California Environmental Protection Agency

Air Resources Board

Vapor Recovery Test Procedures

PROPOSED TP - 201.4

DETERMINATION OF DYNAMIC PRESSURE PERFORMANCE OF VAPOR RECOVERY SYSTEMS OF DISPENSING FACILITIES

Adopted: April 12, 1996
Amended: ____________

Note: this document consists of the text of the proposed amendment to TP 201.4. Proposed deletions are noted by ~~Strikeout~~ and proposed additions are noted by underline.

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Vapor Recovery Test Procedure

TP-201.4

Determination of Dynamic Pressure Performance of Vapor Recovery Systems of Dispensing Facilities

1 APPLICABILITY

Definitions common to all certification and test procedures are 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.

This test procedure can be used to quantify the dynamic pressure (back-pressure) in the vapor path leading from the dispensing nozzle to the storage tank. The dynamic pressure associated with vehicle fueling is determined by various alternative procedures, one of which is applied as appropriate for the operational characteristics of the subject vapor recovery system.

This test procedure is used to determine the ~~static~~ pressure performance standard of a vapor recovery system during the certification process and subsequently to determine compliance with that performance standard for any installations of such a system.

2 PRINCIPLE AND SUMMARY OF TEST PROCEDURE

The principle of this test procedure is to determine the dynamic pressure of a vapor recovery system at known dispensing flow rates. Some alternative procedures are provided and one procedure shall be chosen for application appropriate to the operational characteristics of the subject vapor recovery system. A novel test procedure may be developed and used which incorporates some aspects of the procedures provided.

3 BIASES AND INTERFERENCES

3.1 Any leaks in the nozzle vapor path, vapor hose, or underground vapor return piping will result in erroneously low dynamic back pressure measurements.

3.2 The same procedure must be used to:

(1) determine a dynamic pressure performance standard and

(2) determine compliance with that standard.

4 SENSITIVITY, RANGE, AND PRECISION

4.1 Sensitivity

Sensitivity of measurements of pressure and volumetric flow rate is approximately equal to the graduation interval specified for each instrument in Section 5.

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.

4.2 Range

The range of practical measurements of pressure and volumetric flow rate consistent with this test procedure is limited by the instrument range specified for each instrument in Section 5.

4.2.1 Pressure

The pressure range for §8, Procedure 1, is 0.16 to 0.62 "WC.

4.2.2 Volume Flow

The volume flow range for §8, Procedure 1, is 40 to 80 cubic feet per hour.

4.3 Precision

Non-compliance with an applicable pressure limit shall be determined only when the measured pressure exceeds the applicable limit by more than 5% of the limit value or 0.02 inches of H_2O, whichever is greater.

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:

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

5 EQUIPMENT

5.1 Nitrogen Pressure Drop Test Unit

See Figure 1; the ranges on the pressure gauges are for example only. The unit shall consist of a suitable frame or cabinet to which the pressure measurement device, the rotameter, and the fill pipe adaptor are rigidly attached and shall be equipped with suitable leveling bubble(s) and leveling screws or other provisions for leveling the pressure measurement device and the rotameter while in use. The fill pipe shall be mounted so that nozzles will hang in the normal semi-horizontal position when inserted, and gauges shall be mounted at a height suitable for proper observation. See Figure 1.

Use a fill pipe known to be compatible with all vapor recovery nozzles and equipped with a pressure tap and a separate feeder line consisting of 1/4" or larger copper or stainless steel tubing (or teflon tubing of similar diameter and wall thickness) not longer than 18" delivering nitrogen from the rotameter. Alternatively the pressure tap may be connected to the nitrogen feeder line by a tee not more than 3 inches from the fill pipe.

Use a high pressure nitrogen cylinder capable of maintaining a pressure of 2000 psig and equipped with a compatible two-stage pressure regulator. Use commercial grade nitrogen.

