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Standard Specification for Biodegradable Fire Resistant Hydraulic Fluids¹

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1. Scope*

1.1 This specification covers performance classifications for biodegradable fire-resistant hydraulic fluids that are used in the industrial/mobile and mining industries.

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

1.3 *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 to determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 ASTM Standards:²

- D95 Test Method for Water in Petroleum Products and Bituminous Materials by Distillation
- D664 Test Method for Acid Number of Petroleum Products by Potentiometric Titration
- D892 Test Method for Foaming Characteristics of Lubricating Oils
- D943 Test Method for Oxidation Characteristics of Inhibited Mineral Oils
- D974 Test Method for Acid and Base Number by Color-Indicator Titration
- D1298 Test Method for Density, Relative Density, or API Gravity of Crude Petroleum and Liquid Petroleum Products by Hydrometer Method
- D1401 Test Method for Water Separability of Petroleum Oils and Synthetic Fluids
- D2422 Classification of Industrial Fluid Lubricants by Viscosity System
- D2532 Test Method for Viscosity and Viscosity Change

After Standing at Low Temperature of Aircraft Turbine Lubricants

- D2783 Test Method for Measurement of Extreme-Pressure Properties of Lubricating Fluids (Four-Ball Method)
- D2882 Test Method for Indicating Wear Characteristics of Petroleum and Non-Petroleum Hydraulic Fluids in Constant Volume Vane Pump (Withdrawn 2003)³
- D3427 Test Method for Air Release Properties of Hydrocarbon Based Oils
- D4052 Test Method for Density, Relative Density, and API Gravity of Liquids by Digital Density Meter
- D5182 Test Method for Evaluating the Scuffing Load Capacity of Oils (FZG Visual Method)
- D6046 Classification of Hydraulic Fluids for Environmental Impact
- D6304 Test Method for Determination of Water in Petroleum Products, Lubricating Oils, and Additives by Coulometric Karl Fischer Titration
- D6546 Test Methods for and Suggested Limits for Determining Compatibility of Elastomer Seals for Industrial Hydraulic Fluid Applications
- E70 Test Method for pH of Aqueous Solutions With the Glass Electrode

2.2 DIN Standards:⁴

- DIN 51348 Testing of Fire Resistant Governor Fluids; Determination of Hydrolytic Stability
- DIN 51354-2 Testing of Lubricants; FZG Gear Test Rig – Part 1: Method A/8,3/90 for Lubricating Oils
- DIN 51373 Testing of Fire Resistant Heat Transfer Fluids; Determination of Resistance to Oxidation Including an Assessment of the Catalyst Plates
- DIN 51389-2 Determination of Lubricants; Mechanical Testing of Hydraulic Fluids in the Vane-cell-pump; Method A for Anhydrous Hydraulic Fluids
- DIN 51777-2 Testing of Mineral Oil Hydrocarbons and Solvents; Determination of Water Content according to Karl Fischer; Indirect Method

¹ This specification is under the jurisdiction of ASTM Committee D02 on Petroleum Products, Liquid Fuels, and Lubricants and is the direct responsibility of Subcommittee D02.N0 on Hydraulic Fluids.

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² For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

³ The last approved version of this historical standard is referenced on www.astm.org.

⁴ Available from Deutsches Institut für Normung e.V.(DIN), Am DIN-Platz, Burggrafenstrasse 6, 10787 Berlin, Germany, <http://www.din.de>.

