

Lubricants, Industrial Oils, and Related Products Type T Turbine Oils -- Specification

Foreword—The Society of Automotive Engineers (SAE) Industrial Lubricants Committee has developed a number of industrial, non-production lubricant performance specifications.

The purpose of these voluntary SAE specifications is to:

- a. Define minimum performance requirements for industrial lubricants.
- b. Provide lubricant suppliers with performance targets for a minimum number of key industrial lubricants.
- c. Improve the availability of these lubricants to member companies.
- d. Provide a plant oriented, user friendly, classification system using common test standards and properties.

ISO Standard 6743 - Lubricants, industrial oils and related products (class L) - Classification is the foundation for these documents.

- a. Performance characteristics and test procedures are specified.
- b. For information, equivalent ISO, DIN, CEN, BSI, ASTM, AFNOR, CETOP, and IP test methods are referenced.¹

Industrial lubricant classifications targeted:

- a. Lubricants, Industrial Oils and Related Products - Classification (SAE MS1000)
- b. Hydraulic fluids (SAE MS1004)
- c. Fire resistant hydraulic fluids (SAE MS1005)
- d. Lubricating oils (various applications, SAE MS1001, 1002, 1006, 1007, 1009)
- e. Lubricating greases (SAE MS1011)
- f. Metal Removal Fluids
- g. Metal Forming Fluids

1. International Standards Organization (ISO)
Deutsches Institut für Normung e. V. (DIN)
European Committee for Standardization (CEN)
American Society for Testing and Materials (ASTM)
Association of Francaise de Normalisation (AFNOR)
The Institute of Petroleum (IP) (NOTE: Now combined with BSI)
British Standards Institute (BSI), BS 2000: XXX where XXX is the corresponding IP number
European Committee on hydraulic Oil and Pneumatics (CETOP)

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SAE WEB ADDRESS:

SAE MS1010 Issued AUG2002

See SAE MS1000 - Index of lubricants and symbols.

NOTE— Environmental, Technical Reports, and/or health and safety regulations may present additional specifications to the supplier.

1. **Scope**—See Table 1.

TABLE 1—SCOPE AND FIELD OF APPLICATIONS

Code Letter	General Application	Particular Application	More specific Application	Product Type	Symbol	Typical Application	
T	Turbines	Steam, direct coupled or geared to the load	Normal service	Highly refined petroleum oil with rust protection and oxidation stability	TSA	Power generation and industrial drives and their associated control systems. Marine drives where improved load carrying ability is not required for the gearing	
			Special properties	Synthetic fluids with no specific fire-resistant properties ⁽¹⁾⁽²⁾	TSC	Power generation and industrial drives and their control systems where special properties of the fluid are advantageous, for example, oxidation stability, low temperature properties.	
			Fire-resistant	Phosphate ester lubricant ⁽¹⁾	TSD	Power generation and industrial drives and their associated control systems with need for fire resistance.	
		Gas, direct coupled or geared to the load	High load carrying ability	Highly refined petroleum oil with rust protection, oxidation stability and enhanced load-carrying ability	TSE	Power generation and industrial drives, and marine geared drives and their associated control systems where the gearing requires improved load carrying ability.	
			Normal service	Highly refined petroleum oil with rust protection and oxidation stability	TGA	Power generation and industrial drives and their associated control systems. Marine drives where improved load carrying ability is not required for the gearing.	
			Higher temperature service	Highly refined petroleum oil with rust protection and improved oxidation stability	TGB	Power generation and industrial drives and their associated control systems where high temperature resistance is required due to hot spot temperatures.	
	Control system	Fire-resistant	Special properties	Synthetic fluids with no specific fire-resistant properties ⁽¹⁾⁽²⁾	TGC	Power generation and industrial drives and their control systems where special properties of the fluid are advantageous, for example, oxidation stability, low temperature properties.	
			High load carrying ability	Highly refined petroleum oil with rust protection, oxidation stability and enhanced load-carrying ability	TGD	Power generation and industrial drives and their associated control systems with need for fire resistance.	
			High load carrying ability	Highly refined petroleum oil with rust protection, oxidation stability and enhanced load-carrying ability	TGE	Power generation and industrial drives, and marine geared drives and their associated control systems where the gearing requires improved load carrying ability.	
				Phosphate ester control fluid	TCD	Steam, gas, hydraulic turbine control mechanisms where fluid supply is separate from the lubricant and fire-resistance is needed.	
		Aircraft ⁽³⁾				TA	
		Hydraulic ⁽³⁾				TH	

1. These products may not be compatible with petroleum based products.
2. This category includes synthetic hydrocarbons as well as other chemical types.
3. Classifications for these categories have not been established.

