California Environmental Protection Agency

Air Resources Board

PROPOSED

Vapor Recovery Test Procedure

TP - 201.2J

PRESSURE DROP BENCH TESTING OF VAPOR RECOVERY COMPONENTS

Adopted: _____ _____

California Environmental Protection Agency
Air Resources Board

TP-201.2J

Pressure Drop Bench Testing of Vapor Recovery Components

Definitions common to all certification and test procedures is in:

D-200 Definitions for Vapor Recovery Procedures

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

1. PURPOSE AND APPLICABILITY

This procedure applies to Phase II vapor recovery components installed at gasoline dispensing facilities (GDF). The purpose of this procedure is to determine the pressure drop across components in vapor recovery systems at a specified flow rate for compliance with pressure drop performance standards specified in Certification Procedure 201 (CP-201).

2. PRINCIPLE AND SUMMARY OF TEST PROCEDURE

The pressure drop across a vapor recovery component is determined by measuring the differential pressure at a specified flow rate. Pressure measuring points are located immediately upstream and downstream from the component. Figures 1 illustrates typical components that undergo testing. Figure 2 illustrates a pressure drop test bench.

3. BIASES AND INTERFERENCES

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

3.2 Failure to calibrate precision measuring devices may produce erroneous results. Each instrument shall be calibrated according to the calibration methodology and frequency as specified in this procedure.

4. SENSITIVITY, RANGE, AND PRECISION

4.1 Differential Pressure Meter. Maximum full-scale range of +/- 25.00 inches H_2O with minimum sensitivity of 0.001 inches H2O. The minimum accuracy of the device shall be +/- 0.06 percent of full-scale. Repeatability of the instrument shall be 0.05 percent of full-scale range.

4.3 Mass Flow Meter. The maximum full-scale range shall be 30 LPM with minimum sensitivity of 0.10 LPM and minimum accuracy of 1.0 percent of full-scale. Repeatability of the device shall be 0.2 percent of full-scale.

4.4 Electronic Pressure Gauge. Sensitivity shall be 0.01 inches H_2O with a maximum full-scale range of 20 inches H_2O and minimum accuracy of 0.50 percent full-scale.

5. EQUIPMENT

5.1 Differential Pressure Meter. Use an Ashcroft Model ATE-100 with Model AQS-1/FM transducer, or equivalent, with minimum specifications listed in section 4 to measure the pressure drop across a single or series of components. The high side of the device shall located upstream and the low side of the device located downstream of the component(s) as shown in Figure 2.

5.2 Mass Flow Meter. Use an Aalborg Model GFM37-30 or equivalent, with minimum specifications listed in section 4 to introduce flow into the bench test assembly as shown in Figure 2.

5.3 Pressure Gauge. Use a Dwyer Model 475 Mark III Series or equivalent, electronic digital manometer to check the pressure integrity of the system while performing a leak test.

5.4 Nitrogen (N_2). Use commercial grade, gaseous nitrogen in a high-pressure cylinder, equipped with a single-stage pressure regulator.

5.5 Pressurized Ballast Tank. A 30-gallon or larger pressurized ballast tank is required to smooth out any pressure surges from the nitrogen cylinder and regulator.

6. PRE-CALIBRATION OF TEST EQUIPMENT

6.1 The Mass Flow Meter used in this test procedure shall be certified to a primary standard on an annual basis. To get an initial certification, the correlation coefficient from seven multi-point calibrations must be at least 0.9999. After initial calibration, the annual Mass Flow Meter certification must be within 1.0% of the previously certified slope and intercept. A certification report from an outside laboratory is required. Calibrations shall be no conducted no less than once every twelve (12) months.

6.2 Differential Pressure Measurement devices shall be calibrated in accordance with the manufacturer's specifications at an outside laboratory with documentation of the specifications and the calibrations. The certification results in slope and intercept from a five-point calibration to a known standard are required. Calibrations shall be conducted no less than once every twelve (12) months.

6.3 Temperature Measurement Devices shall be checked semi-annually using an ice bath, ambient air, and boiling water. The accuracy check shall be conducted by comparison to a NIST traceable measurement device.

7. PRE-TEST PROCEDURES

7.1 Ensure that the component to be tested for certification is representative of the equipment used in actual installations of systems.

7.2 Ensure that the test equipment has been calibrated within the past twelve (12) months.

7.3 Perform a precision check of the test equipment using a critical orifice. The observed response of the differential low-pressure meter must be within 3% of the expected response as calculated per Section 9 of this procedure.

7.4 Equipment Leak Test.

7.4.1 Ensure that the liquid paths of the component to be tested are blocked to

prevent N_2 from flowing through them.

7.4.2 Connect the test item with a leak-tight connector to the test bench flanges as shown in Figure 2.

7.4.3 Cap the end of the laminar pipe to obtain a leak-tight seal.

7.4.4 Visually and manually check all fittings for proper assembly.

7.4.5 Slowly establish a stable gauge pressure of 15 "WC.

7**.4.6** Allow the system to stabilize for five minutes noting the minimum pressure.

