



Non Metallic Fuel Tanks Fire Resistance

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 evaluate the fire resistance of non-metallic fuel systems against GM requirements found in GMW14106 and regulatory requirements found in UN R 34.03 Annex 5, Section 5.

1.2 Applicability. This procedure applies to all gasoline/ethanol and diesel powered vehicles with non-metallic fuel tanks. For GMW14106 requirements, all vehicles with fuel tanks made of non-metallic material. For UN R 34.03 Annex 5, Section 5 requirements, Category M, N, or O vehicles which have a primary or secondary non-metallic diesel or gasoline fuel tank. The vehicle categories defined by United Nations Economic Commission for Europe (UN ECE) are:

- Category M: Power-driven vehicles having at least four wheels and used for the carriage of passengers.
- Category N: Power-driven vehicles having at least four wheels and used for the carriage of goods.
- Category O: Trailers (including semi-trailers).

2 References

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

2.1 External Standards/Specifications.

UN R 34.03

2.2 GM Standards/Specifications.

GMW14106

GMW14508

3 Resources

3.1 Facilities. The test facility shall have fuel dispensing equipment and safety equipment necessary to handle fuel.

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.

3.1.3 For safety, the test should be performed outdoors. Wind protection shall be provided so that wind velocity will not exceed 2.5 km/h at the fire pan level.

3.1.4 The test can be performed in a controlled indoor facility equipped with adequate ventilation for complete burning of the fuel and for exhaust of the byproducts.

3.1.5 The test facility **shall** have appropriate firefighting equipment available to be able to control any potential fire. This equipment should include personal protection equipment, i.e., respirator, clothing, etc.

3.2 Equipment. A fire pan with grate and bricks, compliant with the requirements of UN R 34.03 Annex 5, Section 5, is defined in 3.2.1 and 3.2.2 along with additional required equipment in 3.2.3 and 3.2.4.

3.2.1 A fire pan which contains and moves the flaming gasoline with minimum spillage. The specifications of the fire pan are defined in 3.2.1.1 thru 3.2.1.4.

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April 2018

Page 1 of 13

3.2.1.1 The dimensions of the pan shall exceed the length and width dimensions of the fuel tank shell, projected onto a horizontal plane, by 35 cm $\pm$ 5 cm.

Note: Regulation UN R 34.03 Annex 5, Section 5, states that the pan shall exceed the horizontal projection of the tank by at least 20 cm but not more than 50 cm. The dimension of 35 cm $\pm$ 5 cm is a GM convention to reduce test variability. For non-typical or two (2) tank fuel systems, see Figure A1 thru Figure A4 of Appendix A for pan profiles.

3.2.1.2 A grate may be used to prevent fuel slosh as long as the fuel is allowed to freely flow in this pan.

3.2.1.3 Provisions must be made so that the pan is free to slide under and away from the fuel tank during the test.

3.2.1.4 The side walls of the pan shall not project more than 8 cm above the level of the fuel.

3.2.2 A fire screen is used to provide indirect heat from flames produced in the fire pan. The specifications of the fire screen are defined in 3.2.2.1 thru 3.2.2.4.

3.2.2.1 The length and width of the fire screen frame shall be 2 cm to 4 cm smaller than the inside dimensions of the fire pan so that a gap of 1 cm to 2 cm exists between the fire screen frame and the wall of the fire pan to allow ventilation.

3.2.2.2 The fire screen shall be positioned 3 cm $\pm$ 1 cm above the fire pan fuel level.

3.2.2.3 The fire screen must have provisions so that it is free to slide between the fire pan and the fuel tank, and then away from the fuel tank during the test.

3.2.2.4 The screen shall have no gaps between the fire screen bricks.

3.2.2.5 The fire screen bricks shall be supported over the fuel pan in such a manner that the holes in the bricks are not obstructed. Additional fire brick specifications are shown in Figure A5 in Appendix A.

3.2.3 A timing device to measure to 5 minutes.

3.2.4 Devices to measure the amount of fuel put in the fire pan and fuel tanks.

3.3 Test Vehicle/Test Piece. A test fixture which includes a bulkhead used for mounting the fuel tank in a simulated vehicle at unladen curb mass. GM Engineering shall provide the vehicle buck/bulkhead fixture and the buck to ground line dimensional information which simulates the unladen curb mass. The fuel system under test shall include the fuel tank and all attached accessories.

