

# Chapter 5: Stage I and Stage II Vapor Recovery Systems

## Section 5.1: Stage I Vapor Recovery



### 5.1.1 Overview – Stage I

Stage I Vapor Recovery refers to the control of vapors during the transfer of gasoline from the cargo tank to the gasoline dispensing facility. Stage I Vapor Recovery systems control emissions during delivery and storage of gasoline at the gasoline dispensing facility.

During gasoline delivery, emissions are controlled by diverting the displaced gasoline vapor from the storage tank into the tanker compartment of the vehicle unloading gasoline. The captured vapor is then transported back to the terminal for processing by condensation, adsorption or incineration.

Vapor recovery is a control strategy developed to collect vapors generated during the transfer of gasoline in the marketing and distribution process. Vapors are created due to the high volatility of gasoline at atmospheric conditions; there is a strong tendency for gasoline to evaporate. When liquid evaporates in a closed system, molecules in the vapor state have a tendency to strike and condense on the surface of the liquid. At a point when the rates of evaporation and condensation are equal, a state of equilibrium is achieved. When a system is in equilibrium, the concentration of vapor is highest near the surface of the liquid and decreases with the height above the surface. The pressure exerted by vapor in equilibrium with its liquid is referred to as vapor pressure.

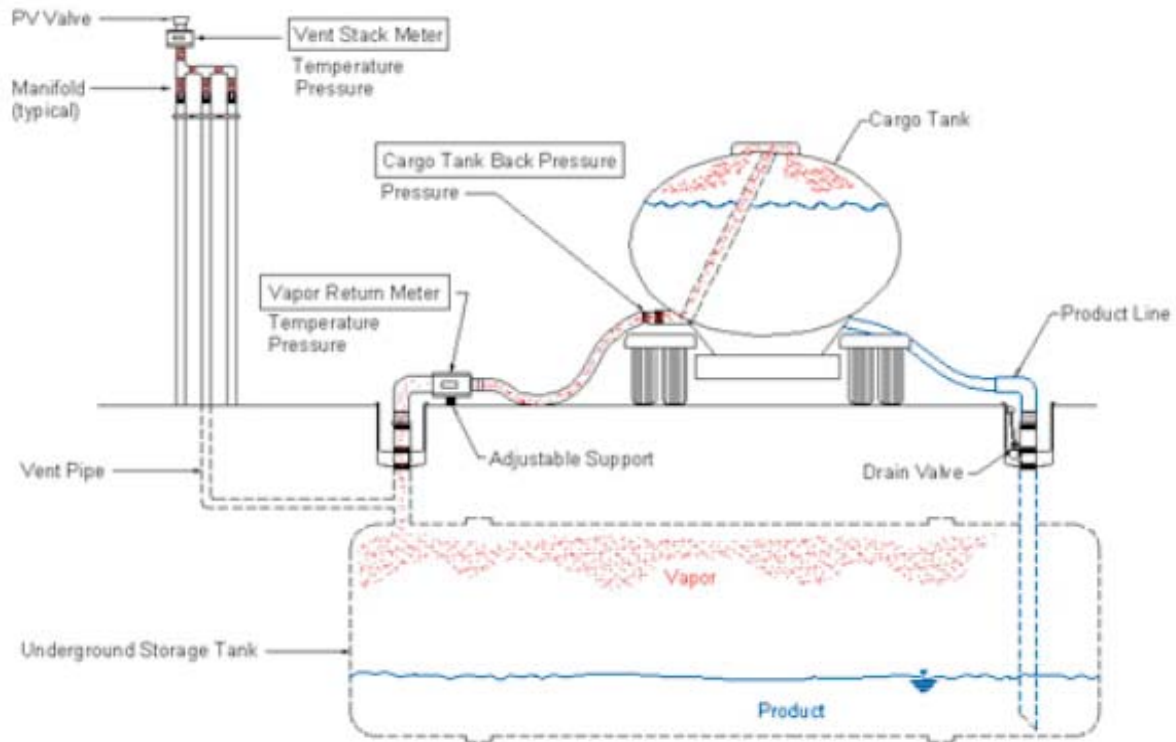
Types of systems used for vapor recovery at gasoline dispensing facilities are:

- **Dual-, or two-point system** – the filling and vapor recovery provisions on the storage tank consist of two attachment points (one for liquid delivery and one for vapor return to the truck). This is the most common type of system.
- **Coaxial, or single-point system** – the filling and vapor recovery provisions consist of a single attachment point.

