

California Environmental Protection Agency



Air Resources Board

Proposed

Spill-Proof System Test Procedure

Test Method 513

DETERMINATION OF PERMEATION RATE FOR
SPILL-PROOF SYSTEMS

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**Test Method 513
Determination of Permeation Rates For
Spill-Proof Systems**

1 APPLICABILITY

For the purpose of this procedure, the term "ARB" refers to the State of California Air Resources Board, and the term "ARB Executive Officer" refers to the Executive Officer of the ARB or his or her authorized representative or designate. Terms used in this test method are defined in Section 2471, Article 6, Chapter 9, Title 13 of the California Code of Regulations.

This procedure is used to determine the permeation rate of spill-proof systems with non-metallic portable fuel containers. It is applicable in all cases where a non-metallic spill-proof system is sold, supplied, offered for sale, or manufactured for use in the State of California.

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

2 PRINCIPAL AND SUMMARY OF TEST PROCEDURE

Portable fuel containers are subjected to 1000 pressure/vacuum cycles and then filled with gasoline and allowed to precondition at ambient temperature and pressure for a minimum of four weeks. The portable fuel containers are then emptied, blown dry and immediately refilled with Phase II California Reformulated Certification (CERT) Fuel. A High Density Polyethylene (HDPE) coupon is then fusion welded over the container opening, the containers are weighed and subjected to a 24-hour variable temperature profile. The containers are then re-weighed and the weight loss in grams is calculated.

3 BIASES AND INTERFERENCES

Portable fuel containers incorrectly sealed will emit evaporative emissions, which can effect the final weight loss calculations.

To accurately quantify the losses attributed to permeation during the test procedure the portable fuel containers must be exposed to the variable temperature for 24-hours \pm 30 minutes.

The balance used to determine the weight lost between 24-hour variable temperature profiles must be of sufficient capacity to accurately weigh large volume portable fuel containers filled to their nominal capacity with CERT fuel.

4 SENSITIVITY, RANGE, AND PRECISION

Range of measurement of filled portable fuel containers is approximately 1,750 grams to 26,000 grams; upper range depends on the volume of the portable fuel container.

5 EQUIPMENT

5.1 A hand held Teflon coated aluminum hot plate thermostatically controlled to approximately 425 °F (hand held fusion welder) and 1/4" thick HDPE coupons. Both the hand held fusion welder and HDPE coupons must be of sufficient diameter to completely cover the opening of the portable fuel container.

5.2 A high capacity top loading balance capable of a maximum weight measurement of not less than 2,000 grams greater than the weight of the largest fuel filled portable fuel container tested with a minimum readability of 1 gram and a reproducibility of ± 0.2 grams.

5.3 Sealed Housing For Evaporative Determination (SHED). Either a fixed or variable volume enclosure as specified in 40 CFR, Chapter 1, Part 86, Section 1207-96 with a temperature conditioning system capable of controlling the internal enclosure air temperature with an instantaneous tolerance of ± 3.0 °F of the nominal temperature versus time profile throughout the test, and an average tolerance of ± 2.0 °F over the duration of the test.

6 CALIBRATION PROCEDURE

The high capacity top loading balance shall be calibrated prior to use per the manufacturer specifications.

7 DURABILITY PROCEDURE

Pressurize the empty portable fuel container to 5 pounds per square inch gauge (psig) using room air heated to 120 °F and then evacuate to 2 inches mercury ("hg). Repeat the pressure/vacuum process until the portable fuel container has been subjected to not less than 1000 cycles in approximately 8 hours.

8 PRECONDITIONING PROCEDURE

Fill the portable fuel container of the spill-proof system to its nominal capacity with gasoline and firmly attach either the spill-proof spout or an appropriate plug or cap. Place the portable fuel container in a suitable vented enclosure. Record the preconditioning start date on the field data sheet (see figure 2). The portable fuel container shall remain undisturbed

for a period of not less than four weeks.

9 SEALING PROCEDURE

- (1) After preconditioning, remove the portable fuel container from the enclosure to a well-ventilated area. Record the preconditioning end date on the field data sheet. Remove the cap, plug, or spill-proof spout and empty the portable fuel container. The portable fuel container must not remain empty for more than fifteen minutes. Quickly dry the interior of the portable fuel container with compressed air. Immediately refill the portable fuel container to its nominal capacity with CERT fuel. Fusion weld the HDPE coupon over the portable fuel container opening taking care to completely seal the container opening.

Heat the sealed portable fuel container until positive pressure (container swelling) is observed. This could be accomplished in several ways. One method is to place the portable fuel container in a well-ventilated area exposed to direct sunlight for two to four hours. If positive pressure (container swelling) is not observed after heating, the closure or portable fuel container is leaking. Carefully check the fusion weld and use good engineering practices to correct the problem. Once positive pressure is observed test the integrity of the closure and sealant by completely immersing the portable fuel container in a water bath for a period of two minutes. Select a water bath large enough to completely cover the portable fuel container plus six inches. Place the portable fuel container upright in the water bath making sure to position it so that no fuel is in contact with the closure. To accomplish this it may be necessary to tilt the portable fuel container back slightly so that the closure is the highest point while holding it under water. Observe the portable fuel container and the closure for any leaks. Leak points will be visible as a bubble or stream of bubbles while immersed in the water bath. Identify and mark any leak points. If leaks are observed remove and dry the portable fuel container and repair all leaks. Continue this process until no leaks are observed.

