Designation: D3527 – 15

Standard Test Method for Life Performance of Automotive Wheel Bearing Grease[1]

This standard is issued under the fixed designation D3527; 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.

1. Scope*

1.1 This test method covers a laboratory procedure for evaluating the high-temperature life performance of wheel bearing greases when tested under prescribed conditions.

NOTE 1—Changes to this test method in the 1985 revision increased test severity. Results will not be comparable with data from earlier procedures.

1.2 The values stated in SI units are to be regarded as standard. No other units of measurement are included in this standard.

1.2.1 *Exception*—Apparatus dimensions in inches are to be regarded as the standard.

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 and health practices and determine the applicability of regulatory limitations prior to use.* For specific warning statements, see 8.1 – 8.4.

2. Referenced Documents

2.1 *AFBMA Standard:*
AFBMA Standard 19, 1974 (ANSI B. 3.19-1975)[2]

3. Terminology

3.1 *Definitions:*

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

3.1.2 *lubricating grease, n*—a semi-fluid to solid product of a dispersion of a thickener in a liquid lubricant.

3.1.2.1 *Discussion*—The dispersion of the thickener forms a two-phase system and immobilizes the liquid lubricant by surface tension and other physical forces. Other ingredients are commonly included to impart special properties.

3.1.3 *thickener, n—in lubricating grease*, a substance composed of finely-divided particles dispersed in a liquid lubricant to form the product's structure.

3.1.3.1 *Discussion*—The solid thickener can be fibers (such as various metallic soaps) or plates or spheres (such as certain non-soap thickeners) which are insoluble or, at the most, only very slightly soluble in the liquid lubricant. The general requirements are that the solid particles be extremely small, uniformly dispersed, and capable of forming a relatively stable, gel-like structure with the liquid lubricant.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *automotive wheel bearing grease, n*—a lubricating grease specifically formulated to lubricate automotive wheel bearings at relatively high grease temperatures and bearing speeds.

3.2.2 *grease life, n— of wheel bearing grease*, amount of time operated under prescribed conditions of load, speed, and temperature until preset torque limit is exceeded.

3.2.2.1 *Discussion*—The *off-time*, which is part of the 20 h and 4 h off-cycle, is not recorded and is not included as part of grease life.

4. Summary of Test Method

4.1 The test grease is distributed in the bearings of a modified, automobile front wheel hub-spindle-bearings assembly. While the bearings are thrust-loaded to approximately 111 N, the hub is rotated at 1000 rpm and the spindle temperature maintained at 160 °C for 20 h, 4 h off operating cycle. The test is terminated when grease deterioration causes the drive motor torque to exceed a calculated motor cut off value. Grease life is expressed as the accumulated on-cycle hours.

5. Significance and Use

5.1 This test method differentiates among wheel bearing greases having distinctly different high-temperature characteristics. It is not the equivalent of longtime service tests, nor is it intended to distinguish between the products having similar high-temperature performance properties.

5.2 This test method has proven to be helpful in screening greases with respect to life performance for automotive wheel bearing applications.

6. Apparatus

6.1 *Test Assembly* (see Fig. 1 and Fig. 2).

[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.G0.05 on Functional Tests - Temperature.