2. References

2.1 Applicable Publications—The following publications form a part of this specification to the extent specified herein. Unless otherwise indicated, the latest version of SAE publications shall apply.

Referenced AFNOR, ASTM, BS, CEN, DIN, IP, and ISO Standard hardcopies are available from the ILI Website (<http://www.ili-info.com>) or by contacting ILI at

Europe

ILI, Index House, Ascot, Berkshire, SL5 7EU, UK
Tel: +44 (0)1344 636400 Fax: +44 (0)1344 291194
Email: databases@ili.co.uk

USA

ILI, 610 Winters Avenue, Paramus, NJ 07652, USA
Tel: 201-986-1131 Fax: 201-986-7886
Email: sales@ili-info.com

2.1.1 SAE PUBLICATIONS—Available from SAE 400 Commonwealth Drive, Warrendale, PA 15096-0001

SAE MS1000—Lubricants, Industrial Oils and Related Products—Classification

SAE MS1001—Lubricants, Industrial Oils and Related Products Type A (General Purpose and Total Loss Systems)—Specification

SAE MS1002—Lubricants, Industrial Oils and Related Products Type C Gears —Specification

SAE MS1004—Lubricants, Industrial Oils and Related Products Type H (Hydraulic Fluids)—Specification

SAE MS1005—Lubricants, Industrial Oils and Related Products Type HF (Fire-Resistant Hydraulic Fluids)—Specification

SAE MS1006—Lubricants, Industrial Oils and Related Products Type F Lubricant for Spindle Bearings and Associated Clutches —Specification

SAE MS1007—Lubricants, Industrial Oils and Related Products Type G Slideway Lubricants—Specification

SAE MS1008—Lubricants, Industrial Oils and Related Products Type M Metal Removal Fluids—Specification

SAE MS1009—Lubricants, Industrial Oils, and Related Products Type P Pneumatic Tool Oils -- Specification

SAE MS1011—Lubricants, Industrial Oils and Related Products Type X (Greases)—Specification

2.1.2 ASTM PUBLICATIONS—Available from ASTM, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959.

ASTM D 92—Test Method for Flash and Fire Points by Cleveland Open Cup

ASTM D 95—Test Method for Water in Petroleum Products and Bituminous Materials by Distillation

ASTM D 97—Test Methods for Pour Point of Petroleum Products

ASTM D 130—Method for Detection of Copper Corrosion from Petroleum Products by Copper Strip Tarnish Test

ASTM D 445—Test Method for Kinematic Viscosity of Transparent and Opaque Liquids (and Calculation of Dynamic Viscosity)

ASTM D 471—Test Method for Rubber Property - Effect of Liquids

ASTM D 664—Test Method for Neutralization Number of Petroleum Products by Potentiometric Titration

ASTM D 665B—Test Method for Rust-Preventing Characteristics of Inhibited Mineral Oil in the Presence of Synthetic Sea Water

ASTM D 892—Test Method for Foaming Characteristics of Lubricating Oils

ASTM D 943—Standard Test Method for Oxidation Characteristics of Inhibited Mineral Oils

