APPENDIX C

California Environmental Protection Agency

Air Resources Board

Portable Outboard Marine Tank Test Procedure

TP-511

Diurnal Rate from Portable Outboard Marine Tanks

DRAFT

Adoption Date: To Be Determined

DRAFT 6/13/08

APPENDIX C

TABLE OF CONTENTS
DRAFT

1. APPLICABILITY 3

1.1 Requirement to Comply with Other Applicable Codes and Regulations 3

1.2 Safety 3

2. PRINCIPLE AND SUMMARY OF TEST PROCEDURE 3

3. BIASES AND INTERFERENCES 4

4. SENSITIVITY AND RANGE 4

5. EQUIPMENT 4

6. CALIBRATION PROCEDURE 5

7. PRECONDITIONING 5

Option A: Ambient Preconditioning 5

Option B: Constant Temperature Preconditioning 5

8. LEAK CHECK 7

9. DIURNAL TEST PROCEDURES 7

Variable Temperature Profile 8

10. CALCULATING RESULTS 8

11. RECORDING DATA 10

12. QUALITY ASSURANCE / QUALITY CONTROL 10

13. ALTERNATIVE TEST PROCEDURES 10

14. REFERENCES 10

Figure 1 - Data Sheet 11

APPENDIX C

California Environmental Protection Agency
Air Resources Board

DRAFT TP-511

Test Procedure for Determining Diurnal Emissions from Portable Outboard Marine Tanks

The definitions in Section 2468.2, Article 6, Chapter 9 of Title 13, California Code of Regulations (CCR) applies 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 the ARB to determine the diurnal emission rate from portable outboard marine tanks as required in Certification Procedure CP-510. This test procedure is applicable in all cases where portable outboard marine tanks are subject to the maximum allowable diurnal emissions rate for portable outboard marine tanks that are manufactured for sale, advertised for sale, sold, or offered for sale in California or that are introduced, delivered or imported into California for introduction into commerce.

1.1 Requirement to Comply with Other Applicable Codes and Regulations

Certification or approval by the Executive Officer does not exempt a portable outboard marine tank or its components 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 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. PRINCIPLE AND SUMMARY OF TEST PROCEDURE

Diurnal emissions may result when a portable outboard marine tank is stored with fuel and subject to daily temperature fluctuations. These emissions may result from permeation or evaporation. This procedure specifies test fuel and requires preconditioning followed by a three (3) day test period. Testing shall be conducted using a portable outboard marine tank self sealing cap and plugged connector.

APPENDIX C

3. BIASES AND INTERFERENCES

3.1 Moisture, temperature and pressure can bias mass measurements. A sealed trip blank shall be used to correct for atmospheric conditions.

3.2 Trip blanks and samples stored near high concentrations of hydrocarbon vapor may gain weight. Care shall be taken to purge the temperature enclosure at regular intervals to limit hydrocarbon vapor buildup.

3.3 Incorrectly installed components may bias the reported results.

3.4 Some electronic balances are sensitive to the effects of small static charges. If small amounts of static electricity influence the balance, the portable outboard marine tank shall be statically discharged or the balance shall be shielded from the effects of static electricity.

4. SENSITIVITY AND RANGE

The range of measurement is approximately 1,000 to 100,000 grams depending on capacity and installed components. All measurements shall be conducted using an electronic top loading balance. This balance shall be capable of a measurement of at least 125% of the expected maximum test weight. The balance shall have a minimum readability of 0.1 grams and minimum reproducibility of ± 0.2 grams.

5. EQUIPMENT

5.1 An electronic top loading balance that meets the requirements of Section 4.

5.2 NIST or NVLAP certified calibration weights. A sufficient number of weights to verify measurements at 20%, 80% and 100% of the balance range.

5.3 A ventilated, variable temperature enclosure capable of controlling the internal air temperature to within +/-2°F of each measurement specified in Table 9.

5.4 Temperature instrument(s) capable of measuring air or surface temperature within the tolerances of those specified in Table 9.

5.5 A barometric pressure instrument capable of measuring atmospheric pressure at the location of the balance to within +/-0.02 inches of mercury.

5.6 A relative humidity instrument capable of measuring relative humidity percentage (%RH) at the location of the balance with a sensitivity of +/-2%RH.

5.7 Test Fuel: E-10 (90% fuel complying with California Phase 3 Reformulated Gasoline requirements with 10% by volume Ethanol).

APPENDIX C

6. CALIBRATION PROCEDURE

6.1 All instruments and equipment used to conduct this procedure shall be calibrated per the manufacturer's specifications before testing.

6.2 The electronic balance shall be calibrated by a certified calibration company or agency within 12 months of testing.

6.3 During testing, the accuracy of the balance shall be verified with calibration weights at 20%, 80% and 100% of the balance range. All verification readings shall be within +/-2% of the calibration weight mass. During test weigh-ins, no more than 25 measurements or 2 hours shall pass (whichever is earliest) without verifying the accuracy of the balance. Tare the balance and repeat the previous measurement if the zero reading drifts more than +/-0.1 grams.

