California Environmental Protection Agency

Air Resources Board

Test Procedure for Determining Diurnal Emissions from Portable Fuel Container Systems

TP-502

Adoption Date: July 26, 2006
Amended: December 9, 2016

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The definitions in section 2467.1, title 13, California Code of Regulations apply to this test procedure.

For the purpose of this procedure, the term "ARB" refers to the California Air Resources Board, and the term "Executive Officer" refers to the ARB Executive Officer or his or her authorized representative or designate.

1. APPLICABILITY

This test procedure is used by ARB to determine the diurnal emission rate from portable fuel containers (PFC) systems as required by ARB Certification Procedure CP-501, *Certification Procedure for Portable Fuel Container Systems*. This procedure is applicable in all cases where portable fuel container systems and their components are manufactured for sale, advertised for sale, sold, or offered for sale in California or are introduced, delivered, or imported into California for introduction into commerce.

1.1. Requirement to Comply with All Other Applicable Codes and Regulations

Certification or approval of a portable fuel container system by the Executive Officer does not exempt the portable fuel container system from compliance with other applicable codes and regulations such as local, State, or federal safety codes and regulations.

1.2. Safety

This test procedure involves the use of flammable materials and should only be used by or under the supervision of those familiar and experienced in the use of such materials. Appropriate safety precautions should be observed at all times while performing this test procedure.

2. PRINCIPLE AND SUMMARY OF TEST PROCEDURE

This procedure is used to determine the diurnal emission rate of six (6) portable fuel containers sealed with a spout. Testing includes a preconditioning period to

maximize permeation rate, a durability demonstration, and a minimum three-day diurnal test using a variable temperature profile. The durability demonstration requires that the spout be actuated while exposed to certification test fuel as defined in section 5 (g) of this test procedure.

Preconditioning is accomplished by soaking the container with certification fuel at minimum 23 °C (73.4 °F) for 140 days or at 43 ± 5 °C (109.4 ± 9 °F) for 70 days. After preconditioning, the container is subjected to a minimum of three 24-hour diurnal cycles and weighed before and after each cycle. Each weigh-in shall be corrected for the effects, if any, of humidity, temperature, and pressure with use of a reference container. The diurnal emission rate shall be calculated using the highest recorded daily corrected mass loss divided by the container's rated storage capacity.

3. BIASES AND INTERFERENCES

(a) Humidity, temperature, and pressure can bias mass measurements. In order to minimize bias, a sealed reference container shall be used to correct for buoyancy effects and varying atmospheric conditions.

(b) The reference container may absorb hydrocarbons and gain mass if stored in close proximity to high levels of gasoline vapor. Care shall be taken to store the reference container separately from fuel-filled containers, and the reference container shall only be placed in close proximity to fuel-filled containers during diurnal testing. Purge the temperature enclosure used for preconditioning at regular intervals to limit gasoline vapor buildup and potential bias.

(c) Incorrectly installed spouts can bias the reported results.

(d) Care shall be taken to ensure no bias occurs as a result of static electricity through use of practices such as statically discharging the containers prior to weighing and repetitive weighing of the containers to demonstrate a constant weight.

4. SENSITIVITY AND RANGE

The range of the mass measurement of filled containers is approximately 1,750 grams to 17,500 grams, depending on the container capacity. A top loading balance, capable of a maximum mass measurement of not less than 120 percent of the mass of the filled container for which it is being used, must be used to perform mass measurements. For mass measurements more than 6,200 grams, the minimum sensitivity of the balance must be 0.1 grams. For mass measurement less than or equal to 6,200 grams, the minimum sensitivity of the balance must be 0.01 grams.

5. EQUIPMENT

(a) One or more top loading balances that meets the requirements of section 4.

(b) NIST-traceable mass standards. A sufficient number of mass standards to verify the measurements listed in section 6 (b).

(c) A ventilated, temperature-conditioning enclosure capable of controlling the internal air temperature from 18.3 °C to 40.6 °C, with a tolerance of 1.1 °C (65 °F to 105 °F, with a tolerance of 2 °F). The enclosure shall be capable of producing a variable temperature profile as specified in Table 9-1.

(d) A temperature instrument capable of measuring the internal temperature of the temperature conditioning enclosure accurately to within ± 1.1 °C (± 2 °F).

(e) A barometric pressure instrument capable of measuring atmospheric pressure at the location of the balance to within ± 70 Pa (± 0.02 inches of mercury).

(f) A relative humidity measuring instrument capable of measuring the relative humidity (RH) at the location of the balance with a sensitivity of ± 2 percent RH.

