



Diesel Exhaust Fluid System Tank Capacity and Filling Performance

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. This document provides procedures to determine the total capacity, usable capacity, and filling performance of vehicle Diesel Exhaust Fluid (DEF) systems.

1.2 Foreword. This is a system-level test of the DEF storage system, including the tank assembly, fill pipe assembly, and the complete venting system.

The tables of fill conditions specify minimum and maximum values for test inputs, as well as maximum allowable values for premature shutoffs (PSO) and spitback. All fill tests must comply with these specifications even if such details were not given in the subsystem or component technical requirements.

1.3 Applicability. This document applies to DEF systems for passenger cars and light/medium/heavy-duty trucks with diesel engines.

2 References

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

2.1 External Standards/Specifications.

None

2.2 GM Standards/Specifications.

GMW14474 (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.

CG3514

3 Resources

3.1 Facilities. Testing should be performed at a facility with adequate ventilation and spill containment to meet all local safety codes.

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 Nozzles. Table A1 specifies a minimum list of dispensing nozzles and containers to be used for this test procedure.

While this list represents the popular dispensing methods in North America and Europe, it is only a sample of the nozzles and containers that are available to retailers. Specific concerns about system interaction with nozzles and containers, other than those listed in Table A1 or unique market requirements, may require testing with additional nozzles or containers.

GM Confidential

© Copyright 2013 General Motors Company All Rights Reserved

November 2013

Page 1 of 12



Documents

Document Sharing Hub

3.2.2 Dispensing Pumps. Dispensing pumps shall be capable of delivering the flow rates to simulate service station dispensers in North America and Europe.

Note: For other markets, the requesting engineer must specify the nozzles and flow rates to use based on the countries in which the vehicle(s) will be sold.

3.2.2.1 Nozzles for Diesel Exhaust Fluid. For testing to simulate the North American market, regulate the dispensing pump to deliver 20 L/minute (5.3 gal/minute) to 40 L/minute (10.6 gal/minute), as required, when the nozzle is set at the fast fill rate detent on the hold-open rack. Maximum static system pressure at the nozzle inlet shall not exceed 350 kPa (50.8 psi).

3.2.2.2 Containers for Diesel Exhaust Fluid. For testing to simulate the North American market, a container support fixture may be used to support the container at 45 degrees for side body applications and 30 degrees for under hood applications. Record the time to empty each container and a description of the fill performance at shutoff or overflow. If using a container for successive fill tests remove spout and rinse with clean water after each fill test series.

3.2.3 Diesel Exhaust Fluid Cooling Equipment. Dispensing equipment must be capable of cooling the fluid to $3 \pm 2^\circ\text{C}$ ($37.4 \pm 3.6^\circ\text{F}$). An environmental chamber may be used to cool the DEF to the desired temperature.

3.2.4 Environmental Chamber. Testing requires an environmental chamber capable of cooling the system to $-15 \pm 2^\circ\text{C}$ ($5 \pm 3.6^\circ\text{F}$).

3.2.5 Miscellaneous. The following equipment is also required:

3.2.5.1 Graduated Cylinders. To measure fill volume (larger than system capacity) and to measure spitback (0 to 100 mL).

3.2.5.2 Level Protractor. To adjust test fixture attitude for fills on 6% grade.

3.2.5.3 Container. To contain spilled fluid.

3.2.5.4 Ammonia Meter. To locally measure ammonia concentration in air during fills (optional).

3.2.5.5 Diesel Exhaust Fluid Refractometer. To measure ammonia concentration in liquid (optional).

3.3 Test Vehicle/Test Piece.

3.3.1 Test Vehicle/Fixture. A test buck that simulates tank mounting in an actual vehicle is required for this test. All contact points between the 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 tank straps and mounting hardware to achieve the proper amount of tank compression.

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

As an alternative, an actual production-intent vehicle may be used in place of the test buck. The vehicle should be set to curb mass and vehicle heights should be within specification.

