Designation: D5579 – 16

# Standard Test Method for Evaluating the Thermal Stability of Manual Transmission Lubricants in a Cyclic Durability Test[1]

This standard is issued under the fixed designation D5579; 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

This test method is written for use by laboratories that use the portions of the test method that refer to ASTM Test Monitoring Center (TMC) services (see Annex A1 – Annex A4). Laboratories that choose not to use the TMC services may simply disregard these portions.

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.

NOTE 1—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.

## 1. Scope*

1.1 This test method covers the thermal stability of fluids for use in heavy duty manual transmissions when operated at high temperatures.

1.2 The lubricant performance is measured by the number of shifting cycles that can be performed without failure of synchronization when the transmission is operated while continuously cycling between high and low range.

1.3 Correlation of test results with truck transmission service has not been established. However, the procedure has been shown to appropriately separate two transmission lubricants, which have shown satisfactory and unsatisfactory field performance in the trucks of one manufacturer.

1.4 Changes in this test method may be necessary due to refinements in the procedure, obsolescence of parts, or reagents, and so forth. These changes will be incorporated by Information Letters issued by the ASTM Test Monitoring Center (TMC).[2] The test method will be revised to show the content of all the letters, as issued.

1.5 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.

1.5.1 *Exception*—When materials, products, or equipment are available only in inch-pound units, SI units are omitted.

1.6 *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.*

1.7 This test method is arranged as follows:

[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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This edition incorporates revisions in all Information Letters through No. 15–1.

[2] ASTM Test Monitoring Center, 6555 Penn Ave., Pittsburgh, PA 15206-4489.

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

## 2. Referenced Documents

2.1 *ASTM Standards:*[3]

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

D7422 Test Method for Evaluation of Diesel Engine Oils in T-12 Exhaust Gas Recirculation Diesel Engine

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

2.2 *SAE Standard:*

SAE J308 Axle and Manual Transmission Lubricants[4]

2.3 *Military Standard:*

MIL-L-2105 Lubricating Oil, Gear, Multipurpose[5]

2.4 *Other Standard:*

GO-H Mack Trucks Oil,Gear: Multi-Purpose[6]

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

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

[6] Available from Volvo Powertrain, North America, 13302 Pennsylvania Ave., Hagerstown, MD 21742.

## 3. Terminology

3.1 *Definitions:*

3.1.1 *wear, n*—the loss of material from a surface, generally occurring between two surfaces in relative motion, and resulting from mechanical or chemical action or a combination of both. **D7422**

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *dual-range transmission, n*—a type of transmission in which the driver first shifts through all of the mainbox gear ratios in low range, and then shifts to high range and shifts through the mainbox again. The section containing the high-low range is the compound section.

3.2.2 *friction disk, n*—a steel circular plate to which a friction material has been bonded.

3.2.3 *glazed, adj*—the condition of the friction disks when precipitates have filled the pores in the friction material, polishing the surface, and changing the frictional properties.

3.2.4 *reaction disk, n*—a steel disk that mates with the friction disk during synchronization.

3.2.5 *shift time, n*—the period of time required, when shifting from high range to low range, for the countershaft speed to increase from 500 r/min to 1700 r/min; or when shifting from low range to high range, for the countershaft speed to decrease from 1700 r/min to 500 r/min.

3.2.6 *synchronizer, n*—a pack of friction and reaction plates used to match the speeds of the low- and high-range gears prior to engagement.

3.2.7 *unsynchronized shift, n*—a shift in which the speed of the mating gears is not matched to the speed of the transmission output shaft by the synchronizer.

## 4. Summary of Test Method

4.1 Prior to each test run, the transmission is disassembled and all parts, including the case and the oil-circulating and heating systems, are thoroughly cleaned. The transmission is rebuilt with a new synchronizer assembly, including measured shifter fork, friction, and reaction disks. All other worn or defective parts are replaced.

4.2 The rebuilt transmission is installed on a test stand.

4.3 The transmission and oil system are flushed with the test oil in accordance with the flush procedure.

4.4 The flush oil is drained, and the test oil is measured and charged to the transmission.

4.5 The transmission is started and operated in low range until the oil temperature reaches the test operating range.

4.6 The transmission is automatically cycled between low and high range until two unsynchronized shifts occur or the desired length of test is reached without failure. The time required to shift from high range to low range is recorded each hour.

4.7 At the conclusion of the test, the test parts are removed and visually inspected. The shifter fork and friction plates are measured again to determine wear.

## 5. Significance and Use

5.1 This test method is used to evaluate automotive manual transmission fluids for thermal instability, which results in deterioration of synchronizer performance.

5.2 This test method may also be utilized in other specifications and classifications of transmission and gear lubricants such as the following:

5.2.1 (final API designation of PG-1),

5.2.2 Military Specification MIL-L-2105,

5.2.3 SAE Information Report J308 Axle and Manual Transmission Lubricants, and

5.2.4 Mack Truck GO-H Gear Lubricant Specification.

## 6. Apparatus

6.1 Table 1 is a list of the make and model of recommended instruments and equipment.

6.2 *Test Transmission*—The test transmission is a MACK T2180, configuration 11KBA51431 (see Fig. 1). Some parts in the transmission are to be removed and some are to be added before testing, as listed in Table 2. The main box shift rail cover can be replaced with an aluminum plate to facilitate transmission cleaning at end of test.

6.3 *Transmission Mounts*—The transmission is mounted as shown in Fig. 2.

6.4 *Oil-Circulating System*—The system heats the oil to the specified operating temperature of 250 °F ± 5 °F (121 °C ± 2.7 °C) and maintains this temperature throughout the duration of the test. The power density of the heater is not high enough to cause degradation of the oil (22 W/in.$^2$ to 25 W/in.$^2$ (3.4 W/cm$^2$ to 3.9 W/cm$^2$)). The oil flow rate is between 6 gal/min and 10 gal/min (23 L/min to 38 L/min). A layout of the oil-circulation system is shown in Fig. 3. A detailed drawing of the recommended oil heating chamber is shown in Fig. 4. The total oil capacity of the test system is 5.25 gal (19.87 L) with the oil level in the transmission at the lower edge of the fill hole. If the system capacity is too small, increase by lengthening oil hoses. When the system capacity is too great, decrease by shortening hoses, if it is practical to do so; otherwise, install an inert (stainless steel) block in the transmission main box sump to raise the oil level. Route the oil lines so that they will empty completely when draining the system.

**TABLE 1 Recommended Test Stand Components**

| Item | Manufacturer | Part No. |
|---|---|---|
| Panel Meters | | |
| Tailshaft rpm | Newport | P-6031D20D |
| Countershaft rpm | Newport | P-6031D20D |
| Shift time | Newport | P-6031D20D |
| Coast down time | Newport | P-6031D20D |
| Control Indication | | |
| Temperature controller | Omron | ESEX-AF |
| Temperature indicator | Newport | INF-0-0-0-0-JF |
| Cycle counter | Redington | P2-1006-115AC |
| Cycle timer | Omron | H5BR-B-AC100-240 |
| T/C selector switch | Thermo Electric | 33112 |
| Oil psi gage/safety | Murphy | A-20EO, O-30 psi |
| Air supply gage | U.S. Gage | P44U, O-160 psi |
| Air regulator | Norgren | RO-8-300 RNMA |
| Shift solenoid | Asco | 8317G35, 3-way solenoid |
| Mag. pickup | Electro | 3010AN |
| 12 VDC Power supply | Sola | SLS-12-017 |
| Air pressure switch | Penn | P61AG-1 |
| Relays—AC | Potter & Brumfield | KUP14A15 |
| Relays—DC | Potter & Brumfield | KUP14D15 |
| Mechanical Components | | |
| Air lines | Mack | 101AX24R, ⅜ in. OD |
| Pump | Brown & Sharp | No. 2 |
| Heater element | Chromalox | MOT330A, 220v, 1Ph |
| Oil lines | Aeroquip | EC-350, No. 12 |
| U Joint yoke | Mack | 1710 Series, 38MU3413M |
| Drive shaft | Rockwell | 1710 Series, 52 in. collapsed |
| Drive motor | General Electric | 25-hp Induction Motor, 1760 rpm |
| High-Speed Recording System | | |
| Pressure transducers | Sensotec | A-5/1034, 0-100 psi |
| Oscillograph | Astro-Med | Dash 4 |

6.5 *Oil Return Hole*—Drill and tap a hole in the compound case for the oil to return after flowing through the heat exchanger. The location and size of this hole are shown in Fig. 5.

