Appendix E

California Environmental Protection Agency

Air Resources Board

PROPOSED

Spark-Ignition Marine Watercraft Evaporative Emissions Test Procedure

TP - 1504

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

Adopted Date: XXX

TABLE OF CONTENTS

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 evaporative emissions control components must be compliant with California emissions standards and must use modified federal test procedures that include California Air Resources Board (ARB) 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 component manufacturer but it applies equally to anyone who does testing for ~~you~~a certifying component manufacturer.

(b) Unless ~~we~~ specifi~~ed~~ed~~y~~ 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 or CE10 fuel. E10 CERT fuel is defined in California Code of Regulations (Cal. Code Regs.), title (tit.) 13, §2853. CE10 fuel means fuel C as specified in ASTM D471 that is blended with ethanol. CE10 contains 10.0 ±1.0 percent ethanol by volume.

(d) The a~~A~~ccuracy and precision of all temperature measurements must be ±1.8 °F (±1.0 °C) or better. If ~~you~~ use~~ing~~ 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. If this is not feasible, (use the starting temperature in Table 1 to §1060.525~~ unless this is not feasible~~).

(e) The ~~Accuracy~~accuracy and precision of the mass balances used for weighing must be ~~sufficient to ensure accuracy and precision of~~ within two percent or ~~better~~ less for

permeation emissions 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~~ found 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 Cal.Code Regs., tit. 13, §§2450-2469 or §§2440-2447, the requirements in this test procedure, TP-1504, shall take precedence.

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

§ 1060.505 Other procedures.

(a) ~~*Your*~~ *Component Manufacturer testing.* The procedures in this part apply for all testing ~~you~~component manufacturers ~~do~~ to show compliance with emissions standards, with certain exceptions listed in this section.

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

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

(1) ~~You~~A component manufacturer may request to use special procedures if ~~your~~their equipment cannot be tested using the specified procedures. ~~We~~ARB will approve ~~your~~ component manufacturers request if ~~we~~ARB determines that ~~it~~they would produce emissions measurements that represent in-use operation and ~~we~~ARB determines that it can be used to show compliance with the requirements of the standard-setting part.

(2) ~~You~~A component manufacturer may ask to use emissions data collected using other procedures, such as those of the United States Environmental Protection Agency or the International Organization for Standardization. ~~We~~ARB will approve this only if ~~you~~a component manufacturer shows ~~us~~ARB that using these other procedures does not affect ~~your~~their ability to show compliance with the applicable emissions standards. This generally requires emissions levels to be far enough below the applicable emissions standards so any test differences do not affect ~~your~~the component manufacturer's ability to state unconditionally that ~~your~~their equipment will meet all applicable emissions 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 above, shall only be used if prior written approval is obtained from the Executive Officer. In order to obtain approval of an alternative test procedure, the applicant is responsible for demonstrating to the Executive Officer that the alternative test procedure is equivalent to this test procedure.

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

(ii) Demonstration of equivalency must include a minimum of three (3) test results each from TP-1504 and from the submitted alternative test procedure. The application must also include a comparison of the results demonstrating that the submitted alternative test procedure yields results equivalent to this test procedure. The applicant must submit the test procedure in detail for an engineering review and clearly identify any modifications to TP-1504.

(iii) 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.

(iv) If a tester requests approval to use other procedures under paragraph (c) of this section, ~~you~~a component manufacturer may not use them until ~~we~~ARB approves ~~you're~~ the 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.~~

(d) *Approval.* If ~~we~~ARB requires ~~you~~a component manufacturer to request approval to use other procedures under paragraph (c) of this section, ~~you~~the component manufacturer may not use them until ~~we~~ARB approves ~~your~~the 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~~es the applicant~~ ~~I~~ test ARB ~~EPA~~ Nonroad Fuel Lines ~~and EPA Cold-Weather Fuel Lines~~ for permeation emissions?

Measure permeation 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 or ~~fuel~~ CE10 fuel, 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 or ~~fuel~~ CE10 fuel, 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" s~~S~~ection 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) Except as specified in paragraph (d) of this section, beginning with model year 2018 SIMW, 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 title 40, CFR, Part 1060, section §1060.810) ~~at~~ using a test temperature of 73.4°F (23°C). If the Executive Officer finds commercial availability of marine fuel hoses as specified in Cal. Code Regs., tit. 13, §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 emissions test over a sampling period of 14 days. Two daily measurements may be omitted in any seven day period. Determine the final emission result based on the average of measured values over the 14-day period. Maintain an ambient temperature of 23±2 °C throughout the sampling period.

(d) For fuel lines with a nominal inner diameter below 5.0 mm, fuel line permeation emissions may alternatively be measured using the equipment and procedures for weight-loss testing specified in SAE J2996 (incorporated by reference title 40, CFR, Part 1060, section 1060.810). Determine the final emission result based on the average of measured values over the 14-day sampling period. Maintain an ambient temperature of 23±2 °C throughout the sampling period.

