New England Interstate Water Pollution Control Commission
116 John Street
Lowell, Massachusetts
01852-1124
www.neiwpcc.org/lustline

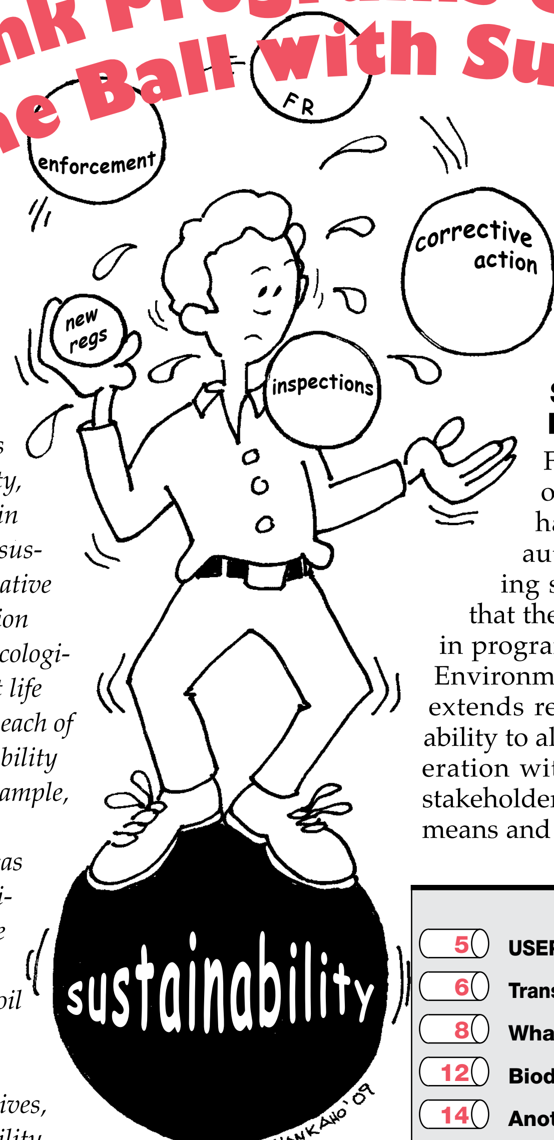
Bulletin 62
August
2009

L.U.S.T.LINE

A Report On Federal & State Programs To Control Leaking Underground Storage Tanks

How Can Tank Programs Get on the Ball with Sustainability?

by Hal White



The term "sustainability" is widely used, but like beauty, its meaning is very much in the eye of the beholder. At its core, sustainability seeks to achieve a qualitative improvement in the human condition such that we are maintaining the ecological capacity of the Earth to support life (Daly, 1996). Within this context, each of us as beholders can define sustainability to suit our own preferences. For example, many people equate sustainability with efforts to reduce greenhouse gas (GHG) emissions to stem global climate change. But, we can also have sustainable farming practices that seek to maintain the health of the soil and its environs for the long term.

Sustainability comprises economic, social, and ecological objectives, the so-called "pillars" of sustainability, and all three must be met concurrently in order to achieve sustainable outcomes. Because sustainability is all-encompassing, no single program can possibly address all of its varied aspects. Those of us in federal, state, tribal, and local UST programs need to answer the question of what sustainability means in the context of our programs. And then we must ask: What can we do to make meaningful progress toward achieving sustainable tank programs?

Sustainability as Environmental Policy

Federal and state UST programs are often operationally constrained by resources and have limits with respect to their regulatory authorities. Nowhere in the federal authorizing statute or regulations is it explicitly stated that the UST program must consider sustainability in program implementation. However, the National Environmental Policy Act (NEPA) of 1969 implicitly extends responsibility for consideration of sustainability to all federal departments and agencies in cooperation with state and local governments and other stakeholders. NEPA requires the "use [of] all practicable means and measures, including financial and technical

■ *continued on page 2*

Inside

■ Tank Programs and Sustainability *from page 1*

assistance, in a manner calculated to foster and promote the general welfare, to create and maintain conditions under which man and nature can exist in productive harmony, and fulfill the social, economic, and other requirements of present and future generations of Americans."

In 1993, USEPA published a report to Congress entitled *Sustainable Development and the Environmental Protection Agency*. In setting the stage for future sustainable development policy, this report cites consensus on three fundamental tenets. First, the adoption of a long-term perspective; second, the interdependence of the economy and the environment; and third, the creation of new integrative approaches. Though this report establishes broad policy goals, responsibility for meeting specific objectives is left to the individual program offices.

In 2005, USEPA launched a "stewardship" initiative that assimilated and refocused the Agency's prior sustainability efforts. The blueprint for this initiative is described in *Everyday Choices: Opportunities for Environmental Stewardship*, which defines stewardship as a: "responsibility for environmental quality shared by all those whose actions affect the environment, reflected as both a value and a practice by individuals, companies, communities, and government organizations." This initiative relies heavily on voluntary approaches to achieve environmental outcomes for six "natural resources [that] are each part of a larger, life-sustaining system": air, ecosystems, energy, land, materials, and water (USEPA, 2005).

Complementing USEPA's efforts to prevent pollution and promote environmental stewardship are its efforts to develop and promote the use of green cleanup approaches to restore sites to productive (re)use. In some cases, conventional remediation efforts may create as much or more pollution than they remediate (Forbes, 2009). In contrast, green cleanups strive to minimize the environmental footprint (USEPA, 2008a).

L.U.S.T.Line

Ellen Frye, *Editor*
Ricki Pappo, *Layout*
Marcel Moreau, *Technical Adviser*
Patricia Ellis, PhD, *Technical Adviser*
Ronald Poltak, *NEIWPCC Executive Director*
Deb Steckley, *USEPA Project Officer*

LUSTLine is a product of the New England Interstate Water Pollution Control Commission (NEIWPCC). It is produced through cooperative agreements (US-83384301 and US-83384401) between NEIWPCC and the U.S. Environmental Protection Agency.

LUSTLine is issued as a communication service for the Subtitle I RCRA Hazardous & Solid Waste Amendments rule promulgation process.

LUSTLine is produced to promote information exchange on UST/LUST issues. The opinions and information stated herein are those of the authors and do not necessarily reflect the opinions of NEIWPCC.

This publication may be copied. Please give credit to NEIWPCC.

NEIWPCC was established by an Act of Congress in 1947 and remains the oldest agency in the Northeast United States concerned with coordination of the multimedia environmental activities of the states of Connecticut, Maine, Massachusetts, New Hampshire, New York, Rhode Island, and Vermont.