7. PRECONDITIONING

Preconditioning is required to ensure the tank and components are permeating at a steady-state rate. Preconditioning may be conducted using one of two options; ambient conditions for at least 140 days or constant temperature for a minimum of 70 days in conjunction with pressure cycling and a weight loss correlation coefficient.

Option A: Ambient Preconditioning

7A.1 Identify the portable outboard marine tank with a unique ID number and record on the data sheet.

7A.2 Fill the tank to 50% (+/-1%) of the rated capacity with test fuel as described in Section 5.7. Record the fuel type, amount dispensed, and start date on the data sheet. At no time during the remainder of testing shall the tank be emptied of test fuel for more than one hour.

7A.3 Install the self sealing cap and plug the fuel fitting.

7A.4 Check the leak tightness of the tank as specified in Section 8.

7A.5 Allow the tank to precondition at ambient conditions for a minimum of 140 days.

Option B: Constant Temperature Preconditioning

7B.1 Identify the portable outboard marine tank with a unique ID number and record on the data sheet.

7B.2 Install the self sealing cap.

7B.3 Connect a pressure/vacuum source to the tank fuel pickup connection. Pressure cycle the tank between 2.0 psig and -0.5 psig (+/-0.10 psig). Repeat until at least 1,000 cycles are completed in 8 hours (+/-1 hour). Pressure cycling shall be performed in 82ºF (+/-9ºF) ambient air with compressed air at no less than 70ºF. Pressure shall not be introduced using a modified fill cap.

7B.4 Fill the tank to approximately 50% rated capacity with test fuel as described in Section 5.7. Record the fuel type, amount dispensed, and start date on the data sheet. At no time during the remainder of testing shall the tank be emptied of test fuel for more than one hour.

7B.5 Check the leak tightness of the tank as specified in Section 8.

7B.6 Obtain a second identical portable outboard marine tank for use as a trip blank. The trip blank shall remain empty and not have been previously exposed to fuel. Perform a leak check by pressurizing the trip blank to at least 5.0 psig and submerging in a water bath as specified in Section 8.2 to verify the absence of leaks.

7B.7 Check the balance with calibration weights at 20%, 80% and 100% of the balance range. See Section 5.2.

7B.8 Ensure the exterior surfaces of the tanks are clean, dry, and free of dirt or debris. Carefully place on the balance. Record the weight, date, time, temperature, relative humidity and barometric pressure on the data sheet (see Figure 1). Repeat with the trip blank.

7B.9 Confirm the balance has not deviated. Check the balance with calibration weights at 20%, 80% and 100% of the balance range. See Section 5.2.

7B.10 Place the tank and trip blank into the temperature enclosure and acclimate at steady-state temperature of at least 104°F for a minimum of 70 days.

7B.11 Ten days prior to the conclusion of preconditioning, weigh the portable outboard marine tank and trip blank once per 24-hour period as specified in Sections 7B.6 through 7B.8. Correct each measurement using the trip blank. Continue preconditioning until constant weight loss has been achieved. Constant weight loss is defined as the results of ten consecutive readings with a correlation coefficient of 95% or greater. See Section 10 for calculation.

APPENDIX C

8. LEAK CHECK

A leak check shall be performed to visually confirm leak integrity.

8.1 Perform a leak check by raising the ambient temperature at least 40ºF for a minimum of two hours. This should expand the fuel vapor and the tank walls. If the tank does not expand, there may be a leak.

8.2 Submerge in a water bath large enough to cover the entire portable outboard marine tank to a depth of at least six (6) inches. Tilt the tank back and fourth while submerged to dislodge air from external cavities. Wait at least thirty (30) seconds. Any bubbles coming from the tank denotes a leak. Remove the tank from the water bath and dry off excess water from the exterior surfaces.

8.3 No repairs may be performed. Tanks with leaks shall be replaced and the failure documented on the data sheet.

9. DIURNAL TEST PROCEDURES

Diurnal testing requires the portable outboard marine tank to undergo three (3) consecutive diurnal temperature cycles as specified in Table 9. A trip blank shall be used to correct for changes in atmospheric conditions during the test period.

9.1 Perform a leak check on the preconditioned tank as specified in Section 8.

9.2 Obtain a second identical portable outboard marine tank for use as a trip blank. The trip blank shall remain empty and not have been previously exposed to fuel. Perform a leak check by pressurizing the trip blank to at least 5.0 psig and submerging in a water bath as specified in Sections 8.2 to verify the absence of leaks.

9.3 Clean the exterior surfaces of the tanks with Alconox™ or another hydrocarbon dissolving solution that effectively removes hydrocarbon residue from the outer surfaces of the portable outboard marine tank and trip blank. This step shall not be repeated for the remainder of testing.

9.4 Place the portable outboard marine tank and trip blank into the temperature enclosure and acclimate at 65°F (+/-5°F) for a minimum of 6 to a maximum of 36 hours to eliminate temperature bias. At no time after the acclimation period shall the tank be removed from the 65°F steady-state temperature enclosure for more than 60 minutes or Section 9.4 shall be repeated.