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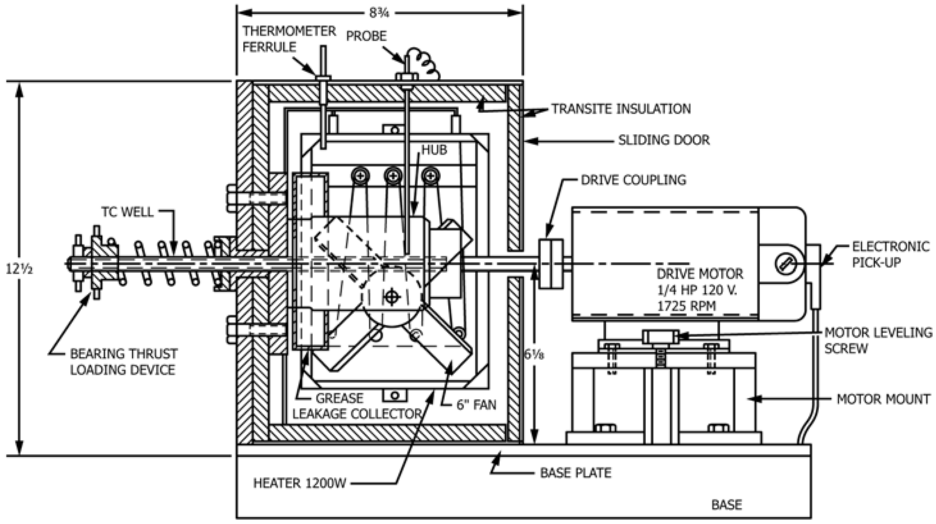
[2] Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036, http://www.ansi.org.

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



NOTE 1—Caution should be taken when modifying older units since some may still contain asbestos insulation leading to a possible inhalation hazard.

FIG. 1 Wheel Bearing Lubricant Tester (Elevation View)

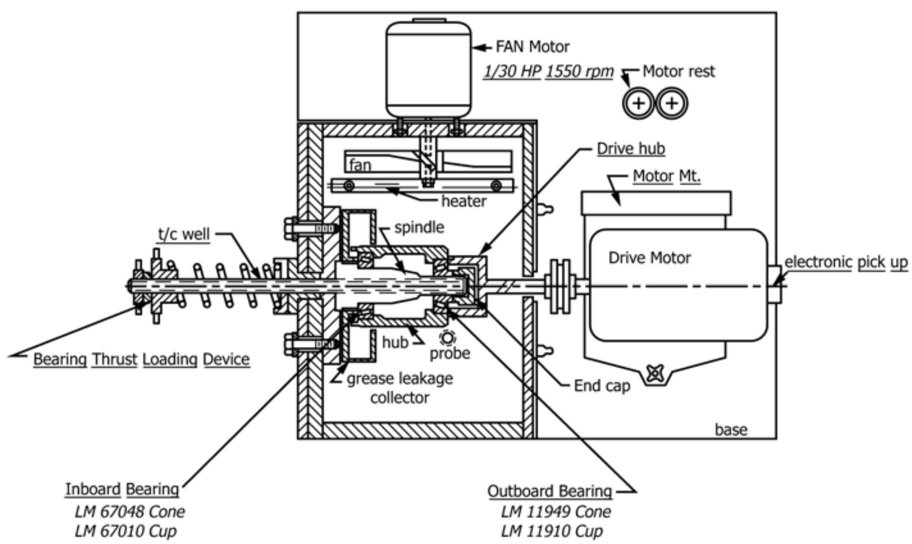


FIG. 2 Wheel Bearing Lubricant Tester (Top View)

6.1.1 *Custom-made Wheel Hub-Spindle-Bearing Assembly* (Fig. 3).

6.1.2 *Oven,* electrically heated by a 1200 watt heater, thermostatically controlled to maintain spindle temperature at 160 ± 1.5 °C.

6.1.3 *Spindle Drive Motor,* ¼ hp, 120 volts dc with 1725 rpm speed control the hub; motor torque is indicated by a meter equipped with an adjustable, automatic cut-off.

6.1.4 *Fan Drive Motor,* 1⁄30 hp, 120 v dc, 1550 rpm.

6.2 Motor speed, oven temperature, spindle temperature, time cycles and torque are controlled or monitored, or both, by accessory equipment.

6.3 *Balance* having a minimum capacity of 100 g and minimum sensitivity of 0.1 g.

