California Environmental Protection Agency

Air Resources Board

Vapor Recovery Test Procedure

TP-201.2B

Determination of Flow Versus Pressure for Equipment in Phase II Vapor Recovery Systems of Dispensing Facilities

Adopted: April 12, 1996

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1 APPLICABILITY

A set of definitions common to all certification and test procedures is in:

D-200 Definitions for
Certification Procedures and
Test Procedures for
Vapor Recovery Systems

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

1.1 General

This procedure applies to the determination of flow versus pressure correlations for equipment in vapor recovery systems at dispensing facilities.

1.2 Modifications

Any modification of this method shall be subject to approval by the ARB Executive Officer.

2 PRINCIPLE AND SUMMARY OF TEST PROCEDURE

The purpose of this test procedure is to determine the flow versus pressure correlations for equipment in vapor recovery systems at dispensing facilities.

The mass flux of fugitive emissions from a dispensing facility is the product of the volumetric flow rate and the flow-weighted mass-per-volume concentration.

Flow versus pressure correlations are based upon simulatneously collected data for flow, pressure, and time. The data are collected from representative equipment used in vapor recovery systems at dispensing facilities. The data are reduced to yield the correlations.

For equipment used in vapor recovery systems at dispensing facilities, the correlations can be used:

(1) as performance specifications during certification,

(2) as compliance determinations after certification, and

(3) for quality assurance and quality control of manufactured equipment.

Figures 1 through 3 are provided to illustrate some aspects of the principle and summary provided below. Figures are at the end of this document.

3 BIASES AND INTERFERENCES

Equipment tested for certification must be representative of the equipment used in actual installations of systems.

4 SENSITIVITY, RANGE, AND PRECISION

4.1 Sensitivity

4.1.1 Inclined Liquid Manometers and Electronic Pressure Meters

Maximum incremental graduations at, above, and below a pressure observation shall be 0.01 inches water column ("WC).

Each such graduation shall be defined as the resolution, P_{Res}, of a pressure observation.

The maximum bias shall be plus-or-minus one-half percent (±0.5%) of full-scale.

4.1.2 Mechanical Spring Diaphragm Pressure Gauges

The minimum diameter of the pressure gauge face shall be 4 inches.

Maximum incremental graduations at, above, and below a pressure observation shall be 0.05 "WC.

Each such graduation shall be defined as the resolution, P_{Res}, of a pressure observation.

The maximum bias shall be plus-or-minus two percent (±2%) of full-scale.

4.1.3 Volume Flow Meters

Maximum incremental graduations at, above, and below a volume flow observation shall be:

(1) 0.01 mL/min for 0.10 to 9.99 mL/min,

(2) 0.1 mL/min for 10.0 to 99.9 mL/min, and

(3) 1 mL/min for 100 to 999 mL/min.

Each such graduation shall be defined as the resolution, Q_{Res}, of a volume flow observation.

The maximum bias shall be plus-or-minus two percent (±2%) of full-scale.

4.2 Range

4.2.1 **Pressure**

The pressure specifications referenced in CP-201 are for +2.00 "WC to -8.00 "WC inches water column.

The range for the pressure meter shall be the range which includes the pressure specification, e.g.:

(1) for +2.00 "WC, the range shall be 0.00 to +10.00 "WC; and

(2) for -8.00 "WC, the range shall be 0.00 to -10.00 "WC.

4.2.2 **Volume Flow**

The volume flow specifications referenced in CP-201 are for 0.0045 and 0.0063 cubic feet per minute (CFM). These specifications correspond to 127 and 178 milliliters per minute (mL/min).

The range for the volume flow meter shall be the range which includes the volume flow specification.

4.3 Precision

4.3.1 **Pressure**

The precision of a pressure observation shall affect the compliance status of a system as described below, where:

$P_{Req@Q}$ ≡ pressure requirement, at a specified volume flow, per the appropriate certification procedure, rounded to the nearest integral multiple of P_{Res},

and

$P_{Obs@Q}$ ≡ pressure observation, at the specified volume flow.