3.3.1 Fire Pan Fuel. Unleaded premium gasoline shall be used for fuel tanks that are either designed specifically for gasoline/ethanol vehicles or for a shared design between gasoline/ethanol vehicles and diesel vehicles. Diesel fuel shall be used for fuel tanks designed only for use in diesel vehicles. See 4.1.1 for the type of fuel specified by GM Engineering. The specification for the fuel tank test fuel type and grade (gasoline or diesel) is taken from UN R 34.03 Annex 5, Section 5. The quantity of fuel shall allow the flame to burn (under free burning conditions) in the fire pan for the whole test (at least 5 minutes). The quantity is typically 15 L/m² of pan area.

3.3.2 Fuel System under Test. For each test, the tank must be installed in a test fixture simulating actual installation conditions as far as possible. The method whereby the tank is fixed in the fixture must correspond to the relevant specifications for the vehicle. Vehicle parts which protect the tank and its accessories against exposure to the flame or affect the course of the fire in any way, as well as specified components installed on the tank and plugs, must be taken into consideration. All fuel system openings must be closed during the test, but venting systems must remain operative.

Three (3) tests must be completed for each type of fuel system architecture for UN ECE type approval.

3.4 Test Time.

Calendar time:	5 d
Test time:	24 h
Coordination time:	16 h

3.5 Test Required Information. Not applicable.

3.6 Personnel/Skills. Firefighting and fuel handling skills are required. The UN R 34.03 Annex 5 tests for UN ECE type approval require witness presence, which shall be arranged with the regulatory agency.

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April 2018

Page 2 of 13

Documents

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4 Procedure

4.1 Preparation.

Note: All firefighting equipment must be readily available during handling and preparation.

4.1.1 Determine and record the **type** of fuel to be used for the three (3) tanks.

4.1.1.1 If the tank is designed for installation on vehicles equipped with either a positive ignition engine or a compression ignition engine, the three (3) tests must be carried out with tanks filled with premium grade gasoline.

4.1.1.2 If the tank is designed for installation on vehicles equipped with only a compression ignition engine, the three (3) tests must be carried out with tanks filled with diesel fuel.

4.1.2 Determine and record the **amount** of fuel to be in the fuel tanks for test. This will be 50% of the total fuel capacity of the fuel tank as defined in GMW14508. For multiple tank or saddle tank designs, 50% of the capacity of each tank or side of saddle shall be used.

4.1.3 Determine the distance that the bottom of the fuel tank shall be above the fuel level in the fire pan. This distance shall correspond to the design height of the bottom of the fuel tank above the road surface at unladen curb weight. For two (2) fuel tank fuel systems, the fuel in the fuel pan is measured to the primary tank when the bottoms of the tanks are at different heights.

4.1.4 Obtain information to properly position bulkhead/fixture in design position as required in 3.3.

4.1.5 Test Preparation Non-Metallic Fuel Tank.

4.1.5.1 Install the fuel tank with all tank straps, shields, lines and fittings, functional venting systems, axle, exhaust system, etc. onto the test fixture.

4.1.5.2 Adjust the fixture to represent the design intent attitude as specified by the GM Design Release Engineer (DRE)/Designing Engineer (DE).

4.1.5.3 Verify the Phase B and Phase C testing position, Figure A6 and Figure A7 in Appendix A, by adjusting the fixture or the fire pan, so that the distance from the bottom of the fuel tank to the fire pan fuel level (see 4.1.5.7) is as specified by GM Engineering.

4.1.5.4 Close all openings of fuel system, excluding venting systems.

4.1.5.5 Verify that venting systems are operative.

4.1.5.6 Position the fire brick screen, fuel system holding fixture and fire pan in the Phase A position as shown in Figure A8 in Appendix A. As needed, preheat or cool the fire brick screen to $35^{\circ}\text{C} \pm 5^{\circ}\text{C}$. The fire bricks may be wetted to achieve this to guarantee the same test conditions for each test.

