



Test Monitoring Center

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L-42 Information Letter No. 03-2
Sequence No. 16
April 15, 2003

ASTM consensus has not yet been obtained on this information letter. An appropriate ASTM ballot will be issued in order to achieve such consensus.

TO: L-42 Mailing List

SUBJECT: 1. Non-interpretable Tests
2. Complete L-42 Test Procedure

1. At the April 8, 2003 L-42 Surveillance Panel meeting, the panel approved a motion that any non-reference oil test that has not been run in a calibrated test stand and/or not conducted on approved hardware shall be considered non-interpretable. The cover page of the test report shall indicate that the test is non-interpretable and has not been conducted in a valid manner in accordance with the test procedure. A new Section 6.2 has been added to the L-42 test procedure (STP 512A). This change is effective the date of this information letter.

2. At the April 8, 2003 L-42 Surveillance Panel meeting, the panel approved a motion to issue a complete L-42 test procedure current through this information letter. The complete test procedure is attached and is effective the date of this information letter.

Kevin Layton
Chairman
L-42 Surveillance Panel

John L. Zalar
Administrator
ASTM Test Monitoring Center

Attachment

c: ftp://ftp.astmtmc.cmu.edu/docs/gears/l42/procedure_and_ils/il03-2.pdf

Distribution: Email

L-42 TEST PROCEDURE
(STP 512A)

(Revision 04/14/03 updated with Information Letter 03-2)

1. SCOPE

- 1.1 This test method is used for determining the anti-scoring properties of gear lubricants under high-speed and shock conditions.

CAUTION—This test method may involve hazardous materials, operations, and equipment. This test method does not purport to address all of the safety problems associated with its use. It is the responsibility of the user of this test method to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.

2. SAMPLE

- 2.1 Approximately 0.5 gal. (1.9 L) of gear lubricant to be tested.

3. APPARATUS

- 3.1 Test Unit—The test unit shall consist of a Spicer Model 44-1 rear axle, 45 to 11 ratio, uncoated gears approved by the L-42 Surveillance Panel (Model No. 044AA-100-1). No change in factory adjustments shall be made.

NOTE 2—When ordering, specify a “Spicer rear axle for L-42 testing; ring pinion ratio, 45:11; no surface treatment.”

3.1.1 Rear Cover Plate—The standard cover plate of the test unit shall be modified to provide a thermocouple mounting as shown in Fig. 1.

3.1.2 Axle Shafts—Ford axle shafts (Dana Part No. 26762-14X) shall be used with this test method.

3.2 The test unit shall be mounted and secured in place with the fixtures supplied with the standardized axle supports manufactured by Southwest Research Institute and shown in Fig. 2.

3.3 Temperature Control—The test axle housing shall include a means of maintaining the lubricant at a specified temperature. This shall include a thermocouple, a temperature recording instrument and a cooling method.

- 3.3.1 Thermocouple—The thermocouple shall be installed in the rear cover plate such that the tip is approximately 3/8 in. (9.5 mm) from the crest of the teeth and approximately on the centerline of the ring gear.
- 3.3.2 Temperature recording instrument—The temperature recording instrument shall continuously record the temperature of the lubricant throughout the test.
- 3.3.3 Cooling—A suitable tube shall be used to distribute water over the rear cover plate and/or housing. The water control valve shall start and stop the flow of water and shall be actuated through the temperature recording instrument (see Fig. 1).
- 3.4 Torque Measuring—The test equipment shall include a means for measuring the load applied to the test unit. It shall consist of the following:
- 3.4.1 Torque Meter—A Himmelstein inline torque meter Model numbers MCRT28061T(1-4)CNZ, MCRT28061T(1-4)NNZ, MCRT2661TN(1-4)NZ, and MCRT2661TC(1-4)NZ with a range of 10,000 lb•in shall be installed to measure pinion torque. Refer to Figures 6, 7, and 8.
- 3.4.2 Signal Conditioning—A Himmelstein Models 701 or 711 strain gage conditioner shall be used for signal conditioning. The low pass cut-off frequency shall be set at 10Hz. No additional hardware or software filtering is allowed.
- 3.4.3 Dynamometers—Two axle dynamometers (Midwest Dynamic, Model 3232 or equivalent) with suitable control equipment shall be used. The suggested minimum average inertia loads are as follows: Coast Side Load, 950 lb•ft (1287.3 N•m); Drive Side Load, 1100 lb•ft (1490.5 N•m). The minimum average peak torque loads suggested are Coast Side Load, 1600 lb•ft (2168 N•m); Drive Side Load, 2300 lb•ft (3116.5 N•m). Test torques may require modification for different gear batch approvals.

NOTE 3—The Midwest dynamometer has a 0.050 in. (1.27 mm) air gap. Its moment of inertia is 1731 in•lb. sec², or 4640 lb•ft² (7428.6 kg/m²).