The precision for a pressure observation shall be one-half of P_{Res}.

$P_{Obs@Q}$ shall be an integral multiple of P_{Res}.

Non-Compliance with a pressure requirement shall be determined when, at a specified volume flow:

$$P_{Req@Q} - P_{Obs@Q} \geq P_{Res}.$$

4.3.2 Volume Flow

The precision of a volume flow observation shall affect the compliance status of a system as described below, where:

$Q_{Req@P}$ ≡ volume flow requirement, at a specified pressure, per the appropriate certification procedure, rounded to the nearest integral multiple of the resolution of Q_{Res},

and

$Q_{Obs@P}$ ≡ volume flow observation, at the specified pressure.

The precision for a volume flow observation shall be one-half of Q_{Res}.

$Q_{Obs@P}$ shall be an integral multiple of Q_{Res}.

Non-Compliance with a volume flow requirement shall be determined when, at a specified pressure:

$$Q_{Req@P} - Q_{Obs@P} \geq Q_{Res}.$$

5 EQUIPMENT

5.1 Pressure Meters

At least two types of pressure meters can meet the specifications of § 4:

(1) inclined liquid manometers and

(2) electronic pressure meters using pressure transducers.

5.2 Volume Meters

At least four types of volume flow meters can meet the specifications of § 4:

(1) meters using soap bubbles,

(2) meters using small calibrated pistons,

(3) meters using hot wire sensors, and

(4) meters using acoustic displacement techniques.

5.3 Nitrogen

Use commercial grade nitrogen in a high pressure cylinder, equipped with a two-stage pressure regulator and a one psig pressure relief valve.

5.4 Pressurized Ballast Tank

A large pressurized ballast tank is required to smooth out any pressure surges from the nitrogen tank and regulator.

6 CALIBRATION PROCEDURE

Follow manufacturers instructions.

7 PRE-TEST PROTOCOL

Establish that equipment tested for certification is representative of the equipment used in actual installations of systems.

8 TEST PROCEDURE

Figure 1 shows examples of locations within the system of equipment to be tested.

Figure 2 shows examples of equipment to be tested, depending upon the application of the certification procedure.

Figure 3 shows an example of a test bench prepared for testing a vapor return valve in a nozzle.

8.1 Steady Flow versus Pressure

(1) Assemble the test equipment as shown in Figure 3, but without connecting the test item yet.

- (a) Use volumetric flow and pressure meter ranges as required in the procedure which applies to the test item.
- (b) Cap the connection for the test item with a leak-tight seal.

(2) Leak-check the test equipment.

- (a) Visually and manually check all fittings for proper assembly.
- (b) Slowly establish a stable gauge pressure at twice the maximum required in the procedure which applies to the test item.
- (c) Check for leaks by applying soap solution around all fittings and by observing the pressure meter.
- (d) If soap bubbles grow around fittings or if the pressure changes by more than 0.1 "WC after stabilizing, then repeat (a) through (d); it may be necessary to provide an isothermal environment for the pressurized ballast tank, too.

(3) Connect the test item with a leak-tight connector as shown in Figure 3.

(4) Slowly establish a stable gauge pressure at the gauge pressure level required in the procedure which applies to the test item.

(5) Measure the flow with the flow meter.

8.2 Transition Flow versus Pressure

Transition flow refers to the flow rate at which a transition occurs in the slope of the plot of flow rate versus pressure for a valve tested. Compliance with a performance specification for transition flow versus pressure must be demonstrated both for opening and closing, as follows:

8.2.1 Opening Transition Pressure

(1) Assemble the test equipment as shown in Figure 3, but without connecting the test item yet.

(a) Use volumetric flow and pressure meter ranges as required in the procedure which applies to the test item.

(b) Cap the connection for the test item with a leak-tight seal.