3.3.2 Test Parts. Tank assembly (including pump assembly), fill pipe assembly, and fill cap.

A minimum of three (3) tank assemblies, one (1) fill pipe assembly, and one (1) fill cap, are required for this test. For plastic tanks, it is recommended that one tank from each mold cavity or cooling fixture be tested for volume verification purposes

3.4 Test Time.

Calendar time:	5 to 10 days
Test hours:	40 to 80 hours
Coordination hours:	1 to 4 hours

3.5 Test Required Information. Not applicable.

3.6 Personnel/Skills. Lab test personnel with fuel system test experience are preferred.

4 Procedure

4.1 Preparation.

4.1.1 Special Instructions. Tests for vehicles that will be sold outside North America or Europe will require special instructions from the requesting engineer regarding dispensing nozzles, flow rates, and temperatures to be used.

GM Confidential

© Copyright 2013 General Motors Company All Rights Reserved

November 2013

Page 2 of 12

Documents
Document Sharing Hub

4.1.2 Instrumentation. Real-time data is to be recorded at a 10 Hz (or faster) sample rate during each fill, unless otherwise instructed by the requesting engineer.

The minimum required data channels are:

- Tank bulk temperature - the thermocouple location must allow the temperature of a 10% pre-fill to be measured.
- Dispensed fluid temperature at or near the nozzle inlet.
- Tank vapor pressure in each vapor dome having one or more vents.

Additional recommended data channels are:

- Fill pipe pressure near the fill cap interface.
- Fill pipe pressure near the tank inlet. The preferred location is 60 to 100 mm from the end of the hose and away from the inside of sharp bends. The pressure sensing device should protrude not more than 1 mm inside the fill pipe.

4.1.3 Test Setup. Install the tank and vent system in the test buck. Ensure that all vent lines and fluid lines are routed correctly. General Motors shall be responsible for providing fill pipe math data coordinates for proper fill pipe positioning. Plug the supply line as applicable.

4.1.4 System Leak Check. The installation of pressure taps and thermocouples into the system creates the potential for leakage of fluid or 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 system be pressure-checked for leaks at least once during each day of testing.

4.2 Conditions.

4.2.1 Environmental Conditions. Specific environmental conditions are specified for each type of fill test and are summarized in Table A2. A thermal chamber is required to attain some of the specified conditions.

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.

Test conditions (dispensing nozzles, temperatures, flow rates, etc.) are summarized in Table A2. When a system temperature is specified, the ambient temperature, pre-fill DEF, tank, and all system components are required to be at the specified temperature at the start of the fill test.

4.3 Instructions.

4.3.1 Fill Tests for Diesel Exhaust Fluid Systems. Fill conditions specific to the North American market are denoted by the prefix Urea Fills North America ("UN") and listed in Table A2. In addition to the required data, any unusual occurrences should be recorded on Data Sheet A1 or Data Sheet A2, as applicable.

4.3.1.1 Urea Fills North America One (1): Volume Verification, Static Undrainable. This is a test of tank capacity and round-up capability using a nozzle. Fill conditions and the number of test samples are specified in Table A2.

For plastic tanks, although a minimum number of test samples is listed, it is recommended that one tank from each mold cavity or cooling fixture be tested.

Record the dispensed volumes, as indicated by the dispensing equipment, on Data Sheet A1.

If the accuracy of volume measurement on the dispensing equipment is not 0.2% or better for both steady-state and transient flows, use a large graduated cylinder to measure the volume of in the tank at the completion of each fill. Drain the system through the installed tank drain into a large graduated cylinder. Measure the volume drained to the graduated cylinder and report this volume on Data Sheet A1. This is the Static Drainable volume. Use this value, rather than the volume indicated by the dispenser, for the Total Capacity calculation described below.

Next, remove the fluid from the system that could not be drained through the tank drain. Measure the fluid in a graduated cylinder and report the volume on Data Sheet A1. This is the Static Undrainable volume.

Finally, calculate the Total Capacity and report this volume on Data Sheet A1.

Total Capacity = fill volume indicated by dispenser + Static Undrainable volume.

or

Total Capacity = Static Drainable volume + Static Undrainable volume.

