Tank-nically Speaking

by Marcel Moreau

Marcel Moreau is a nationally recognized petroleum storage specialist whose column, ***Tank-nically Speaking****, is a regular feature of* LUSTLine**.** *As always, we welcome your comments and questions. If there are technical issues that you would like to have Marcel discuss, let him know at* **marcel.moreau@juno.com.**

Stage I Vapor Recovery Is Coming to a Station Near You!

(Uh oh, Those Air-Quality Folks Are at It Again)

I dearly love breathing air, especially clean air. And I know full well that both air and water are requisite to life as we know it. But we humans can't seem to make that connection at the regulatory level, and history has shown us that the interplay of air quality and water quality regulatory efforts has had some prickly moments. MtBE was our first painful lesson that what might be good for air quality might not be at all good for groundwater quality. Even the current rush to add more and more ethanol to our motor fuels began as an air-quality oxygenate option, yet the use of ethanol fuel blends continues to raise seemingly endless storage-system compatibility and functionality issues (e.g., see "The Transient Behavior of Water in Ethanol-Blended Fuels…" page 6). Meanwhile, with little fanfare, the Air Quality folks at USEPA put into law some new Stage I vapor-recovery requirements in January 2008.

The New Stage 1 Rule

The goal of Stage I vapor recovery is to capture gasoline vapors escaping from storage tanks during the fuel-delivery process (See "A Primer for the Next Generation of Tank People," *LUSTLine* #61). The methodology is fairly simple in that the vapors from both the storage tank and the fuel in the delivery tanker simply exchange places. All that is needed is a vapor-transfer hose between the truck and the storage tank, together with appropriate connections to the storage tank and the truck.

The new rule applies to fuel transfers at gasoline-dispensing facilities (GDF) and bulk plants. Unlike previous rules governing gasoline-vapor emissions, these rules are not limited geographically to regions with poor air quality. The rule comes under the National Emission Standards for Hazardous Air Pollutants (NESHAP) program and is designed to reduce human exposure to toxic gasoline constituents. It imposes vapor-control requirements at GDF and bulk plants nationwide. This article only discusses requirements for GDF. USEPA estimates there will be 14,000 facilities needing work, with a capital cost of about $75 million dollars.

The rule has three tiers of requirements depending on facility throughput. Throughput is calculated by adding the amount of all gasoline products dispensed at a GDF over a 30-day period. Based on monthly throughput, the rule requirements are as follows:

- **Less than 10K** - good housekeeping measures such as not spilling gasoline or storing it in uncovered containers.
- **10K or over** - good housekeeping plus a drop tube in the fill pipe.
- **100K or over** - good housekeeping, plus a drop tube, plus Stage I vapor recovery.

Facilities installed or substantially upgraded after November 9, 2006, should be meeting the applicable NESHAP requirements now. Facilities already in existence prior to November 9, 2006, have until January 10, 2011, to meet the applicable NESHAP requirements. Newly constructed or substantially remodeled facilities must use two-point vapor recovery. (See Figure 1.) Facilities in operation prior to November 9, 2006, may retrofit Stage I vapor recovery using a coaxial drop tube.

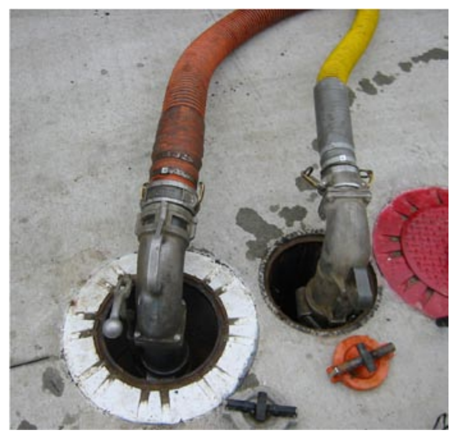

Figure 1. *Two-point Stage I vapor recovery requires two separate openings into the tank. In this photo, the hose on the left is for product, the one on the right is for vapors.*

The NESHAP regulations have some very specific requirements for the Stage I hardware that must be installed, including:

- Pressure/vacuum vent caps
- Fill and vapor adaptors that cannot be loosened or overtightened during normal operation
- Tightly sealed fill caps
- A sealed vapor path, whether two point or coaxial, such that vapors

do not escape when the cap is removed.

The NESHAP rules also specify that the storage system pass a pressure-decay test and that pressure/vacuum vent valves be tested for proper operation every three years. The test procedures specified are based on those developed by the California Air Resources Board. One of the requirements of the pressure-decay test is that the fill and vapor caps be removed while the test is conducted. As we'll see below, this requirement has interesting ramifications for some of the equipment and procedures that UST regulators are familiar with.

