



AEROSPACE MATERIAL SPECIFICATION

AMS1428™**REV. M**Issued 1993-01
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Superseding AMS1428L

Fluid, Aircraft Deicing/Anti-Icing, Non-Newtonian (Pseudoplastic),
SAE Types II, III, and IV

RATIONALE

This document has been revised to incorporate the recommendations of several working groups and to further align AMS1428 with changes already adopted into AMS1424. This includes the addition of 1.5.1 to clarify what tests need to be performed on previously qualified fluids when a standard is revised, removal of obsolete tests in 1.3.3, 3.3.2.4.1, 3.2.1.2, and 3.2.1.5, the addition of 4.4.2.1 to emphasize the importance of testing new sources of glycol, the clarification of the maximum on-wing viscosity testing in 4.2.2.1, the clarification of 4.2.3 to state what happens after a lapse in testing, the adoption of ASTM D1218 to replace ASTM D1747 for Refractive Index Determination, and other editorial changes. Section 1.1 of the Scope was also rewritten as an abstract in order to better describe this document.

TABLE OF CONTENTS

1.	SCOPE.....	3
1.1	Abstract and Form.....	3
1.1.1	Foundation and Category Specifications	3
1.1.2	Classification	3
1.1.3	Non-Newtonian	3
1.1.4	Pseudoplastic.....	3
1.2	Application.....	4
1.3	Precautions	4
1.4	Safety - Hazardous Materials.....	4
1.5	Fluid Qualification.....	4
2.	APPLICABLE DOCUMENTS.....	5
2.1	SAE Publications.....	5
2.2	ASTM Publications	6
2.3	U.S. Government Publications.....	6
2.4	APHA Publications	7
2.5	OECD Publications	7
2.6	ANSI Accredited Publications	7
2.7	Definitions	7
3.	TECHNICAL REQUIREMENTS.....	7
3.1	Material.....	7
3.1.1	Definition of Glycol (Conventional and Non-Conventional) and Non-Glycol.....	7
3.1.2	Requirements.....	7
3.1.3	Non-Glycol Based Fluid	8
3.1.4	Toxicity	8
3.1.5	Appearance	8

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3.1.6	Environmental Information	8
3.1.7	Trace Contaminants	9
3.2	Physical Properties	9
3.2.1	Fluid as Received in Neat Form	9
3.2.2	Fluid Stability	9
3.2.3	Rheological Properties	13
3.2.4	Anti-Icing Performance	13
3.2.5	Aerodynamic Acceptance	14
3.3	Fluid Tested Both Neat and as a Diluted Solution	15
3.3.1	Freezing Point	15
3.3.2	Effect on Aircraft Materials	15
3.3.3	Effect on Painted Surfaces	16
3.3.4	Effect on Unpainted Surfaces	16
3.3.5	Pavement Compatibility	16
4.	QUALITY ASSURANCE PROVISIONS	16
4.1	Responsibility for Inspection	16
4.2	Classification of Tests	16
4.2.1	Lot Acceptance Tests	16
4.2.2	Initial Qualification Tests	16
4.2.3	Periodic Requalification Tests	17
4.3	Sampling and Testing	18
4.4	Approval	18
4.5	Reports	19
4.5.1	Initial Qualification and Periodic Requalification Reports	19
4.5.2	Safety Data Sheets (SDS)	19
4.6	Resampling and Retesting	20
5.	PREPARATION FOR DELIVERY	20
5.1	Packaging and Identification	20
6.	ACKNOWLEDGMENT	20
7.	REJECTIONS	20
8.	SIMILAR SPECIFICATIONS	20
9.	NOTES	20
9.1	Revision Indicator	21
APPENDIX A	SUCCESSIVE DRY-OUT AND REHYDRATION TEST FOR DEICING/ANTI-ICING FLUID	22
Table 1	Classification	3
Table 2	Fluid cycling period	12
Table 3	Minimum anti-icing performance	13
Table 4	Total immersion corrosion	15

