



Fuel System Flame Arresting Capability

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 determine the flame arrestor capability using E85 (a mixture of 15% GMPT-3-018 and 85% fuel grade ethanol) fuel. Fuel grade ethanol contains about 5% hydrocarbon denaturant.

1.2 Applicability. All vehicles with flexible fuel systems designed to use 85% fuel grade ethanol/gasoline fuel blends, except for fill systems that do not require removal of a filler cap prior to nozzle insertion and with Onboard Refueling Vapor Recovery (ORVR). Other exceptions may apply per regional requirements. See GMW15311.

1.3 Remarks. This procedure examines the flame arresting components individually within a system. It does this by:

1.3.1 Evaluating the ability of the flame arrestor(s) to stop propagating flame fronts and deflagrations from entering the fuel tank.

1.3.2 Assessing the ability of the flame arrestor(s) to repeatedly provide this desired performance.

2 References

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

2.1 External Standards/Specifications.

None

2.2 GM Standards/Specifications.

GMW15311

3 Resources

3.1 Facilities. The facility must have a level floor, and provisions to handle fuel spillage, disposal, and vapor. It must be explosion proof and have appropriate fire containment equipment. It must also have vehicle grounding straps to minimize static charge build-up.

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 Test Apparatus. See Appendix A, Figure A1.

3.2.1.1 Evaporation Chamber. Interior dimensions (tank), see Appendix A, Figure A1. Box is 330 mm × 330 mm × 610 mm (13 in × 13 in × 24 in) (length × width × height). A 254 mm × 533 mm (10 in × 21 in) hole in one of the 330 mm × 610 mm (13 in × 24 in) faces is cut out for the blowout panel. The chamber is constructed of polycarbonate sheets inside a 0.6 m × 1.2 m (2 ft × 4 ft) framework. A stainless steel pan with dimensions of 203 mm × 203 mm × 38 mm (8 in × 8 in × 1.5 in) shall be located on top of a variable heating device on bottom of boiling chamber (tank). A 19 mm (0.75 in) injection port for air is located at the bottom of one (1) of the evaporation chamber sides.

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3.2.1.2 Tank Side. See Appendix A, Figure A1. A 70 mm (2.75 in) inside diameter transparent Polycarbonate tube runs up from the top of the chamber, through a 50 mm (2 in) brass ball valve, elbows 90 degrees to horizontal, and continues for approximately 914 mm (36 in) where it is supported. In this tube (verification tube), there is a standard AC Delco spark plug at the zenith of the tube's horizontal center. The spark igniter shall be mounted in the top of the tank side tube 381 mm (15 in) from the end of the tube closest to the fill side.

3.2.1.3 Tank Inlet. See Appendix A, Figure A1. The Inlet Check Value (ICV) assembly, fuel filler interface.

3.2.1.4 Fill Side. See Appendix A, Figure A1. It includes the fuel filler neck assembly. If a non-ORVR system which does not require a cap to be removed for fueling is to be tested, a standard nozzle (i.e., OPW11BP) shall be fully inserted into the filler opening.

3.2.1.5 Vent Side. Fill neck vent to be connected to chamber if the fuel system is a non-ORVR system. See Appendix A, Figure A3.

3.2.1.6 Thermocouple Locations. See Appendix A, Figure A1. One (1) thermocouple is placed in the liquid fuel in the stainless steel pan, one (1) is placed in the vapor space approximately 100 mm (4 in) above the pan, and one (1) is placed in the verification tube, approximately 200 mm (8 in) from the open end. The fourth thermocouple is located 150 mm (6 in) down the fill neck (from the fill mouth).

3.2.1.7 Spark Plug Location. Fill cup spark plug thread shall be 14 mm maximum diameter and a minimum distance of 10 mm from the center of the nozzle restrictor plate opening. See Appendix A, for Figure A4.

3.3 Test Vehicle/Test Piece.

3.3.1 Fill Pipe/Hose. Three (3) per design.

3.3.2 Inlet Check Valve. Six (6) ICVs per design.

3.3.3 Flame Arrestor. Three (3) per design.

3.4 Test Time.

Calendar time: 3 d to 5 d

Test time: 20 h to 40 h

Coordination time: 40 h to 80 h

3.5 Test Required Information.

3.5.1 Production or test-intent fuel filler neck, ICV, and flame arrestor.

3.5.2 Test Equipment.

Note: Minimum specifications for equipment listed 3.5.2.1 through 3.5.2.8.

