California Environmental Protection Agency

Air Resources Board

Spark-Ignition Marine Watercraft Evaporative Emissions Test Procedure

TP-1505

Test Procedure for Determining Pressure Relief Valve Performance: Durability Demonstration and Leak Test

Adopted Date: December 21, 2015

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A set of definitions common to all certification and test procedures are in Cal. Code Regs, tit. 13, §2752 et seq. 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 designate.

1. APPLICABILITY

This test procedure is used by CARB to determine the performance of Pressure Relief Valves used to control evaporative emissions from Spark-Ignition Marine Watercraft (SIMW). SIMW are defined in Cal. Code Regs, tit. 13, §2850 et seq. This test procedure is proposed pursuant to section 43824 of the California Health and Safety Code and applies to fuel tank or equipment manufacturers seeking an Executive Order for an evaporative emissions control system utilizing a pressure relief valve. TP-1505 is used for design-based certification as defined in Cal. Code Regs, tit. 13, §2855.

1.1 Requirement to Comply with All Other Applicable Codes and Regulations

Approval of an evaporative emissions control system component, technology, or system by the Executive Officer does not exempt the manufacturer 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 potentially hazardous operations and should only be used by, or under the supervision of, those familiar and experienced in the use of such operations. Appropriate safety precautions should be observed at all times while performing this test procedure.

2. PERFORMANCE STANDARDS

The minimum performance standard for certification of a SIMW component is defined in Cal. Code Regs, tit. 13, §2855.

3. DURABILITY REQUIREMENT

A durability demonstration is required prior to any testing to determine the performance of a pressure relief valve. Durability demonstration tests are designed to ensure that the

pressure relief valve remains effective throughout the useful life of the SIMW.

Prior to the commencement of a durability demonstration, if the applicant chooses to follow an alternative durability procedure, the applicant is required to submit and obtain approval of an alternative pressure relief valve durability test procedure according to Section 9 of this test procedure. Once approved, a manufacturer is not required to obtain a new approval for a durability demonstration unless changes result in new testing requirements.

Pressure relief valves shall be deemed acceptable if they remain functional after the durability demonstration prescribed below. Unless otherwise specified, all testing may be performed at ambient temperature. All testing temperatures must be within ± 5°F (± 3°C) of the required temperature.

The Executive Officer shall review the method for demonstrating durability based on the following requirements:

The pressure relief valve durability and reliability requirements may be performed on a sealed fuel tank, sealed test rig, or a representative sealed fuel system (manufacturer tank not required). Unless otherwise specified, all testing may be performed at ambient temperature. All testing temperatures must be within ± 5°F (± 3°C) of the required temperature.

3.1 Thermal Cycle

The pressure relief valve is placed in an environment where they are subjected to temperature changes for one cycle in the sequence below:

- 86°F (30ºC) for 15.5 hours,
- 77°F (25 ºC) for 0.5 hours,
- 68ºF (20ºC) for 7.5 hours,
- 77°F (25ºC) for 0.5 hours,
- 86°F (30ºC) for 15.5 hours,
- 77°F (25ºC) for 0.5 hours,
- 68ºF (20ºC) for 7.5 hours, and
- 77°F (25ºC) for 0.5 hours.

Up to 5 minutes is allowed for the temperature to rise/descend and then stabilize. A total of ten (10) cycles are required.

3.2 Pressure/Vacuum

The Pressure/Vacuum test is performed under both high 86°F (30ºC) and low 68ºF (20ºC) temperature. Determine the pressure relief valve's design pressure limit (must be at least 7.35 kPa) under normal operating conditions. Connect the pressure relief valve to a sealed empty tank. Pressurize the empty tank until the valve opens and then evacuate to at least 0 kPa. Flow rates must be no less than 1 L/min. The pressure/vacuum cycling shall be performed at ~~17~~86ºF +/- 5ºF (~~8~~30ºC +/- 3ºC) ambient and at ~~-40~~68ºF+/- 5ºF (~~-~~20ºC +/- 3ºC) ambient. Repeat the pressure/vacuum process until the valve has been subjected to not less than 8,300 cycles in each temperature condition.

3.3 Vibration

The vibration test is performed with a vibration frequency of 11 Hz at an acceleration of 29.4 m/s^2. The valve must be subjected to continuous sinusoidal vibration in its vertical and horizontal (radial and axial) direction for 2.5×10^4 times each.

3.4 Dust

The dust test is performed in a test room filled by dust indicated by JIS (Japanese Industrial Standards) Z8901 type 15 with a concentration of 100 $\mu g/m^3$. The valve is pressured to open and then close when the tank is evacuated to a maximum of -2.94 kPa +/- 0.1kPa. Three hundred (300) pressure/vacuum cycles are required.

3.5 Ozone

The ozone test is a static test performed in an environment that can produce ozone to the specified level and temperature. The pressure relief valve must be subjected to a continuous exposure of 150 ppb +/- 5 ppb (parts per billion) of ozone at 86°F (30°C) for 120 hours.