- 3.5 Power Source—(All parts are available through local General Motors dealers.) The power source shall include:

- 3.5.1 Chevrolet LS-9, 350 in.³ (573 m³) truck engine (Part No. 467377)—The engine shall be mounted on suitable stands, supported at three points by flexible mounts, at front, using normal motor castings, and at the rear of the transmission case. The engine ignition timing shall be adjusted in accordance with manufacturer's specifications. The carburetor idle speed adjustment shall be set so that the engine will stall when the hand throttle is closed and the transmission is in neutral.
- 3.5.2 Four Barrel Carburetor—Rochester Quadrajet. Part No. 17057213.
- 3.5.3 Intake Manifold—Part No. 346250 GM.
- 3.5.4 Camshaft—Part No. 346250 GM.
- 3.5.5 Heads—Part No. 14034808 GM (Group 269).
- 3.5.6 Valve Springs—Intake—6263796 GM, Exhaust—3911068 GM.
- 3.5.7 Clutch Disk—Part No. 3836011 GM.
- 3.5.8 Pressure Plate—Part No. 3837155 GM.
- 3.5.9 Bell Housing—Part No. 460486 GM.
- 3.6 Four Speed Truck Transmission (M-20 GM)
- 3.7 Drive Shaft—Shelby welded steel tubing, 3.5 in. (88.9 mm), OD, 0.093 in. (2.36 mm) wall thickness, 58.5 in. (1486 mm) long from end of spline to eye of U-joint, dynamically balanced up to 5000 rpm.
 - 3.7.1 U-Joint Flange—Part No. 591700 (U-Joint—Spicer 5-200X)
 - 3.7.2 U-Joint Yoke—Part No. 605056 (U-Joint—Spicer 5-178X)
- 3.8 Throttle Actuator—An air actuated device assembled as shown in the schematic drawing, Fig. 3, may be used for regulated actuation of the throttle. This should include:
 - 3.8.1 Honeywell NP-909A-1041 Single Acting Air Cylinder with Spring Return.
 - 3.8.2 Two Skinner Solenoid Actuated Air Valves No. A5DB2127 or A5LB2127.
 - 3.8.3 Orifices for Skinner valves graduated 0.029 in. (0.736 mm) diameter to 0.073 in. (18.5 mm) diameter.

4. MATERIALS

- 4.1 Sealing Compound—Sealing compound, where necessary, is to be Permatex No. 2 or equivalent.
- 4.2 Cleaning Solvent—Stoddard solvent or equivalent.

CAUTION—Cleaning solvent is both toxic and flammable. Do not breathe its fumes or allow it to come in contact with the skin. Keep flames away from the cleaning solvent.

5. PROCEDURE

5.1 Test Preparation

- 5.1.1 Note the nature and extent of the contact area. Record the torques to break and turn the pinion shaft of the assembled unit.
- 5.1.2 Spray clean the gears and interior of the case with Stoddard solvent and air dry. Do not disassemble.
- 5.1.3 Prelubricate the ring and pinion and bearings with a small amount of test lubricant.
- 5.1.4 Measure and record the backlash at four positions and check ring gear runout.

NOTE 4—Backlash can be adjusted to provide acceptable contact patterns. Document in the comment section of the test report that an adjustment was made. Regardless of whether adjustment was made, backlash shall be between 0.004 in. (0.102 mm) and 0.009 in. (0.229 mm). If measurements are not within these limits, do not use the unit for test purpose. Ring gear runout should not exceed 0.003 in. (0.076 mm).

- 5.1.5 Install the test unit on the test stand supports and connect to dynamometers and driveshaft.
- 5.1.6 Fill the axle housing with 3.5 pt (1655 cc) of test lubricant or until the level reaches the bottom of the fill hole in the cover plate.

5.2 SEQUENCE 1 —Break-in the test unit as follows:

- 5.2.1 Record date, oil code, time, three initial backlash measurements, break and turn pinion torque and starting axle oil temperature.
- 5.2.2 Set temperature control unit so that test lubricant temperature does not exceed $225 \pm 5^{\circ}\text{F}$ ($107.2 \pm 2.8^{\circ}\text{C}$).
- 5.2.3 With the engine warmed up and no load applied to the dynamometers, shift into first gear. Operate clutch and throttle so that shifting is smooth to prevent bucking. Continue shifting smoothly into second, third and fourth gears.
- 5.2.4 With transmission in fourth gear, accelerate to 575 ± 5 wheel r/min (2352 pinion r/min). Apply a dynamometer excitation to achieve a pinion torque of 50 ± 10 lbf•ft as measured by the in-line torque meter. When both conditions are met, maintain for 10 ± 0.5 minutes.
- 5.2.5 While maintaining a fixed dynamometer excitation as determined in Section 5.2.4 conduct four cycles varying wheel speed between 575 ± 20 r/min and 385 ± 20 r/min.
- 5.2.6 With transmission in fourth gear, accelerate to 815 ± 5 wheel r/min (3333 pinion r/min). Apply a dynamometer excitation to achieve a pinion torque of 60 ± 10 lbf•ft as measured by the in-line torque meter. When both conditions are met, maintain for 20 ± 0.5 minutes.
- 5.2.7 While maintaining a fixed dynamometer excitation as determined in Section 5.2.6 conduct four cycles varying wheel speed between 815 ± 20 r/min and 670 ± 20 r/min.
- 5.2.8 Record maximum test oil temperature observed during this conditioning.
- 5.2.9 Allow test oil temperature to drop to $200 \pm 5^{\circ}\text{F}$ ($93.3 \pm 2.8^{\circ}\text{C}$) before resuming test.