(2) Leak-check the test equipment.

(a) Visually and manually check all fittings for proper assembly.

(b) Slowly establish a stable gauge pressure at twice the maximum required in the procedure which applies to the test item.

(c) Check for leaks by applying soap solution around all fittings and by observing the pressure meter.

(d) If soap bubbles grow around fittings or if the pressure changes by more than 0.1 "WC after stabilizing, then repeat (a) through (d); it may be necessary to provide an isothermal environment for the pressurized ballast tank, too.

(3) Connect the test item with a leak-tight connector as shown in Figure 3.

(4) Slowly establish a stable gauge pressure at 75% of the gauge pressure level required in the procedure which applies to the test item.

(5) Slowly raise the gauge pressure to 125% of the gauge pressure level required in the procedure which applies to the test item.

(6) At 5% intervals of gauge pressure, measure and record the gauge pressure in and the flow rate through the test item .

(7) Plot the flow versus pressure and determine the opening transition flow rate.

8.2.2 Closing Transition Pressure

(1) Assemble the test equipment as shown in Figure 3, but without connecting the test item yet.

(a) Use volumetric flow and pressure meter ranges as required in the procedure which applies to the test item.

(b) Cap the connection for the test item with a leak-tight seal.

(2) Leak-check the test equipment.

(a) Visually and manually check all fittings for proper assembly.

(b) Slowly establish a stable gauge pressure at twice the maximum required in the procedure which applies to the test item.

(c) Check for leaks by applying soap solution around all fittings and by observing the pressure meter.

(d) If soap bubbles grow around fittings or if the pressure changes by more than 0.1 "WC after stabilizing, then repeat (a) through (d); it may be necessary to provide an isothermal environment for the pressurized ballast tank, too.

(3) Connect the test item with a leak-tight connector as shown in Figure 3.

(4) Slowly establish a stable gauge pressure at 125% of the gauge pressure level required in the procedure which applies to the test item.

(5) Slowly lower the gauge pressure to 75% of the gauge pressure level required in the procedure which applies to the test item.

(6) At 5% intervals of gauge pressure, measure and record the gauge pressure in and the flow rate through the test item .

(7) Plot the flow versus pressure and determine the closing transition flow rate.

9 QUALITY ASSURANCE / QUALITY CONTROL (QA/QC)

This section is reserved for future specification.

10 RECORDING DATA

This section is reserved for future specification.

11 CALCULATING RESULTS

12 REPORTING RESULTS

This section is reserved for future specification.

13 ALTERNATIVE TEST PROCEDURES

Test procedures, other than specified above, shall only be used if prior written approval is obtained from the ARB Executive Officer. 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 this test procedure.

(1) Such approval shall be granted on a case-by-case basis only. Because of the evolving nature of technology and procedures for vapor recovery systems, such approval shall not be granted in subsequent cases without a new request for approval and a new demonstration of equivalency.

(2) Documentation of any such approvals, demonstrations, and approvals shall be maintained in the ARB Executive Officer's files and shall be made available upon request.

14 REFERENCES

This section is reserved for future specification.

15 EXAMPLE FIGURES AND FORMS

15.1 Figures

Each figure provides an illustration of an implementation which conforms to the requirements of this test procedure; other implementations which so conform are acceptable, too. Any specifications or dimensions provided in the figures are for example only, unless such specifications or dimensions are provided as requirements in the text of this or some other required test procedure.

Figure 1
Examples of Locations of Equipment to Be Tested

Figure 2
Examples of Equipment to Be Tested

Figure 3
Example of a Bench Test

15.2 Forms

This section is reserved for future specification.