Both systems must provide a liquid and vapor tight seal during delivery and at all other times.

Stage I Vapor Recovery requires that vapors be collected in the cargo tank as product is delivered into the UST or above-ground storage tank (AST). Most gasoline dispensing facilities have more than one storage tank to store the different grades of gasoline that are sold. Each storage tank has fittings for gasoline delivery and vapor recovery.

The illustration below shows the flow of gasoline and vapors in a typical dual or two-point Stage I Vapor Recovery system:

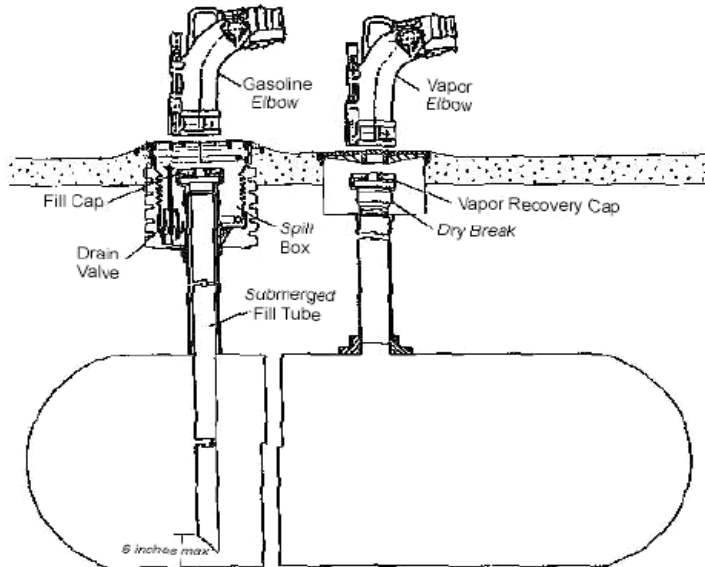


Stage I Gasoline Vapor Recovery using Dual (Two-point) System



Pictured to the left, the more commonly found dual or two-point system has separate points for product delivery and vapor recovery. A product delivery elbow and vapor recovery elbow are attached to each point during a drop. As a BMP, it is standard industry practice to paint the vapor lid orange to make it easy for delivery personnel to identify.

As shown on the previous page, the Stage I dual vapor recovery system consists of two separate spill containment boxes: one for gasoline delivery and the other for vapor collection. Product is delivered using one elbow, and vapor recovered through another elbow. A cross section of a dual system is shown in the illustration below:

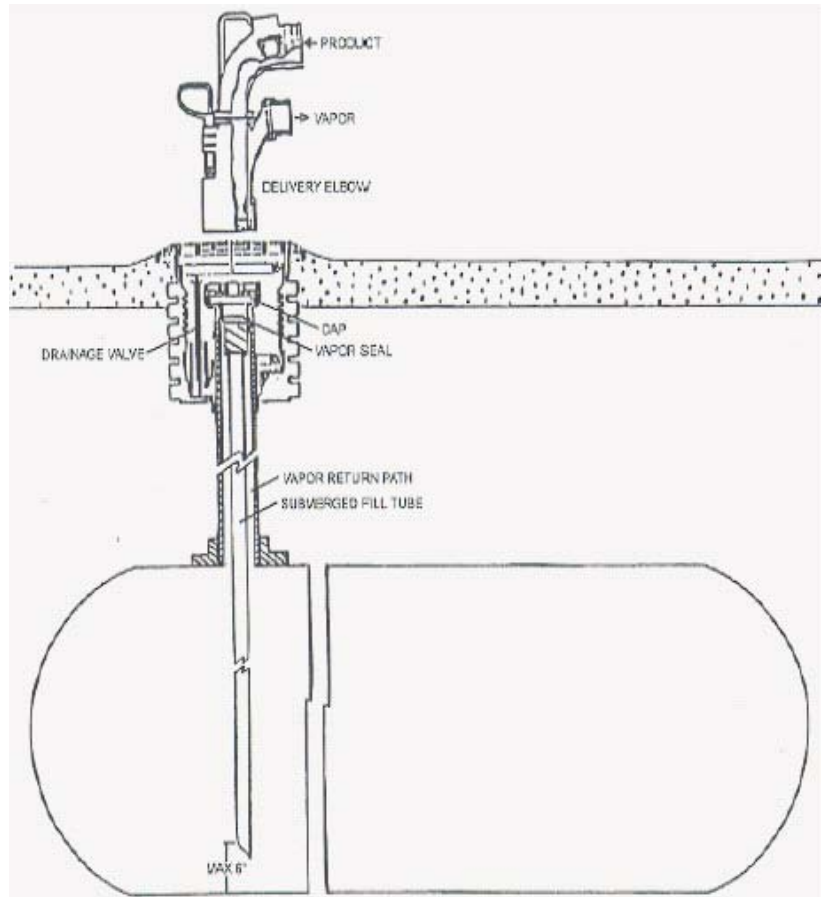


Stage I Dual (Two-point) Vapor Recovery System

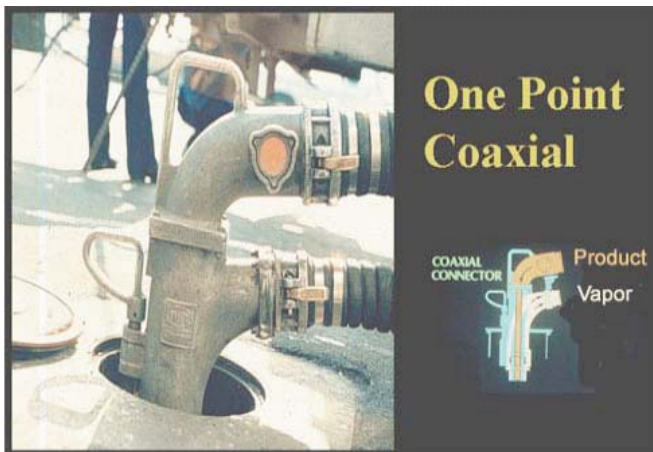
In the dual system, gasoline is delivered to the facility's stationary storage tank, and displaced gasoline vapor is recovered through two separate riser pipes on the tank.

Gasoline is delivered through a submerged drop tube, while the vapor is forced up a riser pipe from the vapor space (i.e., ullage, or free space above liquid product in the gasoline storage tank). The dual system for underground tanks is enclosed in a manhole that is raised slightly above the surrounding pavement, to minimize the infiltration of surface water. Each riser pipe is encased in a spill container (i.e., spill bucket), and fitted with an adaptor and dust cap. Many of the gasoline spill buckets contain a valve through which accumulated gasoline can be drained back into the storage tank manually.

A Stage I coaxial (or single-point) system, which may be found at older gasoline dispensing facilities, uses a single containment box for the delivery of gasoline and for the recovery of vapors. Product is delivered and vapor recovered using the same elbow. A cross section of a coaxial system is shown in the illustration on the following page.



Typical Stage I Coaxial Vapor Recovery System



The picture to the left shows a coaxial or single-point system. Concentric tubing from the UST allows for recovery of vapors via one pipe as product is delivered via the other. Product is delivered and vapor recovered using the same elbow.

## 5.1.2 Vermont Regulations

Stage I Vapor Recovery is addressed in the Vermont Air Pollution Control Regulations (APCR), Section 5-253.5. The entire regulation can be found on the DEC website at <http://www.anr.state.vt.us/air/>. This workbook will discuss the requirements to be met in the regulation.

## 5.1.3 Applicability



The Stage I Vapor Recovery requirements apply to all gasoline dispensing facilities except the following:

- Stationary gasoline storage vessels of less than 550 gallons in capacity used exclusively for the fueling of farming equipment, provided that the containers are equipped with submerged fill pipes.
- Any gasoline dispensing facility that is solely serviced by account trucks. An account truck is a delivery truck with a capacity of less than 4,000 gallons that delivers gasoline to businesses, retail outlets, and farms.



**Even if your facility is exempt from Stage I Vapor Recovery requirements, you still must receive all deliveries by submerged fill.**



Any facility exempt from the Stage I Vapor Recovery requirements is also exempt from the Stage II Vapor Recovery requirements discussed in section 5.2.

