

SAE *International*

**SURFACE
VEHICLE
RECOMMENDED
PRACTICE**

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Manual Transmissions and Transaxle High-speed Lubrication, Unbalance, and Seizure Evaluation

RATIONALE

The technical report covers technology, products, or processes which are mature and not likely to change in the foreseeable future.

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Foreword—With the globalization of the automotive supply industry, there is a growing need for a common evaluation method for transmissions and transaxles during high-speed operation.

1. **Scope**—It is anticipated that this SAE Recommended Practice will be only one step in a comprehensive evaluation of the vehicle/transmission application. This document alone is not adequate “due care” to insure against high-speed seizure or other high-speed problems.

The notes printed in bold print throughout the practice convey important information about the test itself or the results and should be considered carefully.

All references to transmissions also apply to transaxles, except for the unbalance evaluation which applies only to rear-wheel-drive transmissions with propeller shaft output.

- 1.1 **Purpose**—The overall objective of the high-speed spin, high-speed unbalance, and lubrication practice is to evaluate manual transmissions which may be installed in vehicles sold into countries where high vehicle speeds are permitted. The document is segmented into four parts which include:

- 5.1 Pretest Lubrication Evaluation
- 5.2 Pre-high-speed spin test run-in
- 5.3 High-speed spin test
- 5.4 High-speed-output shaft unbalance

2. **References**—There are no referenced publications specified herein.

3. **Definitions**

- 3.1 **Manual Transmission**—The assembly exclusive of the clutch which is driven by the engine and used, through manual interface, to effect a ratio change in transmitting power to the final drive system or half shafts (in the case of a transaxle).

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4. **Equipment**

- 4.1 A simple spin test fixture with a variable speed drive can be used for the lubrication test.
- 4.2 A dynamometer test system capable of driving and absorbing the transmission output torque is required for the pre-test run-in and high-speed spin test.
- 4.3 A reinforced spin test fixture or bed plate mounted dynamometer should be used for the unbalance test. See the bold print notes for safety precautions.
- 4.4 The torque and speed requirement of the equipment will be dictated by the application. See the test procedure for methods of determining. Normal equipment accuracy will be adequate.

5. **Test Procedures**

5.1 **Pre-High-Speed Spin Test Lubrication Evaluation**

- 5.1.1 **OBJECTIVE**—Evaluate and determine the adequacy of the internal lubrication of journal, bearings, and wear surfaces of a manual transmission prior to a high-speed spin test.
- 5.1.2 **NOTE**—**The test transmission used for the lubrication study must be representative of the design but will be modified to facilitate the completion of the lubrication study. It is suggested that only new units be used for the actual high-speed spin test.**
- 5.1.3 **NOTE**—**The pretest lubrication evaluation can be eliminated if the transmission has been evaluated as part of a comprehensive evaluation of its lubrication.**
- 5.1.4 **NOTE**—**It is suggested that transmission have a rating of 2 (see suggested ratings Step 5.1.5.14) or better on all journals, bearing, or surfaces that have a relative speed before proceeding to the high-speed spin test portion of the practice.**
- 5.1.5 **TEST DETAILS**
 - 5.1.5.1 Disassemble the test transmission and thoroughly clean all components. All running clearances and end plays should be within design tolerances (see Step 5.1.5.10 for consideration of press fits, etc.).
 - 5.1.5.2 Reassemble the test transmission, oiling all bearings and journals with a clear motor oil.
 - 5.1.5.3 Prepare a quantity of oil equal to the intended lubricant capacity. Use a premium grade 5W-30 engine oil which is dyed blue with a coloring agent in ratio of 1 to 200, dye to engine oil by volume. A premium grade engine oil is specified because it mixes readily with the recommended oil dyes and easily displaces the clear pre-lube oil. Viscosity is not an issue for the test. Cold or high viscosity operation should be examined separately. Dye such as listed as follows or equivalent can be used.
 - 5.1.5.3.1 **Suggested Oil Dye Sources**
 - 5.1.5.3.1.1 **Keystone Aniline Corporation**
2501 West Fulton
Chicago, IL 60612
(312) 666-2015
Trade Name: Liquid Oil Blue HF