6.6 *Air Pressure Controls*—The transmission is shifted by air pressure applied to alternating sides of the range shift piston. The air pressure is provided by a pilot valve, which is cycled by a solenoid valve at a rate of 5 cpm. These cycles are recorded by a counter, which provides the cycles to mis-shift data for the pass/fail criteria of the test. A typical air control system is shown in Fig. 6.

6.7 *Drive System*—In the truck operation, opposing torques help the synchronizer to complete the shift. In the test stand, the transmission is driven from the rear by an electric motor and belt drive with no loading on the input pinion. The torques, therefore, are not present, and shifting can be delayed. To help the synchronizer shift smoothly without the opposing torque, a vibration in the drive line is intentionally excited. The driveline is set out of phase by rotating the yoke at one end of the shaft with respect to the other by a one spline tooth offset (22°). The transmission output shaft is offset from the shaft of the motor or jack shaft, thereby placing the driveline at an angle. A layout showing the offset of the transmission relative to the jack shaft is shown in Fig. 2.

6.8 *Instrumentation*—Supply sensors and displays, either on the test console or in a data logging computer, as follows:

6.8.1 Oil sump temperature,

6.8.2 Countershaft speed,

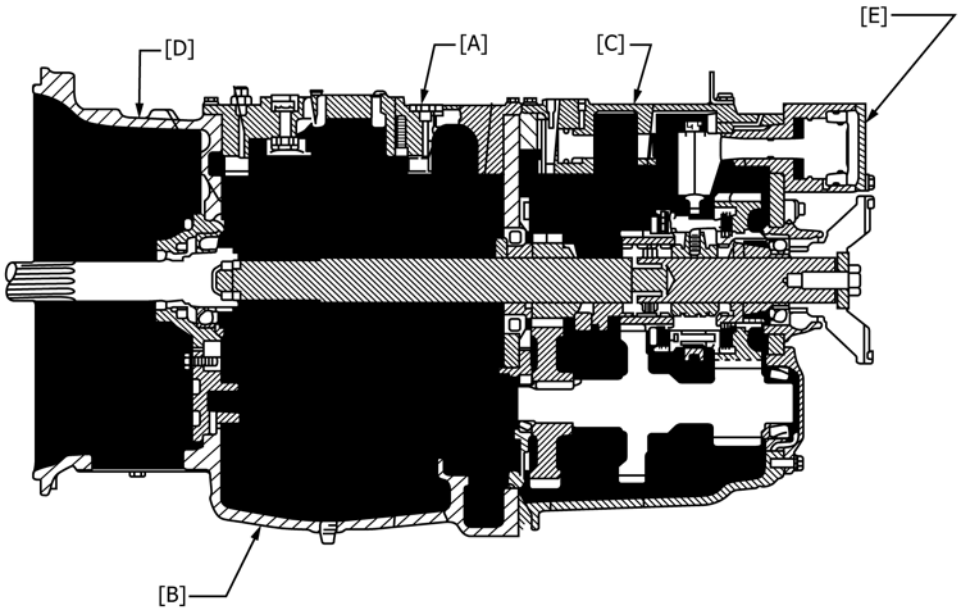
6.8.3 Tail shaft speed,

6.8.4 Air pressure (system),

6.8.5 Air pressure (dynamic during shifting), and

6.8.6 Coast down time.

6.9 *Thermocouple Placement*—Transmission sump temperature is measured in the compound section of the transmission with a thermocouple and conventional display equipment. Drill and tap the compound case to accept the thermocouple at a position located along the centerline of the transmission 8.0 in. (203 mm) forward of the back wall of the main case. Position the tip of the thermocouple to extend 1.5 in. (38 mm) into the sump. As a means of ensuring that the oil is not




NOTE 1—Left side view.
NOTE 2—See Table 2 for references to letters in brackets.

**FIG. 1 Transmission Modified for Testing**

**TABLE 2 Transmission Parts to Be Added or Removed Before Testing**

NOTE 1—Letters in brackets, [ ], refer to locations indicated on Fig. 1.

| | | |
|---|---|---|
| Parts to Be Removed | | |
| Rails, forks, springs, and ball from the mainbox shift cover [A] | | |
| All main box gearing [B]: | | |
| Main shaft gears and thrust washers | | |
| Countershaft assemblies | | |
| Sliding clutches | Mack part numbers 320KB3136 (2)320KB3137A | or Volvo part numbers 25101998 (2)25503685 |
| Compound [C] | | |
| Splitter clutch | Mack part number 320KB3141 | |
| Splitter piston | Mack part number 336KC333 | or Volvo part number 25125890 |
| Splitter fork | Mack part number 575KB3378 | or Volvo part number 25502825 |
| Bell Housing [D] | | |
| All clutch related parts | | |
| Shafts | Mack part number 604KC277A, 604KC34B | or Volvo part number 25085391 N/A |
| Yoke | Mack part number 301KD43B | or Volvo part number 25128328 |
| Parts to Be Added | | |
| Speedometer plug | Mack part number 37KC12 | or Volvo part number N/A |
| Speedometer washer | Mack part number 37AX419 | or Volvo part number 20704759 |
| Orifice to range valve | Mack part number 63AX3466 | or Volvo part number 25107528 |
| Replace cast iron piston housing cover with fabricated steel cover [E] | | |

exposed to excessive heat in the heater, place an additional thermocouple to measure the oil temperature leaving the heater as shown in Fig. 7.

## 7. Reagents and Materials

7.1 *Oil*—Approximately 12 gal (45.4 L) of test oil is required. The integrity of the test oil is the responsibility of the oil supplier.

7.2 *Solvent*—Use only mineral spirits meeting the requirements of Specification D235, Type II, Class C for Aromatic Content (0-2% vol), Flash Point (142°F/61 °C, min), and Color (not darker than +25 on Saybolt Scale or 25 on Pt-Co Scale). (**Warning—**Combustible. Health hazard.) Obtain a Certificate of Analysis for each batch of solvent from the supplier.

## 8. Safety

8.1 The following are suggestions of procedures and equipment that may assist in reducing safety hazards. No attempt has been made to address all possible safety problems. The user of this test method is responsible for establishing appropriate safety and health practices.

8.2 The operating of transmission tests can expose personnel and facilities to a number of safety hazards. Only personnel who are thoroughly trained and experienced in transmission

