SAN DIEGO COUNTY AIR POLLUTION CONTROL DISTRICT
TEST PROCEDURE TP-96-1

THIRD REVISION-3/1/96

STATIC PRESSURE LEAK TEST PROCEDURE VOLITILE FUEL VAPOR RECOVERY INSTALLATIONS EXCEPT ASPIRATOR ASSIST SYSTEMS

1.0 APPLICABILITY

This procedure applies to gasoline dispensing facilities that recover vapors from storage tank fill and vehicle fueling operations (Phase I and II vapor recovery), except for aspirator assist systems that are tested according to TP-96-4. The objective is to determine compliance with District Rules 61.3, 61.4, and 61.8; Chapter 3, Article 5 of the State of California Health & Safety Code (H&SC); and Section 94006, Title 17, California Code of Regulations (CCR).

1.1 **ARB Certification** – Rule 61.8 and State law require that all vapor recovery systems be State of California Air Resource Board (ARB) certified. To be ARB certified, all bulk storage tanks must be connected to the Phase II vapor recovery system in the configuration shown in the applicable ARB Executive Order. Except in special cases involving incineration, vapors must return to the tanks from which fuel was pumped in order for the system to be a certified system as required by State law. A provision of this procedure is used to check vapor manifolds to ensure the underground plumbing complies with the applicable ARB Executive Order.

1.2 **System Effectiveness** – Rule 61.4 and various ARB Executive Orders require that Phase I and Phase II vapor recovery systems perform with the same effectiveness as the State Air Resources Board (ARB) certification test systems associated with the applicable state Executive Orders defining the systems. The certified systems and components either passed an ARB ten-inch water column gauge (wcg) test, a five-inch wcg test or a two-inch wcg test. Systems passing this procedure are at least the same as the certification test sites with regard to vapor leakage. This procedure is also used to identify equipment defects prohibited by Rule 61.4 and Section 94006 of the CCR. Also, liquid blockage occurs in bootless nozzle vacuum assist systems where leaks into the vapor line break or reduce the vacuum needed to clear the vapor return passage of liquid. This procedure is designed to identify those vacuum assist leaks. Although air to liquid (A/L) or vapor to liquid (V/L) tests may indicate a problem, those tests can not be used to identify the cause such as a faulty pump, piping leak, nozzle leak, etc. Those tests may not indicated an existing problem if the hoses are drained of ingested liquid prior to the test.

1.3 **Nozzle Shutoff** – Rule 61.4 and State law require that balance system vapor recovery nozzle back-pressure shutoff mechanisms not malfunction in order to minimize spillage. This procedure is used to check balance system nozzle shutoff mechanisms to ensure they activate between 6 and 8 inches wcg.

1.4 **95% Vapor Recovery** – Rule 61.3 requires 95% vapor recovery during the truck delivery of fuel to bulk storage tanks (Phase I vapor control). Air aspirated into the fuel during Phase I deliveries prevents compliance. Significant vapor leakage from adjacent tanks with a vapor manifold to the tank receiving fuel would also preclude compliance. This will not happen if the system passes this procedure.

2.0 BIASES AND INTERFERENCES

The allowable leak rate, originally developed by California State Fire Marshal, is 0.5 gallons/minute or about .066 ft3 / min. (cfm) at an average system pressure of 9.5 inches wcg. The State Fire Marshal wanted to ensure that any leaks at ground level at operating pressures would dissipate before becoming a fire hazard. Later it was found that this rate ensured that vapor transfer efficiencies from bulk deliveries would not be changed by more than 1%, on the average, if the Fire Marshal's standard was adopted. However, the leak rate is based on the assumption of no vapor expansion during the test. That assumption is not valid under most weather conditions.

This procedure was designed to minimize bias under the conditions in which the test is most likely to be conducted. Most static pressure tests are run in the morning or early afternoon. That is usually when barometric pressure is decreasing and when direct sun on exposed metal vent pipes, metal manhole covers and concrete driveways creates thermal convection in storage tanks that brings unsaturated air into contact with the liquid surface and causes vapor growth. Besides weather, accuracy can also be affected by the last bulk delivery, especially within five hours of that delivery.

Because of factors outside the test, all static pressure leak tests are imprecise screening tests under most field conditions. To accurately determine gas-tightness, other methods, such as the use of soap solutions, helium detection, sonic detectors, etc., must also be used. Explosimeters (gas detectors) may be used except where lines are filled with nitrogen. This procedure requires the addition of other methods of detection, where appropriate, to ensure compliance with local and state requirements.