- 5.3. SEQUENCE 2 —This portion of the test is run with cooling water off.
- 5.3.1 Adjust wheel speed to 530 ± 20 r/min in fourth gear and synchronize the two dynamometers while maintaining pinion torque of 50 ± 10 lbf•ft.
- 5.3.2 While maintaining a fixed dynamometer excitation as determined in Section 5.3.1 conduct five cycles varying wheel speed between 530 ± 20 r/min and 1050 ± 20 r/min.
- 5.3.3 Once Sequence 2 is complete record maximum test lubricant temperature.
- 5.3.4 Non-reference and Discrimination oil test Sequence 2 average coast side torque values shall be within $\pm 15\%$ of the average Sequence 2 coast side torque value of the average of the 3 tests from the most recent operationally and statistically valid calibration sequence for the test to be considered operationally valid. Each test in a calibration sequence is considered operationally valid if the average Sequence 2 coast side torque are within 15% of the average of the 3 acceptable calibration sequence tests.

5.4 SEQUENCE 3

5.4.1 Inspect the gears for scoring and record results.

5.5 SEQUENCE 4

5.5.1 With cooling water off, allow lubricant temperature to cool to 280°F (137.8°C) before starting. Record starting temperature.

5.5.2 With the engine warmed up and no load applied to the dynamometers, shift into first gear. Operate clutch and throttle so that shifting is smooth to prevent bucking. Continue shifting smoothly into second, and third gears.

5.5.3 Adjust wheel speed to 530 ± 5 r/min in third gear and synchronize the two dynamometers while maintaining pinion torque of 70 ± 5 lbf•ft.

5.5.4 While maintaining a laboratory determined fixed dynamometer excitation as determined in Section 5.5.3 conduct ten cycles varying wheel speed between 530 ± 20 wheel r/min and 630 ± 20 wheel r/min.

5.5.5 Non-reference and Discrimination oil test Sequence 4 average coast side torque values shall be within $\pm 10\%$ of the average Sequence 4 coast side torque value of the average of the 3 tests from the most recent operationally and statistically valid calibration sequence for the test to be considered operationally valid. Each test in a calibration sequence is considered operationally valid if the average Sequence 4 coast side torque are within 10% of the average of the 3 acceptable calibration sequence tests.

5.5.6 At the end of the test record maximum test lubricant temperature.

5.6 Disconnect the dynamometers and drive shaft—Record backlash and break and turn torque values of test unit.

5.7 Disassemble Test Unit -- Rate (numerically) the surface distress.

5.7.1 Rating – At completion of the test, the pinion and ring gear are removed from the unit and rated on both drive and coast sides for percent of the contact area exhibiting scoring in accordance with CRC Manual 21. The percent scoring for the non-reference oil is compared to the percent scoring for the three most recent acceptable reference tests.

5.7.1.1 For a test rating to be valid, the gears shall be rated by an individual who has participated in a ASTM gear-rater calibration workshop within the previous twelve months.

Note 9 – Training for those rating gear sets for the gear distress levels may be obtained from Coordinating Research Council (CRC) 219 Perimeter Center Parkway, Atlanta, GA 30346.

6 STAND CALIBRATION

6.1 Each test stand must conduct a calibration sequence every 3 months or at the completion of 15 non-reference oil tests. Each calibration sequence will consist of 3 operationally valid and statistically acceptable calibration tests. Each operationally valid test will be considered statistically acceptable if the end of test pinion coast side scoring meets the Shewhart limits as published by the Test Monitoring Center. Specific Shewhart limits are defined for each gear batch and reference oil combination. Any operationally valid calibration test in the calibration sequence with a end of test pinion coast side scoring value exceeding the Shewhart limits must be repeated until acceptable pinion scoring results are achieved. Every 6 months from the completion of the last test in the calibration sequence or after 4 calibration sequences, each test stand will be required to perform a discrimination test. The end of test pinion coast side scoring value of the discrimination test must be a minimum of twice the average value of the 3 acceptable reference oil tests for the test to be considered acceptable. If a second discrimination test is needed, this discrimination test if acceptable, will count as 1 of the 15 non-reference oil tests. In the event that both discrimination oil tests do not meet the above requirements a complete new calibration sequence must be performed followed by the discrimination requirements as outlined above. For all reference oil tests, the end of test coast side pinion scoring shall be equal to or greater than the end of test ring coast side scoring for the test to be acceptable.

