



AEROSPACE STANDARD

AS1241™**REV. D**Issued 1974-03
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Superseding AS1241C

(R) Fire Resistant Phosphate Ester Hydraulic Fluid for Aircraft

RATIONALE

This revision incorporates a new fluid type, updates references and revises some tests. New requirements have been added and the dynamic seal test has been eliminated.

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1. SCOPE

This document establishes the requirements for physical and chemical properties and the minimum tests to evaluate suitability of phosphate ester hydraulic fluids for use in aircraft systems where fire resistance is required. Additional tests may be specified by the qualifying agency to demonstrate compliance with their specific requirements. The "qualifying agency" will be defined herein to be the airframe manufacturer submitting certification approval for use of the fluid in a specific model airplane.

Fluids meeting the requirements of this specification may be approved by a qualifying agency for use on specific airplane models. Data used to show compliance to this specification can be used by the qualifying agency to show compliance to the applicable regulations for the appropriate certifying authority; e.g., FAA, EASA, etc.

2. APPLICABLE DOCUMENTS

The following publications form a part of this document 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. In the event of conflict between the text of this document and 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.

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.

AMS4035	Aluminum Alloy, Sheet and Plate 4.4Cu - 1.5Mg - 0.60Mn (2024-0) Annealed; or when specified, "As Fabricated" (2024-F)
AMS4045	Aluminum Alloy Sheet and Plate 5.6Zn - 2.5Mg - 1.6Cu - 0.23Cr 7075: (-T6 Sheet, -T651 Plate) Solution and Precipitation Heat Treated
AMS4375	Sheet and Plate, Magnesium Alloy 3.0Al - 1.0Zn - 0.20Mn (AZ31B-0) Annealed and Recrystallized
AMS4376	Plate, Magnesium Alloy 3.0Al - 1.0Zn - 0.20Mn (AZ31B-H26) Cold Rolled and Partially Annealed
AMS4377	Magnesium Alloy, Sheet and Plate 3.0Al - 1.0Zn - 0.20Mn (AZ31B-H24) Cold Rolled, Partially Annealed
AMS4500	Copper, Sheet, Strip, and Plate Soft Annealed
AMS4911	Titanium Alloy, Sheet, Strip, and Plate 6Al - 4V Annealed
AMS4944	Titanium Alloy Tubing, Seamless, Hydraulic 3.0Al - 2.5V Cold Worked, Stress Relieved
AMS5044	Steel, Sheet and Strip 0.15 Carbon, Maximum Half Hard Temper
AMS6280	Steel Bars, Forgings, and Rings 0.50Cr - 0.55Ni - 0.20Mo (0.28 - 0.33C) (SAE 8630)
AMS6350	Steel Sheet, Strip, and Plate 0.95Cr - 0.20Mo (0.28 - 0.33C) (SAE 4130)
AMS-QQ-A-250/4	Aluminum Alloy 2024, Plate and Sheet
AMS-QQ-A-250/12	Aluminum Alloy 7075, Plate and Sheet
AMS-QQ-P-416	Plating, Cadmium (Electrodeposited)
AMS-T-9046	Titanium and Titanium Alloy, Sheet, Strip, and Plate
AMS-T-81533	Trichloroethane 1, 1, 1, (Methyl Chloroform) Inhibited, Vapor Degreasing



AIR1362 Aerospace Hydraulic Fluids Physical Properties

AS4059 Aerospace Fluid Power - Contamination Classification for Hydraulic Fluids

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 A109/A109M Standard Specification for Steel, Strip, Carbon (0.25 Maximum Percent), Cold Rolled

ASTM B152/B152M Standard Specification for Copper Sheet, Strip, Plate, and Rolled Bar

ASTM B700 Standard Specification for Electrodeposited Coatings of Silver for Engineering Use

ASTM D92 Standard Test Method for Flash and Fire Points by Cleveland Open Cup

ASTM D97 Standard Test Method for Pour Point of Petroleum Products

ASTM D445 Standard Test Method for Kinematic Viscosity of Transparent and Opaque Liquids (the Calculation of Dynamic Viscosity)

ASTM D892 Standard Test Method for Foaming Characteristics of Lubricating Oils

ASTM D974 Standard Test Method for Acid and Base Number by Color-Indicator Titration

