



Fuel Spillage During Thermal Expansion

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 standard is to determine the ability of a fuel tank and its vapor vent system to prevent fuel spillage due to siphoning and fuel expansion at different attitudes.

1.2 Applicability. All fuel systems with gasoline (including ethanol blends).

Note: Diesel applications do not require testing due to the low pressure build as a result of ambient temperature change and lack of fuel vaporization. Pressure built within the system is equalized through the system and is insufficient to open the system pressure relief valves.

1.3 Remarks. This specification provides a procedure for evaluating and measuring any fuel loss which occurs during thermal expansion of the fuel. This specification describes evaluation of design studies for worst case attitude determination on a fuel system fixture (test buck). As needed, any part of this procedure can be run separately. Design studies should be used to identify worst case attitude testing for significant reductions in test site resource requirements. Design studies must be completed before requesting test time.

2 References

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

2.1 External Standards/Specifications.

ANSI/ASTM D323-08 EN 13012 SAE J285 SAE J398
EN 12

2.2 GM Standards/Specifications.

GMW14106 GMW14508 GMW15474 (ID)

(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.

2.3 Additional References.

- Fuel Subsystem Technical Specification (FSSTS)
- Saint-Gobain Corporation, Valley Forge, Pennsylvania (www.saint-gobain-northamerica.com)

3 Resources

3.1 Facilities. Environmental chamber or equivalent.

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.

Note: All instrumentation is to be calibrated as required; record instrumentation details and date of calibration on Appendix A, Data Sheet A1 unless the information is otherwise preserved in the testing facility records.

GM Confidential

© Copyright 2017 General Motors Company All Rights Reserved

July 2017

Page 1 of 9

3.2.1 Environmental Chamber. Testing requires an environmental chamber capable of reaching a final temperature of $38\text{ }^{\circ}\text{C} \pm 1\text{ }^{\circ}\text{C}$ ($100\text{ }^{\circ}\text{F} \pm 2\text{ }^{\circ}\text{F}$) and heating rate of $11.5\text{ }^{\circ}\text{C/h} \pm 1\text{ }^{\circ}\text{C/h}$ ($20.5\text{ }^{\circ}\text{F/h} \pm 2\text{ }^{\circ}\text{F/h}$).

3.2.2 A fixture or frame assembly to hold the tank, vent system, vapor trap and other related fuel system components in simulated vehicle locations. The tank mounting must allow the tank to flex as it would in the car. The attitude of the entire system must be adjustable.

3.2.3 Service station type gasoline pump and nozzle which has the following specifications:

- Pump and nozzle can be regulated to deliver 38 L/minute (10 gal/minute).
- Nozzle is equipped with an automatic shutoff mechanism.
- Nozzle meets the current specification SAE J285 or EN 13012.

3.2.4 Static ground to the fixture or frame and the tank. Install before pumping fuel.

3.2.5 Equipment for collecting and measuring fuel spillage at any fuel system vapor vent during testing.

3.2.6 Graduated container to measure fuel loss with a capacity of 0.4 L (0.1 gal).

3.2.7 Temperature sensor(s) to read fuel temperature.

3.2.8 Temperature readout.

3.2.9 Level protractor.

3.2.10 Stopwatch.

3.2.11 Pressure gauge, 0 kPa to 40 kPa (0 in to 150 in of water) full scale.

3.3 Test Vehicle/Test Piece.

3.3.1 Test Vehicle/Fixture. A test buck that simulates fuel tank mounting in an actual vehicle is required for this test. All contact points between the fuel tank and the vehicle body or frame, as well as the fill pipe mounting location and orientation, should be correctly simulated. Be sure to use the correct fuel tank straps and mounting hardware to achieve the proper amount of tank compression.

For On Board Refueling Vapor Recovery (ORVR) fuel systems, the mounting location for the evaporative emissions canister can influence the amount of liquid carryover and should simulate as closely as possible the mounting location in an actual vehicle.

Fuel tank orientation with reference to ground is critical and must be correct.

3.3.2 Test Piece. Fuel tank assembly (including fuel pump assembly), fill pipe assembly, fuel cap, evaporative emissions canister, evaporative emission hoses and canister vent solenoid.

For the fuel tank assembly, a temperature sensor should be installed 25.4 mm (1 in) above and near the center of the tank bottom. A fuel tank drain may also be installed, if desired.

Transparent flexible Tygon tubing (available through Saint-Gobain Corporation) (or equivalent) of same inside diameter as fuel system hoses for replacement to help aid in inspections.