9.5 Check the balance with calibration weights at 20%, 80% and 100% of the balance range. See Section 5.2.

9.6 Weigh the portable outboard marine tank and trip blank and return to the temperature enclosure acclimated at 65°F to avoid temperature bias. Record the date, weight, time, temperature, relative humidity and barometric pressure on the data sheet.

9.7 Confirm the balance has not deviated. Check the balance with calibration weights at 20%, 80% and 100% of the balance range. See Section 5.2.

9.8 Begin the diurnal cycle as specified in Table 9. At the conclusion of the diurnal cycle, repeat Section 9.5 through 9.7

9.9 Repeat until three (3) consecutive diurnal cycles are completed. Care must be taken to avoid temperature bias. A minimum of 6 to a maximum of 36 hours between diurnal cycles is acceptable provided the tanks remain at 65°F steady-state conditions.

9.10 At the conclusion of diurnal testing, repeat the leak check as specified in Section 8 for the portable outboard marine tank. For the trip blank, repeat the leak check specified in Section 9.2.

9.11 Calculate the daily weight loss for each diurnal cycle using the trip blank as specified in Section 10. Record the diurnal emission rate on the data sheet using the highest recorded daily weight loss

Table 9
Diurnal Temperature Profile

Hour	0	1	2	3	4	5	6	7	8	9	10	11	12
(^{o}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	--
(^{o}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 dividing the corrected daily weight loss by the portable outboard marine tank rated capacity. If constant elevated temperature was used for preconditioning, calculate the constant weight loss correlation coefficient as shown below.

APPENDIX C

Weight Loss With Trip Blank

$$L = W_i - C_T$$

Where:

L	=	daily weight loss, with trip blank correction (grams/day)
W_i	=	initial weight of sample portable outboard marine tank (grams)
C_T	=	$W_f + D_T$ (trip blank correction) (grams)

Where:

W_f	=	final weight (grams)
D_T	=	$T_i - T_f$ (grams)

Where:

T_i	=	trip blank weight at the start of the specified time period (grams)
T_f	=	trip blank weight at the end of the specified time period (grams)

Diurnal Emission Rate

$$D_{rate} = L / A$$

Where:

D_{rate}	=	the diurnal emission rate (grams/day/square meter)
L	=	the corrected daily weight loss (grams/day)
A	=	inside surface area (square meters)

Constant Weight Loss Correlation Coefficient

Plot the cumulative daily weight loss (grams) against the sampling time (days). Perform a linear regression of ten (10) consecutive data points (spreadsheet or hand calculation) using the equation shown below. A correlation coefficient of 95% or greater shall demonstrate constant weight loss.

$$r = \frac{n\left(\sum XY\right) - \left(\sum X\right)\left(\sum Y\right)}{\sqrt{\left[n\sum X^2 - \left(\sum X\right)^2\right]\left[n\sum Y^2 - \left(\sum Y\right)^2\right]}}$$

Where:

r	= correlation coefficient
n	= number of samples (10)
X	= day number (i.e., 1-10)
Y	= cumulative daily weight loss (grams)

APPENDIX C

11. RECORDING DATA

Record all data on a field data sheet. An example of a field data sheet is shown in Figure 1. Alternate test forms may be used provided they list the same minimum parameters as shown in Figure 1.

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 above, 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.

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

(2) Documentation of any such requests, equivalency demonstrations, and ARB approvals shall be maintained by the ARB and shall be made available upon request.

14. REFERENCES

Air Resources Board (ARB) “California Exhaust Emission Standards and Test Procedures for 2001 and Subsequent Model Passenger Cars, Light-Duty Trucks, and Medium-Duty Vehicles”, October 2007 revision

APPENDIX C

Figure 1 - Data Sheet

Test Company: _____ Test Personnel: _____

Sample ID #: _____ Test Period Start: _____ Test Period End: _____

OMT Manufacturer: _____ Model: _____ Rated Capacity: _____ (gal)

Balance Make/Model: _____ Capacity/Resolution: _____ Annual Calib. Date: _____

Verification Weights: 20%: ____ 80%: ____ 100%: _____

Preconditioning Method: ___ Ambient ___ Elevated Temperate (check one)

Test Fuel Type: _____ (attach specifications) Steady-State Temp.: _____ (^{o}F or ^{o}C)

Start Date: _____ End Date: _____ CC (Elevated Temp): _____%

Diurnal Test Results (attach test results with computations)

Day 1: Corrected Weight Loss: _____ g/day Temp: _____ Baro. Press: _____ RH: _____%

Day 2: Corrected Weight Loss: _____ g/day Temp: _____ Baro. Press: _____ RH: _____%

Day 3: Corrected Weight Loss: _____ g/day Temp: _____ Baro. Press: _____ RH: _____%

Diurnal Rate: _____ g/gal/day

Documentation of Performance (attach additional sheets if necessary)

Date: Comment (include “failures”):

_____ _____

_____ _____

_____ _____