4. GENERAL SUMMARY OF TEST PROCEDURE

These test procedures are designed to provide consistent methods to evaluate the durability and the leaking potential of a pressure relief valve. Any leaking from the pressure relief valve should remain sealed under a pressure of 7.35 kPa or less in order to control diurnal evaporative emissions.

The leak test procedure is as follows:

- Pressurize the test tank until the pressure relief valve opens. The pressure in the tank should be greater than 7.35 kPa.
- Hold the pressure relief valve open for 5 minutes.
- Shut off the air and wait for the valve to close.
- Once the valve closes, maintain the pressure in the tank for 16 hours. The final pressure should be equal to or greater than 7.35 kPa. The pressure drop from the beginning to the end of the test should not exceed 5 percent.

5. INSTRUMENTATION

- A fuel tank: 3.0L to 19.0 L, able to withstand 22 kPa.
- A pressure gauge: accuracy of <0.1 kPa.
- An air pump.
- An air mass flow controller: 0-1 L/min range with a minimum accuracy of 0.01 L/min.
- An additional air mass flow controller: 0-1 L/min range with a minimum accuracy of 0.01 L/min (optional).
- An air control valve.

6. SENSITIVITY AND RANGE

The minimum sensitivity of the pressure gauge, air flow controller and air flow meter must be selected using good engineering judgment.

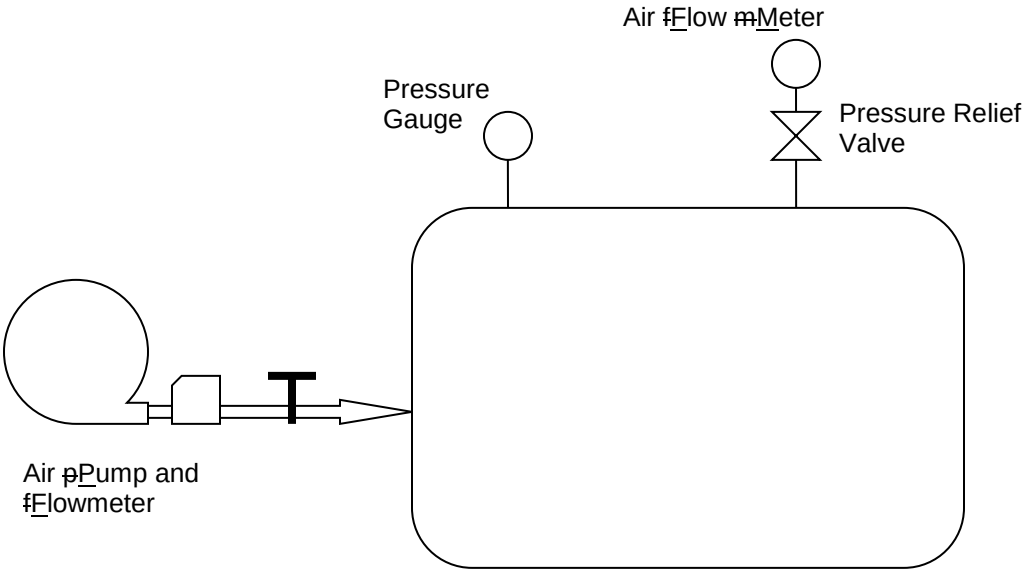
7. EQUIPMENT CALIBRATIONS

Mass flow controllers and meters must undergo an annual multiple point calibration with a primary standard and have a R^2 coefficient of 0.99 or greater.

8. LEAK TEST PROCEDURE

- Connect the pressure gauge, the air pump, the mass flow controller, the valve, flow meter and the pressure relief valve to the tank (Figure 8.1).
- Pump air into the tank at a flow rate of 0.1 L/min.
- Record the reading of the flow meter every minute.
- Record the pressure (P_L) when the air begins leaking from the valve. The P_L must be greater than 7.35 kPa.
- When the pressure relief valve is fully open and the air pressure in the tank is stable, record the pressure reading. Hold the pressure for 5 minutes.
- Shut off the valve, and then turn off the pump.
- When the air pressure in the tank becomes stable, record the pressure reading (Pi). The Pi must be equal or greater than 7.35 kPa. Hold the pressure for at least 16 hours.
- At the end, record the pressure reading (Pe). The Pe must be equal or higher than 7.35 kPa. The difference between Pi and Pe must be less than 5 percent of Pi.

Figure 8.1: Sketch of Pressure Relief Valve Leak Testing System



Usage of an air flow meter is optional. Sprayed bubble producing leak detector solution can be used in place of the air flow meter. If leak detector solution is used, the second to fourth

step of the above test procedure can be amended to read as follows:

- Pump the air into the tank at a flow rate of 0.1 L/min.
- Spray bubble producing leak detector solution on the pressure relief valve.
- Record the pressure (P_L) when the air begins leaking from the valve and bubbles are generated. The P_L must be greater than 7.35 kPa.

9. 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-1505 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-1505.
- 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.