GM WORLDWIDE ENGINEERING STANDARDS	Test Procedure	GMW15423

Performance Testing of Fuel Hoses

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. This test procedure describes performance tests for fuel and fuel filler hoses.

1.2 Applicability. These tests shall be used to determine the performance of fuel and fuel filler hoses.

2 References

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

2.1 External Standards/Specifications.

ASTM D471	ASTM D4678	ISO 1817	ISO 7500-1
ASTM D3703	ISO 188	ISO 4794	ISO 9513

2.2 GM Standards/Specifications.

9985670	GMW14292	GMW14914	GMW16709

2.3 Additional References.

- Gage Products Company (United States) 821 Wanda Street, Ferndale, Michigan 48220
- General Motors Powertrain (GMPT-3018)
- General Motors Powertrain (GMPT-6-019)
- Haltermann GmbH (Europe) - Schlengendeich 17, 21107 Hamburg, Germany
- Haltermann Solutions – (United States) - 15635 Jacintoport Boulevard Houston, Texas 77015
- Total Fluids (France) - 24 Cours Michelet, 92800 Puteaux, France

3 Resources

3.1 Facilities.

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 Beaker 100 ml.

3.2.2 Test fuel to GMW14914.

3.2.3 Test fuel to ISO 1817 (ASTM D471) Liquid C.

3.2.4 Methanol 99% minimum purity to 9985670.

3.2.5 Diesel Test Fuel to GMW14914.

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3.2.6 Sour Gasoline Test Fuel per 4.3.9.

3.2.7 Glass filter crucible No. 4 according to ISO 4794, porosity 10 m^{-6} to 16 m^{-6} and filtering device.

3.2.8 Glass fiber filter, Grade 934AH.

3.2.9 Balance with an accuracy of 0.1 mg.

3.2.10 Water jet pump.

3.2.11 Desiccator.

3.2.12 Heating oven to ISO 188.

3.2.13 Heating unit.

3.2.14 Metal control rods and end plugs in suitable size.

3.2.15 Test machine with force-measuring device to ISO 7500-1 Class 1; and deflection measuring device to ISO 9513 Class 0.2. The test machine shall be such that the required test velocity can be maintained. Force gauge capable of measuring up to 100 N.

3.2.16 Stiffness Test Apparatus, per Appendix A, Figure A1.

3.3 Test vehicle/Test Piece.

3.3.1 Tests are to be conducted on hoses as supplied**.**

3.3.2 For initial sample approval and arbitration purposes, at least three (3) tests are required. For routine quality control purposes, one (1) test is required.

3.4 Test Time. Refer to all the individual tests in 4.3.

3.5 Test Required Information. Not applicable.

3.6 Personnel/Skills. Conform to company and/or laboratory requirements. Technician training records must be available upon request.

4 Procedure

4.1 Preparation. Not applicable.

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. For additional information, see all individual tests in 4.3.

4.3 Instructions.

4.3.1 Test for Inner Cleanliness.

4.3.1.1 Test of Total Amount of Refuse. A complete hose shall be hung up vertically and washed five (5) times with 20 ml Gasoline Tests Fuel to GMW14914 consecutively. The fluid shall be collected in a tared evaporating dish.

4.3.1.2 The test fuel shall be evaporated at +70 °C ± 10 °C for at least 24 h. Then the dish shall cool down for 1 h ± 0.1 h in a desiccator and the refuse in the dish shall be weighed. To determine that all fuel has evaporated, the dish is stored again at +70 °C ± 10 °C for at least 1 h, cooled down at 1 h ± 0.1 h in a desiccator and weighed again. If the weight determined does not differ more than 5% in total from the previous one, the evaporation is complete and the amount of residue is reported in mg/cm^2 inner surface. If weight difference is higher, evaporation and weighing must be continued until the 5% limit is met.

4.3.1.3 Test for Compact Part of Refuse. The total refuse shall be taken off in Gasoline Tests Fuel to GMW14914 and shall be filtered through a tared glass frit G4. The glass frit shall be dried for at least 4 h at +50 °C. After cooling down for 1 h ± 0.1 h in a desiccator the weight of the glass frit shall be determined with an accuracy of 0.1 mg and the amount of deposits shall be calculated. The deposits shall be reported as sediment (Compact Parts of Refuse) in microgram per square centimeter (mg/cm^2) inner surface. Handling of glass frit, see GMW14292.

