SAE Aerospace
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# AEROSPACE MATERIAL SPECIFICATION

SAE AMS 1548A

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Superseding AMS 1548

## Cleaner, Turbine Engine Gas Path Solvent Emulsion Type

NONCURRENT NOTICE

This specification has been declared “NONCURRENT” by the Aerospace Materials Division, SAE, as of April 1994. It is recommended, therefore, that this specification not be specified for new designs.

“NONCURRENT” refers to those materials which have previously been widely used and which may be required on some existing designs in the future. The Aerospace Materials Division, however, does not recommend these as standard materials for future use in new designs. Each of these “NONCURRENT” specifications is available from SAE.





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1. SCOPE:

1.1 Form:

This specification covers a solvent-emulsion cleaner in the form of a solvent-base liquid concentrate.

1.2 Application:

Primarily for cleaning installed turbine engines by spraying diluted cleaner into the intake during a starter crank operation.

1.3 Recommended Water Requirements:

Water used during engine wash operations shall be of potable quality with not more than 100 ppm total dissolved solids and a pH of 6.0 to 8.0 and shall not exceed the following concentrations:

| Element | Concentration (ppm by weight) |
|---|---|
| Sulfur | 10 |
| Chlorine | 50 |
| Sodium plus Potassium | 50 |

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.

2. APPLICABLE DOCUMENTS:

The following publications form a part of this specification to the extent specified herein. The latest issue of Aerospace Material Specifications and Aerospace Recommended Practices shall apply. The applicable issue of other documents shall be as specified in AMS 2350.

2.1 SAE Publications:

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

2.1.1 Aerospace Material Specifications:

| | |
|---|---|
| AMS 2350 | Standards and Test Methods |
| AMS 2400 | Plating, Cadmium |
| AMS 2416 | Plating, Nickel-Cadmium, Diffused |
| AMS 2475 | Protective Treatments, Magnesium Alloys |
| AMS 2825 | Material Safety Data Sheets |
| AMS 4025 | Aluminum Alloy Sheet and Plate, 1.0Mg - 0.60Si - 0.28Cu - 0.20Cr, (6061-0), Annealed |
| AMS 4037 | Aluminum Alloy Sheet and Plate, 4.4Cu - 1.5Mg - 0.60Mn, (2024: -T3 Flat Sheet, -T351 Plate), Solution Heat Treated |
| AMS 4041 | Aluminum Alloy Sheet and Plate, Alclad, 4.4Cu - 1.5Mg - 0.60Mn, (Alclad 2024 and 1-1/2% Alclad 2024; -T3 Flat Sheet, 1-1/2% Alclad 2024-T351 Plate) |
| AMS 4045 | Aluminum Alloy Sheet and Plate, 5.6Zn - 2.5Mg - 1.6Cu - 0.23Cr (7075; -T6 Sheet, -T651 Plate), Solution and Precipitation Heat Treated |
| AMS 4049 | Aluminum Alloy Sheet and Plate, Alclad, 5.6Zn - 2.5Mg - 1.6Cu - 0.23Cr (Alclad 7075; -T6 Sheet, -T651 Plate), Solution and Precipitation Heat Treated |
| AMS 4377 | Magnesium Alloy Sheet and Plate, 3.0Al - 1.0Zn (AZ31B-H24), Cold Rolled, Partially Annealed |
| AMS 4911 | Titanium Alloy Sheet, Strip, and Plate, 6Al - 4V, Annealed |
| AMS 4916 | Titanium Alloy Sheet, Strip, and Plate, 8Al - 1Mo - 1V, Duplex Annealed |
| AMS 5040 | Steel Sheet and Strip, 0.15 max Carbon, Deep Forming Grade |
| AMS 5504 | Steel Sheet, Strip, and Plate, Corrosion and Moderate Heat Resistant, 12.5Cr, (SAE 51410), Annealed |
| AMS 5510 | Steel Sheet, Strip, and Plate, Corrosion and Heat Resistant, 18Cr - 10.5Ni - 0.40Ti, (SAE 30321), Solution Heat Treated |
| AMS 5536 | Alloy Sheet, Strip, and Plate, Corrosion and Heat Resistant, 47.5Ni - 22Cr - 1.5Co - 9.0Mo - 0.60W - 18.5Fe, Solution Heat Treated |
| AMS 5544 | Alloy Sheet, Strip, and Plate, Corrosion and Heat Resistant, 57Ni - 19.5Cr - 13.5Co - 4.2Mo - 3.0T - 1.4Al - 0.05Zr - 0.006B, Consumable Electrode or Vacuum Induction Melted, Annealed |
| AMS 5608 | Alloy Sheet, Strip, and Plate, Corrosion and Heat Resistant, 40Co - 22Cr - 22Ni - 14.5W - 0.07La, Solution Heat Treated |