NEIWPCC
116 John Street
Lowell, MA 01852-1124
Telephone: (978) 323-7929
Fax: (978) 323-7919
lustline@neiwpcc.org

LUSTLine is printed on recycled paper

Opportunities for Sustainable Practices

So, how do we define what "sustainability" means in the context of the UST program? Appreciating that there are many individual "beholders" (states, tribes, and territories, plus USEPA), developing a consensus definition has the hallmark of an involved and protracted undertaking. In the meantime, what can UST programs do to make meaningful progress toward sustainability if we don't know what it means? To get started, let's accept that sustainability is a concurrent achievement of economic, social, and ecological net benefits. With this in mind, we'll then identify opportunities for sustainable practices in each of USEPA's six priority areas within the stewardship framework discussed earlier.

As if the concept of sustainability wasn't protean enough, the environmental impacts of sustainable practices can be either direct or indirect. For example, reduced electricity consumption associated with "green" buildings and green cleanups is a direct energy impact, while the reduced generation of GHGs resulting from reduced electricity consumption is an indirect air impact. We must also remember that our UST programs are operationally constrained. Hence, while we can directly influence practices such as leak detection, we can only indirectly influence practices such as constructing a green gas station.

- **Air** With regard to UST programs, air quality sustainable practices are primarily indirect. For example, a typical gasoline refueling facility consumes a considerable amount of electricity, the majority of which is generated by coal combustion. So a facility owner could opt to reduce the amount of electricity consumed by constructing a green building (e.g., LEED certified) or using green technologies. A LUST program could promote the use of sustainable site-remediation technologies (e.g., use of alternative energy sources such as solar or wind-powered equipment; see Dellens, 2007; EPA, 2007a,c). Such measures would lead to reductions in emissions of GHGs, mercury, and oxides of sulfur and nitrogen. A reduction in energy consumption would also have a financial incentive for a facility owner. Green gas stations are beginning to appear; a recently opened facility in Lawrence, Kansas, is intended to demonstrate the energy- and pollution-reduction benefits as an example for construction of future stations (Pomes, 2008).

- **Ecosystems** The primary purpose of the UST program is to protect drinking water resources for human health and the environment. Only in rare circumstances are ecosystem impacts directly UST-related. Small surface spills that take place during vehicle refueling may result in situations where stormwater runoff washes contaminants into surface-water bodies, impacting aquatic biota. Various Low Impact Development (LID) techniques can be employed to reduce pollutant (and sediment) loading of aquatic ecosystems (EPA, 2000a, 2007c).

  The cleanup and reuse ("revitalization") of abandoned UST facilities can result in both direct and indirect positive impacts. Direct impacts would include such actions as converting an abandoned urban gas station into a green space that serves as a park or playground, creating a microhabitat for insects such as butterflies or birds, simply reusing a site as a gas station, or developing a site for new housing, commercial, business, or public facility use. The indirect impact of such reuses is that construction on a pristine piece of property in an undeveloped area has been avoided (USEPA, 2004).

- **Energy** Opportunities for reduction in energy consumption in the UST program lie chiefly with more efficient use of electricity, especially through the use of green UST facilities and green cleanup technologies. At present, only a few UST facilities employ such technologies, but these may serve as demonstration projects to encourage broader participation (see USEPA, 2009a, pp.14-15; Pomes, 2008). Green cleanup technologies have been used successfully at a number of nonpetroleum remediation sites. (See Dellens, 2007; USEPA, 2007a, 2007b, 2008a.)
- **Land** Many former gas station properties, including a large number of abandoned gas station sites, offer direct opportunities for sustainable reuse of land, especially within the context of smart growth. The UST program has developed a comprehensive plan for addressing these sites in the publication *U.S. EPA's Petroleum Brownfields Action Plan: Promoting Revitalization and Sustainability* (EPA, 2008b). Former UST sites have been reused as commercial and business establishments, public facilities, housing, and a variety of other environmental and recreational purposes. Some of the successes of this program are highlighted in the UST program's recent 25th anniversary report. (See USEPA, 2009a, pp.6-7.)

The UST program has also partnered with the Wildlife Habitat Council to create parks, green space, and habitat from these sites. (See EPA, 2004.) Most of these sites are relatively small. Typical gas stations are on the order of an acre or less, though truck stops may be as much as two or three acres. Although these sites are small, there are many of them, and their reuse as an alternative to developing pristine land in an undeveloped area can be significant in preserving wildlife habitat.

- **Materials** Federal regulations stipulate that UST systems be constructed of materials that are compatible with the substances stored. Beyond this, there is no stipulation as to whether or not system components are produced in a sustainable manner. If we were to take the notion of sustainability to the next life-cycle step, we could envision USEPA negotiating with equipment manufacturers and even setting up public-private partnerships to foster production of UST-system components in a sustainable fashion, but with such a relatively small niche market, participation would need be entirely voluntary.

Sustainability comprises economic, social, and ecological objectives, the so-called "pillars" of sustainability, and all three must be met concurrently in order to achieve sustainable outcomes.

Taking this life-cycle approach requires an analysis for each component. While not impossible, it would be time-consuming and expensive and the results uncertain. Proper economic incentives would have to be developed in order to convince manufacturers and station owners that the effort was worthwhile. In some instances it may be possible to reuse/recycle debris from remediation activities (e.g., excavated soil, pulverized concrete and asphalt).

- **Water** The dwindling availability of potable water supplies has become a global issue. Given the toxicity and other noxious characteristics of most substances stored in USTs, even small releases can render vast quantities of groundwater or surface water unfit to drink. The UST program implements a dual approach to groundwater protection. The first is pollution prevention and the second is rapid cleanup of pollution that does occur. Despite the program's efforts at preventing spills, overfills, and chronic releases, 39 states still identify leaking UST systems among their top ten threats to groundwater (USEPA, 2000b).

Many UST cleanups involve pumping contaminated groundwater, treating it (either above or below ground), and then reinjecting the treated water back into the subsurface. Optimizing pumping systems so they are more hydraulically efficient, and hence more energy efficient, offers another opportunity for sustainable cleanups. (See Forbes, 2009.) Cleaning up contaminated drinking water costs more than preventing contamination in the first place. Additional emphasis on preventing and detecting small-volume releases can better protect water supplies and aquatic ecosystems while concurrently reducing energy and materials use and generation of air pollutants.

UST-systems releases can also discharge into surface waters and adversely impact sources of drinking water (as well as ecosystems). LID techniques, some of which are relatively simple landscaping features, may be employed to minimize the amount of contaminants washed into surface water bodies by stormwater runoff (USEPA, 2000a, 2007c; Pomes, 2008) and concurrently increase groundwater recharge.

