



Gaseous Fuel Engine Warmed-Up Driveability – Subjective Evaluation

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 subjectively evaluate the driveability characteristics of a gaseous fueled vehicle after the powertrain has reached normal operating temperature.

1.2 Applicability. Passenger cars and light duty trucks equipped with mono-fuel or bi-fuel systems. The gaseous fuel can be Compressed Natural Gas (CNG) or Liquefied Petroleum Gas (LPG).

1.3 Remarks. This procedure documents the process for developing and validating the warmed-up driveability characteristics of a gaseous fueled vehicle.

This procedure may be used to evaluate the engine driveability characteristics of prototype vehicles or for auditing production vehicles. It consists of a specific series of maneuvers that are designed to simulate customer usage. Any vehicle rating generated by less than the full test sequence should be identified when presenting test results.

The vehicle rating may be affected by ambient temperature, fuel, and the road system used. Fuel used should be appropriate for ambient conditions as specified by the Requesting Engineer or as specified in the Vehicle Owner's Manual.

GMW17150 should be used for subjectively evaluating gaseous fueled engine cold starting capability and driveability characteristics.

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 GMW17150

2.3 Additional References.

- Emission Control Information Label
- Powertrain Gaseous Fuel Engine Management System (EMS) Fuel Delivery Subsystem Technical Specification (SSTS)
- Vehicle Owner's Manual
- Vehicle Technical Specification (VTS)

3 Resources

3.1 Facilities. Level, smooth, dry paved roads free of traffic are preferred. This procedure may be used on a chassis dynamometer, but the results may not correlate directly with road test results.

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.

- a. Stopwatch
- b. Thermometer or Thermocouple readout
- c. Clipboard for datasheet or,
- d. Laptop/notebook computer

Note: All instrumentation must be calibrated. Record instrumentation details and the date of calibration in the test records unless the information is otherwise preserved in the testing facility records.

3.3 Test Vehicle/Test Piece. The test vehicle to be evaluated using the recommended start procedure intended for inclusion in the Vehicle Owner's Manual.

3.4 Test Time.

Calendar time:	1 day
Test minutes:	25 minutes
Coordination hours:	1 hour

3.5 Test Required Information.

- Fuel quantity (level or pressure)
- Fuel composition
- Software/Calibration/EMS hardware level
- Altitude above sea level

3.6 Personnel/Skills. Engineering test personnel with powertrain experience in engine calibration, dynamic vehicle testing and, drive quality testing is recommended. Prior experience in conducting similar tests is critical to achieving repeatable, objective and accurate results.

The Lead Calibrator for the Gaseous Fuel EMS is responsible to provide a calibration that is suitable for testing and representative of production intent.

During test, the lead calibrator or alternative should be available for consultation.

The Validation or Quality Engineer is responsible to assure that the test is successfully completed by either participating in or monitoring the testing and resulting data from others.

4 Procedure

4.1 Preparation.

4.1.1 Vehicle Instrumentation. The minimum instrumentation required is a thermocouple to record the temperature of the ambient air. At the request of the Test Engineer, additional thermocouples may be added.

Install a thermocouple readout or data acquisition equipment (if used). Confirm the connections are correct and that the equipment operates at low ambient temperatures.

4.1.2 Vehicle Preparation.

4.1.2.1 Confirm all engine, fuel, cooling, Exhaust Gas Recirculation (EGR), Positive Crankcase Ventilation (PCV), air induction and exhaust system components are production intent and installed correctly.

For production audit purposes, the test vehicle should conform to specifications in the Vehicle Owner's Manual and Emission Control Information Label.

4.1.2.2 Confirm that the engine and gaseous fuel controls calibration and software are production intent. For engineering development or validation purposes on prototype vehicles, the status of the Gaseous Fuel EMS components, software and calibration must be recorded.

4.1.2.3 Confirm that the engine coolant provides adequate protection for -40 °C (-40 °F).

4.1.2.4 The gaseous fuel container must be at least one-half full. The gaseous fuel must be the correct composition for the ambient temperature test conditions.

For bi-fuel vehicles, the gasoline/petrol fuel tank must be at least one-half full with the correct seasonal blend for the ambient temperature test conditions.

4.1.2.5 Record the vehicle details, fuel and initial test conditions on the included data sheet or electronic equivalent.

4.1.3 Test Preparation. Before testing the vehicle, it must be driven for warm-up and normalization as in Table 1:

Table 1: Normalization Distance

Ambient Temperature	Distance
≥ -18 °C (10 °F)	16 km (10 mi)
< -18 °C (10 °F)	32 km (20 mi)

The normalization drive shall include five idle periods of 10 s to 30 s duration. Vehicle speed shall not exceed 80 km/h (50 mph).

For saleable, pilot or production vehicles:

- Any base engine or EMS repairs required because of a malfunction during the test preparation shall be penalized 12 demerits.
- If a warning light (e.g., Malfunction Indicator Lamp (MIL), oil, etc.) appears during the vehicle preparation and/or test, complete the test, if possible, and penalize the vehicle 12 demerits.

