



Designation: D4293 – 22

Standard Specification for Phosphate Ester-Based Fluids for Turbine Lubrication and Steam Turbine Electro-Hydraulic Control (EHC) Applications¹

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 (ε) indicates an editorial change since the last revision or reapproval.

1. Scope*

1.1 This specification covers the minimum requirements for phosphate ester-based fluids for turbine lubricants and electro-hydraulic control fluids, as delivered.

1.2 The use of this type of fluid is restricted to turbine systems designed or modified to accommodate phosphate ester fluids.

1.3 This standard does not cover the minimum requirements for in-service phosphate ester fluids for the turbine electro-hydraulic control (EHC) fluid. These requirements are provided in Guide [D8323](#).

1.4 The values stated in SI units are to be regarded as standard. For convenience, other units of measurement are provided in brackets.

1.5 *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, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.6 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 ASTM Standards:²

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.C0.01](#) on Turbine Oil Monitoring, Problems and Systems.

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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.

- [D92](#) Test Method for Flash and Fire Points by Cleveland Open Cup Tester
- [D97](#) Test Method for Pour Point of Petroleum Products
- [D130](#) Test Method for Corrosiveness to Copper from Petroleum Products by Copper Strip Test
- [D445](#) Test Method for Kinematic Viscosity of Transparent and Opaque Liquids (and Calculation of Dynamic Viscosity)
- [D664](#) Test Method for Acid Number of Petroleum Products by Potentiometric Titration
- [D892](#) Test Method for Foaming Characteristics of Lubricating Oils
- [D974](#) Test Method for Acid and Base Number by Color-Indicator Titration
- [D1169](#) Test Method for Specific Resistance (Resistivity) of Electrical Insulating Liquids
- [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
- [D3427](#) Test Method for Air Release Properties of Hydrocarbon Based Oils
- [D4057](#) Practice for Manual Sampling of Petroleum and Petroleum Products
- [D4175](#) Terminology Relating to Petroleum Products, Liquid Fuels, and Lubricants
- [D6304](#) Test Method for Determination of Water in Petroleum Products, Lubricating Oils, and Additives by Coulometric Karl Fischer Titration
- [D7546](#) Test Method for Determination of Moisture in New and In-Service Lubricating Oils and Additives by Relative Humidity Sensor
- [D8112](#) Guide for Obtaining In-Service Samples of Turbine Operation Related Lubricating Fluid
- [D8323](#) Guide for Management of In-Service Phosphate Ester-based Fluids for Steam Turbine Electro-Hydraulic Control (EHC) Systems

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

2.2 EN Standards:³

EN 14832 Petroleum and Related Products—Determination of the Oxidation Stability and Corrosivity of Fire-resistant Phosphate Ester Fluids

EN 14833 Petroleum and Related Products—Determination of the Hydraulic Stability of Fire Resistant Phosphate Ester Fluids

2.3 IEC Standard:⁴

IEC 60247 Insulating Liquids—Measurement of Relative Permittivity, Dielectric Dissipation Factor (tan d) and d.c. Resistivity

2.4 Energy Institute Standard:⁵

IP 510 Energy Institute Standard—Petroleum Products—Determination of Organic Halogen Content—Oxidative Microcoulometric Method

2.5 ISO Standards:⁶

ISO 760 Determination of Water—Karl Fischer Method (General Method)

ISO 2160 Petroleum Products—Corrosiveness to Copper—Copper Strip Test

ISO 2592 Determination of Flash and Fire Points—Cleveland Open Cup Method

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 3170 Petroleum Liquids—Manual Sampling

ISO 3448 Industrial Liquid Lubricants—ISO Viscosity Classification

ISO 3675 Crude Petroleum and Liquid Petroleum Products—Laboratory Determination of Density—Hydrometer Method

ISO 4259 Petroleum Products—Determination and Application of Precision Data in Relation to Methods of Test

