

PERFORMANCE OF GEAR LUBRICANTS IN AXLES AT HIGH SPEED, LOW TORQUE, FOLLOWED BY LOW SPEED, HIGH TORQUE

1. SCOPE

1.1 This method is used for determining the load-carrying, wear, and extreme-pressure characteristics of gear lubricants in axles under conditions of high-speed low-torque operation and low-speed high-torque operation, using a single set of gears.

Note 1. This test method differs from CRC Designation L-20-545 in that it requires a high-speed run on the gears prior to the high-torque run. Also, the high-torque test is more severe.

2. SAMPLE

2.1 Approximately 2 gallons of the gear lubricant to be tested.

3. APPARATUS

3.1 **Test unit.** The test unit shall consist of a new, 3/4 ton Army truck, hypoid rear-axle carrier, 5.83 to 1 ratio (Dodge part No. 930215, Chrysler Corp., Engineering Division, Detroit, Mich.). No change in any of the tooth contact or bearing adjustments shall be made.

CAUTION

Rebuilt carriers shall not be used. Only units especially selected by the manufacturer for this test work, shall be used. Therefore, when ordering, specify a "special carrier for oil tests, to be checked by Gear Engineering Department," and designate whether the gears shall be phosphate coated or uncoated, as required by the specification.

3.2 **Axle housing.** The carrier shall be installed in the axle housing (part No. 1194063) for which it was designed. The housing shall be provided with a vent and an inspection opening as specified below. All other openings which might allow water leakage must be sealed with a suitable sealing compound (Permatex No. 2, or equivalent).

Note 2. When sealing, pay particular attention to all studs holding the carrier to the axle housing, the oil filler hole, drain, and inspection plugs, and to the thermocouple and vent fittings.

(a) *Axle vent.* The axle shall be vented to atmosphere throughout the entire test and cooling-off period. The vent shall consist of a single opening in the left-hand axle housing (as viewed from the rear cover side) into which is fitted a 1/8-inch IPS 90-degree street elbow. The vent shall be arranged so that no water can enter the axle housing.

(b) *Inspection opening.* The axle-housing cover shall be modified to include an inspection opening of sufficient size (approximately 3-1/2 inch pipe size) and so located above the level of the lubricant that the ring-gear tooth-contact surfaces can be readily inspected by removing the plug. (See Figure 1.)

3.3 **Temperature control.** The test setup shall include a means of maintaining the lubricant at a specified temperature. This shall include a thermocouple, a temperature recording instrument, and a cooling bath.

(a) *Thermocouple.* A thermocouple, preferably a hairpin type, shall be installed in the axle housing in such a manner that the junction will be on the centerline of the housing, one inch from the tooth side of the ring gear and one inch from the bottom of the housing. This thermocouple shall actuate a temperature-recording instrument and control an automatic cooling bath.

Note 3. A shielded type thermocouple may be used provided its accuracy is equivalent to that of the hairpin type.

(b) *Temperature-recording instrument.* A temperature-recording instrument (Leeds and Northrup Micromax, Model S-40000, or equivalent) shall be provided for recording the temperature of the lubricant in the axle housing.

(c) *Cooling bath.* A water bath shall be provided for controlling the temperature of the lubricant in the axle housing. The bath shall consist of an electrically operated water-control valve, and spray nozzles arranged as shown in figure 2 to spray cooling water over the rear cover of the axle housing. The water-control valve shall start and stop the flow of water, and