The most serious factor biasing the results is vapor growth due to evaporation and barometric pressure changes. When the rate of growth equals or exceeds the rate of flow out of a leak or leaks, the leaks are undetectable using a static pressure test. This is called "masking". Even when the flow out of the leak exceeds the rate of vapor growth, the growth rate changes the slope of the pressure decay curve. A system that would fail on a windless, foggy morning with constant barometric pressure might pass on a hot day. When sufficient amount of cold nitrogen is introduced into the vent pipes it counter acts convective movement and temporarily stops or significantly reduces evaporation so that the accuracy of the static pressure test significantly improves. This usually works if the ullage is large enough and nitrogen doesn't come in contact with the liquid surface. However, direct radiation from the sun on the system on a day exceeding 100°F will create a bias that renders any pressure decay curve unusable, regardless of ullage. Under such conditions, other methods must be used to determine leak tightness.

For underground tanks, factors outside the test, such as evaporation and barometric changes, preclude the test from being any more accurate than ± 0.1 inches wcg, except under unusually favorable conditions. Because the accuracy is not better than ± 0.1 inches wcg most of the time, it is necessary to have a five-minute, ten-minute and fifteen-minute test depending on the tank ullage in gallons. (See Table 1 and Figures 2, 3, and 4 at the back of the procedure).

For above ground tanks, static pressure tests can not be used alone to determine system leakage under most summer time conditions, even when the tanks are insulated. Solar radiation has a much greater impact on aboveground tanks than it does on underground tanks. The tanks are frequently square which enhances evaporation due to convection. During the summer, it is often not possible to conduct a meaningful static pressure test where the results are based soley on a rate of pressure decay. Therefore, the emphasizes is on demonstrating compliance by passing a soap solution test of all exposed piping and fittings where the system pressure does not decay more than - 0.1 inch over a fifteen minute period.

Because this procedure is used to determine the probability of rule compliance, there are different standards for vacuum assist systems without processors, for balance systems, for vacuum assist systems with processor, and for above ground tanks. There is also a manifolded "tie" test that is part of this procedure which has no known bias.

When determining actual emission rates or system efficiencies for purposes such as emissions inventory, health risk assessments, etc., there is no allowable, unquantifiable leakage. A static pressure test is a screening device. It is not a reliable method to determine if a system is free of leaks. Therefore, additional methods are specified when actual system emission rates are needed. No decay due to leakage is allowed. For this portion of the procedure, there is no known bias because the system either has detectable leaks or it doesn't.

3.0 PREREQUISITES TO TESTING

The following requirements must be met before a valid test may be performed:

3.1 **The District Must Be Notified** – The appropriate person specified in the Air Pollution Control District Authority to Construct letter must be contacted within ten working days of completion of construction to establish a mutually agreeable test date. Normally, the tests will be witnessed by a District representative; however, the District engineer may, under certain circumstances, authorize testing without a District observer being present. If the District is not notified of testing in advance, then this test or other required tests may be declared invalid. If found invalid, testing may have to be repeated with a District observer present.

3.2 **Minimum Tank Ullage** – The ullage (vapor space) in each tank being tested must be at least 15% of the tank's capacity, but in no case less than 300 gallons per tank for tanks under 1000 gallons capacity. If the tanks are manifolded, each tank must meet this minimum ullage requirement. This minimum is design to avoid reactions of the nitrogen with the liquid fuel surface that will cause vapor growth.

3.3 **Maximum Tank Ullage** – The combined maximum ullage space of the tank(s) depends on whether a five-minute, ten-minute or fifteen-minute test is conducted. The maximum ullages are as follows: five-minute test, 10,000 gallons; ten-minute test 20,000 gallons; and fifteen-minute test, 30,000 gallons.

3.4 **Weather Conditions** – This procedure is not valid when the ambient temperature is over 100°F and there is direct sunlight on exposed metal vent pipe(s) and metal manhole cover(s) that are in contact with the vapor space of the storage tanks. However, testing can be conducted at ambient temperatures above 100°F if the system is completely shaded (i.e., early in the morning before the sun hits the vent pipes or after sundown) and the tank vapor space (ullage) is greater that 30% of the volume of the tank(s).