4.1.5.7 Place fuel in the fire pan. The fuel level shall be within 8 cm of the top of the fire pan.

4.1.5.8 Fill the test fuel tank with specified fuel amount and type. See 4.1.1 and 4.1.2. For multiple fuel tank or saddle tank designs, filling the fuel tank(s) out of the buck may be required.

4.1.5.9 Cycle the fire pan, the fire brick screen and the screen/pan assembly through the movements required for the test. This check should eliminate any interference in the test setup and show any conditions where gasoline spillage might occur.

Note: For the test, the fuel tank will be filled per 4.1.1 and 4.1.2, rather than per the unladen curb mass definition.

4.2 Conditions.

4.2.1 Environmental Conditions. See 3.1.3, 3.1.4 and 4.3.

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: All firefighting equipment must be readily available during fuel handling and testing.

4.3.1 Non-Metallic Fuel Tank Test.

4.3.1.1 Phase A: Preheating. Ignite the fuel in the fire pan at a distance of at least 3 m from the tank being tested. After 60 s of preheating, move the fire pan under the fuel tank. See Figure A8 in Appendix A.

4.3.1.2 Phase B: Direct Exposure to Flame. Expose the fuel system under test to the flame from the freely burning fuel for 60 s. See Figure A6 in Appendix A.

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April 2018

Page 3 of 13



Documents

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4.3.1.3 Phase C: Indirect Exposure to Flame. As soon as Phase B is complete, place the fire brick screen between the fire pan and fuel system under test for an additional 60 s. See Figure A7 in Appendix A.

4.3.1.4 Phase D: End of Test. Move the fire pan and fire brick screen away from the fuel system under test to the original Phase A position. Immediately extinguish any fire on the fuel system under test and on the fire pan. See Figure A9 in Appendix A.

4.3.2 Repeat 4.3.1.1 through 4.3.1.4 for the remaining two fuel systems to be tested for UN ECE type approval.

5 Data

5.1 Calculations. Not applicable.

5.2 Interpretation of Results. Record test data and answer the questions found on Data Sheets B1 and Data Sheet B2 in Appendix B. Record comments about any parts of the bulkhead or fuel system under test which sustained burning, any comments about fuel spillage from the fuel system under test, etc. Take photographs as appropriate. After completing Data Sheet B1 and Data Sheet B2 in Appendix B, if conclusions cannot be made, contact the GM DRE/DE of the fuel tank for guidance.

5.3 Test Documentation. Test results on Data Sheet B1 and Data Sheet B2 and a calibration record, Data Sheet B3 in Appendix B, if applicable, and provide:

- Digital pictures of test fixture and fire pan.
- Vehicle option matrix and logic used in selecting vehicle combination for test.
- Digital pictures of test fixture with test pieces as installed.
- Minimum of three (3) videos of the test, one (1) each for GM Record Retention, Tier 1 Record Retention, and the GM DRE/DE.

6 Safety

This Engineering Standard may involve safety requirements for hazardous materials, the method of operations and equipment. This standard does not propose to address all the safety issues associated with its use. It is the responsibility of the user of this standard to ensure compliance with all appropriate safety and health practices. This would include any specific training that may be required. The safety and health standards include site specific rules and procedures, company rules and procedures, and Government Standards. Contact shall be made with the appropriate site Safety and Health personnel for further direction and guidance in these matters.

7 Notes

7.1 Glossary.

Bulkhead: A separator between the passenger compartment and the fuel tank.

Fuel Spillage/Leakage: The fall, flow, or run of fuel from the fuel tank, not including wetness resulting from capillary action.

Liquid Fuel: A fuel which is liquid in normal condition of temperature and pressure.

Unladen Curb Mass: The mass of the vehicle with all standard equipment including all lubricants and fluids plus Air Conditioning (A/C) (if equipped), and the additional mass of the optional engine.

7.2 Acronyms, Abbreviations, and Symbols.

A/C	Air Conditioning
Al ₂ O ₃	Aluminum Oxide
DE	Designing Engineer
DIA	Diameter
DRE	Design Release Engineer
GSSLT	Global Subsystem Leadership Team
P _o	Open Porosity
R	Radius
SK	Seeger-Kegel

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Page 4 of 13