

Submitted for recognition as an American National Standard

Powershift Transmission Fluid Classification

1. **Scope**—This SAE Recommended Practice was prepared by SAE Fuels and Lubricants Technical Committee.
- to assist the designers and users of heavy-duty transmissions in the selection of powershift transmission fluids for field use and
 - to promote a uniform practice for use by marketers of lubricants and equipment builders in identifying and recommending these fluids by type.

This classification is designed for fluids used in heavy-duty truck, bus, earthmoving, and marine transmissions or steering clutches. The fluids must perform the following five functions:

- Transmit hydrodynamic energy in a torque converter.
- Transmit hydrostatic energy in hydraulic circuits.
- Lubricate bearings, bushings, gears, and moving parts.
- Provide proper frictional properties in lubricated bands and clutches.
- Provide heat transfer medium for liquid- or air-cooled systems to maintain suitable operational temperature range.

2. References

2.1 **Applicable Publications**—The following publications form a part of this specification to the extent specified herein.

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

SAE J300d—Engine Oil Viscosity Classification

SAE Technical Standards Board Rules provide that: "This report is published by SAE to advance the state of technical and engineering sciences. The use of this report is entirely voluntary, and its applicability and suitability for any particular use, including any patent infringement arising therefrom, is the sole responsibility of the user."

SAE reviews each technical report at least every five years at which time it may be reaffirmed, revised, or cancelled. SAE invites your written comments and suggestions.

TO PLACE A DOCUMENT ORDER: (724) 776-4970 FAX: (724) 776-0790
SAE WEB ADDRESS <http://www.sae.org>

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

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

ASTM D 471—Method of Test for Change in Properties of Elastomeric Vulcanizates Resulting from Immersion in Liquids

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

ASTM D 1748—Method Test for Rust Protection by Metal Preservatives in the Humidity Cabinet

ASTM D 2240—Method of Test for Indentation of Rubber and Plastics by Means of a Durometer

ASTM D 2983—Test Method for Low-Temperature Viscosity of Automotive Fluid Lubricants Measured by Brookfield Viscometer

2.1.3 DETROIT DIESEL ALLISON DIVISION PUBLICATION—

Transmission Engineering Specifications Serial No. TES 122

2.1.4 CATERPILLAR PUBLICATION—

Engineering Specification No. TO-2

2.2 **Related Publications**—The following publications are provided for information purposes only and are not a required part of this document.

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

SAE Technical Paper 770513, "Development of Type C-3 Torque Fluid for Heavy-Duty Power Shift Transmission," C. R. Potter and R. H. Schaefer, presented at the SAE Earthmoving Industry Conference, Peoria, April 1977

SAE Technical Paper 770512, "Oil Friction Retention Measured by Caterpillar Oil Test No. TO-2," J. A. McLain, SAE Transactions, Vol. 86 (1977)

3. **Significance and Method of Measuring Powershift Transmission Fluid Properties**

3.1 **Viscosity**—Viscosity controls the efficiency of the hydraulic control and torque converter systems. Viscosity grades and recommended temperature ranges are chosen by the individual manufacturer. Both Newtonian and non-Newtonian fluids are used. The viscosity grades are classified by SAE J300d. All other properties of the fluids are covered by this classification.

Powershift transmission fluids must flow readily at low temperatures to oil screens and through inlet tubes. This property is evaluated by the Brookfield Viscometer test, ASTM D 2983, and by the Pour Point test, ASTM D 97.

3.2 **Foaming Characteristics**—Suppression of the foaming tendency of fluids in a powershift transmission is essential to proper operation. Foaming of the transmission fluid can produce erratic pump, converter, and hydraulic control response; and frequently results in fluid loss through the breather or filler tube. Measurement of foaming tendency and foam stability is used for evaluating fluid suitability. The technique for measuring this property in a powershift transmission fluid is the ASTM D 892 Foaming Characteristics test.

3.3 **Fluid/Seal Compatibility**—Compatibility of the powershift transmission fluid with elastomeric seal materials must be established during fluid formulation. Accepted design procedure involves use of a reference elastomer to determine seal swell, shrink, and hardening tendencies in a candidate fluid. Seal materials must be selected to meet transmission performance requirement with the established fluid formulation. Bench test procedures such as ASTM D 471, Method of Test for Change in Properties of Elastomeric Vulcanizates Resulting from Immersion in Liquids, and ASTM D 2240, Method of Test for Indentation of Rubber and Plastics by Means of a Durometer, are of value for screening purposes.

