



Axle Differential Score 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 performance of axle differential components under extreme adverse road conditions.

1.2 Applicability. Front or rear wheel drive passenger cars, Multipurpose Passenger Vehicles (MPV) and light duty trucks. For All Wheel Drive (AWD)/Four Wheel Drive (4WD) vehicles, front and rear axle differentials to be tested simultaneously.

1.3 Remarks. This specification subjects the bearing surfaces of axle differentials to high stresses by free spinning one of the drive wheels at Wide Open Throttle (WOT).

2 References

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

2.1 External Standards/Specifications.

None

2.2 GM Standards/Specifications.

GMW14264

GMW15445

GMW15474

2.3 Additional References.

- Analysis/Development/Validation (ADV) Plan
- Statement of Requirements (SOR)
- Subsystem Technical Specification (SSTS)
- Validation Cross-Reference Index (VCRI)
- Vehicle Technical Specification (VTS)

3 Resources

3.1 Facilities.

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.

3.1.3 A clean and dry paved straight road (asphalt or concrete) approximately 60 m x 8 m (200 ft x 25 ft) minimum.

3.1.4 Differential test water trough (see Figure A1 in Appendix A for specifications).

3.1.5 Water trough is to be located at one end of the test area and arranged so that the vehicle is on the area centerline when the left-hand wheels of the vehicle enter the trough.

3.1.6 Fill trough with water to a depth of 6 mm to 13 mm ($\frac{1}{4}$ in to $\frac{1}{2}$ in). Maintain this water level with the use of water tank or by hand filling.

3.2 Equipment. Potentiometer(s) and thermocouple(s), to monitor axle lubricant temperature and ambient air temperature, tire pressure gage and vehicle scale.

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Note: All instrumentation is to be calibrated as required; record instrumentation details and date of calibration on Data Sheet A1 in Appendix A, unless the information is otherwise preserved in the testing facility records.

3.3 Test Vehicle/Test Piece.

3.3.1 Test Vehicle. A test vehicle equipped as follows:

3.3.1.1 The axle differential components under test.

3.3.1.2 The largest displacement engine released with the test axle.

3.3.1.3 A standard release automatic transmission for the above engine.

3.3.1.4 The widest tread, largest diameter tires which are released with the test axle usage.

3.3.1.5 Any vehicle body style for which the test axle is released.

3.3.2 Test Material.

3.3.2.1 Test samples are to consist of three to six axle assemblies with the test differential assemblies installed. Record special treatment, lubricants and/or material of test components on Data Sheet A2 in Appendix A.

3.3.2.2 Inspect and thoroughly clean all axle components with a suitable solvent to insure no chips or foreign materials are present in the assembly.

3.3.2.3 Run an analysis of a sample of the test lubricant (obtained from the same container from which the axle fill is obtained) to insure that it meets specifications.

3.3.2.4 Text axle assemblies are to be built as follows:

3.3.2.4.1 Lubricate with the test lubricant and assemble the following components in the differential case: Side gears and thrust washers, pinions and thrust washers, and cross shaft and pin.

3.3.2.4.2 Install differential side bearings and differential case assembly into axle.

3.3.2.4.3 Adjust side bearing preload to mean specifications and record.

3.3.2.4.4 Adjust ring gear backlash to mean specification and record.

3.3.2.4.5 Adjust drive gear-set contact pattern to nominal production pattern at production test load or equivalent pattern at no load and record contact observations.

3.4 Test Time. This is a durability test on multiple samples that ends based on wear of components or completing a total number of cycles. The test time is variable dependent on the number of vehicles utilized to run the tests and available manpower for driving and performing the periodic inspections and observed wear. Refer to 4.3.

3.5 Test Required Information. See the data sheets in Appendix A. Possible sources are:

- Statement of Requirements (SOR)
- Vehicle Technical Specification (VTS)
- Subsystem Technical Specification (SSTS)
- Analysis/Development/Validation (ADV) Plan
- Validation Cross-Reference Index (VCRI)
- Application Engineer
- Development Groups
- Drawings

3.6 Personnel/Skills. Familiarity with installation of differentials and axles, see 3.3.2 and 4.3.17 and instrumentation, see 4.1. Driving privileges in the required facilities, see 3.1.