Stage 1 Vapor Recovery and UST Systems

So how will these measures interact with existing equipment and the day-to-day operation of our UST systems? Let's have a look:

■ Drop Tubes

Drop tubes are typically long aluminum tubes that slide down inside the fill pipe and extend to within six inches of the tank bottom. With an installed drop tube, fuel enters the tank below the existing liquid level, thus eliminating the splashing that would occur if the fuel were to fall from the top of the tank down to the surface of the liquid. Eliminating the splashing reduces the amount of vapors that are generated. As a side benefit, drop tubes also increase the speed at which the fuel flows, thus shortening the delivery time. Drop tubes have been in widespread use for many years and do not generally cause any problems in and of themselves. The plot thickens, though, when other vapor-control components, such as pressure/vacuum vent valves, are added.

■ Pressure/Vacuum (P/V) Vent Valves

Traditional vent caps are installed on the top of the vent pipe to both keep precipitation out and direct the vapors that are discharged during a delivery upward. Traditional vent caps allow air and vapors to flow freely in or out of the tank. P/V vent valves do not allow air and vapors to flow freely in or out of the tank. P/V vent valves are designed to seal the opening of the vent pipe and only allow air to flow in if there is a slight vacuum (between 6.0 to 10.0 inches of water column) in the tank, or vapors to flow out if there is a slight pressure (between 2.5 and 6.0 inches of water column) in the tank. An inch of water column is the pressure required to support a column of water one inch square and one inch high, so the pressures we are talking about here are quite small.

The NESHAP regulations have some very specific requirements for Stage I vapor recovery. Some of these requirements have interesting ramifications for USTs.

Like drop tubes, P/V vent valves have also been in widespread use for many years. A storage tank equipped for Stage I vapor recovery with a properly functioning P/V valve will often have a slight pressure inside the tank. This could be due to a number of factors, including heating of the tank ullage during the day, fresh air coming into the tank during dispensing and expanding as it becomes saturated with fuel vapors, or simply the vapor pressure of the fuel itself.

There is no danger that this increase in pressure will rupture the tank, but it causes some interesting effects in the fuel inside the drop tube. Because the drop tube extends well below the liquid level, the air space inside the drop tube is isolated from the air space inside the body of the tank. The slight pressure inside the tank created by the P/V valve pushes down on the surface of the liquid in the tank, causing an upward pressure on the fuel inside the drop tube. If the fill cap is airtight (as it is supposed to be), this creates a slightly pressurized air pocket inside the drop tube. When the fill cap is removed, this pressure is suddenly removed, creating a pressure imbalance.

In this situation the pressure in the drop tube is equal to atmospheric pressure, and the pressure inside the main body of the tank is slightly above atmospheric. Because of the very great difference in the surface area of the fuel in the tank versus the fuel in the drop tube, the fuel in the drop tube is pushed upward, perhaps by as much as several feet.

The momentum of the fuel moving up the drop tube causes it to rise a bit higher than the equilibrium point at which the weight of the column of fuel in the drop tube equals the pressure inside the tank, so the fuel falls back down the drop tube. Because the air in the tank is compressible, the falling product in the drop tube recompresses the air in the tank. The net effect is that the product level in the drop tube oscillates on a scale of several feet when the fill cap is first removed, with the oscillations decreasing gradually so that the liquid level becomes stable after perhaps 15 to 30 seconds.

So here's the rub. If the fill cap was removed in order to take an inventory measurement and the person making the measurement is not paying attention, the inventory measurement can be dramatically off because of the oscillating fluid level in the fill pipe. Even if the oscillations have stopped, the fluid level in the drop tube will be different from the fluid level in the tank, affecting the accuracy of the inventory measurements made with a stick.

The easy answer to this problem is to drill a small hole through the drop tube near the top of the tank so that the pressure inside the tank and inside the drop tube can equalize. But remember that the fill cap must be off when the pressure-decay test to evaluate the vapor tightness of the tank is conducted every three years. This hole will cause the tank to fail the pressure-decay test, so it is not allowed.

I expect that in most cases, facilities that will need to install a P/V valve will be making inventory measurements with a tank gauge, so this will not be a major issue because the effect of the liquid level in the main body of the tank is very small. But for folks who occasionally check the tank gauge accuracy by making a stick measurement, this oscillation of fuel in the drop tube could cause some consternation.

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■ **Fill and Vapor Adaptors That Cannot be Loosened or Overtightened**

When delivery drivers attach their delivery elbows to the tank-fill adaptors, and then attach a 10- to 20-foot-long hose to the delivery elbow, they have essentially created a giant wrench that is clamped on to the fill adaptor. In the process of adjusting this hose to make the connection to the truck, the driver often moves the hose to one side or the other. Depending on the direction of the movement, the fill adaptor that is screwed onto the top of the fill pipe is tightened or loosened. The same scenario is true for the vapor adaptor.

Next time you find a spill bucket with a significant quantity of fresh fuel in it, check the tightness of the fill adaptor. You may well find that the adaptor is loose. Loose adaptors that are not properly screwed onto the top of the fill pipe can leak product into the spill bucket during a delivery. Both fill and vapor adaptors that are loose or have been overtightened so that they do not seal properly can leak vapors as well.

