-85582 primer with abrasive mats conforming to A-A-58054 Type I Class 1 Grade A or equivalent. For each primer, follow the procedure described below.

b. Apply the standardized contaminant mixture (paragraph 4.5.1), or other contaminants appropriate to the specific application, to eight (8) test panels. Wipe the panel surfaces with a cleaning cloth to remove gross contaminants.

c. Wipe four (4) test panels five times with a clean cloth soaked with the candidate cleaner. Wipe the other four (4) test panels with methyl ethyl ketone (ASTM D740) - the control cleaner. For Type 1 cleaner, use the cleaner at the intended use concentration and wipe panel surfaces again with a cloth soaked with de-ionized water (ASTM D-1193, Type IV).

d. Coat at least 125 mm (5 inches) of the panels on one side with a 3 ± ½ mm ($^1/_8 \pm {}^1/_{64}$ inch) thickness of sealing compound per AMS-S-8802 Class B.

e. Impregnate a 70 x 300 mm (2¾ x 12 inch) strip of wire screen (20 to 40 mesh aluminum or Monel wire fabric), or cotton duck, plain weaved with unbleached cotton thread, or equivalent with sealant, such that approximately

125 mm (5 inches) of one end is completely covered with sealant on both sides. Work the sealant well into the fabric.

f. Place the sealant-impregnated end of the fabric on the sealant-coated panel. Smooth the fabric down on the panel, taking care not to trap air beneath the fabric.

g. Apply an additional 1mm ($^1/_{32}$ inch) thick coating of sealing compound over the fabric. Use the standard cure of 14 days at 25 ±2 °C at 50% humidity, or 48 hours at 60 ±2 °C.

h. Completely immerse the panels in jet reference fluid per AMS 2629 Type I at 60 ± 1°C (140 ± 2°F) for 7 days, using covered glass vessels.

i. Cool the panels in the jet reference fluid for 24 hours.

j. Measure the sealant peel strength within 10 minutes after removal from the jet reference fluid: Cut two 25-mm (1-inch) wide sections lengthwise through the fabric and sealing compound on each panel. In a suitable tensile testing machine, strip back the fabric at an angle of 180 degrees to the metal panel, using a rate of 50 mm/min (2 inches/min). During the peel strength testing, make three cuts at approximately 25-mm (1-inch) intervals through the sealing compound to the panel to attempt to promote adhesive failure. Measure the numerical average of the peak loads. Do not include failures of the sealing compound to the fabric in the peel strength values. Measure the percentage of cohesive/adhesive failures. If the control specimens that are prepared with methyl ethyl ketone do not meet the performance requirements, repeat the procedure with a different batch of sealant. Report the test results and the contaminants used, if other than the standard contaminant (paragraph 4.5.1).

4.5.18 Adhesive bonding. Adhesive bonding shall be verified by following the procedure described below using aluminum (7075-T6 bare), stainless steel (AM-355), titanium (6A1-4V), and nickel (electroformed) substrates. The bonding surfaces of the test panels shall be roughened by mechanical abrading.

a. Cut a sufficient number of test panels of each substrate to provide a minimum of six specimens per cleaner for each of the two testing temperatures (i.e. minimum twelve test specimens per cleaner per substrate). Use panel thickness and dimensions that are appropriate to fabricate test specimens per ASTM D 3167. The flexible adherends shall be 0.63 mm (0.025 in.) and the rigid adherends shall be 1.63 mm (0.064 in.).

b. Prepare and apply the standard contaminant according to 4.5.1.

c. Remove the gross contaminant with a clean cloth.

d. Hand wipe the candidate-cleaner panel surfaces until visually clean with a clean cloth soaked with the candidate cleaner at the specified use concentration. For aqueous cleaners, hand wipe panels again with de-ionized water (ASTM D-1193, Type IV) until visual evidence of the cleaner is removed. Hand wipe the control-cleaner panel surfaces until visually clean with a clean cloth soaked with methyl ethyl ketone (ASTM D740).

