



Locking Rear Axle Split Mu Surface Evaluation

1 Scope

Note: Nothing in this standard supercedes applicable laws and regulations.

Note: In the event of conflict between the English and domestic language, the English language shall take precedence.

1.1 Purpose. The purpose of this test is to evaluate the performance of locking rear axle differential components (differential case, differential gears, cam plate, governor, latching bracket mechanism, friction discs, fuse, and other related components) under extreme adverse road conditions.

1.1.1 Estimated Performance Objectives: Refer to the Engineering Performance Objectives or Vehicle Technical Specification for the specific objectives established for this procedure.

1.2 Foreword. This procedure subjects the components of a locking rear axle differential system to high rear axle torques by free spinning one of the drive wheels at high throttle and repeatedly forcing the locking mechanism to engage and disengage.

1.3 Applicability. This test is applicable to all light duty trucks equipped with a fused locking rear differential, e.g., and Eaton locking rear differential.

2 References

Note: Only the latest approved standards are applicable unless otherwise specified.

2.1 External Standards/Specifications.

None

2.2 GM Standards/Specifications.

None

3 Resources

3.1 Facilities. Milford Proving Ground Axle Score Facility (Ice Facility/Soap Dish), or equivalent, consisting of a stainless steel trough for one wheel path and high friction surface for the opposing wheel path. Trough should be approximately 3.8 cm (1.5 in) deep, 4.3 m (14 ft) long (including 0.5 m (1.5 ft) of ramp), and 45.7 cm (18 in) wide. High friction surface should be located approximately 6.7 mm (22 ft) from the edge of the trough, 1.2 m (4 ft) wide and approximately 6.7 m (22 ft) long (including 1.2 m (4 ft) before and after the beginning and end of trough). High friction surface material should be low module epoxy grit, e.g., Boomer Company's Sika low-modules two (2)-part epoxy with **Black Beauty** grit or equivalent.

Refer to Appendix A, Figure A1 for dimensions of water trough.

3.1.1 Calibration. The test facilities and equipment shall be in good working order and shall have a valid calibration label.

3.1.2 Alternatives. Alternative test facilities and equipment may also be used. However, all measuring variables as specified in this standard shall be determined correctly with respect to their physical definition.

3.2 Equipment.

3.2.1 Data acquisition device (Somat, Teac, or equivalent data acquisition system) with 75 Hz (minimum) frequency response and four channel (minimum) data collection capacity. Device must be capable of sorting data to allow for playback and visual examination of times histories.

3.2.2 Voltmeter and miscellaneous cable and cords.

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3.2.3 Two (2) wheel speed monitoring devices.

3.2.4 Strain gauged rear axle shafts, of equivalent device, capable of monitoring rear axle shaft torques.

Note: Do not use torque wheels for monitoring rear axle torques as they will increase inertia and affect test results.

3.2.4.1 Optional: Engine speed monitoring device.

3.2.4.2 Optional: Thermocouples and readout devices to monitor axle lubricant temperatures.

3.2.5 Ectron or equivalent signal conditioning system, four channel (minimum).

3.2.6 Generation II Driver's Aid or equivalent precision vehicle speed read-out device.

Note: All instrumentation is to be calibrated as required. Record instrumentation details and date of calibration on Data Sheet A1.

3.2.7 Power supply – 12 V automotive-type battery or equivalent.

3.2.8 Miscellaneous safety equipment.

3.2.9 Hoist.

3.2.10 Fixturing, fasteners, and mounting provisions to secure instrumentation and test equipment inside and outside the test vehicle.

3.3 Test Vehicle/Test Piece.

3.3.1 Test Vehicle. A test vehicle equipped with the locking rear differential components under test and with the released combination of powertrain components that create the greatest loading on the rear axle components and representing the specific design configuration to be tested. The test vehicle should be equipped with the following components, as released, for the specific locking rear differential configuration being tested:

3.3.1.1 The largest displacement engine.

3.3.1.2 The highest numerical rear axle ratio.

3.3.1.3 The largest width, largest diameter tires (highest inertia) with tire pressure as specified by Design Engineer.

3.3.1.4 Vehicle should be updated with latest level calibrations to ensure maximum engine torque output.

3.3.2 Test Piece. Three (3) to six (6) axle assemblies with lock rear differential components installed per test request documentation.