4.2 Conditions.

4.2.1 Environmental Conditions. This test procedure can be conducted in all types of weather, but not when winds exceed 25 km/h (15 mph) or with gusts above 40 km/h (25 mph).

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. Manual transmissions and automatic transmissions with manual shift control are to be shifted as specified in the Vehicle Owner's Manual for normal driving or at the vehicle speeds indicated by the in-dash shift light. Up-shifts may be made at lower speeds if the vehicle will be cruising at a speed below the recommended acceleration shift points.

With manual transmissions, deceleration to a stop should be with the clutch pedal depressed (disengaged). Avoid deceleration with the transmission in gear, clutch engaged, as this can force the engine into an under speed condition.

Automatic transmissions and transmissions tested in automatic mode are to be evaluated in the highest drive gear position.

Automatic transmissions that provide manual shift control, e.g., **TAPshift**, should be evaluated in each shift mode (two separate tests).

Vehicles equipped with traction control should be evaluated with the system enabled.

The fractional throttle positions for acceleration maneuvers are proportional to full pedal travel.

The accelerations should be performed by quickly applying throttle until the desired pedal position is reached, and then maintaining the pedal position until achieving the desired vehicle speed.

For bi-fuel vehicles, record the fuel mode used, Petrol or Gaseous, during each test maneuver. Use the in-dash fuel mode light or on-board development instrumentation to determine fuel mode.

If a warning light (e.g., MIL, oil, etc.) appears during the test, complete the test, if possible.

Turn on all available electrical accessories except for the sound system, which should be turned off.

Set the heater/air conditioner controls to provide the highest electrical and mechanical loads on the engine at the minimum tolerable temperature level. The radio/sound system and fan settings are required to provide a quiet ambient for assessing engine roughness, detonation and dieseling.

Note: The electrical loads may be changed at the direction of the test engineer.

4.3.1 Standing Accelerations and Cruises.

Conduct the warmed-up driveability evaluation immediately after the test preparation in 4.1.3. Record results on either Data Sheet B1 or Data Sheet B2, Appendix B. The following maneuver sequence is mandatory.

1. Stop and idle for 10 s.
2. $\frac{1}{4}$ throttle acceleration to 50 km/h (30 mph).
3. 50 km/h (30 mph) steady state cruise.
4. Stop and idle for 10 s.
5. Interrupted acceleration maneuver; rapidly apply $\frac{1}{2}$ throttle acceleration, followed immediately by a full brake stop. Total vehicle travel must be no greater than 1.0 m (approximately 3 ft).
6. $\frac{1}{2}$ throttle acceleration to 55 km/h (35 mph).

7. 55 km/h (35 mph) steady state cruise.
8. Stop and idle for 10 s.
9. $\frac{3}{4}$ throttle acceleration to 70 km/h (45 mph).
10. 70 km/h (45 mph) steady state cruise.
11. Light throttle acceleration to 80 km/h (50 mph).
12. 80 km/h (50 mph) steady state cruise.
13. Stop and idle for 10 s.
14. Wide Open Throttle (WOT) acceleration to 90 km/h (55 MPH).
15. 90 km/h (55 MPH) steady state cruise.

4.3.2 Rolling Accelerations and Cruises.

16. Closed throttle coast to 50 km/h (30 mph) and steady state cruise.
17. $\frac{1}{4}$ throttle acceleration to 80 km/h (50 mph).
18. Closed throttle coast to 50 km/h (30 mph) and steady state cruise.
19. $\frac{1}{2}$ throttle acceleration to 80 km/h (50 mph).
20. Closed throttle coast to 50 km/h (30 mph) and steady state cruise.
21. $\frac{3}{4}$ throttle acceleration to 80 km/h (50 mph).
22. Closed throttle coast to 50 km/h (30 mph) and road load cruise.
23. WOT acceleration to 80 km/h (50 mph) and closed throttle coast to idle.

4.3.3 Hot Idle. Evaluate hot idle in neutral for manual transmissions with clutch released and in drive for automatic transmissions, both when service brakes are applied.

24. Idle for 1 minute with Air Conditioning (A/C) on (if equipped) without steering input.
25. Idle for 1 minute with A/C on (if equipped) while making a full left to right, stop to stop steering input. Return wheel to center.
26. Idle for 1 minute with A/C off (if equipped) without steering input.

4.3.4 Hot Restart and Driveability.

27. Stop the engine and soak the vehicle at ambient temperature for 5 minutes.

Leave A/C system in the on position (if equipped). Restart engine as directed in the Vehicle Owner's Manual or by the test engineer. Record the restart time and the fuel used for starting. Assign one demerit for each second of cranking time over 1 s.

28. Idle in Neutral (manual transmission) or Park (automatic transmission), for 10 s.
29. $\frac{1}{2}$ throttle acceleration to 50 km/h (30 mph).
30. 50 km/h (30 mph) steady state cruise.
31. Stop and idle for 10 s.