4 Procedure

4.1 Preparation.

4.1.1 Determine and record the number of cycles to be tested based on requirements in 3.5 or as required by Requesting Engineer. **Note:** The test limit based on experience is 200 cycles, however, refer to the documents called out in 3.5 or Requesting Engineer's determination for the definitive number of cycles to run.

4.1.2 Install a thermocouple so that it is always immersed in axle sump lubricant.

4.1.3 Fill test axle with the specified quantity of the test lubricant.

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4.1.4 Install test axle in test vehicle.

4.1.5 Tune engine to manufacturer's specification, with latest updated level calibrations.

4.1.6 Weigh and ballast test vehicle to GM Maximum Curb Mass plus 68 kg placed as close as possible over the axle assembly. Record the front and rear mass distribution of the vehicle on Data Sheet A2 in Appendix A. Reference GMW15474 and GMW15445.

4.1.7 Inflate tires to maximum recommended tire pressure that is shown on the tire placard located on driver's door or per design intent by direction of applicable Design Engineer if non production level vehicle.

4.1.8 Install direct reading potentiometer in test vehicle.

4.2 Conditions.

4.2.1 **Environmental Conditions.** Test between 0 °C and 45 °C, see 3.1.3.

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.

4.2.3 For selectable AWD/4WD systems, engage secondary axle by selecting "Auto" mode or "4H" mode.

4.2.4 Disengage Traction Control System (TCS) and Vehicle Stability Control (VCS).

4.3 Instructions.

4.3.1 Record odometer reading on Data Sheet A2 in Appendix A.

4.3.2 Break in the test axle by driving 25 circles each in both right and left directions. Front wheels should be just off maximum turn and vehicle speed approximately 24 km/h (15 mph). (Just off maximum turn is used to preserve power steering pump.)

4.3.3 Evaluate for axle noise at light drive, float, and coast, on Data Sheet A2 in Appendix A, to ascertain normal operations at various speeds up to 113 km/h (70 mph). If unusual noise develops, notify Test Engineer.

4.3.4 Record odometer reading on Data Sheet A2 in Appendix A.

4.3.5 Obtain cross shaft noise evaluation by making a light throttle acceleration to 32 km/h (20 mph), and then decelerate with closed throttle. Make tight **S** turns while decelerating until speed is reduced to 13 km/h (8 mph).

4.3.6 Repeat 4.3.5 four times (five cycles total).

4.3.7 Enter water trough with left wheels.

4.3.8 Stop when both left wheels have entered the trough making sure wheels are aligned straight in the trough.

4.3.9 Record odometer, axle lube temperature, and ambient temperature Data Sheet A3 in Appendix A.

4.3.10 Apply service brake.

4.3.11 Apply full throttle in low range or first gear, then release service brake.

4.3.12 Continue full throttle until left wheel stops spinning or a maximum of 17 m (55 ft) of vehicle travel with left wheel spinning.

4.3.13 Stop vehicle.

4.3.14 Reverse vehicle and back up into trough (one cycle).

4.3.15 Run the requested number of cycles (as defined in 4.3.7 through 4.3.14) at requested intervals. **Note:** It is recommended to alternate cycles so that five (5) cycles are run on driver's side large frictional coefficient (μ) surface, i.e., "hi-Mu", then five (5) cycles on driver's side small μ surface, i.e., "low-Mu".

4.3.16 Inspect differential components at intervals requested. **Note:** It is recommended that new materials/new technology type components be inspected at ten (10) cycle intervals (to capture buds of problems such as gear and pin scoring). For validation of established components, recommended inspection intervals are every 50, or more, cycles as required by Requesting Engineer.

4.3.17 Inspection Procedure.

4.3.17.1 Drain lubricant into a container and note foaming, metal contamination, or other peculiarities in the lubricant.

4.3.17.2 Remove differential case assembly internal parts and rate per Subjective Rating Scale shown on GMW14264. Record these ratings on Data Sheet A3 in Appendix A. Mark internal parts to permit as tested reassembly.

4.3.17.2.1 Record scoring and wear of the differential shaft and pinion gear bores.

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