*A Summary of Changes section appears at the end of this standard

2.3 ISO Standards:⁵

- ISO 2049 Petroleum Products—Determination of Color (ASTM Scale)
- ISO 2160 Petroleum Products—Corrosiveness to Copper—Copper Strip Test
- ISO 2592 Determination of Flash and Fire Points—Cleveland Open Cup Method
- ISO 3104 Petroleum Products—Transparent and Opaque Liquids—Determination of Kinematic Viscosity and Calculation of Dynamic Viscosity
- ISO 3105 Glass Capillary Kinematic Viscometers—Specifications and Operating Instructions
- ISO 3448 Industrial Liquid Lubricants—ISO Viscosity Classification
- ISO 3675 Crude Petroleum and Liquid Petroleum Products—Laboratory Determination of Density—Hydrometer Method
- ISO 3733 Petroleum Products and Bituminous Materials—Determination of Water—Distillation Method
- ISO 4263-1 Petroleum and Related Products—Determination of the Aging Behavior of Inhibited Oils and Fluids—TOST Test—Part 1: Procedure for Mineral Oils
- ISO 4404-1 Petroleum and Related Products—Determination of the Corrosion Resistance of Fire-Resistant Fluids—Part 1: Water-Containing Fluids
- ISO 4406 Hydraulic Fluid Power—Fluids—Method for Coding the Level of Contamination by Solid Particles
- ISO 5884 Aerospace—Fluid Systems and Components—Methods for System Sampling and Measuring the Solid Particle Contamination of Hydraulic Fluids
- ISO 6072 Compatibility between Fluids and Standard Elastomeric Materials
- ISO 6245 Petroleum Products—Determination of Ash
- ISO 6247 Petroleum Products—Determination of Foaming Characteristics of Lubricating Oils
- ISO 6296 Petroleum Products—Determination of Water—Potentiometric Karl Fischer Titration Method
- ISO 6618 Petroleum Products and Lubricants—Determination of Acid or Base Number—Color Indicator Titration Method
- ISO 6619 Petroleum Products and Lubricants—Neutralization Number—Potentiometric Titration Method
- ISO 6743-4 Lubricants, Industrial Oils and Related Products (class L)—Classification—Part 4: Family H (Hydraulic Systems)
- ISO 7120 Petroleum Products and Lubricants—Petroleum Oils and Other Fluids—Determination of Rust Preventing Characteristics in the Presence of Water
- ISO 7745 Hydraulic Fluid Power—Fire-resistant (FR) Fluids—Guidelines for Use
- ISO 9120 Petroleum and Related Products—Determination of Air Release Properties of Steam Turbine and Other Oils—Impinger Method
- ISO 12185 Crude Petroleum and Petroleum Products—Determination of Density—Oscillating U-Tube Method

- ISO 12922 Lubricants, Industrial Oils and Related Products (class L)—Family H (Hydraulic Systems)—Specifications for Categories HFAE, HFAS, HFB, HFC, HFDR, and HFDU
- ISO 12937 Petroleum Products—Determination of Water—Coulometric Karl Fischer Titration Method
- 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 15380 Lubricants, Industrial Oils and Related Products (Class L)—Family H (Hydraulic Systems)—Specifications for Categories HETG, HEPG, HEES, and HEPR

2.4 Lux Standards:⁶

- Lux 3.1.3 Stabilized Flame Heat Release—Spray Test
- Lux 5.2.3 Determination of the Emulsion Stability of HFB Fluids at Medium Temperature
- Lux 5.2.4 Determination of the Emulsion Stability of HF-B...LT Fluids at Low Temperature
- Lux 5.3.1 Determination of Aging Properties of HFC Fluids
- Lux 5.8 Determination of the Shear Stability of Hydraulic Fluids
- Lux 5.9.1 Determination of the Corrosion Inhibiting Properties of HFA, HFC, and HFD Fluids

2.5 Other Standards:

- CETOP RP 65H Manifold Ignition Test⁷
- CETOP RP 67H Antiwear Vane Pump Test for Hydraulic Fluids⁷
- IP 281⁸
- FM 6930 Flammability Classification of Industrial Fluids⁹
- 30 CFR Part 35 Fire Resistant Hydraulic Fluids¹⁰

3. Terminology

3.1 Definitions:

3.1.1 *bioaccumulation, n*—the net accumulation of a substance by an organism as a result of uptake from all environmental sources.

3.1.2 *biodegradable, n*—any substance containing <10 % wt. O₂ content which undergoes ≥60 % biodegradation as theoretical CO₂ in 28 days and ≥67 % biodegradation as theoretical O₂ uptake in 28 days, or any hydraulic fluid containing ≥10 % wt. O₂ content which undergoes ≥60 % biodegradation as theoretical CO₂ or as theoretical O₂ uptake in 28 days.

⁶ European Commission, Safety and Health Commission for the Mining and Other Extractive Industries, "Requirements and Tests Applicable to Fire-Resistant Hydraulic Fluids Used for Power Transmission and Control (Hydrostatic and Hydrokinetic)," Seventh Edition, Doc. N4746/10/91 EN, Luxembourg, April 1994.

⁷ Available from the Comité Européen des Transmissions Oléohydrauliques et Pneumatiques (CETOP), Lyoner Straße 18, 60528, Frankfurt am Main, Germany.

⁸ Available from Energy Institute, 61 New Cavendish St., London, W1G 7AR, U.K., <http://www.energyinst.org>.

⁹ Available from FM Global, 270 Central Ave., P. O. Box 7500, Johnston, RI 02919-4923, <http://www.fmglobal.com>.

¹⁰ Available from U.S. Government Printing Office Superintendent of Documents, 732 N. Capitol St., NW, Mail Stop: SDE, Washington, DC 20401, <http://www.access.gpo.gov>.

⁵ Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036, <http://www.ansi.org>.

