Fuel Tank Pressure/Vacuum Cycling Durability

1 Scope

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 determine the fatigue life of a fuel tank assembly (including straps and attachment points) by alternately applying an internal pressure and vacuum to the tank at a given rate.

1.2 Foreword. This procedure simulates pressure and vacuum variations which develop within vehicle fuel tank systems during vehicle operation. Pressure and vacuum variations occur due to:

- Fuel motion
- Tank wall motion
- Engine vacuum via purge
- Vapor pressure changes due to change in ambient temperatures and vehicle hot fuel handling

This test may also show a tendency of a fuel tank to **"oil can"** due to the pressure and vacuum extremes of the test.

1.3 Applicability. All passenger cars and light-duty trucks which have a primary or secondary diesel or gasoline fuel tank of metallic or non-metallic material.

2 References

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

2.1 External Standards/Specifications.

None

2.2 GM Standards/Specifications.

GMW14106

2.3 Additional References.

Fuel Tank Assembly Component Technical Specification (CTS)

3 Resources

3.1 Facilities. A laboratory test facility capable of controlling temperature, housing the test fixture and cycling the fuel tank(s) between pressure and vacuum.

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 Data Sheet A1, in Appendix A, unless the information is otherwise preserved in the testing facility records.

3.2.1 A fixture system capable of holding the fuel tank assembly in design-intent position. The fuel tank strap attachment points shall be of intended design and location. The fixture must also duplicate the body contact

points to the fuel tank. Actual underbodies may not last for multiple tests because they would have to be replaced as required. In practice, most facilities use special fabricated fixtures or reinforced production designs. The fixture must allow access to the fuel level sending unit for tank measurements.

3.2.2 A controlled heat source may be required for non-metallic fuel tanks to maintain a liquid temperature of 82 °C ± 3 °C (180 °F ± 5 °F). The heat source may be either a thermal chamber (preferred) or water heating device.

3.2.3 For fuel tank fluid, use water at a volume equal to 75% of the customer fill tank capacity with gasoline. This liquid level is intended to simulate the mass of a full tank of gasoline. This level may be decreased to prevent liquid from coming out of the tank during the vacuum cycle.

3.2.4 Liquid leak detector (e.g., soapy water) to check for leaks above liquid line.

3.2.5 Equipment capable of:

3.2.5.1 Cycling between pressure and vacuum limits of 14.9 kPa ± 5% (2.2 psi ± 5%) pressure and 7.0 kPa ± 5% (1.0 psi ± 5%) vacuum (27 kPa ± 5% (3.9 psi ± 5%) pressure and 15 kPa ± 5% (2.2 psi ± 5%) vacuum for Plug-in Hybrid Electric Vehicle (PHEV)/Extended Range Electric Vehicle (EREV) systems) or to a level determined by design or test engineer and approved by the Global Subsystem Leadership Team. Use of a calibrated transducer (with an accuracy 10 × the allowable variation) to check the pressure and vacuum levels at start of test is recommended. The cycle time is 4 ± 2 cycles per minute. It is important to maintain consistent cycle times from sample to sample of this same design to reduce test variation.

3.2.5.2 Producing a smooth waveform when changing between peak loads of pressure and vacuum.

3.2.5.3 Producing time at peak pressure and vacuum greater than or equal to 1 s (to assure proper load application). Maximum load hold time is not specified.

3.2.5.4 Conducting a pressure leak test during inspections. This is important to determine if there might be an unobservable leak (one that would not produce a visible leak due to the leak being above the liquid level, or a leak too slow to observe). Alternately, a measurement of the time necessary to obtain pressure or vacuum readings may be used. For example, a leak might have occurred if the time to obtain test pressure/vacuum is longer than at the beginning of test. **Note:** This is not a substitute for leak checking tanks during preparation since this method may only identify large leaks.

3.2.5.5 Measuring torque.

3.2.6 Instrumentation. Instrumentation is needed to do the following:

- Measure pressure and vacuum internal to the fuel tank.
- Count pressure/vacuum (P/V) cycles.
- For non-metallic tanks only, measure liquid temperature inside tank.

3.3 Test Vehicle/Test Piece.

3.3.1 Tank Assemblies. Three complete fuel tank assemblies, from as many cavities as possible (with attachment components) are required for test. The fuel fill pipe is required to be installed with an aluminum or non-venting style fuel cap.