1. SCOPE

1.1 Abstract and Form

The AMS1428 specification defines the technical requirements for Type II, III, and IV aircraft deicing/anti-icing fluids. These non-Newtonian thickened fluids are formulated to effectively remove frost, ice, and snow from aircraft surfaces while offering protection times longer than Type I fluids against refreezing or frozen contamination. The document outlines key performance criteria, such as freezing point, aerodynamic acceptance, and anti-icing performance, alongside environmental properties like biodegradability, aquatic toxicity, biochemical oxygen demand (BOD), and chemical oxygen demand (COD). Operational considerations, including storage stability, materials compatibility, exposure to dry air, dry-out exposure to cold dry air, successive dry-out and rehydration, and physical properties like pH, refraction, and rheological properties (viscosity) are also specified. Additionally, the specification details the required testing methods to evaluate these properties and sets forth guidelines for the initial qualification, site or unit qualification, periodic requalification, and lot acceptance of Type II, III, and IV fluids.

This foundation specification (AMS1428) and its associated category specifications (refer to AMS1428/1 and AMS1428/2) cover a deicing/anti-icing material in the form of a fluid.

1.1.1 Foundation and Category Specifications

This foundation specification establishes the requirements for all Type II, III, and IV aircraft deicing/anti-icing fluids. It defines glycol (conventional and non-conventional) based fluids and non-glycol based fluids and contains additional properties and requirements that apply to both glycol (conventional and non-conventional) and non-glycol based products.

1.1.2 Classification

Deicing/anti-icing fluids covered by this specification are classified as follows:

Table 1 - Classification

Fluid SAE Type	Anti-Icing Performance Use Table 3 (see 3.2.4.1)	Aerodynamic Performance Use AS5900 (see Note)	Color
Type II	II	High-speed ramp test. The low-speed and middle-speed ramp tests are optional.	Yellow
Type III	III	Either the low-speed and/or middle-speed ramp test. High-speed ramp test is optional.	Bright Yellow
Type IV	IV	High-speed ramp test. The low-speed and middle-speed ramp tests are optional.	Green

NOTE: The designations in Table 1 are for fluid classification purposes only. See 3.2.5.2 for additional information.
Consult the fluid manufacturer for complete aerodynamic test data.

1.1.3 Non-Newtonian

A fluid defined as non-Newtonian exhibits a different apparent viscosity value when tested at the same temperature using the same viscometer and spindle in a predetermined volume when the only variant is the rotational speed of the spindle. Typically, the non-Newtonian fluid shear stress is not in direct proportion to its rate of flow.

1.1.4 Pseudoplastic

A fluid described as pseudoplastic shall exhibit reduced apparent viscosity values as the spindle speed is increased and revert to original flow behavior when the shear stress is removed. This shall be demonstrable at the temperatures listed in 3.2.3.2.

1.2 Application

This document establishes the minimum requirements for the qualification of ground-based aircraft deicing/anti-icing fluids.

Refer to AS6285 for more information on the proper use or restrictions of SAE Type II, III, and IV aircraft deicing/anti-icing fluids.

1.3 Precautions

- 1.3.1 The deicing/anti-icing formulation may be mildly toxic, and contact with human skin and eyes should be avoided. Prolonged exposure to concentrations of vapor or windborne mists should be avoided. Consult the fluid manufacturers' Safety Data Sheets for further information.
- 1.3.2 A fluid meeting this specification is unique to each manufacturer and may be adversely affected by mixing with other aircraft deicing/anti-icing fluids.
- 1.3.3 Slippery conditions may exist on the ground or equipment following the deicing/anti-icing procedure.
- 1.3.4 Deicing/anti-icing fluids should be compatible with carbon brake material. Refer to AS6285 and the aircraft manufacturer's maintenance and service documents for further information on fluid use. The industry standard test method for compatibility is AIR5567.
- 1.3.5 SAE Type II, III, and IV fluids, especially when used in a one-step process, or in the first step of a two-step process, may cause residues to collect in aerodynamically quiet areas, cavities, and gaps. These residues can affect flight safety. Refer to AS6285 for more information.