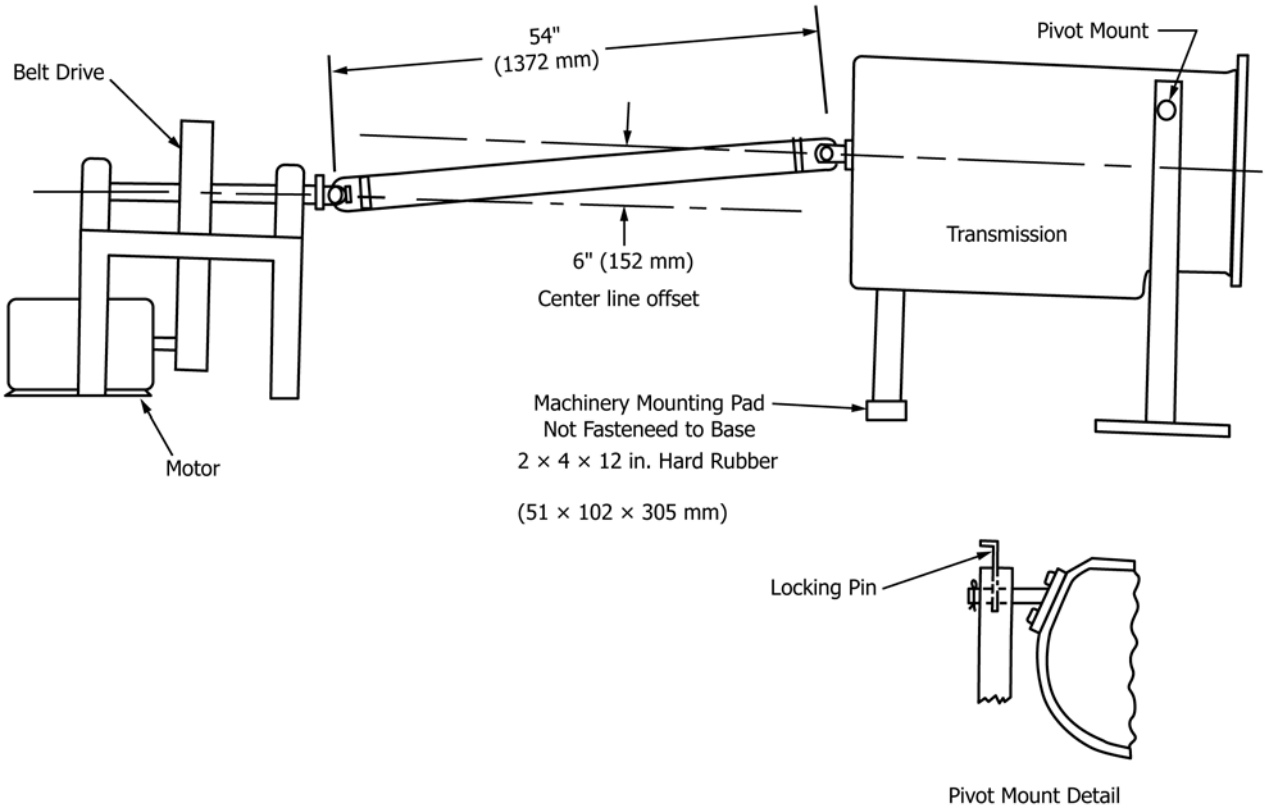



**FIG. 2 Typical Layout of Drive System**

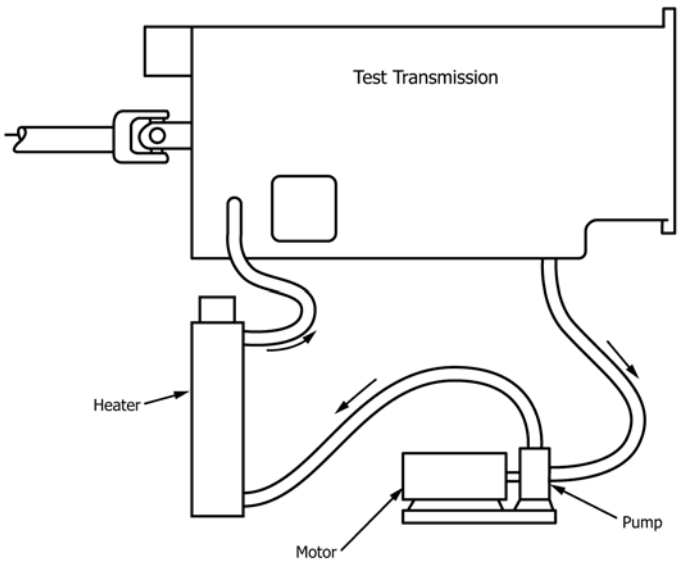



**FIG. 3 Schematic of Oil System**

testing should undertake the design, installation, and operation of transmission test stands.

8.3 Each laboratory conducting transmission tests should have its test installation inspected and approved by its safety department. Personnel working on the transmissions should be provided with the proper tools, be alert to common sense safety practices, and avoid contact with moving or hot transmission parts, or both. Heavy-duty guards should be installed around the driveline. When the test stand is operating, personnel should be cautioned against working alongside the transmission and drivelines. All oil lines and electrical wiring should be properly routed and grounded, guarded, and kept in good order. Safety masks or glasses should always be worn by personnel working on the transmissions. Loose or flowing clothing, long hair, or other accessories to dress that could become entangled, should not be worn near rotating equipment.

8.4 The external parts of the transmission and the floor area around the transmission should be kept clean and free of oil spills. In addition, the working area should be free of all tripping hazards. In case of injury, no matter how slight, first aid attention should be applied at once and the incident reported. Personnel should be alert for leaking oil, which represents a fire hazard. Do not permit containers of oil to accumulate in the test area.

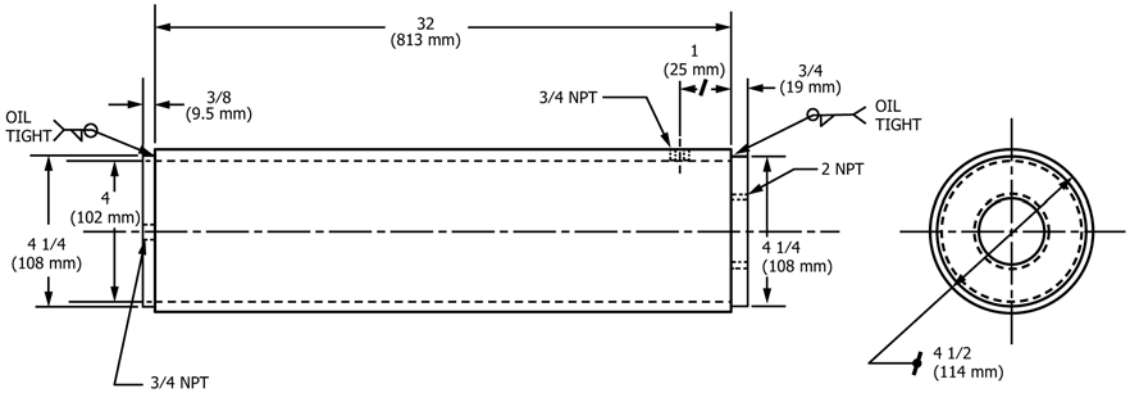
8.5 A remote station for shutting off the motor, pump, and heater is recommended. Fixed fire-protection equipment should be provided.

8.6 Normal precautions should be taken when using flammable solvents for cleaning purposes. Make sure adequate ventilation is provided and fire-fighting equipment is immediately accessible.

8.7 It is recommended that safeties be provided to shut down the drive motor and oil heater when the following conditions occur:

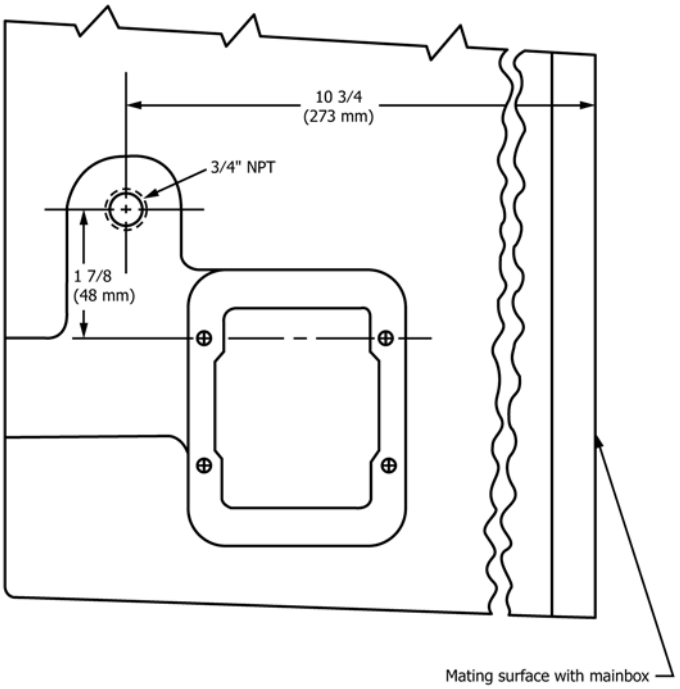
8.7.1 Oil temperature in transmission sump becomes excessive,

8.7.2 Oil temperature leaving the oil-heating chamber becomes excessive,




NOTE 1—Material 1018 is similar material.
NOTE 2—All dimensions are in inches, unless otherwise noted.

**FIG. 4 Typical Oil Heater Chamber**




NOTE 1—Figure is not drawn to scale.

**FIG. 5 Oil Return Hole Location**

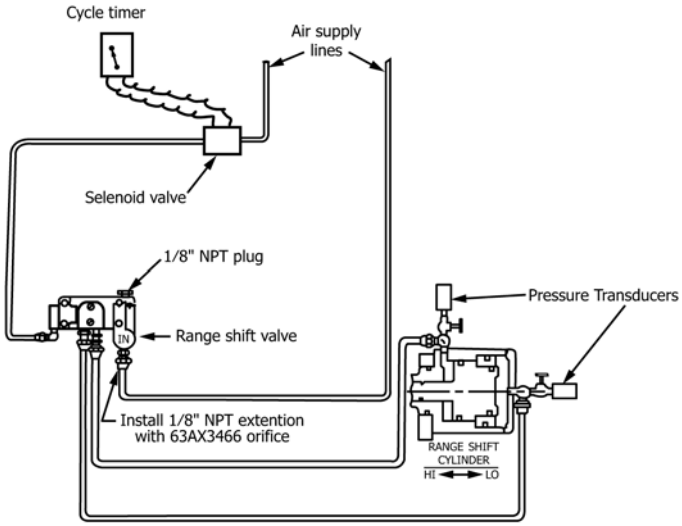



**FIG. 6 Air Control and Supply System**

8.7.3 Oil-circulating system loses pressure,
8.7.4 Motor over-speeds or under-speeds, and
8.7.5 The fire-protection system is activated.