5.2 Rotameter(s)

Use a calibrated rotameter capable of accurately measuring nitrogen flowrates of 40, 60, and 80 CFH and having a range of 10-100 SCFH Air and a graduation interval no greater than 2 SCFH Air, equipped with a flow control valve. A rotameter designed for measurement of air flow rates, or calibrated against such a rotameter, shall be used and no correction for gas density shall be applied to readings when measuring nitrogen flow rates.

5.3 Pressure gauge(s)

Use a pressure measuring device (either a transducer with electronic readout, an inclined manometer, or a Magnahelic gauge) with a design range suitable for the pressure being measured. with a range of 0 to 1.00 inches of H_2O and a graduation interval no greater than 0.02 inches of H_2O. Additional gauges with a lesser range may be used for low-range measurements if desired.

For the nitrogen pressure drop test unit (Figure 1 for example), use two differential pressure gauges equipped with toggle valves connected to the high pressure inlets.

5.4 Hand Pump

Use a gasoline compatible hand pump to drain condensate pots.

6 CALIBRATION PROCEDURE

6.1 Rotameters

Rotameters' calibration shall be checked annually at 20%, 40%, 60%, 80% and 100% of full scale against a dry gas meter, passing air (not nitrogen) through a toggle valve, thence through the rotameter at a constant rate, and thence through the dry gas meter for a measured time interval of at least one minute. If volume measured by the dry gas meter divided by the measured time interval (converted to hours) does not agree with the rotameter's indicated flow rate within 3% of that indicated flow rate or 2 CFH (whichever is greater) at each flow rate, the rotameter shall be replaced or repaired.

6.2 Pressure Measurement Devices

Pressure measurement devices' calibration shall be checked annually at 20%, 40%, 60%, 80% and 100% of full scale against an inclined manometer. If pressure measured by the inclined manometer does not agree with the pressure measurement device's indicated pressure within 3% of that indicated pressure or 0.02 inches H_2O (whichever is greater) at each pressure level, the pressure measurement device shall be replaced or repaired.

7 PRE-TEST PROTOCOL

7.1 Location of Test Site

Prototype systems will be located within 100 miles of Sacramento for testing. Other locations may be accepted at the discretion of the ARB Executive Officer.

7.21 Specification of Test, Challenge, and Failure Modes for Certification Testing

The specification of test, challenge, and failure modes such as the number of liquid transfer episodes, volume and volumetric rate of liquid transfer, storage tank volumes, etc. shall be done according to the principles of CP-201 § 5 for the testing and evaluation of vapor recovery equipment. The facility and system shall be prepared to operate according to any specified test, challenge, and failure modes.

7.32 System and Facility Preparation

System equipment and components shall be completely operational and, at newly constructed facilities, any storage tanks involved in the test shall be have been initially filled for the first time to the appropriate volume a minimum of 24 hours prior to the scheduled test.

In addition the system and facility shall be prepared to operate according to any specified test, challenge, and failure modes.

7.43 Check Facility Operating Mode

7.43.1 (1) If performing a test during the certification process, examine the subject facility to determine the most appropriate application of the alternative test procedures provided, giving preference to Procedure 1 except where it's use is demonstrated to be impractical. If none of these are appropriate, document those features necessary for incorporation into a novel test procedure. If reasonable and practical, make field revisions to the most appropriate procedure and proceed. Otherwise report the need for novel test procedure development.

(2) If performing a test to determine the compliance status of a subject facility, use the test procedure which was specified during the certification process.

7.43.2 For those Phase II systems which do not utilize a remote vapor check valve, assemble theuse apparatus as shown in Figure 1 unless otherwise required by an ARB Exectutive Order applicable to the particular type of vapor recovery system.for example, ensuring that the riser shut-off valve on the test equipment is closed. If a Hirt Phase II system is used the vapor recovery system is equipped with a device acting to reduce internal system pressure to a level below atmospheric pressure, the vacuum producing device shall be turned off during this test.

