

California Environmental Protection Agency

 **Air Resources Board**

Vapor Recovery Test Procedure

PROPOSED: TP - 201.2B

~~DETERMINATION OF FLOW VERSUS PRESSURE FOR
EQUIPMENT IN PHASE II VAPOR RECOVERY SYSTEMS OF
DISPENSING FACILITIES~~

PRESSURE INTEGRITY OF VAPOR RECOVERY EQUIPMENT

Adopted: April 12, 1996
Amended:

The method is being amended to revise the title and to add Appendix 1. For ease of viewing, Appendix 1 is shown as proposed text for adoption.

California Environmental Protection Agency
Air Resources Board

Vapor Recovery Test Procedure

TP-201.2B

~~Determination of Flow vs. Pressure for Equipment in
Phase II Vapor Recovery Systems of
Dispensing Facilities~~

Pressure Integrity of Vapor Recovery Equipment

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 Procedures**

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 simultaneously 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:

$$Q_{\text{Req@P}} - Q_{\text{Obs@P}} \leq Q_{\text{Res}}$$

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.

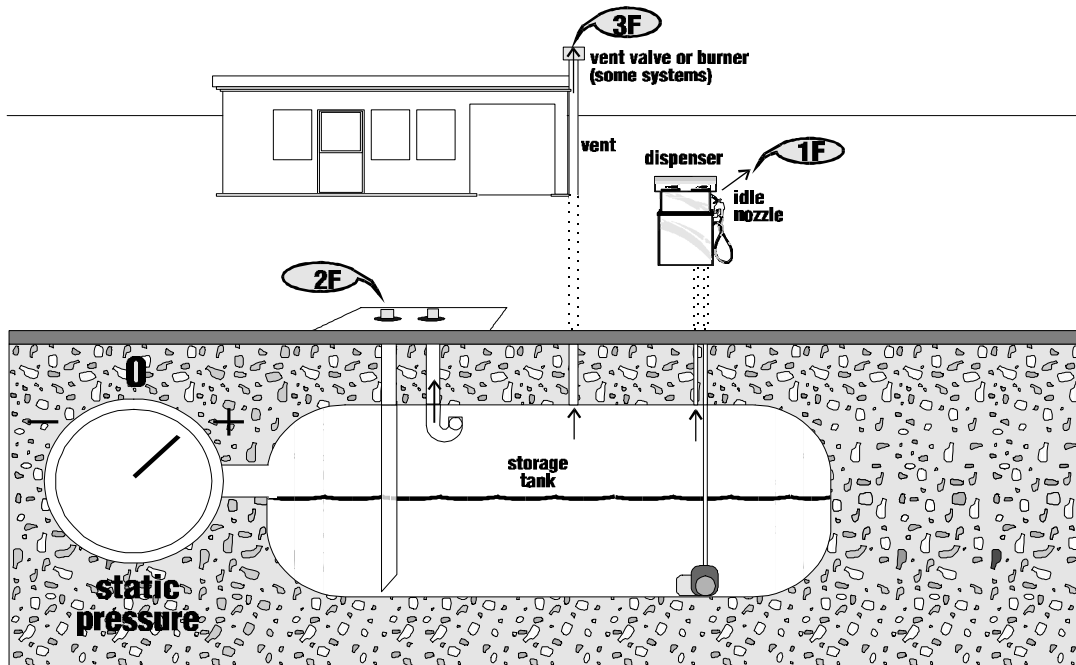
APPENDICES:

Appendix 1: Pressure and Vacuum Performance of Pressure/Vacuum Vent
Valves

Figure 1

Examples of Locations of Equipment to be Tested

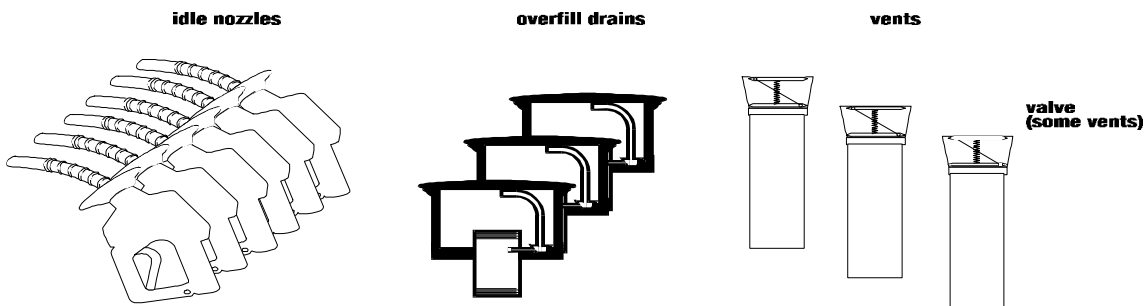
- 1F "closed" idle nozzle check valves**
- 2F "closed" overfill drain valves**
- 3F "closed" vent valves**