8.8 See Fig. 8 for a typical schematic of safety circuits.

## 9. Preparation of Apparatus

9.1 *Cleaning of Parts:*

9.1.1 *Transmission Case*—Thoroughly clean the transmission case with a cleaning solvent (see 7.2) to remove any oil, sludge, or varnish deposits remaining from the previous test and then air dry.

9.1.2 *Gears, Shafts, Synchronizer*—Remove all sludge, varnish, and deposits. Rinse with a cleaning solvent (see 7.2) and air dry.

9.1.3 *Heater, Oil-Circulating System*—Flush oil lines with a cleaning solvent (see 7.2) to remove any previous test oil and then air dry. Disassemble the heater, clean, and air dry after each test. Check the heater periodically for leaks and replace when necessary.

9.2 *Assembly:*

9.2.1 *General*—Assemble all parts as instructed in the Mack Transmission Service Manual T2130/2180,[6] except where the service manual applies to parts that are modified for this test method. Refer to Table 3 for a list of approved test hardware part numbers. Use test oil for lubricating parts during assembly.

9.2.2 *New Parts*—Obtain the following parts from an authorized Mack truck dealer. Install the new parts listed in Table 4 for each test:

9.2.2.1 Inspect the following parts after each test and replace if worn or damaged:

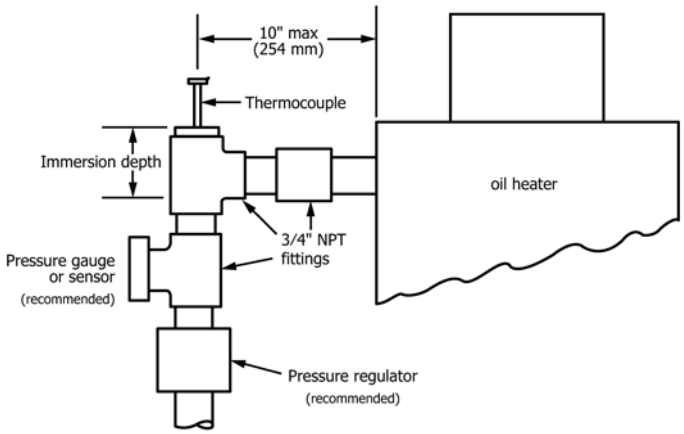
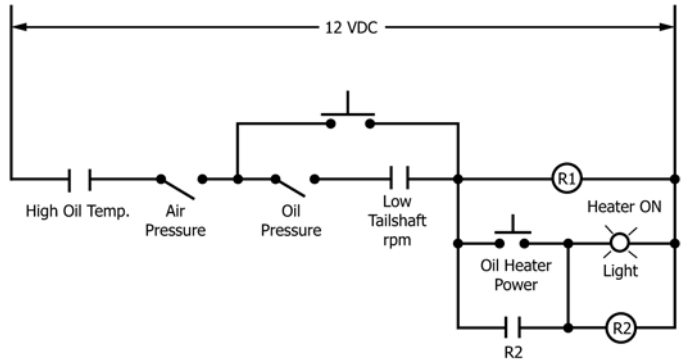



**FIG. 7 Location of Oil Out-of-Heater Thermocouple, Pressure Regulator, and Sensor**



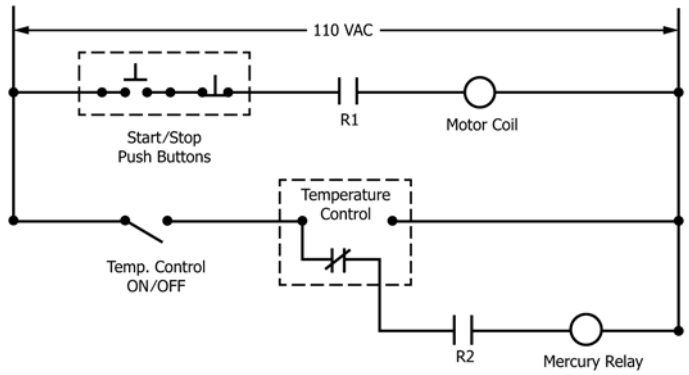




**FIG. 8 Typical Schematics of Safety Circuits**

**TABLE 3 Part Numbers for Approved Hardware**

| Part description | Test Hardware Part Numbers | |
|---|---|---|
| | Mack Part Number | Volvo Part Number |
| Synchronizer clutch assembly | 320KB459A[A] or 320KB463[B] | 25132811[A] or 21636360[B] |
| Synchronizer pin (3 each) | 301KC33 | 25500623 |
| Synchronizer pin (3 each) | 301KC34 | 25498886 |
| Synchronizer pin (3 each) | 301KC35 | 25500385 |
| Synchronizer pre-load spring (3 each) | 107KD247 | 25500680 |
| High range mainshaft gear | 751KB4123[A] or 751KB4176[B] | 25502562[A] or 21649207[B] |
| Low range mainshaft hub | 84KC47[A] or 84KC411[B] | 25502560[A] or 21631781[B] |
| Compound mainshaft, rear | 601KC432 | ... |
| Bearing, compound mainshaft | 46AX538 | 25499676 |
| Snap ring (2 each) | 97AX151 or 97AX171 | 25108495 |
| Snap ring (2 each) | 97AX267 | ... |
| Shift rail | 591KC3154A | ... |
| O-ring, low range shift piston | 56AX560 | 25108495 |
| Piston, high low range shift[C] | 336KC318 | ... |
| Cylinder housing, hi-lo shift piston | 55KC46A | ... |
| O-ring, range high low shift piston | 56AX588 | 20705679 |
| Countershaft gear, front | 757KB3322 or 757KB4108 | ... |
| Countershaft gear, rear | 757KB4106 | ... |
| Range shift valve | 216KD42 | 21041938 |

[A] Parts required in hardware "CONFIGURATION 2".
[B] Parts required in hardware "CONFIGURATION 3".
[C] The piston, high low range shift, has an outside diameter of 3.740 to 3.738 in. (95.00 to 94.95 mm).

**TABLE 4 New Parts for Each Test**

| Name | Quantity | Mack Part Number | Volvo Part Number |
|---|---|---|---|
| Friction plate | 8 | N/A | N/A |
| Range fork | 1 | 575KB457 | 25126946 |
| Low range main shaft hub | 1 | 84KC47[A] or 84KC411[B] | 25502560[A] or 21631781[B] |
| Sliding clutch | 1 | 320KB459A[A] or 320KB463[B] | 25132811[A] or 21636360[B] |
| Pin | 3 | 301KC33 | 25500623 |
| Pin | 3 | 301KC34 | 25498886 |
| Spacer tube | 3 | 301KC243C | 25501259 |
| Ball/Pin | 6 | 301KC35 | 25500385 |
| Spring | 6 | 107KD247 | 25500650 |
| Reaction disk | 8 | 495KB367 | 25097624 |

[A] New parts to be used in combination with Part No. 751KB4123 or 25502562 as hardware CONFIGURATION 2. Identify the test as "CONFIGURATION 2" in the space provided in the test report.
[B] New parts to be used in combination with Part No. 751KB4176 or 21649207 as hardware CONFIGURATION 3. Identify the test as "CONFIGURATION 3" in the space provided in the test report.

| | Number Required | Mack Part No. | Volvo Part No. |
|---|---|---|---|
| Thrust Washer | 3 | 223KD249 | 25500345 |
| Thrust Washer | 2 | 223KD316A | 25500919 |
| Clutch Housing | 2 | 53KC486C | 25502585 |
| High Range Main Shaft Gear | 1 | 751KB4123[A] or 751KB4176[B] | 25502562[A] or 21649207[B] |

[A] One of the parts required in hardware "CONFIGURATION 2".
[B] One of the parts required in hardware "CONFIGURATION 3".

9.2.3 *Inspection of Air Valves*—Inspect the piston of the range shift valve and the fork air cylinder and replace if damaged or visibly worn. Replace the O-rings in these valves when nicked, cut, softened, or hardened. However, replace these O-rings at least every six months. Install a 1⁄16-in. (1.59 mm) thick shim between the shaft cylinder and the transmission case for "CONFIGURATION 2" and "CONFIGURATION 3" tests.

