



Accelerated Drivetrain Durability for Manual Transmission Equipped Vehicles

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 evaluate the performance of manual transmissions (particularly synchronizers), clutches, axles and prop shafts after being subjected to severe loads resulting from aggressive type of driving.

1.2 Applicability. Passenger cars, multipurpose passenger vans, and light commercial vehicles equipped with manual transmissions.

1.3 Remarks. This test is typically run by Global Propulsion Systems and is used for development and validation of the transmission synchronizers. It is also used for validation and development of the drivetrain system. This system includes, but is not limited to, driveshaft, half shafts, axles, suspension bushings, etc.

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

2.3 Additional References

- Analysis/Development/Validation (ADV) Plan
- Drawings for driveline components (i.e. axles, propshafts, transmissions, etc.)
- Statement of Requirements (SOR)
- Subsystem Technical Specification (SSTS)
- Validation Cross Reference Index (VCRI)
- Vehicle Technical Specification (VTS)

3 Resources

3.1 Facilities. Equivalent roads with similar friction characteristics may be acceptable.

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 Milford Proving Ground (MPG) – North-South Straightaway.

3.1.4 Desert Proving Ground Yuma (DPGY) – 2.3 km (1.4 mi) Straightaway.

3.1.5 Dudenhofen High Speed Track.

Note: Equivalent roads with similar friction characteristics may be acceptable. For performance oriented vehicles where customer usage is expected to include drag racing, the tests should be run on prepared drag racing

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surface (i.e., testing and/or Road Load Data Acquisition (RLDA) at actual drag racing facility on prepared surface).

3.2 Equipment.

3.2.1 Transmission, axle oil sump, clutch bell housing and ambient thermocouples and temperature display.

3.2.2 Calibrated tachometer or equivalent.

Note: All instrumentation shall be calibrated as required. Record instrumentation details and date of calibration (Appendix A, Data Sheet A1), unless information is obtainable in the testing laboratory records or otherwise.

3.3 Test Vehicle/Test Piece. Vehicle shall be equipped for driveline being tested with:

- Highest torque engine.
- Wheels and tires that produce the highest rotating inertia; typically, the largest released diameter and highest mass wheel/tire combination.
- Tires that produce the highest tractive effort.
- Lowest numerical final drive ratio.

Note: If highest inertia engine does not correspond with highest torque, multiple tests may be required. Impact load during launch and shift are inertia dependent. Steady state driveline loads during Wide Open Throttle (WOT) accelerations are dependent on engine torque.

3.3.1 Vehicle Ballast. Production intent vehicle curb weight, plus driver and equipment.

3.3.2 Clutch. New clutch assembly with measured clamp load that is within the design intent tolerance zone.

3.3.3 Clutch Hydraulic. Production intent clutch hydraulics with intended restrictive orifice Peak Torque Limiter (PTL) and damper, if applicable. Production intent clutch pedal return spring/over center spring, as released for the vehicle.

3.3.4 Transmission synchronizer with measured "wear gap," if applicable.

3.3.5 Drivetrain Hardware. All drivetrain hardware that is being validated should be new.

3.4 Test Time.

Calendar time: 7 days

Test hours: 40 hours

Coordination hours: 16 hours

3.5 Test Required Information. 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 for driveline components (i.e. axles, propshafts, transmissions, etc).

3.6 Personnel/Skills. Ability to evaluate driveline noise in vehicles, according to GMW14264. Ability to conduct end of test inspection of test parts if required.

4 Procedure

4.1 Preparation.

4.1.1 Prior to the test, assure that Appendix B, Data Sheet B1 is available and complete the following:

4.1.1.1 Determine and record the number of test starts, as defined in 4.3. Use 200 test starts as a default and at least one (1) set of hardware to 500 cycles for development tests.

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4.1.1.2 Determine and record if engine shall be revved for starts to other than launch engine speed $n = 4000$ rpm. Collect road load data at performance launch control algorithm speed (if available) and at 500 rpm increments from maximum engine speed (in rpm) down to 2500 rpm to determine peak driveline torque. The launch engine speed (n) is equal to the engine speed that coincides with the peak driveline torque.

4.1.1.3 Determine and record maximum transmission and axle lubricant excursion and maximum continuous operating temperatures for test.

4.1.1.4 Record tire pressure specifications.

4.1.1.5 Determine and record responsible owner for disassembling transmission/axle or components (e.g., GM or Supplier).

4.1.2 Check all fluid levels. Fill as required.

4.1.3 Set tire pressure to recommended specifications.

4.1.4 Install instrumentation to measure ambient temperature and transmission and axle lubricant temperatures. Install calibrated tachometer.

4.1.5 Pretest Rating. According to GMW14264.

4.1.5.1 Rate drivetrain for pretest noise using GMW14264, and record on Appendix B, Data Sheet B1.

4.1.5.2 Rate leaks using GMW14264 and record on Appendix B, Data Sheet B1.

4.1.5.3 Put vehicle on hoist and conduct inspection on:

- Engine Mounts.
- Suspension.
- Frame and Body Supports.
- Axle Housing.
- Other reaction supporting members.