TABLE 1 Specifications for Categories HFAE and HFAS Fluids According to ISO 12922

Characteristic or Test	Unit	Specification		Standard or Test Method
		Finished Emulsion Category HFAE ^A	Finished Solution Category HFAS ^A	
Composition		Type HFAE: These are oil-in-water emulsions, typically with more than 80 % water content (+5 °C to + 50 °C, ISO 7745) Type HFAS: These are chemical solutions in water, typically more than 80 % water content (+5 °C to +50 °C, ISO 7745)		
Appearance		<i>B</i>	<i>C</i>	
Water content, min.	% (V/V)	80	80	D95, D6304
Foam at: +25 °C max. ^D	mL/mL	300/10	300/10	D892
+50 °C max.	mL/mL	300/10	300/10	
+25 °C max.	mL/mL	300/10	300/10	
pH at 20 °C		6.7 to 11.0	6.7 to 11.0	E70
Emulsion stability (50 °C/600 h), max.	Rating	2A-2R	<i>B</i>	D1401
—free oil	% (v/v)	Trace	<i>B</i>	
cream, max. % (v/v)	% (v/v)	0.5	<i>B</i>	
Corrosion protection	Rating	<i>E</i>	<i>E</i>	(ISO 4404)
Elastomer compatibility NBR1, EPDM1 and FPM1 elastomer, 60 °C/168 h		<i>E</i>	<i>E</i>	D6546
relative volume change, max.	%	7	7	
relative hardness change: min.	IRHD	-7	-7	
max.	IRHD	+2	+2	
change in tensile strength	%	<i>E</i>	<i>E</i>	
elongation at break		<i>E</i>	<i>E</i>	

^A These products are normally supplied as concentrates, and should be used with the correct water quantity as specified by the supplier (viscosity of concentrate to be 350 mm²/s maximum at 20 °C).

^B The requirement is not relevant to this fluid type.

^C The appearance of the delivered fluid shall be clear and bright and free of any visible particulate matter, under normal visible light at ambient temperature, using a clear container of approximately 10 cm diameter.

^D For fluids with a viscosity greater than 10 mm²/s at 20 °C.

^E Report only on request.

3.1.3 *biodegradation, n*—the process of chemical breakdown or transformation of a material caused by organisms or their enzymes.

3.1.3.1 *Discussion*—Biodegradation is only one mechanism by which materials are transformed in the environment.

3.1.4 *fire-resistant fluid, n*—hydraulic liquid that has greater fire-resistance than mineral oil as determined with an acknowledged standard.

3.1.4.1 *Discussion*—Acknowledged standards include FM 6930, ISO 12922, and 30 CFR Part 35.

3.1.5 *hydraulic fluid, n*—a liquid used in hydraulic systems for lubrication and transmission of power.

4. Classification

4.1 The following classifications of fire-resistant hydraulic fluids, except for HEPG, were taken from ISO 6743-4.

4.1.1 *HFA*—Fire resistant hydraulic fluids that may be further classified as:

4.1.1.1 *HFAE*—Oil-in-water emulsions containing more than 80 % by weight water and typically in the range 95 % to 99 % by weight water.

4.1.1.2 *HFAS*—Chemical solutions. Not containing emulsions and typically contains more than 80 % by weight water.

4.1.2 *HFB*—Water-in-oil emulsions containing approximately 60 % by weight oil.

4.1.3 *HFC*—Aqueous monomer and polymer polyglycol solutions. Water content not less than 35 % by weight.

4.1.4 *HFD*—Phosphate ester or polyolester-based, water-insoluble fire-resistant fluids.

4.1.5 *HFDR*—Phosphate ester-based fluids.

4.1.6 *HFDU*—Water-free fluids based on chemical compounds other than phosphate esters and chlorinated hydrocarbons.

4.1.7 *HEPG*—Anhydrous “environmentally friendly” polyalkylene glycol-derived hydraulic fluids that may be water soluble or insoluble.

5. Classification Requirements

5.1 *Type HFA Hydraulic Fluids*—The requirements for this type of fluid are presented in **Table 1**.

5.2 *Type HFB Hydraulic Fluids*—The requirements for this type of fluid are presented in **Table 2** and include ISO viscosity grades from 46 to 100, in accordance with Classification **D2422** (ISO 3448).

5.3 *Type HFC Hydraulic Fluids*—The requirements for this type of fluid are presented in **Table 2** and include ISO viscosity grades from 22 to 68, in accordance with Classification **D2422** (ISO 3448).

5.4 *Type HFD Hydraulic Fluids*—The requirements for this type of fluid are presented in **Table 2** and include ISO viscosity grades from 15 to 100, in accordance with Classification **D2422** (ISO 3448).

5.5 *Type HEPG Hydraulic Fluids*—The requirements for this type of fluid are presented in **Table 3** and include ISO viscosity grades from 22 to 68, in accordance with Classification **D2422** (ISO 3448).

6. Inspection

6.1 Inspection of the material shall be agreed upon between the purchaser and the supplier.