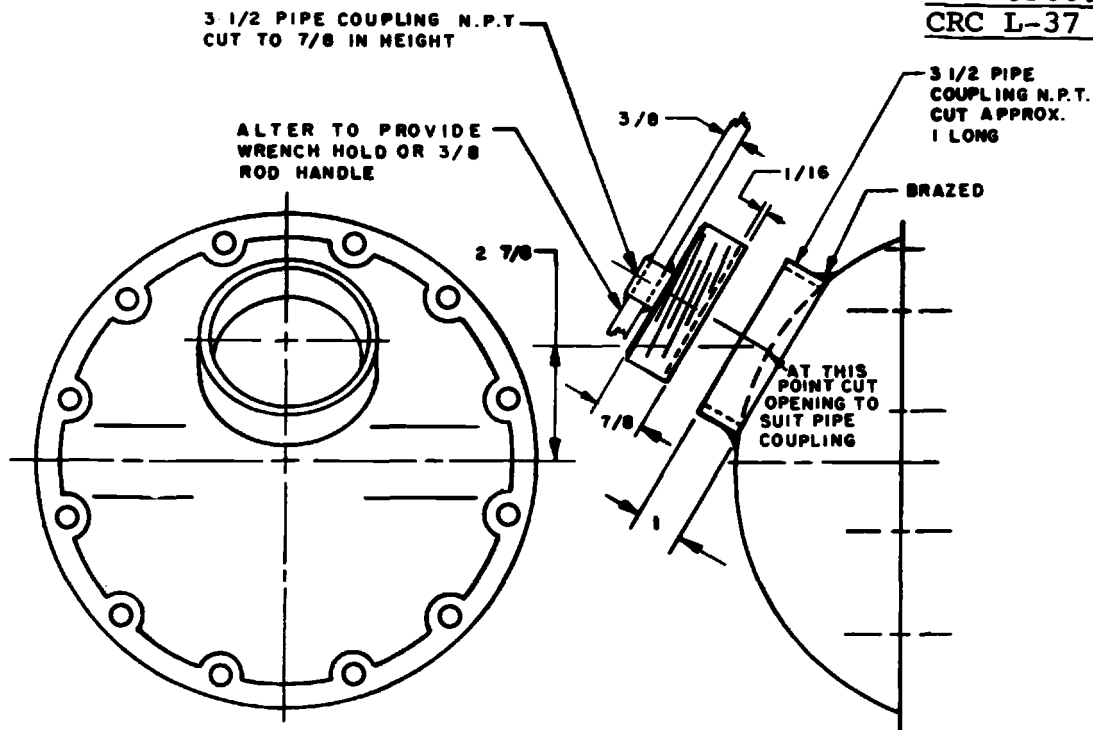


FIGURE 1.—Rear cover plate.

shall be actuated by the thermocouple through the temperature-recording instrument.

Note 4. If a pan is used to direct waste water to the drain, take care that any water that collects in the pan does not touch the bottom of the housing.

3.4 Dynamometers. Two axle dynamometers (Midwest Dynamatic, Model 3232, or equivalent) with suitable control equipment shall be used. The control equipment shall have sufficient sensitivity of adjustment and control to permit maintenance of a uniform ring gear torque to within 2 percent and a uniform speed to within 1 percent. Each dynamometer shall have a revolutions counter so that the number of revolutions of the ring gear during the test may be recorded.

3.5 Power source. The power source shall consist of a six-cylinder, 235 cubic inch Chevrolet truck engine (part No. 3709971) or equivalent with standard ignition and carburetor. The engine shall have new spark plugs (Champion J-11 or AC 46-5), and shall have the generator and fan disconnected, and the air cleaner removed. The engine must be in the best possible condition; breaker points, ignition timing, valve

backlash, and valve seating must be adjusted to shop manual specifications. Also, head deposits must be removed after every third test.

Note 5. The air cleaner may be installed during the high-torque low-speed portion of the test procedure.

3.6 Transmission and coupling. The engine shall be coupled to the test unit through a 10-inch Chevrolet truck clutch, a four-speed truck transmission (part No. 591703), and a special drive shaft (4-inch OD, 0.095-inch wall thickness), and universal joints.

4. MATERIALS

4.1 Sealing compound, Permatex No. 2 or equivalent.

4.2 Dry cleaning solvent, in accord with P-D-680, Types I or II.

4.3 Preservative oil, in accordance with MIL-L-3150.

CAUTION

Dry 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 dry-cleaning solvent.

