California Environmental Protection Agency

Air Resources Board

Spark-Ignition Marine Watercraft Evaporative Emissions Test Procedures

TP - 1504

Test Procedures for Determining Permeation Emissions from Installed Marine Fuel Tanks, Marine Fuel Hoses and Marine Fuel Caps

Adopted Date: December 21, 2015

TP-1504
TABLE OF CONTENTS

SECTION **Page**

NOTE:

This document incorporates by reference Title 40, Code of Federal Regulations (CFR), Part 1060 – **Control of Evaporative Emissions from New and In-use Nonroad and Stationary Equipment**, Subpart F – Test Procedures which was adopted on October 8, 2008 (Federal Register, Volume 73, pages 59111 through 59114).

Beginning with model year 2018, spark-ignition marine watercraft and emission control components must be compliant with more stringent California emissions standards and must use the following test procedures that include California provisions. The original text for the federal test procedures is indicated by plain text. All additions to the text are indicated by underlined text, and all deletions to that text are indicated by ~~strikeout.~~

PART 1060—CONTROL OF EVAPORATIVE EMISSIONS FROM NEW AND IN—USE NONROAD AND STATIONARY EQUIPMENT

Subpart F—Test Procedures

§ 1060.501 General testing provisions.

(a) This subpart is addressed to you as a certifying manufacturer but it applies equally to anyone who does testing for you.

(b) Unless we specify otherwise, the terms “procedures” and “test procedures” in this part include all aspects of testing, including the equipment specifications, calibrations, calculations, and other protocols and procedural specifications needed to measure emissions.

~~(c) The specification for gasoline to be used for testing is given in 40 CFR 1065.710. Use the grade of gasoline specified for general testing. For testing specified in this part that requires a blend of gasoline and ethanol, blend this grade of gasoline with fuel-grade ethanol meeting the specifications of ASTM D4806 (incorporated by reference in §1060.810). You do not need to measure the ethanol concentration of such blended fuels and may instead calculate the blended composition by assuming that the ethanol is pure and mixes perfectly with the base fuel. For example, if you mix 10.0 liters of fuel-grade ethanol with 90.0 liters of gasoline, you may assume the resulting mixture is 10.0 percent ethanol. You may use more or less pure ethanol if you can demonstrate that it will not affect your ability to demonstrate compliance with the applicable emission standards. Note that unless we specify otherwise, any references to gasoline-ethanol mixtures containing a specified ethanol concentration means mixtures meeting the provisions of this paragraph (c).~~

(c) Beginning with model year 2018, permeation testing must be conducted using E10 CERT fuel or fuel CE10. E10 CERT fuel is defined in Title 13, California Code of Regulations, section 2853. As defined by the federal rule, fuel CE10 means fuel C as specified in ASTM D471 blended with ethanol such that the blended fuel has 10.0 ± 1.0 percent ethanol by volume.

(d) Accuracy and precision of all temperature measurements must be ±1.8 °F (±1.0 °C) or better. If you use multiple sensors to measure differences in temperature, calibrate the sensors so they will be within 0.9°F (0.5 °C) of each other when they are in thermal equilibrium at a point within the range of test temperatures (use the starting temperature in Table 1 to §1060.525 unless this is not feasible).

(e) Accuracy and precision of mass balances must be sufficient to ensure accuracy and precision of two percent or better for emission measurements for products at the

maximum level allowed by the standard. The readability of the display may not be coarser than half of the required accuracy and precision. Examples are shown in the following table for a digital readout:

	Example #1	**Example #2**	**Example #3**
Applicable standard	1.5 g/m^2/day	1.5 g/m^2/day	15 g/m^2/day.
Internal surface area	1.15 m^2	0.47 m^2	0.015 m^2.
Length of test	14.0 days	14.0 days	14.1 days.
Maximum allowable mass change	24.15 g	9.87 g	3.173 g.
Required accuracy and precision	±0.483 g or better	±0.197 g or better	±0.0635 g or better.
Required readability	0.1 g or better	0.1 g or better	0.01 g or better.

(f) This part is severable, and in the event that any subpart or paragraph of this part is held to be invalid, the remainder of this part shall remain in full force and effect.