Figure 1

Examples of Locations of Equipment to be Tested

1F "closed" idle nozzle check valves
2F "closed" overfill drain valves
3F "closed" vent valves

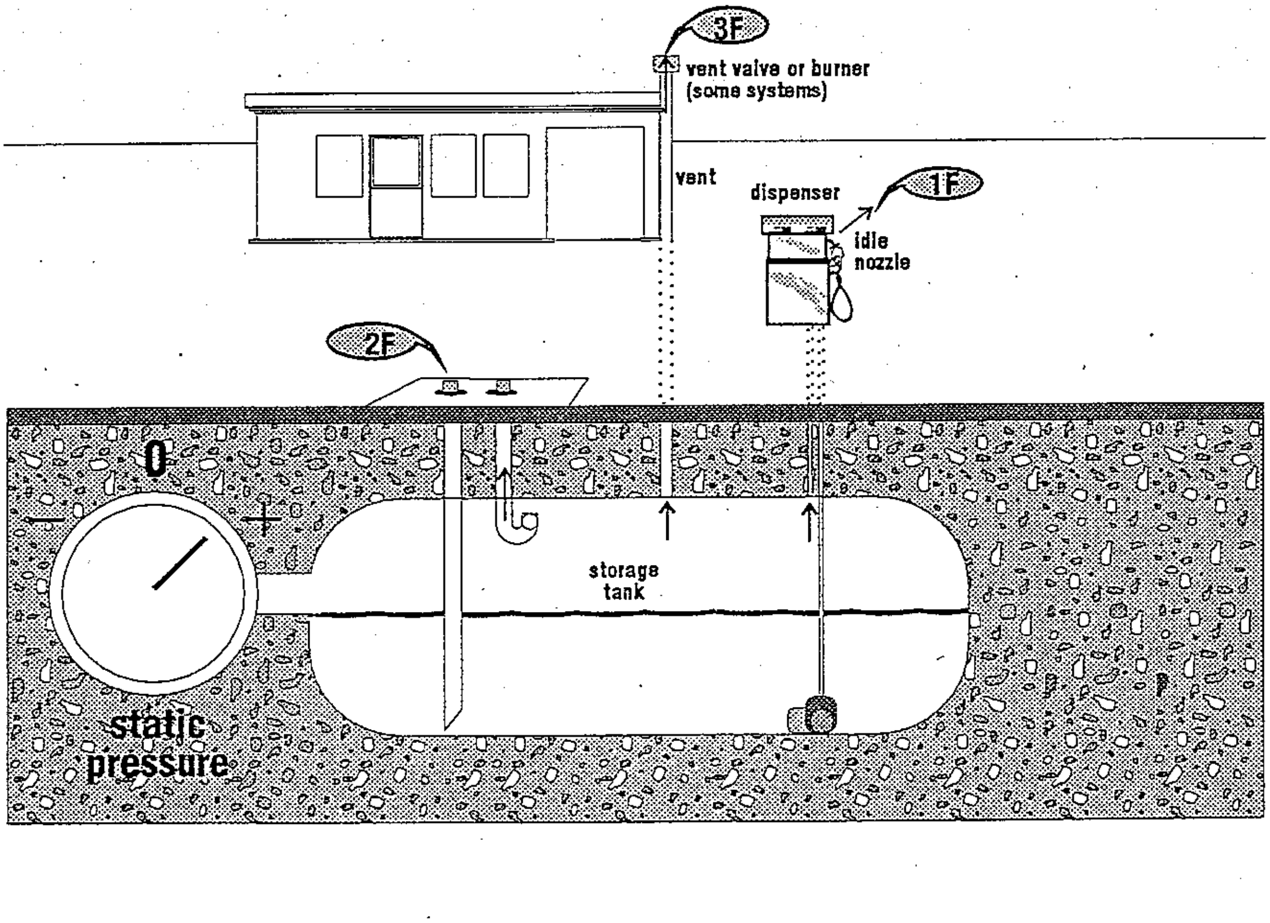

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FIGURE 2

Examples of Equipment to be Tested