7. Test Bearings

7.1 Use LM67048-LM67010 and LM11949-LM11910 (AFBMA Standard 19) inboard and outboard bearings,[3] respectively.

8. Reagents and Materials

8.1 *n-Heptane*—reagent grade minimum purity (**Warning—**Flammable. Harmful if inhaled.)

8.2 *Isopropyl Alcohol*—reagent grade minimum purity (**Warning—**Flammable.)

[3] Timken or Bower bearings are suitable.

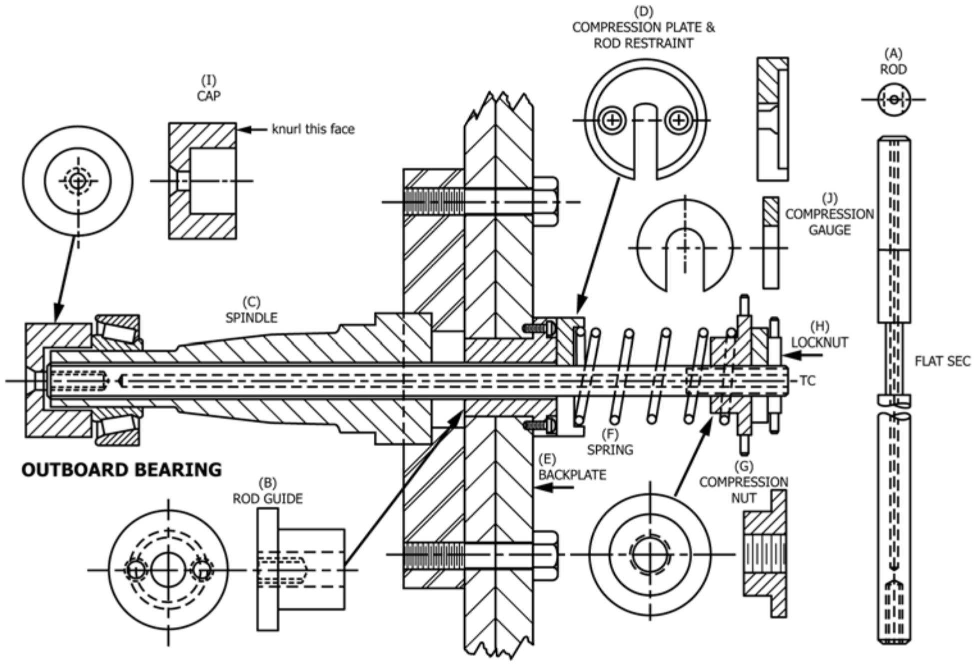


FIG. 3 Spindle and Thrust Rod Components

8.3 *Penmul L460 (previously called Penetone ECS)*[4]—(**Warning—**Combustible. Vapors can be harmful.)

8.4 *Mineral Spirits, Reagent Grade*—(**Warning—**Combustible. Vapors may be harmful.)

8.5 *SAE 10W Engine Oil.*

8.6 *00 Grade Steel Wool.*

9. Preparation of Bearings

9.1 Carefully remove new bearings (cups and cones) from their packages and place in a suitable clean container. Wash with *n*-Heptane to remove all rust preventative.

9.2 Repeat washing with *n*-Heptane two additional times to be certain all rust preventative has been removed. Use a clean beaker each time.

9.3 Drain *n*-Heptane from the bearings and set them on a clean, lint-free cloth or towel to air dry.

NOTE 2—Cleaning may be facilitated by the use of a sonic cleaner.

10. Procedure

10.1 Prior to each test, check the freedom of movement of the thrust loading shaft (Fig. 3) in the spindle. If binding is noted, remove and clean both shaft and spindle bore.