6.2 A non-reference oil test that has not been run in a calibrated test stand and/or not conducted on approved hardware shall be considered non-interpretable. The cover page of the test report shall indicate that the test is non-interpretable and that it has not been conducted in a valid manner in accordance with the Test Procedure.

7. TEST REPORTING

- 7.1 When reporting reference oil test results to the TMC transmit by facsimile the complete report form package (Annex A1) and any other supporting information to the ASTM TMC within five days of test completion. A copy of the final test report shall be mailed within 30 days of test completion to the ASTM Test Monitoring Center, 6555 Penn Avenue, Pittsburgh, PA 15206-4489. Electronic transfer of test results (see Section 7.4) to the ASTM TMC is also permitted for approved laboratories.
- 7.2 For reference oil tests, the standardized report form set and data dictionary for reporting the test results and for summarizing the operational data are required. The report forms and data dictionary are available on the ASTM Test Monitoring Center Web Page at <http://astmtmc.cmu.edu/> or can be obtained in hardcopy format from the TMC. The final test report will include a completed report form package and one 8 x 10 black and white photo of the ring and pinion coast sides labeled or identified by oil and run number.
- 7.3 Deviations from Test Operational Limits – Report all deviations from specified test operational limits on Form 4 (Annex A1) under Other Comments.
- 7.4 Electronic Transmission of Test Results – Electronic transfer of reference and non-reference oil test report data can be done utilizing the ASTM Data Communications Committee Test Report Transmission Model (see Section 2 - Flat File Transmission Format) available from the ASTM TMC.

8. PRECISION AND BIAS

- 8.1 The precision and bias of this test have not yet been formally established.

9. INSTRUMENT CALIBRATION

- 9.1 A complete system calibration to include thermocouples, speed pick-ups and the in-line torque meter is to be performed every three (3) months or sixty (60) tests whichever comes first.
- 9.2 The in-line torque meter must have an electronic shunt calibration performed prior to each reference test.

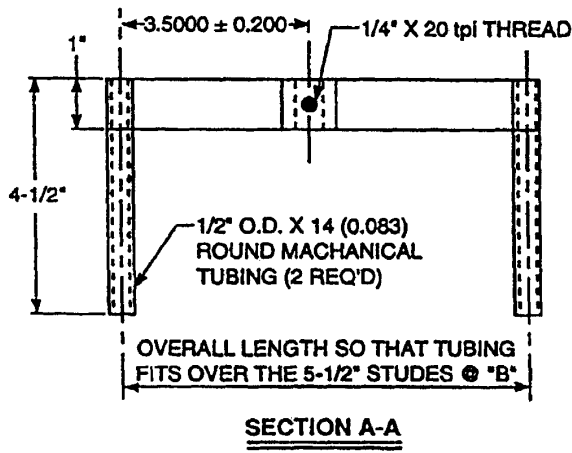
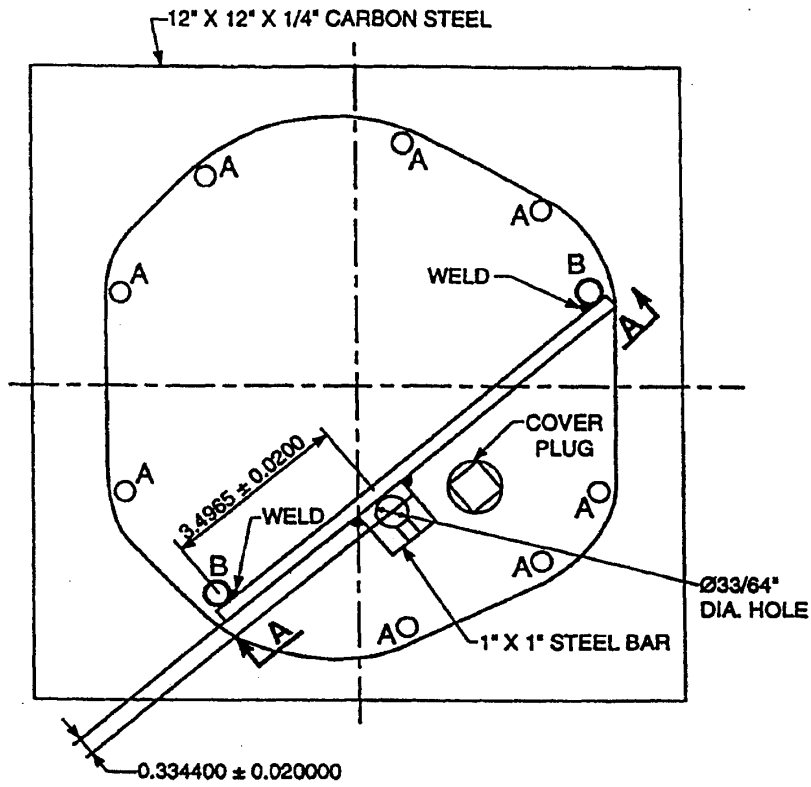


