INTERNATIONAL STANDARD

ISO 9940

First edition
2015-08-01

Aerospace series — Fluid, hydraulic, phosphate ester-base, fire resistant — Technical specification

Série aérospatiale — Fluide, hydraulique, esters phosphoriques, résistant au feu — Spécification technique

Reference number
ISO 9940:2015(E)

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT) see the following URL: Foreword - Supplementary information

The committee responsible for this document is ISO/TC 20, *Aircraft and space vehicles*, Subcommittee SC 10, *Aerospace fluid systems and components.*

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Aerospace series — Fluid, hydraulic, phosphate ester-base, fire resistant — Technical specification

1 Scope

This International Standard defines technical requirements, qualification and quality control conditions (product qualification, batch control, acceptance) test and measurement methods to be used by manufacturers for qualification of fire-resistant phosphate-ester-base fluids used for hydraulic transmissions in aircrafts.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 37, *Rubber, vulcanized or thermoplastic — Determination of tensile stress-strain properties*

ISO 48, *Rubber, vulcanized or thermoplastic — Determination of hardness (hardness between 10 IRHD and 100 IRHD)*

ISO 1817, *Rubber, vulcanized or thermoplastic — Determination of the effect of liquids*

ISO 2592, *Determination of flash and fire points — Cleveland open cup method*

ISO 2921, *Rubber, vulcanized — Determination of low-temperature retraction (TR test)*

ISO 3016, *Petroleum products — Determination of pour point*

ISO 3104, *Petroleum products — Transparent and opaque liquids — Determination of kinematic viscosity and calculation of dynamic viscosity*

ISO 3116, *Magnesium and magnesium alloys — Wrought magnesium alloys*

ISO 3675, *Crude petroleum and liquid petroleum products — Laboratory determination of density — Hydrometer method*

ISO 3696, *Water for analytical laboratory use — Specification and test methods*

ISO 4407, *Hydraulic fluid power — Fluid contamination — Determination of particulate contamination by the counting method using an optical microscope*

ISO 6247, *Petroleum products — Determination of foaming characteristics of lubricating oils*

ISO 6618, *Petroleum products and lubricants — Determination of acid or base number — Colour-indicator titration method*

ISO 6619, *Petroleum products and lubricants — Neutralization number — Potentiometric titration method*

ISO 11171, *Hydraulic fluid power — Calibration of automatic particle counters for liquids*

ISO 11218, *Aerospace — Cleanliness classification for hydraulic fluids*

ISO 11500, *Hydraulic fluid power — Determination of the particulate contamination level of a liquid sample by automatic particle counting using the light-extinction principle*

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ISO 12185, *Crude petroleum and petroleum products — Determination of density — Oscillating U-tube method*

ISO 12937, *Petroleum products — Determination of water — Coulometric Karl Fischer titration method*

ISO 13357-2, *Petroleum products — Determination of the filterability of lubricating oils — Part 2: Procedure for dry oils*

ISO 13573:2012, *Corrosion of metals and alloys — Test method for thermal-cycling exposure testing under high-temperature corrosion conditions for metallic materials*

ISO 14935, *Petroleum and related products — Determination of wick flame persistence of fire-resistant fluids*

ISO 15029-1, *Petroleum and related products — Determination of spray ignition characteristics of fire-resistant fluids — Part 1: Spray flame persistence — Hollow-cone nozzle method*

ISO 15597, *Petroleum and related products — Determination of chlorine and bromine content — Wavelength-dispersive X-ray fluorescence spectrometry*

ISO 20823, *Petroleum and related products — Determination of the flammability characteristics of fluids in contact with hot surfaces — Manifold ignition test*

EN 1652, *Copper and copper alloys — Plate, sheet, strip and circles for general purposes*

EN 2395, *Aerospace series — Aluminium alloy AL-P2024A — T4 or T42 — Sheet and strip — 0,4 mm ≤ a ≤ 6 mm*

EN 10130, *Cold rolled low carbon steel flat products for cold forming — Technical delivery conditions*

ASTM D 92[1)], *Standard Test Method for Flash and Fire Points by Cleveland Open Cup Tester*

ASTM D 97[1)], *Standard Test Method for Pour Point of Petroleum Products*

ASTM D 445[1)], *Standard Test Method for Kinematic Viscosity of Transparent and Opaque Liquids (and Calculation of Dynamic Viscosity)*

ASTM D 664[1)], *Standard Test Method for Acid Number of Petroleum Products by Potentiometric Titration*