(g) In the event of conflict between the requirements of this part and the requirements of 13 CCR 2450-2469 or 13 CCR 2440-2447, the requirements in the CFR shall take precedence.

[73 FR 59298, Oct. 8, 2008, as amended at 74 FR 8427, Feb. 24, 2009]

§ 1060.505 Other procedures.

(a) *Your testing.* The procedures in this part apply for all testing you do to show compliance with emission standards, with certain exceptions listed in this section.

(b) *~~Our~~ARB testing.* These procedures generally apply for testing that we do to determine if your equipment complies with applicable emission standards. We may perform other testing as allowed by the Clean Air Act.

(c) *Exceptions.* ~~We~~ARB may allow or require you to use procedures other than those specified in this part in the following cases:

(1) You may request to use special procedures if your equipment cannot be tested using the specified procedures. We will approve your request if we determine that it would produce emission measurements that represent in-use operation and we determine that it can be used to show compliance with the requirements of the standard-setting part.

(2) You may ask to use emission data collected using other procedures, such as those of the United States Environmental Protection Agency or the International Organization for Standardization. We will approve this only if you show us that using these other procedures does not affect your ability to show compliance with the applicable emission standards. This generally requires emission levels to be far enough below the applicable emission standards so any test differences do not affect your ability to state unconditionally that your equipment will meet all applicable emission standards when tested using the specified test procedures.

~~(3) You may request to use alternate procedures that are equivalent to allowed procedures or are more accurate or more precise than allowed procedures. See 40 CFR 1065.12 for a description of the information that is generally required to show that an alternate test procedure is equivalent.~~

(3) Test procedures, other than specified herein, shall only be used if prior written approval is obtained from the ARB Executive Officer or his/her delegate. 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 the testing procedures documented herein.

(i) Such approval shall be granted on a case-by-case basis only.

(ii) Documentation of any such approvals, demonstrations, and approvals shall be maintained by the ARB Executive Officer and shall be made available upon request.

(2) Demonstration for equivalency must include a minimum of three (3) test results each from the CARB test procedure and from the submitted alternative test procedure. The application must also include a comparison of the results demonstrating that the submitted alternative test procedure meets or exceeds the standard. The applicant must also submit the test procedure in detail for an engineering review and clearly identify any modifications to the CARB test procedure.

(iv) Once approved for use, an alternative test procedure may be used and referenced by any manufacturer subject to the limitations and constraints in the Executive Order approving the alternative test procedure.

(v) If a tester requests approval to use other procedures under paragraph (c) of this section, you may not use them until we approve your request.

~~(4) The test procedures are specified for gasoline-fueled equipment. If your equipment will use another volatile liquid fuel instead of gasoline, use a test fuel that is representative of the fuel that will be used with the equipment in use. You may ask us to approve other changes to the test procedures to reflect the effects of using a fuel other than gasoline.~~

(4) The test procedures are specified for marine watercrafts that are gasoline-fueled and spark-ignition only.

(d) *Approval.* If we require you to request approval to use other procedures under paragraph (c) of this section, you may not use them until we approve your request.

~~§ 1060.510 How do I test EPA Low-Emission Fuel Lines for permeation emissions?~~

~~For EPA Low-Emission Fuel Lines, measure emissions according to SAE J2260, which is incorporated by reference in §1060.810.~~

~~[74 FR 8427, Feb. 24, 2009]~~

§ 1060.515 How do I test ARB~~EPA~~ Nonroad Fuel Lines ~~and EPA Cold-Weather Fuel Lines~~ for permeation emissions?

Measure emissions as follows for ARB~~EPA~~ Nonroad Fuel Lines ~~and EPA Cold-Weather Fuel Lines~~:

(a) Prior to permeation testing, use good engineering judgment to precondition the fuel line by filling it with ~~the fuel specified in this paragraph (a),~~ E10 CERT fuel or fuel CE10, sealing the openings, and soaking it for at least four weeks at 109.4 ±9 °F (43 ±5 °C) or eight weeks at 73.4±5 °F (23 ± 5 °C).