- 5.1.5.3.1.2 Morton International
Specialty Chemicals Grp.
333 West Wacker Drive
Chicago, IL 60606-1292
(312) 807-2000
Trade Name: Automate Blue 8
- 5.1.5.4 Install the test transmission on a suitable test stand capable of driving the transmission input at the sequence RPM and position the unit at the vehicle installed attitude. Cap the output shaft or axle drive outlets. As a safety precaution, the caps should be securely retained to prevent their coming loose during the test.
- 5.1.5.5 A funnel on the fill opening or some other means of quickly filling the test transmission with lubricant should be provided in the test transmission.
- 5.1.5.6 When all is ready, start the test stand drive and rapidly bring the input speed to the correct test sequence RPM. The test oil and test unit start at room temperature.
- 5.1.5.7 Rapidly pour the measured sample of test oil into the test transmission and start to time the test after all the oil is in the test unit.
- 5.1.5.8 *Test Sequence*—(See Table 1.)

TABLE 1—TEST SEQUENCE

Input RPM	Gear	Run Time
1000	Top	5 Min Each
2000	Top	5 Min Each
3000	Top	5 Min Each
4000	Top	5 Min Each
5000	Top	5 Min Each
6000 ⁽¹⁾	Top	5 Min Each
7000 ⁽¹⁾	Top	5 Min Each

1. Or Maximum Transmission RPM Limit

- 5.1.5.9 After 5 min, stop the test. Drain the test lubricant which can be saved and used again. Do this as the drive coasts to a stop.
- 5.1.5.10 Attempt to keep the test unit in the vehicle installed position while it is rapidly being disassembled. The rapid disassembly is important as a true reading of the lubrication flow must be observed before the lubricant has a chance to migrate away from the surfaces under observation. Therefore, press fits and other difficult disassembly procedures should be modified to speed the test unit disassembly.
- 5.1.5.11 All journals, bearing, and other wear surfaces, including synchronizer surfaces, should be inspected for the presence of the dyed oil.
- 5.1.5.12 Suitable data sheets should be prepared in advance representing the test transmission configuration. Graphic and tabulated sheets can be extremely helpful (a sample sheet is included at the end of the text).
- 5.1.5.13 The relative quantity of the lubricant present at each journal, bearing, and wear surface should be rated and recorded on the appropriate data sheets. A suggested rating system is as follows in Table 2:

TABLE 2—SUGGESTED RATING SYSTEM

Rating		
0	None	None of the dyed oil present.
1	Trace	Very light coloration of surface being rated.
2	Trace-Moderate	Between trace and moderate.
3	Moderate	Moderate amount of dyed oil present over entire surface but still some of the pre-assembly oil may be present as well.
4	Moderate-Heavy	Between moderate and heavy.
5	Heavy	Surface being evaluated is completely covered with dyed oil, little if any of the pre-assembly oil is present.

5.1.5.13.1 (See Figure 1.)

5.1.5.14 Repeat sequence in next lower gear.

5.1.5.15 Complete the test sequence and see Note in 5.1.4.

5.2 Pre-High-Speed Spin Test Run-In

5.2.1 **OBJECTIVE**—Normalized and remove manufacturing burrs, etc., from a transmission in preparation for a high-speed spin test.

5.2.2 **NOTE**—A thermocouple or other temperature measuring means should be installed in the test transmission sump. A significant temperature rise during the run-in and actual high-speed spin test should be noted and the test unit inspected for incipient failure.

5.2.3 **NOTE**—Units subjected to the High-Speed Spin test including the run-in should be design intent with the recommended quantity and type of lubricant.

5.2.4 **NOTE**—A disconnecting or shearing device between the test stand and the test transmission is recommended to prevent damage to the test equipment and to minimize damage to the test transmission in the event of failure.

5.2.5 **RUN-IN SEQUENCE**—(See Table 3.)

TABLE 3—RUN-IN SEQUENCE

Gear	% Rated Torque ⁽¹⁾	Input RPM ⁽²⁾	Time In Gear (Min)	Total Accum. Time (HR:30)
Highest	20%	25%	:30	:30
Next Gear	20%	25%	:30	1:00
Next Gear	20%	50%	:30	1:30
:	:	:	:	:
Lowest	:	:	:	n ⁽¹⁾ :30
Reverse	:	:	:	((n+1) ⁽¹⁾ :30)

1. This is a percent of the full rated torque capacity. This may not be the same as the torque used for the actual spin test. See note about test facilities and torque capabilities. It may be necessary to eliminate the input torque provision.