- 3.4 Rust Protection**—The bench test used to evaluate the rust-preventative properties of powershift transmission fluids is ASTM D 1748, Method Test for Rust Protection by Metal Preservatives in the Humidity Cabinet.
- 3.5 Wear Resistance**—Powershift transmission fluids must inhibit scoring and wear of rubbing surfaces in the transmission. There is no transmission test available which correlates with wear in field service. A power steering pump test is used for evaluation of the wear performance of powershift transmission fluids.
- 3.6 Oxidation Stability**—Fluids used in powershift transmissions must be capable of operating at temperatures up to 150 °C. Introduction of air, through normal transmission breathing, results in severe oxidizing conditions which change many new fluid characteristics. Some effects which oxidation can produce are:
- a. Alteration of frictional characteristics which result in excessive clutch and band slippage, producing high localized clutch temperatures, which in turn make oxidizing conditions more severe.
 - b. Acids or peroxides formed in fluid oxidation which may be corrosive to bushing and thrust washer materials, and detrimental to elastomeric seal materials and the composition clutch plates.
 - c. Viscosity increases great enough to degrade transmission operation.
 - d. Sludge which can plug hydraulic controls and fluid passages.
 - e. Varnish formation which can lead to control valve or governor sticking and ultimate transmission failure.
 - f. Oxidation products which can reduce antifoamant effectiveness.
- 3.7 Friction Retention**—Matching fluid-friction properly with clutch and band materials is a fundamental design consideration in all currently produced powershift transmissions.

Fluid friction characteristics are important in automatic transmissions that utilize lubricated clutches to change gear ratios. Extensive performance and durability testing is performed in actual transmissions and bench friction test apparatus. No single friction test can evaluate the requirements of different clutch plate friction materials. The performance of powershift transmission fluids with bronze faced friction plates is evaluated using a 15 000 cycle test procedure and the performance with graphite faced plates is evaluated with a second 5500 cycle procedure. Both procedures are conducted in the SAE No. 2 friction machine.

TABLE 1—TEST TECHNIQUES AND PERFORMANCE CRITERIA

Test Technique	Limits	Test Method
1. Brookfield Viscosity at - 18 °C, cSt	2500 max for 5W and 10W oils report result for other SAE grades	ASTM D 2983
2. Pour Point, °C	-30 max for SAE 5W or 10W oils -25 max for SAE 15W oils -15 max for SAE 30 or 40 oils	ASTM D 97
3. Foaming Characteristics Sequence 1, cm ³ Sequence 2, cm ³ Sequence 3, cm ³	25/0 max 50/0 max 25/0 max	ASTM D 892
4. Seal Compatibility		(1)
(a) Total Immersion Test ⁽²⁾ (Nitrile Rubber) Volume Change, % Hardness Change, Points	0 to +5 for SAE 5W and 10W oils -1 to +5 for other SAE grades 0 to ±5	
(b) Dip Cycle Test ⁽²⁾ (Polyacrylate) Volume Change, % Hardness Change, Points	0 to +10 0 to +5	
(c) Tip Cycle Test ⁽²⁾ (Silicone) Volume Change, % Hardness Change, Points	0 to +5 0 to -10	
5. Rust Resistance	No rust ("no more than 3 random spots 1 mm or less in diameter at least 6 mm away from edge of panel")	(1)
Other Properties		
6. Wear Test	Pump Cam Ring shall show grinding pattern for 360 deg and be free from scuffing, scoring, or chatter marks.	(1)
7. Oxidation Test	—No significant varnish or sludge on transmission parts —No blackening or flaking of copper containing parts —Oil shall not gain more than 15% in viscosity at 100 °C	(1)
8. Friction Retention Tests		
(a) Test A—(5500 cycles)	Slip Time—0.85 s max Dynamic Torque—102 N·m min Decrease in Dynamic Torque— 40 N·m max	(1)
(b) Test B—(15 000 cycles)	Stopping Time Increase—15% max Wear—Bronze disc 0.25 mm max Steel Plate 0.1 mm max	(3)

1. Detroit Diesel Allison Division Transmission Engineering Specifications Serial No. TES 122.
2. Nominal values which are adjusted for each elastomer batch.
3. Caterpillar Engineering Specification No. TO-2.

PREPARED BY THE SAE FUELS AND LUBRICANTS TECHNICAL COMMITTEE