



Designation: D5704 – 22a

Standard Test Method for Evaluation of the Thermal and Oxidative Stability of Lubricating Oils Used for Manual Transmissions and Final Drive Axles¹

This standard is issued under the fixed designation D5704; 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.

INTRODUCTION

Portions of this test method are written for use by laboratories that make use of ASTM Test Monitoring Center (TMC)² services (see [Annex A1 – Annex A4](#)).

The TMC provides reference oils, and engineering and statistical services to laboratories that desire to produce test results that are statistically similar to those produced by laboratories previously calibrated by the TMC.

In general, the Test Purchaser decides if a calibrated test stand is to be used. Organizations such as the American Chemistry Council require that a laboratory utilize the TMC services as part of their test registration process. In addition, the American Petroleum Institute and the Gear Lubricant Review Committee of the Lubricant Review Institute (SAE International) require that a laboratory use the TMC services in seeking qualification of oils against their specifications.

The advantage of using the TMC services to calibrate test stands is that the test laboratory (and hence the Test Purchaser) has an assurance that the test stand was operating at the proper level of test severity. It should also be borne in mind that results obtained in a non-calibrated test stand may not be the same as those obtained in a test stand participating in the ASTM TMC services process.

Laboratories that choose not to use the TMC services may simply disregard these portions.

1. Scope*

1.1 This test method is commonly referred to as the L-60-1 test.² It covers the oil-thickening, insolubles-formation, and deposit-formation characteristics of automotive manual transmission and final drive axle lubricating oils when subjected to high-temperature oxidizing conditions.

1.2 The values stated in inch-pound units are to be regarded as standard. The values given in parentheses are mathematical

conversions to SI units that are provided for information only and are not considered standard.

1.2.1 *Exceptions*—The values stated in SI units for catalyst mass loss, oil mass and volume, alternator output, and air flow are to be regarded as standard.

1.2.2 SI units are provided for all parameters except where there is no direct equivalent such as the units for screw threads, or where there is a sole source supply equipment specification.

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, health, and environmental practices and determine the applicability of regulatory limitations prior to use.* Specific warning information is given in Sections 7 and 8 and [Annex A7](#).

1.4 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the*

¹ This test method is under the jurisdiction of ASTM Committee D02 on Petroleum Products, Liquid Fuels, and Lubricants and is the direct responsibility of Subcommittee D02.B0.03 on Automotive Gear Lubricants & Fluids.

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² Until the next revision of this test method, the ASTM Test Monitoring Center will update changes in the test method by means of information letters. Information letters may be obtained from the ASTM Test Monitoring Center, 203 Armstrong Drive, Freeport, PA 16229. Attention: Director. This edition incorporates revisions in all information Letters through No. 22-2.

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:³

B224 Classification of Coppers

D235 Specification for Mineral Spirits (Petroleum Spirits) (Hydrocarbon Dry Cleaning Solvent)

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

D893 Test Method for Insolubles in Used Lubricating Oils

D6984 Test Method for Evaluation of Automotive Engine Oils in the Sequence IIIF, Spark-Ignition Engine

E29 Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications

E527 Practice for Numbering Metals and Alloys in the Unified Numbering System (UNS)

2.2 ANSI Standard:⁴

ANSI/ISA-S7.3 Quality Standard for Instrument Air

2.3 Military Specification:⁵

MIL-L-2105D Lubricating Oil, Gear, Multipurpose

2.4 Adjunct:⁶

Engineering Drawings

3. Terminology

3.1 Definitions:

3.1.1 *carbon, n—in manual transmissions and final drive axles*, a hard, dry, generally black or gray deposit that can be removed by solvents but not by wiping with a cloth.

3.1.2 *lubricant, n—any material interposed between two surfaces that reduces the friction or wear, or both, between them.*

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3.1.3 *sludge, n—in manual transmissions and final drive axles*, a deposit principally composed of the lubricating oil and oxidation products that do not drain from parts but can be removed by wiping with a cloth.

3.1.4 *thermal and oxidative stability, n—in lubricating oils used for manual transmissions and final drive axles*, a lack of deterioration of the lubricating oil under high-temperature conditions that is observed as viscosity increase of the lubricating oil, insolubles formation in the lubricating oil, or deposit formation on the parts, or a combination thereof.

3.1.5 *varnish, n—in manual transmissions and final drive axles*, a hard, dry, generally lustrous deposit that can be removed by solvents but not by wiping with a cloth.

4. Summary of Test Method

4.1 A sample of the lubricant to be tested is placed in a heated gear case containing two spur gears, a test bearing, and a copper catalyst. The lubricant is heated to a specified temperature and the gears are operated at predetermined power and speed conditions for 50 h. Air is bubbled through the lubricant at a specified rate and the bulk oil temperature of the lubricant is controlled throughout the test. Parameters used for evaluating oil degradation after testing are viscosity increase, insolubles in the used oil, and gear cleanliness.

5. Significance and Use

5.1 This test method measures the tendency of automotive manual transmission and final drive lubricants to deteriorate under high-temperature conditions, resulting in thick oil, sludge, carbon and varnish deposits, and the formation of corrosive products. This deterioration can lead to serious equipment performance problems, including, in particular, seal failures due to deposit formation at the shaft-seal interface. This test method is used to screen lubricants for problematic additives and base oils with regard to these tendencies.

5.2 This test method is used or referred to in the following documents:

5.2.1 American Petroleum Institute (API) Publication 1560-Lubricant Service Designations for Automotive Manual Transmissions, Manual Transaxles, and Axles,⁷

5.2.2 STP-512A—Laboratory Performance Tests for Automotive Gear Lubricants Intended for API GL-5 Service,⁸

5.2.3 SAE J308-Information Report on Axle and Manual Transmission Lubricants,⁹ and

5.2.4 U.S. Military Specification MIL-L-2105D.

6. Apparatus

6.1 A description of essential apparatus features is given as follows, including mandatory equipment type and performance specification where established. See **Annex A5** and **Annex A6** for schematics and additional information of a general nature. Those wishing to build this test apparatus shall base construction on full engineering drawings (see **6.2**).

6.1.1 *Gear Case Assembly*, used in conjunction with a new test bearing, new lip seals, new O-rings, a pair of new test gears, copper catalyst, and the lubricant to be tested. The gear case assembly has been redesigned to incorporate improvements over designs in use prior to this test method. Construct the gear case and associated parts in accordance with the engineering drawings. The gear case and associated parts shall comply in dimension, material, surface finish where

³ 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.

⁴ Joint standard of ANSI/ISA. Available from Instrument Society of America, 67 Alexander Drive, P.O. Box 12277, Research Triangle Park, NC 27709.

⁵ Available from Standardization Documents Order Desk, DODSSP, Bldg. 4, Section D, 700 Robbins Ave., Philadelphia, PA 19111-5098.

⁶ Detailed drawings necessary for rig construction. Available from the TMC website <https://www.astmtmc.org/>.

⁷ Available from American Petroleum Institute (API), 200 Massachusetts Ave. NW, Suite 1100, Washington, DC 20001, <http://www.api.org>.

⁸ Supporting data have been filed at ASTM International Headquarters and may be obtained by requesting Research Report RR:D02-1353. Contact ASTM Customer Service at service@astm.org.

⁹ Available from SAE International (SAE), 400 Commonwealth Dr., Warrendale, PA 15096, <http://www.sae.org>.