(g) Certification fuel as described in part II, section A.100.3.1.2 of the "California 2015 and Subsequent Model Criteria Pollutant Exhaust Emission Standards and Test Procedures and 2017 and Subsequent Model Greenhouse Gas Exhaust Emission Standards and Test Procedures for Passenger Cars, Light Duty Trucks, and Medium-Duty Vehicles" (September 2, 2015) or in 40 C.F.R. Part 1065.710 (b), (November 20, 2015) which are incorporated by reference herein.

6. CALIBRATION PROCEDURE

(a) All instruments and equipment used to conduct this procedure shall be calibrated at the minimum interval specified by the manufacturer.

(b) The balance listed in section 5 (a) shall be calibrated by an independent organization using National Institute of Standards and Technology (NIST)-traceable mass standards annually. The accuracy of the balance shall be checked using NIST-traceable mass standards prior to and following mass measurements (25 containers maximum). At minimum, the accuracy shall be checked at approximately 80 percent, 100percent, and 120 percent of the container's expected test weight. If the measured mass of any of the NIST-traceable mass standards drifts more than ± 0.1 gram for a balance with 0.1 gram sensitivity and ± 0.02 grams for a balance with 0.01 gram sensitivity between initial and final measurements, the balance shall be re-calibrated or

a different balance that is within specification shall be used. The NIST-traceable mass standards shall be calibrated annually by an independent organization.

7. DURABILITY DEMONSTRATION

A durability demonstration is required at the beginning and conclusion of the preconditioning period (section 8 (a)). This durability demonstration is performed during a minimum 10 day period at both the beginning and end of the preconditioning period. This durability demonstration exposes the PFC spout, seals, and mechanisms to fuel in order to demonstrate durability. Compliance testing may be performed without this durability demonstration.

(a) Use a permanent marker to identify the containers. Use a unique ID number for each container. Record the ID number on the data sheet.

(b) Fill each container to 50% of the rated capacity with certification fuel and install and tighten the spouts per ASTM F852-08 section 4. Record the amount of fuel dispensed into each container and the temperature at which the spouts are installed.

(c) Check the leak tightness of the portable fuel container systems by raising the ambient temperature at least 14 ºC (25 ºF) for a minimum of two hours. This should slightly expand the containers. Any container that does not expand may have a leak.

For any container that does not expand, allow the container and fuel to return to the temperature at which the spout was installed. Remove the spout, then install and tighten it per ASTM F852-08 section 4 and record the temperature at which the spout is installed. Place the container in an environment that is at least 14 ºC (25 ºF) warmer than the temperature at which the spout was installed for a minimum of two hours.

After removing a portable fuel container system from the elevated temperature environment, submerge it in a water bath large enough to submerge the entire container to a depth of least six (6) inches. Tilt the container back and forth while submerged to dislodge any air from external cavities. Wait at least thirty (30) seconds. Any bubbles coming from the container denote a leak.

No repairs may be performed unless documentation from the manufacturer or independent laboratory performing the testing is provided. Leaks, repairs, or adjustments shall be listed on the data sheet. For containers with leaks that cannot be repaired without the use of tools, sealant, etc., those containers and spouts shall be removed from testing and the failure documented on the

data sheet. Remove the container from the water bath and dry off all excess water from the exterior surfaces.

(d) Actuate the spout, by fully opening and closing without dispensing fuel, to relieve pressure. Take care to point the spout away from the user.

(e) Fill each container to nominal capacity with certification fuel and install and tighten the spouts per ASTM F852-08 section 4.

(f) Slowly invert the portable fuel container system and keep it inverted for at least five (5) seconds to ensure that the spout and mechanisms become saturated with fuel. Any fuel leaking from any part of the system will denote a leak and shall be reported on the data sheet as a failure. Once completed, place the container on a flat horizontal surface in the upright position.

(g) With the portable fuel container system in the upright position, actuate the spout by fully opening and closing without dispensing fuel. For fuel containers configured in such a manner that actuating the spout with the container upright results in dispensing fuel, the container may be rotated to the degree necessary that actuating the spout does not dispense fuel. The spout shall return to the closed position without the aid of the operator (e.g., pushing or pulling the spout closed). Repeat for a total of ten (10) actuations. If the portable fuel container system has a pressure relief valve, actuate the valve for a total of ten (10) actuations. If at any point the spout or valve fails to return to the closed position, the container fails the test.

(h) Repeat the steps in paragraphs (f) and (g) of this section.