3.5.2.1 Power Supply (Spark Igniter). Six-thousand (6000) V step-up ignition transformers that run off 115 V.

3.5.2.2 Power Supply (Plate Heater). Five (5) W plate heater controlled by a 115 V, 10 W variable alternating current step-down transformer.

3.5.2.3 Air Supply. Compressor with a reservoir capable of 550 kPa (80 psi) delivery.

3.5.2.4 Flow Meter. The airflow is controlled by a Dwyer 50 standard cubic feet per hour (SCFH) rotometer.

3.5.2.5 Thermocouples (4). Three (3) Type K, exposed bead thermocouples, with a tolerance of $\pm 2^\circ\text{C}$. The fourth is an Inconel-sheathed, 1.5 mm ($1/16$ in) Type K. An additional (fifth) Type K is required on non-ORVR systems to monitor the vent line temperature at the approximate center of the vent pipe length.

3.5.2.6 Data Acquisition System. Minimum of four (4) channels with capable of reading all five Type K thermocouples at a minimum rate of one (1) sample per second.

3.5.2.7 Spark Igniter. Standard AC Delco spark plug.

3.5.2.8 Fire Extinguisher. Standard Carbon Dioxide fire extinguisher.

3.6 Personnel/Skills.

3.6.1 Engineer and technician shall be fire safety trained.

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4 Procedure

4.1 Preparation.

4.1.1 The Engineer Shall:

4.1.1.1 Procure appropriate parts for test and arrange with appropriate test lab. The recommended test facilities are Southwest Research Institute (SwRI) in San Antonio, Texas and Testing Services Group (TSG) in Lapeer, Michigan. Labs other than SwRI and TSG must be approved by the System Management Team (SMT).

4.1.1.2 Supply drawing of fuel fill neck in vehicle position, including the inlet height from the ICV. See Appendix A, Figure A2.

4.1.1.3 Record/provide test and vehicle information on data to test lab.

4.1.1.4 Obtain test fuels.

4.1.1.4.1 E85 (85% fuel grade ethanol, 15% Howell EEE Gasoline).

4.1.2 Setup.

4.1.2.1 The fuel system component containing the flame arrestor (ICV or fuel fill pipe assembly) sample is installed into the test apparatus along with any corresponding affected components (ICV if flame arrestor is in the fuel fill pipe, or vice versa, etc.) See Appendix A, Figure A1.

4.1.2.2. If the fuel fill system design includes a flame arrestor in the tank vent fitting on non-ORVR systems, a tank vent fitting must be attached to the chamber in a similar manner as required.

4.1.2.3 The fuel fill pipe should be assembled to the test apparatus in vehicle position. See Appendix A, Figure A2.

4.1.2.4 Attach thermocouples at indicated locations. See Appendix A, Figure A1.

4.2 Conditions.

4.2.1 Environmental Conditions. Minimal air flow < 3.2 km/h (2 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.

Note: It is essential to understand the entire test procedure before proceeding with this test.

4.3.1 Test Procedure.

4.3.1.1 Set up, but do not trigger the data acquisition system yet. Verify the proper Data File Identification that is the record name.

4.3.1.2 Install the fill pipe/hose and arrestor in to the test fixture apparatus.

4.3.1.3 Close the 50 mm (2 in) ball valve at the top of the tank.

4.3.1.4 Place 200 mL of E85 test fuel into the evaporation pan.

4.3.1.5 Cover the front opening (completely) of the Polycarbonate tank and the outlet vent tube opening with aluminum foil.

4.3.1.6 Heat the evaporation pan until the temperature of the pan reaches approximately 65 °C (150 °F). At this temperature, the fuel vapor should condense on the inside walls of the Polycarbonate tank.

4.3.1.7 Initiate data acquisition system.

4.3.1.8 For systems with an ICV, the check valve should be held open at this stage. This can be accomplished by attaching a nylon wire to the tank side. Then, inject air into the Polycarbonate tank at a rate of 30 SCFH to 50 SCFH for 3 minutes and 30 s. (Flow rate requirements change based on altitude, humidity, and temperature, and should be optimized during test set up for local conditions.)

4.3.1.9 After each interval, close the check valve and turn off the air flow. Ignite the air fuel mixture in the fuel fill pipe by turning on the spark igniter for 5 s.

4.3.1.10 If the mixture does not ignite, re-open the check valve and re-inject air at the same rate determined in 4.3.1.8 for 10 s.

4.3.1.11 Repeat this portion of the procedure until a flame is propagated down through the fuel fill pipe to the flame arrestor.

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