NOTE: The vapor check valve, which acts to block the vapor passage when the nozzle is not in use, is commonly located in the nozzle and actuated by compressing the bellows, but in some rare instances may be located "remotely" in or near the dispenser.

7.4.3 Perform an initial visual examination for vapor leaks at the nozzle and hose of the Phase II system to be tested.

7.4.43.3 Disconnect and drain the vapor hosereturn riser for all dispensers to be tested. Pour two (2) gallons of gasoline, or a larger quantity if specified by the control agency having jurisdiction, into each vapor return riser. Reconnect vapor hose. Allow fifteen (15) minutes for liquid in the vapor return piping to drain, then reconnect the vapor return risers. For Phase II systems which do not employ a remote vapor check valve, the 2 gallons of gasoline may be introduced through the vapor passage in the nozzle.

7.3.3.1 If all dispensers to be tested have previously passed this test and no changes have been made to underground piping, addition of 2 gallons of gasoline to each vapor return riser may be omitted if approved by the regulatory authority having jurisdiction.

NOTE: The intention of adding liquid gasoline to the vapor return risers is to verify proper drainage of underground piping and ensure that newly constructed or modified stations which may not have had time for condensate to accumulate in any low spots in underground piping are appropriately tested.

7.4.53.4 Completely drain all gasoline from the spout and bellows, if appropriate.

7.4.63.5 For those vapor piping configurations which utilize a condensate pot, drain the pot prior to testing.

7.4.73.6 For Procedures 2 and 3 tThe Phase I vapor poppet shall be propped open in such a manner that the valve is not damaged, for instance with a rolled up cloth rag.

7.54 Check Equipment and Supplies

The test equipment must be leak-checked each day prior to use.

For the nitrogen pressure drop test unit, plug the nozzle end of the auto fill pipe with a suitable gas cap or other device, open and disconnect nitrogen supply line at the nitrogen cylinder. and the Open any toggle valves onisolating the magnahelic gaugesrotameter and pressure measuring device(s). Adjust the flow meter control valveWith a hand pump or by blowing into the nitrogen supply line, introduce air until a pressure of 50 percent of full scale is indicated on the high range pressure gauge approximately 1 inch of H_2O is indicated. Close the rotameter valve and observe any progressive loss of pressure.nitrogen cylinder valve and toggle valves. A pressure decay of 0.2 up to 0.10 inches H_2O, in one minute five minutes, is considered acceptable.

8 TEST PROCEDURE

The facility and system shall be prepared to operate according to any specified test, challenge, and failure modes.

Each test procedure is based on direct measurements only; no sampling, recovery, or analysis is involved.

8.1 Procedure 1 - Nitrogen Pressure Test

(Systems *without* a Remote Vapor Check Valve)

Phase II systems which do not utilize a remote vapor check valve may be tested using the following procedure. Insert the nozzle into the fill pipe of the nitrogen pressure drop test assembly, ensuring that a tight seal at the fillpipe/nozzle interface is achieved. Ensure that the riser shut-off valve on the test equipment is closed.

8.1.1 Close both toggle valves and connect the nitrogen supply.

8.1.21 Perform an initial visual examination for vapor leaks at the nozzle and hose of the Phase II system to be tested.

NOTE: If obvious vapor leaks are present, report them and do not proceed further. This test assumes the vapor passages, including the bellows and hose, are intact.

Drain all gasoline from the spout, bellows and hose, compressing the bellows and extending the hose to ensure proper drainage.

Insert the nozzle in the fillpipe of the test apparatus, ensuring that a tight seal at the fillpipe/nozzle interface is achieved.

Open the nitrogen supply, set the delivery pressure to 10 psig, and use the flowmeterrotameter control valve to adjust the flow rate to 4020 CFH.

8.1.23 Open the toggle valve on the 0 to 0.5 inches H_2O gauge. If the pressure is greater than 0.5 inches H_2O, close this valve and use, for example, the 0 to 2.0 inches H_2O gauge.