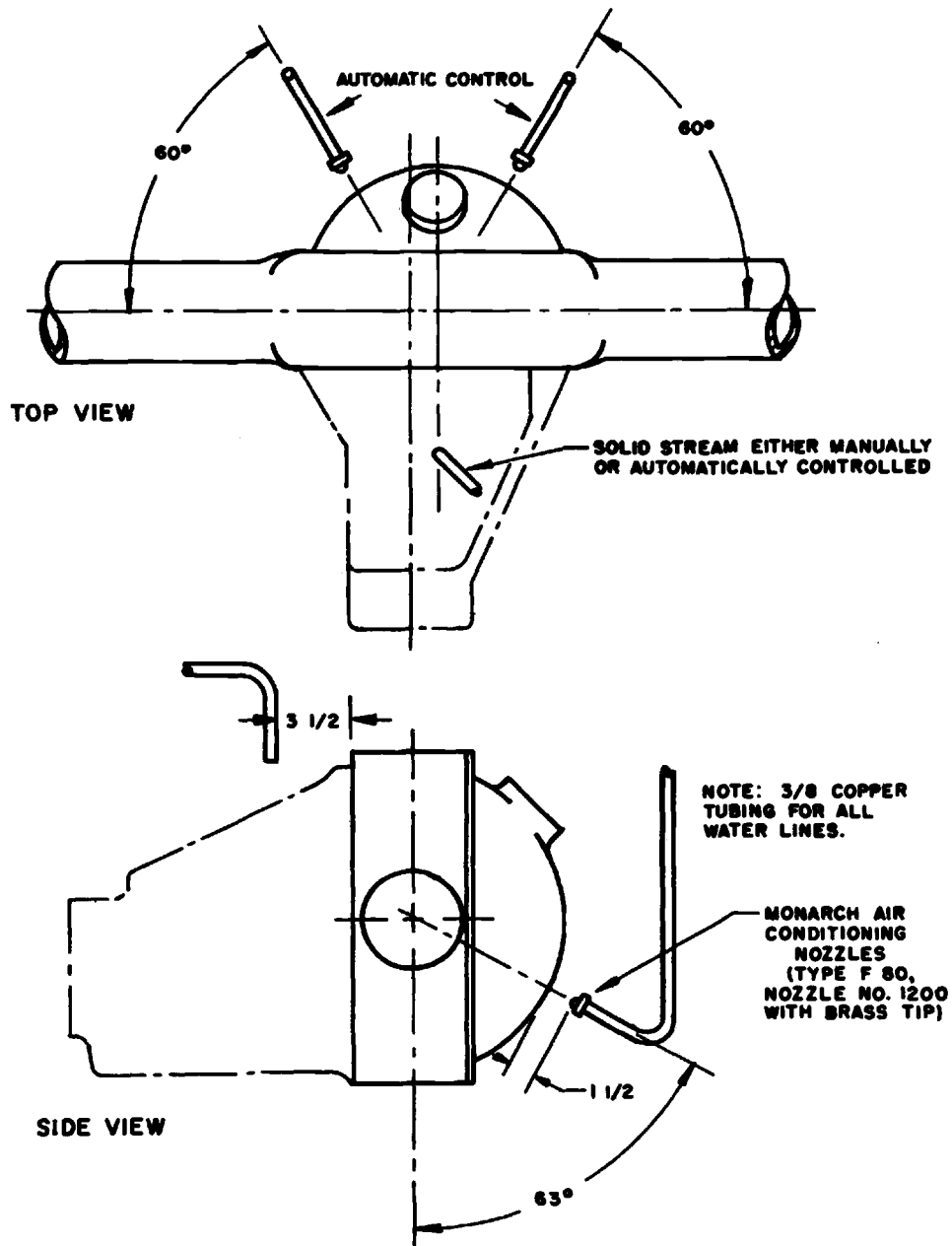


FIGURE 2.—Cooling system.

5. PROCEDURE

5.1 Prepare the apparatus for the test as follows:

(a) Wash the axle housing, axle shafts, and test unit, using dry-cleaning solvent (P-D-680), paying particular attention to the pinion bearings to remove all preservative oil. Dry by blowing with clean, dry compressed air.

Note 6. The preservative oil can be removed from the bearings by directing a spray into each of the oil passages cast in the housing of the unit.

(b) Lubricate the carrier bearings, pinion bearings, differential gears, and the ring and pinion gears, using the test lubricant.

(c) Determine and record the torques required to break and to turn the pinion shaft of the completely assembled test unit.

(d) Determine and record the backlash in the gearing.

(e) Connect the dynamometers to the axles.

(f) Fill the axle housing with five pints of the test lubricant.

(g) Set the revolutions counters to zero (or record the readings).

5.2 **High-speed low-torque operation.** Operate the test unit under high-speed low-torque conditions for 100 minutes as follows:

(a) Set the temperature control to maintain a lubricant temperature of 295° to 300°F (146.1° to 148.8°C).

(b) Determine the dynamometer field voltage required for a torque of 9460 ± 150 lb-in. at 440 ± 5 rpm.

(c) With the engine warmed up, and with no load applied to the dynamometers start the test unit in first gear (low-low). When the engine speed reaches 2000 to 2200 rpm shift to the next higher gear. Continue to shift into successively higher gears when the engine speed is 2000 to 2200 rpm until the unit is operated in direct drive (fourth gear).