Measuring Progress Toward Sustainable Outcomes

Now that we have discussed some potential opportunities for employing sustainable practices, what metrics should be used to measure progress toward sustainability? There are two general classes of metrics that can be considered: (a) conventional metrics and

■ continued on page 4

■ **Tank Programs and Sustainability** *from page 3*

(b) "sustainability metrics." Conventional metrics include contaminant emissions reduced to meet applicable standards, acres of contaminated sites restored to beneficial uses, and number of people protected from drinking contaminated groundwater. These metrics are imperfect for a variety of reasons. Most significantly, they tend to be output-oriented, and it is difficult to quantify avoided impacts with any degree of precision and credibility.

Sustainability metrics, on the other hand, are intended to reflect more broadly the health and well-being of the system as an integrated whole. These metrics tend to be outcome-oriented and include a wide variety of measures, indices, and indicators. Linking outcomes to policies and practices is often difficult, however. The development of appropriate, specific metrics requires collaboration among state and federal regulators as the utility of such metrics would necessarily reflect a balancing of what is optimally desired with what is feasible.

Sustainable practices with regard to air and energy are related through reductions in the generation of GHGs due to reduced energy usage. In the case of air, the impacts are indirect, but they are direct in terms of energy use. One measure of reduced electricity usage would be a reduction in the monthly electric bill. Electricity generation statistics can be obtained or calculated in order to quantify reductions in emissions correlated to reductions in energy consumption.

Sustainable practices with regard to land and ecosystems are related through the preservation of pristine land and the reuse of abandoned gas station properties. Though not technically difficult to quantify, the first problem is that there is no national inventory of abandoned UST sites, so there are no reliable data regarding the size of individual properties, how many there are, or where they are. The UST program collaborates with the federal Brownfields program to promote and communicate cleanup- and revitalization-related accomplishments and associated benefits to society. USEPA has recently issued guidance on developing inventories of relatively low-risk petroleum-contaminated brownfield properties to overcome the unique challenges posed by these sites (USEPA, 2009b).

Metrics for sustainable practices with regard to materials are difficult to identify in a comprehensive manner. UST systems are comprised of a large number of components, some of which are produced by industries with a large environmental footprint. Tanks are generally made from either steel or fiberglass-reinforced plastic. Pumps are made of a variety of metals. A number of different organic coatings and sealants are used to protect system components and join them together. Manufacture of each component could conceivably have an environmental impact, and determination of such impacts requires a life-cycle analysis.

Our move toward sustainability will not happen overnight, but it can find a place in our day-to-day thinking and even in our stated goals.

Sustainability metrics associated with water resources are also difficult to quantify as they require a number of assumptions to estimate avoided impacts. Though an output and not an outcome, reduction in the number of leaks/releases from USTs is perhaps the most significant measure with regard to water quality.

Moving Toward Sustainability

Granted, our UST programs have their hands full juggling many competing priorities—budget, financial responsibility, SPA, leak detection, corrective action, enforcing regulations, writing regulations, dealing with legislatures, holding on to staff, maintaining databases, addressing training needs...the list goes on. So our move toward sustainability will not happen overnight, but it can find a place in our day-to-day thinking and even in our stated goals.

The concept of sustainability is extremely broad and complex, so no one program can address its many facets. The principal activities/practices in which our UST programs can engage to achieve sustainable outcomes are: (a) reduce generation of greenhouse gases by reducing electricity consumption through use of green buildings and green cleanup technologies, (b) promote reuse of gas station sites to preserve pristine land and wildlife habitat, revitalize communities, and restore green space in urban areas, (c) employ low-impact development techniques for management of stormwater runoff, and (d) refocus attention on methods to prevent and detect small-volume releases to better protect water resources.

The gains from these practices in the UST program may appear modest at the individual site level, but there are a large number of such sites such that in the aggregate meaningful steps toward sustainability can be achieved. ■

Hal White is an environmental scientist with USEPA's Office of Underground Storage Tanks. This article has been adapted from a paper he wrote for a course in environmental science and policy at George Mason University. The views herein are the author's alone and do not necessarily reflect the views of USEPA, and no official endorsement should be inferred. Hal thanks OUST staffers Robin Hughes and Sharon Fredericks for their input, which greatly improved the article. Hal can be reached via email at white.hal@epa.gov.

References Cited

Daly, H.E. (1996). Beyond growth: The economics of sustainable development. Boston: Beacon Press.

Dellens, A.D. (2007). Green remediation and the use of renewable energy sources for remediation projects. Available at: *http://cluin.org/download/studentpapers/Green-Remediation-Renewables-A-Dellens.pdf.*

Forbes, R. (2009). Sustainable remediation at the Massachusetts Military Reservation. LUSTLine Bulletin, 60: 4-6. Available at: *http://www.neiwpcc.org/lustline/.*

Pomes, M. (2008). First green energy gateway fuel station opens in Lawrence, Kansas. LUSTLine Bulletin, 59: 4-6. Available at: *http://www.neiwpcc.org/lustline/.*

U. S. Environmental Protection Agency. (1993). Sustainable development and the Environmental Protection Agency: Report to Congress (EPA 230-R-93-005). Washington, DC: Office of Policy, Planning, and Evaluation. Available at *http://nepis.epa.gov/EPA/html/Pubs/pubtitle.htm.*

U. S. Environmental Protection Agency. (2000a). Low Impact Development (LID): A Literature Review (EPA-841-B-00-005). Washington, DC: Office of Water. Available at *http://www.epa.gov/owow/nps/lid/lid.pdf.*

U. S. Environmental Protection Agency. (2000b). National Water Quality Inventory: 2000 Report. Washington, DC: Office of Water. Available at *http://www.epa.gov/305b/2000report/*.

U. S. Environmental Protection Agency. (2004). EPA and wildlife habitat council partner to foster reuse of abandoned gas stations for parks, wildlife habitat, and green space (EPA-510-F-04-007). Washington, DC: Office of Solid Waste and Emergency Response. Available at *http://www.wildlifehc.org/ewebeditpro/items/O57F4848.pdf*.

U. S. Environmental Protection Agency. (2005). Everyday choices: Opportunities for environmental stewardship. Washington, DC: EPA Environmental Stewardship Staff Committee. Available at *http://www.epa.gov/innovation/pdf/techrpt.pdf*.

U.S. Environmental Protection Agency. (2007a). Wind turbine cost study shows need for redesigned ground-water remediation systems (EPA 542-N-06-009). Washington, DC: Technology Innovation Office. Available at *http://clu-in.org/products/newsltrs/tnandt/view.cfm?issue=0507.cfm#1*.

U.S. Environmental Protection Agency. (2007b). Solar power recirculates contaminated ground water in low-energy bioreactor (EPA 542-N-06-009). Washington, DC: Technology Innovation Office. Available at *http://clu-in.org/products/newsltrs/tnandt/view.cfm?issue=0507.cfm#1*.