### 5.1.3.1 Control Systems



No person may transfer or allow the transfer of gasoline from a delivery truck into any storage tank unless the storage tank is equipped with a submerged fill pipe. At all facilities subject to the Stage I regulation, the vapors displaced from the storage tank during filling must be captured by a vapor control system. The vapor control system must include:

- A vapor tight line from the storage vessel to the delivery vessel
- Equipment that will ensure that vapors will be transferred from the storage vessel to the delivery vessel, including pressure/vacuum (P/V) valves on the vent line of any gasoline storage tank. For facilities with vacuum assist Stage II Vapor Recovery systems, the required settings of the P/V valve are 3, plus or minus 0.5 inches of water column pressure and 8, plus or minus 2 inches of water column pressure, unless otherwise specified in the applicable California Air Resources Board (CARB) certification. CARB tests and certifies vapor recovery equipment. DEC uses CARB's determinations to evaluate vapor recovery equipment.

### 5.1.3.2 Gasoline Storage Vessel (Tank) Requirements and Gasoline Tank Truck (Cargo Tank) Requirements



The Gasoline Tank Truck is subject to the conditions outlined below:

1. The gasoline tank truck must be tested and certified to be vapor tight at all times.
2. Documentation that the tank truck is vapor tight shall be carried in the tank truck and shall include results of the pressure and vacuum tests.
3. The gasoline tank truck must display a sticker that shows the date that the gasoline tank truck last passed the pressure and vacuum tests.



Each owner of a gasoline storage tank and gasoline tank truck shall:

1. Purchase and install all necessary control systems and make all necessary process modifications to comply with vapor control system and delivery cargo tank requirements described above.
2. Repair, replace, or modify any worn out or malfunctioning component or element.

### 5.1.3.3 Operators of Gasoline Dispensing Facilities



Owners or operators of gasoline dispensing facilities required to install Stage I vapor recovery systems must conduct Visual Inspections of the Stage I system components and repair or replace worn or ineffective components to ensure the vapor tight integrity of the system.

### 5.1.3.4 Records



The owner/operator shall keep written monthly records of the quantity of gasoline delivered to the facility.



The records outlined above shall be maintained for a period of three (3) years, and should be accessible for review by a DEC inspector.

### 5.1.4 Stage I Inspection Information

Inspections of Stage I Vapor Recovery systems must be conducted, as required by Stage I Vapor Recovery regulations described in APCR Section 5.235.5(d). The vapor recovery system information that follows is provided to assist owners and operators with properly identifying components of their systems, and completing the required weekly visual checks. The following items should be checked as part of the inspection:

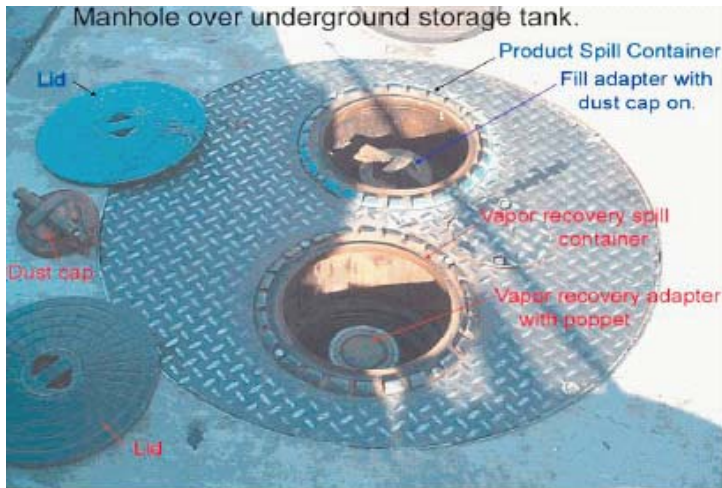
- ✓ **Fill/Dry Break Caps** – check to ensure caps are fully intact and operational, sealing properly, and have no cracks or damage.
- ✓ **All Gaskets** – check to ensure that all gaskets in caps are intact and have no cracks.
- ✓ **Dry Breaks (vapor recovery adaptors)** – check to ensure that dry breaks are intact and providing a tight, uniform seal, and that rubber gaskets are sealing properly and not damaged.
- ✓ **Fill Adaptors and Dry Breaks** – check to ensure that all adaptors are tightly threaded onto riser pipes.
- ✓ **Spill Bucket Drain Valves** – check to ensure a tight seal, with no apparent vapor emissions.
- ✓ **Drop Tubes** – check to ensure that they are installed in all gasoline tanks.