FIG. 1 Cover Plate Temperature Sensor Locating Device

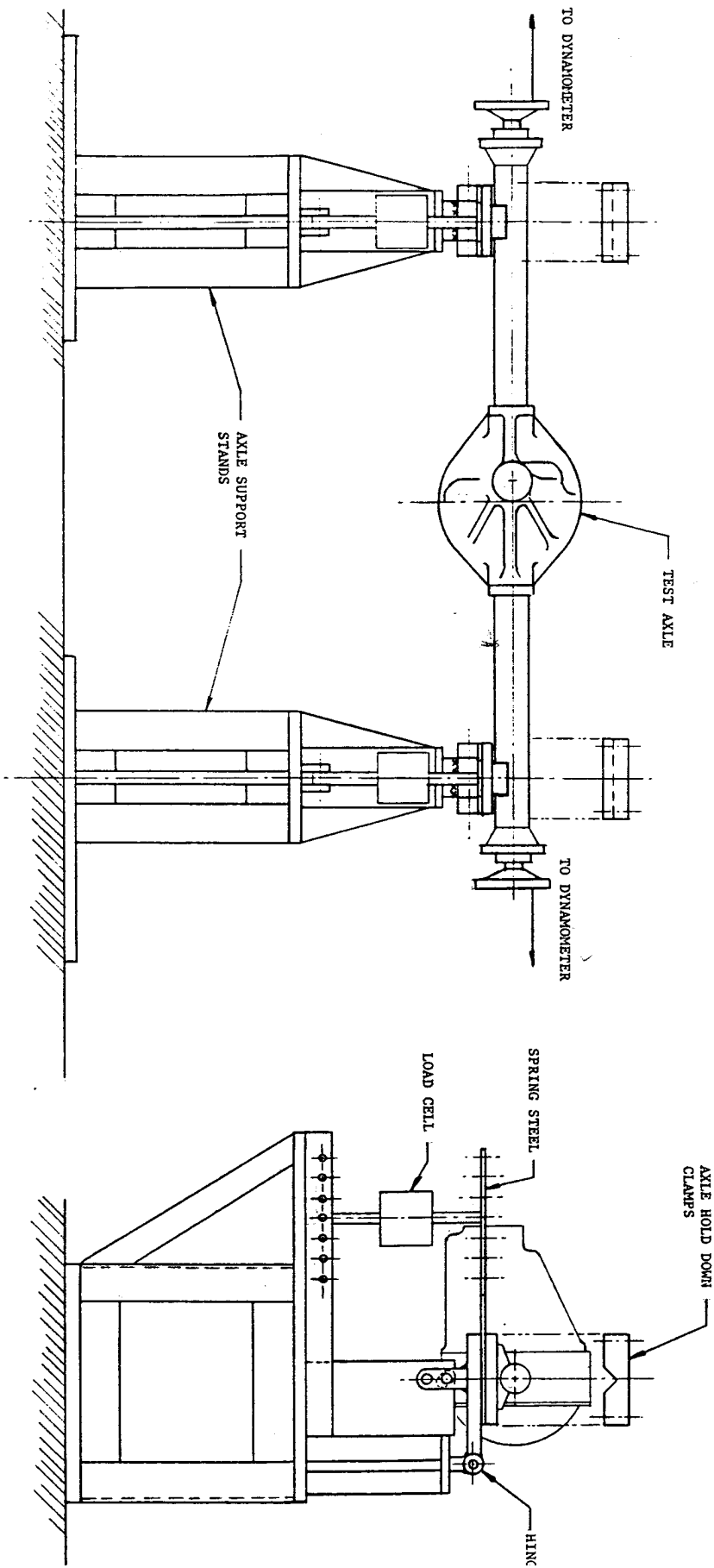
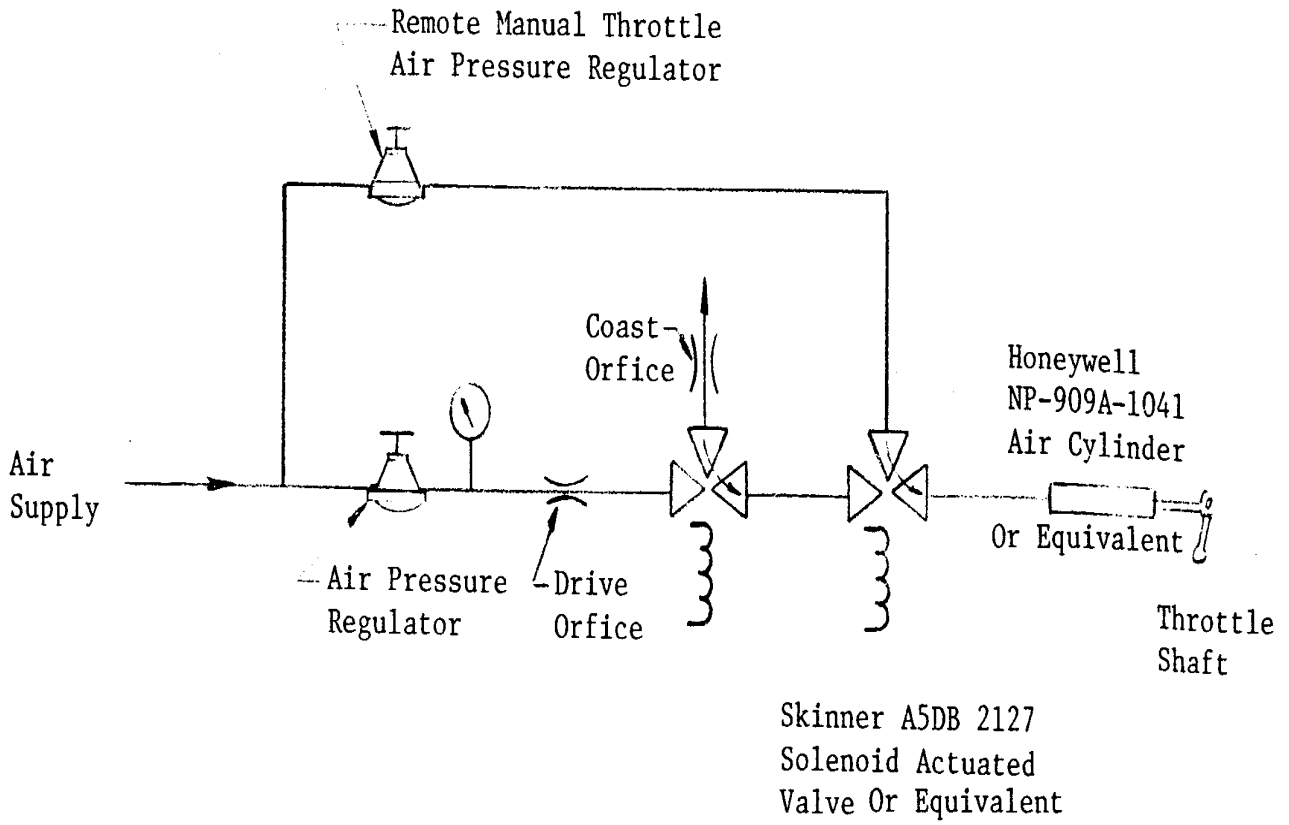
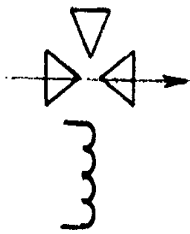