3.5 **Condition of the Vapor Recovery System** – The complete vapor recovery system must be installed and intact during the test. If the installation includes a Phase II vapor recovery system, all hoses, nozzles, fittings, valves, and other system components must be installed as if the system were to be placed into service. All system components must be free of all visible defects such as torn or punctured bellows, loose or torn faceplates, or defective check valves. Plugging the vapor return plumbing where a vapor recovery nozzle, overfill basin drain valve or remote check valve have been found leaking is **not** allowed. The system must be in the configuration that will be used in normal service. **The caps on the Phase I riser(s) and on the bulk liquid fill riser(s) must be removed.**

3.6 **Restrictions on Gasoline Transfer Operations** – Bulk transfers of gasoline into the storage tanks are prohibited within the 8-hour period preceding the test. In addition, dispensing of gasoline is not allowed during the test.

4.0 **<u>EQUIPMENT</u>**

The following equipment is required. (Refer to the schematic in Figure 1 at the back of the procedure for a typical setup.)

4.1 **<u>Compressed Gas</u>** – A bottle of compressed gaseous nitrogen and pressure regulators capable of regulating final downstream pressure to 1.0 pound per square inch gauge (psig) are required. Use assorted valves, fittings, and pressure tubing as necessary. A means of providing and electrical grounding path from the bottle of compressed nitrogen must be employed. The bottle shall be grounded for safety. It is recommended that the tubing be flexible metal tubing or shall be nonmetal tubing that incorporates a grounding path throughout its length.

WARNING

The nitrogen bottle must be securely fastened upright to a large, stationary object at all times. <u>A compressed gas cylinder which falls and is damaged can easily become a lethal projectile.</u>

4.2 **<u>Pressure Relief</u>** – A pressure relief device must be installed prior to static pressure testing. The pressure relief device is necessary to prevent accidental over pressurization. When conducting a ten-inch test, the device must be adjusted to vent at not more than one pound per square inch gauge (psig) [27.7 inches water column gauge (wcg)].

WARNING

Attempting the pressure decay test without a Pressure relief device may result in over-Pressurizing the system, which <u>may create a hazardous condition and may cause damage to the underground storage tanks, associated piping, and other system components</u>

4.3 **<u>Pressure Measurement</u>** – An accurate device for measuring pressure, such as a water manometer, pressure transducer or a Magnehelic gauge (or equivalent), is required. This device must be accurate to one-tenth (0.1) of an inch of water column pressure at full scale.

4.4 **<u>Time Measurement</u>** – A stopwatch accurate to within 1 second.

4.5 **<u>Leak Location Detection</u>** – Soap solution and plastic bags to test leaks from pressure/vacuum (p/v) valves are required. Addition methods of leak detection may be used in lieu of soap solutions such as helium detection, sonic detection, and, where nitrogen does fill the line, explosimeters (gas detectors).

4.6 **Plastic Bags** – At least 2-ply plastic trash bags and tape.

5.0 TEST PROCEDURE

5.1 GENERAL PROCEDURES

5.1.1 **Bulk Deliver Time:** - Ask for a copy of the last bulk gasoline delivery manifest from the facility manager and obtain the time of the last bulk delivery. Do not conduct the static pressure test until at least eight hours after the last delivery.

5.1.2 **Ullage Calculation** – Determine the ullage of the underground storage tank (or tanks, if manifolded). Obtain the gasoline gallonage in the underground storage tank(s). Calculate the ullage space for the storage tank(s) by subtracting the gasoline gallonage present from the tank capcity(ies). Note the ullage and total tank capacity in the appropriate space of the data log (attached). The actual tank ullage must meet the minimum tank ullage criteria specified in Section 3.2 and the maximum ullage specified in Section 3.3.

5.1.3 **Pressurization Preparation** – Install the grounding wire, fittings, tubing, and equipment needed to pressurize and to monitor the system vapor space (see Figure 1). Nitrogen shall be introduced into the system through the storage tank vent pipe.

5.1.4 **Venting Preparation** – Existing pressure/vacuum (p/v) valves set at three inches may be temporarily removed and tested separately either after the ten inch test or bench tested in accordance with Paragraph 5.1.6 below. In all cases, static pressure tests shall be conducted with a safety p/v valve. Except where an existing p/v valve is adequate, install system pressure relief protection as follows:

(a) **For facilities with new storage tanks and/or new underground piping where the underground tanks have manifolded vent lines,** temporarily detach the manifold and install the pressure relief safety valve, in the opening of one of the storage tank vents and cap the remaining storage tank vents. (Manifolding the vent line outlets interferes with the check of underground vapor manifolds.)