9.2.4 *Pre-test Measurements*—Measure the range fork for hardness and thickness at the locations shown in Fig. A7.1. The hardness of the fork pads shall be a minimum of 55 $R_c$ at each of the four locations. Mark the friction disks on the spline tangs with an etching tool at three locations equally spaced. Measure

and record the pad thickness at these locations in the Data Dictionary (see Annex A6).

9.2.4.1 This hardness is greater than the manufacturing minimum. Some parts meeting the manufacturing specification may be rejected for this test method.

9.2.5 *Countershaft Bearing Preload*—Measure the pre-load on each of the three countershafts prior to each test as follows:

9.2.5.1 Assemble the transmission as specified in the Mack Transmission Service Manual up to and including installing the yoke on the output shaft. Rotate the transmission so that the shafts are vertical.

9.2.5.2 Remove the bearing cap from the rear cover for the first countershaft to be checked. Measure the thickness of a 0.010 in. (0.254 mm) nominal shim, and record. Add the shim to the shim pack of the shaft, and reinstall the bearing cap. Torque the bolts to 40 lb-ft to 50 lb-ft (54 N·m to 68 N·m).

9.2.5.3 Mount a dial indicator in the main transmission case, and adjust the indicator probe to measure the axial end play of the countershaft.

9.2.5.4 Using a pry bar, move the countershaft up to the end of travel. Release the lifting force, and record the total travel of the shaft. Repeat this measurement at least three times to ensure that the values are repeatable.

9.2.5.5 Mack specifications call for a preload of from 0.002 in. to 0.006 in. (0.051 mm to 0.152 mm). To accomplish this, adjust the shim pack thickness by removing shims equal to the measured end play plus 0.002 in. to 0.006 in. (0.051 mm to 0.152 mm) additional.

9.2.5.6 Repeat this procedure for the other two countershafts. Record the measurements on the form in Fig. A7.3 or an equivalent.

9.2.6 *Transmission Torque Measurement*— Rotate the transmission so that it is in the horizontal position. With the transmission in low range and dry, measure the break and turn torques by turning the output shaft clamp plate capscrew, with a torque wrench, in the normal direction of rotation. Make the measurements three times and report the average of both the break and turn values (see Fig. A7.3). Continue with the assembly of the test apparatus.

9.2.7 *Transmission Coast Down Measurement*—With the drive shaft installed but before attaching the top cover, measure the time for the countershafts to coast down from 1500 r/min to 500 r/min, as follows:

9.2.7.1 Shift the transmission into low range. Using a spray bottle charged with the next test oil, spray approximately ½ oz (15 mL) lubricant on each of the main shaft, tail shaft, and six countershaft bearings.

9.2.7.2 Start the drive motor and bring up to speed (countershaft at 1750 r/min). Turn off the motor and allow the transmission to coast down to at least 500 r/min. Electronically measure the time required for the countershafts speeds to decrease from 1500 r/min to 500 r/min using a meter capable of measuring to 0.01 s. See Table 1 for a recommendation. Repeat the coast downs until five readings have been obtained. Calculate the average of these five readings, and record the readings and their average in the appropriate spaces in Fig. A7.3.

## 10. HTCT-specific Calibration and Standardization Items

*(See Annex A2 for general calibration and standardization information)*

10.1 *Transmission and Test Stand Calibration*—Calibrate transmission and test stands by running tests on reference oils. The purposes are to:

10.1.1 Verify standardized transmission operation,

10.1.2 Document a test stand severity level, and

10.1.3 Determine the passing limit for a given transmission and test stand.

10.2 *Reference Oils*—Two reference oils have been used in the development of this test method, a high-quality (passing) and a poor-quality (failing) oil. Routine testing is conducted on the passing oil. The failing oil is used to verify that test severity is maintained when new hardware is introduced or a procedural change could affect severity or when a new stand is being calibrated for the first time. Obtain the reference oils from the ASTM TMC.

10.3 *Reference Oil Test Frequency*—The test stand calibration period is defined as six months or ten tests, whichever occurs first. It begins on the completion date of an operationally and statistically acceptable reference oil test as determined by the TMC. Any test started on or before the stand calibration expiration date is defined to have been run on a calibrated stand.

10.4 *Instrumentation Calibration*—Calibrate the following instrumentation immediately prior to each set of reference tests. Unless otherwise specified in this test method, follow the instructions provided by the manufacturers of the instruments regarding the method of calibration. In calibrating each instrument, use certified reference standards, having known values covering the range of measurements to be encountered in using this test method, and having tolerances less than those of the measurement tolerances specified in this test method. It is recommended that the calibration records be retained for a minimum of 24 months.

10.4.1 Tailshaft and counter shaft speed measurement systems,

10.4.2 Temperature sensors and measurement system,

10.4.3 Pressure sensors and measurement system, and

10.4.4 Shift time measurement system.

10.5 *Shift Time Calibration*—The shift timing system can be calibrated by using an oscillograph, or other equally precise methods, to record the air application event and the counter shaft speeds.

## 11. Operating Procedure

11.1 *System Flush and Charge:*

11.1.1 Connect all hoses so that the pump, oil heater, and transmission are connected for testing. Charge the system with 5 gal (19 L) of test oil. Turn on the pump to circulate oil through the entire system.

11.1.1.1 If the test oil is a non-reference oil, first ensure that acceptable results on the passing and failing reference oils have been obtained, and then conduct the non-reference oil test on the same hardware configuration used for the reference oil tests.

11.1.2 With the oil heater turned off, circulate the oil through the system for a minimum of 10 min.

11.1.3 Drain the flush oil by removing the drain plug on the transmission and opening the drain valve on the heater. Allow the system to drain for l0 min.

11.1.4 Replace the drain plug and charge the system with 5.25 gal (19.9 L) of test oil. Complete the assembly of the test apparatus.

11.2 *Test Operation:*

11.2.1 Set the air pressure to 90 psi (621 kPa). Start the drive motor and accelerate the tail shaft to 750 r/min with the transmission operating in low range. Turn on the oil heater.

11.2.2 Continue to operate the transmission in low operating range, not shifting, until the oil temperature is in the operating range, 250 °F ± 5 °F (121 °C ± 2.7 °C).

11.2.3 When the operating temperature is reached, turn on the automatic shifting cycler, set the cycle timer to zero, and operate under the following conditions:

| | |
|---|---|
| Tailshaft Speed | 750 r/min ± 10 r/min |
| Cycle Rate | 6 s ± 0.3 s high range |
| | 6 s ± 0.3 s low range |
| Air Pressure | 90 psi ± 2 psi (621 kPa ± 14 kPa) |
| Temperature | 250 °F ± 5 °F (121 °C ± 2.7 °C) |

11.2.4 Use the data log sheet shown in Fig. A7.4, or its equivalent, for recording all required operating conditions at least once each hour during the test.

11.2.5 Using an oscillograph and suitable pressure transducers located as shown on Fig. 6 (see Table 1 for recommended equipment), record the shift activating air pressures input shaft and countershafts speeds during at least one shift each from high to low range and low to high range, during the following periods as applicable: 30 cycles ± 20 cycles, 25 000 cycles ± 300 cycles, 50 000 cycles ± 300 cycles, 60 000 cycles ± 300 cycles, and a final recording 5000 cycles ± 300 cycles less than the average cycles to failure of the most recent five passing reference tests.

11.2.6 Examine these recordings to ensure that the range shift valve and cylinder are operating properly.

11.3 *Shut-Down Procedure:*

11.3.1 Terminate the test when the transmission experiences two unsynchronized shifts. An unsynchronized shift results in a clashing of the clutch teeth producing a loud noise (exceeding 114 dB). Alternatively, the test can be terminated after the passing limit established by the applicable specification has been achieved without a failure.

11.3.2 Record the final operating conditions, and turn off the shift cycler, oil heater, and drive motor.

11.3.3 Drain the test oil from the transmission and heater.

11.4 *Transmission Disassembly*—Disassemble the transmission as specified in the Mack Service Manual and inspect for signs of unusual wear or parts failure. Measure the clutch plates and shifter fork (as described in 9.2.4), and record the measured wear and visual condition of mating surfaces, using the forms shown in Figs. A7.1 and A7.2, or their equivalent.

## 12. Determination of Test Results

12.1 *Failure Criteria*—The number of shifting cycles to failure of synchronization is the criteria for determining the performance of the lubricant. To ensure that the lack of synchronization is not a single non-repeatable occurrence, terminate the test after two non-synchronized shifts have occurred. The passing limits are established by the specification(s) requiring this test.

