California Environmental Protection Agency

Air Resources Board

Spark-Ignition Marine Watercraft Evaporative Emissions Test Procedure

TP - 1501

Test Procedure for Determining Diurnal Evaporative Emissions from Spark-Ignition Marine Watercraft

Adopted Date: December 21, 2015

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A set of definitions common to all certification and test procedures is in Cal. Code Regs., tit. 13, §2752 et seq. These definitions apply to all applicable instances in this test procedure.

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

1. APPLICABILITY

This test procedure, TP-1501, is used to determine the diurnal evaporative emissions from spark-ignition marine watercraft (SIMW). This test procedure is proposed pursuant to sections 39600, 39601, 43013, and 43018 of the Health and Safety Code, and is applicable in all cases where SIMW are sold, supplied, offered for sale, or manufactured for use in the State of California.

1.1 Requirement to Comply with All Other Applicable Codes and Regulations

Certification or approval of any evaporative emissions control system by the Executive Officer does not exempt the engine or evaporative emissions control systems from compliance with other applicable codes and regulations such as state and federal safety codes and regulations.

1.2 Safety

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

2. PERFORMANCE STANDARDS

The performance standard for certification of evaporative emissions control systems on SIMW is contained in Cal. Code Regs., tit. 13,§2855.

3. DURABILITY REQUIREMENTS

A demonstration of durability of the applicant's evaporative emissions control system is required prior to performing an evaporative emissions test.

Prior to the commencement of a durability demonstration, the applicant is required to submit and obtain approval from CARB of an evaporative emissions durability test procedure. The test procedure must subject all evaporative emissions control system components to conditions representative of those likely to be experienced throughout their useful life. Once the emissions durability test procedure is approved, the approval remains valid for certifying all subsequent model years, provided that no major changes are made to the evaporative emissions control system. If major changes are made to the evaporative control system, the previously approved durability test procedures no longer apply and approval of a revised durability test procedures is required.

A durability demonstration is required prior to any testing to determine the performance of a carbon canister or pressure relief valve. The durability demonstration is designed to ensure that the carbon canister or pressure relief valve remains effective throughout the useful life of the equipment on which it is being used. The durability demonstration must follow the applicable requirements outlined in TP-1503, Test Procedure for Determining Diurnal Vented Emissions from Installed Marine Fuel Tanks, section 5**.**

4. GENERAL SUMMARY OF TEST PROCEDURE

A sealed housing for evaporative determination (SHED) is used to measure diurnal emissions. This method subjects SIMW to a variable temperature profile while maintaining a constant pressure and continuously sampling for hydrocarbons (HC) with a flame ionization detector. The total mass of HC from an evaporative emissions control system over the test period is calculated using the ideal gas equation.

This test procedure measures diurnal evaporative emissions from SIMW with complete evaporative emissions control systems as defined in Cal. Code Regs., tit. 13, §2752 (a)(8). The basic process is as follows:

- Fill the SIMW fuel tank to 55 percent with fuel.
- Operate engine at 50 percent maximum governed speed for 15 minutes.
- Precondition the evaporative emissions control and fuel delivery system for no less than 140 days.
- Drain and fill fuel tank to 55 percent capacity with fuel.
- Purge carbon canister (if so equipped) with 4300 bed volumes of nitrogen or dry air (at 50+/- 25 grains water vapor per lb. of dry air at 20-30ºC) at the carbon manufacturer's recommended rate.
- Operate the engine at 50 percent maximum governed speed for fifteen minutes to allow the engine to reach normal operating temperature.
- Subject the SIMW to a three-hour constant 105°F (40.6^{o}C) hot soak procedure.
- Soak the SIMW until fuel temperature reaches 65°F (18.3^{o}C).
- Subject the SIMW to a 24-hour (65°F-105°F-65°F) (18.3°C-40.6°C-18.3°C) diurnal temperature profile.