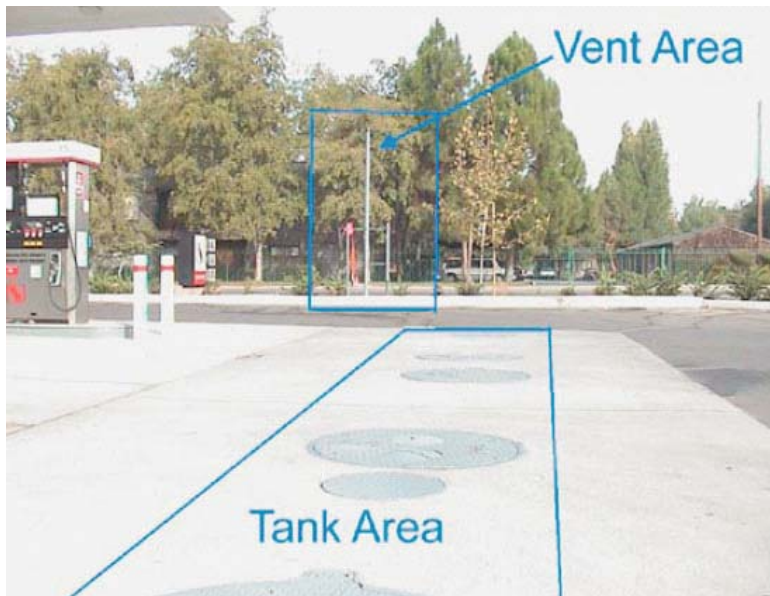
The Stage I Vapor Recovery System typically consists of the following components:

- **Spill Containment Box** – containment manhole, sometimes equipped with a drain valve, installed around the storage tank product riser pipe.
- **Riser** – 3- or 4-inch diameter pipe mounted to the top of the UST, with each riser fitted with an adaptor and dust cap.
- **Pressure/Vacuum (PV) Relief Valves** – dual purpose valves that automatically prevent excessive positive or negative pressure in the tank or pipe to which they are connected. P/V valves close so that the vent pipe is not constantly open to the atmosphere, which helps reduce emissions of gasoline vapor from vent pipes when the tanks are under relatively low positive pressure. As noted above, for facilities with vacuum assist Stage II Vapor Recovery systems, the required settings of the P/V valve are 3, plus or minus 0.5 inches of water column pressure and 8, plus or minus 2 inches of water column pressure, unless otherwise specified in the applicable CARB certification.
- **Overfill Protection Device** – a device added to a storage tank, to prevent overfilling and spillage during a fuel drop by a cargo tank.
- **Fill Adaptor (Coupler)** – a fitting on each riser pipe inside a spill container that allows a leak-proof seal with the delivery elbow of the cargo tank.
- **Drop Tube** – fill pipe through which product is delivered into a storage tank from a tank truck.

- **Dust Cap** – a cover with a gasket that seals the top of either a fill adaptor or a Stage I drybreak/poppet.
- **Drain Valves** – valves located at the bottom of a spill container to drain accumulated liquid into the UST.
- **Dry Break (Poppet or Vapor Adaptor)** – a spring-loaded valve that prevents vapor from escaping through the vapor recovery riser pipe opening of a storage tank.



The image to the left shows the location of some Stage I Vapor Recovery system components