ASTM D1217 Standard Test Method for Density and Relative Density (Specific Gravity) of Liquids by Bingham Pycnometer

ASTM D2155 Standard Test Method of Test for Autoignition Temperature of Liquid Petroleum Products

ASTM D4052 Standard Test Method for Density and Relative Density of Liquids by Digital Density Meter

ASTM D4172 Standard Test Method for Wear Preventive Characteristics of Lubricating Fluid (Four Ball Method)

ASTM D6304 Standard Test Method for Determination of Water in Petroleum Products, Lubricating Oils, and Additives by Coulometric Karl Fischer Titration

2.3 IP Publications

Available from Energy Institute, 61 New Cavendish Street, London, W1G 7AR, UK, Tel: +44 (0) 20 7467 7100, www.energyinst.org.

IP 15 Standard Test Method for Pour Point of Petroleum Products

IP 36 Standard Test Method for Flash and Fire Points by Cleveland Open Cup

IP 71 Kinematic Viscosity of Transparent and Opaque Liquids (the Calculation of Dynamic Viscosity)

IP 139 Standard Test Method for Acid and Base Number by Color Indicator Titration

IP 146 Standard Test Method for Foaming Characteristics of Lubricating Oils

IP 365 Standard Test Method for Density and Relative Density of Liquids by Digital Density Meter

2.4 NAS Publications

Available from Aerospace Industries Association, 1000 Wilson Boulevard, Suite 1700, Arlington, VA 22209-3928, Tel: 703-358-1000, www.aia-aerospace.org.

NAS 1613 Seal Element, Packing, Preformed, Ethylene Propylene Rubber

2.5 U.S. Government

Copies of this document are available online at <http://quicksearch.dla.mil>.

MIL-PRF-680 Degreasing Solvent (Stoddard Petroleum Solvent, or equivalent)

2.6 Other References

AS1241 erosion test valve drawings available from SAE International on special request (see contact information above).

3. TECHNICAL REQUIREMENTS

The fluid shall meet all the requirements specified herein. The fluid supplier shall maintain and provide upon request documentation demonstrating that the fluid complies with this specification and successfully completed all required testing. Fluid samples shall be provided to the qualifying agency in the quantities requested, to allow the qualifying agency to perform any of the tests specified herein.

3.1 Composition

The fluid shall consist of a phosphate ester base to which an additive package is blended. The composition must serve satisfactorily in systems designed to be compatible with phosphate ester fluid. New candidate fluids must be completely compatible in all proportions of mixing with all phosphate ester hydraulic fluids that are commercially available and in compliance with AS1241. A list of AS1241 approved fluids may be obtained from AS1241 qualifying agencies.

3.2 Types, Classes, Grades

3.2.1 Types

- a. Type I: Obsolete
- b. Type II: Obsolete
- c. Type III: Obsolete
- d. Type IV: Erosion Arresting, Fire Resistant Fluid
- e. Type V: Erosion Arresting, Fire Resistant, Improved Thermal Stability Fluid.

3.2.2 Classes

Type IV fluids shall be divided into classes as follows:

- a. Class 1: Low density - specific gravity 0.970 to 1.020
- b. Class 2: High density - specific gravity 1.021 to 1.066

Grades

Type V fluids shall be divided into grades defined by the pumping and erosion resistance tests as follows:

- a. Grade A - The erosion resistance test and the pumping test are both conducted at 275 °F (135 °C).
- b. Grade B - Either the erosion resistance test or the pumping test is conducted at the Type V temperature requirement of 275 °F (135 °C). The other test is then conducted at the Type IV temperature requirement.

3.3 Physical and Chemical Properties

3.3.1 New Fluid Properties

New fluids of all types, classes, and grades shall be in accordance with the physical and chemical properties defined in Table 1.