ASTM D 877[1)], *Standard Test Method for Dielectric Breakdown Voltage of Insulating Liquids Using Disk Electrodes*

ASTM D 892[1)], *Standard Test Method for Foaming Characteristics of Lubricating Oils*

ASTM D 974[1)], *Standard Test Method for Acid and Base Number by Color-Indicator Titration*

ASTM D 1217[1)], *Standard Test Method for Density and Relative Density (Specific Gravity) of Liquids by Bingham Pycnometer*

ASTM D 1298[1)], *Standard Test Method for Density, Relative Density, or API Gravity of Crude Petroleum and Liquid Petroleum Products by Hydrometer Method*

ASTM D 2155[1)], *Standard Test Method for Determination of Fire Resistance of Aircraft Hydraulic Fluids by Autoignition Temperature*

ASTM D 4052[1)], *Standard Test Method for Density, Relative Density, and API Gravity of Liquids by Digital Density Meter*

ASTM D 4172[1)], *Standard Test Method for Wear Preventive Characteristics of Lubricating Fluid (Four-Ball Method)*

ASTM D 4636[1)], *Standard Test Method for Corrosiveness and Oxidation Stability of Hydraulic Oils, Aircraft Turbine Engine Lubricants, and Other Highly Refined Oils*

1) Published by: ASTM International www.astm.org

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ASTM D 5621[1)], *Standard Test Method for Sonic Shear Stability of Hydraulic Fluids*

ASTM D 6304[1)], *Standard Test Method for Determination of Water in Petroleum Products, Lubricating Oils, and Additives by Coulometric Karl Fischer Titration*

ASTM D 6443[2)], *Test Method for Determination of Calcium, Chlorine, Copper, Magnesium, Phosphorus, Sulfur, and Zinc in Unused Lubricating Oils and Additives by Wavelength Dispersive X-ray Fluorescence Spectrometry (Mathematical Correction Procedure)*

ASTM D 6793[2)], *Standard Test Method for Determination of Isothermal Secant and Tangent Bulk Modulus*

ASTM E 1269[2)], *Standard Test Method for Determining Specific Heat Capacity by Differential Scanning Calorimetry*

DEF STAN 03-19[3)], *Electro-Deposition of Cadmium*

3 Technical requirements

3.1 General

The product shall be a fire resistant, phosphate ester-base fluid for hydraulic power transmissions. Its chemical composition (additives, contaminants) and intrinsic physical and chemical properties shall be in strict compliance with the requirements of this International Standard.

All delivered hydraulic fluids shall be fully compatible with any other phosphate ester-base fluid already qualified, whatever the mixture proportions.

In the following clauses, the International Standard appearing in brackets shall be considered as an alternative method to the preceding standard, e.g. ISO 3104 (ASTM D 445); ASTM D 445 is an alternative standard to ISO 3104.

3.2 Fluid types

Fluids types covered by this International Standard are listed in the Table 1 with their corresponding properties.

Table 1 — Type of fluid and properties

Type of fluid		Fluid properties
IV	"HD" (High Density)	Fire resistant, low water content, anti-erosion, high viscosity at low temperature and high density
	"LD" (Low Density)	Fire resistant, low water content, anti-erosion, low density
V		Fire resistant, low water content, low density, anti-erosion, improved thermal stability and in service lifetime.

3.3 Physical and chemical properties

The main physical and chemical properties of the fluid covered by this International Standard are listed in the Table 2.

2) Published by: ASTM International www.astm.org

3) Published by: MINISTRY OF DEFENCE (United Kingdom) www.gov.uk/government/organisations/ministry-of-defence

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3.4 Products and manufacturers qualification

The qualified products list appears in the AMM (Aircraft Maintenance Manual).

3.5 Approved laboratories

All laboratories used should be ISO 9001 registered and AS/EN/JIS Q 9100 compliant.