FIG. 2 Flexible Axle Mount



Energized



De-Energized

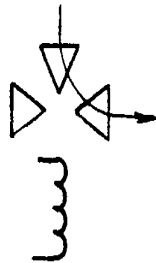


FIG. 3 Remote Air Throttle

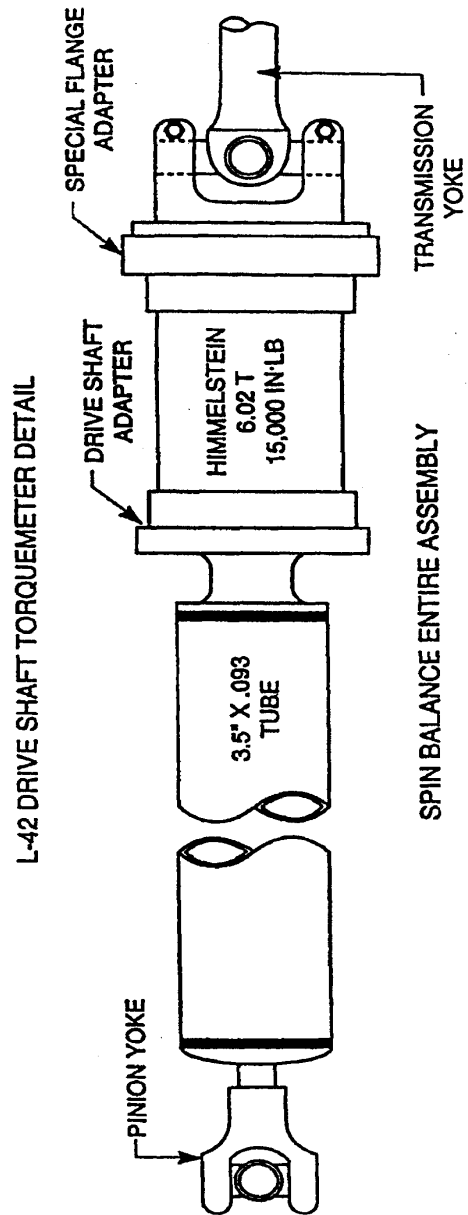
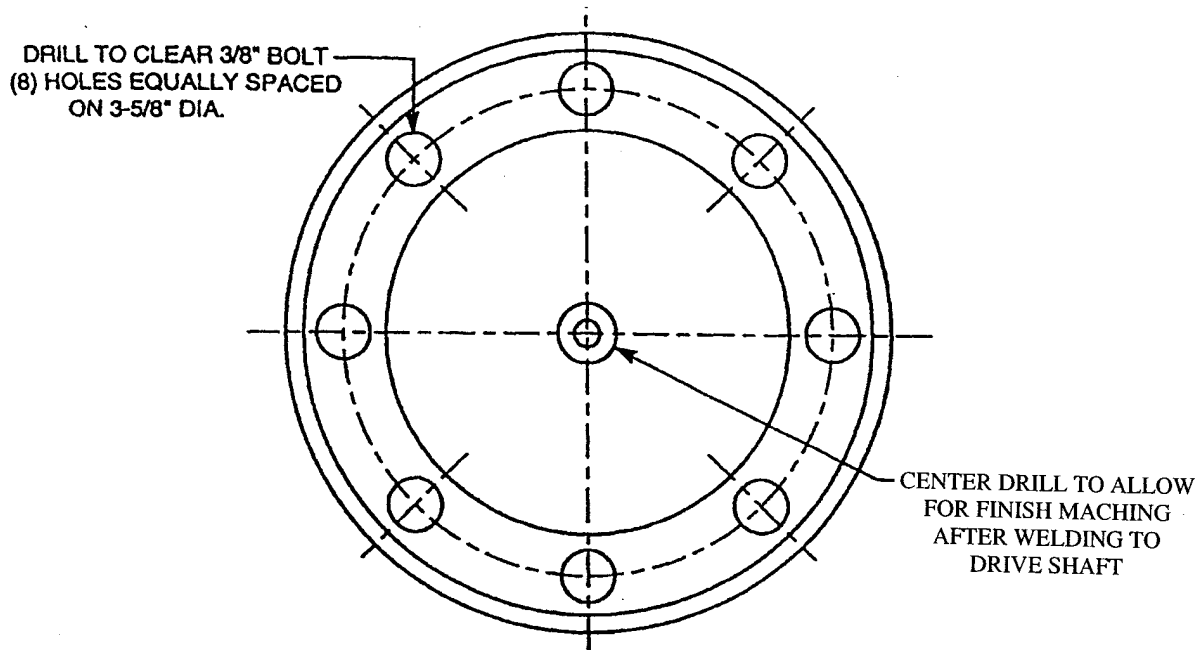
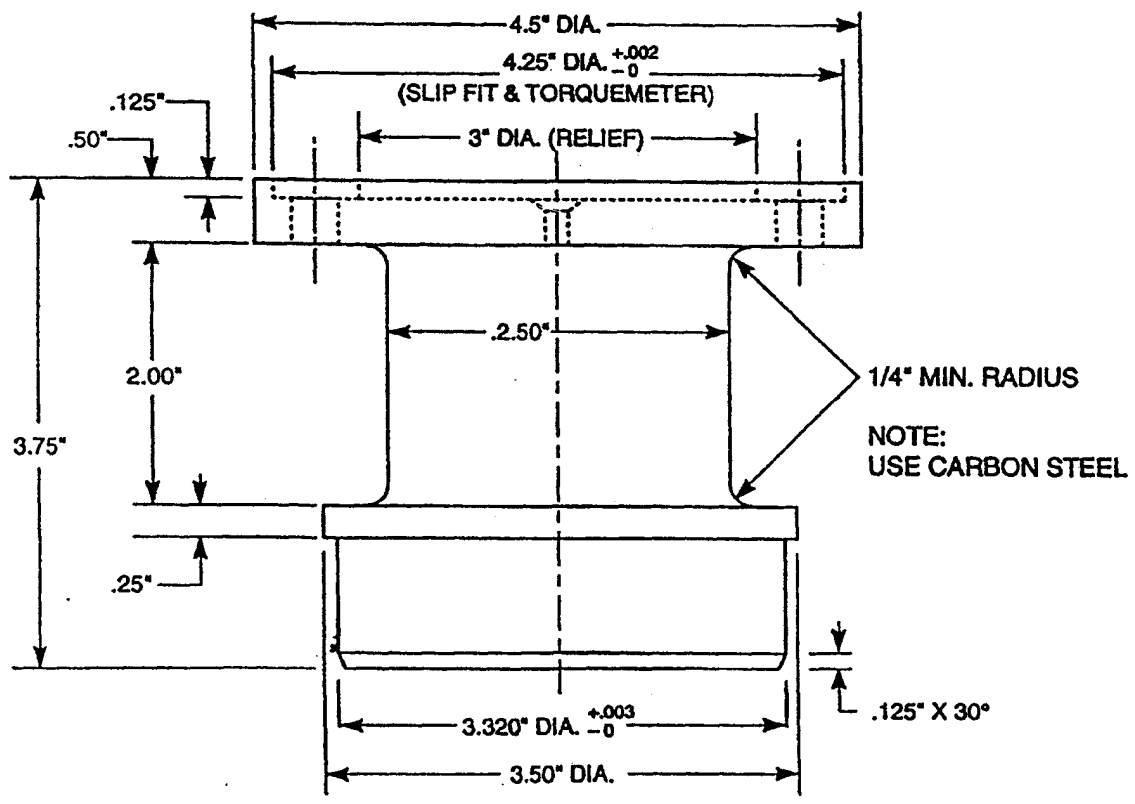