(d) After shifting into high gear, apply the predetermined field voltage (for 9460 ± 150 lb-in. at 440 ± 5 rpm), open the throttle fully and record the time. Hold the variation in speed between the axles to a minimum.

Note 7. The time required to accelerate to the test condition of 440 rpm (axle speed) is about two minutes.

(e) Run the test for 100 minutes from the time of full throttle application.

(f) At the end of 100 minutes, close the throttle, and stop the equipment.

(g) Record the revolutions, average rpm, total time, and temperature of the lubricant.

(h) Without draining the lubricant from the axle housing, remove the inspection plug and examine the ring-gear tooth surfaces for burnishing, scratches, wear, surface fatigue, scoring, discoloration, corrosion, and deposits. Report the condition on a form similar to that shown in Figure 3, giving the extent, nature, and character of the condition where applicable.

Note 8. Gear-tooth surface conditions, such as burnishing, are defined in Table I.

TABLE I.—Gear-tooth surface condition terminology

| Condition | Definition |
|----------------------|--|
| Burnish..... | Alteration of original surface to a dull or brightly polished condition. |
| Scratching..... | Formation of random irregular grooves in the direction of sliding of the surfaces, such as is caused by abrasive particles. |
| Wear..... | Removal of metal (without evidence of surface fatigue or scoring) with partial or complete elimination of toolmarks. Also development of a discernible shoulder ridge at bottom of contact area near root or at toe or heel end of pinion tooth. |
| Surface fatigue..... | Rippling—More or less regular pattern resembling ripples on water, or fish scales (evident under oblique lighting). Condition may be accompanied by ridging. Ridging—Series of parallel raised and polished diagonal ridges partially or completely across tooth surface of hypoid gear. Pitting—Formation of small irregular cavities resulting from breaking out of small surface areas. |
| Scoring..... | Spalling—Breaking out (more extensive than pitting) of irregular flakes of tooth surface. |
| Discoloration..... | Displacement of metal from one tooth to another to produce a matte finish. |
| Corrosion..... | Any alteration in normal color of finished steel surfaces. |
| Deposits..... | General discoloration, accompanied by roughening not attributable to mechanical action. Pasty, gummy, or brittle material adhering to or collecting around working parts. |

(i) As soon as practicable, replace the plug in the inspection opening, and continue the test with low-speed high-torque operation.

5.3 Low-speed high-torque operation. Operate the test units under low-speed high-torque conditions for 24 hours as follows:

(a) Set the temperature control to maintain a lubricant temperature of $275^{\circ} \pm 3^{\circ}\text{F}$ ($135^{\circ} \pm 1.6^{\circ}\text{C}$).

(b) Determine the dynamometer field voltage required for a torque of $41,800 \pm 150$ lb-in. at 80 ± 1 rpm.

(c) With the engine warmed up and with no load applied to the dynamometers, start and run the test unit in first gear (low-low).

(d) After shifting into low-low gear, apply the predetermined field voltage for 41,800 lb-in. torque, and adjust the engine speed for an axle speed of 80 ± 1 rpm. Record the time. Hold the variation in speed between axles to a minimum.

(e) Run the test continuously for 24 hours.

Note 9. No more than a total of three stops because of equipment failure, or for the purpose of checking engine oil level, shall be made during the test period.

(f) At the end of the 24 hours, stop the engine and record the revolutions, average speed in rpm, total time of test run, and the temperature of the lubricant.

(g) While the unit is hot, disconnect the drive shaft, and determine and record the torque required to break and to turn the pinion shaft of the completely assembled test unit.

(h) Allow the unit to cool, and record the torques required to break and to turn the pinion shaft.

(i) Disconnect the axle shafts, and record the pinion-shaft torques. Also determine and record the backlash in the gearing.

(j) Remove the carrier unit from the axle housing.

CAUTION

In handling the test unit, avoid staining the cleaned and polished surfaces with perspiration or with moisture from other sources.

(k) Remove the ring gear and differential assembly from the carrier.

(l) Determine and record the torques required to break and to turn the pinion shaft.

(m) Completely disassemble the differential and the pinion shaft assemblies for inspection.

5.4 Inspect the test unit as described in the following paragraphs, and report the results on a form similar to that shown in Figure 3.