(i) After twenty (20) actuations are completed, remove and replace the spout by tightening per ASTM F852-04 section 4 to simulate filling the container. If the portable fuel container system has a non-removable spout, remove and replace the refueling cap.

(j) Repeat the steps in paragraphs (f), (g), (h), and (i) of this section no more than once per day nine more times until two hundred spout actuations and ten spout replacements are completed in a minimum ten-day period.

(k) Repeat the steps in paragraphs (f), (g), (h), (i), and (j) of this section beginning at least ten days before the conclusion of the preconditioning period.

(l) Record the dates and number of spout actuations and replacements completed on the data sheet where provided.

8. PRECONDITIONING FUEL SOAK

Complete the following steps before performing diurnal emissions testing. Compliance testing may be performed without this preconditioning fuel soak.

(a) Ensure that the portable fuel containers are filled with the specified fuel to their nominal capacities, seal them using the spouts by tightening per ASTM F852-08 section 4, and allow them to soak for 140 days at minimum 23°C (73.4°F) or for 70 days at 43 ± 5 °C (109.4 ± 9 °F). The time required to perform the Durability Demonstration in section 7 of this procedure and the Pressure Cycling Test, UV Exposure Test, and Slosh Test in section 5 of TP-501 may count as part of the preconditioning fuel soak, as long as the temperature remains within the specified temperature range for either the 140 day or 70 day preconditioning fuel soak. During the preconditioning fuel soak, fuel may be added or replaced as needed to maintain liquid level at nominal capacity;

(b) At the conclusion of the preconditioning soak period, pour the fuel out of the containers and immediately refill to 50 percent of nominal capacity. Be careful to not spill any fuel on the containers. Wipe the outside of the containers as needed to remove any liquid fuel that may have spilled on them. Record the volume of fuel dispensed into each container on the data sheet; and

(c) Install the spout assembly that will be used in the production containers and tighten per ASTM F852-08 section 4. All manual closures other than fuel caps must be left off the container and spout during testing in section 9.

9. DIURNAL TEST WITH REFERENCE CONTAINER CORRECTION

The diurnal test is performed after preconditioning to determine the evaporative (permeation and vented) emission rate when the portable fuel container system is subjected to a minimum of three (3) diurnal cycles. This test measures evaporative emissions (permeation and vented) when a container is subjected to the California summertime temperature profile specified in Table 9.1.

(a) Repeat the leak check described in section 7 (c) on each of the six portable fuel container systems (test containers). It is not necessary to perform the leak check on the reference container. The containers may continue being tested with the fuel added in paragraph (b) of section 8.

(b) A reference container is required to correct for buoyancy effects that may occur during testing. Prepare the reference container as follows:

(1) Obtain a seventh container of the same model as the set of six containers tested in other sections of this procedure. The container

must not have previously contained fuel or any other contents that might affect the stability of its mass;

(2) Fill the reference container with enough dry sand, glass beads, or other inert material so that the mass of the reference container is approximately the same as the test container when filled with fuel. Use good engineering judgment to determine how similar the mass of the reference container needs to be to the mass of the test container considering the performance characteristics of your balance;

(3) Ensure that the sand, glass beads, or other inert material is dry. This may require heating the container or applying a vacuum to it; and

(4) Seal the reference container with a spout by tightening per ASTM F852-08 section 4.

(c) Place the reference container and test containers into a temperature enclosure acclimated at 105°F ± 2°F for a minimum of 24-hours to remove excess hydrocarbon buildup that may have resulted from preconditioning. The tester may elect to skip this step.

(d) Place the reference container and test containers into a temperature enclosure acclimated at 18.3 °C ± 1.1°C (65°F ± 2°F) for a minimum of 24 hours to stabilize the temperature of the containers and their contents. Vent the containers at the conclusion of the stabilization period to relieve any positive or negative pressure that may have developed during stabilization.

(e) The accuracy of the balance shall be checked using NIST-traceable mass standards prior to and following mass measurements (25 containers maximum). At minimum, the accuracy shall be checked at approximately 80 percent, 100 percent, and 120 percent of the container's test weight. Refer to section 6 (b).

(f) Carefully place each container on the balance. Record the date, initial mass, start time, relative humidity, and barometric pressure on the data sheet. The initial mass is determined by repeating the weighings until two consecutive weighings are within 0.1 grams for a balance with 0.1 gram sensitivity or within 0.05 grams for a balance with 0.01 gram sensitivity. No more than fifteen (15) minutes shall lapse between the temperature stabilization period (section 9 (d)) and replacing the containers into the temperature enclosure after weighing. Precautions should be taken to ensure the containers remain at 18.3 °C ± 1.1 °C (65 °F ± 2 °F).