U.S. Environmental Protection Agency. (2007c). Reducing stormwater costs through low-impact development (LID) strategies and practices (EPA 841-F-07-006). Available at *http://www.epa.gov/owow/nps/lid/costs07/documents/reducingstormwatercosts.pdf*.

U. S. Environmental Protection Agency. (2008a). Green remediation: Incorporating sustainable environmental practices into remediation of contaminated sites. Washington, DC: Office of Solid Waste and Emergency Response. Available at *http://www.epa.gov/tio/download/remed/green-remediation-primer.pdf*.

U. S. Environmental Protection Agency. (2008b). U.S. EPA's petroleum brownfields action plan: Promoting revitalization and sustainability. Washington, DC: Office of Underground Storage Tanks. Available at *http://www.epa.gov/oust/rags/petrobfactionplan.pdf*.

U. S. Environmental Protection Agency. (2009a). Underground storage tank program: 25 years of protecting our land and water (EPA-510-B-09-001). Washington, DC: Office of Underground Storage Tanks. Available at *http://www.epa.gov/oust/pubs/25annrpt.pdf*.

U. S. Environmental Protection Agency. (2009b). (EPA 510-R-09-002). Washington, DC: Office of Underground Storage Tanks. Available at *http://www.epa.gov/oust/pubs/pbfdevelopinventories.pdf*.

USEPA Region 3 Spearheads Effort to Develop a Green Cleanup Standard

In late 2008, USEPA's Office of Solid Waste and Environmental Response (OSWER) and USEPA Region 3's Hazardous Site Cleanup Division (HSCD) and Land and Chemicals Division (LCD) set in motion an initiative to create a Green Cleanup Standard. The effort has been taken on by a Green Cleanup Standard work group led by Region 3's Deborah Goldblum, Resource Conservation and Recovery Act Revitalization Coordinator, and Kristeen Gaffney of the Brownfields and Land Revitalization office. The group is tasked with developing a cleanup standard and verification system that promotes more sustainable cleanups at contaminated sites.

The standard would establish a uniform approach, with incentives, to encourage property owners, regulators, responsible parties, developers, and communities to use green cleanup practices during project planning and implementation.

"We want to develop an 'umbrella' green cleanup standard that could be applied to all of EPA's cleanup programs including storage tanks, brownfields, federal facilities, RCRA, and Superfund," says Goldblum. "Having one standard regardless of program or region should make green cleanups much easier to implement."

Sustainable benefits anticipated for the green cleanup standard may include:

- Minimizing total energy use and maximizing use of renewable energy
- Minimizing air pollutants and greenhouse gas emissions
- Minimizing water use and impacts to water resources
- Reducing, reusing, and recycling material and waste
- Protecting land and ecosystems.

So far, the group has worked to identify potential benefits of and incentives for green cleanups, develop core elements, and identify a standards organization to work with USEPA. By law, the Agency is encouraged to develop standards through a consensus process. In this case, USEPA will collaborate with ASTM International to develop the green cleanup standard. An ASTM task group will work collaboratively with USEPA and stakeholders to develop the standard, beginning at ASTM's annual fall meeting in October, 2009.

The USEPA work group members have identified several key elements that they agree are important for the standard—it should be flexible (with program or state-specific recognition options); be market driven; require minimal resources; and be transparent, universal, verifiable, and voluntary.

USEPA and state UST/LUST programs are exploring how such a standard would be applied at LUST sites and what incentives could be established to promote the use of a green cleanup standard. Goldblum notes that some of the key challenges the group faces in developing the standard include avoiding unintended consequences (e.g., a bias toward more passive, protracted cleanups), balancing various stakeholders' needs, defining boundaries (i.e., cleanup versus reuse), establishing a baseline for measuring improvements, identifying potential incentives and certification prior to completion of a standard, and keeping it simple.

In addition to USEPA Region 3 personnel, the Green Cleanup Standards work group includes representatives from all OSWER cleanup programs, USEPA regional offices, and states. Robin Hughes is USEPA's Office of Underground Storage Tanks work group member.

For more information on green cleanup and the progress of the work group, visit the group's CLU-IN website at *http://www.clu-in.org/greenremediation/subtab_b5.cfm.*

See also:

- ASTM International *http://www.astm.org/DATABASE.CART/WORKITEMS/WK23495.htm*
- The Association of State and Territorial Solid Waste Management Officials has a Greener Cleanup Task Force with papers on green cleanup. *(http://astswmo.org/resources_sustainability_greenercleanups.html).*
- The Sustainable Remediation Forum's white paper on sustainable remediation *(http://www.sustainable remediation.org/library/issue-papers)* ■

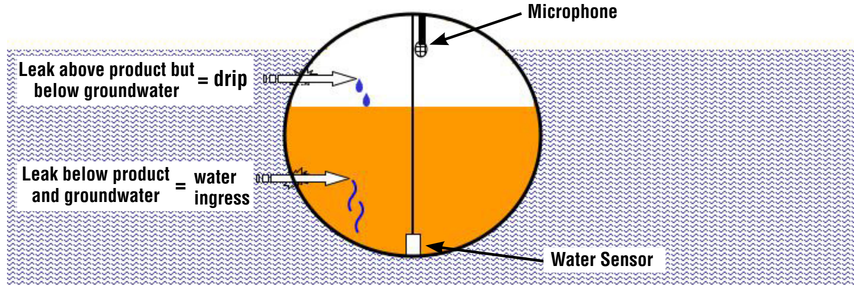
The Transient Behavior of Water in Ethanol-Blended Fuels — Implications for Leak Detection

by Kevin Henderson

In recent months, a great deal of attention has been focused on the compatibility of ethanol-blended fuels with underground storage tanks (USTS) and dispensing equipment in an effort to prevent failures (leaks) that may result from the use of ethanol. However, scant attention has been given to the functionality of the equipment and methods utilized to detect whether a leak from these systems has occurred. While it is clearly desirable to prevent a leak from occurring in the first place, it should be equally apparent that we need to be able to quickly and accurately detect such a failure. We are introducing ethanol, a chemical with very different corrosivity and solvent properties from traditional gasoline, into an aging fuel-storage and dispensing infrastructure with relatively little compatibility information. Seems kind of risky. Shouldn't effective leak detection be a key component of the overall ethanol strategy for the UST regulator? Therefore, a holistic approach to the identification and resolution of any potential issues that may arise from the introduction of ethanol-blended fuels into our existing petroleum storage and dispensing infrastructure demands that our attention to leak detection be commensurate with that afforded leak prevention.

Detecting Water Ingress with Nonvolumetric ("Vacuum") Precision Tightness Test Methods

Groundwater Above Bottom of Tank



Water ingress that occurs above the product level is heard as a drip or flow entering the tank.