(b) **For individual separate vent line outlet (non-manifolded) systems**, test each product vapor recovery system separately with the pressure relief safety valve installed either on the vent outlet of the storage tank being tested or in-line on the nitrogen hose to the vent connection. See Figure 1. (alternative setups may be used as long as they do not interfere with the objectives of the test and have prior District approval.)

(c) **For a modified facility with manifolded underground tank vents** and where the tanks have previously passed a tank tie test, replace the single pressure/vacuum valve with a safety p/v valve or bag the system's p/v valve according to Subsection 5.1.6 – Option 1, unless the facility has a p/v valve with a pressure setting greater than 10 inches wcg.

5.1.5 **Storage tank Preparation** – Remove the Phase I adapter (dust) cap(s) on the vapor return drybreak valve(s) and the tank fill rieser cap(s) of the underground storage tank(s). The tank fill riser cap(s) must be off during the pressure decay test to check for the possibility of unsaturated air aspiration into the liquid stream during bulk gasoline deliveries.

5.1.6 **Pressure/Vacuum Valve Tests** – Most certified vacuum assist systems require p/v valves set at three inches wcg which means they can not be tested with a ten inch static pressure test. There are two options.

Option 1 - Bag Test. Place plastic bag(s) over the pressure/vacuum (p/v) valves(s) (and tape the bag(s) tightly to the vent line(s). Proceed to Section 5.1.7 and conduct the system pressure leak check. The p/v valve will open and inflate the bag. Using soap solution, make sure the are no leaks at the base of bag where it is taped to the vent line. After successful completion of the static pressure test, remove the bag and allow the system pressure to decrease to the lower set point of the p/v valve. For systems with three-inch p/v valves, the pressure can not decrease below 2.5 inches wcg before the valve resets. After the valve closes, check for leakage at the bottom of the treaded connection using soap solution. (Note: p/v valves with clamp-on connections are prohibited. Rule 61.4 requires that the p/v valve operate the same as the p/v valve that under went certification testing. Thermal contraction and expansion causes the screws used for the clamp to back off over time causing the valve to leak and, therefore, not operate the same as the valve that was tested for certification purposes.) If possible, use soap solution on the valve seat or re-attach the bag to see if the valve seat is tight. (Note: An explosimeter can not be used to determine leakage from a p/v valve if the vent line is full of nitrogen.)

P/v valves that don't close at their lower set point or that seep vapors below the lower set point are defective and must be replaced, repaired or cleaned. (Properly designed p/v valves that only need cleaning are usually tight for a year or more before grime again causes leakage. Clean valves should not leak at all.)

Option 2 – Bench Test. Based on field observations, there is usually a repair phase followed by a test phase. During the repair phase, existing p/v valves are often replaced with plugs or p/v valves with higher pressure release settings so that the system can be pressurized beyond ten inches wcg to provide amble time to locate and repair system leaks. Also, p/v valves are often removed so they can be cleaned.

In these cases, while the ten-inch wcg test is being conducted, bench test the system's p/v valves. The bench test is conducted with a section of two-inch pipe treaded on one end and capped on the other. The pipe has two threaded ports, one is used for the line to the pressure measuring device and the other is used for the nitrogen line. The p/v valve, after it is cleaned, is screwed on to the section of pipe and the pressure raised to within 0.5 inches wcg of the release set point. Check the p/v valve for leaks at the higher and lower set points. If a p/v valve releases vapors below the lower set point allowed by the applicable State Executive Order, the valve fails. After completion of the ten-inch wcg test, remove the plug(s) and/or test p/v valve from the vent. If the system's p/v valve(s) passed the bench test, apply amble sealant to cover the pipe threads of the underground tank vent. Carefully screw on the system's p/v valve(s) until it is tight. With the proper application of a good pliable sealant, hand tight is sufficient. The excessive use of a wrench can crack the valve housing. It is not necessary to conduct further testing if the sealant completely covers the pipe thread at the base of the p/v connection to the vent pipe.

Alternatives to the above options can be used if approved by the District.

5.1.7 <u>System Pressurization</u> – With no dispensing taking place, **slowly** pressurize the vapor system (or subsystem for individual vapor return line systems) until the pressure reaches 11" wcg. Let the system sit for ten minutes to allow for thermal stabilization in the tank(s).

(a) During this time, check the vent cap assembly(ies), nitrogen connector assembly, nozzles, vapor return adapter(s) and all accessible vapor connections using soap solution to verify that the test equipment is leak tight.

(b) If after ten minutes, the pressure is still above 10" wcg, reduce the system pressure to 10.0" wcg. If the pressure is below 10" wcg, then again pressurize the vapor system to 10.0" wcg.