(1) For ARB~~EPA~~ Nonroad Fuel Lines, use E10 CERT fuel or fuel CE10, which is Fuel C as specified in ASTM D471 (incorporated by reference in §1060.810) blended with ethanol such that the blended fuel has 10.0 ± 1.0 percent ethanol by volume.E10 CERT Fuel is California certification gasoline as specified in "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" Section II.A.100.3.1.2 as adopted March 22, 2012, as incorporated by reference herein. ~~(2) For EPA Cold-Weather Fuel Lines, use gasoline. blended with ethanol such that the blended fuel has 10.0 ± 1.0 percent ethanol by volume.~~

(b) Drain the fuel line and refill it immediately with the fuel specified in paragraph (a) of this section. Be careful not to spill any fuel.

(c) Beginning in model year 2014, measure fuel line permeation emissions using the equipment and procedures for weight-loss testing specified in SAE J30 or SAE J1527 (incorporated by reference in §1060.810) at a test temperature of 73.4°F (23°C). If the Executive Officer finds commercial availability of marine fuel hoses as specified in 13 CCR Section 2855, then the test temperature will change to 104°F (40°C) beginning in 2020, or two years from the date that the Executive Officer determines that the marine fuel hoses become commercially available, whichever is later. Start the measurement

procedure within 8 hours after draining and refilling the fuel line. Perform the emission test over a sampling period of 14 days.

(d) Use good engineering judgment to test fuel line segments with short length or ~~narrow~~small inner diameters. For example, size the fuel reservoir appropriately for the tested fuel line and take steps to eliminate air bubbles from ~~narrow~~small-diameter fuel lines.

[73 FR 59298, Oct. 8, 2008, as amended at 74 FR 8427, Feb. 24, 2009]

§ 1060.520 How do I test fuel tanks for permeation emissions?

Measure permeation emissions by weighing a sealed fuel tank before and after a temperature-controlled soak. In general, you must test a preproduction product that will represent actual production. However, you may test a tank with standardized geometry provided that it is made of the same material(s) and appropriate wall thickness. (a) *Preconditioning durability testing.* If your emission control technology involves surface treatment or other post-processing treatments such as an epoxy coating ~~T~~take the following steps before an emission test~~, in any order, if your emission control technology involves surface treatment or other post-processing treatments such as an epoxy coating~~:

(1) *Pressure cycling.* Perform a pressure test by sealing the tank and cycling it between +13.8 and −1.7 kPa (+2.0 and −0.5 psig) for 10,000 cycles at a rate of 60 seconds per cycle. The purpose of this test is to represent environmental wall stresses caused by pressure changes and other factors (such as vibration or thermal expansion). If your tank cannot be tested using the pressure cycles specified by this paragraph (a)(1), you may ask to use special test procedures under 40 CFR §1060.505.

(2) *UV exposure.* Perform a sunlight-exposure test by exposing the tank to an ultraviolet light of at least 24 W/m^2 (0.40 W-hr/m^2 /min) on the tank surface for at least 450 hours. Alternatively, the fuel tank may be exposed to direct natural sunlight for an equivalent period of time as long as you ensure that the tank is exposed to at least 450 daylight hours.

(3) *Slosh testing.* Perform a slosh test by filling the tank to 40–50 percent of its capacity with the fuel specified in paragraph (e) of this section and rocking it at a rate of 15 ±3 cycles per minute until you reach one million total cycles. Use an angle deviation of +15° to −15° from level.

(b) *Preconditioning fuel soak.* Take the following steps before an emission test:

(1) Fill the tank with the fuel specified in paragraph (e) of this section, seal it, and allow it to soak at 83.3 ±9°F (28 ±5 °C) for at least 20 weeks. Alternatively, the tank may be soaked for at least 10 weeks at 109.4 ±9°F (43 ±5 °C). You may count the time of the preconditioning steps in paragraph (a) of this section as part of the preconditioning fuel

soak as long as the ambient temperature remains within the specified temperature range and the fuel tank is at least 40 percent full; you may add or replace fuel as needed to conduct the specified durability procedures.

(2) Empty the fuel tank and immediately refill it with the specified test fuel to its nominal capacity. Be careful not to spill any fuel.

