Designation: D7452 – 22

# 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[1]

This standard is issued under the fixed designation D7452; 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 use 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 covers the determination of the anti-scoring properties of final drive axle lubricating oils when subjected to high-speed and shock conditions. This test method is commonly referred to as the L-42 test.[2]

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*—SI units are provided for all parameters except where there is no direct equivalent such as the units for screw threads, National Pipe Threads/diameters, tubing size, and single source equipment suppliers.

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 4 and 7.

1.4 *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:*[3]

D235 Specification for Mineral Spirits (Petroleum Spirits)

[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 (TMC) will update changes in this 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. 22-1. The TMC is also a source of reference oils.

[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.

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

(Hydrocarbon Dry Cleaning Solvent)
E29 Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications

2.2 *Society of Automotive Engineers Standards:*[4]
SAE J308 Information Report on Axle and Manual Transmission Lubricants
SAE J2360 Lubricating Oil, Gear Multipurpose (Metric) Military Use

## 3. Terminology

3.1 *Definitions of Terms Specific to This Standard:*

3.1.1 *coast side, n*—the convex side of the pinion and the concave side of the ring gear which are in contact during deceleration in a forward gear.

**ASTM Distress Rating Manual 21**[5]

3.1.2 *drive side, n*—the concave side of the pinion and the convex side of the ring gear which are in contact during acceleration in a forward gear.

**ASTM Distress Rating Manual 21**

3.1.3 *scoring, n—on the ring and the pinion gear teeth*, the displacement of metal by local momentary welding from the gear tooth, resulting in the development of a matt, or frosted dull surface.

**ASTM Distress Rating Manual 21**

## 4. Summary of Test Method

4.1 Charge a specially prepared light duty hypoid rear axle (Dana Model 44 ASTM Part No. 044AA100-1)[6] with the lubricant sample to be tested (see 10.1). Mount the axle between two load absorbing dynamometers which are driven with a V-8 gasoline engine through a manual transmission.

4.2 Condition the test axle with light loads at different speed, torque and temperature conditions on both the drive and coast sides of the gears. (**Warning—**High-speed rotating equipment, electrical shock, high-temperature surfaces.) After conditioning, subject the test axle to high speed and shock loadings at higher temperatures.

4.3 Rate the drive and coast side of the pinion and ring gears at the end of test (EOT) for scoring distress.

## 5. Significance and Use

5.1 Final drive axles are often subjected to severe service where they encounter high speed shock torque conditions, characterized by sudden accelerations and decelerations. This severe service can lead to scoring distress on the ring gear and pinion surface. This test method measures anti-scoring properties of final drive lubricants.

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

5.2.1 American Petroleum Institute (API) Publication 1560.[7]

5.2.2 SAE J308 and SAE J2360.

## 6. Apparatus

6.1 This test method provides a description of essential apparatus features, including mandatory equipment type and performance specifications where established.

6.2 *Test Axle*—The test unit consists of a Dana model 44 rear axle, 45 to 11 (4.09) ratio, and uncoated gears. (Dana ASTM part number 044AA100-1.[6] See 10.1.)

6.3 *Cover Plate*—Modify the rear cover plate of the test unit to provide an inspection port and thermocouple fitting. Locate the thermocouple fitting by using the locating fixture shown in Fig. A6.1. An optional ¼ in. NPT (National Pipe Thread) drain fitting may be added.

6.4 *Axle Shaft Assemble*—Use a Ford Axle shaft assembly, (Dana Part No. 26762-14X[6]) or equivalent with this test method.

6.5 *Hinge Plate Stand Assembly*—Mount and secure the test unit in place on the hinge plate assembly, see Figs. A6.6-A6.9.

6.6 *Temperature Control System*—The temperature control apparatus consists of a thermocouple, a temperature recording system, temperature controller and a cooling system that is able to maintain lubricant temperature at specified conditions.

6.6.1 *Thermocouple*—Install the thermocouple such that the thermocouple tip is flush with the cover plate lip by placing the cover plate face on a flat surface and inserting the thermocouple into the cover plate until the thermocouple tip is flush with the flat surface. For recording and control of the test lubricant temperature, use a ⅛ in. (3.2 mm) diameter J or K type closed tip style thermocouple.