8.1.4 Observe the pressure measurement device. A pulsating gauge needle pressure, if observed, indicates nitrogen passing through a liquid obstruction in the vapor return system. If this occurs, verify that liquid from recent "topping off" is not present in the hose as follows: close the flowmeterrotameter control valve, disengage the nozzle and redrain the nozzle and hose assembly. Re-engage the nozzle, open the flowmeterrotameter control valve and repeat the test. Record the measured pressure, or the midpoint of the range of measured pressures if pulsation continues.

NOTE: All mechanical gauges including rotameters, Magnahelic gauges, and inclined manometers must be read with the eye on a line normal to the scale face where the indicator rests and never from an oblique angle!

8.1.53 Repeat Sections 8.1.2 through 8.1.4 Increase the nitrogen flow rate in steps and measure the pressure drop for nitrogen flowrates of 40, 60 and 80, and 100 CFH. In certification testing or when a dispenser nozzle does not comply with an applicable dynamic back pressure limit, repeat testing (at the entire sequence of nitrogen flowrates) until dynamic pressure has been measured at each flowrate three times.

8.1.64 Close and replace the dust cover on the Phase I poppet after all dispenser nozzles have been tested.

8.1.75 Record data as instructed in the section, "RECORDING DATA".

8.2 Procedure 2 - Torus Pressure Test

For some systems, the dynamic pressure can be measured directly during dispensing into vehicles using apparatus assembled according to the design in Figure 2; the range on the pressure gauge is for example only.

Warning: This procedure shall only be used as a screening procedure for the other procedures provided. If this is the only procedure with which a system is compatible, then such system shall be considered to be incompatible with the application of TP-201.4 unless an alternative procedure is developed per § 13.

8.2.1 Measure the dispensing rate and dynamic pressure for any fueling episode during which four or more gallons is dispensed.

8.2.2 Collect data at high, mid-range, and low dispensing rates for five dispensing episodes at each rate.

8.2.3 Record the actual dispensing rate and dynamic pressure for each dispensing episode.

8.3 Procedure 3 - Fixed Volume Pressure Test

IMPORTANT: Use this procedure for compliance determinations only if specified by Executive Order applicable to the specific type of vapor recovery system being tested.

For some systems, the dynamic pressure can be measured directly during dispensing into a surrogate for a vehicle tank using apparatus assembled according to the design in Figure 3; the range on the pressure gauge is for example only.

~~In theory, this procedure yields the least direct measurement of dynamic pressure performance of the procedures provided; yet in some cases the other procedures can not be applied practically. The practical requirements for the application of this procedure are:~~

~~(1) the fixed volume (can, tank, etc.) can be sealed around the nozzle product dispensing path and the vapor return path;~~

~~(2) the dispensing rate can be known and controlled for repeated dispensing episodes of half of the fixed volume;~~

~~(3) a characteristic and repeatable dynamic pressure can be observed for repeated dispensing episodes of half of the fixed volume;~~

~~(4) the variation of the results of this procedure can be correlated with the variation of efficiency test results on the same vapor recovery equipment.~~

8.3.1 Measure the dispensing rate (using a stopwatch and the dispenser's metered gallonage) and dynamic pressure for any fueling episode during which half of the fixed volume is dispensed.

8.3.2 Collect data at high, mid-range, and low dispensing rates for five dispensing episodes at each rate. Set constant dispensing rates using the nozzle's hold-open clip or a wooden wedge.

8.3.3 Record the ~~actual~~ dispensing time, gallons dispensed, calculated dispensing rate and dynamic pressure for each dispensing episode.

9 QUALITY ASSURANCE / QUALITY CONTROL (QA/QC)

This section is reserved for future specification.

10 RECORDING DATA

Figure 4, for example, is the field data sheet for the procedures provided.

Data sheets for other procedures shall be composed in a similar manner, based on field operating parameters.