Swivel adaptors were developed to solve this problem. The top part of a swivel adaptor is designed to rotate independently of the bottom part that is screwed onto the riser. No matter how much the driver moves the hose around, the adaptor remains liquid and vapor tight.

I don't see any downsides to swivel adaptors at the moment, other than that they cost more than a traditional adaptor, and the seals that make the joint between the top and bottom of the adaptor liquid and vapor tight wear out, so that the swivel adaptor will need to be replaced.

A special tool is required to install and remove swivel adaptors, so that drivers will no longer be able to use their hoses and elbows as wrenches to unscrew a vapor adaptor and punch out the ball of the ball-float valve that is often directly below. This will make it more difficult to destroy ball-float valves, but there are plenty of other ways that drivers have figured out to get around ball-float valves.

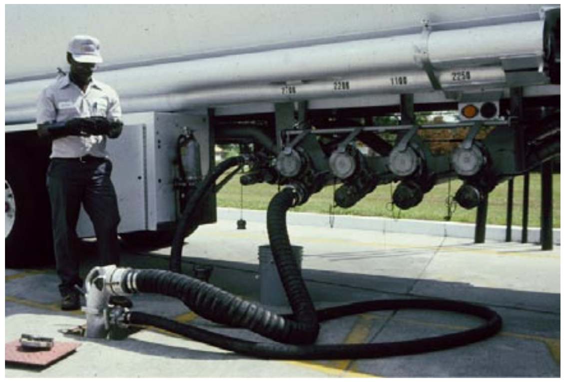

Figure 2. *Coaxial Stage I vapor recovery is easy to retrofit to existing tanks because it usually does not require breaking concrete. However, because the diameter of the drop tube is reduced, the delivery flow rate is slower and the time required to make a delivery is increased.*

■ **Fill Caps That Seal Tightly**

Tightly fitting fill caps are a good idea and are necessary for vapor control. Whether more widespread implementation of Stage I regulations results in a general increase in the vapor tightness of our fill-cap population remains to be seen. Tight vapor caps do contribute to the fuel oscillation associated with the drop tube issue described above.

■ **Vapor Path Must Seal When Vapor Cap Is Removed**

This is a pretty straightforward issue for two-point vapor recovery where vapor adaptors have always had spring-loaded poppets that seal the opening into the tank vapor space, whether the cap is on or off. But this requirement also applies to coaxial vapor recovery, which means that the annulus between the drop tube and the fill riser must also include a mechanism to seal the opening except when the fill adapter is connected.

■ **Coaxial Vapor Recovery**

Perhaps the biggest issue I see cropping up with the new Stage I rule is the likelihood that a lot of facility owners will opt for coaxial vapor recovery for existing facilities. Many of these tanks will likely have ball floats for overfill prevention. The addition of the coaxial vapor recovery essentially bypasses the ball float so that the new coaxial drop tube needs to include a flapper valve as well (unless an alarm is installed for overfill prevention) to meet overfill-prevention requirements. (See figure 2.)

Fortunately, installing the coaxial drop tube essentially disables the ball float, so the ball float will not interfere with the operation of the flapper valve. How does that work, you say? Well, let's say we have a two-point-vapor-recovery system, with a ball float at the bottom of the vapor riser and a flapper valve in the drop tube. If the ball float is installed to operate at 90 percent of tank capacity and the flapper valve operates at 95 percent of tank capacity, the ball float will close first, thus slowing down the flow of fuel substantially.

The flapper valve is operated by the rapid flow of fuel coming down the drop tube, so it will likely have an insufficient flow rate to operate properly in this two-point Stage I scenario. With a coaxial drop tube, the tank now vents through the fill pipe, so even if the ball float closes, it has no effect on the venting of the tank or the velocity of the fuel flowing down the drop tube, so the ball float does not interfere with the operation of the flapper valve.

Because the tank has to pass a pressure-decay test with the fill cap off, the flapper valve has to be a special model that is reasonably airtight in order for the tank to pass the test. Installers who are working in parts of the country where Stage I vapor recovery has not been prevalent may need to be reminded that coaxial vapor recovery bypasses ball floats and that flapper valves need to be the airtight.

So if you're inspecting a facility with newly installed coaxial Stage I vapor recovery, be sure you see a flapper valve in the fill pipe or an alarm on the wall, otherwise the facility will most likely be in violation of the overfill-prevention requirements.

To Learn More...

For the full text of the NESHAP requirements, go to: *www.epa.gov/ttn/atw/area/fr10ja08.pdf.* The P/V vent-cap requirements of the rule were amended in June of 2008. The amendments can be found at: *www.epa.gov/ttn/atw/gasdist/fr25jn08.pdf.* For more information about Stage I vapor recovery, go to *www.pei.org/RP300.* ■