3.3.2.1 Rear axle lubricant, as indicated in the test request documentation.

Note: Do not use friction modifiers.

3.3.2.2 Spare parts and other related test material as indicated in the test request documentation.

3.4 Test Time. Not applicable.

3.5 Test Required Information. Not applicable.

3.6 Personnel/Skills. Driver and/or technician capable of performing the specific instrumentation requirements and driving events described in this procedure.

4 Procedure

4.1 Preparation.

4.1.1 Facility. Procure the facilities as described in 3.1. Check the condition of the trough and high friction surface. Repair the trough and repair and replace the high friction surface as required. Fill the trough with approximately 1.9 cm (0.75 in) of water or other fluids as indicated in the test documentation.

4.1.2 Equipment. Procure the instrumentation and test equipment in 3.2. Record part numbers and calibration information on Data Sheet A1.

4.1.3 Development/Validation. Inspect test samples and note discrepancies in comments section of the test documentation, Data Sheet A2. Document test vehicle information on Data Sheet A3.

4.2 Conditions. Test facility must be clear of rain, snow, ice, or other foreign material. The high friction surface must be dry and free of dirt, soil, and/or other foreign material: abort test if surface becomes wet. Trough must be free of dirt, soil or other material. Trough bottom should be clear of all debris, including rubber.

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4.2.1 Environmental Conditions. Not applicable.

4.2.2 Test Conditions. Deviations from the requirements of this standard shall have been agreed upon. Such requirements shall be specified on component drawings, test certificates, reports, etc.

4.3 Instructions.

4.3.1 Operator Responsibilities. Take necessary precautions to assure a safe testing environment.

4.3.2 Test Setup.

4.3.2.1 Install and secure the data acquisition system in the right front passenger seat of the test vehicle.

4.3.2.2 Install and secure signal conditioning.

4.3.2.3 Install and secure power cabling from the vehicle battery or power supply to instrumentation and test equipment.

4.3.2.4 Install the instrumented rear axle shafts or equivalent rear axle torque monitoring device as indicated in 3.2.4. Run cabling to data acquisition system and check for operation.

4.3.2.5 Install the wheel speed monitoring devices. Run cabling to data acquisition system and check operation.

4.3.2.5.1 Optional: Install the engine speed monitoring device and run cabling to data acquisition system and check.

4.3.2.5.2 Optional: Install thermocouples at locations specified in the test documentation. Install readout devices, run the necessary cabling, and assure proper operation.

4.3.2.6 Install, secure, and calibrate Driver's Aid per manual.

4.3.2.7 Secure all instrumentation and cabling. Weatherproof connectors and other critical areas. Remove all miscellaneous equipment from the test vehicle.

4.3.2.8 Enter Channel information on Data Sheet A4.

Note: Vehicle preparation must be performed under the direction of and approved by the responsible Design, Development, and Test Engineers.

4.3.2.9 Perform an axle break-in per manufacturer's instruction.

Optional: Monitor fluid temperatures to assure adequate rear axle warm up.

4.3.2.10 Perform a system shake down by driving the vehicle to the test site and entering the trough with the left wheels. Stop when both left wheels are aligned straight in the rearmost position of the trough. Check the right wheels for alignment on the high friction surface. Realign vehicle, as necessary. Record odometer, ambient temperature, and (optional) axle lube temperature on Data Sheet A5. Record zero and calibration information on acquisition device. Ensure that Traction Control has been disabled if vehicle is so equipped. Place transmission in the lowest gear and rapidly apply approximately 50% throttle. Continue 50% throttle until the locking mechanism engages and the left wheel stops spinning. Immediately lift off throttle and exit the trough. Stop the vehicle and the recording device. Verify that all systems are functioning properly. Note the performance characteristics of the differential carrier. Record any knocking, popping or other unusual sounds in the test log. Perform **S** turn to assure that the locking mechanism has unlocked.