ASTM D 974—Test Method for Acid and Base Number by Color-Indicator Titration

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ASTM D 1298—Test Method for Density, Relative Density (Specific Gravity), or API Gravity of Crude Petroleum and Liquid Petroleum Products by Hydrometer Method
ASTM D 1401—Test Method for Water Separability of Petroleum Oils and Synthetic Fluids
ASTM D 1744—Test Method for Determination of Water in Liquid Petroleum Products by Karl Fischer Reagent
ASTM D 2070—Standard Test Method for Thermal Stability of Hydraulic Oils
ASTM D 2140—Test Method for Carbon-Type Composition of Insulating Oils of Petroleum Origin
ASTM D 2270—Practice for Calculating Viscosity Index from Kinematic Viscosity at 40 and 100 °C
ASTM D 2422—Classification of Industrial Fluid Lubricants by Viscosity System
ASTM D 2782—Standard Test Method for Measurement of Extreme Pressure Properties of Lubricating Fluids (Timken Method)
ASTM D 3238—Method for Calculation of Carbon Distribution and Structural Group Analysis of Petroleum Oils by the N-D-M Method
ASTM D 4052—Test Method for Density and Relative Density of Liquids by Digital Density Meter
ASTM D 4172—Test Method for Wear Preventive Characteristics of Lubricating Fluid (Four-Ball Method)
ASTM E 1687—Standard Test Method for Determining Carcinogenic Potential of Virgin Base Oils in Metalworking Fluids

2.1.3 BS PUBLICATIONS—Available from ILI as referenced in 2.1.

BS 188—Determination of the Viscosity of Liquids
BS 2000—Methods of Testing for Petroleum and Its Products—Petroleum Products—Calculation of Viscosity Index from Kinematic Viscosity
BS 4231—Classification for Viscosity Grades of Industrial Liquid Lubricants
BS 4832—Determination of the Behavior of Rubber and Elastomers when Exposed to Liquids, Vapors and Gases (Superseded by ISO 6072)

2.1.4 DIN PUBLICATIONS—Available from ILI as referenced in 2.1.

DIN 51 519—Lubricants; ISO Viscosity Classification for Industrial Liquid Lubricants
DIN 51 558/1—Testing of Mineral Oils; Determination of the Neutralization Number, Colour Indicator Titration
DIN 51 561—Testing of Mineral Oils, Liquid Fuels and Related Liquids; Measurement of Viscosity Using the Vogel-Ossag Viscometer; Temperature Range: Approximately 10 to 150-Deg C (CANCELLED)
DIN 51 562/1—Viscometry - Determination of Kinematic Viscosity Using the Ubbelohde Viscometer - Part 1: Apparatus and Measurement Procedure
DIN 51 566—Testing of Lubricants; Determination of Foaming Characteristics (CANCELLED)
DIN 51 569—Determination of Viscosity of Mineral Oils, Liquid Fuels and Related Liquids at Temperatures from -55°C To Approximately 10°C Using the Vogel-Ossag Viscometer
DIN 51 585—Testing of Lubricants; Testing of Corrosion Protection Properties of Steam Turbine Oils and Hydraulic Oils Containing Additives
DIN 51 587—Testing of Lubricants; Determination of the Ageing Behavior of Steam Turbine Oils and Hydraulic Oils Containing Additives
DIN 51 599—Testing of Lubricating Oils; Determination of Demulsification Capacity According to the Stirring Method
DIN 51 757—Testing of Mineral Oils and Related Materials; Determination of Density
DIN 51 759/1—Testing of Liquid Mineral Oil Products; Method of Test for Copper Corrosion; Copper Strip Test (SUPERSEDED BY ISO 2160)
DIN 53 505—Testing of Rubber, Elastomers, and Plastics; Shore Hardness Testing A and D
DIN 53 521—Determination of the Behaviour of Rubber and Elastomers when Exposed to Fluids and Vapours
DIN 53 538/2—Standard Reference Elastomers: Acrylonitrile-Butadiene Rubber (NBR); Peroxide Cured, for Characterizing Service Fluids with Respect to Their Action on NBR

2.1.5 EPA PUBLICATIONS—Standard test methods of the U. S. Environmental Protection Agency. SW-846 Methods are available on-line (Website: <http://www.epa.gov/epaoswer/hazwaste/test/8xxx.htm>). Method 24 available in the Code of Federal Regulations in 40 CFR, Part 60, Appendix A).