The corrected diurnal mass of total HC measured by the SHED over the 24-hour diurnal temperature profile is compared with the performance standard in Cal. Code Regs., tit. 13, §2855. Evaporative emissions control systems that achieve results less than or equal to the performance standard are considered compliant.

5. INSTRUMENTATION

The instrumentation necessary to perform evaporative emissions testing for SIMW is the same instrumentation used for passenger cars and light duty vehicles, and is described in title 40 Code of Federal Regulations (CFR), Part 86, section 86.107-96.

5.1 Calibrations

Evaporative emissions enclosure calibrations are specified in title 40, CFR, Part 86, section 86.117-90, as incorporated by reference amended with the following subsection:

The diurnal evaporative emissions measurement enclosure calibration consists of the following parts: initial and periodic determination of enclosure background emissions, initial determination of enclosure volume, and periodic HC and ethanol retention check and calibration. Calibration for HC and ethanol may be conducted in the same test run or in sequential test runs.

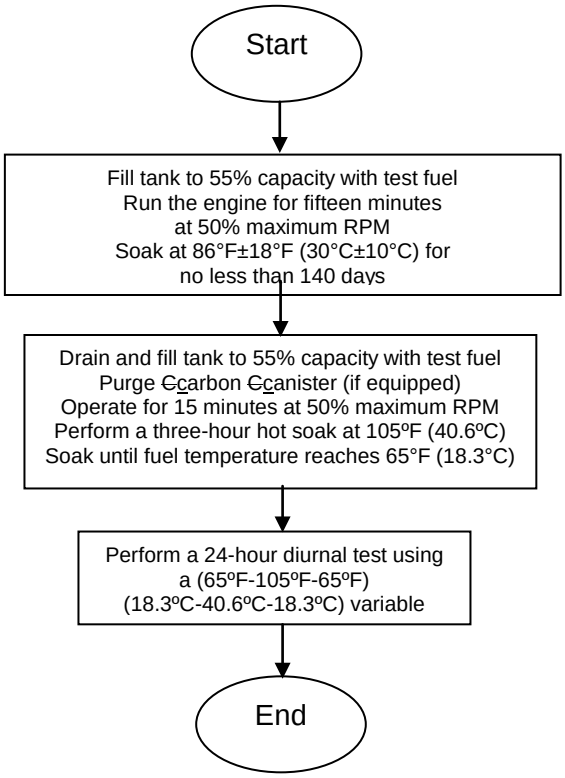
- All test fuels must be tested to ensure they meet CARB specification for E10 CERT fuel. Fuel analysis certification results from a fuel supplier are sufficient to meet this requirement.
- The SHED must be able to control temperature to within the specification of this test procedure while keeping pressure constant.

6. TEST PROCEDURE

The 24-hour diurnal test sequence is shown graphically in Figure 6.1. The temperatures monitored during testing shall be representative of those experienced by the equipment. The equipment shall be approximately level during all phases of the test sequence to prevent abnormal fuel distribution. The temperature tolerance of a soak period may be waived for up to 10 minutes to allow purging of the enclosure or transporting the equipment into the enclosure.

Testing a representative piece of equipment from each evaporative family and comparing the results to the appropriate performance standard determines compliance with requirements of Cal. Code Regs., tit. 13, §2855.

Figure 6.1: Flow Chart of Test Procedure



6.1 Fuel System Preconditioning

The purpose of the preconditioning period is to introduce gasoline into the fuel system and precondition all fuel system components. Precondition the tank and other fuel delivery system components by filling the tank to 55 percent of its nominal capacity with fresh E10 CERT fuel as specified in section 7. After filling the tank, start the engine and allow it to run at 50 percent of the maximum rated speed for approximately fifteen minutes. Soak the tank and other components at 86°F±18°F (30°C±10°C) for not less than 140 days. Data documenting that the tank has reached equilibrium must be provided for tanks soaked less than 140 days. Alternatively, the tank may be soaked for at least 10 weeks at 110°F±9°F (43°C±5°C). Perform a slosh test by filling the tank to 40-50 percent of its capacity with fuel specified and rocking it at a rate of 15 cycles per minute until you reach one million total cycles. The fuel tank may be removed from the watercraft before the slosh test and re-installed afterwards. Use an angle deviation of +15° to -15° from level.