5.1.8 <u>Static Pressure Test</u> – With the system pressurized to 10.0" wcg, begin the test.

(a) Start the stopwatch and note the initial time at which the test was begun in the appropriate space on the data log.

(b) Intermediate readings may be taken to monitor the performance of the system.

(c) Proceed to Section 5.2 to determine compliance for the specific vapor control system under evaluation.

5.1.9 <u>Underground Piping Check (Tie Test)</u> - This test is only applicable to underground tanks and piping. **There is no need to conduct a tie test if the tanks were previously tested, passed the tests, the tests are on file with the District, and no underground tank or underground piping modifications or replacements have taken place in the interim.**

At the end of the pressure decay test, with the system still pressurized, complete the following checks:

(a) For systems with manifolded underground vapor piping between tanks, depress the Phase I vapor drybreak valve of each tank to see if gases are released under pressure. If gases are not released under pressure, then the system is not manifolded as required by the applicable Authority to Construct and ARB Executive Order. At facilities with four underground tanks, the forth tank may have a liquid manifold but no vapor manifold. When the system is pressurized, the fourth tank may also be pressurized due to hydrolytic effects. When the dry break is depressed the release of gases slows and the system pressure levels off until gases are no longer venting from the forth tank. However, the other three tanks in the system remain under pressure. In either case, where there are no gases released or where the flow of gases stop without all the tanks going to zero pressure, the underground piping does not represent an ARB certified system. Therefore, the system fails the test.

(b) For non-manifolded underground vapor piping to tanks, depress the vapor drybreak valve of each tank to see if the product in the storage tank matches the product dispensed by the nozzles where checks were made of the back pressure shutoff mechanisms. (This is a check to see if the underground vapor piping is crossed and goes to the wrong storage tanks. If crossed piping is indicated, verify by sending five gallons of liquid down the Phase II piping while a second person listens for splashing at the tank with the drybreak open. See Test Procedure TP-91-2-Liquid Blockage Test.) If the system doesn't pass this test, it is not a certified system and the facility is in violation of State Law and District Rule 61.8.

5.2 <u>SYSTEM SPECIFIC DETERMINATIONS OF COMPLIANCE</u>

Go directly to the specific system under evaluation and determine compliance.

5.2.1 <u>Vacuum Assist System Without Processors</u>

(a) **Allowable Pressure Decay Due to Leaks:** After thermal stablization is achieved, the system passes if the decay rate does not exceeded the limits, rounded off to 0.1 inch of water, as shown in Figure 2 for the five-minute test for ullages up to 10,000 gallons, or in Figure 3 for the ten-minute test for ullages between 10,000 and 20,000 gallons, or Figure 4 for the fifteen-minute test for ullages of 20,000 to 30,000 gallons. Or, as an option, the equations shown in Figures 2, 3, or 4 may be used, depending on the ullage, where the allowable rate is rounded off to 0.1 inch of water.

(b) **Phase II Leak Check Where The Vacuum Pumps Are In the Dispensers:** While the system is under pressure during the static pressure test, use soap solution on all hose breakaways and dispenser vapor piping connections to detect leaks. **No leaks are allowed from the nozzle check valve back to the vacuum pump.** Minute leaks will prevent the temporary increase in vacuum needed to clear the vapor return hose of ingested liquid. **This leak check does not have to be repeated if it was conducted and documented during leak repairs within one week of the application of this static pressure test, provided the leak check was conducted at pressures of ten inches wcg or greater.**

5.2.2 **Balance Systems**

(a) **Allowable Pressure Decay Due to Leaks:** After thermal stablization is achieved, the system passes if the decay rate does not exceeded the limits, rounded off to 0.1 inch of water, as shown in Table 1 or Figure 2 for the five-minute test for ullages between 10,000 gallons, or in Figure 3 for the ten-minute test for ullages between 10,000 and 20,000 gallons, or Figure 4 for the fifteen-minute test for ullages of 20,000 to 30,000 gallons. Or, as an option, the equations shown in Figures 2, 3, or 4 may be used, depending on the ullage, where the allowable rate is rounded off to 0.1 inch of water.

(b) **Nozzle Shutoff Check:** While the system is still pressurized, check the integrity of the automatic back-pressure shutoff device, on each balance system nozzle connected to the vapor recovery system, by pulling on the nozzle's trigger. The shutoff device is acceptable if there is no resistance when the nozzle's trigger is pulled. Nozzles with defective back-pressure shutoff devices shall be replaced.

