



# SURFACE VEHICLE INFORMATION REPORT

J308™

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## Axle and Manual Transmission Lubricants

### RATIONALE

This SAE Information Report describes the overall performance characteristics of axle lubricants and heavy-duty transmission fluids. It will be a useful tool for those new to this industry. The document has been updated to reflect the latest trends and specifications in the industry.

#### 1. SCOPE

This SAE Information Report was prepared by the SAE Fuels and Lubricants Technical Committee for two purposes: (a) to assist the users of automotive equipment in the selection of axle<sup>1</sup> and manual transmission lubricants for field use, and (b) to promote a uniform practice for use by marketers of lubricants and by equipment builders in identifying and recommending these lubricants by a service designation.

#### 2. REFERENCES

##### 2.1 Applicable Documents

The following publications form a part of this specification to the extent specified herein. Unless otherwise indicated, the latest issue of SAE publications shall apply.

##### 2.1.1 SAE Publications

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or +1 724-776-4970 (outside USA), [www.sae.org](http://www.sae.org).

SAE J306 Automotive Gear Lubricant Viscosity Classification

SAE J2360 Automotive Gear Lubricants for Commercial and Military Use

##### 2.1.2 PRI Publications

Available from Performance Review Institute, 161 Thorn Hill Road, Warrendale, PA 15086-7527, Tel: 724-772-1616, [www.pri-network.org](http://www.pri-network.org).

PD4000 Gear Lubricant Review Program

<sup>1</sup> Axle in this document is defined as a drive axle incorporating reduction gearing and/or differential gears.

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### 2.1.3 ASTM Publications

Available from ASTM International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959, Tel: 610-832-9585, [www.astm.org](http://www.astm.org).

|            |                                                                                                                                                                                   |
|------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| ASTM D130  | Standard Test Method for Corrosiveness to Copper from Petroleum Products by Copper Strip Test                                                                                     |
| ASTM D445  | Standard Test Method for Kinematic Viscosity of Transparent and Opaque Liquids (and Calculation of Dynamic Viscosity)                                                             |
| ASTM D892  | Standard Test Method for Foaming Characteristics of Lubricating Oils                                                                                                              |
| ASTM D5182 | Standard Test Method for Evaluating the Scuffing Load Capacity of Oils (FZG visual method)                                                                                        |
| ASTM D5579 | Standard Test Method for Evaluating the Thermal Stability of Manual Transmission Lubricants in a Cyclic Durability Test                                                           |
| ASTM D5662 | Standard Test Method for Determining Automotive Gear Oil Compatibility with Typical Oil Seal Elastomers                                                                           |
| ASTM D5704 | (L-60-1) - Standard Test Method for Evaluation of the Thermal and Oxidative Stability of Lubricating Oils Used for Manual Transmission and Final Drive Axles                      |
| ASTM D6121 | (L-37 Test) - Standard Test Method for Evaluation of Load-Carrying Capacity of Lubricants Under Conditions of Low Speed and High Torque Used for Final Hypoid Drive Axles         |
| ASTM D7038 | (L-33-1 Test) - Standard Test Method for Evaluation of Moisture Corrosion Resistance of Automotive Gear Lubricants                                                                |
| ASTM D7450 | Standard Specification for Performance of Rear Axle Gear Lubricants Intended for API Category GL-5 Service                                                                        |
| ASTM D7452 | (L-42 Test) - Standard Test Method for Evaluation of the Load-Carrying Properties of Lubricants Used for Final Drive Axles Under Conditions of High Speed and Shock Loading       |
| ASTM D7603 | Standard Test Method for Determining of Storage Stability and Compatibility in Automotive Gear Oils                                                                               |
| ASTM D8165 | (L-37-1 Test) - Standard Test Method for Evaluation of Load-Carrying Capacity of Lubricants Used in Hypoid Final-Drive Axles, Operated Under Low-Speed and High-Torque Conditions |

### 2.1.4 API Publication

Available from API, 1220 L Street, NW, Washington, DC 20005-4070, Tel: 202-682-8000, [www.api.org](http://www.api.org).