(e) Use good engineering judgment to test short fuel line segments. For example, individual fuel line segments may need to be joined using proper connection fittings to achieve enough length and surface area for a proper measurement. Size the fuel reservoir appropriately for the tested fuel line.

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

§ 1060.520 How does the applicant ~~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~~a component manufacturer must test a preproduction product that will represent actual production. However, ~~you~~a component manufacturer 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 the emissions control technology involves surface treatment, or other post-processing treatments such as an epoxy coating, ~~T~~take the following steps before an emissions 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 −3.4~~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~~the tank cannot be tested using the pressure cycles specified by this paragraph (a)(1), ~~you~~a component manufacturer may ask to use special test procedures under title 40, CFR, Part 1060, section §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~~ it reaches one million total cycles. Use an angle deviation of +15° to −15° from level.

(b) *Preconditioning fuel soak.* Take the following steps before an emissions 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~~ Ccount 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~~ Sseal 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~~is expected to be used with fuel tanks from the emissions family. It would generally be appropriate to consider an HDPE fuel cap with a nitrile rubber seal to be worst-case.

(B) ~~You may~~ Sseal the fuel inlet with a nonpermeable covering if ~~you~~ separately measure~~e~~ing the permeation from a worst-case fuel cap as described in title 40, CFR, Part 1060, section §1060.521.

(C) If ~~you use or specify~~ a fuel gasket made of low-permeability material is used, ~~you may seal~~ the fuel inlet may be sealed with a nonpermeable covering and calculate an emissions 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 may be produced.

(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 whose total volume is within 5 percent of the test tank's volume ~~that is identical to the test tank~~. ~~You may not use a~~ A tank that has previously contained fuel or any other contents that might affect its mass stability may not be used.

(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~~ the 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 l~~Less accurate estimates of the surface area may be used if ~~you make sure~~ not ~~to~~ overestimated ~~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~~as needed, 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 a~~Alternatively, ~~hold~~ the temperature of the room or enclosure at 104 ± 7.2 °F (40 ± 2 °C) may be held 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 weight loss in grams for each measurement. Calculate the coefficient of determination, r2, based on a linear plot of cumulative weight loss vs. test days. Use the equation in title 40, CFR, Part 1065, section 1065.602(k), with cumulative weight loss represented by y_i and cumulative time represented by $y_{ref.}$ The daily measurements must be at approximately the same time each day. ~~You may omit up to t~~Two daily measurements may be omitted in any seven-day period. Test for ten full days, then determine when to stop testing as follows:

(i)~~You may stop t~~Testing may be stopped after the measurement on the tenth day if r2 is at or above 0.95 or if the measured value is less than ~~50 percent of~~ the applicable standard. (Note that if a Family Emission Limit applies for the family, it is considered to be the applicable standard for that family.) This means that if ~~you stop~~ testing is stopped with an r2 below 0.95, ~~you may not use~~ the data may not be used to show compliance with a Family Emission Limit less than twice the measured value.

(ii) If after ten days of testing ~~your~~the r2 value is below 0.95 and ~~your~~the measured value is more than ~~50 percent of~~ the applicable standard, continue testing for a total of 20 days or until r2 is at or above 0.95. If r2 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.

Alternatively, if the r^2 has not been met after the testing of ten full days, a 95 percent confidence interval (CI) can be calculated to demonstrate that the permeation rate has

been stabilized enough to measure against 75 percent of the allowable limit. Construct a 95 percent confidence interval for the mean of each dataset and demonstrate that the 95 percent confidence interval for the mean is less than 75 percent of the maximum allowable daily permeation rate.

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

95 percent 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 percent 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 emissions 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 emissions 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~~the result to the same number of decimal places as the emissions standard.

(e) *Fuel specifications beginning with model year 2018.* 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~~ Cal. Code Regs., tit. 13, §2853. As an alternative, ~~you may use Fuel~~ CE10 fuel may be used, 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~~es the applicant I~~ test fuel caps for permeation emissions?

If ~~you~~a component manufacturer measures a fuel tank's permeation emissions with a nonpermeable covering in place of the fuel cap under title 40, CFR, Part 1060, section §1060.520(b)(5)(ii)(B), ~~you~~they must separately measure permeation emissions from a fuel cap. ~~You~~They may show that ~~your~~the fuel tank and fuel cap meet emissions standards by certifying them separately or by combining the separate measurements into a single emissions rate based on the relative surface areas of the fuel tank and fuel cap. However, ~~you~~the component manufacturer may not combine these emissions measurements if ~~you~~they 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~~ is expected to be used with fuel tanks from the emissions 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~~the component manufacturer 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 emissions 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).