5.2.3 **Systems With Above Ground Tanks, Systems With Vapor Processors Dependent On Tank Pressures or Vacuums, And Research Efforts.**

Since static pressure tests are not reliable indicators of system leakage and the systems in this category must be gas-tight, additional means of detection are required to ensure compliance. Furthermore, a viable mass emission estimate or system efficiency is impossible to determine if detectable unquantifiable emissions are occurring. Therefore, the requirements, in addition to those of Subsection 5.1, are as follows:

(a) **Leak Checks:** While the system is under pressure, check every exposed pipe joint, connection, fitting, drybreak, fill riser, hose breakaway, dispenser fittings, emergency p/v valve, and all other possible leak sources using soap solution or helium detection or sonic detection. An explosimeter may be used where nitrogen does not entirely displace the gasoline vapors. Use soap solution and/or an explosimeter at locations where vapor return pipes emerge from underground. (Leakage form underground pipe connections will often follow the outside of the pipe to the surface because it is usually the path of least resistance.) Identify all detectable leakage for repairs or replacements.

(b) **Static Pressure:** Pressure decay is only permissible for thermal effects caused when cold nitrogen enters the system. Once thermal effects from the nitrogen have ended, usually within ten minutes, the system pressure must remain constant to within 0.1 inch wcg or increase within a fifteen minute period.

5.3 PRESSURE RELEASE

Release system pressure by carefully removing the vent cap assembly(ies). Allow any remaining pressure to be relieved through the vent pipe outlet(s). Release of gasoline vapor at ground level without special precautions, such as at vapor drybreaks, is considered hazardous and is **not** recommended.

WARNING

If , for purposes of some other test procedure, there is a vent volume meter mounted on the vent pipe outlet, do **not** suddenly release tank pressure to blowdown through the meter. This could cause overspeeding of the mechanism and could blow vent pipeline debris into the meter, damaging it.

5.4 RETESTING

If the system tested fails to meet the criteria for passage set forth in Section 5.0, repressurize the system and check all accessible vapor connections using leak detection solution. If vapor leaks in the system are encountered, repair or replace defective component(s) and repeat the static pressure test. **(Note: Applicants and contractors are advised to do a pre-test before the District witnesses compliance tests. Repairs that keep the District inspector waiting or that result in scheduling a retest may result in substantial reinspection fees.)**

6.0 REPORTING REQUIREMENTS

For those sites having Authorities to Construct requiring this or any other District tests, documentation of the testing and test results must be submitted to the District before a Permit to Operate will be issued. It is the ultimate responsibility of the applicant to make sure that the necessary documentation is submitted to the District. However, the District will accept test documentation directly from the contractor performing the tests. When a District observer is present and NCR forms are used, the observer will take the original of the form with him/her back to the office.

End of Procedure

TABLE 1 – ALLOWABLE DECAY RATES

ULLAGE (GALLONS)	Five Min Press Drop (IN. H20)	Ten Min Press. Drop (IN. H20)	Fifteen Min Press. Drop (IN. H20)
400	2.5	5.0	7.5
800	1.3	2.5	3.8
1200	0.8	1.7	2.5
1600	0.6	1.3	1.9
2000	0.5	1.0	1.5
2400	0.4	0.8	1.3
2800	0.4	0.7	1.1
3200	0.3	0.6	0.9
3600	0.3	0.6	0.8
4000	0.3	0.5	0.8
4400	0.2	0.5	0.7
4800	0.2	0.4	0.6
5200	0.2	0.4	0.6
5600	0.2	0.4	0.5
6000	0.2	0.3	0.5
6400	0.2	0.3	0.5
6800	0.1	0.3	0.4
7200	0.1	0.3	0.4
7600	0.1	0.3	0.4
8000	0.1	0.3	0.4
8400	0.1	0.2	0.4
8800	0.1	0.2	0.3
9200	0.1	0.2	0.3
9600	0.1	0.2	0.3
10000	0.1	0.2	0.3
10400		0.2	0.3
10800		0.2	0.3
11200		0.2	0.3
11600		0.2	0.3
12000		0.2	0.3
12400		0.2	0.2
12800		0.2	0.2
13200		0.2	0.2
13600		0.1	0.2
14000		0.1	0.2
14400		0.1	0.2
14800		0.1	0.2
15200		0.1	0.2
15600		0.1	0.2
16000		0.1	0.2