3.3.3 Test Fuel. Thermal expansion tests use a base fuel of 9.0 Reid Vapor Pressure (RVP) ± 0.3 RVP at $15\text{ }^{\circ}\text{C} +1\text{ }^{\circ}\text{C}/-3\text{ }^{\circ}\text{C}$ ($59\text{ }^{\circ}\text{F} +1\text{ }^{\circ}\text{F}/-5\text{ }^{\circ}\text{F}$).

3.4 Test Time.

Calendar time:	5 days
Test time:	4 hours/attitude
Coordination time:	1 hour to 8 hours

3.5 Test Required Information. Not applicable.

3.6 Personnel/Skills. GM Fuel System Designing Engineer and/or fuel system supplier engineer capable of doing grade venting studies.

GM Confidential

© Copyright 2017 General Motors Company All Rights Reserved

July 2017

Page 2 of 9

AVA Documents
Document Sharing Hub

4 Procedure

4.1 Preparation.

4.1.1 Review math based grade studies for all attitudes as outlined in 4.4.1. This includes customer usable capacity plus 2.2% fuel expansion for gasoline.

4.1.2 Identify, as a minimum, the two (2) worst case attitudes where fuel would come closest to the tank venting outlets. Record on Appendix A, Data Sheet A2. The fuel system Design Engineer shall provide this data to test site.

4.2 Conditions.

4.2.1 Environmental Conditions. Not applicable.

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.

4.2.3 Fuel Tank Conditioning. A metallic fuel tank should be conditioned by filling it completely and then emptying it prior to the testing.

A plastic fuel tank should be conditioned by installing the tank in the test fixture, filling it with fuel to the estimated customer usable volume and soaking it at room temperature for at least one (1) month. This procedure is similar to the method described in SAE J398.

An alternative method for conditioning a plastic tank is to install the tank in its simulated body position, fill it with 21 °C (70 °F) fuel to the estimated customer usable volume, and place the tank/fixture in a thermal chamber at 60 °C (140 °F) for 8 h. Allow the tank to vent. Turn off chamber heat after the 8 h soak. Allow tank to cool. Fuel can be removed when it cools to 38 °C (100 °F) or below.

4.2.3.1 Fuel System Leak Check. The installation of pressure taps and thermocouples into the fuel system creates the potential for leakage of liquid fuel or fuel vapor from the installed test fittings and seals. The fittings and seals used for test data acquisition purposes are not intended for long term use and need to be monitored. It is required that the fuel system be pressure checked for leaks at least once during each day of testing.

4.3 Instructions. Test buck preparation.

4.3.1 Fuel tank must be installed on a test buck in the simulated vehicle position.

4.3.2 Install the temperature sensor in the fuel tank assembly. If desired, install pressure taps and drain valve in fuel tank assembly.

4.3.3 Install the pressure gauge or connect temperature and pressure lines to a data acquisition unit.

4.3.4 Install fuel tank assembly and all related hardware into test buck.

4.3.5 Gasoline Systems. Install the liquid collection device in place of the canister. Use hose of similar inside diameter as Fuel Limit Vent Valve (FLVV) outlet to route vapors from the canister connection to the outside of the chamber. Mount liquid collection device (drain trap) outside of chamber or heated area. Ensure that line is at a downward slope to drain trap to avoid liquid pooling. Ensure vapors leaving the trap are properly vented.

Note: If necessary, additional traps should be installed in any vapor recirculation line if the line is separate from the vent line to the canister.

4.3.6 Leak check the tank and vent system at the venting line using 4 kPa to 8 kPa (15 in to 34 in) of water. Run this pressure test for at least 5 minutes or until tank is stabilized or run it to a level and duration determined by the design or test engineer. Repair as needed.

4.3.7 Select longitudinal and lateral reference planes for the level protractor.

4.3.8 Install static grounds.

4.3.9 Plug all fuel feed and return lines.

4.3.10 Determine reference planes on the fuel tank for use of the level protractor. These planes should be at known angles to reference lines established at vehicle curb weight.

4.3.11 Fuel Fill Procedure.

4.3.11.1 Fuel system must be filled on level surface prior to each grade orientation test.

4.3.11.2 Use the three (3)-click fill method, as described in GMW14508.

Note: The fuel tank should be filled from empty with new fuel before each thermal expansion test attitude.

GM Confidential

© Copyright 2017 General Motors Company All Rights Reserved

July 2017

Page 3 of 9