TP 201.2B F.1/B. CORDOVA '95

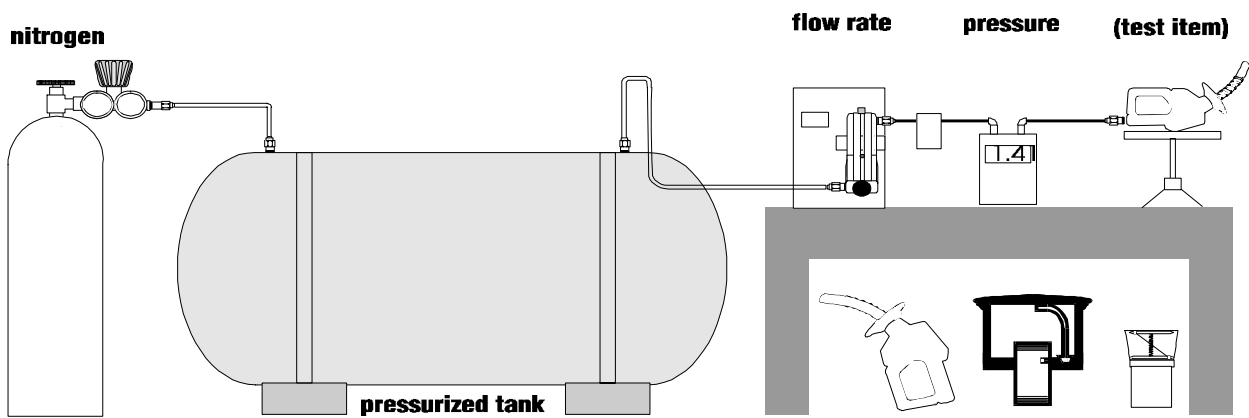
FIGURE 2
Examples of Equipment to be Tested

idle nozzles
overflow drains
vents



TP 201.2B F.2/ B. CORDOVA '95

FIGURE 3
Example of a Bench Test



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Vapor Recovery Test Procedure

TP-201.2B, Appendix 1

**Pressure and Vacuum Performance Specifications
For Pressure/Vacuum Vent Valves**

Adopted: _____

All text is proposed for adoption.

**California Environmental Protection Agency
Air Resources Board**

Vapor Recovery Test Procedure

TP-201.2B, Appendix 1

**Pressure and Vacuum Performance Specifications
For Pressure/Vacuum Vent Valves**

Definitions common to all certification and test procedures are in:

D-200: Definitions for Vapor Recovery Procedures

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

1 PURPOSE AND APPLICABILITY

1.1 The purpose of this vapor recovery test procedure is to determine the pressure and vacuum at which a pressure/vacuum vent valve (P/V valve) opens, and to determine the leakrate of a P/V valve at a given pressure and vacuum. This procedure is applicable for use with both new and in-use P/V valves. This procedure requires the removal of in-use P/V valves from vent pipes. This test procedure and test equipment was not intended for use in an environment containing gasoline vapors.

2 PRINCIPLE AND SUMMARY OF TEST PROCEDURE

2.1 The P/V valve is attached to a test standpipe and then either evacuated or pressurized to determine the range(s) where the flow versus pressure plot shows a "knee" in the plot, indicating valve opening.

2.1.1 A given pressure or vacuum is established and held constant in the test standpipe. The flowrate of air into or out of the test standpipe is then measured and compared to limits specified in the Performance Standards contained in the Certification Procedure, CP-201. For P/V valves that were certified to more stringent performance specifications, the performance specifications to which the valve was certified shall be substituted for the Performance Standards in CP-201.

2.1.2 Alternately, the maximum allowable leakrate is established and the observed pressure or vacuum is compared to limits specified in CP-201, or the performance specifications to which the valve was certified.

3 BIASES AND INTERFERENCES

- 3.1 Any leaks in the test stand piping may result in erroneously high leakrates being observed.
- 3.2 P/V valves improperly mounted on the test stand may result in erroneously high leakrates being observed.

4 SENSITIVITY, RANGE AND PRECISION

- 4.1 If mechanical pressure gauges are used, the full-scale range of the devices shall not exceed -20 to 0 to 20 inches H₂O and -10 to 0 to 10 inches H₂O respectively. The minimum diameter of the gauge face shall be four inches, and the minimum accuracy of the gauge shall be three percent of full scale.
- 4.2 If an electronic pressure measuring device is used, the full-scale range of the device shall not exceed 0 to 10 inches H₂O with a minimum accuracy of 0.5 percent of full scale. A 0 to 20 inches H₂O device may be used provided that the equivalent accuracy is not less than 0.25 percent of full-scale.