(3) Perform durability cycles on a fuel cap ~~intended for use with handheld equipment~~ by putting the fuel cap on and taking it off 300 times. Tighten the fuel cap each time in a way that represents the typical in-use experience.

(4) Allow the tank and its contents to equilibrate to the temperatures specified in paragraph (d)(7) of this section. Seal the fuel tank as described in paragraph (b)(5) of this section once the fuel temperatures are stabilized at the test temperature. You must seal the tank no more than eight hours after refueling. Until the fuel tank is sealed, take steps to minimize the vapor losses from the fuel tank, such as keeping the fuel cap loose on the fuel inlet or routing vapors through a vent hose.

(5) Seal the fuel tank as follows:

(i) If fuel tanks are designed for use with a filler neck such that the fuel cap is not directly mounted on the fuel tank, you may seal the fuel inlet with a nonpermeable covering.

(ii) If fuel tanks are designed with fuel caps directly mounted on the fuel tank, take one of the following approaches:

(A) Use a production fuel cap expected to have permeation emissions at least as high as the highest-emitting fuel cap that you expect to be used with fuel tanks from the emission family. It would generally be appropriate to consider an HDPE fuel cap with a nitrile rubber seal to be worst-case.

(B) You may seal the fuel inlet with a nonpermeable covering if you separately measure the permeation from a worst-case fuel cap as described in 40 CFR §1060.521.

(C) If you use or specify a fuel gasket made of low-permeability material, you may seal the fuel inlet with a nonpermeable covering and calculate an emission rate for the complete fuel tank using a default value of 30 g/m^2 /day for the fuel cap (or 50 g/m^2 /day for testing at 104°F (40 °C). Use the smallest inside cross-sectional area of the opening on which the cap is mounted as the fuel cap's surface area.

(iii) Openings that are not normally sealed on the fuel tank (such as hose-connection fittings and vents in fuel caps) may be sealed using nonpermeable fittings such as metal or fluoropolymer plugs.

(iv) Openings for petcocks that are designed for draining fuel may be sealed using nonpermeable fittings such as metal or fluoropolymer plugs.

(v) Openings for grommets may be sealed using nonpermeable fittings such as metal or fluoropolymer plugs.

(vi) Rather than sealing a fuel tank with nonpermeable fittings, you may produce a fuel tank for testing without machining or stamping those holes.

(c) *Reference tank.* A reference tank is required to correct for buoyancy effects that may occur during testing. Prepare the reference tank as follows:

(1) Obtain a second tank that is identical to the test tank. You may not use a tank that has previously contained fuel or any other contents that might affect its mass stability.

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

(3) Ensure that the inert material is dry.

(4) Seal the tank.

(d) *Permeation test run.* To run the test, take the following steps after preconditioning:

(1) Determine the fuel tank's internal surface area in square-meters, accurate to at least three significant figures. You may use less accurate estimates of the surface area if you make sure not to overestimate the surface area.

(2) Weigh the sealed test tank and record the weight. Place the reference tank on the balance and tare it so it reads zero. Place the sealed test tank on the balance and record the difference between the test tank and the reference tank. This value is M_o. Take this measurement directly after sealing the test tank as specified in paragraphs (b)(4) and (5) of this section.

(3) Carefully place the tank within a temperature-controlled room or enclosure. Do not spill or add any fuel.

(4) Close the room or enclosure as needed to control temperatures and record the time. However, you may need to take steps to prevent an accumulation of hydrocarbon vapors in the room or enclosure that might affect the degree to which fuel permeates through the fuel tank. This might simply involve passive ventilation to allow fresh air exchanges.

(5) Ensure that the measured temperature in the room or enclosure stays within the temperatures specified in paragraph (d)(7) of this section.

(6) Leave the tank in the room or enclosure for the duration of the test run.

(7) Hold the temperature of the room or enclosure at 82.4 ± 7.2 °F (28 ± 2 °C); measure and record the temperature at least daily. You may alternatively hold the temperature of the room or enclosure at 104 ± 7.2 °F (40 ± 2 °C) to demonstrate compliance with the alternative standards specified in §1060.103(b).