Note: If the carrier is not unlocked, spin up on the next cycle will not occur. Repeat shake down with the right wheels aligned in the trough and the left wheels on the high friction surface and at 50% throttle, verifying that all systems are functioning properly and documenting any unusual sounds. Repeat the shakedown procedure on both left and right sides at 100% throttle, with throttle release immediately after locker engagement. Make adjustments, as required, and verify that all systems are functioning properly. Document system performance characteristics and record shakedown cycles on Data Sheet A5.

4.3.2.11 Adjust the height of the water in the trough, if necessary, to avoid over-splash onto the high friction surface.

4.3.3 Test.

4.3.3.1 Assure that proper vehicle weight, per test request documentation, is achieved and documented.

4.3.3.2 Assure proper warm up of rear axle components.

4.3.3.3 Drive the vehicle to the test site and enter the trough with the left wheels. Stop when both left wheels are aligned straight in the rearmost position of the trough. Check the right wheels for alignment on the high friction surface. Realign test vehicle, as needed. Record odometer, ambient temperature, and (optional) axle lube

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temperature on Data Sheet A5. Record zero and calibration information on acquisition device. Place transmission in the lowest gear and rapidly apply 100% throttle (or throttle as directed in the test request documentation). Maintain throttle position until the locking mechanism engages and the left wheel stops spinning. Immediately release throttle and exit the trough. Stop the vehicle and the recording device. Note the performance characteristics of the differential carrier. Record any knocking, popping or other unusual sounds in the test log. Perform an **S** turn to assure that the locking mechanism has unlocked.

Note: If the carrier is not unlocked, spin up on the next cycle will not occur.

4.3.3.4 Adjust the height of the water in the trough, if necessary, to avoid over-splash onto the high friction surface.

4.3.3.5 Repeat 4.3.3.3 and 4.3.3.4 four times for a total of five (5) cycles, recording only the first cycle. Record cycles in test log.

4.3.3.5.1 Optional: Record axle lube temperatures at the end of the fifth cycle.

4.3.3.6 Perform a cooling lap to alleviate localized heating, if required, and as indicated in the test request documentation.

4.3.3.7 Repeat 4.3.3.3 thru 4.3.3.6 four (4) times with the right wheels in the trough and the left wheels on the high friction surface, assuring proper rear axle warm up, water height, and vehicle weight, and noting system performance on Data Sheet A5. Record only the first cycle.

4.3.3.7.1 Optional: Record axle lube temperature at the end of the fifth cycle.

4.3.3.8 Repeat 4.3.3.3 thru 4.3.3.7 to complete the number of the test cycles as directed on the test request documentation. Maintain throttle position and vehicle weights as directed and inspect the differential components at the interval specified. Maintain facility consistency, both high and low friction surfaces. Note system performance in test log.

4.3.3.9 Repeat 4.3.3.3 thru 4.3.3.7, as directed in the test documentation, at the throttle positions and ballast conditions indicated.

5 Data

5.1 Calculations. See Data Sheets A2 thru Data Sheet A5.

5.2 Interpretation of Results. See Data Sheets A2 thru Data Sheet A5.

5.3 Test Documentation. Record pertinent test results on the supplied data sheets. Record test summary information on separate data sheet.

5.3.1 Data Archival. Archive the test data per the direction of the Design or Test Engineer and in accordance with corporate procedures for Engineering Records Retention.

6 Safety

This standard may involve hazardous materials, operations, and equipment. This standard does not propose to address all the safety problems 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.

7 Notes

7.1 Glossary.

Fuse: A toothed plate inside a locking differential that is designed to absorb torque and curb the action of a locking differential under severe abuse conditions.

Locking Rear Differential: A rear axle system comprised of bevel gears, spur gears and/or worm gears that act to establish equal torques between the right and left hand driven wheels under normal driving conditions, and a case locking mechanism to lock left and right hand axle shafts to provide torque to the high traction wheel under split coefficient conditions.

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