5. EQUIPMENT

- 5.1 Test Stand. Use a 2" diameter pipe, approximately 4" long, sealed at the bottom and capable of accepting P/V valves utilizing a 2" threaded connection. The standpipe shall have ports to connect to pressure/vacuum gauges and to the anti-surge/ballast tank through a flow meter.
- 5.2 Slip-fit P/V valve adapter. Use a 2" diameter pipe approximately 6" long with one end cut at a 90° angle to the length of the pipe and the other threaded to fit onto the test stand using a straight coupler.
- 5.3 Test Caps. Threaded and slip fit caps for checking the leak tightness of the test equipment.
- 5.4 Flowmeters. Use a Dwyer Model VFA-1-SSV, or equivalent, with a scale of 0.0 to 1.0 SCFH for measuring flows under pressure. Use a Dwyer Model RMA-2-TMV vacuum flowmeter, or equivalent, with a scale of 0.00 to 1.00 SCFH, for measuring flows under vacuum
- 5.5 Pressure/Vacuum Reservoir Tank. Use a pressure/vacuum tank with a minimum internal volume of 5 gallons and pressure rated to at least 5 psi. Outfit the tank with a mechanical pressure gauge or equivalent with a full-scale range of -20 to 0 to 20 inches H₂O. The minimum diameter of the gauge face shall be four inches, and the minimum accuracy of the gauge shall be three percent of full scale.
- 5.6 Metal Bellows Pump. Use a Parker Hannifin Model MB-41 Metal Bellows Pump, or equivalent, and capable of producing -2 psi through +2 psi.
- 5.7 Stopwatch. Use a stopwatch accurate to within 0.2 seconds.

- 5.8 Teflon sealing tape. To be used only if a sealant is specified in the manufacturer's installation instructions.
- 5.9 3" diameter bushing.adapter. For use with P/V valves with 3" diameter bases.
- 5.10 Self-adhesive stickers for identifying individual P/V valves that do not have serial numbers.

6 PRE-TEST PROTOCOL

- 6.1 Conduct a pre-test leak check of the test stand apparatus prior to any series of testing at a specified location.
 - 6.1.1 Configure test equipment as shown in Figure xx to pressurize the reservoir tank.
 - 6.1.2 Apply teflon tape to test stand apparatus and thread on test cap.
 - 6.1.3 Pressurize reservoir tank to 20" +/- 2" WC using metal bellows pump.
 - 6.1.4 Connect reservoir tank to pressure flow meter, first ensuring that flow meter valve is closed.
 - 6.1.5 Open flow meter and raise the pressure in the test stand apparatus to five inches H₂O, gauge (5.00 +/- .05"WCg).
 - 6.1.6 Close flow meter, start stopwatch and observe pressure gauge. There should be no observable pressure drop of more than 0.05" H₂O from initial pressure after three minutes. If pressure drop exceeds limit, find potential leak sources by squirting liquid leak detector solution on connections and other potential leak sources while watching for the formation of bubbles. Tighten any loose connections and repeat decay test until passing results are obtained.
 - 6.1.7 Failure of this test, precludes the use of the test equipment until any necessary repairs are completed and passing results are obtained.
- 6.2 All pressure measuring device(s) shall be bench calibrated using either a reference gauge or incline manometer. Calibration shall be performed at 20, 50, and 80 percent of full scale. Accuracy shall be within 0.5 percent at each of these calibration points. Calibrations shall be conducted on a frequency not to exceed 180 days.

7 TEST PROCEDURES

- 7.1 Remove P/V valve from packaging and remove any packing material that may be present in base of valve.