2. See RPM rating discussion in 5.3.4.

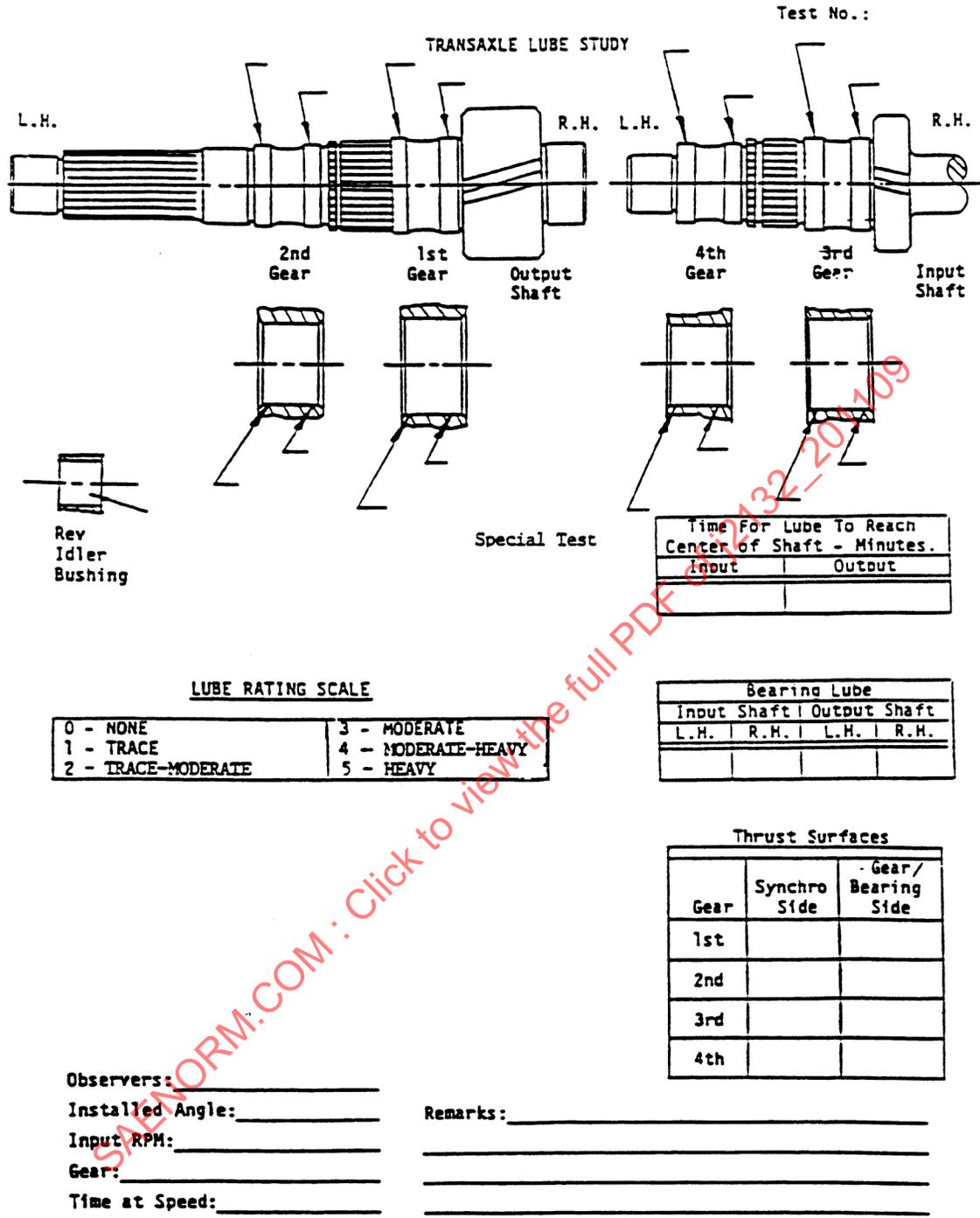


FIGURE 1—SAMPLE DATA SHEET