EPA SW 846, Method 8082—Polychlorinated Biphenyls (PCB's) By Gas Chromatography
EPA SW 846, Method 8121—Chlorinated Hydrocarbons By Gas Chromatography: Capillary Column Technique
EPA SW 846, Method 8270C—Semivolatile Organic Compounds By Gas Chromatography/Mass Spectrometry

2.1.6 IP PUBLICATIONS—Available from ILI as referenced in 2.1.

IP 15—Petroleum Products - Determination of Pour Point
IP 19—Determination of Demulsibility Characteristics of Lubricating Oil
IP 36—Determination of Open Flash and Fire Point - Cleveland Method
IP 71 (Sect. 1)—Petroleum Products - Transparent and Opaque Liquids - Determination of Kinematic Viscosity and Calculation of Dynamic Viscosity
IP 74—Determination of Water Content of Petroleum Products - Distillation Method
IP 135—Determination of Rust-Preventing Characteristics of Steam Turbine Oil In the Presence of Water
IP 139—Petroleum Products and Lubricants - Determination of Acid or Base Number - Colour-Indicator Titration Method
IP 146—Determination of Foaming Characteristics of Lubricating Oils
IP 154—Petroleum Products - Corrosiveness to Copper - Copper Strip Test
IP 160—Determination of Density - Hydrometer Method
IP 177—Test Method for Acid Number by Potentiometric Titration
IP 226—Petroleum Products - Calculation of Viscosity Index from Kinematic Viscosity
IP 240—Determination of Extreme—Pressure Properties of Lubricating Fluids (Timken Method)
IP 278—Determination of Seal Compatibility Index of Petroleum Oils

2.1.7 ISO PUBLICATIONS—Available from ILI as referenced in 2.1.

ISO 868—Plastics and ebonite—Determination of indentation hardness by means of a durometer (Shore hardness)
ISO 1817—Rubber vulcanized—Determination of the effect of liquids
ISO 2160—Petroleum products—Corrosiveness to copper—Copper strip test
ISO 2592—Petroleum products; Determination of flash and fire points; Cleveland open cup method
ISO 2909—Petroleum products—Calculation of viscosity index from kinematic viscosity
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 3448—Industrial liquid lubricants—ISO viscosity classification
ISO 3675—Crude petroleum and liquid petroleum products—Laboratory determination of density or relative density—Hydrometer method
ISO 3733—Petroleum products and bituminous materials; Determination of water; Distillation method
ISO 4263—Petroleum products—Inhibited mineral oils—Determination of oxidation characteristics
ISO 4406—Hydraulic fluid power—Fluids—Method for coding level of contamination by solid particles
ISO 6072—Hydraulic fluid power—Compatibility between elastomeric materials and fluids
ISO 6247—Petroleum products—Lubricating oils—Determination of foaming characteristics
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

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ISO 6743/0—Lubricants, industrial oils and related products (Class L); Classification; General
ISO 7120—Petroleum products and lubricants—Petroleum oils and other fluids—Determination of rust—
preventing characteristics in the presence of water
ISO 7619—Rubber—Determination of indentation hardness by means of pocket hardness meters

3. **Concept**—The lubricants defined by this specification are high quality oils formulated with additives to provide good oxidation resistance, corrosion protection, demulsibility and foam stability. They are types TSA, TSC, and TSE intended for use in turbine applications.

a. Properties for Type TSD, TGA, TGB, TGC, TGD, TGE, TCD, TA, and TH oils are not addressed in this document.

4. **Requirements and Testing**—See Table 2.

Type T lubricants shall be compatible with all materials normally encountered, including elastomer seals, coatings, metallic and non-metallic components, etc.

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TABLE 2—TYPE T (TURBINE LUBRICANTS)