e. Abrade the panel bonding surfaces with an orbital sander: 180 grit for aluminum, 120 grit for titanium, and 80 grit for stainless steel and nickel. Clean again per step d.

f. Fabricate test specimens per ASTM D 3167, using a paste adhesive (Dexter Hysol EA 9309.3NA or equivalent). Use shims or scrim cloth, if necessary, to control the bondline thickness to 5 - 10 mils. Cure the adhesive as recommended by its manufacturer. Record the bondline thickness and the adhesive cure conditions.

g. Perform floating roller peel tests in accordance with ASTM D3167 on a suitable testing machine (e.g., Instron or equivalent). Condition and test at least six (6) specimens for each testing temperature as follows: (1) Condition at 25°C (75°F)/ambient humidity for 24 hours minimum. Test at 25°C (75°F). (2) Condition at 80°C (180°F)/95% humidity environment for 30 days. Test at 80°C (180°F).

h. Examine/compare and record failure surface characteristics, particularly adhesive/cohesive failure modes. Record measured peel strength values and any pertinent observations or anomalies. Record the contaminants used, if other than the standard contaminant, and the cleaner concentration used (for aqueous cleaner).

4.5.19 Paint adhesion. Paint adhesion shall be verified by following the procedure described below:

a. Prepare six 100 x 100 mm (4 x 4 inch) aluminum test panels of each of the following: (1) Aluminum 2024-T3 bare anodized per MIL-A-8625 Type I., (2) Aluminum 2024-T3 clad conversion coated per MIL-C-5541 Class 3. Allow panels to dry for 24 hours at room temperature.

b. Apply the standardized contaminant mixture (paragraph 4.5.1), or other contaminants appropriate to the specific application, to the test panels.

c. Clean the panels with the candidate cleaner using the cleaning process that is recommended for the particular cleaner/application. Allow panels to dry at room temperature for 24 hours.

d. Prime three panels of each type with MIL-PRF-23377 primer and apply MIL-PRF-85285 topcoat (gloss white). Prime the remaining panels with MIL-PRF-85582 primer and apply MIL-PRF-85285 topcoat (gloss white). Allow the coatings to dry for seven (7) days at room temperature, then immerse the test panels in de-ionized water for 24 hours.

e. Test paint adhesion per FED-STD-141, Test Method No. 6301. Examine for any separation of primer from the substrates. Report the contaminants used, if other than the standard contaminant, and the cleaning process used, including the cleaner concentration, processing time, and temperature.

4.5.20 Fluorescent penetrant inspection. The following procedure shall be conducted for the fluorescent penetrant inspection. The entire procedure shall be repeated three times as a minimum.

a. Prepare the 25 x 150 x 6 mm (1 x 6 x ¼ inch) test specimen bars with the fatigue-induced cracks according to Table V.

TABLE V. Fatigue-induced crack length

ALLOY	CRACK LENGTH
Inconel 718	0.50 ± 0.05 mm (0.020 ± 0.002 inch)
Inconel 718	1.50 ± 0.25 mm (0.060 ± 0.010 inch)
Ti-6Al-4V	1.50 ± 0.25 mm (0.060 ± 0.010 inch)
Ti-6Al-4V	9.50 ± 0.50 mm (0.375 ± 0.020 inch)

b. Pre-clean the test specimen bars as follows: Hand wash with soapy water, e.g., Alconox solution. Rinse in hot tap water and wipe dry with clean cloth. Dip in methanol (O-M-232 Grade A) for fifteen minutes. Ultrasonically clean in perchloroethylene (ASTM D-4376), trichloroethylene (ASTM D-4080), or methyl ethyl ketone (TT-M-261) for thirty minutes. Check the bars under ultraviolet (black) light to ensure that all penetrant has been removed from the bar surfaces/cracks. If penetrant remains, repeat above steps. Dry bars in oven at 55°C (130°F) for five minutes and allow to cool to room temperature.