12.2 *Shifter Fork Wear*—Measure shifter fork wear and report at the end of test (see Fig. A7.2).

12.3 *Test Validity Determination*—Calculate the validity of the test as described in Annex A5. The test is determined to be operationally valid if the percent deviation of critical operating parameters, the downtime during the test, and the average total cycle time are within the limits specified and defined in Annex A5.

12.4 Round test results according to Practice E29.

## 13. Report

13.1 For reference oil tests, use the standardized report form set available from the ASTM TMC. Report the non-reference oil test results on these same forms if the results are intended to be submitted as candidate oil results against a specification.

13.1.1 Fill out the report forms according to the formats shown in the data dictionary.

13.1.2 Transmit results to the TMC within 5 working days of test completion.

13.1.3 Transmit the results electronically as described in the ASTM Data Communications Committee Test Report Transmission Model (Section 2—Flat File Transmission Format) available from the ASTM TMC. Upload files via the TMC's website.

13.2 Report all reference oil test results, whether aborted, invalidated, or successfully completed, to the TMC.

13.3 Deviations from Test Operational Limits—Report all deviations from specified test operational limits

13.4 Precision of Reported Units—Use the Practice E29 rounding off method for critical pass/fail test result data. Report the data to the same precision as indicated in data dictionary.

13.5 In the space provided, note the time, date, test hour, and duration of any shutdown or offtest condition. Document the outcome of all prior reference oil tests from the current calibration sequence that were operationally or statistically invalid.

13.6 If a calibration period is extended beyond the normal calibration period length, make a note in the comment section and attach a written confirmation of the granted extension from the TMC to the test report. List the outcomes of previous runs that may need to be considered as part of the extension in the comment section.

13.7 Include in the test report a plot of shift time scaling the Y-axis from 0 s to 6 s. Plot at least one data point per test hour along the X-axis.

## 14. Precision and Bias

14.1 *Test Precision-Reference Oils*—Test precision is established on the basis of operationally valid reference oil test

results monitored by the TMC. The data are reviewed annually by the HTCT Surveillance Panel. Contact the ASTM TMC for current industry data. (See Table 5.)

14.2 *Intermediate Precision Conditions*—Conditions where test results are obtained with the same test method using the same oil, with changing conditions such as operators, measuring equipment, test stands, test engines, and time.

NOTE 2—Intermediate precision is the appropriate term for this test method, rather than repeatability, which defines more rigorous within-laboratory conditions.

14.2.1 *Intermediate Precision Limit* (i.p.)—The difference between two results obtained under intermediate precision conditions that would, in the long run, in the normal and correct conduct of the test method, exceed the values shown in Table 5 in only one case in twenty. When only a single test result is available, the intermediate precision limit can be used to calculate a range (test result ± intermediate precision limit) outside of which a second test result would be expected to fall about one time in twenty.

14.3 *Reproducibility Conditions*—Conditions where test results are obtained with the same test method using the same test oil in different laboratories with different operators using different equipment.

14.3.1 *Reproducibility Limit* (R)—The difference between two results obtained under reproducibility conditions that would, in the long run, in the normal and correct conduct of the test method, exceed the values shown in Table 5 in only one case in twenty. When only a single test result is available, the reproducibility limit can be used to calculate a range (test result ± reproducibility limit) outside of which a second test result would be expected to fall about one time in twenty.

**TABLE 5 Reference Oil Precision[A]**

| Variable | Intermediate Precision | | Reproducibility | |
|---|---|---|---|---|
| | $S_{i.p.}$[B] | i.p.[C] | $S_R$[B] | R[C] |
| Cycles to Fail | 9131 | 25567 | 9131 | 25567 |

[A] These statistics are based on results obtained on TMC Reference Oils 151-2 and 151-3 with Configuration 2 hardware over the period from Jan. 25, 1999 through March 19, 2005.
[B] S = standard deviation.
[C] This value is obtained by multiplying the standard deviation by 2.8.

14.4 This procedure has no bias since the ability of the fluid to maintain synchronization of gears during shifting is defined only in terms of this test method.

## 15. Keywords

15.1 cyclic transmission test; forkwear; manual transmission lubricants; shifting synchronization; shift time; thermal stability; total cycle time

## ANNEXES

**(Mandatory Information)**

### A1. ASTM TEST MONITORING CENTER ORGANIZATION

A1.1 *Nature and Functions of the ASTM Test Monitoring Center (TMC)*—The TMC is a non profit organization located in Pittsburgh, Pennsylvania and is staffed to: administer engineering studies; conduct laboratory inspections; perform statistical analyses of reference oil test data; blend, store, and ship reference oils; and provide the associated administrative functions to maintain the referencing calibration program for various lubricant tests as directed by ASTM Subcommittee D02.B0 and the ASTM Executive Committee. The TMC coordinates its activities with the test sponsors, the test developers, the surveillance panels, and the testing laboratories. Contact TMC through the TMC Director at:
ASTM Test Monitoring Center
6555 Penn Avenue
Pittsburgh, PA 15206–4489
www.astmtmc.cmu.edu

A1.2 *Rules of Operation of the ASTM TMC*—The TMC operates in accordance with the ASTM Charter, the ASTM Bylaws, the Regulations Governing ASTM Technical Committees, the Bylaws Governing ASTM Committee D02, and the Rules and Regulations Governing the ASTM Test Monitoring System.

A1.3 *Management of the ASTM TMC*—The management of the Test Monitoring System is vested in the Executive Committee elected by Subcommittee D02.B0. The Executive Committee selects the TMC Director who is responsible for directing the activities of the TMC.

A1.4 *Operating Income of the ASTM TMC*—The TMC operating income is obtained from fees levied on the reference oils supplied and on the calibration tests conducted. Fee schedules are established by the Executive Committee and reviewed by Subcommittee D02.B0.

## A2. ASTM TEST MONITORING CENTER: CALIBRATION PROCEDURES

A2.1 *Reference Oils*—These oils are formulated or selected to represent specific chemical, or performance levels, or both. They are usually supplied directly to a testing laboratory under code numbers to ensure that the laboratory is not influenced by prior knowledge of acceptable results in assessing test results. The TMC determines the specific reference oil the laboratory shall test.

A2.1.1 *Reference Oil Data Reporting*—Test laboratories that receive reference oils for stand calibration shall submit data to the TMC on every sample of reference oil they receive. If a shipment contains any missing or damaged samples, the laboratory shall notify the TMC immediately.

A2.2 *Calibration Testing*:

A2.2.1 Full scale calibration testing shall be conducted at regular intervals. These full scale tests are conducted using coded reference oils supplied by the TMC. It is a laboratory's responsibility to keep the onsite reference oil inventory at or above the minimum level specified by the TMC test engineers.

A2.2.2 *Test Stands Used for Non Standard Tests*—If a non standard test is conducted on a previously calibrated test stand, the laboratory shall conduct a reference oil test on that stand to demonstrate that it continues to be calibrated, prior to running standard tests.

A2.3 *Reference Oil Storage*—Store reference oils under cover in locations where the ambient temperature is between –10 °C and +50 °C.

A2.4 *Analysis of Reference Oil*—Unless specifically authorized by the TMC, do not analyze TMC reference oils, either physically or chemically. Do not resell ASTM reference oils or supply them to other laboratories without the approval of the TMC. The reference oils are supplied only for the intended purpose of obtaining calibration under the ASTM Test Monitoring System. Any unauthorized use is strictly forbidden. The testing laboratory tacitly agrees to use the TMC reference oils exclusively in accordance with the TMC's published Policies for Use and Analysis of ASTM Reference Oils, and to run and report the reference oil test results according to TMC guidelines. Additional policies for the use and analysis of ASTM Reference Oils are available from the TMC.

A2.5 *Conducting a Reference Oil Test*—When laboratory personnel are ready to run a reference calibration test, they shall request an oil code via the TMC website.

A2.6 *Reporting Reference Oil Test Results*—Upon completion of the reference oil test, the test laboratory transmits the data electronically to the TMC, as described in 13.1.3. The TMC reviews the data and contacts the laboratory engineer to report the laboratory's calibration status. All reference oil test results, whether aborted, invalidated, or successfully completed, shall be reported to the TMC

A2.6.1 All deviations from the specified test method shall be reported.