Property Type of Lubricating Oil	Requirements TSA	Requirements TSC	Requirements TSE	Testing as specified in ISO	Technical Equivalent Standards DIN	Technical Equivalent Standards ASTM	Technical Equivalent Standards IP/BS
ISO viscosity classification	VG 32 <-----> VG 150	VG 32 <-----> VG 150	VG 32 <-----> VG 150	3448	51 519	D 2422	BS 4231 IP 226
Base Oil Specification:							
Paraffinic, Naphthenic, Aromatic Content	Report	Report	Report			D 3238 D 2140	
Total PNA, ppm	1000 Max.	1000 Max.	1000 Max.				EPA SW-846 TN 8270C
Total PCB, ppm	Not Detectable	Not Detectable	Not Detectable				EPA SW-846 TN 8082
Total Organic Halogens, ppm	5 Max.	5 Max.	5 Max.				EPA SW-846 TN 8121
Ames Mutagenicity:						E 1687	
Fold Increase	Report	Report	Report				
Mutagenicity Index	1 max	1 max	1 max				
Mutagen.Potency Index	Report	Report	Report				
Corrosive effect on steel	Not exceeding degree of corrosion ISO 7120 - 0 - A	Not exceeding degree of corrosion ISO 7120 - 0 - A	Not exceeding degree of corrosion ISO 7120 - 0 - A	7120	51 585	D 665B	IP 135
Corrosive effect on copper 3 h at 100 °C	Not exceeding degree of corrosion 1B; ISO 2160 - 100A3	Not exceeding degree of corrosion 1B; ISO 2160 - 100A3	Not exceeding degree of corrosion 1B; ISO 2160 - 100A3	2160	51 759	D 130	IP 154
Foam Volume, in mL. Seq. I Seq. II Seq. III per ASTM D 892	≤ 50/0	≤ 50/0	≤ 50/0	6247	51 566	D 892	IP 146
Timken OK load, kg	NA	NA	≥16			D 2782	IP 240
Four ball wear test (40 kg load) wear scar diameter, mm	NA	NA	≤0.45			D 4172	
Behavior towards the SRE-NBR 1 sealant. ⁽¹⁾ Relative change in volume, %.	-10 to +10	-10 to +10	-10 to +10	1817 6072	53 521	D 471	
Change in shore hardness	-7 to +10	-7 to +10	-7 to +10	1817 868 7619	53 521 with 53 505	D 471	IP 278, BS 4832
Level of contamination by solid particles, max. ⁽²⁾	20/18/14	20/18/14	20/18/14	4406			

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TABLE 2—TYPE T (TURBINE LUBRICANTS) (CONTINUED)

Property Type of Lubricating Oil	Requirements TSA	Requirements TSC	Requirements TSE	Testing as specified in ISO	Technical Equivalent Standards DIN	Technical Equivalent Standards ASTM	Technical Equivalent Standards IP/BS
Thermal Stability							
Comparative IR Scan	Report	Report	Report			D 2070	Cincinnati
Acid Number Change	≤ 0.15	≤ 0.15	≤ 0.15			(except 75 mL oil	Milacron
Viscosity Change	≤ 5%	≤ 5%	≤ 5%			in 100 mL	Procedure B
Sludge, mg/ 100 mL	≤ 25	≤ 25	≤ 25			beaker, 101 °C,	
Copper rod color	≤ 5	≤ 5	≤ 5			72 h)	
Copper weight loss, mg	≤ 10	≤ 10	≤ 10				
Steel rod color (Cin. Mil.)	1 max	1 max	1 max				
Oxidation stability TAN (1500 h)	≤ 2.0	≤ 2.0	≤ 2.0	4263	51 587	D 943	
Water separability, 30 minutes maximum at 54 °C	Time to 40 / 40 / 0	Time to 40 / 40 / 0	Time to 40 / 40 / 0	6614	51 599	D 1401	IP 19
Viscosity index	90 minimum	90 minimum	90 minimum	2909	DIN ISO 2909	D 2270	IP 226 BS 2000: PTA226
Pour Point °C	≤ -4	≤ -4	≤ -4	3016	DIN ISO 3016	D 97	IP 15
Flash Point °C	≥ 190	≥ 200	≥ 200	2592	DIN ISO 2592	D 92	IP 36
Water content, expressed as a proportion by mass, ppm	≤ 100	≤ 100	≤ 100	3733	DIN ISO 3733	D 95 D 1744	IP 74
Kinematic viscosity in mm ² /s at 40 °C	ISO Grade ± 10%	ISO Grade ± 10%	ISO Grade ± 10%		51561, 51 562 Part 1; or 51 569	D 445	IP 71 BS 188
Neutralization number (acid or alkaline), in mg KOH/g	To be specified by the supplier	To be specified by the supplier	To be specified by the supplier	6618	51 558 Part 1	D 664 D 974	IP 139 IP 177
Density at 15 °C in g/mL	To be specified by the supplier	To be specified by the supplier	To be specified by the supplier	3675	51 757	D 1298 D 4052	IP 160

1. SRE-NBR 1 sealant must be used as specified in DIN 53 538, specified reference sealant is available from Bundesantalt fur, Berlin Materialforschung und-prufung (BAM) Unter den Eichen 87, D-12205 Berlin, Germany Telephone ++49 03 8104-0.
2. To be met at point of delivery by the supplier, and at point of use by the customer.