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4.3.2 Extractables Test.

4.3.2.1 A 300 mm length of hose shall be tested. Aluminum or steel end plugs are used to seal both ends of the hose sample. The minimum Outer Diameter (OD) of each plug must be equal to or larger than the maximum Inner Diameter (ID) of the size of hose tested to effectively seal the hose sample for test. The length of the plug shall be 12.5 mm. Each plug must allow for the support, placement, and positioning of a steel or aluminum rod within the ID of the hose such that a 4 mm to 6 mm gap is maintained between the OD of the rod and the ID of the hose for hoses with diameter >15 mm.

4.3.2.1.1 The purpose of the rod is to reduce the amount of solvent needed within the hose for the extraction process. Each plug must also have a port positioned such that solvent can be introduced into the assembly between the ID of the hose and the OD of the rod.

4.3.2.1.1.1 Total effective length of hose with end plugs inserted shall be 275 mm.

4.3.2.1.1.2 Where hose length of 300 mm cannot be reached, complete hose is to be tested.

4.3.2.2 Record hose sample ID, length, and inside surface area.

4.3.2.3 Assemble fixture rod and plugs to hose sample and fill the assembly with ISO 1817 Liquid C. Seal assembly and allow to rest horizontally at 22 °C to 25 °C for 24 h.

4.3.2.4. Drain fluid from hose into a beaker.

4.3.2.5 Add additional ISO 1817 Liquid C to assembly, in equal volume to original amount, to rinse the inside of the test assembly, and add this volume of solvent to the original solvent in the beaker.

4.3.2.6 Remove solvent by evaporation by heating at 80 °C to 95 °C until no fuel odor is detectable and then store sample at room temperature under a laboratory hood for a minimum of 16 h.

4.3.2.7 Take up the residue in the beaker with 20 ml of room temperature methanol.

4.3.2.8 Filter the solution on a tared crucible or fine fritted glass, rinsing beaker with 10 ml of room temperature methanol.

4.3.2.9 Place crucible or fine fritted glass in beaker and dry in a 65 °C to 90 °C oven for 1 h to ensure complete evaporation of methanol.

4.3.2.10 Cool to room temperature in a desiccator and weigh the crucible or fine fritted glass and determine mass of extractable expressed as gram per square meter (g/m^2) using inside surface area of hose in contact with the ISO 1817 Liquid C solvent. Handling of glass frit, see GMW14292.

4.3.3 Compressibility. This test is to be conducted only on hoses with ID ≥ 30 mm.

4.3.3.1 Using a flat plate of minimum 100 mm length and width, apply a compressive force to a hose section of 100 mm length.

4.3.3.1.1 Apply a preload of 1 N and determine the original initial outer diameter for compressibility test (OD_1**)** of the hose parallel to the direction of the applied force.

4.3.3.1.2 Apply a load of total 50 N at a rate of 5 mm/minute and determine the final outer diameter for compressibility (OD_2**)** of the hose.

4.3.3.1.3 Subtract the measured OD_2 from the OD_1 of the hose at preload and calculate the percentage of compressibility.

4.3.4 Fuel Exposure and Cold Flexibility, Burst Strength.

4.3.4.1 Fill two (2) 300 mm long samples of hose with ISO 1817 Liquid C and seal both ends.

4.3.4.2 Allow filled hoses to stand at room temperature for 48 h.

4.3.4.3 Drain ISO 1817 Liquid C from hoses.

4.3.4.4 Perform Cold Flexibility Test.

4.3.4.4.1 For fuel hoses of > 19.05 mm ID: Within 30 minutes after draining the fuel from the hoses, cut a 250 mm long sample out of the middle of one (1) of the 300 mm long test samples.

4.3.4.4.1.1 Expose the sample for 70 h in a cold chamber at -40 °C ± 3 °C. While in the cold chamber, flex the hose between flat plates within a period of 4 s through one-half (½) its nominal ID.