3.3.1.1 Fuel tank assemblies are to be visually inspected to assure they represent test intent for:

- Proper metal or material flow.
- Metal creases.
- Proper seam weld technique.

3.3.1.2 Non-metallic tanks must have proper tank coatings and treatments.

3.3.1.3 Internal baffle or reservoir system.

3.3.1.4 Remove module reservoir assembly and secondary module (if applicable), and inspect for abnormalities.

3.3.2 Tank Straps. New tank straps are required for each test.

3.4 Test Time. The following is an estimate on the amount of time (work hours) needed to perform this procedure.

Calendar time:	4 days
Test hours:	8 hours
Coordination hours:	20 hours

Note: Preparation and other downtime, actual test, and analysis of data are considered in capturing a total calendar time.

3.5 Test Required Information. Not applicable.

3.6 Personnel/Skills. Not applicable.

4 Procedure

4.1 Preparation.

4.1.1 The Test Engineer shall:

4.1.1.1 Fill out test information on Data Sheet A1, in Appendix A.

4.1.1.2 Provide tank strap static torque specifications for tank strap attachments and minimum fastener torque specifications for other tank attachments per Master Process Document or part data file.

4.1.1.3 Determine fuel tank customer fill capacity. Refer to Data Sheet A1. This information is used to calculate the volume of liquid solution that is required for the test.

4.1.1.4 Determine and instruct technicians where to attach air lines to tank assembly for pressure/vacuum. Be aware that check valves or anti-siphon devices may affect air flow.

4.1.1.5 Determine the number of pressure/vacuum cycles to perform, as stated in GMW14106.

4.1.2 Attach tank and related parts (if included) to frame or underbody with design-intent fasteners at nominal static torque, or per engineer discretion.

4.1.3 Check the continuity of the electrical attachments to the fuel pump assembly before the beginning of the test.

4.1.4 Pressure and vacuum check installed tank to the same pressure and vacuum as the cycling testing is conducted at. Run this test for at least 5 minutes or until tank is stabilized or run it to a level and duration determined by design or test engineer. Discontinue this pressure/vacuum test if leaks are observed.

4.1.5 Fill tank with water to volume specified by Test Engineer on Data Sheet A1. Monitor and add liquid as necessary during test to maintain test volume**.**

4.1.6 Adjust equipment to cycle between 14.9 kPa ± 5% (2.2 psi ± 5%) pressure and 7.0 kPa ± 5% (1.0 psi ± 5%) vacuum (27 kPa ± 5% (3.9 psi ± 5%) pressure and 15 kPa ± 5% (2.2 psi ± 5%) vacuum for PHEV/EREV systems) or to pressure vacuum level to be determined by requesting engineer. If the fuel cap set point pressure value is different from standard pressure vacuum value, the test may be run to that different value; however, a deviation must be granted by GM after review and approval with the Subsystem Leadership Team.

4.1.7 Use a thermocouple in the tank to verify a stabilized liquid temperature in the fuel tank of 82 °C ± 3 °C (180 °F ± 5 °F).

4.1.8 Pressurize the assembly through the Fuel Limit Vent Valve, a Grade Vent Valve or Roll Over Valve location. The valve of choice must be removed prior to pressurizing the assembly to prevent corking of the valve during a test.

4.2 Conditions.

4.2.1 Environmental Conditions. Elevated liquid temperatures are required for non-metallic fuel tanks. Otherwise, run tests at ambient lab temperature.

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 Instructions. Run test to the number of cycles specified by the Fuel Tank Assembly CTS. Suspend test when one of the following occurs:

- Visible fuel tank leakage is observed, or
- Fuel tank leakage is indicated by failure to maintain pressure during a leak check, or
- Stress cracks in the tank straps or attachments are observed before the required number of cycles is completed, or
- The tank straps or attachments lose function.

For any specimen that does not meet the number of cycles specified by the Fuel Tank Assembly CTS, conduct testing of 6 samples to failure and produce a Weibull plot the resulting data.

