

California Environmental Protection Agency



Vapor Recovery Test Procedure

TP-201.2F

Pressure Related Fugitive Emissions

Adopted: February 1, 2001

Amended: October 8, 2003

This procedure is being amended. For ease of viewing, the method is shown as proposed text and then shown as repealed text in the text of the procedure adopted February 1, 2001, which follows. Strikeout and underline for changes to the February 1, 2001 version have been omitted as authorized by title 2, California Code of Regulations, section 8.

**California Environmental Protection Agency
Air Resources Board**

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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 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

The purpose of this test procedure is to quantify the mass rate of fugitive emissions from storage tanks with positive gauge pressures. The mass rate is then used with other terms to determine the Phase II efficiency and to determine compliance with the performance standard specified in Section 4 of Certification Procedure 201 (CP-201).

This procedure is applicable only to facilities with manifolded storage tanks. Where storage tanks are not manifolded, the applicant shall develop an alternate procedure for quantifying the mass rate of fugitive emissions. The alternate procedure must be approved in advance as specified in section 14 of this test procedure.

2. PRINCIPLE AND SUMMARY OF TEST PROCEDURE

The fugitive emission rate is determined by the volumetric flow rate and hydrocarbon vapor concentration. The volumetric flow rate is calculated by using an allowable leak rate in conjunction with the actual pressure found by monitoring the storage tank over a minimum 30-day period. The storage tank hydrocarbon vapor concentration is determined either by measurement by non-dispersive infrared gas analyzer or by a predetermined concentration approved by the Executive Officer. The molecular weight of the vapor is determined either by gas chromatography where the hydrocarbon components are speciated or by use of pre-determined value for propane (C₃) or butane (C₄) approved by the Executive Officer.

In order to standardize test results, the fugitive emission rate (lbs/1000 gallons) shall be calculated using 150,000 gallons per month throughput and the maximum allowable leak rate specified in CP-201. Storage tank pressure of zero (0) inches H₂O or less shall be considered as zero pressure.

3. BIASES AND INTERFERENCES

- 3.1** The location(s) chosen to measure the hydrocarbon concentration or sample for molecular properties may not represent the concentration that is emitted at every fugitive leak point. The selected location for sampling gasoline vapor shall be at the top of the storage tank vapor containment space in order to provide uniformity.
- 3.2** The location chosen to measure storage tank pressure may not represent the pressure that is present at every location of the vapor recovery system. The location used for monitoring storage tank pressure shall be pre-approved by the Executive Officer.
- 3.3** If the predetermined hydrocarbon concentration is used, the calculated fugitive emission mass rate may be higher than the actual fugitive emission mass rates.
- 3.4** Conducting leak decay or other types of testing at the test facility during the pressure monitoring period may bias the pressure profile results. No testing shall take place at the test facility during the pressure monitoring period.
- 3.5** Non-typical vehicle fueling, deliveries or operation at facility may bias results. The test facility shall undergo routine systems operation throughout the duration of testing and continuous pressure monitoring.

4. SENSITIVITY, RANGE, AND PRECISION

Sensitivity, range, and precision have not been formally established.

5. EQUIPMENT

- 5.1** Electronic Pressure Transducer. Use an intrinsically safe (NEMA 4) differential pressure transducer. Sensitivity shall be 0.01 inches H₂O with minimum differential full-scale range of 15 inches H₂O and minimum accuracy of 0.050 percent of full-scale range. The device shall be capable of sending an electronic output signal to the data acquisition system or strip chart recorder at a minimum frequency of once every 5 seconds.
- 5.2** Electronic Ambient (barometric) Pressure Transducer. Minimum sensitivity shall be 1.0 mbar with minimum accuracy of 0.25 percent full-scale and maximum full-scale range of 1100 mbar. The device shall be capable of

sending an electronic output signal to the data acquisition system or strip chart recorder at a minimum frequency of at least once every five (5) seconds.