(g) Begin the variable temperature profile (diurnal cycle) as shown in Table 9-1.

(h) At conclusion of the diurnal cycle, place each container on the balance and record the final mass, date, end time, relative humidity, and barometric pressure on the field data sheet. The final mass is determined by repeating the weighings until two consecutive weighings are within 0.1 grams for a balance with 0.1 gram sensitivity or within 0.05 grams for a balance with 0.01 gram sensitivity. If the containers are removed from the enclosure for weighing, no more than fifteen (15) minutes shall lapse before being replaced into the enclosure.

(i) Repeat the steps in paragraphs (g) and (h) of this section until a minimum of three (3) diurnal cycles have been completed.

Table 9-1 Diurnal Temperature Profile

Hour	0	1	2	3	4	5	6	7	8	9	10	11	12
(°C)	18.3	19.2	22.6	26.8	30.1	32.6	34.8	36.7	38.4	39.7	40.5	40.6	40.1
(°F)	65	66.5	72.7	80.2	86.2	90.7	94.6	98.1	101.1	103.5	104.9	105.1	104.2
Hour	13	14	15	16	17	18	19	20	21	22	23	24	–
(°C)	38.4	35.2	31.6	29.1	27.1	25.4	24.1	22.2	21.1	20.1	19.2	18.3	–
(°F)	101.1	95.4	88.9	84.4	80.8	77.7	75.4	72.0	70.0	68.2	66.5	65	–

10. CALCULATING RESULTS

The diurnal emission rate is calculated by using the highest recorded individual mass loss of all diurnal cycles tested. The diurnal emission rate shall be calculated in grams per gallon per day using the following equations:

Calculating the Diurnal Emission Rate

$$\text{Emission Rate} = \frac{M_{initial} - M_{final}}{(\text{nominal capacity}) \times (\text{one day})}$$

Where:

$M_{initial}$ = Initial Test Container Mass – Initial Reference Container Mass (grams)
M_{final} = Final Test Container Mass – Final Reference Container Mass (grams)

11. RECORDING AND REPORTING DATA

Record data on the field data sheet shown in Figure 1. Alternate test forms may be used provided they list the same minimum parameters as shown in Figure 1. Data forms, field notes, and any supporting documentation shall be made available

to ARB upon request. The manufacturer shall maintain these documents for a period of not less than 5 years after the completion of testing.

12. QUALITY ASSURANCE / QUALITY CONTROL

All data must be carefully recorded on the field data sheet during the test. Any unusual occurrences in the process operation, unusual test instrument readings, or items that could possibly affect the test results should be noted on the data sheet. It is recommended that a checklist, in addition to the data sheet, be used to assure all data needed for calculation or process information are obtained.

13. ALTERNATIVE TEST PROCEDURES

Test procedures, other than specified herein, shall only be used if prior written approval is obtained from the Executive Officer. In order to secure the Executive Officer's approval of an alternative test procedure, the applicant is responsible for demonstrating to the Executive Officer's satisfaction that the alternative test procedure is equivalent to this test procedure as described in section 6 of ARB Certification Procedure "CP-501, *Certification Procedure for Portable Fuel Container Systems*." The Executive Officer reserves the right to require the applicant of an innovative system to develop an alternative test procedure which demonstrates the intent of each test requirement not achieved due to the innovative design.

14. REFERENCES

Control of Evaporative Emissions From New and In-Use Portable Fuel Containers. Title 40, Code of Federal Regulations, Part 59. United States Environmental Protection Agency, Subpart F.

California 2015 and Subsequent Model Criteria Pollutant Exhaust Emission Standards and Test Procedures and 2017 and Subsequent Model Greenhouse Gas Exhaust Emission Standards and Test Procedures for Passenger Cars, Light Duty Trucks, and Medium-Duty Vehicles. Part II, section A.100.3.1.2.

Engine Fluids, Test Fuels, Analytical Gases and Other Calibration Standards. Title 40, Code of Federal Regulations, Part 1065. United States Environmental Protection Agency, Subpart H.

ARB Certification Procedure for Portable Fuel Container Systems, CP-501.

ARB Test Procedure for Determining Integrity of Portable Fuel Container Systems, TP-501.

Standard Specification for Portable Gasoline Containers for Consumer Use, ASTM F852-08.

15. FIGURES

Figure 1. Test Data Sheet.