7.4.7 Monitor the system for an additional five minutes. If the pressure does not fall below the noted minimum pressure in 8.1.5, the system is leak tight. If the pressure continues to drop over the monitoring period, the system may be leaking and need repair.

7.4.8 If the pressure check is unable to verify a seal, check for leaks by applying soap solution around all fittings and by observing the pressure meter. If soap bubbles grow around fittings or if the pressure continues to decrease, repeat 7.4.1 through 7.4.5. It may be necessary to provide an isothermal environment for the pressurized ballast tank to minimize pressure changes caused by temperature fluctuations.

8. TEST PROCEDURE

Figure 1 shows example test equipment. Figure 2 shows an example of a test bench.

8.1 Install the component(s) to be tested into the test bench fittings.

8.2 Measure Barometric Pressure and Flow Temperature.

8.2.1 Verify that the electronic instruments have been powered up for at least 15 minutes to ensure accurate readings.

8.2.2 Remove the cap from the end of the laminar pipe used for leak checking the equipment.

8.2.3 Slowly establish a stable flow rate by adjusting the needle valves until the display on the Mass Flow Meter reads 28.3 LPM.

8.2.4 Allow a minimum of 30 seconds for the system to reach equilibrium.

8.2.5 Record the downstream flow temperature and ambient barometric pressure on the Vapor Recovery Component Pressure Drop Bench Test Data Form.

8.3 Calculate the Mass Flow Meter display that corresponds to an actual flow rate of 28.3 LPM using the calibration slope and intercept along with the barometric pressure and flow temperature as shown on Form 1.

8.4 Slowly establish a stable flow rate by adjusting the needle valves until the Mass Flow Meter display reads the value calculated in Section 8.3.

8.5 Once a stable flow is established, record the differential pressure drop and stop the flow momentarily. Re-establish the flow at the rate calculated in Section 8.3 and wait 30 seconds for the flow to stabilize. Record the second pressure drop and stop the flow momentarily. Re-establish flow at the rate calculated in Section 8.3 and wait 30 seconds for the flow to stabilize. Record the third pressure drop. Record each of the results on Form 1 where provided.

9. POST TEST PROCEDURES

9.1 Remove the vapor recovery component from the test bench and couple the upstream and downstream test bench flanges together.

9.2 Perform the leak test following 7.4.1 through 7.4.8.

9.3 Slowly establish a stable test flow rate by adjusting the needle valves until the display of Mass Flow Meter reads the value as calculated in Section 8.3.

9.4 After a stable test flow is obtained, record the pressure drop reading from the differential pressure meter. Record the reading on Form 1.

10. QUALITY ASSURANCE AND QUALITY CONTROL

10.1 Equipment Certification. All test equipment (mass flow meter, differential low pressure transmitter, temperature transducer, and barometric pressure transducer) shall be certified annually against a primary standard traceable to the NIST.

10.2 Precision Check. The test equipment used to measure pressure drop shall be challenged with a critical orifice prior to testing. The critical orifice will generate a known pressure drop for a given flow based on its dimensions. The measured pressure drop across the critical orifice must be within 3% of the predicted pressure drop for a flow rate of 28.3 LPM using the following equation:

Critical Orifice Pressure Drop: $$p = \frac{}{2}(1 - \frac{A_2^2}{A_1^2})(\frac{Q}{C_d A_2})^2$$ **Equation 10-2**

Where:

p_1 = Pressure one laminar pipe diameter before orifice

p_2 = Pressure one half laminar pipe diameter after orifice

v_1 = Velocity of fluid in laminar pipe leading to orifice

v_2 = Velocity of fluid in critical orifice

r = Density of test fluid (Nitrogen = 1.16 kg/m^3 @ 20ºC

A_1 = Cross sectional area of laminar pipe leading to orifice

A_2 = Cross sectional area of square edged orifice

Q = Flow in laminar pipe leading to orifice

C_d = Orifice discharge coefficient

11. CALCULATING RESULTS

The three differential pressure drop readings from the component(s) are averaged. The result is compared with the requirements specified in CP-201 for determination of compliance.

12. REPORTING RESULTS

Record the results for differential pressure, flow, temperature and barometric pressure on Form 1 where provided. Alternate data sheets of Forms may be used provided they contain the same parameters as identified on Form 1.

13. ALTERNATE PROCEDURES

This procedure shall be conducted as specified. Any modifications to this test procedure shall not be used unless prior written approval has been obtained from the ARB Executive Officer pursuant to section 14 of Certification Procedure CP-201.

14. REFERENCES

Mott, Robert L. (2000). Applied Fluid Mechanics 5th Edition. New Jersey: Prentice-Hall.