- 5.3 Data Acquisition System.** Use a data acquisition system to record the storage tank and ambient pressure signals sent by the transducers described in 5.1 and 5.2. Minimum two (2) channel capacity. Capable of recording or storing data points at a minimum frequency of at least once every five (5) seconds for a minimum of fifteen (15) days. For certification testing, the Executive Officer shall pre-approve all Data Acquisition Systems prior to installation. Methods of retrieving and exporting data shall receive prior approval of the Executive Officer. See TP-201.7 for a more detailed example of a continuous pressure monitoring system.
- 5.4 Hydrocarbon Non-Dispersive Infrared (NDIR) Gas Analyzer.** Use a NDIR with minimum specifications listed below to continuously monitor the hydrocarbon concentration at the top of the storage tank vapor space for at least sixty (60) minutes. Sampling shall be conducted in accordance with CARB Test Method 100, "Procedures for Continuous Gas Emission Stack Sampling." Capacity to measure hydrocarbon concentrations between the ranges of 1.0 to 50 percent measured as propane. The analyzer shall meet the following specifications:
- 5.4.1 Repeatability/accuracy of $\pm 1\%$ of full scale,
 - 5.4.2 Linearity of ± 1 of full scale,
 - 5.4.3 Noise level of 1% of full scale, and
 - 5.4.4 Response time of less than 30 seconds to determine at least 95% of the sample concentration.
- 5.5 Bag Sampling Train.** Use an Integrated Bag Sampling Train or equivalent as specified by CARB Method 422, "Determination of Volatile Organic Compounds In Emission From Stationary Sources," to obtain a gasoline vapor sample at the top of the storage tank vapor space for at least sixty (60) minutes.
- 5.6 Vapor Sampling Assembly.** Use a vapor sampling assembly to extend three probes into the vapor containment space of the storage tank, below the Phase I vapor adaptor. One probe shall be used for measuring hydrocarbon concentration with the NDIR (Section 5.4), and two other probes are used for drawing an integrated gaseous sample (Section 5.5) into two different bag samples. The probes consist of one-quarter (1/4) inch sampling lines whose lengths are determined in accordance with Section 6.7.
- 5.7 RVP Sample Assembly.** Use a suitable sampling container with opening diameter of three-quarter (3/4) inches which conforms to the guidelines of

Section 2296, Title 13, California Code of Regulations, for collecting gasoline fuel samples for determining Reid Vapor Pressure (RVP).

- 5.8** Leak Decay Test Equipment. Assemble test equipment as specified in TP-201.3 to determine the leak rate of the test facility.

6. PRE-TEST PROCEDURES

These methods are not inclusive with respect to specifications (e.g., equipment and supplies) and procedures (e.g., sampling and analytical) essential to its performance. Persons using these methods should have a thorough knowledge of gasoline, gasoline vapor recovery systems and source sampling methods. Particular care should be exercised in the area of safety and equipment operation in the presence of gasoline vapor and potential explosive atmospheres.

- 6.1** Ensure that all of the gasoline storage tanks installed at the facility are manifolded by conducting a Tie-Tank Test in accordance with TP-201.3C.
- 6.2** Install the Data Acquisition System and Electronic Pressure Transducers. Choose a location to mount the equipment and/or equipment case. When selecting an equipment case and location, consideration should be given to minimize the possibility of tampering, vandalism, or accidental shut-off. The case shall be located at a position not to interfere with normal station operation and shall be installed in accordance with the Department of Industrial Relations, Division of Occupational Safety and Health (OSHA), the California Department of Forestry and Fire Protection, Office of the State Fire Marshal, and any other local or state fire ordinances. Responsibility for contacting, approving and meeting all local and state ordinances or regulations for installing such a system is the responsibility of the applicant and person(s) installing the monitoring equipment.
- 6.3** All pressure measuring device(s) shall be calibrated using a reference gauge, incline manometer or NIST traceable standard following installation at the test site. Calibration shall be performed at 20, 50, and 80 percent of full scale. Accuracy shall be within five (5) percent at each of these calibration points. Both barometric pressure and ambient temperature shall be recorded at the time of calibration and a calibration report shall be presented to Executive Officer for approval prior to commencing the data acquisition period.
- 6.4** Verify that each instrument and the data acquisition system are functioning properly. This may be accomplished by either downloading a specific time interval of data and compared to previous measurements taken by pre-calibrated instruments. Or, by observing real-time recordings from the data acquisition system and comparing to pre-calibrated instruments.