The period of slosh testing may be considered part of the preconditioning period provided each tank and all fuel system components tested remain filled with fuel and are never empty for more than one hour over the entire preconditioning period.

If equipped with a carbon canister, the carbon canister must be preconditioned according to 40 CFR, Part 86, section 86.132-96(h).

6.2 Refueling and Hot Soak Procedure

Following the preconditioning period, drain the fuel tank and refill to 55 percent of its nominal capacity with E10 CERT fuel. For evaporative emissions control systems that use a carbon canister, the canister must be purged following the preconditioning period but prior to initiating the hot soak procedure. The sequence starts by first bench purging the canister with 400 bed volumes of dry air or nitrogen in 30 minutes. Bed volume is the design volume of the carbon contained in the canister. The purge rate will therefore vary with canister size. Purge may be accomplished by drawing a vacuum at the tank or purge port, or by pushing air or nitrogen into the atmospheric vent. Operate the engine at 50 percent of its maximum governed speed for fifteen minutes. Immediately place the engine in the SHED enclosure preheated to 105°F (40.6°C) within two minutes. Perform a three-hour hot soak at a constant 105°F (40.6°C).

6.3 Forced Cooling

After the hot soak procedure, purge the enclosure to reduce the HC concentration to near background levels. Cool the enclosure to attain a wall temperature of 65°F± 3.0°F (18.3°C± 1.7°C). After cooling the enclosure to 65°F (18.3°C), soak the SIMW in the enclosure until the fuel temperature reaches 65°F± 3.0°F (18.3°C± 1.7°C).

6.4 24-Hour Diurnal Test

Immediately after soaking, purge the enclosure to reduce the HC concentration to near background levels and perform a 24-hour diurnal test by smoothly following the temperature profile shown in Table 6.1.

Table 6.1: Diurnal Temperature Profile (Fahrenheit)

Hour	0	1	2	3	4	5	6	7	8	9	10	11	12
(°F)	65.0	66.6	72.6	80.3	86.1	90.6	94.6	98.1	101.2	103.4	104.9	105.0	104.2
Hour	13	14	15	16	17	18	19	20	21	22	23	24	--
(°F)	101.1	95.3	88.8	84.4	80.8	77.8	75.3	72.0	70.0	68.2	66.5	65.0	--

Table 6.1: Diurnal Temperature Profile (Celsius)

Hour	0	1	2	3	4	5	6	7	8	9	10	11	12
(°C)	18.3	19.2	25.6	26.8	30.1	32.6	34.8	36.7	38.4	39.7	40.5	40.6	40.1
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	--

6.5 Calculation of Mass of Diurnal Evaporative Emissions

The calculation of the mass of the diurnal evaporative emissions is as specified in Part III of the “California Evaporative Emission Standards and Test Procedures for 2001 and Subsequent Model Motor Vehicles.”

7. TEST FUEL

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.

8. 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 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.

- Documentation of any such approvals and demonstrations shall be maintained by the Executive Officer and shall be made available upon request.
- Demonstration of equivalency must include a minimum of three (3) test results each from TP-1501 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-1501.
- 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.

9. REFERENCES

1. *California Evaporative Emission Standards and Test Procedures for 2001 and Subsequent Model Motor Vehicles*, California Environmental Protection Agency, Air Resources Board, El Monte, CA, March 2012.

2. *California Exhaust Emission Standards and Test Procedures for 2001 and Subsequent Model Passenger Cars, Light-Duty Trucks and Medium-Duty Vehicles*, California Environmental Protection Agency, Air Resources Board, El Monte, CA, August 1999.

3. *Control of Emissions from New and In-use Highway Vehicles and Engines*, Code of Federal Regulations Part 86, June 1995.