Table 1 - Physical and chemical properties for new fluid

Property	Type IV Class 1	Type IV Class 2	Type V
Viscosity, cSt (ASTM D445) (IP 71)			
-65 °F (-53.9 °C)	2000 max	3500 max	2600 max
100 °F (37.8 °C)	9.0 - 12.5	9.0 - 12.5	9.0 - 12.5
210 °F (98.9 °C)	3.0 - 4.0	3.0 - 4.0	3.0 - 4.0
260 °F (126.7 °C)	---	---	1.5 min
Chemical Contamination, max ppm /2/			
Chlorine	50	50	50
Calcium	10	10	10
Sodium	10	10	10
Potassium	10	10	10
Sulfur	150	150	150
Water Content, % H2O by weight (ASTM D6304)	0.20 max	0.20 max	0.20 max
Density, gm/ml at 77 °F (25 °C) (ASTM D1217) (ASTM D4052) (IP 365)	1.020 max	1.021 to 1.066	1.020 max
Acid Number, mg Potassium Hydroxide/gm (ASTM D974) (IP 139)	0.10 max	0.10 max	0.10 max
Electrical Conductivity	0.20 micro Siemens/cm - minimum at 68 °F (20 °C)	0.20 micro Siemens/cm - minimum at 68 °F (20 °C)	0.20 micro Siemens/cm - minimum at 68 °F (20 °C)
Pour Point (ASTM D97) (IP 15)	Less than -80 °F (-62 °C)	Less than -80 °F (-62 °C)	Less than -80 °F (-62 °C)
Flash Point (ASTM D92) (IP 36)	320 °F min (160 °C)	320 °F min (160 °C)	310 °F min (154 °C)
Fire Point (ASTM D92) (IP 36)	350 °F min (177 °C)	350 °F min (177 °C)	350 °F min (177 °C)

Table 1 - Physical and chemical properties for new fluid (continued)

Property	Type IV Class 1	Type IV Class 2	Type V 3
Auto Ignition Temp. (ASTM D2155)	750 °F min (399 °C)	750 °F min (399 °C)	750 °F min (399 °C)
Exhaust Manifold Test (see 4.1.1)	Km $\geq$ 10	Km $\geq$ 10	Km $\geq$ 10
High Pressure Spray Ignition Test (see 4.1.2)	Kn $\geq$ 10	Kn $\geq$ 10	Kn $\geq$ 10
Wick Ignition Test (see 4.1.3)	25 cycles minimum	25 cycles minimum	25 cycles minimum
Color	Clear, blue to purple when viewed with white light passing through a fluid column of approximately 1 inch (25 mm) diameter	Clear, blue to purple when viewed with white light passing through a fluid column of approximately 1 inch (25 mm) diameter	Clear, blue to purple when viewed with white light passing through a fluid column of approximately 1 inch (25 mm) diameter
Appearance	Clear liquid, without layering or separation	Clear liquid, without layering or separation	Clear liquid, without layering or separation
Bulk Modulus (see 4.2)	210000 psi min at 100 °F (1447900 kPa at 38 °C)	210000 psi min at 100 °F (1447900 kPa at 38 °C)	210000 psi min at 100 °F (1447900 kPa at 38 °C)
Coefficient of Thermal Expansion	1.0×10^{-3} in ³ /in ³ °F max between 77 and 210 °F (1.8 x 10 ⁻³ ml/ml °C max between 25 and 99 °C)	1.0×10^{-3} in ³ /in ³ °F max between 77 and 210 °F (1.8 x 10 ⁻³ ml/ml °C max between 25 and 99 °C)	1.0×10^{-3} in ³ /in ³ °F max between 77 and 210 °F (1.8 x 10 ⁻³ ml/ml °C max between 25 and 99 °C)
Toxicity	Minimal irritant properties, low sensitization potential, see 4.10	Minimal irritant properties, low sensitization potential, see 4.10	Minimal irritant properties, low sensitization potential, see 4.10
Hydrolytic Stability (see 4.3)	See 4.3.5	See 4.3.5	See 4.3.5
Thermal Stability (see 4.4)	See 4.4.3	See 4.4.3	See 4.4.3
Compatibility With Other Materials (see 4.5)	See 4.5.1, 4.5.2, 4.5.3, 4.5.4	See 4.5.1, 4.5.2, 4.5.3, 4.5.4	See 4.5.1, 4.5.2, 4.5.3, 4.5.4
High Temperature Effect on Metals (see 4.6)	See 4.6.1	See 4.6.1	See 4.6.1
Four Ball Wear (see 4.7)	See 4.7	See 4.7	See 4.7
Fluid Performance Test (Pumping Test) (see 4.8)	See 4.8, 4.8.3	See 4.8, 4.8.3	See 4.8, 4.8.3
Flow Control Valve Life (Erosion Resistance Test) (see 4.9)	See 4.9	See 4.9	See 4.9