idle nozzles
overfill drains
vents

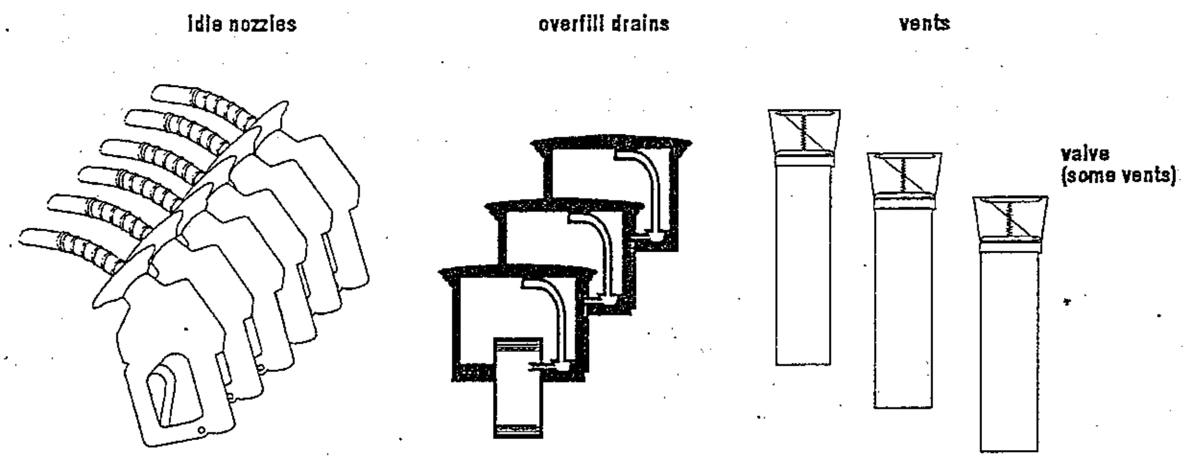

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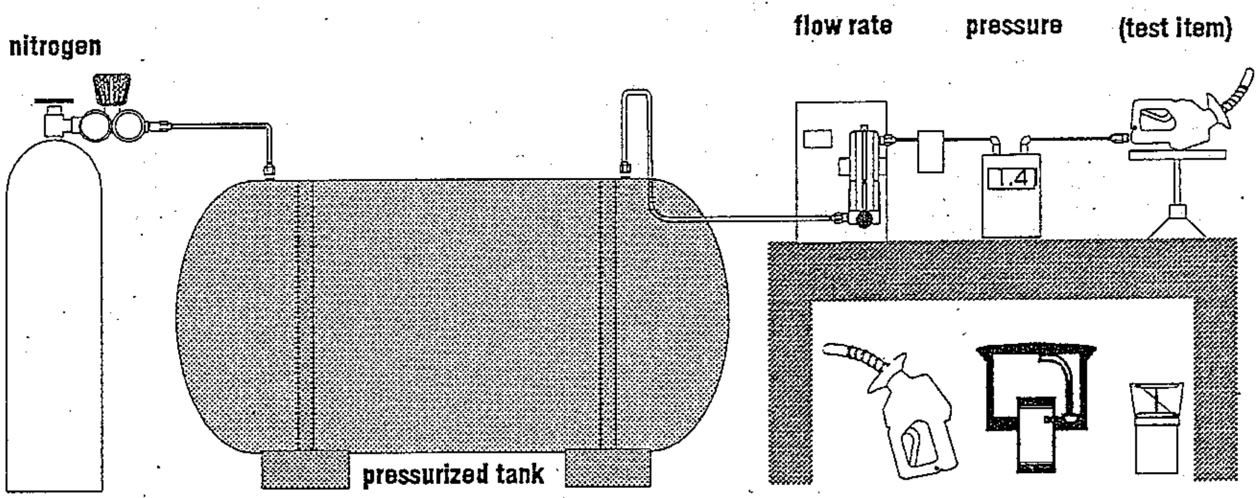
FIGURE 3

Example of a Bench Test



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