- 6.5** Conduct a leak decay test in accordance with TP-201.3 to ensure that the system is operating in compliance and that no leaks were introduced with the installation of the Data Acquisition System or its components.
- 6.6** Bleed off the excess pressure introduced into the system from conducting the leak decay procedure for a maximum of one (1) minute. A minimum of twenty-four (24) hours of routine product dispensing and/or deliveries shall take place prior to measuring the hydrocarbon concentration or molecular properties contained in the storage tank.
- 6.7** Remove the Phase I vapor adaptor and determine whether a Ball Float Overfill Prevention Device is installed. If applicable, remove the Ball Float in order to install the vapor sampling assembly with the three one-quarter (1/4) inch ID sampling lines. The lengths of sample lines shall terminate at the top of the storage tank vapor space.
- 6.8** Calibrate the NDIR using either propane or butane as specified in ARB Method 100.
- 6.9** Assemble the Integrated Bag Sampling Train or equivalent as specified in CARB Method 422 and calculate the sampling rate required to produce a sample that is integrated over sixty (60) minutes. Insert a flow meter to ensure the desired sample rate is achieved.
- 6.10** Install the vapor sampling assembly on the Phase I vapor adaptor.
- 6.11** Connect the NDIR and Two Integrated Bag Train Samplers to sampling lines on vapor sampling assembly.

7. TEST PROCEDURE

- 7.1** Start the Data Acquisition System. Ensure that it is storing data points at a minimum frequency of at least once every five (5) seconds.
- 7.2** Continue to collect storage tank and ambient pressure data points at a minimum rate of once every five (5) seconds for at least (30) days.
- 7.3** Submit storage tank and ambient pressure data to the Executive Officer within the interval specified by Section 10 of this procedure.
- 7.4** Use the NDIR hydrocarbon analyzer to continuously monitor the hydrocarbon concentration at the top of the storage tank vapor space for a minimum of sixty (60) minutes or as specified by the Executive Officer.

- 7.4.1 In lieu of measuring the gasoline vapor hydrocarbon concentration, a predetermined concentration as C₃ or C₄ may be used with prior approval of the Executive Officer.
- 7.5 Use the Integrated Bag Sampling Train to collect a minimum of two (2) samples of gasoline vapor used for determining molecular weight. Samples shall be taken from the top of the storage tank vapor space for a minimum of sixty (60) minutes or as specified by the Executive Officer.
- 7.5.1 In lieu of sampling and analyzing a gasoline vapor sample, a predetermined molecular weight as C₃ or C₄ may be used with prior approval of the Executive Officer.
- 7.6 Collect samples of the gasoline contained in each storage tank using the "Top Sample" method as specified by Section 2296, Title 13, California Code of Regulations.

8. POST-TEST PROCEDURES

- 8.1 Disconnect all hydrocarbon sampling instrumentation and restore the Phase I equipment back to its original condition prior to testing. Re-install the Ball Float if removed.
- 8.2 Conduct post-test leak checks on the NDIR hydrocarbon gas analyzer using either propane or butane as specified in CARB Method 100. Ensure that the instrument did not deviate during testing. A deviation of the instrument denotes an adjustment to the data and shall be noted on the data sheet where provided.
- 8.3 Report all hydrocarbon concentration information obtained by the NDIR during the sixty (60) minute analysis on Form 1. Attach additional sheets to Form 1 as needed.
- 8.4 Analyze the gasoline vapor sample in accordance with CARB SOP MLD 102/103 Revision 2, Procedure for the Determination of C₂ to C₁₂ Hydrocarbon in Automotive Exhaust Samples by Gas Chromatography, for known gasoline vapor constituents and report the compounds in terms of parts per million (ppm). Average the results from the two bag samples to determine the average hydrocarbon molecular weight. Attach the laboratory analysis results to Form 1.
- 8.5 Analyze the gasoline liquid sample(s) in accordance with the procedure specified by Section 2296, Title 13, California Code of Regulations to determine the Reid Vapor Pressure. Attach the laboratory analysis results to Form 1.

- 8.6** Following the minimum thirty (30) day pressure data acquisition period, conduct a leak decay test in accordance with TP-201.3 to ensure that the system has maintained pressure integrity and that no leaks were introduced during the pressure monitoring period. A failure of the leak decay test invalidates all test data acquired during the 30-day period
- 8.6.1 During leak decay testing, verify that the data acquisition system is operating properly by observing the storage tank pressure using the calibration device from 6.3 and the output sent by the data acquisition system. Deviations greater than five (5) percent may denote a re-calibration of the data acquisition system and additional pressure monitoring may be necessary. Note the ambient temperature and ambient pressure at the time of verification.
- 8.7** Following the minimum thirty (30) day data acquisition period, collect and export the storage tank and ambient pressure data from data acquisition system to a format approved by the Executive Officer and submit the information to the Executive Officer as provided in Section 10.
- 8.8** Submit a report of gasoline throughput for the facility detailing the gasoline throughput during the time when pressure data are collected. Failure to submit results of gasoline throughput may result in additional pressure monitoring or delay of certification.
- 8.9** Use the equations in Table 9.1 to calculate the fugitive volumetric flow rate during positive tank pressure episodes.
- 8.10** Determine the volumetric flow rate for the test period as provided in Section 9.2.
- 8.11** Use the results of Sections 9.1 and 9.2 to calculate the fugitive mass emission rate as provided by Equation 9.3.1.