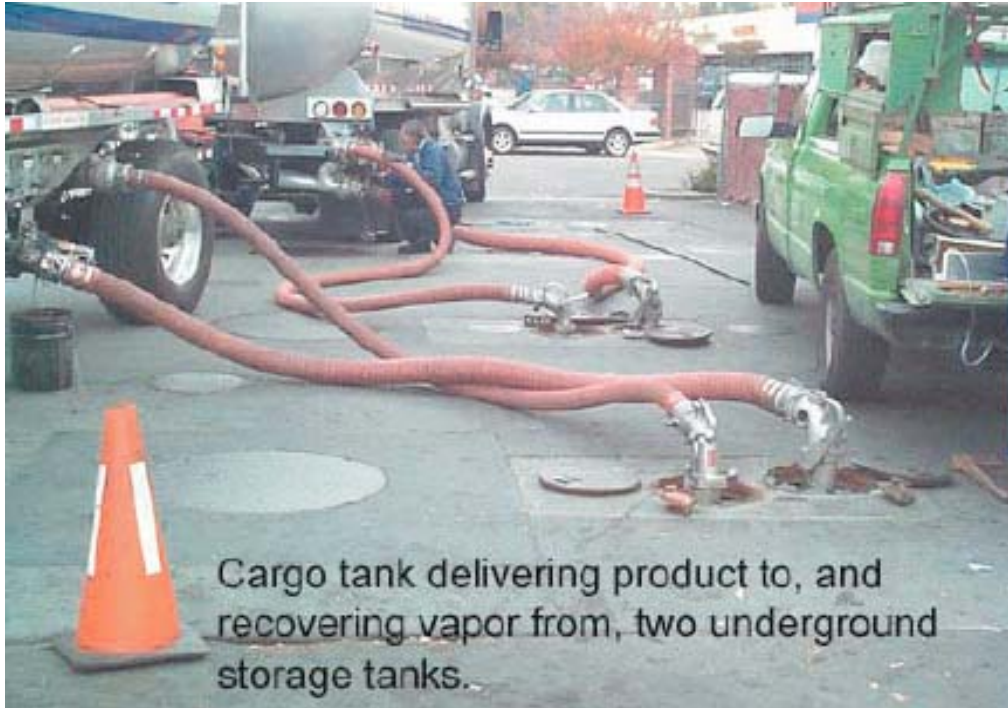


The components of Stage I Vapor Recovery Systems are found in two locations at gasoline dispensing facilities, the **tank area** and the **vent area**, as shown to the left.

## The Tank Area

The tank area has manholes with access to each UST. This allows gasoline product to be delivered from the tank truck through one pipe and displaced vapor to be collected in the tank truck by means of the other.

The illustration below shows a typical tank area of a gasoline dispensing facility, with a tank truck delivering gasoline product to, and recovering vapor from, two USTs.

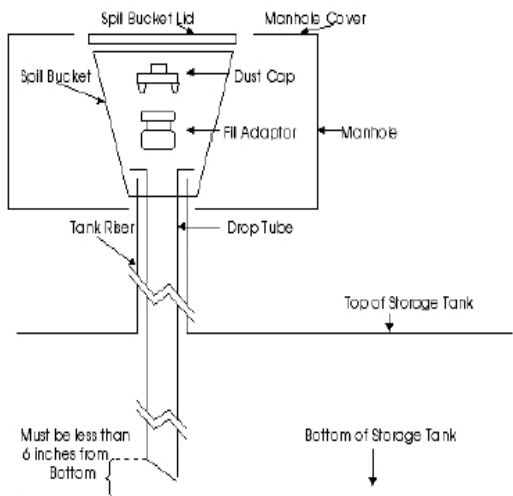


The illustration on the next page shows both product delivery and vapor recovery sides of a tank, with some of the components labeled. In the dual (two point) system, as shown in the illustration, the manholes above the underground storage tank contain two tank risers. One riser is for delivering product from the tank truck to the underground tank. The other riser, which includes the vapor recovery adaptor (drybreak), is for delivering displaced vapor from the UST back to the tank truck.



**Stage I Product Delivery**

DIAGRAM OF PRODUCT DELIVERY PIPING INTO THE UNDERGROUND STORAGE TANK AT A GDF



The schematic to the left shows the product delivery piping. Product is delivered to the UST from the cargo tank via a submerged pipe called a drop tube. The drop tube is guided into the UST by the tank riser pipe.

## The Vent Area

Storage tanks have vent pipes equipped with P/V relief valves. P/V valves are designed to open at specified positive and negative pressures, so that the tank is protected from physical damage or permanent deformation caused by routine increases in internal pressure or vacuum. Additionally, the P/V valve setting on the tank vent is such that it acts as a flow control device that preferentially allows displaced vapors to pass to the tank truck compartment during a drop.

Tanks need to breathe because of volume fluctuations due to temperature changes, barometric pressure changes, and variations in the vapor/liquid ratio during refueling. When the internal pressure exceeds the valve design setting, the valve opens to vent the excess pressure to the atmosphere. When the vacuum exceeds the design setting, the valve opens to allow air to flow into the tank and relieve the excess vacuum condition.

The vent area contains one to three product vent lines, usually one vent for each UST. Each vent line must be capped with a P/V valve, as shown in the illustration below on the right, or manifolded with the other lines, as shown in the illustration on the left.



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Thanks to California Air Resources Board, Stationary Source Division, Compliance Assistance Program Vapor Recovery Interactive CD, August 2002; CARB Interactive CD w/ Stage I & II.