GM WORLDWIDE ENGINEERING STANDARDS	Test Procedure	GMW17149

Long Drive Icing Test for Gaseous Fueled 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 susceptibility of a vehicle to powertrain icing, under long drive conditions.

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. When vehicles are driven for long periods of time, at conditions just over the freezing point and with high humidity, the probability of ice forming inside the throttle body, induction, or Positive Crankcase Ventilation (PCV) system increases. This is due to the airflow induced pressure drop through the induction system and throttle causing the temperature of the air entering the engine to drop under the freezing point. When the humidity of the intake air is high, the probability of ice forming is greater. Secondary sources of water vapor are the engine blow-by through the PCV system and from the Exhaust Gas Recirculation (EGR) system. The throttle body area is susceptible for two (2) reasons; it is located close to the exit point for both PCV and EGR, and due to interior airflow, it is normally cooler than surrounding parts. Vehicles operating on CNG and LPG are more sensitive to icing because gaseous fuels produce more water vapor during combustion compared to gasoline.

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. None.

3 Resources

3.1 Facilities. A vehicle test facility having a level, reasonably smooth track, with an appropriate layout for uninterrupted drives at 100 km/h (62 mph). The test facility and track must be operational when the ambient temperature is under 2 °C (36 °F).

The General Motors Cold Weather Development Center in Kapuskasing, Ontario, Canada, or the equivalent, is recommended.

This procedure can be used in a climate controlled room with 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.

3.2.1 Equipment for measuring the ambient temperature at the test facility.

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3.2.2 Appropriate measurement equipment for reading and recording temperature from thermocouples.

3.2.3 Equipment for measuring time intervals between portions of the test.

3.2.4 Equipment for taking photographs under low light conditions.

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 must be equipped with production intent engine, cooling system, air intake system, fuel system(s), Heating, Ventilation, Air Conditioning (HVAC) system and any underhood heat shields or ductwork that could impact air flow patterns.

3.4 Test Time.

Calendar time:	4 d
Test time:	18 h
Coordination time:	4 h
Soak hours	12 h

3.5 Test Required Information. Not applicable.

3.6 Personnel/Skills. Engineering test personnel trained in the use of thermocouples and data acquisition, vehicle testing and environmental chambers. Prior experience in conducting similar tests is critical to achieving valid results.

4 Procedure

4.1 Preparation.

4.1.1 Vehicle Instrumentation. Install thermocouples to measure the temperatures at the locations (a through g). Label as indicated.

a. Ambient air (AMB).
b. Engine coolant (COOL).
c. Engine oil (OIL).
d. Air inlet (AIR IN).
e. Induction system interior surface before throttle body (INDUC).
f. Throttle body interior surface (TB INT).
g. Intake manifold interior surface after throttle body (INTAKE).

4.1.1.1 Vent gas temperature on each end of all vent lines and before and after valves, check valves, orifices, etc., for example:

a. Vent gas temperature in passage close to induction system on fresh air side (VGT_I_FAS).
b. Vent gas temperature in passage close to engine on fresh air side (VGT_E_FAS).
c. Vent gas temperature in passage post Positive Crankcase Ventilation (PCV) valve or orifice. (Post_PCV_V_T) or (Post_PCV_O_T).
d. Vent gas temperature in passage pre-PCV valve or orifice (Pre_PCV_T).
e. Vent gas temperature in passage PCV port at turbo compressor inlet (PCV_Turbo_IN).
f. Charge Air Cooler (CAC) inlet and outlet temperatures if applicable (CAC_IN, CAC_OUT).

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

4.1.1.2 Install the pressure transducers (a and b).

a. Crankcase Pressure (at oil fill cap) (CCP).
b. CAC inlet and outlet, pressures if applicable (CAC_IN_P), (CAC_OUT_P).

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4.1.2 Vehicle Preparation.

a. Confirm all engine, fuel, cooling, EGR, PCV, air induction and exhaust system components are production intent and installed correctly.

b. Confirm that the engine calibration and software are production intent.

c. If applicable, confirm that the CNG/LPG controller(s) calibration(s) and software are production intent.

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

e. Confirm correct operation of throttle system.

f. Install new spark plugs.

g. Install new air cleaner filter.

h. Fill fuel tank(s).

4.1.2.1 Set up engine instrumentation to read and record the data parameters (a through f).

a. Throttle position.

b. Engine speed.

c. Vehicle speed.

d. Coolant out engine temperature.

e. Manifold Absolute Pressure (MAP).

f. All parameters described in 4.1.1, 4.1.1.1 and 4.1.1.2.

4.1.3 Oil Preparation: Change oil and filter. Add distilled water to crankcase oil at a rate of:

a. Gasoline Engines: 50 cm^3/L of oil (5% of volume).

b. Diesel Engines: 10 cm^3/L of oil (1% of volume).

4.1.4 Test Preparation. After the completion of 4.1.3, prepare the vehicle for the start of testing by driving no more than 1.6 km (1 mi). This serves to blend the oil and water mixture thoroughly. Park the vehicle in the soak area.

4.2 Conditions.

4.2.1 Environmental Conditions.

4.2.1.1 Ambient Temperature Range. The ambient temperature at the start of test must be -30 °C (-22 °F) or lower.

4.2.1.2 Relative Humidity. The relative humidity at the start of test must be between 80% and 100%.

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 Allow vehicle to soak overnight for a minimum of 12 h and a maximum of 24 h. Install a 100% State of Charge (SOC) battery.

4.3.2 Record the ambient conditions, soak time and all temperatures (ambient, coolant, oil, and components). Use the Data Sheet A1, Appendix A, or electronic equivalent. The supplier shall work with the GM requesting engineer to comprehend this requirement. Start the vehicle, and as soon as possible enter the test track or public highway and accelerate to 100 km/h (62 mph).

4.3.3 Maintain a speed of 100 km/h for 6 h. Record all temperatures every 5 minutes. Check throttle response by periodically lifting off the throttle pedal. Record any irregularities in throttle operation.

Note: At any time, if a throttle irregularity is detected, stop the vehicle as soon as safely possible and conduct the inspection described in 4.3.5.

4.3.4 A driver change is permissible (though not desired) during test, provided the time of the driver switch is under 3 minutes. The engine should not be shut off during this driver switch.

4.3.5 At the end of the drive test, slow down and exit the test track. Stop in the soak area and idle in drive for 30 s. Record all temperatures before and after the idle period. Evaluate the idle quality. Turn the engine off.

4.3.6 Shut down vehicle and stop data logging, open hood as soon as possible after conclusion of the test to prevent any ice formation from melting.

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