Water ingress that occurs beneath the level of product in the tank cannot be heard and must be detected by a water sensor placed at the bottom of the tank.

A Matter of Failed Tank Integrity

First, we should make it clear that in this discussion I am talking only about tank leak detection—pipe leak detection is not part of this discussion. More specifically, for reasons described below, I am concerned about nonvolumetric ("vacuum") precision tank-tightness testing and "in-tank" methods of leak detection.

Typically, leak detection, as applied to USTs, is thought of as the ability to ascertain the occurrence of an unexpected loss of fluid from a tank. However, another important aspect of tank leak detection is the ability to recognize the occurrence of an unexpected *gain* of fluid (i.e., ingress). When groundwater is above the bottom of the tank, as is often the case, it is not uncommon for tank failures to manifest themselves via water ingress. So the term "leak detection" is really somewhat of a misnomer.

What we are really talking about is a breach in the wall of a tank (i.e., tank-integrity failure). A breach may allow the stored substance to leak out of the tank or it may allow external fluids (e.g., groundwater) to enter the tank. Whether groundwater enters the tank or the stored substance leaks out depends on the physical relationship between the level of fluid stored in the tank and the level of the groundwater outside of the tank. So when we say "leak detection," we are really referring to the ability to detect a failure of the primary storage tank integrity. Nevertheless, since "leak detection" is more commonly used, I will use this terminology when referring to our ability to detect a failure of tank integrity.

The transitory behavior of water in ethanol-blended fuels, which I will discuss below, is a major concern with regard to leak detection. Its importance has to do with the fact that it may not be possible to detect a tank failure via water ingress with ethanol-blended fuels under certain conditions. Although this is the short version, there are quite a few aspects of this issue that complicate the discussion. What follows is an attempt to provide a more complete explanation of these circumstances and why we should be directing our attention to this issue.

Setting the Stage

To keep things simple, I will set a few parameters. First, the ability to detect water ingress is usually of importance only when water is above the bottom of a single-walled tank. There are some possible scenarios where water ingress could be of concern with double-walled tanks as well, but I will limit this discussion to single-walled tanks.

Second, while methods of in-tank leak detection include automatic tank gauging, statistical inventory reconciliation, and inventory control/tank-tightness testing, I will focus on nonvolumetric ("vacuum") precision tank-tightness test methodologies that utilize in-tank water sensors to detect water ingress. [In the next issue of *LUSTLine*, Marcel Moreau will discuss ATGs and ethanol-blended fuels.] Typically, these methodologies involve the application of a relatively small vacuum to the tank ullage (space above the product level). A microphone is placed within the tank ullage and the test operator listens for the acoustic characteristics of a leak. When groundwater is above the bottom of the tank, a water sensor must be placed in the tank.

There are two scenarios to consider relative to the detection of water ingress. If the breach is above the fuel level in the tank but beneath groundwater, the ingress should be detected acoustically as a drip entering the tank. If the breach is beneath both the product level and groundwater, the ingress cannot be heard as a drip and the in-tank water sensor must be able to detect the water ingress.

Other factors to consider include temperature of the fuel, turbulence within the tank, water saturation of the fuel, and rate of water ingress. In order to further simplify this discussion, let's assume the temperature is a standard 70° F and the fuel blend initially does not contain any water. This leaves the percentage of ethanol in the fuel blend and the rate of water ingress for discussion.

Ethanol Blend Percentage

How does the percentage of ethanol in the fuel blend affect our ability to detect water ingress? While the problem of being able to detect water ingress applies to any ethanol-blended fuel (including E10), it is exacerbated as the percentage of ethanol increases. Since water is infinitely miscible with ethanol, it will mix with ethanol in the fuel blend and will not form a layer of "free" water on the bottom of the tank as is typical in tanks that contain conventional gasoline. At some point, if enough water flows in and mixes with the ethanol, phase separation will occur and a layer of ethanol/water will form at the bottom of the tank.

How much water can mix with the fuel before phase separation occurs? This depends on a number of factors, the most important of which is the percentage of ethanol in the fuel blend. Although it is difficult to find any citable references, it is generally stated that the percentage of water that can be absorbed before phase separation occurs ranges from as little as 0.5 percent in an E10 blend to as much as 15 percent in an E85 blend. As the percentage of ethanol increases in a blend, so does the amount of water necessary to cause phase separation. If we assume that we will be able to detect water ingress once phase separation occurs (and this may not be a valid assumption in some cases), it then follows that it becomes more difficult to detect water ingress as the percentage of ethanol increases.

Rate of Water Ingress

How does the rate of water ingress affect our ability to detect water ingress? Let's consider the requirements for nonvolumetric precision tightness testing. In order to meet the performance standard for nonvolumetric precision tightness testing, the federal rules require that the methodology must be able to detect a 0.1 gph leak (ingress) with a 95 percent probability. To meet the required 95 percent probability of detection, most methodologies set the threshold at 0.05 gph. This is a very small leak rate, but just how much of a leak does this represent? Translating this to a rate we can better visualize, a 0.05 gph leak is equivalent to a little over one drop per second. Another way to visualize this would be to consider that it would take 20 hours for one gallon of water to enter a tank at the rate of 0.05 gph.

Most nonvolumetric precision-tightness-testing methodologies rely on an in-tank sensor installed at the bottom of the tank to detect water ingress that occurs below the product level. These in-tank water sensors operate on the principle that given sufficient time, enough water will accumulate on the bottom of the tank to trigger the sensor if water ingress occurs during the test.

Because of several factors that must be taken into consideration, the length of the test must be calculated to allow enough time during the test for enough water to enter and accumulate at the bottom of the tank. Although the length of the calculated test time varies, it typically ranges from as little as ten minutes to as much as one hour or more.

It is important to note that although only a small volume of water is needed to trigger the water sensor, the calculation assumes that all of the water that leaks in during the test will remain at the bottom of the tank for the duration of the test. Is this assumption correct?

Transient Behavior of Water

The behavior of water when it enters a tank containing an ethanol-blended fuel is very different from when it enters a tank containing conventional gasoline. Although scientifically valid data regarding the exact behavior of water upon entering a tank containing an ethanol-blended fuel has been hard to find, we do know that water is infinitely miscible with ethanol. If we assume that the ethanol-blended fuel does not already contain water, then we know that small volumes of water that enter the tank will mix with the ethanol/fuel blend and will not exist as "free" water on the bottom of the tank.

But how exactly does the water behave when it first enters the tank, and how does the mixing then occur? Anecdotal evidence indicates that the water will reside as free water at the bottom of the tank for a relatively short period of time. After 10 to 15 minutes or so, the water will rather suddenly mix with the ethanol within the fuel blend.