4.3.2 Inspections. Inspect tank assembly daily for leaks. Record the following on Data Sheet A1, in Appendix A:

4.3.2.1 Cycles run.

4.3.2.2 Maximum pressure and vacuum readings.

4.3.2.3 Results of any built-in pressure or vacuum leak check. (Reference 3.2.5.4.) Or, record time to obtain pressure or vacuum if leak testing is not part of the testing equipment.

4.3.2.4 Observations including:

- Visible tank leakage and location of leak. Liquid leak detector may help identify leaks at tank openings and seam welds (above the liquid level in the tank) during the pressure cycle.
- Stress cracks (and their locations) in the tank straps or attachments.
- Loss-of-function of tank straps or attachments.
- Tank abrasion or deformation.
- Any other incident.

4.3.2.5 Observer's initials.

4.3.2.6 Photograph any incident.

4.3.3 Post-test Instructions.

4.3.3.1 Complete inspection in 4.3.2.

4.3.3.2 Photograph any incidents.

4.3.3.3 Pressure check installed tank to the same pressure at which the cycling testing was conducted. Run this pressure check for at least 5 minutes or until tank is stabilized, or run it to a level and duration determined by design or test engineer.

4.3.3.4 Remove the module reservoir assembly and secondary module (if applicable), and inspect for abnormalities. Check the continuity of the electrical attachments to this assembly.

4.3.3.5 Inspect any internal baffle or reservoir system for abnormalities.

4.3.3.6 Cut tank assembly to inspect for any internal tank abnormalities.

5 Data

5.1 Calculations. Not applicable.

5.2 Interpretation of Results. Not applicable.

5.3 Test Documentation. Data shall be collected per Appendix A and reported in an Engineering Report.

6 Safety

This standard may involve hazardous materials, operations, and equipment. This standard does not propose to address all the safety problems associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.

7 Notes

7.1 Glossary.

Oil Can: A popping sound made when formed sheet metal is forcibly distorted in an opposing direction.

7.2 Acronyms, Abbreviations, and Symbols.

CTS Component Technical Specification
EREV Extended Range Electric Vehicle
PHEV Plug-in Hybrid Electric Vehicle
P/V Pressure/Vacuum

8 Coding System

This standard shall be referenced in other documents, drawings, etc., as follows:

Test to GMW14842

9 Release and Revisions

This standard was originated in November 2005. It was first approved by the Chassis Fuel Systems Group in February 2006. It was first published in February 2007.

Issue	Publication Date	Description (Organization)
1	FEB 2007	Initial publication.
2	AUG 2008	3.2.2 Temperature range modified, 3.2.3 Glycol solution added, 3.2.5.1 Pressure conversions added, 4.1.6 Tolerances added, Data Sheet A1 and A2 combined. (Chassis Fuel Systems).
3	NOV 2009	3.2.2 temperature range modified; 3.2.3 Glycol solution removed; 3.4 calendar duration modified; 4.1.2 strap torque requirements added; 4.1.5 pressure vacuum test values modified; 4.1.7 tank pressurization info added; 4.3.1 modified test information; 4.3.2.4 observations modified. (Chassis Fuel Systems).
4	DEC 2010	4.1.3, 4.3.3.4 – Include information to check the electrical connectors to the fuel pump assembly. (Chassis Fuel System)
5	JUL 2012	Paragraph 4.3.3.6 – Added section to cut tank for internal inspection. (Global Chassis Fuel System GSSLT)
6	AUG 2013	3.2.5.1 and 4.1.6, updated pressure/vacuum values. (Chassis Fuel System GSSLT)

Appendix A

Data Sheet A1: Test Information and Data

Activity Request Number	
Vehicle Platform and Model Year	
Test Date	
Fuel Tank Assembly Part Number	
Tank Strap Part Number(s)	
Fuel Fill Pipe Part Number	
Test Fixture Description	

Pre-test Information from Test Engineer

Torque for Tank Strap Fasteners	
Torque for Fill Pipe Hose Attachment	
Customer Usable Capacity	
Glycol Solution Volume for Test	
Number of Pressure/Vacuum Cycles	
Results of Leak Test	

Post-test Information

Results of leak test	
Describe any deformation of tank straps, fuel pump module, tank baffles, interior walls, etc.	

P/V Cycling Test Data

Date	Cycle	Time	Observations (Leakage, Cracks, Abrasion, Deformation, Loss-of-Function, etc.)	Technician