2.1.2 Aerospace Recommended Practices:

| | |
|---|---|
| ARP1512 | Corrosion of Aluminum Alloys By Aircraft Maintenance Chemicals, Sandwich Test |
| ARP1862 | Cleaning Efficiency of Turbine Engine Gas Path Cleaners, Laboratory Test Method |

2.2 ASTM Publications:

Available from American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103.

| | |
|---|---|
| ASTM D93 | Flash Point by Pensky-Martens Closed Tester |
| ASTM D445 | Kinematic Viscosity of Transparent and Opaque Liquids (and the Calculation of Dynamic Viscosity) |
| ASTM D1141 | Substitute Ocean Water |
| ASTM D1193 | Reagent Water |
| ASTM D1568 | Sampling and Chemical Analysis of Alkylbenzene Sulfonates |
| ASTM D2667 | Biodegradability of Alkylbenzene Sulfonates |
| ASTM D4191 | Sodium in Water by Atomic Absorption Spectrophotometry |
| ASTM D4192 | Potassium in Water by Atomic Absorption Spectrophotometry |
| ASTM E70 | pH of Aqueous Solutions with the Glass Electrode |
| ASTM E442 | Chlorine, Bromine, or Iodine in Organic Compounds by Oxygen Flask Combustion |
| ASTM F483 | Total Immersion Corrosion Test for Aircraft Maintenance Chemicals |
| ASTM F484 | Stress Crazing of Acrylic Plastics in Contact with Liquid or Semi-Liquid Compounds |
| ASTM F502 | Effects of Cleaning and Chemical Maintenance Materials on Painted Aircraft Surfaces |
| ASTM F503 | Preparing Aircraft Cleaning Compounds, Liquid Type, for Storage Stability Testing |
| ASTM F519 | Mechanical Hydrogen Embrittlement Testing of Plating Processes and Aircraft Maintenance Chemicals |
| ASTM F945 | Stress-Corrosion of Titanium Alloys by Aircraft Engine Cleaning Materials |

2.3 U.S. Government Publications:

Available from Commanding Officer, Naval Publications and Forms Center, 5801 Tabor Avenue, Philadelphia, PA 19120.

2.3.1 Military Specifications:

| | |
|---|---|
| MIL-S-7952 | Steel, Sheet and Strip, Uncoated, Carbon (1020 and 1025) (Aircraft Quality) |
| MIL-G-9954 | Glass Beads, For Cleaning and Peening |
| MIL-C-81751 | Coating, Metallic Ceramic |
| MIL-C-85704 | Cleaning Compound, Turbine Engine Gas Path |

2.3.2 Military Standards:

| | |
|---|---|
| MIL-STD-794 | Parts and Equipment, Procedures for Packaging and Packing of |

3. TECHNICAL REQUIREMENTS:

3.1 Composition:

Cleaner shall be a blend of solvents, surfactants, and corrosion inhibitors conforming to the requirements of 3.1.1 and 3.2. Cleaner shall contain neither phenol nor cresol.

3.1.1 Cleaner shall not exceed the following concentrations, determined in accordance with recognized analytical practices; cleaner shall be diluted to 10% by weight in ASTM D1193, Type III, water for inductively coupled plasma-atomic emission spectroscopy (ICP-AES) and atomic absorption spectroscopy (AAS):

| Element | Concentration ppm by weight | Method |
|---|---|---|
| Sulfur | 500 | ICP-AES |
| Chlorine | 100 | ASTM-E442 |
| Sodium | 50 | ASTM D4191 (AAS) |
| Potassium | 50 | ASTM D4192 (AAS) |
| Phosphorus | 50 | ICP-AES |
| Other Metals, each | 10 | ICP-AES |



3.2 Properties:

Cleaner shall conform to the following requirements; tests shall be performed in accordance with specified test methods on cleaner supplied in the concentrated form and on cleaner diluted as in 3.2.2:

3.2.1 Concentrated Cleaner: Cleaner, supplied as a concentrated liquid, shall meet the following requirements:

3.2.1.1 Ash Content: Shall not exceed 0.05% by weight, determined as follows: Using a balance accurate to 0.1 mg, weigh approximately 10 g cleaner into a tared porcelain crucible. Heat crucible for 24 hours ± 0.5 at 105°C ± 5 (221°F ± 9) plus an additional 24 hours ± 0.5 at 240°C ± 5 (464°F ± 9). Heat crucible in a Bunsen-type gas flame, ignite the contents, and heat for 10 minutes ± 0.1. Heat crucible in a muffle furnace for 2 hours ± 0.1 at 1040°C ± 30 (1904°F ± 54), cool in a desiccator, and weigh residue. Ash content is the residue expressed as a percentage of the initial sample weight.

3.2.1.2 Biodegradability: Vendor shall supply evidence that surfactants used in the compound shall be at least 90% biodegradable, determined in accordance with ASTM D2667 or by other method appropriate to surfactant type.

3.2.1.3 Flash Point: Shall be not lower than 60°C (140°F), determined in accordance with ASTM D93.

3.2.1.4 Viscosity: Shall be within 15 to 25 centistokes at 25°C ± 1 (77°F ± 2), determined in accordance with ASTM D445.

3.2.1.5 Low- Temperature Stability: The cleaner shall neither solidify or crystallize at -12°C (+10°F) nor shall it separate on warming to room temperature from -25°C (-13°F). A 50 mL sample of cleaner shall be refrigerated at -12°C ± 1 (+10°F ± 2) for 16 hours ± 0.5 and examined for solidification and crystallization. The sample shall be refrigerated at -25°C ± 1 (-13°F ± 2) for 24 hours ± 0.5, removed from the refrigerator, exposed to room temperature for 8 hours ± 0.25, and, without agitation, examined for separation.

3.2.1.6 Accelerated Storage Stability: The cleaner shall not exhibit any change in appearance, shall not separate, and shall not cause any visual corrosion of MIL-S-7952 steel strip, when tested as in 3.2.1.6.1.

3.2.1.6.1 Polish a MIL-S-7952 steel strip, nominally 0.04 x 0.5 x 6 inches (1.0 x 12.7 x 152 mm), using 240 grit silicon carbide paper. Clean the specimen using absorbent paper tissue and wiping first with methyl ethyl ketone and then with isopropanol. Dry the specimen, place it in a clean glass pressure bottle, add enough cleaner to cover half of the strip, cap the bottle, roll it on its side to coat the strip, and immerse the bottle in a water or oil bath. Program the temperature of the bath for 60°C ± 1 (140°F ± 2) for 8 hours ± 0.25 and no heat input for 16 hours ± 0.5. After five 24-hour cycles, and without agitation, examine the cleaner and the steel strip.

3.2.1.7 Storage Stability: Cleaner shall exhibit no visual evidence of deterioration and shall conform to all other technical requirements of this specification, after storage in accordance with ASTM F503 for one year.

3.2.2 Cleaner At Use Dilution: Concentrated cleaner diluted to 20% by volume with ASTM D1193, Type III, water shall meet the following requirements:

3.2.2.1 pH: Shall be 7.5 to 9.5, determined in accordance with ASTM E70.

3.2.2.2 Total Immersion Corrosion: Neither evidence of visual corrosion nor a weight change of any test panel greater than the following shall result from 30 minutes ± 1 exposure to diluted cleaner heated to 55°C ± 1 (131°F ± 2), determined in accordance with ASTM F483 except that the alternative test panel, nominally 0.04 x 2.0 x 4.0 inches (1 x 51 x 102 mm), shall be permitted.