Given that water will not stay on the bottom of a tank for more than a short period of time before it mixes with the ethanol/gasoline blend, it is easy to understand why this raises concerns with regard to the ability of leak-detection equipment and methodologies to detect water ingress. In particular, nonvolumetric precision tank-tightness testing methods that utilize in-tank water sensors must take into consideration the apparent 10- to 15-minute residence time of water.

Since the length of the precision tank tightness test can be as much as one hour or more, it should be apparent that all of the water in the tank will not stay at the bottom of the tank for the duration of the test. Therefore, it appears that this fundamental assumption made when calculating the length of the test time necessary to conduct a nonvolumetric precision tightness test is suspect. It does not require a great extrapolation of logic to see how the transitory behavior of water in ethanol-blended fuels could also affect in-tank leak-detection methodologies commonly in use today.

Transient, Shmansient—Who Cares?

While the conditions necessary to completely mask water ingress are probably uncommon, given the behavior of water in ethanol-blended

■ *continued on page 13*

Wander LUST

A roving column by reporter Patricia Ellis, a hydrologist with the Delaware Department of Natural Resources and Environmental Control, Tank Management Branch. Pat served as a member of USEPA's Blue Ribbon Panel on MtBE. She welcomes your comments and suggestions and can be reached at *Patricia.Ellis@state.de.us.*

What If Methanol…?

Buried in the Waxman-Markey "Clean Energy and Security Act of 2009" (HR 2454), is Section 127, the Open Fuel Standard Act. This bill amends the Open Fuel Standard for Transportation (Chapter 329, title 49, United States Code). It requires that, starting in 2012, 50 percent of new automobiles, and starting in 2015, 80 percent of new automobiles, be flex-fuel vehicles (FFVs), warranted to run on gasoline, ethanol, or methanol, as well as biodiesel-capable vehicles. This is to break the "Chicken versus Egg" syndrome, an impasse brought about because car companies don't want to make FFVs until the requisite fueling infrastructure has been built, and marketers don't want to pay to install fueling facilities for FFVs, because there aren't enough of them on the road. At present, Waxman-Markey has been passed by the House, but not the Senate, so we don't know whether this provision will remain in the final bill.

One New York legislator, Rep. Eliot Engel, stated that he wouldn't have supported the bill if the provision to make vehicles that could run on methanol was not in it, because the legislation is "not just about reducing emissions" but also curbing our dependence on foreign oil. (http://online.wsj.com/article/SB124744273187130105.html) *But in terms of energy security, it is important to note that our methanol may well come from the Middle East. So, what if methanol were to enter the nation's fuel mix? What if?*

The Why and Wherefrom of Methanol

Methanol can be produced from any carbon-based source. These sources include natural gas, coal, municipal wastes, landfill gas, wood wastes, and seaweed. Methanol is primarily produced by steam-reforming natural gas to create a synthesis gas (combination of hydrogen and carbon monoxide), which is fed into a reactor vessel in the presence of a nickel catalyst to produce water vapor and methanol. A distillation step is used to remove water from the finished methanol. Work is also under way to make methanol from CO_2.

Most methanol, a common industrial chemical, is produced from natural gas, rather than from biomass. Because its economics depend on low-priced sources of natural gas, much of the world's methanol is produced in the Middle East; in fact, some plants in North America have closed. It's not clear that increased U.S. methanol demand would be met by either domestic or nonhydrocarbon sources. Hence, methanol's efficacy in addressing energy security or climate change looks questionable. In addition, vehicle mileage from methanol is even worse than mileage from ethanol.

In a listing of methanol plants in the world prepared by Jim Jordan and Associates, there were ten methanol plants in the U.S. at the end of 2008. Eight are listed as using natural gas as a feedstock, and two list coal as a feedstock. From the listing, it appears that six of the plants (all using natural gas as a feedstock), may currently not be operating (the current capacity is listed as 0). *(http://www.methanol.org/contentIndex.cfm?section=methanol&topic=specialReports&title=Index)*

In the Renewable Fuel Standard subtitle of the Energy Infrastructure and Security Act of 2007 (EISA), methanol, if made from organic matter from renewable biomass, qualifies as an advanced biofuel. The new renewable-fuel standard starts at 9.0 billion gallons in 2008 and rises to 36 billion gallons in 2022. Starting in 2016, all of the increase in the RFS target must be met with advanced biofuels, defined as cellulosic ethanol and other biofuels derived from feedstock other than corn starch—with explicit carve-outs for cellulosic biofuels and biomass-based diesel. Advanced biofuel includes "butanol or other alcohols produced through the conversion of organic matter from renewable biomass."

Even after you modify a car to run on M50 (50% methanol, 50% gasoline) or M85 (85% methanol, 15% gasoline), you can't compensate for its lower energy content without precluding operation on regular gasoline. While a car running on E85 typically uses 35-40 percent more fuel per mile than gasoline, you would need 75 percent more M85 to go the same distance, because methanol's energy content is 25 percent lower than ethanol's and less than half that of gasoline. A Ford Fusion FFV that is rated for a combined city/highway mileage of 21 mpg would get about

15 mpg on E85 and 12 mpg on M85. Even with a 17.5-gallon gas tank, the range on M85 would be barely 200 miles

How Methanol Was Approved as a Motor Fuel

In 1979, USEPA issued a sub-sim (substantially similar) waiver for the use of up to 5.5 percent by volume of a combination of methanol with tertiary-butyl alcohol (TBA) in equal parts. This waiver allowed an oxygen concentration of about 2 percent by weight. In 1981, USEPA granted a waiver for use of ARCO's "Oxinol," allowing up to 4.75 percent methanol with an equal amount of TBA, which provides approximately 3.5-3.7 percent oxygen. This oxygen level became the effective limit thereafter.

USEPA subsequently granted waivers to DuPont Corporation (1985) and Texas Methanol Corporation (1988) allowing methanol/cosolvent combinations up to 3.7 percent oxygen and including ethanol as a cosolvent alcohol, in addition to higher alcohols already allowed. Several applications for use of higher concentrations of methanol and cosolvents have been denied by USEPA.

In the mid 1980s, ARCO undertook the only serious effort at marketing methanol blends in the U.S., using its Oxinol mixture of methanol and TBA. It used the Oxinol in some of its own gasoline and also marketed it to independent retailers and blenders. However, many of those independent customers subsequently discontinued purchase of the Oxinol, citing reports from customers of phase separation and/or damage to elastomers and other real or perceived problems. ARCO discontinued marketing Oxinol sometime around 1986. In 1989, USEPA made a ruling on fuel volatility, which allowed for a 1 psi differential for ethanol blends, but not for methanol/cosolvent blends, putting methanol blends at a major disadvantage, a possible death knell.