10 TEST PROCEDURE

- (1) Make sure that the exterior surface of the sealed portable fuel container is clean, dry, and free of dirt and debris. Carefully place the sealed portable fuel container on the high capacity balance. Record the initial weight (W_i), date, and start time on the field data sheet.
- (2) Immediately place the sealed portable fuel container in the SHED. Begin the 24-hour variable temperature profile (see figure 1). If more than one hour elapses between the time the sealed portable fuel container was weighed and the initiation of the variable temperature profile, the sealed portable fuel container must be re-weighed before initiating the 24-hour variable temperature profile.

- (3) At the conclusion of the 24-hour variable temperature profile immediately remove the sealed portable fuel container from the SHED and ensure that the exterior surface is clean, dry, and free of dirt and debris. Carefully place the sealed portable fuel container on the high capacity balance. Record the final weight (W_f), date, and end time on the field data sheet. If more than one hour elapses between the conclusion of the 24-hour variable temperature profile and the final weighing of the sealed portable fuel container, the final weight is invalid and should not be used in future calculations. If this occurs, the test procedure must be reinitiated. Calculate the difference between the initial weight (W_i) and the final weight (W_f). This is the weight loss (W_l) due to permeation. Record the weight loss (W_l) on the field data sheet.
- (4) Repeat this process until the weight loss (W_l) from five consecutive 24-hour cycles displays a standard deviation of 0.25 grams.
- (5) When sufficient weight loss data have been collected, move the sealed portable fuel container to a well-ventilated area. Place the sealed portable fuel container on a clean surface such as a large sheet of paper or cardboard. Carefully remove the threaded plug or cap allowing the loose sealant to fall on the paper. Drain the contents of the portable fuel container into an appropriate receptacle through a finely screened funnel. Dry the interior of the portable fuel container with compressed air. Check the screened funnel for any sealant that may have fallen into the portable fuel container during remove of the cap or plug. Place any particles of sealant found in the screened funnel on the paper or cardboard and allow them to air dry. Collect the particles of sealant from the paper or cardboard, the cap or plug, and the portable fuel container and place them on the high capacity balance. Record this weight on the field data sheet as the tare weight (W_t).

11 QUALITY ASSURANCE / QUALITY CONTROL (QA/QC)

This section is reserved for future specification.

12 RECORDING DATA

Record data on a form similar to the one shown in Figure 2.

13 CALCULATING RESULTS

The weight loss in grams is calculated for each 24-hour cycle as follows:

$$W_l = W_i - W_f$$

Where:

W_l = The weight loss in grams

- W_i = The initial weight of the portable fuel container in grams
- W_f = The final weight of the portable fuel container in grams

The standard deviation of five consecutive diurnal cycles is calculated as follows:

$$SDV = \sqrt{\frac{\sum_{i=1}^n (x_i - \bar{x})^2}{n - 1}}$$

Where:

- SDV = Standard Deviation
- n = number of samples
- X_i = i th weight loss in grams
- \bar{x} = mean of weight losses in grams

The permeation rate in grams per gallon per day for each 24-hour cycle is calculated as follows:

$$P = \frac{Wl}{\left(\frac{W_i - W_t}{d}\right)}$$

Where:

- P = The permeation rate in grams/gallon/day
- Wl = The weight loss in grams
- W_i = The initial weight of the portable fuel container in grams
- W_t = The tare weight of the portable fuel container in grams
- d = The density of CERT fuel in grams/gallon

14 REPORTING RESULTS

After calculating the permeation rate for each 24-hour cycle, an average of the five consecutive rates selected is calculated to determine the final permeation rate in grams per gallon per day.

15 ALTERNATIVE TEST PROCEDURES

Test procedures, other than specified above, shall only be used if prior written approval is

obtained from the ARB Executive Officer. In order to secure the ARB Executive Officer's approval of an alternative test procedure, the applicant is responsible for demonstrating to the ARB Executive Officer's satisfaction that the alternative test procedure is equivalent to this test procedure.

- (1) Such approval shall be granted on a case-by-case basis only.
- (2) Documentation of any such approvals, demonstrations, and approvals shall be maintained by the ARB Executive Officer and shall be made available upon request.

16 REFERENCES

This section is reserved for future specification.

17 FIGURES

Figure 1. 24-Hour Variable Temperature Profile

Figure 2. Field Data Sheet

Figure 1
24-Hour Variable Temperature Profile

HOUR	MINUTE	ET / MIN	TEMP °F
0	0	1440	65.0
1	60	1380	66.6
2	120	1320	72.6
3	180	1260	80.3
4	240	1200	86.1
5	300	1140	90.6
6	360	1080	94.6
7	420	1020	98.1
8	480	960	101.2
9	540	900	103.4
10	600	840	104.9
11	660	780	105.0
12	720	720	104.2
13	780	660	101.1
14	840	600	95.3
15	900	540	88.8
16	960	480	84.4
17	1020	420	80.8
18	1080	360	77.8
19	1140	300	75.3
20	1200	240	72.0
21	1260	180	70.0
22	1320	120	68.2
23	1380	60	66.5
24	1440	0	65.0

Figure 2. Field Data Sheet

Spill-Proof System Manufacturer: _____

Container Volume: _____

Container I.D.: _____

Tested By: _____

Water Bath Test (pass/fail): _____

Tare Weight (W_t) (grams): _____

DATE/TIME START		DATE/TIME END		INITIAL WEIGHT W_i (grams)	FINAL WEIGHT W_f (grams)	WEIGHT LOSS W_l (grams)