9. CALCULATING RESULTS

- 9.1** The pressure-related fugitive flowrate shall be calculated using the equations in Table 9.1 that correspond to the system type, number of nozzles, and pressure measurements present at the test site. The flow versus pressure (Q vs. P) equations were generated by direct measurement of Q at various P using the steady-state flow method as described in Appendix A.

**Table 9.1
Q vs. P Equations**

System Type	Nozzles	Pressure Range (in WC)	Equation for Q (Flow Rate in CFM)
Assist	7-12	0.00 – 1.00	$Q = -0.0188 P^2 + 0.0644 P - 0.0028$
		1.00 – 2.00	$Q = -0.0049 P^2 + 0.0408 P + 0.007$
		2.00 – 3.50	$Q = -0.0018 P^2 + 0.0291 P + 0.0181$
	13-18	0.00 – 1.00	$Q = -0.0205 P^2 + 0.0694 P - 0.0031$
		1.00 – 2.00	$Q = -0.0054 P^2 + 0.0434 P + 0.0081$
		2.00 – 3.50	$Q = -0.0022 P^2 + 0.0327 P + 0.017$
	19-24	0.00 – 1.00	$Q = -0.0228 P^2 + 0.0744 P - 0.0034$
		1.00 – 2.00	$Q = -0.0055 P^2 + 0.0454 P + 0.0087$
		2.00 – 3.50	$Q = -0.002 P^2 + 0.0318 P + 0.0217$
Balance	7-12	0.00 – 1.00	$Q = -0.0322 P^2 + 0.1002 P - 0.0042$
		1.00 – 2.00	$Q = -0.0063 P^2 + 0.0577 P + 0.0131$
		2.00 – 3.50	$Q = -0.0029 P^2 + 0.044 P + 0.027$
	13-18	0.00 – 1.00	$Q = -0.0354 P^2 + 0.1075 P - 0.0055$
		1.00 – 2.00	$Q = -0.0075 P^2 + 0.0629 P + 0.0117$
		2.00 – 3.50	$Q = -0.0032 P^2 + 0.0465 P + 0.0272$
	19-24	0.00 – 1.00	$Q = -0.0385 P^2 + 0.116 P - 0.0064$
		1.00 – 2.00	$Q = -0.008 P^2 + 0.0679 P + 0.0119$
		2.00 – 3.50	$Q = -0.004 P^2 + 0.053 P + 0.0259$

9.2 The volumetric flow rate during the pressure monitoring period is calculated using the Q vs. P equation. The equation provides the fugitive flowrate associated with each pressure interval. The equations provided in Table 9.1 shall be used unless other equations are approved by the Executive Officer. The pressure data shall be averaged over 1 minute intervals unless otherwise designated by the Executive Officer. The total volume of fugitives and the average volumetric flowrate for the test period are determined as follows:

$$V_{\text{tot}} = \sum_{i=1}^n t_i q_i \quad \text{Equation 9.2.1}$$

where:

- V_{tot} = Total volume of fugitive emissions for entire period monitored, cubic feet (CF)
- q_i = Flow rate at i^{th} pressure interval, CFM
- t_i = Number of minutes at i^{th} pressure interval
- n = Number of pressure intervals

$$Q_{\text{test}} = \frac{V_{\text{tot}}}{T} \quad \text{Equation 9.2.2}$$

where:

Q_{test}	=	Average volumetric flow rate of fugitive emissions for entire period monitored, cubic feet per hour (CFH)
V_{tot}	=	Total volume of fugitive emissions for entire period monitored, cubic feet (CF)
T	=	Total number of hours for entire period monitored

9.3 The fugitive emission mass rate of pressure-related fugitives shall be calculated as follows:

$$M = \left[\frac{(Q_{\text{test}})(C)(MW)}{(MV)(100)} \right] \quad \text{Equation 9.3.1}$$

where:

M	=	Mass rate of fugitive emissions, lb/hour
Q_{test}	=	Average volumetric flowrate over the test period, cubic feet per hour (ft ³ /hour) [see Equation 9.2.2]
C	=	Hydrocarbon vapor concentration, percent, measurement or 36 for C ₃ or 27 for C ₄
MW	=	Molecular weight, lb/lb-mole, measurement or 44.096 for C ₃ or 58.123 for C ₄
MV	=	Molar volume, 386.7 ft ³ /lb-mole at 70°F
100	=	Conversion factor for percent to mole fraction

9.4 The mass emission factor pressure-related fugitives at the specified gasoline throughput is calculated as follows:

$$E = \left(\frac{1,000 \text{ gallons}}{208 \text{ gallons/hour}} \right) M \quad \text{Equation 9.4.1}$$

10. REPORTING RESULTS

Report results on Form 1. Attach additional data sheets identifying other test results (e.g., pre and post leak decay, hydrocarbon vapor concentration, hydrocarbon vapor speciation, and RVP analysis) to Form 1. Alternate data sheets may be used with prior approval of the Executive Officer.

Report the results obtained from the data acquisition system to the Executive Officer on a continuous basis not to exceed once every 15-days Prior to submitting data obtain approval of the Executive Officer on the data format and submittal process.

11. ALTERNATE PROCEDURES

This procedure shall be conducted as specified. Modifications to this procedure shall not be used unless prior written approval has been obtained from the Executive Officer, pursuant to Section 14 of Certification Procedure CP-201.

12. EXAMPLE CALCULATION

An example calculation, demonstrating the method used for determining pressure-related fugitive emissions for a vacuum-assist system is shown below.

Given:

Number of nozzles	10
Hydrocarbon Concentration, %	34 (measured)
Molecular Weight Hydrocarbons, lb/lb-mole	37.3 (measured)
Molar Volume of Hydrocarbons at 70°F	386.7 ft ³ /lb-mole

Tank pressure monitoring duration 720 hours (30 days)

1. Pressure is at 0.0 inches H₂O or negative for 31,200 minutes (520 hours), P₁
2. Pressure is at 0.25 inches H₂O for 10,800 minutes (180 hours), P₂
3. Pressure is at 0.50 inches H₂O for 1,200 minutes (20 hours), P₃

Q vs. P equation: $Q = -0.0188 P^2 + 0.0644 P - 0.0028$

Determine the fugitive mass emission rate:

A. Calculate the individual volumetric Q values for each P_i by use of the Q vs. P equation and then summing with Equation 9.2.1 as follows:

$$Q_i = -0.0188 P^2 + 0.0644 P - 0.0028$$

$$Q_1 = Q = -0.0188(0)^2 + 0.0644(0) - 0.0028 = -0.0028 \text{ (negative flows are counted as 0.0 CFM)}$$

$$Q_2 = -0.0188(0.25)^2 + 0.0644(0.25) - 0.0028 = 0.0121 \text{ CFM}$$

$$Q_3 = -0.0188(0.50)^2 + 0.0644(0.50) - 0.0028 = 0.0247 \text{ CFM}$$

$$V_{\text{tot}} = \sum_{i=1}^n t_i q_i \quad \text{Equation 9.2.1}$$

$$V_{\text{tot}} = (31,200 \text{ min})(0 \text{ CFM}) + (10,800 \text{ min})(0.0121 \text{ CFM}) + (1,200 \text{ min})(0.0247 \text{ CFM})$$

$$V_{\text{tot}} = 160.3 \text{ CF}$$

$$Q_{\text{test}} = \frac{V_{\text{tot}}}{T} \quad \text{Equation 9.2.2}$$

$$Q_{\text{test}} = (160.3 \text{ CF}) / (720 \text{ hours}) = 0.223 \text{ CFH}$$

B. Calculate the total mass emission rate by inserting the results for total volumetric flow rate and molecular properties of the gasoline vapor into Equation 9.3.1 as follows:

$$M = \left[\frac{(0.223 \text{ cfh})(34\%)(37.30 \text{ lb/lb - mole})}{(386.7 \text{ ft}^3/\text{lb - mole})(100\%)} \right] = 0.0073 \text{ lbs/hour}$$

C. For a Phase II system operating at a gasoline dispensing facility with typical 150,000 gallons per month, the following throughput factor shall apply:

$$\left(\frac{150,000 \text{ gal - month}}{30 \text{ days - month}} \right) \left(\frac{1 \text{ day}}{24 \text{ hrs}} \right) = 208 \text{ gallons/hour}$$

D. The mass emission factor for the vacuum-assist system, operating at the various storage tank pressures is calculated using Equation 9.4.1.