The California Methanol Experiment

In 1981, Ford delivered 40 dedicated methanol-fueled Escorts to Los Angeles County. Four refueling stations were installed throughout the county. The 200-mile driving range of these vehicles made it clear that four stations were inadequate to cover the requirements of the county. But the drivers loved the performance, offering 20 percent more power than similar gasoline-powered cars and a 15 percent improvement in fuel efficiency. These were cars designed to run only on methanol, not on blends, so they were optimized for mileage with methanol. They would currently be considered Alternative Fuel Vehicles, rather than FFVs. That was one of the problems with them—there were so few fueling locations, and they wouldn't run on anything else. In addition, the vehicles were able to meet the air-emission standard for NOx, which gasoline vehicles hadn't been able to achieve.

I guess you have to sit down and compare all the pros and cons for methanol. What will the costs be to make the fuel-distribution and storage infrastructure compatible with methanol? What happens…?

Based on the success of these vehicles, California asked for several hundred more, which were delivered by Ford in 1983. The compression ratio was increased to 11.8:1, which provided the increase in power, and the fuel tank was increased to provide a driving range of about 230 miles. To fuel the vehicles, California installed 18 additional fueling locations throughout the state. This number of stations was totally inadequate for the area covered, and drivers had to carefully plan their routes and constantly monitor their fuel gauges.

In 1982, Ford began development of the flexible-fuel vehicle as a solution to the fueling-infrastructure problem. These vehicles had higher performance when running on methanol, but they could also be run on gasoline. This technology was seen as a way to bridge the gap while the methanol-refueling infrastructure grew. However, with the introduction of reformulated gas in the late 1980s, the air quality benefits of methanol over gasoline became smaller. Following Desert Storm in 1991, complacency over future oil supplies grew, and energy security was no longer a big driver.

Today, the momentum of the FFV program has focused on the E85 version. Ethanol has its large base of support in the farming community and has a government subsidy for part of its costs. In addition, ethanol FFVs receive large credits through the federal CAFE program.

Health and Safety Issues

Methanol is a more difficult fuel to handle than either gasoline or ethanol. Methanol is toxic to humans. It is a neurotoxin. Ingestion of even a small quantity can produce blindness or death. Siphoning fuel containing methanol, as is sometimes done in emergencies, is a no-no. Labeling should not use the word "alcohol," as this may encourage drinking the methanol. Methanol can be absorbed through the skin and its odor threshold is high enough that you can be exposed to unsafe levels of vapors without knowing it. If it catches fire, the flame is nearly invisible.

According to a 2001 Statoil report, there are about 35,000 cases per year in the U.S. of accidental ingestion of gasoline, mostly due to siphoning by mouth. *(http://www.methanol.org/pdfFrame.cfm?pdf=Methanol_human-tox_rev.pdf)* The lethal dose of methanol in humans is 25 to 90 mL (in a 70 kg body). The corresponding dose of gasoline is approximately 400 mL. Ingestion of 400 mL of gasoline is a very unlikely event, whereas a mouthful of methanol may cause severe toxicity in some individuals. Methanol is readily absorbed by ingestion, inhalation, and skin exposure. Shortly after exposure, it causes a temporary effect on the brain, similar to but weaker than that of ethanol. The more severe, detrimental effects are delayed and are mainly caused by the toxic metabolite formic acid. In severe cases, methanol poisoning may lead to permanent blindness or death.

A study by the U.S. National Capital Poison Center suggested that "A comparison of methanol and gasoline fatality rates reveals a 25 fold greater fatality rate for methanol. From a public health vantage, the acute hazard posed by conversion to methanol-based fuels is unacceptable unless appropriate measures

■ *continued on page 10*

■ **What if Methanol?** *from page 9*

are taken to prevent the predicted increases in fatalities, blindness, and permanent neurological disability." (Concawe, *1995 Alternative Fuels in the Automotive Marketplace*, Report 2/95.)

The odor threshold of methanol may vary from 100 to nearly 6,000 ppm. Assuming that an average value of 2,000 ppm is correct, it would be possible for people to be exposed to concentration values well above the occupational exposure limit value without noticing (US Department of Transport 1995). However, the addition of an odorant to the fuel may help in detection of spills and minimize exposure. (See Table 1.)

Table 1. Exposure Limits for Ethanol and Methanol at ACGIH, NIOSH, and OSHA		
Agency/Organization	**Exposure Limits for Ethanol**	**Exposure Limits for Methanol**
American Conference of Government Industrial Hygienists (ACGIH)	1000 ppm threshold limit value (TLV)	200 ppm TLV; 250 ppm STEL; skin - potential for cutaneous absorption
National Institute for Occupational Safety and Health (NIOSH)	1000 ppm time-weighted average (TWA); 1900 mg/m^3 TWA; 3300 ppm immediately dangerous to life or health (IDLH)	200 ppm TWA; 260 mg/m3 TWA; STEL skin 200 ppm; 6,000 ppm IDLH
Occupational Safety and Health Administration (OSHA) – final permissible exposure limits (PELs)	1000 ppm TWA; 1900 mg/m^3 TWA	200 ppm TWA; 260 mg/m3 TWA

USEPA has not established an MCL for methanol, although it has set a Reference Dose (RfD) of 0.5 mg/kg/day. An estimate of an MCL can be derived from this RfD by using a formula that accounts for the typical weight of an adult and a typical daily amount of water consumption. If this formula is applied using the RfD for methanol, a maximum concentration of 3.5 mg/L is obtained.

It has been suggested that additives could be used to address several safety concerns related to the use of methanol. Chemicals could be added to increase the visibility of flames from methanol, bad-tasting chemicals could be added to reduce the possibility of ingestion, and a colorant could be added to help distinguish methanol from other liquids (Malcolm Pirnie, 1999). *(http://www.methanol.org/pdfframe.cfm?pdf=evaluation.pdf)*

Phase Separation

Gasoline containing 10 percent methanol will absorb 0.1 percent water—ten times as much as gasoline alone. Small amounts of water can be carried away and burned in the engine. If larger amounts of methanol are present, more water can be absorbed, and the components may phase-separate. The separation of the components may be prevented by the presence of small amounts of higher alcohols (e.g., propanol, isobutanol) in methanol fuels. It is actually cheaper to produce methanol with these other alcohols in it, and plant output is increased significantly. All of the waivers that have been granted for use of methanol in gasoline have required that methanol be accompanied by a higher alcohol for this reason.

Materials Compatibility

Lead, tin, and magnesium can be attacked by methanol, but there shouldn't be any parts of these metals in the combustion zones of an engine. Iron and steel are immune, as are brass and bronze. Gasoline tanks are sometimes made of "terne plate," sheet steel coated with lead to prevent water in gas tanks from rusting the tanks. But the methanol slowly dissolves the lead, causing a sludge that clogs fuel filters. When starting to use methanol, the filters should be checked and replaced frequently, and the lead will be gone in a week or two. A solution is for automobile manufacturers to abandon the terne plate for an epoxy-coated lining in a plain steel tank.

