



# Standard Specification for Phosphate Ester Based Fluids for Turbine Lubrication<sup>1</sup>

This standard is issued under the fixed designation D4293; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon ( $\epsilon$ ) indicates an editorial change since the last revision or reapproval.

## 1. Scope

1.1 This specification covers the requirements for phosphate ester based fire resistant fluids for use in turbine lubrication.

1.2 The specification defines only unused fluid before it is installed in the turbine. It is not intended for fluids used in electrohydraulic control (EHC) systems.

1.3 The use of this type of fluid is restricted to turbine systems that have been designed or modified to accommodate phosphate ester lubricants.

1.4 The values stated in SI units are to be regarded as standard. No other units of measurement are included in this standard.

1.5 The following precautionary caveat pertains only to Sections 5 and 5.3. *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

## 2. Referenced Documents

### 2.1 ASTM Standards:<sup>2</sup>

- D92 Test Method for Flash and Fire Points by Cleveland Open Cup Tester
- D97 Test Method for Pour Point of Petroleum Products
- D445 Test Method for Kinematic Viscosity of Transparent and Opaque Liquids (and Calculation of Dynamic Viscosity)
- D665 Test Method for Rust-Preventing Characteristics of Inhibited Mineral Oil in the Presence of Water
- D892 Test Method for Foaming Characteristics of Lubricating Oils
- D974 Test Method for Acid and Base Number by Color-Indicator Titration
- D1744 Test Method for Determination of Water in Liquid

<sup>1</sup> This specification is under the jurisdiction of ASTM Committee D02 on Petroleum Products and Lubricants and is the direct responsibility of Subcommittee D02.N0.06 on Fire Resistant Fluids.

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<sup>2</sup> For referenced ASTM standards, visit the ASTM website, [www.astm.org](http://www.astm.org), or contact ASTM Customer Service at [service@astm.org](mailto:service@astm.org). For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

Petroleum Products by Karl Fischer Reagent<sup>3</sup>

D2619 Test Method for Hydrolytic Stability of Hydraulic Fluids (Beverage Bottle Method)

D4057 Practice for Manual Sampling of Petroleum and Petroleum Products

2.2 Federal Test Method Standard:<sup>4</sup>

791B, Method 5308 Corrosiveness and Oxidation Stability of Light Oils (Metal Strip)

2.3 SAE Aeronautical Material Specification:<sup>5</sup>

SAE AMS 3150C Hot Manifold and High Temperature Ignition Flammability Tests

## 3. Functional Property Requirements

3.1 Requirements for ISO viscosity grades 32 and 46 phosphate ester based fire resistant fluids are shown in Table 1.

3.2 The choice of viscosity grade for use in a particular turbine should comply with the turbine manufacturer's recommendation.

3.3 The autoignition temperature property for phosphate esters, although important to turbine manufacturers and to fluid users, is not listed because there is no published procedure in the ASTM manual.

## 4. Significance and Use

4.1 This is a specification to define the requirements of fire resistant fluids for use in turbine lubrication. This specification defines phosphate ester fluids which will give satisfactory lubrication performance in a turbine engine. However, it is possible that phosphate esters that do not meet this specification may give adequate performance in the field.

4.2 Fire resistant fluids are more difficult to ignite and show little tendency to propagate a flame. The term "fire resistant fluid" does not mean that the fluid will not burn.

4.3 The normal fluid operating temperature will be in the range of 54 to 65°C and will experience a maximum temperature of about 93°C during flow across the turbine bearings whose housing temperature may be as high as 343°C.

<sup>3</sup> Withdrawn. The last approved version of this historical standard is referenced on [www.astm.org](http://www.astm.org).

<sup>4</sup> Available from Standardization Documents Order Desk, DODSSP, Bldg. 4, Section D, 700 Robbins Ave., Philadelphia, PA 19111-5098, <http://www.dodssp.daps.mil>.

<sup>5</sup> Available from Society of Automotive Engineers (SAE), 400 Commonwealth Dr., Warrendale, PA 15096-0001, <http://www.sae.org>.

**TABLE 1 Requirements for Fire Resistant Turbine Lubricants**

Property	Test Method	Limits ISO Viscosity Grade	
		32	46
Viscosity, cSt, 40°C	D445	28.8–35.2	41.4–50.6
Pour point, °C, max	D97	0	+6
Foaming tendency, mL, max Sequence I	D892	25	25
Fire properties:			
Flash point, °C, min	D92	225	225
Fire point, °C, min	D92	325	325
Hot manifold, °C, min	SAE AMS 3150C	704	704
Flammability, high temperature spray ignition (high pressure)	SAE AMS 3150C	Report	Report
Total acid number, mgKOH/g, max	D974	0.2	0.2
Rust prevention, procedure A	D665	Pass	Pass
Water content, % max	D1744	0.1	0.1
Oxidation stability, 175°C, 72 h	791B, Method 5308		
Percent change in viscosity at 40°C		–5 to +20	–5 to +20
Increase in total acid number, max		3.0	3.0
Hydrolytic stability	D2619	Report <sup>A</sup>	Report <sup>A</sup>

<sup>A</sup> The hydrolytic stability test shall be run to meet the customer's requirement.

## 5. Safety Precautions

5.1 The fire tests are used to measure and describe the properties of the phosphate esters in response to heat and flame under controlled laboratory conditions and should not be considered or used for the description or appraisal of the fire hazard of the fluids under actual fire conditions.

5.1.1 Fires that have occurred in operating turbines have usually been caused by fluid or vapors contacting hot surfaces. For example, fluid that may spill and be absorbed into unprotected thermal insulation can experience an exothermic reaction with resultant, potential rapid temperature increase. The ignition of the absorbed fluid can occur at temperatures below the fluid autoignition temperature. Thus, the high autoignition temperatures of phosphate esters have relevance to turbine lubricant fire hazards. Likewise, the **SAE AMS 3150C** tests are relevant to the particular hazards in turbine lubrication.

5.2 Conducting tests for fire properties such as Test Method **D92** and **SAE AMS 3150C** could result in a serious fire or explosion. It is recommended that only experienced personnel run these tests.

5.3 Fumes generated by the above tests may be hazardous from the standpoint of both inhalation and skin irritation. Therefore, the Test Method **D92** should be conducted so that all fumes and vapors are contained in a draft-free shield in a hood.

High pressure spray flammability tests should, if possible, be remotely controlled from an area outside of or isolated from the test room, or if necessary, by an operator(s) provided with protective clothing and breathing apparatus with safety glasses or face shields, or both, appropriate to the test environment.

5.4 Because **SAE AMS 3150C** test pressures are controlled at 6.9 MPa, all equipment must be maintained carefully, checked for leakage before each test, and operated only by trained personnel.

5.5 A portable carbon dioxide fire extinguisher shall be conveniently located in the test area for emergency use.

## 6. Sampling

6.1 Take all fluid samples in accordance with Practice **D4057**.

6.2 Clean, dry, and free all sampling apparatus from any substance that might contaminate the fluid.

6.3 Care shall be taken to ensure that the fluid is mixed properly before samples are withdrawn for test and that the samples are representative of the whole.

6.4 The fluid shall normally meet the specification requirements at the point where it passes from the supplier to the consumer unless other contractual arrangements have been made.

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