10.2 Install the new cups in the cleaned hub in the location shown in Figs. 1 and 2.

10.3 Weigh an inboard and outboard bearing cone to the nearest 0.1 g. Fill the cones with test grease using an extra set of cups and the grease packer shown in Figs. 4 and 5. Use care to avoid moving the rollers or bearing components while removing the cones from the cups and in all subsequent wiping and handling steps. Strike off excess grease flush with the front face of the cone (near small end of rollers) using a small spatula. Wipe all grease from cone bore, cone back face, exterior cage surfaces, and exposed roller surfaces with a clean, lint-free cloth or towel and reweigh. Adjust the grease weight in the inboard cone to 3.0 ± 0.1 g and in the outboard cone to 2.0 ± 0.1 g by wiping or adding grease to the groove between the cage and the cone back face. Apply a thin film of grease on the cups.

10.4 Install the leakage collector, inboard cone, hub, and outboard cone on the spindle (Fig. 2). Lock the components in place with the end cap and screw. Install the spindle connector.

10.5 Referring to Fig. 3, adjust the thrust load as follows: tighten the compression nut *G* until the spring *F* is seated against the back plate *E, but not compressed*. Bring the lock nut *H* up to the compression nut *G*. Without moving *H*, compress *F* by tightening *G* until the compression gage *J* will fit between *H* and *G*. Hold *J* in position and back off *G* until *J* is held firmly between *H* and *G*.

NOTE 3—Compression gage *J* has been machined such that insertion and adjustment of *G* causes spring *F* to compress and apply approximately 111 N (25 lbf) of axial loading on the wheel bearings. It is the understanding of Subcommittee G that the intent of the axial load is to ensure that the bearing is properly aligned on the spindle and remains so through the duration of the test.

Evaluation of a limited selection of these parts indicates the potential for significant variations in axial load when the instructions in 10.5 are followed. Since it was first published, this test method has not required

[4] The sole source of supply of Penmul L460 (previously called Penetone ECS) known to the committee at this time is Penetone Corp., 74 Hudson Ave., Tenafly, NJ 07670. 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.