- 7.2** Apply adhesive label with a sequential numbering system to P/V valves not having individual serial numbers for purpose of identification throughout testing. Record Manufacturer, Model number, Serial Number and/or ID number on data sheet. The sequential number or the P/V valve serial number shall be used to subsequently identify the valve for tracking during the testing and any subsequent enforcement action.
- 7.3** If manufacturer's installation procedures recommend a sealant be used during installation, apply sufficient amount of teflon tape to test stand to ensure proper seal. Under no circumstances shall pipe dope be used.
- 7.4** Carefully install the P/V valve onto the test stand following the manufacturer's recommended installation instructions. Care must be taken during installation to prevent the valve from being cross-threaded on the test stand.
- 7.4.1** For slip-fit P/V valves, install the straight pipe section onto test stand ensuring a good seal is made at the threaded connection. Install the P/V valve on straight pipe section, following manufacturer's installation instructions.
- 7.4.2** For P/V valves with a 3" diameter base, install bushing adapter to the test stand ensuring a good seal is made at the threaded connection. Install the P/V valve on the adapter, following manufacturer's installation instructions.
- 7.5** Measuring P/V Valve Pressure Performance Specifications.
- 7.5.1** Configure test equipment as shown in Figure **xx** to pressurize the reservoir tank.
- 7.5.2** Pressurize Reservoir Tank to 20" +/- 2" WC using metal bellows pump. Isolate surge tank from pump. Re-establish the 20" H₂O pressure in the reservoir tank as needed or when pressure falls below 10.0" H₂O.
- 7.5.3** Connect Reservoir Tank to pressure flow meter, first ensuring that flow meter valve is closed.
- 7.5.4** Fully open flow meter valve and observe pressure gauge connected to test stand. Record the pressure established in the test stand prior "transition pressure" or "cracking pressure" which occurs at the "knee" in a plot of flow versus pressure for a P/V valve's performance.
- 7.5.5** Using the valve on the flow meter, establish the pressure specified in CP-201 for the maximum leakrate specified and record the flowrate on the data sheet.
- 7.5.6** Alternately, establish the maximum allowable flowrate as specified in CP-201 and record the pressure in the test stand.

7.6 Measuring P/V Valve Vacuum Performance Specifications.

- 7.6.1 Configure test equipment as shown in Figure **xx** to evacuate the reservoir tank.
- 7.6.2 Evacuate Reservoir Tank to -20" +/- 2" H₂O using metal bellows pump. Isolate reservoir tank from pump. Re-establish the -20" H₂O pressure in the reservoir tank as needed or when the vacuum falls below -10.0" H₂O.
- 7.6.3 Fully open the flow meter valve and observe pressure gauge connected to test stand. Record the vacuum established in the test stand prior "transition vacuum" or "cracking vacuum" which occurs at the "knee" in a plot of flow versus vacuum for a P/V valve's performance.
- 7.6.4 Using the valve on the flow meter, established the vacuum specified in CP-201 for the maximum leakrate specified and record the flowrate on the data sheet.
- 7.6.5 Alternatively, establish the maximum allowable flowrate as specified in CP-201 and record the vacuum in the test stand.

7.7 Remove P/V valve from test stand.

7.8 Test the next P/V valve pursuant to Sections 7.1 through 7.7.

8 POST TEST PROTOCOL

8.1 Run leak check pursuant to Section 6.1 on the test stand equipment at the conclusion of testing at given location. If the test stand does not pass the leak check, the test results are invalid.

9 REPORTING RESULTS

9.1 Record results for each P/V valve on appropriate data sheet.

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PV Valve Bench Test Data Form

Manufacturer: _____ **Model #** _____
Parts House or Station _____
Address: _____

GDF # or Permit # (if applicable) _____

Passing Criteria:	Cracking Pressure	3.0" WC +/- 0.5 "WC
	Maximum Allowable Leakrate	< 0.38 CFH (.0063 CFM) @ 2.0" WC
	Cracking Pressure	-8.0" WC +/- 2.0 " WC
	Maximum Allowable Leakrate	< 0.50 CFH (.0083cfm) @ - 4.0 " WC

Valve # _____ Cracking Pressure: _____ inches H₂O
 Leakrate at 2 inches H₂O _____ CFH
 or Pressure @ 0.38 CFH _____ inches H₂O

 Cracking Vacuum _____ inches H₂O
 Leakrate @ -4 inches H₂O _____ CFH
 or Vacuum @ 0.50 CFH _____ inches H₂O
Pass • Fail •

Valve # _____ Cracking Pressure: _____ inches H₂O
 Leakrate at 2 inches H₂O _____ CFH
 or Pressure @ 0.38 CFH _____ inches H₂O

 Cracking Vacuum _____ inches H₂O
 Leakrate @ -4 inches H₂O _____ CFH
 or Vacuum @ 0.50 CFH _____ inches H₂O
Pass • Fail •

Valve # _____ Cracking Pressure: _____ inches H₂O
 Leakrate at 2 inches H₂O _____ CFH
 or Pressure @ 0.38 CFH _____ inches H₂O

 Cracking Vacuum _____ inches H₂O
 Leakrate @ -4 inches H₂O _____ CFH
 or Vacuum @ 0.50 CFH _____ inches H₂O
Pass • Fail •

Test Performed By: _____ Date: _____