



Differential Case Durability Test

1 Introduction

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. To determine differential case fatigue life, under simulated environment.

1.2 Applicability. This standard applies to passenger cars, Multipurpose Passenger Vehicles (MPV) and light-duty trucks.

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

2.3 Additional References.

- Component Technical Specification (CTS)
- Statement of Requirements (SOR)
- Subsystem Technical Specification (SSTS) (for Axle or Rear Drive Module)
- Validation Cross Reference Index (VCRI)

3 Resources

3.1 Facilities. The test facility shall have a valid International Organization for Standardization (ISO) certificate, which is noted in the test report.

A bedplate large enough for securing the test rig and capable of withstanding dynamic loading of the rig/specimen is required.

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

All instrumentations is to be calibrated as required; record instrumentation details and date of calibration on data sheet (Appendix A, Table A1), unless the information is otherwise preserved in the test laboratory records.

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 Axle dynamometer or other suitable loading device capable of delivering the required pinion torque and absorbing the required output torque at the required speeds.

3.2.2 Fixtures, reaction members and adapters to mount the test axle.

3.2.3 External recirculating oil pump and cooler with adequate capacity to maintain the axle sump temperature at 80 °C (176 °F).

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3.2.4 Instrumentation and related control equipment to maintain:

- a. Input load within 0.5%.
- b. Ring gear speed within 0.5%.
- c. Axle sump temperature within 2.5 °C (5 °F).

3.2.5 Vibration monitoring device to provide automatic shutdown if failure occurs.**3.2.6 Counter to record either pinion or ring gear cycles.**

3.3 Test Vehicle/Test Piece. Test sample size to be determined by the test engineer. A minimum of six (6) differential cases is suggested. Each test is to be run with new drive gear set, bearings and ring gear bolts.

3.4 Test Time.

Calendar time: 11 days

Test hours: 12 hours (each piece)

Coordination hours: 8 hours

3.5 Test Required Information. Possible sources are:

- Statement of Requirements (SOR)
- Subsystem Technical Specification (SSTS)
- Validation Cross Reference Index (VCRI)

3.6 Personnel/Skills. Test Technician. Should be proficient in proper selection and operation of the equipment listed in 3.2.

4 Procedure**4.1 Preparation.**

4.1.1 Install the axle assembly on the test stand.

4.1.2 Install the temperature controlling equipment. It is recommended that oil from the cooler be returned to a fitting installed in the carrier between pinion bearings to insure adequate pinion bearings to insure adequate pinion bearing lubrication.

4.1.3 With the recirculating system operating, fill the axle with fresh oil to the specified level.

4.1.4 Attach the vibration sensing and oil temperature sensing units.

4.1.5 Determine the test load, typically this is 75% of the Axle Torque Capacity (ATC), unless something different is provided by the requesting engineer. If load is measured at the pinion, use an axle efficiency factor of 95%.

Note: This efficiency value is an approximate figure. If an efficiency curve is available for the test axle, select the appropriate value from the curve.

4.1.6 All samples shall be inspected for geometrical conformance with the appropriate specimen drawing (and weld specification, if applicable). Any non-compliant specimens must be set aside and a compliant specimen be tested in its place.

4.1.7 Check that all parts and fixtures needed are included for the mounting.

4.1.8 Paint critical areas with an appropriate color (e.g., white) to make it easier to find cracks.

4.1.9 Test Stand Review. The test setup and methodology must be reviewed with the GM System Validation Engineer (SVE). The GM SVE may request review by the Design Release Engineer (DRE) and/or the Bill of Material Family Owner (BFO). Photographs and/or computer aided design images of the test must be provided.

4.2 Conditions.

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 Unless otherwise specified, the GM SVE is to approve test setup.

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4.3.2 Take photograph or digital image of test configuration.

4.3.3 New test samples shall be used. For product validation testing off-tool parts are mandatory. For design validation testing prototype parts may be used.

4.3.4 The test sample orientation on the test bench shall be the same as within the vehicle. Any deviation needs to be approved by the GM SVE and/or the DRE.

4.3.5 Test shall be controlled and monitored by a computer program. Load, displacement and cycles of the specimen shall be monitored through entire test until failure.

4.3.6 Failure mode is to be recorded and failure location shall be identified for each test specimen. Pictures shall be taken for typical failure modes and any anomalous failures documented and photographed.

4.3.7 Mount the test part in the fixturing.

4.3.8 Set the ring speed to 80 rpm at no load in the reverse direction.

4.3.9 Set the temperature controlling equipment to maintain an axle sump temperature of $82\text{ }^{\circ}\text{C} \pm 2.5\text{ }^{\circ}\text{C}$ ($180\text{ }^{\circ}\text{F} \pm 5\text{ }^{\circ}\text{F}$).

4.3.10 Run the following break-in schedule:

Torque	Time
10% axle test torque	15 minutes
20% axle test torque	15 minutes

4.3.11 Set load to the test load established in 4.1.5 and start the cycle counter.

4.3.12 Run until an axle component failure occurs or until the requested number of test cycles have been concluded.

4.3.13 If other than the differential case failed, replace such components and continue test.

4.3.14 Record total hours and ring gear cycles at failure or end of test.

4.3.15 Inspect for evidence of bearing turning on case hubs.

4.3.16 Note the condition of axle components. (Use magnetic particle crack detection as needed on the case and drive gear set.)

4.3.17 A metallurgical inspection of at least one differential case is suggested.

5 Data

5.1 Calculations. Not applicable.

5.2 Interpretation of Results. The results determined shall be compared with the SSTS/Component Technical Specification (CTS)/component drawing and evaluated accordingly.

Ensure that the test part has failed posttest and there has not been a failure of the test stand fixturing. Confirm that the failure induced during the testing was caused solely by the input of test parameters, and not misalignment or other test stand set up issues.

5.3 Test Documentation. The results shall be compiled in a test report as in 5.3.1 thru 5.3.7.

5.3.1 Results Summary and Evaluation.

- Brief evaluation of results (OK, Not OK (NOK)).
- Test specification and, if required, any deviations.
- Comparison of results with the specifications in the SSTS/CTS/part drawing.

5.3.2 Test Piece Description. Part name and number, development status, date of manufacture, drawing number, drawing revision, drawing date and photograph.

5.3.3 Test Description. Description of test bench **with photograph**, brief description of testing machine, description of used test setup, calibration of testing equipment, initial cracking criterion and detection, load cell, force application mass measured from load cell connection, ISO certificate of test facility.

5.3.4 Documentation of Individual Results. Test load, travel amplitude of test cylinder, test direction, test frequency, number of cycles for initial cracks, position and photograph of initial cracks.

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