



Vehicle Dynamometer Procedure Active Fuel Management - Equivalent Fuel Consumption

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. This test procedure is used to assess vehicle level EFC (Equivalent Fuel Consumption) for vehicles with AFM (Active Fuel Management). This test can be used to verify that tested hardware performs consistently with analytical models. Testing can be performed utilizing a two wheel drive (2WD) or four wheel drive (4WD) chassis roll or spindle coupled dynamometer.

1.2 Applicability. The test procedure described applies to vehicles with Active Fuel Management (AFM) cylinder deactivation technology.

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.

Global Energy Library - [https://share.gm.com/sites/GEAETL/Pages \(ID\)](https://share.gm.com/sites/GEAETL/Pages/(ID))

(ID) = This website is limited to internal use within General Motors and shall not be accessed outside this company. Contact the GM Lead Engineer for further instructions.

3 Resources

3.1 Facilities. This test procedure is intended for a General Motors managed dynamometer facility.

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. This procedure assumes that adequate physical equipment to measure fuel consumption is available and installed. The following sections provide a partial list of the equipment required. Other equipment may be substituted at the discretion of the testing facility as long it provides the same data and/or data record, with equivalent accuracy as specified herein or by the requestor.

3.2.1 Dynamometer Test Cell. This procedure is written for testing a full vehicle on a spindle coupled or chassis roll type dynamometer. The capability to accurately simulate the vehicle loading via 3-term road load coefficients (F0, F1, and F2) is required.

3.2.2 Fan/Air Stream. Testing shall be conducted with an external (test cell) cooling fan placed in front of vehicle. The coolant fan speed and/or spot coolers will be used to maintaining stable (+5 °C/-0 °C) engine and transmission operating temperatures during testing. The preferred option is a road speed cooling fan to represent real world vehicle operation. The road speed fan from Prime One with 1050 m³/minute outlet flow rate is

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recommended. If road speed cooling fan is not available, a fixed speed fan and spot coolers can be used to maintain a relatively steady fluid temperature profile during sampling time.

3.2.3 Drive Robot. The robot replaces the real driver. It controls clutch, brakes, throttle travel and gear changing as well as launching and stopping of the vehicle. The drive style parameters need to be optimized to provide stable and consistent operation. If robot driver operation is not stable and consistent, utilizing the in-vehicle cruise control system is a viable alternative approach.

3.2.4 Fuel Flow Meter. A method for measuring fuel consumed is required. It is highly recommended that an in-line volumetric fuel flowmeter be used. The meter should be installed as close to the fuel injectors as possible.

- E.g., Pierburg PLU, Max Machinery P213, AVL PLUtron or equivalent.

3.2.5 Instrumentation. Instrumentation with the ability to collect and control engine and transmission functions (ETAS/Inca) along with dynamometer operation variables is required.

3.3 Test Vehicle/Test Piece. Vehicle must contain instrumentation and instrumented controllers (i.e., ETAS/INCA and instrumented Engine Control Unit (ECU) and Transmission Control Unit (TCU) or equivalent instrumentation to record and control necessary engine and transmission parameters and functions).

3.4 Test Time.

Calendar time: 3 d

Test time: 16 h

Coordination time: 8 h

3.5 Test Required Information. The following information shall be supplied by the test requestor, using the units specified:

- Program Designation.
- Vehicle identification number (VIN) or GM Fleet number.
- Model Year, Brand, Model, Trim Level (e.g., 2018 Chevrolet Traverse LTZ).
- Regular Production Options (RPO) (including engine, transmission, axle).
- Tire size (revolutions per kilometer (rpk)), construction number, cold inflation pressure.
- Drive Type (e.g., FWD, RWD, full-time AWD, part-time AWD, selectable 4WD).
- Final Drive Ratio.
- Inertial Weight Class (IWC) or Environmental Protection Agency (EPA) Equivalent Test Weight (ETW) (lb).
- Road Load Coefficients (F0, F1 and F2).
- Engine RPO, displacement, configuration, aspiration (e.g., LGX 3.6L V6 NA).
- Engine software levels and calibration file names
- Transmission RPO, Model, Type (e.g., MN8, 8L90E, 8 speed RWD Automatic)
- Transmission software levels and calibration file names
- Desired gear state for each vehicle speed interval (manual transmission/automatic if required).
- Test Fuel (e.g., Tier 3 Cert E10 Regular)
- Vehicle speed points in full cylinder mode that align with target engine speed per Table 1, as applicable.

Table 1: Target Vehicle Speed

Target engine speed (rpm)	1000	1250	1500	1750	2000	2250
Gear closest to 1:1 ratio	XX km/h	km/h	km/h	km/h	km/h	km/h
Top Gear	YY km/h	km/h	km/h	km/h	km/h	km/h

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3.6 Personnel/Skills. Prior experience in setting up and running similar tests and experience in the use of the referenced test equipment. Trained technicians to operate dynamometer needed.

4 Procedure

4.1 Preparation.

4.1.1 Vehicle Documentation. Ensure that test required information is documented. Most of these items are required for the Energy Lab Test Request system.

4.1.2 Vehicle Preparation. Vehicles should be prepared by test requestor. Vehicle should be in test ready condition per the checklist (Figure B1 in Appendix B).

4.1.3 Dynamometer Preparation. The dyno loading will be based on certification test mass and corresponding 3-term (F0, F1 and F2) road load coefficients representative of a nominal vehicle.