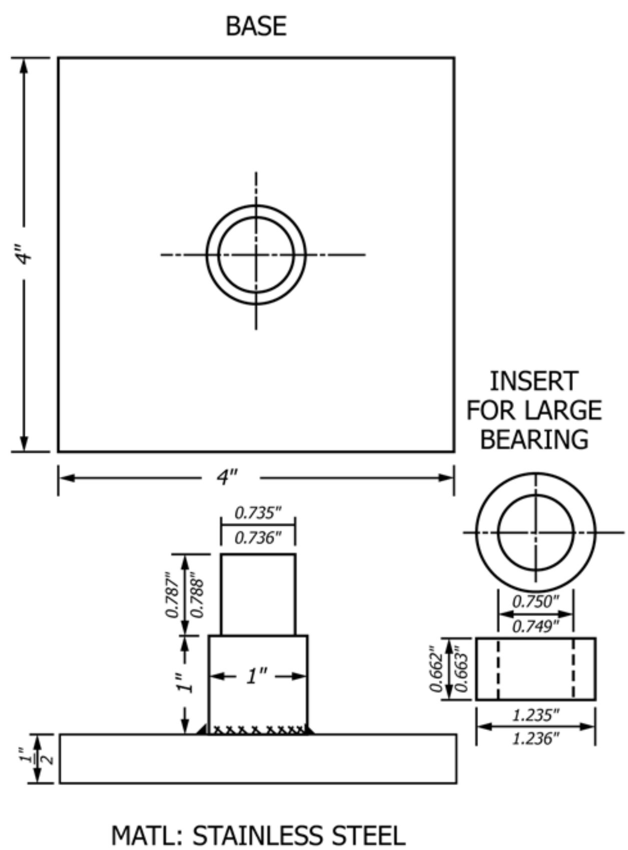


FIG. 4 Bearing Packer

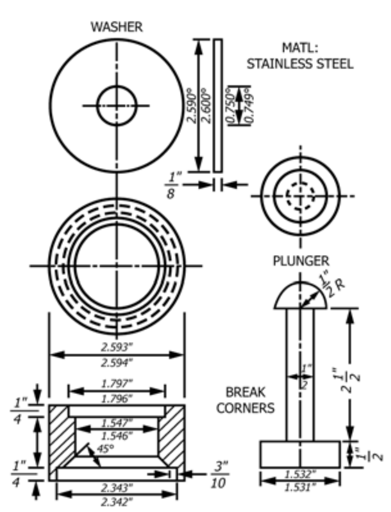


FIG. 5 Bearing Packer

calibration of the compression nut, spring, and gauge. So it seems that it is not critical to achieve an axial load of 111 N within an unspecified tolerance. Therefore there is no requirement to calibrate the test parts or to confirm the loading achieved.

10.6 Insert the thermocouple in the spindle thrust rod and position the junction at the center of the outboard bearing position. Close the cabinet and position the motor to operating location. (**Warning—**Do not engage the drive at this point. Start the motor and adjust the speed to 1000 ± 50 rpm. At this point observe and record the unloaded motor current *N*.)

10.7 Turn off the motor, engage the drive coupling and lock in position. Set the timer to begin a 20 h cycle. Restart the motor and again adjust the speed to 1000 ± 50 rpm. Turn on the heaters and adjust the oven temperature to maintain the spindle temperature at 160 ± 1.5 °C (320 ± 2.7 °F). When the spindle temperature has stabilized at the test temperature, make no further adjustment of the oven temperature for the duration of the test.

10.8 A steady-state running torque will develop in the first 2 h of operation as indicated by a stabilized value on the meter. Record this value as steady-state current *T* . Determine the motor cutoff value as follows:

$$C = 8(T - N) + N \tag{1}$$

where:

C = motor cut-off value, amps,
T = steady-state current, amps, and
N = unloaded motor current, amps.

Set the automatic torque cutoff of motor to value of *C*.

10.9 Permit the apparatus to operate under the prescribed conditions of load, speed, and temperature until the preset torque limit is exceeded at which point the test will be terminated automatically. Record the time the unit shuts down.

NOTE 4—The motor is protected by a 30 s time delay.

NOTE 5—The 30 s delay described in Note 4 has been interpreted by some users as a set requirement of the test method, when it was originally intended only for information purposes about the protection of the electric motor from prolonged exposure to high current (torque) levels. Work conducted by the D02.G0.05 Task Force indicates that test precision may be improved by increasing this delay time to 90 s without significantly affecting test severity or increasing the risk of motor burn-out. However, the effect of this change has not been evaluated according to ASTM requirements for development of test precision. Additionally, the Task Force found that the cyclic nature of running torque means that the cut-off torque value (and test severity) may be dependent on the sampling time used to establish this parameter and taking the average value of several readings may be useful.

10.10 Allow the tester to cool to a safe handling temperature and disassemble. If the tester is disassembled hot, use insulated gloves.

11. Parts Cleanup

11.1 With a suitable spatula, remove as much grease as possible from the grease collector, end cap, and spindle connector.

11.2 Place the parts in a suitable clean container (preferably stainless steel) and cover with Penmul L460 (**Warning—**See 8.3). Install a loosely fitting cover and heat gently (70 ± 10 °C) until the parts are clean (several hours). Avoid prolonged (overnight) heating as parts corrosion can occur.

11.3 Remove the parts from the solvent and wash with hot running water. Rinse immediately with isopropyl alcohol (**Warning—**See 8.2). Air dry. If the parts will not be used immediately, apply a film of SAE 10W engine oil.

11.4 Use a suitable spatula to scrape grease off of the spindle. Remove the remaining deposits from the spindle using 00 grade steel wool and mineral spirits (**Warning—**See 8.4). If strongly adherent deposits resist this treatment, remove the spindle and clean in hot Penmul L460.