The following information shall be recorded on the field data sheet:

Facility Identification and Address
Pump Number and Product Grade
Nozzle Make and Model
Nitrogen Flowrate, CFH
Dynamic Back Pressure, inches H_2O

11 CALCULATING RESULTS

Calculate the average dynamic pressure for each dispensing rate tested at each nozzle.

12 REPORTING RESULTS

~~12.1 Procedure 1~~

In compliance testing, t~~T~~he maximum allowable~~ average~~ dynamic back pressure~~s~~ for ~~a~~ ~~system~~individual dispenser nozzles, with the dry breaks open, ~~are~~is as ~~follows:~~ specified in the CARB Executive Order applicable to the specific vapor recovery system or in any applicable regulation. In certification testing, appropriate allowances for performance variations between individual dispenser nozzles and associated system components shall be made in establishing dynamic pressure limits. Dynamic pressure limits shall be applicable to individual dispenser nozzles.

<table to be deleted>

~~**Flow Rate (cubic feet per hour)**~~	~~**Dynamic Pressure (inches of water column)**~~
~~40~~	~~0.16~~
~~60~~	~~0.35~~
~~80~~	~~0.62~~

12.1 Procedure 1

The dynamic pressure performance of each dispenser nozzle shall be reported as the average dynamic pressure at each flow rate.

The dynamic pressure performance measured during certification shall be used as a basis for the performance standard for any installation of the subject vapor recovery system tested. The dynamic back pressure limits specified at each flow rate shall be indicative of the upper limit of the normal range of dynamic back pressures for individual dispensing nozzles at the facility during certification.

12.2 Procedure 3

The dynamic pressure performance shall be reported as the average dynamic pressure at each flow rate.

The dynamic pressure performance measured during certification shall be used as a basis for the performance standard for any installation of the subject vapor recovery system tested. The dynamic back pressure limits specified at each flow rate shall be indicative of the upper limit of the normal range of dynamic back pressures for individual dispensing nozzles at the facility during certification.

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

Each figure or form 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 or forms 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
~~Nitrogen Pressure Test Assembly~~<u>Typical Apparatus for Procedure 1</u>