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4.3.4.4.2 For fuel hoses of ≤ 19.05 mm: Within 30 minutes after draining the fuel from the hoses, start the Cold Flexibility Test to GMW16709, at -40 °C ± 3 °C on one (1) of the samples.

4.3.4.4.3 Use visual examination to evaluate the samples.

4.3.4.5 For fuel hoses of all ID sizes, perform the Burst Test of second hose with a pressure increase of 7 MPa/minute.

4.3.5 Fuel, Heat and Ozone Resistance, Adhesion Test. Two (2) samples of hose shall be exposed to the sequential tests in 4.3.5.1 through 4.3.6.

4.3.5.1 Totally fill and cap fuel hose samples with ISO 1817 Liquid C for 48 h at room temperature.

4.3.5.2 After exposure, drain hose sample and place in an air circulating oven for 96 h at 100 °C ± 2 °C.

4.3.5.3 Repeat 4.3.5.1 and 4.3.5.2 using fresh ISO 1817 Liquid C.

4.3.5.4 Expose a 25 mm wide × 150 mm long sample cut from the hose cover to ozone. See 4.3.7.1 through to 4.3.7.4.

4.3.5.5 Perform Adhesion Test to respective material specification.

4.3.6 Dry Heat Resistance.

4.3.6.1 For fuel hoses of >19.05 mm ID, perform 4.3.6.1.1 through 4.3.6.1.3,

4.3.6.1.1 Expose a 300 mm length of hose for a period of 1 h at 125 °C ± 2 °C.

4.3.6.1.2 Remove the hose from the oven and plug each end with a short nylon or metal rod and resume heat aging at the temperature specified above for 720 h.

4.3.6.1.3 Remove the hose from the oven, remove plugs, and allow cooling to room temperature for a minimum of 2 h. Flex a 25 mm wide section of hose cut from the center of the test sample between flat plates within 4 s through one-half (½) of its nominal ID.

4.3.6.2 For fuel hoses of ≤ 19.05 mm ID, perform 4.3.6.2.1 through 4.3.6.2.3.

4.3.6.2.1 The hose shall be exposed 1008 h +0 h/-2 h to +90 °C ± 3 °C for Temperature Limit A, to +125 °C ± 3 °C for Temperature Limit B and to +150 °C ± 3 °C for Temperature Limit C mounted as shown in Appendix A, Figure A4.

4.3.6.2.2 Remove the hose from the oven and allow cooling to room temperature for a minimum of 2 h. Remove the hose from the fixture and slowly straighten (taking 4 s to 8 s) it.

4.3.6.2.3 Use visual examination to evaluate the sample.

4.3.7 Heat Aging, Ozone Resistance.

4.3.7.1 Heat age a 25 mm wide × 150 mm long sample cut from the hose cover along the longitudinal axis of the hose for 70 h at 125 °C ± 2 °C.

4.3.7.2 Firmly fasten the rectangular sample to a test block in such a manner as to cause an extension of 20% as measured between gage marks 100 mm apart centered at the middle of the strip.

4.3.7.3 After mounting, the sample shall be permitted to rest in a relatively ozone free atmosphere for 24 h at room temperature. The mounted sample shall be placed in a suitable ozone test chamber that is maintained at an ozone concentration of 100 parts ozone ± 5 parts ozone per 100 million parts of air (volume basis) and a chamber ambient temperature of 38 °C ± 1 °C.

4.3.7.4 After 2 weeks of exposure, sample shall be removed from the chamber and permitted to cool to room temperature, while still on the fixture, shall be visually inspected for signs of cracking under 2x magnification. The area immediately adjacent to the sample attachment shall be ignored in making the visual inspection and rating.

4.3.8 Stiffness.

4.3.8.1 Test Sample Preparation. Mount a 125 mm straight fuel filler hose sample in the fixture as shown in Appendix A, Figure A1. The test plugs securing the ends of the hose must have an OD equal to the nominal ID of the hose being tested. The hose is clamped to the test plugs using constant dimension clamps. The clamps to be used for the test are to be the production release clamps for the hose, or as specified by the GM Design Release Engineer for the program for which the hose is to be used. Torque the clamps to a minimum of 7.0 Nm.

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