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 that 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 processes and to take necessary precautionary measures to ensure the health and safety of all personnel involved.

1.5 Fluid Qualification

- 1.5.1 For products qualified under previous versions of this specification, only tests for which the technical requirements have changed in subsequent versions from the original qualification need to be performed in order for the product to meet the requirements of the current version of this specification
- 1.5.2 The lowest operational use temperature (LOUT) for an SAE Type II, III, and IV fluid shall be determined for the neat (undiluted) fluid or for each intended use dilution and is the lowest temperature at which the fluid has been tested and certified as acceptable in accordance with the appropriate aerodynamic acceptance test (see 3.2.5) while still maintaining the 7 °C (13 °F) freezing point temperature buffer (refer to AS6285). The fluid manufacturers' literature shall clearly state the LOUT for the neat fluid and intended use dilutions. This literature should clearly state which speed ramp test the LOUT is applicable to.
- 1.5.3 Tendency to Foam: At the option of the user, the vendor shall demonstrate that fluid as supplied or in intended use dilutions and heated to intended use temperatures, applied through commercial deicing/anti-icing vehicle systems to an inclined flat or curved surface, preferably an aircraft wing or horizontal stabilizer, at pressures and flow rates normal for the intended use, does not cause foam that does not rapidly collapse, and the fluid surface shall not have the appearance of snow or slush.
- 1.5.4 It is not sufficient for an SAE Type II, III, or IV fluid to meet all of the requirements of AMS1428 for airlines to be able to use it. For such a fluid to be used commercially, it must also have holdover time guidelines and be identified on a list of qualified fluids acceptable to regulators.
- 1.5.5 For more information on the qualification process of an AMS1428 fluid, refer to ARP5718.

2. APPLICABLE DOCUMENTS

The issue of the following documents in effect on the date of the purchase order forms 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 cancelled and no superseding document has been specified, the last published issue of that document shall apply.

2.1 SAE Publications

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or +1 724-776-4970 (outside USA), www.sae.org.

AMS1428/1	Fluid, Aircraft Deicing/Anti-Icing, Non-Newtonian (Pseudoplastic), SAE Types II, III, and IV Glycol (Conventional and Nonconventional) Based
AMS1428/2	Fluid, Aircraft Deicing/Anti-Icing, Non-Newtonian (Pseudoplastic), SAE Types II, III, and IV Non-Glycol Based
AMS2470	Anodic Treatment of Aluminum Alloys, Chromic Acid Process
AMS2475	Protective Treatments, Magnesium Alloys
AMS4037	Aluminum Alloy, Sheet and Plate, 4.4Cu - 1.5Mg - 0.60Mn (2024; -T3 Flat Sheet, -T351 Plate), Solution Heat Treated
AMS4041	Aluminum Alloy, Sheet and Plate, Alclad, 4.4Cu - 1.5Mg - 0.60Mn (2024, -T3 Sheet/-T351 Plate with 1-1/2% Alclad), Solution Heat Treated, Cold Worked, and Naturally Aged
AMS4049	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
AMS4376	Plate, Magnesium Alloy, 3.0Al - 1.0Zn - 0.20Mn (AZ31B-H26), Cold Rolled and Partially Annealed
AMS4911	Titanium Alloy, Sheet, Strip, and Plate, 6Al - 4V, Annealed
AMS5045	Steel, Sheet and Strip, 0.25 Carbon, Maximum (SAE 1020), Hard Temper
AMS5886	Alloy, Corrosion and Heat-Resistant, Bars, Forgings, and Rings, 50Ni - 20Cr - 20Co - 5.8Mo - 2.2Ti - 0.45Al, Consumable Electrode or Vacuum Induction Melted, 2100 °F (1149 °C) Solution Heat Treated
AMS-P-83310	Plastic Sheet, Polycarbonate, Transparent
AIR5567	Test Method for Catalytic Carbon Brake Disk Oxidation
ARP5485	Endurance Time Test Procedures for SAE Type II/III/IV Aircraft Deicing/Anti-Icing Fluids
ARP5718	Qualifications Required for SAE Type II/III/IV Aircraft Deicing/Anti-Icing Fluid
AS5900	Standard Test Method for Aerodynamic Acceptance of AMS1424 and AMS1428 Aircraft Deicing/Anti-Icing Fluids
AS5901	Water Spray and High Humidity Endurance Test Methods for AMS1424 and AMS1428 Aircraft Deicing/Anti-Icing Fluids
AS6285	Aircraft Ground Deicing/Anti-Icing Processes
AS7766	Terms Used in Aerospace Metals Specifications