TABLE 1 CONTINUED

ULLAGE (GALLONS)	Five Min Press. Drop (IN. H20)	Ten Min Press. Drop (IN. H20)	Fifteen Min Press. Drop (IN. H20)
16400		0.1	0.2
16800		0.1	0.2
17200		0.1	0.2
17600		0.1	0.2
18000		0.1	0.2
18400		0.1	0.2
18800		0.1	0.2
19200		0.1	0.2
19600		0.1	0.2
20000		0.1	0.2
20400			0.1
20800			0.1
21200			0.1
21600			0.1
22000			0.1
22400			0.1
22800			0.1
23200			0.1
23600			0.1
24000			0.1
24400			0.1
24800			0.1
25200			0.1
25600			0.1
26000			0.1
26400			0.1
26800			0.1
27200			0.1
27600			0.1
28000			0.1
28400			0.1
28800			0.1
29200			0.1
29600			0.1
30000			0.1

FIGURE 1
PRESSURE DROP VS. TANK ULLAGE (5 MINUTE TEST)

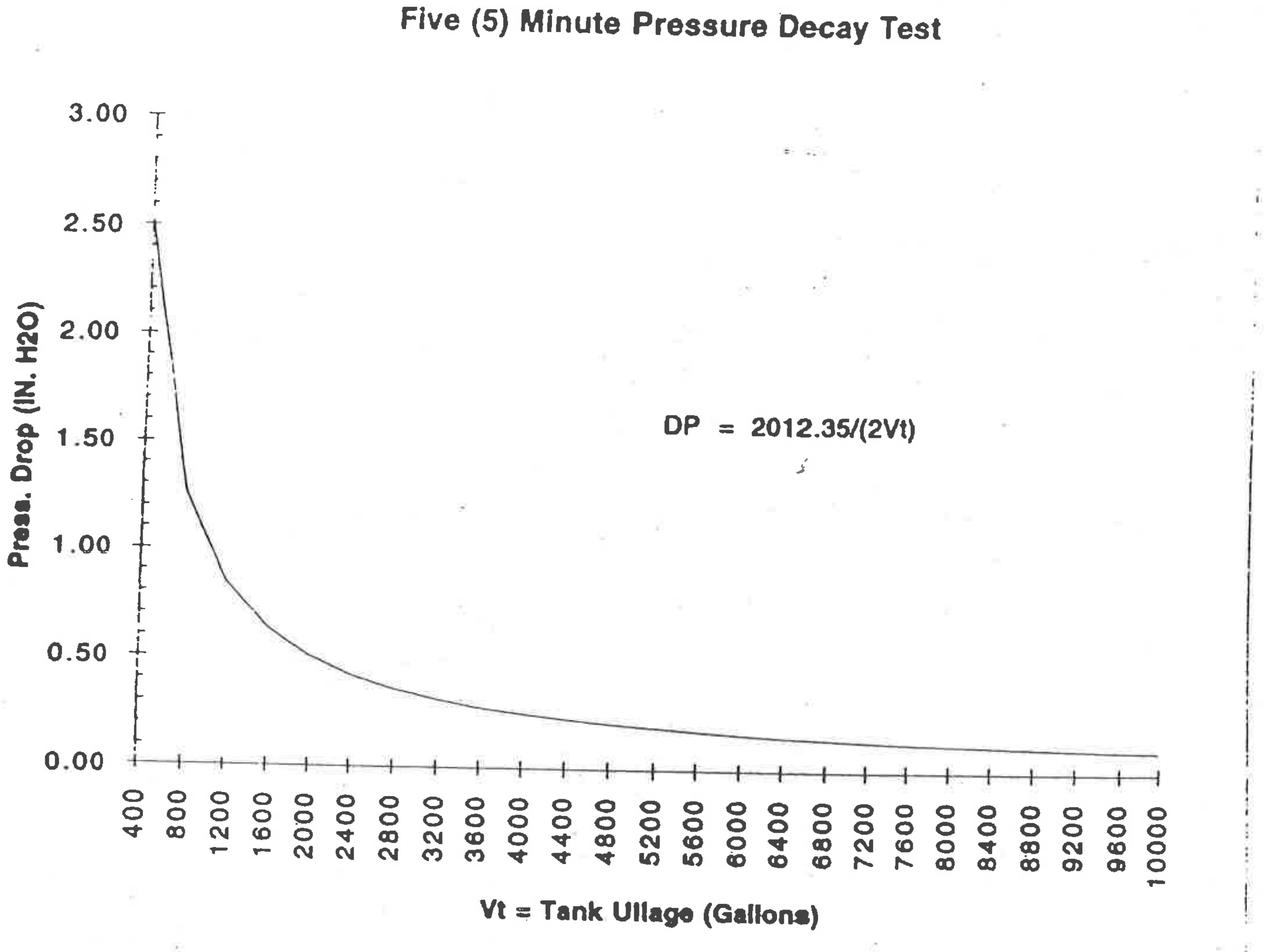

FIGURE 2
PRESSURE DROP VS. TANK ULLAGE (10 MINUTE TEST)