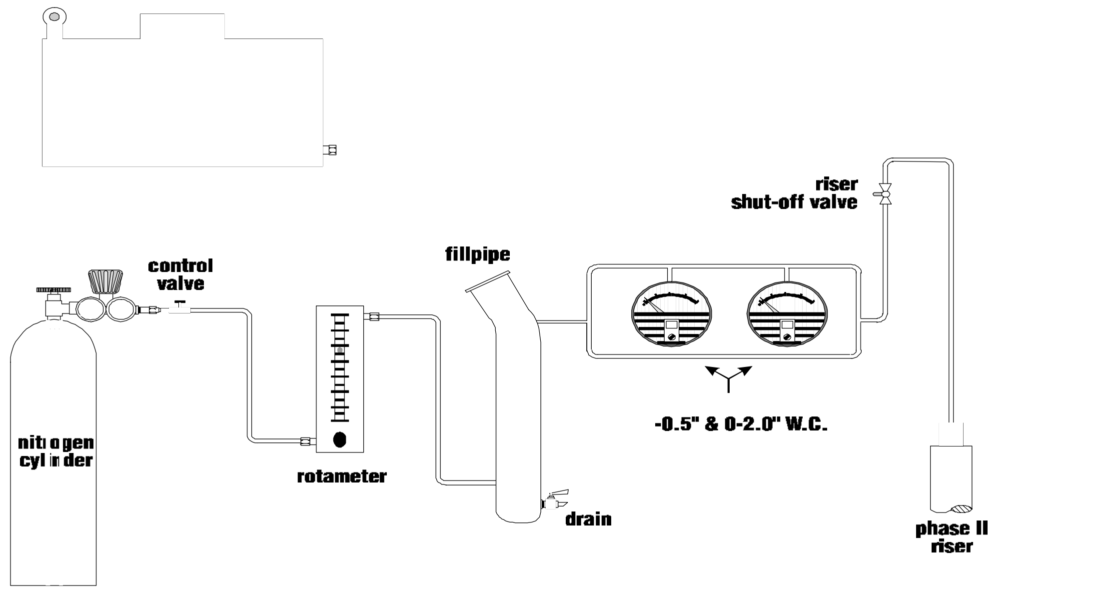
Figure 2
Torus Pressure Test Assembly

Figure 3
Fixed-Volume Pressure Test Assembly

Figure 4
Field Data Form

<Figure to be deleted>

FIGURE 1



<Figure to be added>