$$E = \left(\frac{1,000 \text{ gallons}}{208 \text{ gallons - hour}} \right) (0.0073 \text{ pounds/hour})$$

$$E = 0.0351 \text{ pounds/1000 gallons}$$

FORM 1

TP-201.2F Summary of Pressure-Related Fugitive Emissions

Station Name	Phase II System Manufacturer
Station Address	Phase II System Model
City	Phase I System Type

Ambient Conditions

Test Date	Relative Humidity
Ambient Temp	Wind Speed
Barometric Pressure	Other
Start Time	End Time

Storage Tank and Vapor Recovery Component Information

	Grade	Grade	Grade	Grade	
Ullage, gal					Number of Nozzles
Gallorage, gal					Number of PV Valves
Capacity					Number of Drain Valves
					Number of Overfill Valves

Hydrocarbon Vapor Concentration (ARB Method 100)

NDIR Analyzer Make/Model	Post Calibration Deviation
Calibration Gas (propane, butane)	Conducted By
Sampling Interval (minutes)	Concentration (provide data sheet)

Hydrocarbon Bag Sample and Analysis (CARB Method 422 (Sampling)/ SOP MLD 102/103 Revision 2 (Analysis))

Sampler Type	Sample Flow Rate
Sample Size	Conducted By
Sample Interval (minutes)	Molecular Weight (Attach Lab Analysis)

RVP Analysis (California Code of Regulations, Title 13, Section 2296)

Sample Bottle Number	Reference Symbol or ID Number
Location Type	Conducted By
Gasoline Grade	Gasoline RVP (Attach Lab Analysis)

TP-201.2F APPENDIX 1

DETERMINATION OF Q VS. P EQUATION

In summary, this method creates a standard pressure (P) vs. flow (Q) curve for a model station that is modified to exhibit the maximum allowable leak rate. The points on the curve are found through steady-state measurement of flow at various system pressures at the model station. An equation is fitted to the data in order to provide a means to calculate flow at all pressures recorded during the certification test period.

1. Configure Test Apparatus to Exhibit Maximum Allowable Leak at 2 inches WC

Ensure the simulated tank test apparatus exhibits a leak rate less than or equal to the maximum allowable at 2" WC as calculated using the equation below and allowable final pressures from TP-201.3.

$$Q_{\max} = (60\text{min/hr}) \left[\frac{(25,000 \text{ gallons})(2.00 - P_f)}{(5)(7.481)(406.9) \left(2.00 \left(\frac{P_f}{2.00} \right)^{1/2} \right)^{1/2}} \right] (2)^{1/2} \quad \text{Equation 1-A}$$

where:

Q_{\max}	=	Maximum allowable flowrate at 2 inches H ₂ O, cubic feet per hour (CFH)
60	=	Conversion factor, minutes per hour
25,000	=	Predetermined tank ullage, leak decay specification
2.00	=	Predetermined initial pressure, TP-201.3, inches H ₂ O
P_f	=	Predetermined final pressure for maximum allowable leak
5	=	Predetermined time period, TP-201.3, minute
7.481	=	Conversion factor for gallons to cubic feet, gallons/ft ³
406.9	=	Atmospheric pressure, inches H ₂ O

The maximum allowable leakrates calculated using Equation 1-A are provided below:

Table 1A
Maximum Allowable Leakrates (CFH)

Number of Nozzles	Balance	Assist
7-12	6.20	4.19
13-18	6.44	4.41
19-24	6.69	4.65

Configure equipment to allow measurement of flows at various pressures using the steady-state technique. Include a valve in the system in order to adjust the leak rate to match maximum allowable leak rate. In the steady-state technique, a flowmeter is used to measure flow of nitrogen (N₂) into the simulated tank vapor space at equilibrium pressure conditions. Equilibrium pressure is defined as a pressure change of no more than 0.02 inches water over a 2-minute period.

Introduce N₂ into the system (use long line or other means to bring N₂ to ambient temperature before entering vapor space) and bring pressure to 2 inches. Adjust valve so that steady-state flow into tank at 2 inches WC is the maximum allowable leak rate.

2. Collect Flow Data at Other Pressures

Measure steady-state flow at various pressures. **DO NOT ADJUST THE OUTFLOW VALVE** once the maximum leakrate has been set at 2 inches, this “defined leak” is not changed for measurement at other pressures. Collect flow information for at least 5 different pressures.

3. Prepare Q vs. P Curve

Plot measured values of Q vs. P. Use a curve-fitting program to derive an equation that best fits the data collected.