Table 2 — Main characteristics and properties

Property	Unit	Condition	Requirements		Test method(s)		Sub clause
	Symbol		TYPE IV	TYPE V	Preferred International Standard	Alternative International Standard	
Absolute kinematic viscosity	$mm^2 \cdot s^{-1}$ (centiStokes) "ν"	−54 °C (−65 °F) 38 °C (100 °F) 99 °C (210 °F) Atmospheric pressure	HD: ≤ 2 900 LD: ≤ 2 000	LD: ≤ 2 000	ISO 3104	ASTM D 445	4.1
			∈ [9,00; 12,50] ∈ [3,00; 4,00]				
Water content	H_2O % mass or ppm[a]	—	≤0,20 or 2 000		ISO 12937[b]	ASTM D 6304	4.2
Density	$kg \cdot m^{-3}$ "ρ"	(23 ± 3) °C	1 021 ≤ HD ≤ 1 066 LD: ≤ 1 020	LD:≤ 1 020	ISO 3675 or ISO 12185	ASTM D 1298 D 4052 or D 1217	4.3
Acid number Acidity index	mg KOH per g of fluid	—	≤0,10		ISO 6618 or ISO 6619	ASTM D 974 or D 664	4.4
Electrical conductivity	$\mu S \cdot cm^{-1}$ "γ"	20 °C (−10 °C to 100 °C)	≥0,30 ∈ [0,02 ; 6,00]		ISO 9940	—	4.5
Chlorine content	Cl^- ppm[a]	Tot. chlorine	≤50		ISO 15597	ASTM D 6443	4.6
Pour point temperature	°C (°F)	—	≤ −62 (−80)		ISO 3016	ASTM D 97	4.7
Flash point temperature			≥160 (320)		ISO 2592	ASTM D 92	4.8
Fire point temperature			≥177 (350)				
Auto ignition temperature			≥399 (750) ≥460 (860) for HD	≥399 (750)	ASTM D 2155	—	4.9
Flammability	Seconds	5 s, 10 s, 20 s and 30 s	Mean persistence time of the flame < 7,5 s		ISO 14935	—	4.10.1
	Seconds	—	Time elapsed between removal of the igniting flame and extinction of the spray along the spray pattern ≤ 4 s		ISO 15029-1	—	4.10.2
	Ignition category	700 °C ± 5 °C	$k_m \geq 10$		ISO 20823	—	4.10.3

[a] ppm = parts per million = $\mu g \cdot g^{-1}$ (10^{-6}).

[b] Deviation to ISO 12937 is granted for water content above 0,1.

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Table 2 *(continued)*

Property	Unit	Condition	Requirements		Test method(s)		Sub clause
	Symbol		TYPE IV	TYPE V	Preferred International Standard	Alternative International Standard	
Colour condition	—	—	Purple Clear appearance		—	—	4.11
Isothermal secant Bulk Modulus	Pa	38 °C, 20,6·10⁶ Pa	Mini value: 1 450·10⁶ Pa		ASTM D 6793	—	4.12
Thermal expansion	°C⁻¹ "α"	−25 °C to 99 °C	≤1·10⁻³		ASTM D 1217	—	4.13
		−54 °C to 110 °C	Curve to provide				
Solid particulate contamination (counting)	Cleanliness class	—	≤7		ISO 11218 ISO 11171 ISO 11500 or ISO 4407	—	4.16
Filterability	F	—	∈ [1,00 ; 1,60]		ISO 13357-2	—	
Foaming	cm³	24 °C 93 °C 24 °C	After 5 min ≤250 ≤150 ≤450	Persistence ≤100 s ≤50 s 250 s	ISO 6247	ASTM D 892	4.17

a ppm = parts per million = µg·g⁻¹ (10⁻⁶).

b Deviation to ISO 12937 is granted for water content above 0,1.

4 Qualification requirements

4.1 Absolute kinematic viscosity "ν"

Absolute kinematic viscosity "ν" of the fluid shall be determined at the temperatures indicated below and at atmospheric pressure using viscosimetric capillary tubes in accordance with ISO 3104 (ASTM D 445). The limits values are in $mm^2 \cdot s^{-1}$ (centiStokes), see Table 3.

Table 3 — Viscosity limit values

Temperatures		Type	
°C	°F	IV High Density	IV & V Low Density
−54	−65	$\nu \leq 2\,900$	$\nu \leq 2\,000$
−40	−40	Values to be measured and provided	
−15	5		
38	100	$9{,}00 \leq \nu \leq 12{,}50$	
99	210	$3{,}00 \leq \nu \leq 4{,}00$	

Measurements shall be taken in a thermostatic bath at accurate temperatures, controlled using an accurate contacting thermometer in accordance with ISO 3104 (ASTM D 445).

NOTE At low temperatures, viscosimetric tubes may be connected to dehydration tubes to avoid condensation forming inside.

An evolution curve "Viscosity vs. Temperature" from −54 °C to 99 °C is requested.

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