AS9968	Laboratory Viscosity Measurement of Thickened Aircraft Deicing/Anti-icing Fluids with a Viscometer
MAM4911	Titanium Alloy Sheet, Strip, and Plate, 6Al - 4V, Annealed

2.2 ASTM Publications

Available from ASTM International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959, Tel: 610-832-9585, www.astm.org.

ASTM C672	Scaling Resistance of Concrete Surfaces Exposed to De-Icing Chemicals
ASTM D93	Flash Point by Pensky-Martens Closed Cup Tester
ASTM D1177	Freezing Point of Aqueous Engine Coolants
ASTM D1193	Reagent Water
ASTM D1218	Standard Test Method for Refractive Index and Refractive Dispersion of Hydrocarbon Liquids
ASTM D1568	Sampling and Chemical Analysis of Alkylbenzene Sulfonates
ASTM D1747	Refractive Index of Viscous Materials
ASTM D3278	Flash Point of Liquids by Small Scale Closed Cup Apparatus
ASTM D4177	Automatic Sampling of Petroleum and Petroleum Products
ASTM E70	pH of Aqueous Solutions with the Glass Electrode
ASTM F483	Total Immersion Corrosion Test for Aircraft Maintenance Chemicals
ASTM F484	Stress Cracking of Acrylic Plastics in Contact with Liquid or Semi-Liquid Compounds
ASTM F485	Effects of Cleaners on Unpainted Aircraft Surfaces
ASTM F502	Effects of Cleaning and Chemical Maintenance Materials on Painted Aircraft Surfaces
ASTM F519	Mechanical Hydrogen Embrittlement Evaluation of Plating Processes and Service Environments
ASTM F945	Stress Corrosion of Titanium Alloys by Aircraft Engine Cleaning Materials
ASTM F1105	Preparing Aircraft Cleaning Compounds, Liquid Type, Temperature-Sensitive, or Solvent-Based, for Storage Stability Testing
ASTM F1110	Sandwich Corrosion Test
ASTM F1111	Corrosion of Low-Embrittling Cadmium Plate by Aircraft Maintenance Chemicals

2.3 U.S. Government Publications

Copies of these documents are available online at <https://www.epa.gov/>.

EPA 40 CFR 797.1300	Daphnid Acute Toxicity Test
EPA 40 CFR 797.1400	Fish Acute Toxicity Test

Copies of these documents are available online at <https://quicksearch.dla.mil>.

MIL-PRF-25690 Plastic, Sheets and Formed Parts, Modified Acrylic Base, Monolithic, Crack Propagation Resistant

MIL-STD-870 Cadmium Plating, Low Embrittlement, Electrodeposited

2.4 APHA Publications

Available from American Public Health Association, 800 I Street, NW, Washington, DC 20001, Tel: 202-777-2742 or www.apha.org.

Standard Methods for the Examination of Water and Wastewater

2.5 OECD Publications

Available from OECD, 2, rue André Pascal, Cedex 16, 75016 Paris, France, or www.oecd.org.

OECD Guidelines for Testing of Chemicals

2.6 ANSI Accredited Publications

Copies of these documents are available online at <https://webstore.ansi.org/>.