(a) Examine the axle shafts, axle housing, carrier housing, ring gear, pinion, differential, and differential pins for discoloration, rust, condensation, or other deposits.

(b) Examine the tooth surfaces on the drive sides of the pinion and the ring gear for burr-nishing, scratches, wear, surface fatigue, scoring, discoloration, and corrosion.

Note 10. Gear-tooth surface conditions, such as burr-nishing, are defined in Table I.

(c) Examine the bearings for discoloration, corrosion, deposits, and wear.

(d) Examine the differential pins for evidence of removal of copper plating from the surfaces.

Note 11. Do not confuse discoloration of the copper with removal of the metal.

5.5 Examine the used lubricant, comparing it with new lubricant for evidence of water, foreign material, sludge, and discoloration. If inspection reveals any unusual condition, retain used lubricant for chemical analysis.

LABORATORY TEST QUESTIONNAIRE AND FINAL SUMMARY OF RESULTS

| A. GEAR LUBRICANT IDENTIFICATION | B. GEAR TEST IDENTIFICATION | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
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| 1. Company _____ Brand _____ Name _____ 2. Formula No. _____ Viscosity _____ | 1. Test run at _____ Under their code no. _____ 2. Date of start _____ Date of completion _____ | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| C. EVALUATION OF TEST PARTS | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 1. Ring-Gear Drive Side Inspection after completion of High-Speed Low-Torque 100-minute run. <table style="width: 100%; margin-top: 10px;"> <thead> <tr> <th style="width: 80%;"></th> <th style="width: 10%; text-align: center;">Ring Gear</th> <th style="width: 10%;"></th> </tr> </thead> <tbody> <tr> <td>a. Gear-tooth surface condition</td> <td></td> <td></td> </tr> <tr> <td> (1) Burnish</td> <td style="text-align: center;">_____</td> <td></td> </tr> <tr> <td> (2) Wear</td> <td style="text-align: center;">_____</td> <td></td> </tr> <tr> <td> (3) Surface fatigue</td> <td></td> <td></td> </tr> <tr> <td> (a) Rippling</td> <td style="text-align: center;">_____</td> <td></td> </tr> <tr> <td> (b) Ridging</td> <td style="text-align: center;">_____</td> <td></td> </tr> <tr> <td> (c) Pitting</td> <td style="text-align: center;">_____</td> <td></td> </tr> <tr> <td> (d) Spalling</td> <td style="text-align: center;">_____</td> <td></td> </tr> <tr> <td> (4) Score</td> <td style="text-align: center;">_____</td> <td></td> </tr> <tr> <td> (5) Discoloration</td> <td style="text-align: center;">_____</td> <td></td> </tr> <tr> <td> (6) Corrosion</td> <td style="text-align: center;">_____</td> <td></td> </tr> <tr> <td> (7) Deposits</td> <td style="text-align: center;">_____</td> <td></td> </tr> </tbody> </table> | | Ring Gear | | a. Gear-tooth surface condition | | | (1) Burnish | _____ | | (2) Wear | _____ | | (3) Surface fatigue | | | (a) Rippling | _____ | | (b) Ridging | _____ | | (c) Pitting | _____ | | (d) Spalling | _____ | | (4) Score | _____ | | (5) Discoloration | _____ | | (6) Corrosion | _____ | | (7) Deposits | _____ | | 2. Pinion-Gear Drive Side and Ring-Gear Drive Side inspection after complete test. <table style="width: 100%; margin-top: 10px;"> <thead> <tr> <th style="width: 60%;"></th> <th style="width: 20%; text-align: center;">Pinion Gear</th> <th style="width: 20%; text-align: center;">Ring Gear</th> </tr> </thead> <tbody> <tr> <td>a. Gear-tooth surface condition</td> <td></td> <td></td> </tr> <tr> <td> (1) Burnish</td> <td style="text-align: center;">_____</td> <td style="text-align: center;">_____</td> </tr> <tr> <td> (2) Wear</td> <td style="text-align: center;">_____</td> <td style="text-align: center;">_____</td> </tr> <tr> <td> (3) Surface fatigue</td> <td></td> <td></td> </tr> <tr> <td> (a) Rippling</td> <td style="text-align: center;">_____</td> <td style="text-align: center;">_____</td> </tr> <tr> <td> (b) Ridging</td> <td style="text-align: center;">_____</td> <td style="text-align: center;">_____</td> </tr> <tr> <td> (c) Pitting</td> <td style="text-align: center;">_____</td> <td style="text-align: center;">_____</td> </tr> <tr> <td> (d) Spalling</td> <td style="text-align: center;">_____</td> <td style="text-align: center;">_____</td> </tr> <tr> <td> (4) Score</td> <td style="text-align: center;">_____</td> <td style="text-align: center;">_____</td> </tr> <tr> <td> (5) Discoloration</td> <td style="text-align: center;">_____</td> <td style="text-align: center;">_____</td> </tr> <tr> <td> (6) Corrosion</td> <td style="text-align: center;">_____</td> <td style="text-align: center;">_____</td> </tr> <tr> <td> (7) Deposits</td> <td style="text-align: center;">_____</td> <td style="text-align: center;">_____</td> </tr> <tr> <td>b. Backlash</td> <td></td> <td></td> </tr> <tr> <td> (1) Initial</td> <td style="text-align: center;">_____</td> <td></td> </tr> <tr> <td> (2) After tests</td> <td style="text-align: center;">_____</td> <td></td> </tr> <tr> <td> (3) Avg. increase</td> <td style="text-align: center;">_____</td> <td></td> </tr> </tbody> </table> | | Pinion Gear | Ring Gear | a. Gear-tooth surface condition | | | (1) Burnish | _____ | _____ | (2) Wear | _____ | _____ | (3) Surface fatigue | | | (a) Rippling | _____ | _____ | (b) Ridging | _____ | _____ | (c) Pitting | _____ | _____ | (d) Spalling | _____ | _____ | (4) Score | _____ | _____ | (5) Discoloration | _____ | _____ | (6) Corrosion | _____ | _____ | (7) Deposits | _____ | _____ | b. Backlash | | | (1) Initial | _____ | | (2) After tests | _____ | | (3) Avg. increase | _____ | |