| Test Panel | | Weight Change mg/cm$^2$ per 30 minutes |
|---|---|---|
| AMS 4025 Aluminum Alloy, | blasted with MIL-G-9954, size 13, glass beads | 0.02 |
| AMS 4037 Aluminum Alloy, | blasted with MIL-G-9954, size 13, glass beads | 0.02 |
| AMS 4377 Magnesium Alloy, | dichromate treated as in AMS 2475 | 0.10 |
| AMS 4911 Titanium Alloy, | blasted with MIL-G-9954, size 13, glass beads | 0.02 |
| AMS 5040 Carbon Steel, | cadmium plated as in AMS 2400 | 0.10 |
| AMS 5040 Carbon Steel, | nickel-cadmium plated as in AMS 2416 | 0.10 |
| AMS 5040 Carbon Steel, | coated with MIL-C-81751, Type I, Class 4 | 0.04 |
| AMS 5504 Stainless Steel, | blasted with MIL-G-9954, size 13, glass beads | 0.04 |
| AMS 5536 Nickel Alloy, | blasted with MIL-G-9954, size 13, glass beads | 0.02 |

3.2.2.3 Hot Corrosion: Cleaner shall neither produce visual corrosion nor localized microscopic corrosion where the depth of attack is greater than 0.0075 mm (0.0003 inch), determined in accordance with 3.2.2.3.1 on the following alloys:

| Test Panel | | Bake Temperature °C | °F |
|---|---|---|---|
| AMS 4025 Aluminum Alloy | | 455 | 851 |
| AMS 4037 Aluminum Alloy | | 455 | 851 |
| AMS 4911 Titanium Alloy | | 480 | 896 |
| AMS 4916 Titanium Alloy | | 480 | 896 |
| AMS 5040 Carbon Steel, | nickel-cadmium plated as in AMS 2416 | 455 | 851 |
| AMS 5040 Carbon Steel, | coated with MIL-C-81751, Type I, Class 4 | 455 | 851 |
| AMS 5504 Stainless Steel | | 480 | 896 |
| AMS 5510 Stainless Steel | | 870 | 1598 |
| AMS 5536 Nickel Alloy | | 1095 | 2003 |
| AMS 5544 Nickel Alloy | | 980 | 1796 |
| AMS 5608 Cobalt Alloy | | 980 | 1796 |

3.2.2.3.1 Degrease two suitable sized panels of each alloy, except coated or plated panels, using absorbent paper tissue and wiping first with methyl ethyl ketone and then with isopropanol. After drying at ambient temperature for 60 minutes ± 5, immerse one panel of each type in dilute cleaning compound for 15 seconds, air dry, and bake for 4 hours ± 0.1 at the indicated temperature ±5°C (±9°F). Cross-section, mount, and metallographically examine both the baked and unbaked panels of each type at 250X magnification.

3.2.2.4 Titanium Stress Corrosion: Cleaner shall produce no microscopic cracking of either AMS 4911 or AMS 4916 titanium alloy, determined in accordance with ASTM F945, Method A.

3.2.2.5 Sandwich Corrosion: Cleaner shall produce a rating not worse than 1, determined in accordance with ARP1512 using specimens of AMS 4037, AMS 4041, AMS 4045, and AMS 4049 aluminum alloys.

3.2.2.6 Hydrogen Embrittlement: Cleaner shall be non-embrittling, determined in accordance with ASTM F519, Types 1a, 1c, or 2a.

3.2.2.7 Effect on Painted Surfaces: Cleaner shall neither decrease the hardness of the paint film by more than two pencil hardness levels nor shall it produce any streaking, discoloration, or blistering of the paint film, determined in accordance with ASTM F502.

3.2.2.8 Effect on Silicone Elastomers: Cleaner shall meet the requirements of MIL-C-85704 for effect on silicone elastomers.

3.2.2.9 Effect on Epoxy Adhesives: Cleaner shall meet the requirements of MIL-C-85704 for effect on epoxy adhesives.

3.2.2.10 Effect on Acrylics: Cleaner shall cause neither crazing nor cracking of Type A specimens stressed to 2000 psi (15 MPa) and Type C specimens stressed to 3000 psi (20 MPa), determined in accordance with ASTM B484.

3.2.2.11 Rinsability: When applied to a salt-coated surface, cleaner shall rinse clean leaving no visible non-rinsable film, determined as follows:

3.2.2.11.1 Using test panels prepared as in 3.2.2.7, cover the paint surface with a fine mist of synthetic sea water prepared in accordance with ASTM D1141. Dry the panel at 60°C ± 1 (140°F ± 2) for 60 minutes ± 5, immerse half the panel in dilute cleaner for 1 minute ± 0.1, withdraw the panel, allow it to drain for 1 minute ± 0.1, and dry as before. Rinse the panel, using a flowing stream of ambient temperature ASTM D1193, Type III, water, until the salt from the unsubmerged area appears to have been removed. Dry the panel as before and examine for evidence of a non-rinsable film.