6.6.2 *Temperature Recording System*—Throughout the test, ensure the temperature recording system records the temperature of the test oil at a minimum frequency of 1 Hz.

6.6.3 *Temperature Controller*—Proportional-Integral-Derivative (PID) type; percent output adjustable.

6.6.4 *Axle Cooling*—Use three spray nozzles to distribute water over the cover plate and axle housing as shown in Fig. A6.2. Actuate the water control valve by the temperature PID control system.

6.6.4.1 Depending on how the system is plumbed, use spray nozzles in any combination of the following part numbers: Straight Male NPT (Part No. 3/8GG-SS22), 90° Male NPT (Part No. 3/8GGA-SS22), Straight Female NPT (Part No. 3/8G-SS22), and 90° Female NPT (Part No. 3/8GA-SS22).[8,9]

6.6.4.2 Use a single control valve to control the cooling water supply. The control shall be a ½ in. (12.7 mm) two-way,

[4] Available from Society of Automotive Engineers (SAE), 400 Commonwealth Dr., Warrendale, PA 15096-0001, http://www.sae.org.

[5] Formerly known as *CRC Rating Manual, No. 21*. Available from the ASTM website, www.astm.org, ASTM Stock No. TMCMNL21.

[6] Parts and *Model 44 Maintenance Manual* available from Dana Corporation, P.O. Box 2424, Fort Wayne, IN 46801.

[7] API Publication 1560, *Lubricant Service Designations for Automotive Manual Transmissions, Manual Transaxles, and Axles*, American Petroleum Institute, Washington, DC.

[8] The sole source supply of the apparatus known to the committee at this time is Spray Systems Company, and can be purchased through E. I. Pfaff Company, 3443 Edwards Road, Suite D, Cincinnati, OH 45208.

[9] If you are aware of alternative suppliers, please provide this information to ASTM International Headquarters. Your comments will receive careful consideration at a meeting of the responsible technical committee,[1] which you may attend.

C linear trim, air to close, Research Control valve. Use a single PID loop to maintain the axle lubricant temperature control for both the Standard and Canadian version test. A separate PID loop control for each version is not permitted. See Annex A5.

6.6.4.3 Use *only* ⅜ in. or ½ in. (9.5 mm or 12.7 mm) line material to the spray nozzles.

6.6.4.4 Use a minimum supply water pressure of 25 psig (172 kPa) to the control valve.

6.6.4.5 Use an axle containment box as shown in Fig. A6.10. The purpose is to contain water.

6.6.4.6 Use a locating pin or stop block as an indexing device to ensure that all subsequent axle installations are consistently installed perpendicular with the axle housing cover to engine and transmission drive-shaft centerline.

6.7 *Torque Meter*—Include in the test equipment a torque meter installed in the drive shaft (see Figs. A6.3-A6.5) to measure the torque applied to the pinion. Install a Himmelstein inline torque meter Model numbers MCRT28061T(1-4) or MCRT2661TN(1-4)[9,10] without a foot mount and a range of 10 000 lb-in. (1130 N·m) shall be installed to measure pinion torque. Additional suffix letters only indicate allowable options.

6.8 *Signal Conditioning*—Use a Himmelstein Models 701 or 711 strain gage conditioner for signal conditioning. Set the low pass cut-off frequency at 10 Hz.

6.9 *Digital Data Acquisition System*—System requires capability of measuring a minimum of five channels at sampling frequencies outlined in Section 10.

6.9.1 Do not use hardware or software filtering for the pinion torque channel during data acquisition periods of the test.

6.10 *Dynamometers*—Two axle dynamometers (Midwest Dynamatic, Model 3232)[9,11] with suitable control equipment capable of maintaining specified test conditions.

6.11 *Engine Speed Control*—System requires a device to maintain steady state conditions and also provide adjustable throttle acceleration and deceleration rates to attain specified shock loading torques.

6.11.1 *Throttle Controller System*—Use a Foxboro/Jordan Controller, Model AD7530.[9,12] Use a power transformer from Acme Electric Corp. PN T-1-81058 or equivalent, primary volts 120X240, secondary volts (120 V primary by 240 V secondary), 16/32 (13 mm) center tap, 0.500 kVA (0.5 kW) in conjunction with the Foxboro/Jordan Controller.