GM Confidential

© Copyright 2013 General Motors Company All Rights Reserved

November 2013

Page 3 of 12

Documents
Document Sharing Hub

Optional method: Volume determination may be performed by utilizing a pretest and posttest mass of entire system. The mass of the dry system is subtracted from the mass of the wet system. The wet mass is then converted to volume by use of the specific gravity of the DEF. Volume of DEF (L) = Mass of DEF (kg)/Specific Gravity of DEF. The spreadsheet attached in document CG3514 can be used for this purpose.

4.3.1.2 Urea Fills North America Two (2): Stuffed Tank. This is a test of system performance when the tank is overfilled. Fill conditions and the number of test samples are specified in Table A2.

Container: Unsealed spout shall be used for this test. Fill tank until fluid exits the top of the fill pipe. Wait 5 s and repeat.

Record the total dispensed volume on Data Sheet A1.

If the accuracy of volume measurement on the dispensing equipment is not 0.2% or better for both steady-state and transient flows, use a large graduated cylinder to measure the volume of fluid in the tank at the completion of each fill. Drain the system through the installed tank drain into a large graduated cylinder. Measure the volume drained to the graduated cylinder and report the Stuffed Tank Volume on Data Sheet A1. Otherwise, if the dispensing equipment is sufficiently accurate, report the Stuffed Tank Volume indicated by that equipment.

Optional method: Volume determination may be performed by utilizing a pretest and posttest mass of entire system. The mass of the dry system is subtracted from the mass of the wet system. The wet mass is then converted to volume by use of the specific gravity of the DEF. Volume of DEF (L) = Mass of DEF (kg)/Specific Gravity of DEF. The spreadsheet attached in document CG3514 can be used for this purpose.

4.3.1.3 Urea Fills North America Three (3): Volume Verification, Static Undrainable. This is a test of tank capacity and round-up capability using a container. Fill conditions and the number of test samples are specified in Table A2.

For plastic tanks, although a minimum number of test samples is listed, it is recommended that one tank from each mold cavity or cooling fixture be tested.

Record the dispensed volumes, as indicated by the dispensing equipment, on Data Sheet A1.

If the accuracy of volume measurement on the dispensing equipment is not 0.2% or better for both steady-state and transient flows, use a large graduated cylinder to measure the volume of in the tank at the completion of each fill. Drain the system through the installed tank drain into a large graduated cylinder. Measure the volume drained to the graduated cylinder and report this volume on Data Sheet A1. This is the Static Drainable volume. Use this value, rather than the volume indicated by the dispenser, for the Total Capacity calculation described below.

Next, remove the fluid from the system that could not be drained through the tank drain. Measure the fluid in a graduated cylinder and report the volume on Data Sheet A1. This is the Static Undrainable volume.

Finally, calculate the Total Capacity and report this volume on Data Sheet A1.

Total Capacity = fill volume indicated by dispenser + Static Undrainable volume.

or

Total Capacity = Static Drainable volume + Static Undrainable volume.

Optional method: Volume determination may be performed by utilizing a pretest and posttest mass of entire system. The mass of the dry system is subtracted from the mass of the wet system. The wet mass is then converted to volume by use of the specific gravity of the DEF. Volume of DEF (L) = Mass of DEF (kg)/Specific Gravity of DEF. The spreadsheet attached in document CG3514 can be used for this purpose.

4.3.1.4 Urea Fills North America Four (4) thru Urea Fills North America Seven (7): Nozzle and Container. This is a test sequence of fill performance when using nozzles and containers. Fill conditions and the number of test samples are specified in Table A2.

At the completion of each fill, report on Data Sheet A2 the fill volume, number of PSO and spitback volume.

Optional: Measure ammonia concentration at angles of 45 degrees and 65 degrees from locations 5 mm and 60 mm along fill pipe opening centerline. Record results on Data Sheet A2. United States Council for Automotive Research DEF fill test ammonia concentration data may be used in place of actual test data.

4.3.1.5 Urea Fills North America Eight (8) and Urea Fills North America Nine (9) (Urea Fills North America Ten (10) Deleted): Low Temperature: This test simulates a winter fill with cold fluid into a cold tank. Fill conditions and the number of test samples are specified in Table A2.

GM Confidential

© Copyright 2013 General Motors Company All Rights Reserved

November 2013

Page 4 of 12

Documents
Document Sharing Hub