ISO 4406 Hydraulic Fluid Power—Fluids—Method for Coding the Level of Contamination by Solid Particles

ISO 6072 Rubber—Compatibility Between Hydraulic Fluids and Standard Elastomeric Materials

ISO 6247 Petroleum Products—Determination of Foaming Characteristics of Lubricating Oils

ISO 6614 Petroleum Products—Determination of Water Separability of Petroleum Oils and Synthetic Fluids

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 7537 Petroleum Products—Determination of Acid Number—Semi-micro Colour-indicator Titration Method

ISO 8068 Lubricants, Industrial Oils and Related Products (Class L)—Family T (Turbines)—Specification for Lubricating Oils for Turbines

ISO 9001 Quality Management Systems

ISO 9120 Petroleum Products—Determination of Air-release Properties of Steam Turbine and Other Oils—Impinger Method

ISO 10050 Lubricants, Industrial Oils and Related Products (Class L)—Family T (Turbines)—Specifications of Triaryl Phosphate Ester Turbine Control Fluids (Category ISO-L-TCD)

ISO 11500 Hydraulic Fluid Power—Determination of the Particulate Contamination Level of a Liquid Sample by Automatic Particle Counting Using the Light-extinction Principle

ISO 12185 Crude Petroleum and Petroleum Products—Determination of Density—Oscillating U-tube Method

ISO 14935 Petroleum Products—Determination of Wick Flame Persistence of Fire-resistant Fluids

ISO 15597 Petroleum Products—Determination of Chlorine and Bromine Content—Wavelength X-ray Fluorescence Spectrometry

ISO 20764 Petroleum and Related Products—Preparation of a Test Portion of High-boiling Liquids for the Determination of Water Content—Nitrogen Purge Method

ISO 20823 Petroleum and Related Products—Determination of the Flammability Characteristics of Fluids in Contact with Hot Surfaces—Manifold Ignition Test

2.6 General Electric Turbine Manufacturing Standards:⁷

GEK 46357H Steam Turbine-Generator EHC Fluid Specification and Maintenance

2.7 Siemens Turbine Manufacturing Technical Purchasing Specification:⁸

TLV 9012 03 Fire-resistant triaryl phosphate ester hydraulic fluids (TXP-free)

3. Terminology

3.1 Definitions:

3.1.1 For definitions and terms relating to this specification, refer to Terminology **D4175**.

4. Significance and Use

4.1 Over the last six decades, increasing demand for greater power supply stability forced the steam-turbine manufacturers to provide a more efficient turbine control system. To accomplish this increased grid stability, faster response to a changing load on the electric grid, and to provide more precise control, a new system, called Electro-Hydraulic Control (EHC), was developed. This EHC system is a complex design consisting of two major systems: electronic control systems and a dedicated high-pressure (typically between 6895 kPa to 13790 kPa (1000 psi to 2000 psi) hydraulic fluid system. In addition, it also has an emergency trip system, valve controllers, and a monitoring system.

³ Available from British Standards Institution (BSI), 389 Chiswick High Rd., London W4 4AL, U.K., <http://www.bsigroup.com> or from Deutsches Institut für Normung e.V.(DIN), Am DIN-Platz, Burggrafenstrasse 6, 10787 Berlin, Germany, <http://www.din.de>.

⁴ Available from International Electrotechnical Commission (IEC), 3, rue de Varembe, P.O. Box 131, CH-1211 Geneva 20, Switzerland, <http://www.iec.ch>.

⁵ Available from Energy Institute, 61 New Cavendish St., London, W1G 7AR, U.K., <http://www.energyinst.org>.

⁶ Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036, <http://www.ansi.org>.

⁷ Available from General Electric, 5 Necco St., Boston, MA 02210, <https://www.ge.com>

⁸ Available from Siemens Energy, 4400 N Alafaya Trail, Orlando, FL 32826, <https://www.siemens-energy.com>.