## A3. ASTM TEST MONITORING CENTER: MAINTENANCE ACTIVITIES

A3.1 *Special Reference Oil Tests*—To ensure continuous severity and precision monitoring, calibration tests are conducted periodically throughout the year. Occasionally, the majority or even all of the industry's test stands will conduct calibration tests at roughly the same time. This could result in an unacceptably large time frame when very few calibration tests are conducted. The TMC can shorten or extend calibration periods as needed to provide a consistent flow of reference oil test data. Adjustments to calibration periods are made such that laboratories incur no net loss or gain in calibration status.

A3.2 *Special Use of the Reference Oil Calibration System*—The surveillance panel has the option to use the reference oil system to evaluate changes that have potential impact on test severity and precision. This option is only taken when a program of donated tests is not feasible. The surveillance panel and the TMC shall develop a detailed plan for the test program. This plan requires all reference oil tests in the program to be completed as close to the same time as possible, so that no laboratory/stand calibration status is left pending for an excessive length of time. In order to maintain the integrity of the reference oil monitoring system, each reference oil test is conducted so as to be interpretable for stand calibration. To facilitate the required test scheduling, the surveillance panel may direct the TMC to lengthen and shorten reference oil calibration periods within laboratories such that the laboratories incur no net loss or gain in calibration status. To ensure accurate stand, or laboratory, or both severity assessments, conduct non reference oil tests the same as reference oil tests.

A3.3 *Donated Reference Oil Test Programs*—The surveillance panel is charged with maintaining effective reference oil test severity and precision monitoring. During times of new parts introductions, new or re blended reference oil additions,

and procedural revisions, it may be necessary to evaluate the possible effects on severity and precision levels. The surveillance panel may choose to conduct a program of donated reference oil tests in those laboratories participating in the monitoring system, in order to quantify the effect of a particular change on severity and precision. Typically, the surveillance panel requests its panel members to volunteer enough reference oil test results to create a robust data set. Broad laboratory participation is needed to provide a representative sampling of the industry. To ensure the quality of the data obtained, donated tests are conducted on calibrated test stands. The surveillance panel shall arrange an appropriate number of donated tests and ensure completion of the test program in a timely manner.

A3.4 *Intervals Between Reference Oil Tests*—Under special circumstances, such as extended downtime caused by industry wide parts or fuel shortages, the TMC may extend the intervals between reference oil tests. Such extensions shall not exceed one regular calibration period.

A3.5 *Introducing New Reference Oils*—Reference oils produce various results. When new reference oils are selected, participating laboratories will be requested to conduct their share of tests to enable the TMC to recommend industry test targets. ASTM surveillance panels require a minimum number of tests to establish the industry test targets for new reference oils.

A3.6 *TMC Information Letters*—Occasionally it is necessary to revise the test method, and notify the test laboratories of the change, prior to consideration of the revision by Subcommittee D02.B0. In such a case, the TMC issues an Information Letter. Information Letters are balloted semi annually by Subcommittee D02.B0, and subsequently by D02. By this means, the Society due process procedures are applied to these Information Letters.

A3.6.1 *Issuing Authority*—The authority to issue an Information Letter differs according to its nature. In the case of an Information Letter concerning a part number change which does not affect test results, the TMC is authorized to issue such a letter. Long term studies by the surveillance panel to improve the test procedure through improved operation and hardware control may result in the issuance of an Information Letter. If obvious procedural items affectingtest results need immediate attention, the test sponsor and the TMC issue an Information Letter and present the background and data supporting that action to the surveillance panel for approval prior to the semiannual Subcommittee D02.B0 meeting.

A3.7 *TMC Memoranda*—In addition to the Information Letters, supplementary memoranda are issued. These are developed by the TMC and distributed to the appropriate surveillance panel and participating laboratories. They convey such information as batch approvals for test parts or materials, clarification of the test procedure, notes and suggestions of the collection and analysis of special data that the TMC may request, or for any other pertinent matters having no direct effect on the test performance, results, or precision and bias.

## A4. ASTM TEST MONITORING CENTER: RELATED INFORMATION

A4.1 *New Laboratories*—Laboratories wishing to become part of the ASTM Test Monitoring System will be requested to conduct reference oil tests to ensure that the laboratory is using the proper testing techniques. Information concerning fees, laboratory inspection, reagents, testing practices, appropriate committee membership, and rater training can be obtained by contacting the TMC Director.

A4.2 *Information Letters*—COTCO Approval—Authority for the issuance of Information Letters was given by the committee on Technical Committee Operations in 1984, as follows: “COTCO recognizes that D02 has a unique and complex situation. The use of Information Letters is approved providing each letter contains a disclaimer to the affect that such has not obtained ASTM consensus. These Information Letters should be moved to such consensus as rapidly as possible.”

A4.3 *Precision Data*—The TMC determines the precision of test methods by analyzing results of calibration tests conducted on reference oils. Precision data are updated regularly. Current precision data can be obtained from the TMC.

## A5. TEST VALIDITY CALCULATIONS AND LIMITS

A5.1 For a test to be operationally valid it shall not exceed the limits on unscheduled downtime, and deviation from operating parameters and average cycle time as follows.

A5.1.1 *Downtime Limits:*

A5.1.1.1 *During Warm-up*—No limit on number of occurrences nor length of time down.

A5.1.1.2 During test (regardless of length of test):

*(1)* Occurrences less than 15-min duration—not counted, but reported.

*(2)* Occurrences, over 15-min duration—maximum of three.

*(3)* Total time down, no occurrence >16 h.

A5.1.2 *Deviation from Test Operating Parameters:*

A5.1.2.1 The following operating parameters are considered critical to test validity.

*(1)* Oil sump temperature,

*(2)* Shift air supply pressure, and

*(3)* Tailshaft speed.

A5.1.2.2 Calculate the percent deviation as follows:

$$\text{percent out} = \sum_{i=1}^{n}\left(\frac{Mi}{0.5R}\times\frac{Ti}{D}\right)\times 100 \qquad \text{(A5.1)}$$

where:

$Mi$ = magnitude of test parameter out from specification limit at occurrence, $i$,

$R$ = test parameter specification range,

$Ti$ = length of time the test parameter was outside of specification range at occurrence, $i$, ($Ti$ is assumed to be no less than the recorded data-acquisition frequency unless supplemental readings are documented), and

$D$ = test or test phase duration in same units as $Ti$.

NOTE A5.1—A reading out of specification using once-per-hour data recording is considered to be out for the full hour, unless otherwise documented.

A5.1.2.3 The deviation percentages for the critical operating parameters shall not exceed:

| | Limits, % |
|---|---|
| Oil sump temperature | 2.0 |
| Shift air supply pressure | 2.0 |
| Tailshaft speed | 5.0 |

A5.1.2.4 As an example, assume:

*(1)* Test length—200 h,

*(2)* Oil sump temperature—250 °F ± 5 °F (121 °C ± 2.8 °C): 259 °F (126 °C) for 1 h,

*(3)* Oil sump temperature—250 °F ± 5 °F (121 °C ± 2.8 °C): 244 °F (118 °C) for 6 h,

*(4)* Shift air supply press—90 psi ± 2 psi (620 kPa ± 14 kPa): 93 psi (641 kPa) for 2 h, and

*(5)* Tailshaft speed—750 r/min ± 10 r/min. No out of specification readings.

A5.1.2.5 *Oil Temperature:*

$$\frac{4}{5}\times\frac{1}{200}\times 100 = 0.40\,\%\ \ \frac{1}{5}\times\frac{6}{200} = 0.60\,\% \qquad \text{(A5.2)}$$

$$\text{Total Deviation Percentage} = 0.40\,\% + 0.60\,\% = 1.00\,\%$$

A5.1.2.6 *Air Pressure:*

$$\frac{1}{2}\times\frac{2}{200}\times 100 = 0.50\,\% \qquad \text{(A5.3)}$$

A5.1.3 *Average Cycle Time:*

A5.1.3.1 The average total cycle time for a complete test shall be within 12 s ± 0.6 s for the test to be considered operationally valid.

$$\text{Average Total Cycle Time} = \frac{3600\times\text{total operating hours of test}}{\text{total cycles of test}} \qquad \text{(A5.4)}$$

A5.1.3.2 The total cycle time is the time to complete shifts from low range to high range and back to low range—nominally 12 s.