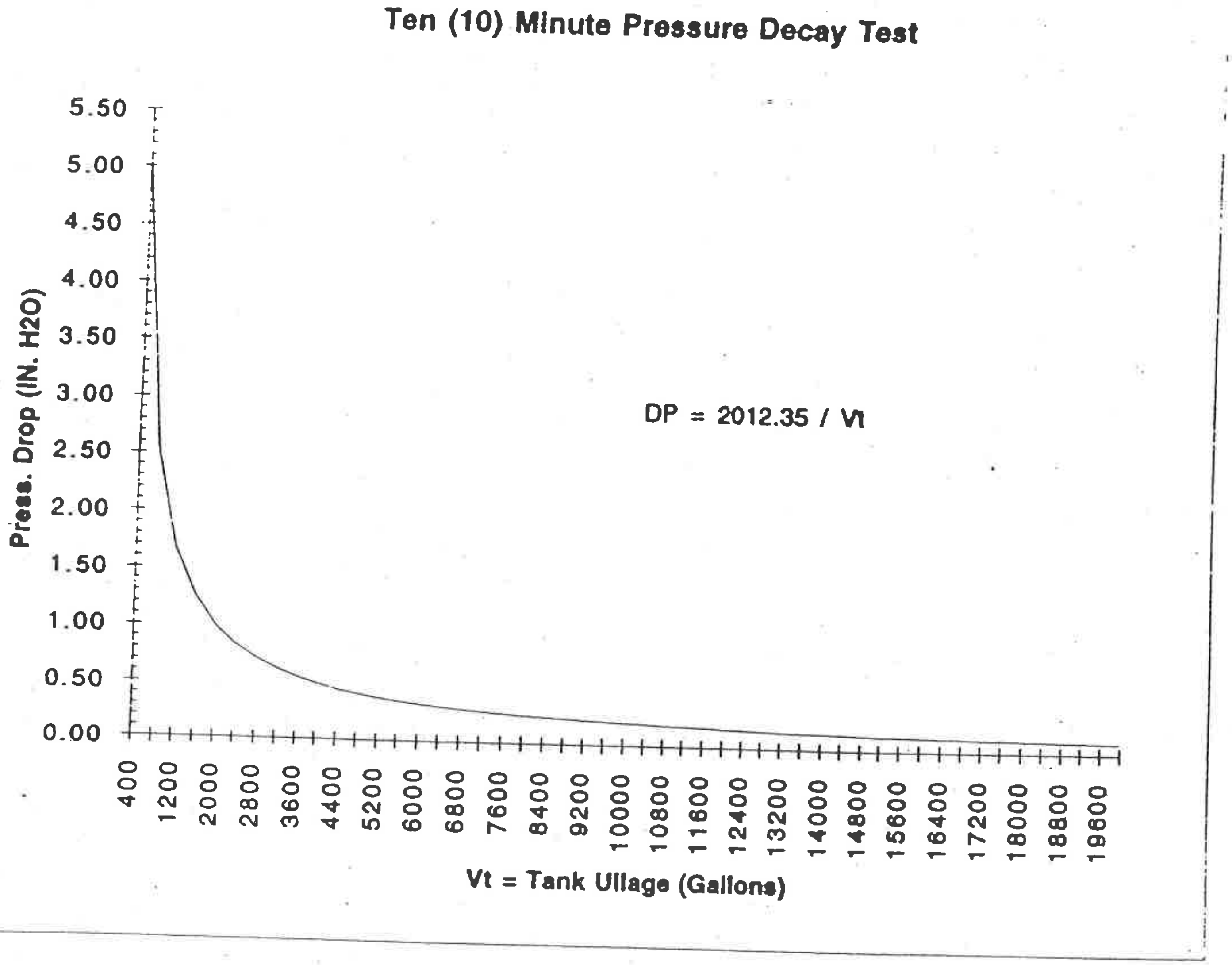

FIGURE 3
PRESSURE DROP VS. TANK ULLAGE (15 MINUTE TEST)