ANSI Z400.1/Z129.1-2010 Hazardous Workplace Chemicals - Hazard Evaluation and Safety Data Sheet and Precautionary Labeling Preparation

2.7 Definitions

Term used in AMS1428 for aerospace metals specifications are defined in AS7766.

3. TECHNICAL REQUIREMENTS

3.1 Material

The composition of the fluid shall be optional to the manufacturer and shall be based on freezing point depressants with additives, such that the finished product shall meet the requirements of this specification.

3.1.1 Definition of Glycol (Conventional and Non-Conventional) and Non-Glycol

For the purpose of classification for AMS1428 aircraft deicing/anti-icing fluids, freezing point depressants used to formulate AMS1428M Type II, III, and IV deicing/anti-icing fluids are classified as “glycol (conventional and non-conventional)” and “non-glycol” based fluids.

3.1.1.1 Glycol (conventional) is defined as ethylene glycol, diethylene glycol, or propylene glycol.

3.1.1.2 Glycol (non-conventional) is defined as organic non-ionic diols and triols, e.g., 1,3-propanediol, glycerin, and mixtures thereof, and mixtures with glycol (conventional).

3.1.1.3 Non-glycol is defined as all that is not glycol (conventional and non-conventional), such as organic salts, e.g., sodium formate, sodium acetate, potassium formate, potassium acetate, and any mixtures thereof. Mixtures of glycol (conventional and non-conventional) and non-glycol are defined as non-glycol.

3.1.2 Requirements

3.1.2.1 Glycol (conventional and non-conventional) based fluids shall meet all technical requirements of this specification, except 3.1.3.

3.1.2.2 Non-glycol based fluids shall meet all the requirements of this specification, including 3.1.3.

3.1.3 Non-Glycol Based Fluid

A fluid based on non-glycol freezing point depressants shall be tested as follows:

3.1.3.1 Corrosion of AMS5886 Nickel Alloy

Two pieces of AMS5886 bar, 35 mm diameter and 15 mm long, shall have one end of each machined flat. An 8.5-mm drill shall then be used to drill a centered hole 6.5 mm deep in one end to allow the milling of a cup-shaped depression. A 12.5-mm bullnosed end mill shall be used to open up the drilled hole to produce a 7 mm deep depression. The cup shall then be finished by improving the surface with 600 μm , 180 μm , and 6 μm diamond paste. The cups shall be cleaned and degreased using a suitable solvent and allowed to dry. One cup shall be filled with the candidate test fluid, the other with water conforming to ASTM D1193 Type IV. Both test pieces shall then be placed in an oven at $105\text{ }^{\circ}\text{C} \pm 2\text{ }^{\circ}\text{C}$ ($221\text{ }^{\circ}\text{F} \pm 4\text{ }^{\circ}\text{F}$). The fluid shall then be allowed to evaporate by progressive increase in oven temperature at the rate of $10\text{ }^{\circ}\text{C}$ ($18\text{ }^{\circ}\text{F}$) per minute to a final temperature of $250\text{ }^{\circ}\text{C} \pm 5\text{ }^{\circ}\text{C}$ ($482\text{ }^{\circ}\text{F} \pm 9\text{ }^{\circ}\text{F}$), where it shall be maintained for 15 minutes ± 1 minute. Test pieces shall then be transferred to an air furnace set at $1040\text{ }^{\circ}\text{C} \pm 10\text{ }^{\circ}\text{C}$ ($1904\text{ }^{\circ}\text{F} \pm 18\text{ }^{\circ}\text{F}$) and maintained for 2 hours ± 5 minutes.

Test pieces shall be removed and allowed to cool to ambient temperature. Microscopic examination of the polished cups at 500X shall be undertaken. No corrosion worse than that of the control cup shall be evident in the candidate test fluid cup.

The report shall include photographs of both cups after testing, and the candidate test fluid cup shall be identified.