6.12 *Connecting Shafts*—Use connecting shafts of equal length ±1 in. (25.4 mm) and less than 30 in. (762 mm) long from flange face to flange face. Use a tubing diameter of 3.5 in. ± 0.2 in. (88.9 mm ± 5.1 mm) OD, with a wall thickness of 0.095 in. ± 0.005 in. (2.41 mm ± 0.13 mm) if tubing is required to fabricate the shafts. Ensure the shafts are dynamically (spin) balanced and strong enough to handle torques up to 2100 lbf-ft (2847 N·m). Use an operating angle of 0° ± 0.5°.

**TABLE 1 Recommended Power Train Replacement Parts List**

| Parts | Part Number |
|---|---|
| Ramjet Engine Includes ECM | 12495515 |
| Five Speed Transmission | 15747134 or 15747232 |
| Bell Housing | 15998496 |
| Clutch Assembly | 15002591 |
| Throw Out Bearing | 15705563 |
| Dip Stick | 10190942 |
| Dip Stick Tube | 12552920 |
| Flywheel | 10105832 |
| Flywheel Bolt (6 req.) | 12337973 |
| Pilot Bearing | 14061685 |
| Master Cylinder | 15727261 |
| Actuating Cylinder | 15046288 |
| Pulley, Water Pump | 14023155 |
| Pulley, Crankshaft | 14023147 |
| Belt | 9433720 |
| Starter | 10496873 |
| Engine Control Unit | 12489488 |
| Throttle Body from 2000 Corvette. | 17113669 |
| Throttle Body TPS Connector | P/N 12116247 |
| Throttle Body Actuator Motor Connector | P/N 12167121 |
| K&N Inlet Air Filter | P/N RD6020 |

6.13 *Power Train*—The power train consists of a gasoline powered V-8 GM performance Ramjet 5.7 L marine engine coupled with a five speed manual transmission capable of supplying specified shock loading torques. The engine and transmission operating angle shall be 0° ± 0.5°.

6.13.1 All recommended replacement parts are available through local General Motors dealers. A list of these replacement parts are shown in Table 1. Do not make modifications to the engine that would affect the engines factory displacement or compression ratio.

6.14 *Drive Shaft*—Welded steel tubing, 3.5 in. ± 0.2 in. (90 mm ± 5.1 mm) outside diameter, 0.095 in. ± 0.005 in. (2.41 mm ± 0.13 mm) wall thickness, 34.5 in. ± 1 in. (880 mm ± 25 mm) long from center weld to center weld. (See Figs. A6.3-A6.5.) Dynamically (spin) balance the drive shaft and torque meter. The operating angle shall be 0° ± 0.5°.

6.14.1 *Transmission U-Joint*—(Spicer 5-178X)[13] or Neapco 2-1435[14]

6.14.2 *Pinion U-Joint*—(Spicer 5-153X).

6.14.3 *Flange Yoke*—Connects transmission yoke through u-joint to drive shaft.

6.14.4 *Pinion Drive Shaft Slip Yoke*—Connects the drive shaft through the u-joint to the axle yoke.

6.14.5 *Flange Adaptor*—Manufacture flange adapter to specifications in Figs. A6.4 and A6.5.

6.15 *Spring Plate*—Manufacture spring plates to specification as shown in Fig. A6.8.

6.16 *Spring Plate Rod Connection*—Mount a rod connecting the spring plate to the gear stand using ½ in. (13 mm) spherical rod ends. See Figs. A6.6 and A6.7.

[10] The sole source supply of the apparatus known to the committee at this time is S. Himmelstein and Company, 2490 Pembroke Avenue, Hoffman Estates, IL 60195.

[11] Available from Dyne Systems, P.O. Box 18 W209 N17391 Industrial Drive, Jackson, WI 53037.

[12] Available from Fox/Jordan, Inc., 5607 West Douglas Avenue, Milwaukee, WI 53218.

[13] Available from any local drive shaft supplier.

[14] Available from Neapco, LLC, 6735 Haggerty Rd., Belleville, MI 48111.