PREPARED BY THE SAE INDUSTRIAL LUBRICANTS COMMITTEE

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Rationale—Not applicable.

Relationship of SAE Standard to ISO Standard—Not applicable.

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Reference Section

SAE MS1000—Lubricants, Industrial Oils and Related Products—Classification

SAE MS1001—Lubricants, Industrial Oils and Related Products Type A (General Purpose and Total Loss Systems)—Specification

SAE MS1002—Lubricants, Industrial Oils and Related Products Type C Gears –Specification

SAE MS1004—Lubricants, Industrial Oils and Related Products Type H (Hydraulic Fluids)—Specification

SAE MS1005—Lubricants, Industrial Oils and Related Products Type HF (Fire-Resistant Hydraulic Fluids)—Specification

SAE MS1006—Lubricants, Industrial Oils and Related Products Type F Lubricant for Spindle Bearings and Associated Clutches –Specification

SAE MS1007—Lubricants, Industrial Oils and Related Products Type G Slideway Lubricants—Specification

SAE MS1008—Lubricants, Industrial Oils and Related Products Type M Metal Removal Fluids—Specification

SAE MS1009—Lubricants, Industrial Oils, and Related Products Type P Pneumatic Tool Oils -- Specification

SAE MS1011—Lubricants, Industrial Oils and Related Products Type X (Greases)—Specification

ASTM D 92—Test Method for Flash and Fire Points by Cleveland Open Cup

SAE MS1010 Issued AUG2002

ASTM D 95—Test Method for Water in Petroleum Products and Bituminous Materials by Distillation

ASTM D 97—Test Methods for Pour Point of Petroleum Products

ASTM D 130—Method for Detection of Copper Corrosion from Petroleum Products by Copper Strip Tarnish Test

ASTM D 445—Test Method for Kinematic Viscosity of Transparent and Opaque Liquids (and Calculation of Dynamic Viscosity)

ASTM D 471—Test Method for Rubber Property - Effect of Liquids

ASTM D 664—Test Method for Neutralization Number of Petroleum Products by Potentiometric Titration

ASTM D 665B—Test Method for Rust-Preventing Characteristics of Inhibited Mineral Oil in the Presence of Synthetic Sea Water

ASTM D 892—Test Method for Foaming Characteristics of Lubricating Oils

ASTM D 943—Standard Test Method for Oxidation Characteristics of Inhibited Mineral Oils

ASTM D 974—Test Method for Acid and Base Number by Color-Indicator Titration

ASTM D 1298—Test Method for Density, Relative Density (Specific Gravity), or API Gravity of Crude Petroleum and Liquid Petroleum Products by Hydrometer Method

ASTM D 1401—Test Method for Water Separability of Petroleum Oils and Synthetic Fluids

ASTM D 1744—Test Method for Determination of Water in Liquid Petroleum Products by Karl Fischer Reagent

ASTM D 2070—Standard Test Method for Thermal Stability of Hydraulic Oils

ASTM D 2140—Test Method for Carbon-Type Composition of Insulating Oils of Petroleum Origin

ASTM D 2270—Practice for Calculating Viscosity Index from Kinematic Viscosity at 40 and 100 °C

ASTM D 2422—Classification of Industrial Fluid Lubricants by Viscosity System

ASTM D 2782—Standard Test Method for Measurement of Extreme Pressure Properties of Lubricating Fluids (Timken Method)

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ASTM D 4172—Test Method for Wear Preventive Characteristics of Lubricating Fluid (Four-Ball Method)

ASTM E 1687—Standard Test Method for Determining Carcinogenic Potential of Virgin Base Oils in Metalworking Fluids

BS 188—Determination of the Viscosity of Liquids