3.1.4 Toxicity

The user shall ensure that the fluid meets all local, state, and/or federal toxicity regulations. The information to satisfy the federal, state, and provincial requirements shall be provided by the manufacturer and for local requirements, upon request, by the user.

3.1.5 Appearance

The fluid, as received by the purchaser, shall be homogeneous, uniform in color, and free from skins, lumps, and foreign materials which would be detrimental to usage of the product. The fluid may be clear or cloudy, as described by the manufacturer. The fluid shall be colored according to Table 1.

3.1.6 Environmental Information

Formulated fluid shall be tested in accordance with APHA "Standard Methods for the Examination of Water and Wastewater." The following tests shall be performed and the results reported:

3.1.6.1 Biochemical Oxygen Demand (BOD)

The fluid shall be incubated at $20\text{ }^{\circ}\text{C}$ ($68\text{ }^{\circ}\text{F}$) for 5 days, 15 days, 20 days, or 28 days, dependent upon the method chosen and the BOD determined.

3.1.6.2 Total Oxygen Demand (TOD) or Chemical Oxygen Demand (COD)

The TOD or COD of the fluid, expressed in kilograms of oxygen per kilogram of fluid, shall be determined.

3.1.6.3 Biodegradability

This characteristic can be approximated by determining the ratio of BOD to TOD or COD. The percent of fluid biodegraded can be calculated by dividing BOD by TOD or COD and shall be reported for the incubation time periods specified in the chosen test method.

3.1.6.4 Aquatic Toxicity

The fluid shall be tested in accordance with EPA 40 CFR 797.1300 and EPA 40 CFR 797.1400, revised July 1, 1989, or OECD (Organization for Economic Cooperation and Development) "Guidelines for Testing of Chemicals" methods 202 and 203, using test species required by regulatory agencies for permitted discharges. Examples include fathead minnows, daphnia magna, and rainbow trout. The LC50 concentration (the highest concentration at which 50% of the organisms do not survive the test period) shall be stated in milligrams per liter.

3.1.7 Trace Contaminants

Determine and report the presence, in percentages by weight or parts per million by weight, of sulfur, halogens, phosphate, nitrate, and heavy metals (lead, chromium, cadmium, and mercury). Report the test method used and detection limits.

3.2 Physical Properties

The fluid shall conform to the following requirements; tests shall be performed in accordance with the specified test methods:

3.2.1 Fluid as Received in Neat Form

3.2.1.1 Flash Point

Shall be not lower than 100 °C (212 °F) determined in accordance with ASTM D93 or ASTM D3278. In case of dispute, the flash point determined in accordance with ASTM D93 shall apply.

3.2.1.2 Repealed

3.2.1.3 pH

The pH shall be determined in accordance with ASTM E70 and the results reported.

Results for periodic requalification or quality control testing shall be within ± 0.5 unit of the fluid's initial qualification value.

3.2.1.4 Refractive Index

Refractive index shall be determined in accordance with ASTM D1218 and the results reported.

Results for periodic requalification or quality control testing shall be within ± 0.0015 of the fluid's initial qualification value.

3.2.2 Fluid Stability

3.2.2.1 Thermal Stability - Accelerated Aging

This test is to simulate long-term heated storage without water loss.

Age sample as in 3.2.2.1.1 and examine as in 3.2.2.1.2.

3.2.2.1.1 Transfer 800 mL $\pm$ 10 mL of fluid to a 1-L borosilicate bottle (e.g., Pyrex® brand or equivalent) fitted with a tight, heat-resistant plastic seal and tightly close. For the reference sample, also keep 800 mL $\pm$ 10 mL of the fluid in an identical bottle and store at room temperature until the completion of 3.2.2.1.2. Transfer the other closed bottle containing the test fluid to a circulating-air oven or heated oil or water bath. Elevate the temperature to 70 °C $\pm$ 2 °C (158 °F $\pm$ 4 °F) and maintain the test sample in this environment for 30 days.