(8) Measure weight loss daily by retaring the balance using the reference tank and weighing the sealed test tank. Calculate the cumulative permeation rate~~weight loss~~ in g/m^2 /day for each measurement. Calculate the coefficient of determination, r^2 , based on a linear plot of cumulative weight loss vs. test days as described in 40 CFR 1065.602(k). Continue testing for ten full days or, if r^2 is below 0.95, continue testing until r^2 is at or above 0.95. If r^2 is not at or above 0.95 within 20 days of testing, discontinue the test and precondition the fuel tank further until it has stabilized emission levels, then repeat the testing. The daily measurements must be at approximately the same time each day. You may omit up to two daily measurements in any seven-day period. Alternatively, if the r^2 has not been met after the testing of ten full days, a 95% confidence interval can be calculated to demonstrate that the permeation rate has been stabilized enough to measure against 75% of the allowable limit. Construct a 95% confidence interval for the mean of each dataset and demonstrate that the 95% confidence interval for the mean is less than 75% of the maximum allowable daily permeation rate.

Where for a large sample (30 or more days),

95% CI = xbar +/- tσxbar

xbar = mean of the sample
σxbar(standard deviation of the means) =σ/n
σ = standard deviation of the sample
n = sample size
t = 1.96

Where for a small sample (less than 30 but greater than or equal to 10 days),

95% CI = xbar +/- tσxbar

xbar = mean of the sample
σxbar(standard deviation of the means) =σ/n
σ = standard deviation of the sample
n = sample size
t = 2.262

(9) Record the difference in mass between the reference tank and the test tank for each measurement. This value is M_i, where *i* is a counter representing the number of days elapsed. Subtract M_i from M_o and divide the difference by the internal surface area of

the fuel tank. Divide this g/m^2 value by the number of test days (using at least two decimal places) to calculate the emission rate in g/m^2 /day. Example: If a tank with an internal surface area of 0.720 m^2 weighed 1.31 grams less than the reference tank at the beginning of the test and weighed 9.86 grams less than the reference tank after soaking for 10.03 days, the emission rate would be—

((−1.31 g) − (−9.82 g)) / 0.720 m^2 / 10.03 days = 1.36 g/m^2 /day.

(10) Round your result to the same number of decimal places as the emission standard.

(e) *Fuel specifications beginning model year 2016.* Use gasoline E10 CERT fuel ~~blended with ethanol such that the blended fuel has 10.0 ± 1.0 percent ethanol by volume~~ as specified in Title 13, California Code of Regulations, section 2853. As an alternative, you may use Fuel CE10, as described in §1060.515(a)(1).

~~(f) *Flow chart.* The following figure presents a flow chart for the permeation testing described in this section:~~

§ 1060.521 How do I test fuel caps for permeation emissions?

If you measure a fuel tank's permeation emissions with a nonpermeable covering in place of the fuel cap under 40 CFR §1060.520(b)(5)(ii)(B), you must separately measure permeation emissions from a fuel cap. You may show that your fuel tank and fuel cap meet emission standards by certifying them separately or by combining the separate measurements into a single emission rate based on the relative surface areas of the fuel tank and fuel cap. However, you may not combine these emission measurements if you test the fuel cap at a nominal temperature of 28 °C and you test the fuel tank at 104°F (40 °C). Measure the fuel cap's permeation emissions as follows:

(a) Select a fuel cap expected to have permeation emissions at least as high as the highest-emitting fuel cap that you expect to be used with fuel tanks from the emission family. Include a gasket that represents production models. If the fuel cap includes vent paths, seal these vents as follows:

(1) If the vent path is through grooves in the gasket, you may use another gasket with no vent grooves if it is otherwise the same as a production gasket.

(2) If the vent path is through the cap, seal any vents for testing.

(b) Attach the fuel cap to a fuel tank with a capacity of at least one liter made of metal or some other impermeable material.

(c) Use the procedures specified in §1060.520 to measure permeation emissions. Calculate emission rates using the smallest inside cross sectional area of the opening on which the cap is mounted as the fuel cap's surface area.

(d) Use the same fuel specifications as those required for fuel tank permeation testing under § 1060.520(e).

§ 1060.801 What definitions apply to this part?

We (us, our) means the Executive Officer of the California Air Resources Board and any authorized representatives.