4.1.6 Break-In. A break-in is recommended for new engines and transmissions. It is mandatory if a new axle is installed on a test vehicle.

4.1.6.1 Complete as follows:

- Accelerate lightly to 100 km/h (65 mph) using normal shifts, then vary vehicle speed between 100 km/h and 125 km/h (65 mph to 75 mph). Upshift every 5 km (3 mi) and lightly accelerate through top gear.
- Decelerate lightly, while downshifting normally at 3000 rpm, to a stop.
- Repeat cycles as above until a distance of 200 km is attained. A minimum of 200 km is mandatory if rear axle is included in the validation (in such case measure axle sum temperature during the break-in of the transmission).

4.2 Conditions.

4.2.1 Environmental Conditions.

4.2.1.1 Road must be dry.

4.2.1.2 Ambient temperature should be between -7°C to 27°C . High ambient temperatures are not desired since engine power is lowered and may affect test results.

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.

4.2.2.1 Axle lubricant temperature must be 70°C minimum before starts are made.

4.2.2.2 Maximum temperature allowed either on transmission or axle lubricants is determined by the engineer and recorded on Appendix B, Data Sheet B1. Run cooling laps if necessary to cool lubricants as required.

4.2.2.3 If traction control is available as a "driver selected option", it must be turned off during the test.

4.2.2.4 If vehicle powerhops during launch, contact the test engineer for determination whether to mitigate it or to complete the test with powerhop. Comment on method of mitigation in Appendix B, Data Sheet B1.

4.2.2.5 If vehicle has Active Rev Match, determine how to disable it for downshifts.

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4.3 Instructions.

Note: Terminate test if:

- Transmission oil temperature or rear axle temperature exceeds short or long term permissible value according to oil type and specifications.
- Engine temperature exceeds permissible value. If occurring, usually displayed on the vehicle's display.
- Shift system component temperatures exceed permissible value, according to material specifications; particularly with regard to shift system validation test performance.

4.3.1 Perform test according to defined total number of cycles for validation. Predefined total number of cycles per test is either 200 cycles or 500 cycles. Reference 4.1.1.1.

For development, the test may be performed according to total number of test cycles specified by engineer.

Record the ambient air, transmission and axle lubricant temperature at the start of the test and after every 10 cycles (Appendix C, Data Sheet C1).

4.3.2 Launch.

4.3.2.1 Launch Engine Speed.

4.3.2.1.1 Cycles 1 thru 30. Perform at engine speed as determined in 4.1.1.2, with traction control switched off.

4.3.2.1.2 Cycles 31 thru 200. Perform at vehicle performance launch control rpm and with vehicle performance launch control activated. Vehicles without performance launch control, perform at $n = 4000$ rpm.

4.3.2.2 Launch Method.

4.3.2.2.1 Cycles 1 thru 30. Rapid clutch engagement (see section 7), maintain throttle and allow initial tire spin for 0.5 s, (this should be 0.5 s) followed by releasing throttle to regain traction, then accelerate to WOT at the maximum rate allowable without slipping tires.

4.3.2.2.2 Cycles 31 thru 200. Quick clutch engagement (see section 7) followed by maximum acceleration rate obtainable without breaking tires traction, then WOT.

4.3.2.2.3 Cycles 201 thru 500 (if required). Quick clutch (see section 7) followed by maximum acceleration rate obtainable without breaking tires traction, then WOT.

4.3.3 Upshift.

4.3.3.1 Upshift Engine Speed. All next upshifts at approximately engine redline (200 rpm below fuel cutoff).

4.3.3.2 Upshift Method.

4.3.3.2.1 Cycles 1 thru 200. Speed Shift (see section 7) through all gears until peak vehicle test speed is reached (see 4.3.3.3). At peak vehicle test speed, maintain speed and shift normally through the remaining gears, then lift throttle and downshift as specified (see 4.3.4).

4.3.3.2.2 Cycles 201 thru 500. Quick Shift (section 7).

4.3.3.3 Speed Restriction/Peak Vehicle Test Speed. Recommended maximum is at 220 km/h. Deviation from this maximum is at engineer's discretion based on test track/vehicle.

Note: Speed limit for specific facility may require prior permission. Request permission based on peak vehicle speed, or according to SSTS requirement.

4.3.4 Downshift.

4.3.4.1 Downshift Engagement. Upon reaching peak vehicle test speed, lift throttle and allow the vehicle to coast. Select engine speed without over revving. Engage standard clutch engagement and ensure tire traction not to be broken (if such case occurs, release the clutch less rapidly). For shift time, refer to section 7.

4.3.4.2 Downshift Engine Speed. Engine rpm in target (lower) gear is between 95% and 100% of fuel redline (i.e., 0 rpm to 50 rpm below engine redline)

Note: Active Rev Match should not be used on cars so equipped.

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