12. Report

12.1 Report the hours to failure.

13. Precision and Bias[5]

13.1 The precision of this test method was determined by statistical examination of interlaboratory results. Research Report RR:D02-1007[6] procedures were followed in the round-robin testing and statistical analysis of data. In 1988 a more precise description of the bearing packing procedure was included in 10.3. The precision data shown in Table X2.1 was obtained earlier using a less detailed packing procedure.

13.1.1 *Repeatability*—The difference between two test results obtained by the same operator with the same apparatus under constant operating conditions on identical test material would, in the long run, in the normal and correct operation of the test method, exceed the following values in only one case in twenty:

$$\text{Repeatability} = (0.8)X \tag{2}$$

where:

X = the average of the two test results.

13.1.2 *Reproducibility*—The difference between two single and independent results obtained by different operators working in different laboratories on identical test material would, in the long run, in the normal and correct operation of the test method, exceed the following values in only one case in twenty:

$$\text{Reproducibility} = (1.2)X \tag{3}$$

where:

X = the average of the two test results.

13.2 *Bias*—The procedure in this test method has no bias because the value of grease life can be defined only in terms of the test method.

NOTE 6—A round robin of twelve cooperators testing five greases has resulted in the precision statement shown above. The data are shown in Table X2.1. In this round robin, determinations were made using testers by PAM, Koehler, and Falex. No distinction was made as all testers gave equivalent results.

14. Keywords

14.1 automotive wheel bearing grease; grease life performance; lubricating grease

[5] Supporting data have been filed at ASTM International Headquarters and may be obtained by requesting Research Report RR:D02-1177.

[6] Supporting data have been filed at ASTM International Headquarters and may be obtained by requesting Research Report RR:D02-1007.

APPENDIXES

(Nonmandatory Information)

X1. METRIC EQUIVALENTS

X1.1 See Table X1.1.

TABLE X1.1 Metric Equivalents for Figs. 1, 4, and 5

in.	mm	in.	mm
⅛	3.175	1.546	39.268
¼	6.350	1.547	39.294
½	12.700	1.796	45.618
0.661	16.789	1.797	45.644
0.662	16.815	2.342	59.487
0.735	18.669	2.343	59.512
0.736	18.694	2½	63.500
0.749	19.025	2.590	65.786
0.75	19.050	2.6	66.040
0.787	19.990	2.594	65.888
1.00	25.400	4.0	101.600
1.235	31.369	6.0	152.400
1.236	31.394	6⅛	155.570
1.531	38.887	8¾	222.250
1.532	38.913	12½	317.500

X2. WHEEL BEARING LIFE TEST (HOURS)

X2.1 See Table X2.1.

TABLE X2.1 Wheel Bearing Life Test (Hours)

G827	G828	G829	G830	G831	Laboratory
80	230	160	20	100	1^A
60	220	180	40	80	
60	320.5	344.5	39.9	80.2	2^B
60.1	419.8	360	60	160	
98.8	278	298	40	65	3^C
74	160	179	40	20	
93	160	–99.99	80	120	6^B
89	140	–99.99	40	180	
100	220	326	60	180	6^A –1
100	240	404	80	140	
154	205	360	40	160	6^A –2
100	220	977	60	180	
75	427	426	82	124	7^A
61	326	749	41	224	
163.4	187.7	443	61.3	121.5	8^A
164.4	184.6	551	58.9	101.6	
80.7	179.4	454.4	71.6	117	8^B
97.4	159.4	241.4	64.5	122	
267	193	379	92	184	9^A
280	200	350	102	175	
99.6	310	619.3	60.3	80.7	10^A
99.9	280	463.5	60.3	160.5	
100	280	280	40	60	11^B
120	180	240	80	100	

[A] Koehler.
[B] PAM.
[C] Falex.

SUMMARY OF CHANGES

Subcommittee D02.G0 has identified the location of selected changes to this standard since the last issue (D3527 – 11) that may impact the use of this standard. (Approved April 1, 2015.)

(1) Revised subsection 4.1 and Note 3.