c. Apply the standardized contaminant mixture (paragraph 4.5.1) to the test bars as follows: Using a clean glass rod covering the fatigue crack, apply two drops of the contaminant to each bar, and evenly spread the contaminant over the surface of each bar in the area of the crack. Place the bars in a dry air-circulating oven for two hours at 55°C (130°F).

d. Wipe excess contaminant from the bars with clean cloths. Clean the bars with the candidate cleaner, using a cleaning/rinsing process that is recommended for the particular cleaner/application. Test at the intended use concentration and temperature. Report the cleaning/rinsing process, including the cleaner concentration, cleaning method, and processing time and temperature.

e. Place the bars in an oven at 55°C (130°F) for five minutes. Remove the bars from the oven and allow them to cool at room temperature for three minutes.

f. Penetrant inspect in accordance with ASTM E-1417 or ASTM E-1210, using penetrant materials that are qualified per AMS 2644. If classification is not known, use Type I (fluorescent dye), Method D (post emulsifiable, hydrophilic), and Level 3 (high) sensitivity, and Form A (dry powder) developer. Record the product names and classification of penetrant, emulsifier, and developer used.

g. Measure the fluorescent brightness intensity of the penetrant materials as follows: Calibrate, zero, and focus a suitable photometer/spotmeter (e.g., Photo Research Photomultiplier-Tube Optical Photometer {Model UBD, PR-1500 Spectra Spotmeter}). Place specimen bars under ultraviolet (black) light per ASTM E-1417, ASTM E-1219 or ASTM E-1210. For each bar, measure the intensity value of the crack indication and the background intensity value on the bar surface near the crack. Subtract the background reading value from the crack reading value to obtain the relative intensity of the crack indication. Record all measurements and observations. Take all measurements in similar sequence and minimize the amount of time between readings to ensure similar dwell times.

h. Repeat steps b through g, but replace the candidate cleaner/process in step d with the control cleaning method (e.g., cleaning with methyl ethyl ketone (TT-M-261), or vapor degreasing with perchloroethylene {ASTM D-4376} or trichloroethylene {ASTM D-4080}).

i. Compare the brightness intensities obtained with the candidate and the control cleaners.

j. When all testing has been completed, clean specimen bars as described in step b to remove all residual penetrant inspection materials.

5.0 PACKAGING

5.1 Packaging. For acquisition purposes, the packaging requirements shall be as specified in the contract or order (see 6.2). Packaging requirements are maintained by the Inventory Control Point's packaging activity within the Military Department or Defense Agency, or within the Military Department's System Command. Packaging data retrieval is available from the managing Military Department's or Defense agency's automated packaging files, CD-ROM products, or by contracting the responsible packaging activity.

6.0 NOTES

(This section contains information of a general or explanatory nature that may be helpful, but is not mandatory.)

6.1 Intended use. The cleaners covered by this specification are intended to be used on components of both fixed and rotary wing aircraft. The inclusion of three types of cleaners is indicative of the need for specialization to remove various types of soils. It is the responsibility of the user to determine whether a cleaner is capable of cleaning satisfactorily, prior to using this test protocol. Certain critical cleaning operations, such as cleaning before bonding and fluorescent penetrant inspection, necessitate testing beyond the tests for materials compatibility.

6.2 Acquisition requirements. Acquisition documents must specify the following.

a. Title, number and date of the specification.

b. Issue of DoDISS to be cited in the solicitation, and if required, the specific issue of individual documents referenced (see 2.1)

c. Quantity desired.

d. Grade (see 1.2).

e. Toxicity (see 6.5).

f. Packaging and marking (see 5.1 and 4.3.1.1).

6.3 First-time suppliers. First time suppliers who have not previously supplied products to ADS-61-PRF and wish to have their material tested may do so at their own expense. The attention of contractors is called to this requirement. Manufacturers are urged to have the products that they propose to offer to the federal government tested so that they may be eligible to be awarded contracts or purchase orders for the products covered by this specification.