4.1.4 Data Logging. The following signals must be recorded during the testing, using the units specified.

- Vehicle Speed (km/h)
- Engine Speed (rpm)
- Engine Brake Torque Managed (N·m)
- Engine Indicated Torque (N·m)
- Fuel Mass Flow Rate (L/s, gal/s)
- Catalytic Converter Temperatures (°C)
- Engine Oil Temperature (°C)
- Engine Coolant Temperature (°C)
- Intake Manifold Temperature (°C)
- Transmission Oil Temperature (°C)
- Manifold Absolute Pressure (MAP) Sensor (kPa)
- Transmission Gear Attained
- AFM Number of Cylinders Deactivated or Firing Fractions
- Accelerator Pedal Position (%)
- Throttle Blade Position (%)
- TCC Slip Speed (rpm)
- TCC Slip Error
- TCC Mode
- Purge Flow Command
- Total or Final Spark Advance (degrees BTDC)
- Spark Offset due to Intake or Manifold Air Temperature (degrees BTDC)
- Spark Offset due to Coolant Temperature (degrees BTDC)
- Engine Total Knock Spark Retard for average of all Active Cylinders (degrees BTDC)
- Intake Cam Phaser (advance degrees – BTDC)
- Exhaust Cam Phaser (retard degrees – BTDC)
- Delivered Air per Cylinder – APC (mg/cylinder/cycle)
- Desired Air per Cylinder – APC (mg/cylinder/cycle)
- Dyno Force (N) or Torque (N·m) [Vehicle dyno signal]
- Dyno Fuel Meter Reading (cm³/s) [Vehicle dyno signal]

4.2 Conditions.

4.2.1 Environmental Conditions. Testing will be conducted in a temperature controlled dynamometer room with an ambient temperature of 19 °C to 25 °C.

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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 Test Procedure

4.3.1.1 In-Vehicle EFC for Normal Operation Mode.

4.3.1.1.1 Step 1. Vehicle setup as per Appendix B.

4.3.1.1.2 Step 2. Warmup. Run two EPA Highway cycles to achieve target operating temperatures.

- Operating temperatures should equate to temps at the end of FTP/Hwy cycle or be controlled with the test cell cooling fan to maintain equivalent operating temperatures between runs. (Under-coolers can be utilized when necessary). Operating temperatures should not vary ± 5 °C run to run to ensure consistency. If > 5 °C, run a normalization cycle to normalize temperatures.

4.3.1.1.3 Step 3. Select transmission gear (establish vehicle speed prior to gear selection to alleviate stalling) using ETAS instrumentation. Select top gear and gear with closest to 1:1 ratio as initial test conditions. Further gears can be selected for further testing where time permits.

4.3.1.1.4 Step 4. Disable Active Fuel Management (AFM) using ETAS instrumentation.

4.3.1.1.5 Step 5. Dyno should be in Throttle RLS mode, and pedal will be controlled with drive robot.

4.3.1.1.6 Step 6. Set fixed vehicle speed per Table 1 (see 4.3.1.3 Remarks). Lock gear. Set negative starting grade to a torque match point approximately 30 N·m to 35 N·m (If too low torque value, slip levels may increase for stall compensation). Start recording data in INCA and dyno. Linearly increase grade on dyno at a rate of 0.03%/s. The maximum grade will be above Full Range Performance Assessment (FRaPA) EFC torque and below engine maximum torque at that engine speed.

4.3.1.1.7 Step 7. Save data and return ECU and TCU settings to normal operation.

4.3.1.1.8 Step 8. Repeat for prescribed engine speeds per Table 1.

4.3.1.2 In-Vehicle EFC for Cylinder Deactivation Mode or Specified Firing Fraction Test Procedure.

4.3.1.2.1 Step 1. Vehicle setup as per Appendix B.

4.3.1.2.2 Step 2. Warmup, if required. Run two EPA Highway cycles to achieve target operating temperatures.

- Operating temperatures should equate to temps at the end of FTP/Hwy cycle or be controlled with the test cell cooling fan to maintain equivalent operating temperatures. (Under-coolers can be utilized when necessary).

4.3.1.2.3 Step 3. Select transmission gear (establish vehicle speed prior to gear selection to alleviate stalling) using ETAS instrumentation. Select top gear and gear with 1:1 ratio as initial test conditions. Further gears can be selected for further testing where time permits.

4.3.1.2.4 Step 4. Activate AFM or Specified Firing Fraction using ETAS instrumentation.

Note: Set NVH torque limit table to 999 in all cells so full AFM operation is enabled without restriction.

4.3.1.2.5 Step 5. Dyno should be in Throttle RLS mode, and pedal will be controlled with robot.

4.3.1.2.6 Step 6. Set fixed vehicle speed per Table 1 (see 4.3.1.3 Remarks). Lock gear. Set negative starting grade to a torque match point approximately 30 N·m to 35 N·m (If too low torque value, slip levels may increase for stall compensation). Start recording data in INCA and dyno. Linearly increase grade on dyno at a rate of 0.03%/s. The maximum grade will be decided by grade at which the pedal position starts increasing (typically beyond 30%) without corresponding increase in engine torque.

Note: In Cylinder Deactivation Mode or Specified Firing Fraction, engine speeds will be higher due to higher torque converter slip at same vehicle speed as Full Cylinder Mode.

4.3.1.2.7 Step 7. Save data and return ECU and TCU settings to normal operation.

4.3.1.2.8 Step 8. Repeat for prescribed engine speeds per Table 1.

4.3.1.2.9 Step 9. Repeat 4.3.1.2 for additional Firing Fractions if desired.

4.3.1.3 Remarks.

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