| | Ring Gear | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
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| (1) Burnish | _____ | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| (2) Wear | _____ | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| (3) Surface fatigue | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| (a) Rippling | _____ | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| (b) Ridging | _____ | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| (c) Pitting | _____ | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| (d) Spalling | _____ | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| (4) Score | _____ | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| (5) Discoloration | _____ | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| (6) Corrosion | _____ | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| (7) Deposits | _____ | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | Pinion Gear | Ring Gear | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| a. Gear-tooth surface condition | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| (1) Burnish | _____ | _____ | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| (2) Wear | _____ | _____ | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| (3) Surface fatigue | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| (a) Rippling | _____ | _____ | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| (b) Ridging | _____ | _____ | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| (c) Pitting | _____ | _____ | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| (d) Spalling | _____ | _____ | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| (4) Score | _____ | _____ | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| (5) Discoloration | _____ | _____ | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| (6) Corrosion | _____ | _____ | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| (7) Deposits | _____ | _____ | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| b. Backlash | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| (1) Initial | _____ | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| (2) After tests | _____ | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| (3) Avg. increase | _____ | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 3. For stability and corrosion (indicate extent and nature of deposits, discoloration, corrosion, or rusting) <table style="width: 100%; margin-top: 10px;"> <tbody> <tr><td>a. Axle shafts</td><td>_____</td></tr> <tr><td>b. Axle housing</td><td>_____</td></tr> <tr><td>c. Carrier housing</td><td>_____</td></tr> <tr><td>d. Pinion assembly</td><td>_____</td></tr> <tr><td>e. Ring-gear assembly</td><td>_____</td></tr> <tr><td>f. Bearings</td><td>_____</td></tr> <tr><td>g. Differential assembly</td><td>_____</td></tr> <tr><td>h. Differential pins</td><td>_____</td></tr> </tbody> </table> | a. Axle shafts | _____ | b. Axle housing | _____ | c. Carrier housing | _____ | d. Pinion assembly | _____ | e. Ring-gear assembly | _____ | f. Bearings | _____ | g. Differential assembly | _____ | h. Differential pins | _____ | 4. For stability <table style="width: 100%; margin-top: 10px;"> <tbody> <tr> <td>a. Pinion-shaft torque, lb-ft (before test)</td> <td>_____</td> </tr> <tr> <td> (1) Full axle assembly:</td> <td>_____</td> </tr> <tr> <td> break</td> <td>_____ turn</td> </tr> <tr> <td>b. Pinion-shaft torque, lb-ft (after test)</td> <td>_____</td> </tr> <tr> <td> (1) Full axle assembly (hot):</td> <td>_____</td> </tr> <tr> <td> break</td> <td>_____ turn</td> </tr> <tr> <td> (2) Full axle assembly (cool):</td> <td>_____</td> </tr> <tr> <td> break</td> <td>_____ turn</td> </tr> <tr> <td> (3) Axle shafts removed:</td> <td>_____</td> </tr> <tr> <td> break</td> <td>_____ turn</td> </tr> <tr> <td> (4) Pinion assembly:</td> <td>_____</td> </tr> <tr> <td> break</td> <td>_____ turn</td> </tr> </tbody> </table> | a. Pinion-shaft torque, lb-ft (before test) | _____ | (1) Full axle assembly: | _____ | break | _____ turn | b. Pinion-shaft torque, lb-ft (after test) | _____ | (1) Full axle assembly (hot): | _____ | break | _____ turn | (2) Full axle assembly (cool): | _____ | break | _____ turn | (3) Axle shafts removed: | _____ | break | _____ turn | (4) Pinion assembly: | _____ | break | _____ turn | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| a. Axle shafts | _____ | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| b. Axle housing | _____ | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| c. Carrier housing | _____ | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| d. Pinion assembly | _____ | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| e. Ring-gear assembly | _____ | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| f. Bearings | _____ | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| g. Differential assembly | _____ | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| h. Differential pins | _____ | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| a. Pinion-shaft torque, lb-ft (before test) | _____ | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| (1) Full axle assembly: | _____ | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| break | _____ turn | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| b. Pinion-shaft torque, lb-ft (after test) | _____ | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| (1) Full axle assembly (hot): | _____ | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| break | _____ turn | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| (2) Full axle assembly (cool): | _____ | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| break | _____ turn | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| (3) Axle shafts removed: | _____ | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| break | _____ turn | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| (4) Pinion assembly: | _____ | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| break | _____ turn | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| D. GENERAL OPERATING CONDITIONS | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 1. High-speed low-torque <table style="width: 100%; margin-top: 10px;"> <tbody> <tr> <td>a. Revolution counter reading:</td> <td>start _____ finish _____</td> </tr> <tr> <td> Total</td> <td>Avg. rpm _____</td> </tr> <tr> <td>b. Time: start _____ finish _____</td> <td></td> </tr> <tr> <td> Total time</td> <td>minutes _____</td> </tr> <tr> <td>c. Oil temperature:</td> <td>start _____ finish _____</td> </tr> </tbody> </table> | a. Revolution counter reading: | start _____ finish _____ | Total | Avg. rpm _____ | b. Time: start _____ finish _____ | | Total time | minutes _____ | c. Oil temperature: | start _____ finish _____ | 2. Low-speed high-torque <table style="width: 100%; margin-top: 10px;"> <tbody> <tr> <td>a. Revolution counter reading:</td> <td>start _____ finish _____</td> </tr> <tr> <td> Total</td> <td>Avg. rpm _____</td> </tr> <tr> <td>b. Time: start _____ finish _____</td> <td></td> </tr> <tr> <td> Total time</td> <td>hours _____ minutes _____</td> </tr> </tbody> </table> <p style="margin-top: 10px;">(Note: If test is interrupted during test run, record time of interruptions and minimum gear oil temperature reached.)</p> | a. Revolution counter reading: | start _____ finish _____ | Total | Avg. rpm _____ | b. Time: start _____ finish _____ | | Total time | hours _____ minutes _____ | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| a. Revolution counter reading: | start _____ finish _____ | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Total | Avg. rpm _____ | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| b. Time: start _____ finish _____ | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Total time | minutes _____ | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| c. Oil temperature: | start _____ finish _____ | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| a. Revolution counter reading: | start _____ finish _____ | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Total | Avg. rpm _____ | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| b. Time: start _____ finish _____ | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Total time | hours _____ minutes _____ | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 3. Remarks _____ _____ _____ _____ | c. Room temperature. max _____ min _____ Avg _____ d. Cooling-water temperature. Avg _____ e. Gear-lubricant temperature. avg max _____ avg min _____ f. The complete temperature-time chart shall be attached to and become a part of this report. | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 4. Photographic evidence. Show by photographs: (1), tooth surface condition of pinion gear and ring gear; (2), any evidence of deposits, corrosion, or rusting. | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Date _____ | Signed _____ | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Company _____ | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

FIGURE 3. - Typical report form.