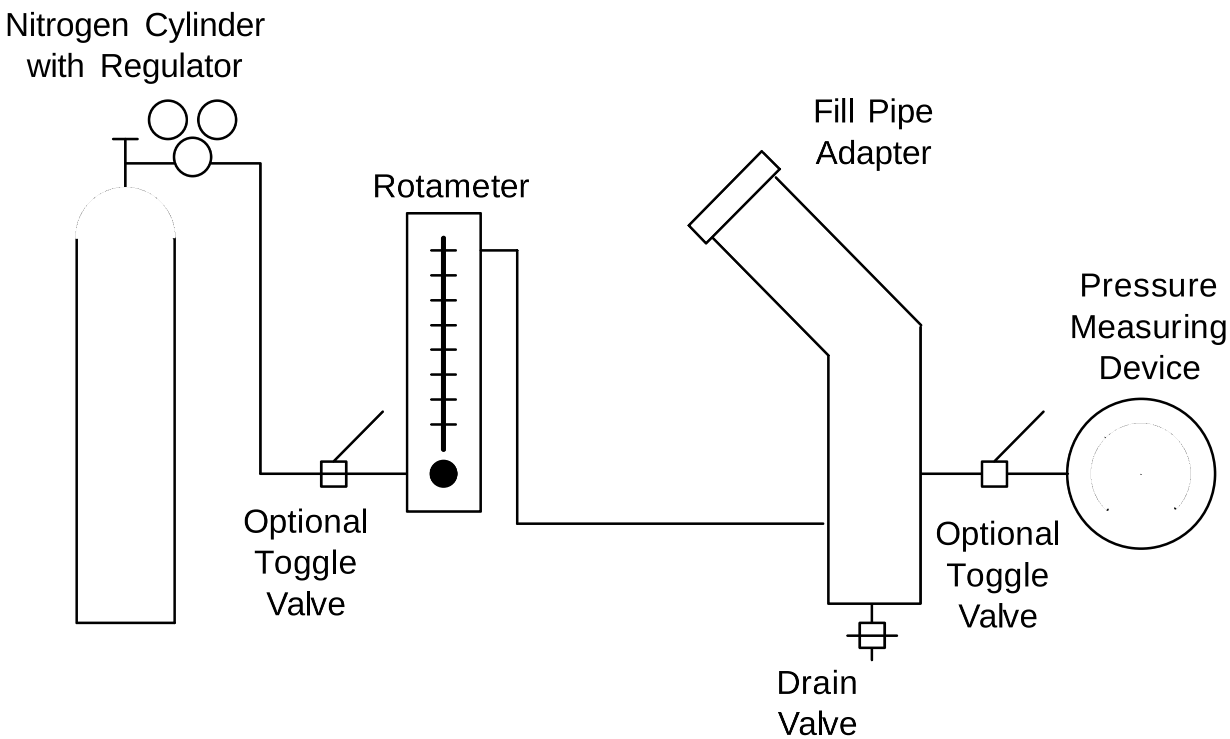


Figure 1 - Typical Apparatus for Procedure 1

FIGURE 2
Torus Pressure Test Assembly

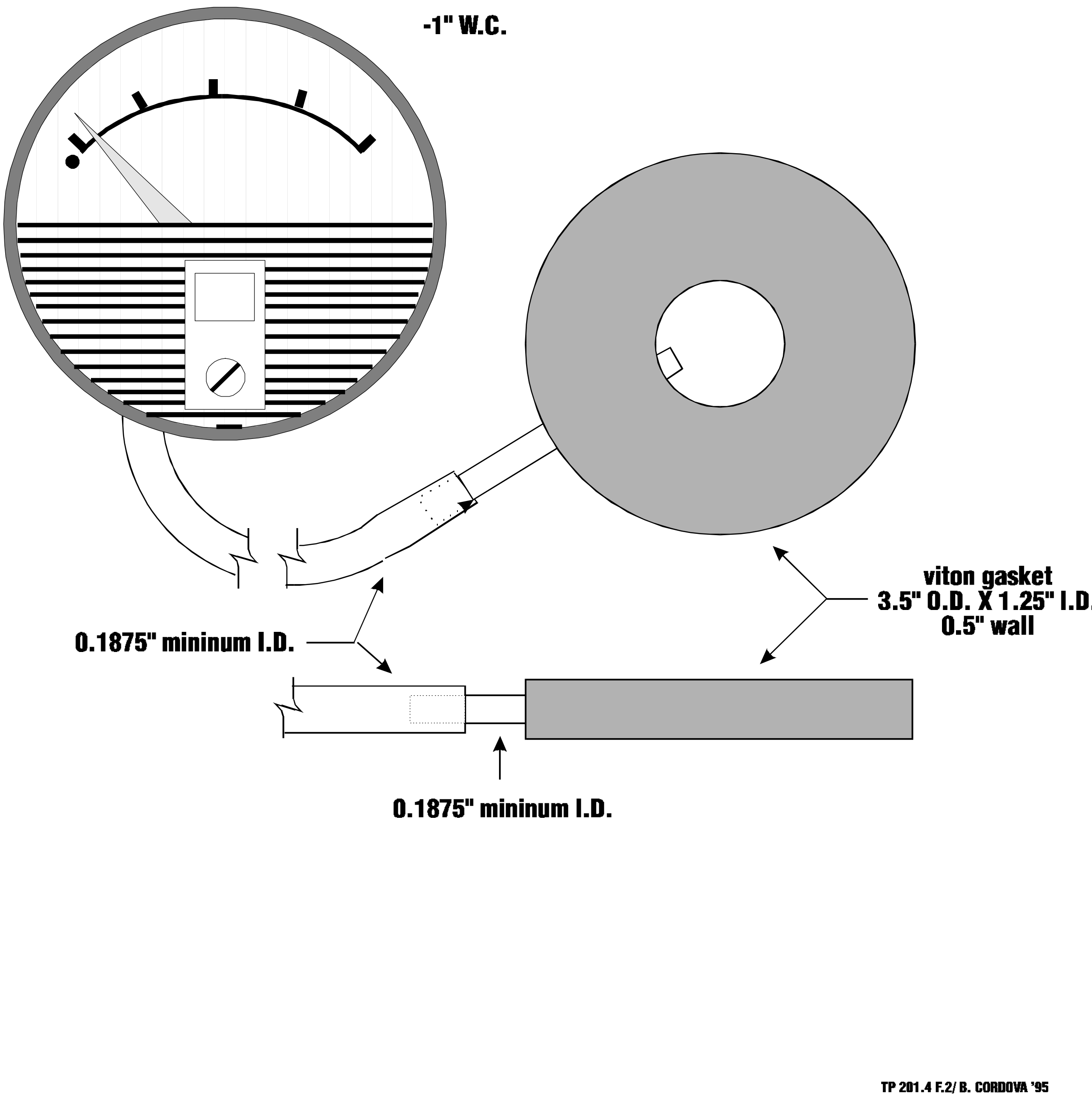
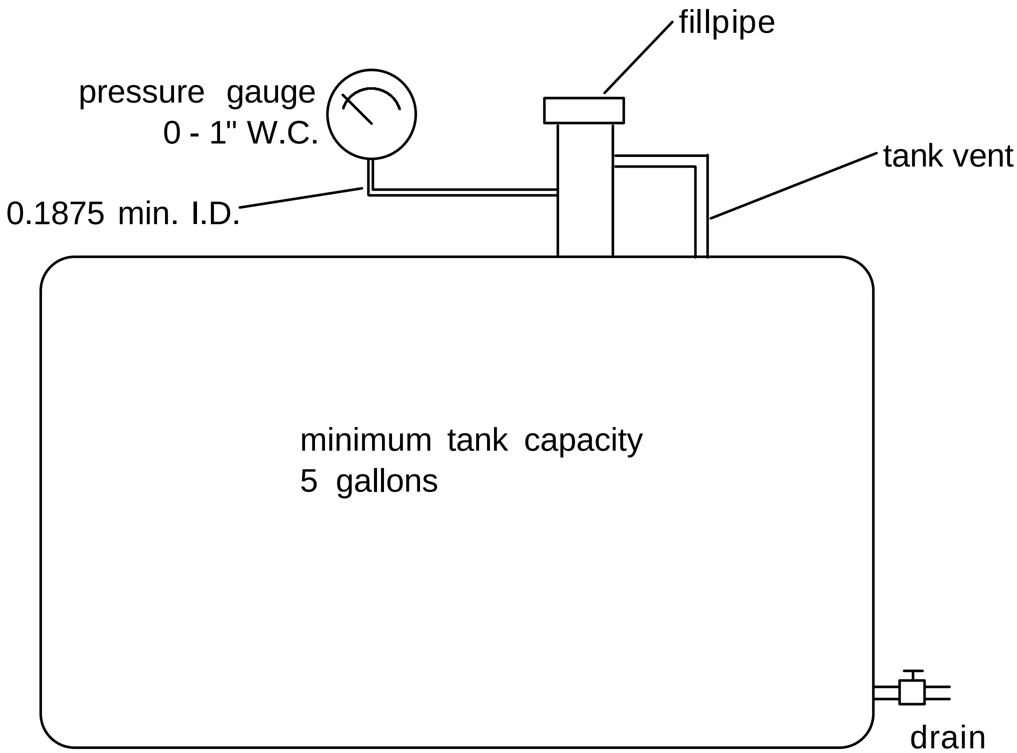