## A6. HTCT TEST REPORT FORMS AND DATA DICTIONARY

A6.1 The required report forms and data dictionary are available on the ASTM Test Monitoring Center web page at http://www.astmtmc.cmu.edu/, or they can be obtained in hardcopy format from the TMC.

| | |
|---|---|
| Form 0 | Test Report Cover |
| Form 1 | Test Results Summary Page |
| Form 2 | Test Conditions and Measurements Summary |
| Form 3 | Downtime and Comments Sheet |
| Form 4 | Shift Graphs |
| Form 5 | Shift Time Graphs |

## A7. MANUAL TRANSMISSION CYCLIC DURABILITY TEST PARTS INSPECTION AND WEAR MEASUREMENTS

A7.1 Figs. A7.1-A7.4 are examples of the necessary report forms.

**(Use these forms to document all required measurements. Some of these measurements may also appear on Figures contained in A7.)**

Customer Oil Code _____ Test No. _____ EOT Date _____

| | Friction Disk Wear (in.) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Before Test | | | | After Test | | | | |
| Position | 1 | 2 | 3 | Average | 1 | 2 | 3 | Average | Average Wear |
| Plate 1 | | | | | | | | | |
| Plate 2 | | | | | | | | | |
| Plate 3 | | | | | | | | | |
| Plate 4 | | | | | | | | | |
| Plate 5 | | | | | | | | | |
| Plate 6 | | | | | | | | | |
| Plate 7 | | | | | | | | | |
| Plate 8 | | | | | | | | | |

| Range Fork Pre-test Hardness | |
|---|---|
| Location | Hardness, $R_C$ |
| Front Left | |
| Front Right | |
| Rear Left | |
| Rear Right | |
| | |
| Range Fork Visual Inspection | |
| Fork Number | |
| Ridging of Pad Surfaces after Test | |
| Left Pad | |
| Right Pad | |

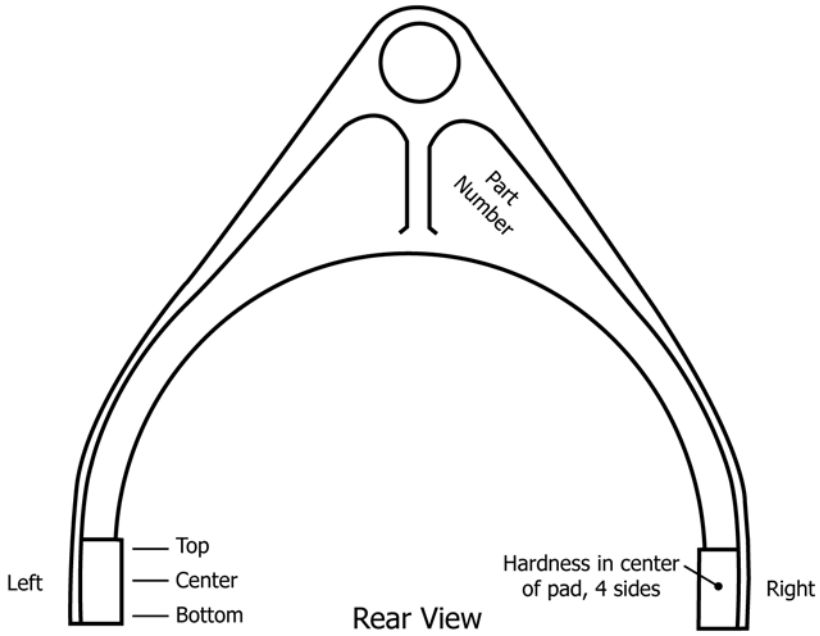
Note 1—Use one of the following terms to describe pad surface—none, light, medium, or heavy

**FIG. A7.1 Typical Form for Recording Friction Disk Wear**

Customer Oil Code _____ Test No. _____ EOT Date _____

Cycles at Wear Measurement _____ EOT Cycles _____

| Fork Pad Thickness Wear Measurements (in.) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Left[1] | | | | Right[1] | | | |
| | Top | Center | Bottom | **Average** | **Top** | **Center** | **Bottom** | **Average** |
| Pre-test | | | | | | | | |
| Post-test | | | | | | | | |
| Left Fork Pad Wear | | | | | Right Fork Pad Wear | | | |




NOTE 1—Side of fork with forged angle and part number is the rear side. View the fork from this side to identify the pads as left and right.

NOTE 2—Post-test wear measurement may be made at EOT or at passing cycles. See "Cycles at Wear Measurement" for the point at which the post-test wear measurement was taken.

**FIG. A7.2 Typical Form for Recording Fork Pad Thickness Wear Measurements**

Customer Oil Code _____ Test No. _____ EOT Date _____

| Preload Measurements (in.) | | | |
|---|---|---|---|
| | Countershaft Number | | |
| | 1A | 2A | 3A |
| Preload Measurement | | | |

| Pre-test Transmission Break and Turn Torque | | |
|---|---|---|
| | **Break** | **Turn** |
| Torque, lbf-ft (low range) | | |

| Pre-test Countershafts Coast Down Time | |
|---|---|
| Time 1, Coasting from 1500 to 500 r/min, s | |
| Time 2, Coasting from 1500 to 500 r/min, s | |
| Time 3, Coasting from 1500 to 500 r/min, s | |
| Time 4, Coasting from 1500 to 500 r/min, s | |
| Time 5, Coasting from 1500 to 500 r/min, s | |
| Average Time, s<br>Coasting from 1500 to 500 r/min | |

**FIG. A7.3 Typical Form for Recording Preload Measurements**

Lab Oil Code _____ Customer Oil Code _____ Test No._____ Page No. ____

| | | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Date | | 1 | | | | | | | | | | |
| Observer | | 2 | | | | | | | | | | |
| Time | | 3 | | | | | | | | | | |
| Hours on Test | | 4 | | | | | | | | | | |
| Hour Meter | Record | 5 | | | | | | | | | | |
| Cycles | Record | 6 | | | | | | | | | | |
| Cycle Time (12 s) | | 7 | | | | | | | | | | |
| Tailshaft, r/min | 750 ± 10 | 8 | | | | | | | | | | |
| Counter haft, r/min | HI | 9 | | | | | | | | | | |
| Countershaft, r/min | LO | 10 | | | | | | | | | | |
| Trans Oil Sump, °F | 250 ± 5 (121 °C ± 3 °C) | 11 | | | | | | | | | | |
| Oil Heater Out, °F | Record | 12 | | | | | | | | | | |
| Lock-up Time, s | | 13 | | | | | | | | | | |
| Air Pressure, psig | 90 ± 2 (620 kPa ± 14 kPa) | 14 | | | | | | | | | | |
| Oil Pressure, psig | 20 ± 2 (138 kPa ± 14 kPa) | 15 | | | | | | | | | | |
| | | | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
| Date | | 1 | | | | | | | | | | |
| Observer | | 2 | | | | | | | | | | |
| Time | | 3 | | | | | | | | | | |
| Hours on Test | | 4 | | | | | | | | | | |
| Hour Meter | Record | 5 | | | | | | | | | | |
| Cycles | Record | 6 | | | | | | | | | | |
| Cycle Time (12 s) | | 7 | | | | | | | | | | |
| Tailshaft, r/min | 750 ± 10 | 8 | | | | | | | | | | |
| Counter haft, r/min | HI | 9 | | | | | | | | | | |
| Countershaft, r/min | LO | 10 | | | | | | | | | | |
| Trans Oil Sump, °F | 250 ± 5 (121 °C ± 3 °C) | 11 | | | | | | | | | | |
| Oil Heater Out, °F | Record | 12 | | | | | | | | | | |
| Lock-up Time, s | | 13 | | | | | | | | | | |
| Air Pressure, psig | 90 ± 2 (620 kPa ± 14 kPa) | 14 | | | | | | | | | | |
| Oil Pressure, psig | 20 ± 2 (138 kPa ± 14 kPa) | 15 | | | | | | | | | | |

NOTE 1—Log all shutdowns and repairs on the back of the log sheet.

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**FIG. A7.4 Data Log Sheet**

## SUMMARY OF CHANGES

Subcommittee D02.B0 has identified the location of selected changes to this standard since the last issue (D5579 – 15) that may impact the use of this standard. (Approved April 1, 2016.)

*(1)* Subsection 10.3, wording revised to clarify frequency of reference oil testing.

Subcommittee D02.B0 has identified the location of selected changes to this standard since the last issue (D5579 – 14) that may impact the use of this standard. (Approved April 1, 2015.)

*(1)* The purpose of the following changes was to describe more clearly the role of the Test Monitoring Center.
*(2)* Added new Introduction.
*(3)* Deleted former subsections 10.3.1 through 10.3.1.4, and 10.6.
*(4)* Rewrote Section 13.
*(5)* Added new Annex A1 – Annex A4; renumbered subsequent Annex sections.