FIG. 4 Drive Shaft Torque Meter Assembly

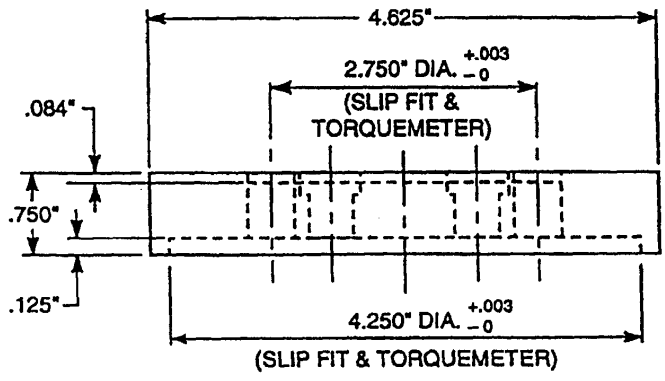
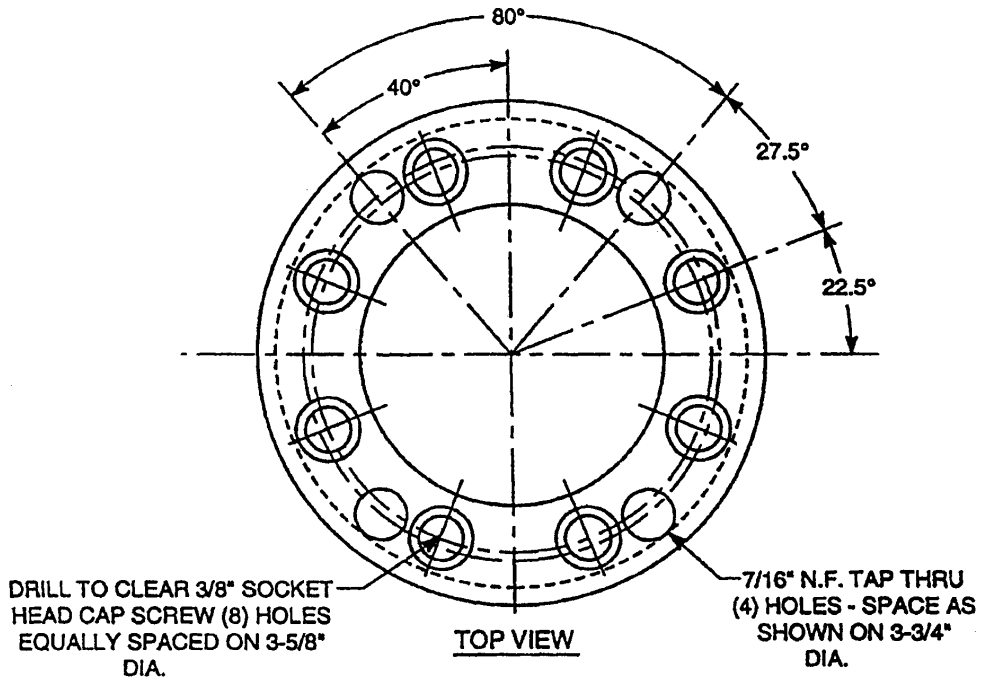


TOP VIEW



SIDE VIEW

FIG. 5 Assembly Flange



SIDE VIEW

NOTE:
ONE REQUIRED
MATERIAL - CARBON STEEL

FIG. 6 Assembly Flange

A1. L-42 TEST REPORT FORMS and DATA DICTIONARY

The required report forms and data dictionary are available on the ASTM Test Monitoring Center Web Page at <http://astmtmc.cmu.edu/> or can be obtained in hardcopy format from the TMC.

Form 0	Test Report Cover
Form 1	Test Result Summary Sheet
Form 2	Operational Summary Sheet
Form 3	Measurement Summary Sheet
Form 4	Lost Time and Comments Sheet