3.2.2.12 Emulsibility: Cleaner shall form a homogeneous emulsion which shall not show any evidence of separation after standing undisturbed for 48 hours ± 1 at 25°C ± 1 (77°F ± 2). Pour 100 mL of diluted cleaner into a 100 mL graduated cylinder, invert the cylinder once, allow to stand for 60 seconds ± 5, and examine for homogeneity; after shaking for 15 seconds ± 1, the emulsion shall be allowed to stand undisturbed for 48 hours ± 1 before examining for separation.

3.2.2.13 Hard Water Stability: Cleaner, diluted with synthetic hard water, shall not show any evidence of separation after standing undisturbed for 16 hours ± 0.5 at 25°C ± 1 (77°F ± 2). Synthetic hard water shall be prepared by dissolving 0.20 g ± 0.005 calcium acetate monohydrate and 0.14 g ± 0.005 magnesium sulfate heptahydrate in one liter of ASTM D1193, Type III, water. Test solution shall be prepared by pouring 10 mL concentrated cleaner into a 100 mL graduated cylinder, diluting to 10% by volume with synthetic hard water, and shaking for 15 seconds ± 1; after standing undisturbed for 16 hours ± 0.5, the emulsion shall be examined for separation.

3.2.2.14 Salt Water Stability: Cleaner, contaminated with synthetic salt water, shall not show any evidence of separation after standing undisturbed for 60 minutes ± 5 at 25°C ± 1 (77°F ± 2). Synthetic salt water shall be prepared in accordance with ASTM D1141. Test solution shall be prepared by pouring 20 mL concentrated cleaner into a 100 mL graduated cylinder, diluting to 20% by volume with ASTM D1193, Type III water, and shaking for 15 seconds ± 1; after adding 5 mL ± 0.1 of synthetic salt water and shaking as before, the emulsion shall be allowed to stand undisturbed for 60 minutes ± 5 before examining for separation.

3.2.2.15 Acid Stability: Cleaner, contaminated with an acetic acid solution, shall not show any evidence of separation after standing undisturbed for 60 minutes ± 5 at 25°C ± 1 (77°C ± 2). Test solution shall be prepared by pouring 20 mL concentrated cleaner into a 100 mL graduated cylinder, diluting to 20% by volume with ASTM D1193, Type III, water, and shaking for 15 seconds ± 1; after adding 5 mL ± 0.1 of a 1.0% ± 0.05 by weight glacial acetic acid solution and shaking as before, the emulsion shall be allowed to stand undisturbed for 60 minutes ± 5 before examining for separation.

3.2.2.16 Performance: Cleaning efficiency of the cleaner shall be at least equal to the control formulation, determined in accordance with ARP1862.

3.3 Quality:

The cleaner, as received by purchaser, shall be a homogeneous liquid, free of foreign matter and other impurities detrimental to usage of the cleaner. A faint turbidity is acceptable.

4. QUALITY ASSURANCE PROVISIONS:

4.1 Responsibility for Inspection:

The vendor of the cleaner shall supply all samples for vendor's tests and shall be responsible for performing all required tests. Results of such tests shall be reported to the purchaser as required by 4.5. Purchaser reserves the right to sample and to perform any confirmatory testing deemed necessary to ensure that the cleaner conforms to the requirements of this specification.

4.2 Classification of Tests:

4.2.1 Acceptance Tests: Tests to determine conformance to requirements for ash content (3.2.1.1), flash point (3.2.1.3), viscosity (3.2.1.4), pH (3.2.2.1), total immersion corrosion (3.2.2.2), effect on acrylics (3.2.2.10), rinsability (3.2.2.11), emulsibility (3.2.2.12), hard water stability (3.2.2.13), salt water stability (3.2.2.14), and acid stability (3.2.2.15) are classified as acceptance tests and shall be performed on each lot.

4.2.2 Preproduction Tests: Tests to determine conformance to all technical requirements of this specification, except storage stability, are classified as preproduction tests and shall be performed prior to or on the initial shipment of cleaner to a purchaser, when a change in material 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, substantiating test data and, when requested, preproduction test material shall be submitted to the cognizant agency as directed by the procuring activity, contracting officer, or request for procurement.