FIGURE 3

Fixed Volume Pressure Test Assembly



<table to be deleted>

~~FIGURE 4~~

~~Field Data Form~~

~~Facility Name~~	~~Address~~	~~City~~	~~Phone~~
~~ARB Monitor~~	~~Tester~~	~~Date~~	~~Phone~~

~~Pump~~ ~~(id)~~	~~Grade of Liquid Gasoline~~	~~Nozzle Type~~	~~Volume Dispensed~~ ~~(gal)~~	~~Time~~ ~~(min:sec)~~	~~Flowrate~~ ~~(gpm) (cfh)~~	~~Vapor Valve~~ ~~(model)~~	~~Dynamic Pressure Measured (in. W.C.)~~	~~Dynamic Pressure Allowed (in. W.C.)~~

<table to be added>
Figure 4 - Field Data Form

Facility Name & Address____
Inspector______________________ Date________________
Vapor Recovery System Type____
Applicable Air Resources\ Board Executive Order # _________________________
Dynamic Pressure Limits from Executive Order: Inches of H_2O CFH Nitrogen

_________ @ ___________
_________ @ ___________
_________ @ ___________

Pump Number	Gasoline Grade	Pressure, Inches of H_2O		Proc. 1 Nitrogen Flow, CFH		Proc. 3 Gallons Dispensed	Proc. 3 Time to Dispense	Proc. 3 Dispensing Rate, CFH