API 1560 (April, 2013) Lubricant Service Designation for Automotive Manual Transmissions, Manual Transaxles and Axles

## 3. PERFORMANCE CHARACTERISTICS

In axles and manual transmissions, gears and bearings of different designs are employed under a variety of service conditions. Therefore, the selection of a lubricant involves careful consideration of the performance characteristics required. The following sections describe performance characteristics of axle and manual transmission lubricants which are important in field service. A lubricant is a blend of base stocks and additives optimized for a particular service. Additive packages enhance base stock performance for each performance characteristic.

### 3.1 Load-Carrying Capacity

One of the most important performance characteristics of an automotive gear lubricant is load-carrying capacity. The load on gear teeth is a function of the contact area of, and the force applied to, the surfaces in contact. Contact area is controlled by gear design; applied force is determined by the power needed to drive the equipment. The load-carrying capacity of a gear lubricant is defined by the maximum load which can be sustained by the lubricant without failure of gear teeth surfaces. If the load-carrying capacity is exceeded, the lubricant fails to protect the gears and the gear teeth become damaged. The most common forms of damage are adhesive wear (scuffing) and scoring.

Load-carrying capacity is determined by a fluid's viscosity at the operating temperature, and by additives. Gear lubricants compounded to achieve increased load-carrying capacity may be referred to as "extreme pressure" (EP) lubricants. However, when this term is applied to a gear lubricant, it means only that the load-carrying capacity of the lubricant is greater than that of untreated oil,<sup>2</sup> with no distinction as to how much greater it may be. The American Petroleum Institute (API) and SAE have developed classification systems which address this concern (see Section 5).

### 3.2 Viscosity

Identification of the proper viscosity to be used in a specific piece of equipment under specific operating conditions is generally determined by equipment manufacturers. Refer to SAE J306 for axle and manual transmission lubricant viscosity classification information.

#### 3.2.1 Viscosity Loss - Multi-Grade Lubricants

Viscosity and film thickness are critical in both axle and transmission applications. Some multi-grade gear lubricants are formulated with viscosity modifiers. Caution should be exercised when multi-grade gear lubricants are used, since these may experience significant viscosity loss due to shear in field service. The shear stresses and shear rates encountered in gear applications can be significantly greater than those in most other lubricant applications. Multi-graded lubricants meeting the SAE J306 stay-in-grade requirement, however, have proven acceptable in shear stability.

### 3.3 Thermal Stability and Oxidation Resistance

Factors affecting thermal stability (cleanliness) and oxidation (thickening) characteristics while the lubricant is in service include ambient temperature, duty cycle, length of service, and contamination. Poor lubricant thermal stability and oxidation resistance can result in oil thickening and/or the formation of deposits on parts. Even when lubricants are stored (prior to use), care should be exercised to ensure that they are not exposed to extreme temperatures and are kept free of contaminants. These precautions are intended to ensure optimum lubricant life.

Modern vehicle designs have resulted in significantly higher operating temperatures in axles and transmissions. Oils which do not have a high degree of thermal stability and oxidation resistance can form significant carbon and varnish deposits, which can cause premature seal failure and/or interfere with frictional surfaces used for traction control.

For automotive axles and transmissions in mild service, the temperature of the lubricant may not be sufficiently high to cause significant oxidation. For vehicles operating in moderate to severe conditions of service, thermal stability and oxidation resistance are important factors. Accordingly, only oils with a high degree of thermal stability and oxidation resistance should be used in these applications. The vehicle operator should consult the manufacturer's service guide for oil quality, drain interval and refill recommendations.

### 3.4 Foaming and Air Entrainment

Excessive foaming or air entrainment may interfere with proper lubrication of gear and bearing surfaces and should be avoided. Further, foaming can cause leakage via normal venting passages, thereby reducing lubricant sump volume. Foam can appear as a heavy froth on the surface of the oil. Air entrainment occurs when tiny air bubbles remain suspended in the body of the oil.

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<sup>2</sup> Untreated oil is defined as either refined petroleum or synthetic lubricant base oil containing no supplemental performance additives.