Table 1 - Physical and chemical properties for new fluid (continued)

Property	Type IV Class 1	Type IV Class 2	Type V 3
Anti-erosion Additive Content	/2/	/2/	/2/
Foaming (ASTM D892) (IP 146)	See Table 2	See Table 2	See Table 2
Particulate Contamination, max (AS4059)	Class 7	Class 7	Class 7

NOTES:

- /1/ Elements introduced as part of the base stock or the additive package shall not be considered as contamination, and shall be assigned a nominal value by the supplier.
- /2/ The nominal content shall be determined at the time of qualification and will be proprietary. Variation from the nominal content shall not exceed the algebraic sum of the manufacturing tolerance and the accuracy of the analytical determination. The manufacturing and analytical tolerances may be combined.
- /3/ Type V physical and chemical requirements apply to both grades A and B. The only differences between the grades are the pumping and the erosion resistance tests (see 3.2.3).

Table 2 – Foam Limits for New Fluid

Sequence	Temperature	Foam After 5 minutes Blowing (ml, max)	Time for Complete Foam Collapse (seconds, max)
1	75 °F (24 °C)	250	100
2	200 °F (93 °C)	150	50
3	75 °F (24 °C)	450	250

3.3.2 Fluid Mixtures

New candidate fluids must be completely compatible in all proportions of mixing with all phosphate ester hydraulic fluids that are commercially available and in compliance with AS1241. When mixed with any other approved product, the mixture shall meet the requirements as stated in Table 3. See 4.5.1 for definition for the test procedure to check mixing of hydraulic fluids.

Table 3 - Mixture properties

Property	Requirement
Miscibility	Complete miscibility in all mixture proportions, without precipitation or cloudiness
Foaming, for 25/75, 50/50, 75/25 mixes (ASTM D892, see 2.2.4)	(See Table 4)

Table 4 - Foam limits for mixtures

Sequence	Temperature	Foam After 5 minutes Blowing (ml, max)	Time for Complete Foam Collapse (seconds, max)
1	75 °F (24 °C)	400	250
2	200 °F (93 °C)	425	200
3	75 °F (24 °C)	425	220

4. QUALIFICATION

The fluid supplier shall have test facilities or use commercial test laboratories with the capability to test in accordance with the requirements herein.

4.1 Flammability

Fluid shall meet the flammability requirements as specified in Table 1. When performing flammability tests, perform a control test using an approved fluid to verify the test set-ups. Identify test fluid and test results in test report. If the test produces unexpected results with the approved fluid, verify the test setup is correct. For proper comparison, the tests on both fluids should be performed under identical atmospheric conditions, preferably one immediately following the other.

4.1.1 Exhaust Manifold Test

Fabricate a simulated exhaust stack section and mount in a shield as shown in Figure 1. Opposite the steel rod, spot-weld a thermocouple, and insulate the leads to insure proper temperature readings. Insert a heating element [Globar Type At, 31 x 12 x 1 inches (790 x 305 x 25 mm), 0.633 Ω , made by Carborundum Co., Niagara Falls, NY, or equivalent] into the tube and make the necessary electrical connections. Adjust the voltage so that the temperature of the tube is 1300 °F $\pm$ 25 °F (704 °C $\pm$ 14 °C). Clean the tube before each series of tests with steel wool.

As a control test to verify the test set-up, slowly pour 10 ml $\pm$ 1 ml of an approved fluid (identify fluid in test report) on the tube in 40 seconds $\pm$ 5 seconds.

Record the results as follows:

- a. Fluid burns on tube (0 points), fluid does not burn on tube (5 points) and
- b. Fluid burns on bottom of the shield (0 points), fluid flashes on the bottom of the shield (5 points), or fluid does not burn on the bottom of the shield (10 points).

$$K_m = a + b.$$

If the test produces unexpected results with the approved fluid, verify the test setup is correct. Repeat the test using the candidate fluid. Record the results. Report the results of the control test and the candidate fluid test so that the tests performed to qualify the control fluid can be compared to the control test results and used to validate the results of the candidate fluid.