



Steady State Fuel Economy Validation

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. The purpose of this document is to define the procedure for measuring the steady state fuel economy over a range of vehicle at speeds. The speeds to be tested are:

- Mandatory: Speeds at 60 km/h, 90 km/h, and 120 km/h
- Optional: Speeds at 32.2 km/h (20 mph), 48.3 km/h (30 mph), 64.4 km/h (40 mph), 80.5 km/h (50 mph), 96.6 km/h (60 mph), 112.7 km/h (70 mph), and 128.7 km/h (80 mph)

Note: mph = mile per hour

The preceding “mandatory” speeds listed are intended to be common test points across all regions. These speeds **must** be tested. The speeds listed as “optional” are specific to GMNA, and can be modified (or deleted) by other regions. They are provided for reference only. Any region is free to add or delete speeds to their Vehicle Technical Specifications (VTS) based on their applicability to their customer.

1.2 Applicability. This procedure applies to vehicles designed for sale in any region. For regions outside of North America, they may choose to measure steady state fuel economy at additional speeds that they define – designed to more closely match customer usage in that region. The 60 km/h, 90 km/h, and 120 km/h speeds must always be tested.

The procedure is applicable to vehicles equipped with either automatic or manual transmissions.

1.3 Remarks. In order for General Motors vehicles to meet the expectations of our customers, it is imperative that they have class-leading fuel economy. Verifying the steady state fuel economy at the speeds listed in 1.1 will ensure:

- That customer expectations are met.
- That energy development engineers have the capacity required to meet their fuel economy targets for on-cycle (e.g., Federal Test Procedure (FTP)) and off-cycle (e.g., GMW15963 Northeast Off Cycle (NEOC)) fuel economy.

This procedure is related to Vehicle Technical Specifications (VTS) on steady state fuel economy. This allows GM to highlight potential issues early in the development process.

2 References

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

2.1 External Standards/Specifications.

None

2.2 GM Standards/Specifications.

GMW15963 (ID)

Note: (ID) = This standard is limited to internal distribution within General Motors and shall not be distributed outside this company. Contact the GM Lead Engineer for further instructions.

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2.3 Additional References.

- Federal Test Procedure (FTP) for fuel economy.
- NeoVI Fire device and Vehicle Spy software made by Intrepid Control Systems.
- Vehicle Technical Specification (VTS).

3 Resources

3.1 Facilities. 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.

3.1.1 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. Testing will be conducted with an external (test cell) cooling fan placed in front of vehicle. The larger the cooling fan, the better for maintaining stable engine operating temperatures during testing. A fan with a minimum flow of 4719.5 L/s (15 000 ft³/minute) is recommended.

A method for measuring fuel consumed is required. This can either be done via an in-line fuel flowmeter or by using an emissions bench and sampling bags.

3.3 Test Vehicle/Test Piece. The test article (vehicle) shall be supplied by the requestor in excellent operating condition. There shall be no performance or cooling system deficiencies.

3.4 Test Time.

Calendar time:	0 days
Test hours:	3 h
Coordination hours:	0 h

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

- Program Designation.
- Vehicle number.
- Model year.
- Model number.
- Model name.
- Regular Production Options (RPO) (including engine, transmission, axle).
- Tire size (revolutions per kilometer (rpk) or revolutions per mile).
- Tire make/model/pressure.
- Environmental Protection Agency (EPA) test weight class (lb).
- Road Load Coefficients (F0, F1 and F2)

3.6 Personnel/Skills. Qualified dyno operator.

4 Procedure

4.1 Preparation.

4.1.1 Dyno Preparation. The dyno loading will be based on 3-term (F0, F1 and F2) road load coefficients. In order to generate data that accurately represents our products, it is critical that the road load coefficients used are:

- a. not “optimized” for fuel economy, and
- b. representative of a typical customer vehicle.

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If the available road load coefficients do not meet the preceding list criteria, a development coastdown is required prior to test to generate accurate loading information. It is strongly encouraged that several development coastdowns be conducted during the initial production builds.

Input to the dyno for inertia simulation shall be certification test weight class for the given region (EPA test weight class (TWC) for GMNA). If the content of the actual vehicle chosen for test exceeds TWC due to option content, the dyno-simulated inertia input shall be adjusted upwards to reflect the true mass of the vehicle (including 68 kg (150 lb) driver and fluids).

Note: A Development coastdown is run using procedures similar to a certification test except that there are less stringent requirements, e.g., trim heights are not measured, no soaks periods are required, the brakes are not checked, etc. A development coast also does not use the boom/anemometer setup for wind correction, so it is typically run in low wind conditions to eliminate the need to correct the results for wind effects. Data (vehicle speed and time) is taken using serial data from a device such as a NeoVI serial data tool. Setup for this test is much quicker than a certification test.

4.1.2 Vehicle Preparation. Ensure that the vehicle is fueled with the correct fuel. It is recommended that regional certification fuel be used. In GMNA, this would be Reformulated Gasoline (RFG) Tier 2 Higher Sulfur EPA Certification Fuel. If premium fuel is recommended, then it must be used (RFG Tier II fuel is premium fuel). If alternate fuels are used, then the test report must clearly state that in the results. For example, if eighty-five percent (85%) Ethanol (E85) fuel is used (with the intent of measuring the associated degradation in fuel economy), the header of the test report must **clearly** state the results are for E85 in that case.

Verify that the battery is fully charged.

Preparations are also required to allow for the measurement of fuel flow/consumption. This can either be done using a fuel flowmeter or by sampling exhaust emissions.

It is highly recommended that an in-line fuel flowmeter be used. The meter can be installed at either of two locations:

- the fuel line connections at the fuel tank, or
- the top of the engine.

If the exhaust sampling method is to be used, it may be necessary to modify the tailpipe to ensure that the connection to the sampling hose can be made easily and is free of leaks.

Ensure that there are adequate vehicle tie-downs (to the frame) for the dyno being used.

4.1.3 Instrumentation. The following signals must be recorded during the testing, using the units specified. This data is typically gathered via monitoring of the vehicle controller area network bus (CANBUS) via a controller area network (CAN) interface device. The hardware/software standard for this within GM has been the "NeoVI Fire" device and "Vehicle Spy" software made by Intrepid Control Systems.

- Engine speed (rpm).
- Vehicle speed (km/h).
- Distance (km (mi)).
- Oil temperature (degree C or degree F).
- Fuel flow rate (cm³/s).
- Fuel accumulation (cm³ or liter).

In addition, it is recommended that the following channels be monitored via Class II interface:

- Battery Voltage (V).
- Battery Current (A).
- Battery State of Charge (%).
- Regulated Voltage Control (RVC) Mode (record the mode number (not necessarily the RVC version)).
- Engine Cooling Fan Speed (rpm or %).
- Spark Advance (degree).
- Throttle Position (%).
- Accelerator Pedal Position (%).

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