Form 1

California Environmental Protection Agency

Air Resources Board

Vapor Recovery Component Pressure Drop Bench Test Data Form

Manufacturer: _____ **Model #** _____

Performance Type: Nozzle ☐ **Hose** ☐ **Breakaway** ☐ **Dispenser** ☐ **Swivel** ☐

Barometric Pressure:_____mmhg Flow Temp:_____ºCelsius

Mass Flow Meter (MFM) Reading: _____ MFM Slope: _____ MFM Int.: _____

Q_{STD} = MFM Display*MFM Slope + MFM Int.: _____

$$Q_{Actual} = Q_{STD} * (\frac{FlowTemp + 273.15}{298.15}) * (\frac{760}{Barometric\ Pressure})$$

Q_{Actual} = _____L/Min

$$MFMDisplay = \frac{((\frac{28.3}{(\frac{FlowTemp + 273.15}{298.15}) * (\frac{760}{Baro\ Pressure})}) - MFMInt)}{MFMSlope}$$

Serial # _____

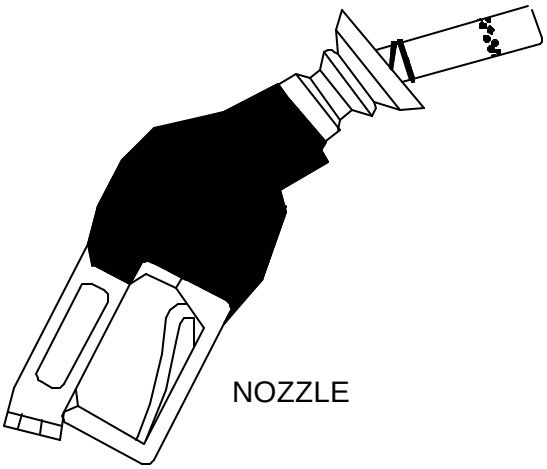
Run #1 Pressure Drop:	_____	inches H_2O
Run #2 Pressure Drop:	_____	inches H_2O
Run #3 Pressure Drop:	_____	inches H_2O
Average:	_____	inches H_2O
Background Drop:	_____	inches H_2O
Average - Background:	_____	inches H_2O
Requirement:	_____	inches H_2O

Average Pressure Drop - Background≤ Requirement? **Pass** ☐ **Fail** ☐

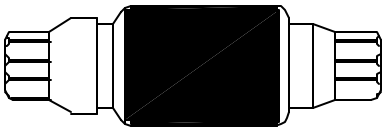
Performance Type	***Requirement***
Nozzle Pressure Drop	?P at 28.3 LPM of N_2 ≤ 0.08 inches H_2O
Hose Pressure Drop	?P at 28.3 LPM of N_2 ≤ 0.09 inches H_2O
Breakaway Pressure Drop	?P at 28.3 LPM of N_2 ≤ 0.04 inches H_2O
Dispenser Pressure Drop	?P at 28.3 LPM of N_2 ≤ 0.08 inches H_2O
Swivel Pressure Drop	?P at 28.3 LPM of N_2 ≤ 0.01 inches H_2O

Test Performed By: _____ Date:_____

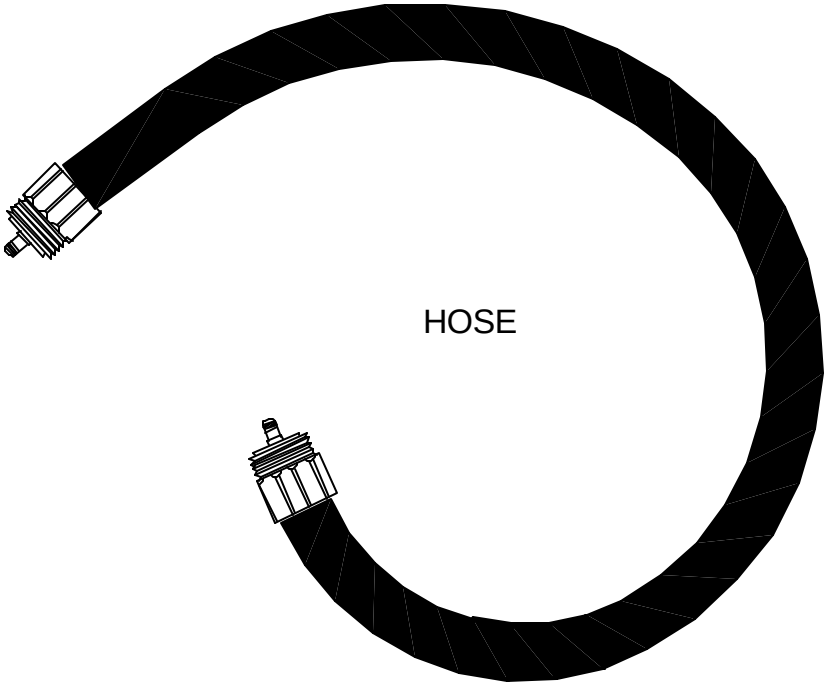
Figure 1
Examples of Equipment to Be Tested



NOZZLE



BREAKAWAY



HOSE

Figure 2
Example of a Bench Test