Infrastructure Impacts

The use of methanol as a transportation fuel would have infrastructure impacts in a number of areas:

- **Distribution** Methanol is typically shipped via railroad car, barge, and tanker truck, depending on volume and distance. The same issues are involved in transporting methanol as ethanol, with the addition of potential material compatibility. In addition, compatible storage tanks need to be available to store large amounts of methanol at the destination.
- **Storage** Methanol must be stored in appropriately designed tanks. To limit moisture infiltration, a conservation vent with a flame arrestor is recommended, or nitrogen blanketing. Proper grounding is essential, given the low conductivity of methanol. Tanks may be made of stainless steel, carbon steel, or methanol-compatible fiberglass. In the U.S., methanol tanks placed underground must have secondary containment because methanol is classified as a hazardous substance.

At service stations, a conservation vent with a flame arrestor is used rather than a nitrogen blanket. The vent operates when the pressure in the tank exceeds a threshold value or when the vacuum exceeds a specific value. This is especially important when storing neat methanol, since the vapor space in the tank will be flammable, unlike storage of gasoline or M85, where the vapor space will be too rich to be flammable. The lower explosion limit (LEL) for methanol is 6 percent by volume, and the upper explosion (UEL) limit is 36 percent by volume.

Within the approximate temperature range of 12°C to 41°C, methanol will produce a concentration of vapor that is explosive upon contact with an ignition source.

- **Service stations** At service stations, the submersible pump as well as the piping must be made of materials compatible with methanol. Like tanks, piping can be made of stainless steel, carbon steel, or methanol-compatible fiberglass and, like tanks, must be double-walled or have secondary containment. All connections must be methanol-compatible. All dispenser parts must be methanol-compatible, and filters should be finer than for gasoline fuels to capture any corrosion particles that may occur. All leak-detection equipment must be certified for use with methanol.

- **Other infrastructure concerns** How many different fuels will stations need to supply? E0, E10, E15, E85, M10, M85? Regular, Midgrade, Premium grades of some of these fuels? There is a limited amount of space for underground storage tanks at retail facilities. Even with blender pumps, picture the maze of piping that would be required to supply all of the possible combinations! How many dealers want to spend the money required to add yet another type of fuel at their station, particularly when E85 hasn't exactly taken off in popularity? Who gets stuck with the liability when vehicles are accidently or inadvertently misfueled? Or misfueled because ethanol currently costs about $2/gallon and methanol is currently about $0.75/gallon. Even with the mileage disadvantage of methanol, if the sale price is lower, customers may be tempted to fill up with it anyway.

Methanol Use in FFVs

Relatively few changes are needed to change a vehicle into a FFV. An alcohol fuel sensor is used to monitor the fuel mixture and signal the onboard computer to adjust the fuel flow and spark timing (current ethanol model FFVs have eliminated the sensor, performing that task with software). Larger fuel injectors are used to compensate for methanol's lower energy content to assure that the same amount of maximum engine power is produced.

Because methanol is corrosive, certain metals and elastomers are avoided, and fuel tanks are nickel-plated or stainless steel, Teflon or stainless steel fuel lines are used, and methanol-compatible elastomers are used. An anti-siphon neck is installed in the fuel-filler neck, and an enlarged carbon canister reduces evaporative emissions when commingling occurs in the fuel tank. To enable the vehicle to also run on gasoline, the engine has not been modified to achieve the power and efficiency of vehicles that can run on methanol only.

Existing engines can be converted to use pure methanol by decreasing the ratio of air to fuel consumed from about 14 for gasoline to 6 for methanol by recycling more heat from the exhaust to the carburetor and by providing for cold starts. For methanol, a higher compression ratio (or variable compression ratio) and fuel injection is needed. It is unclear whether all existing E85 FFVs would be capable of running on M85, but I doubt that the warranty is currently written for M85.

Fate and Transport of Methanol in the Environment

Methanol is completely miscible in water; pure methanol yields a saturation concentration of 792,000 mg/L. Following a spill, methanol will dissolve in soil moisture. Methanol has a relatively high vapor pressure, allowing significant transfer of mass to the atmosphere or soil gas. However, because of its Henry's Law constant, it is not readily transferred to soil gas once it dissociates into water. Methanol does not readily partition onto mineral surfaces or organic carbon present in an aquifer, and as a result, the average velocity of methanol in groundwater is the same as the average groundwater velocity. Methanol degrades under a wide variety of aerobic and anaerobic conditions.

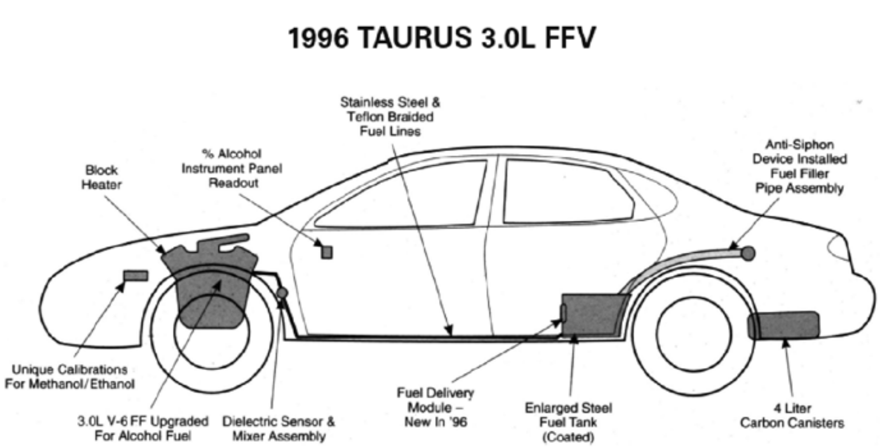
Let's look at different scenarios for releases of methanol into the environment. If pure methanol is spilled into a pristine environment and concentrations are sufficiently high to disrupt the microbial population, degradation of the methanol will be delayed until concentrations have become sufficiently diluted through dispersive transport. High concentrations may remain in the core of the plume for years. If concentrations of the initial spill are sufficiently low, first-order decay rates might be expected, and the plume will be relatively short-lived.

In the case where pure methanol is spilled in the same area as a preexisting BTEX plume, processes that must be considered are multi-component dissolution of gasoline, enhanced solubility of BTEX due to co-solvency, inhibition of methanol and BTEX degradation at high methanol concentrations, 3-D advective dispersive transport, and electron acceptor-limited competitive biodegradation with microbial growth. In this case, high concentrations in the core of the benzene plume will extend significantly greater distances beyond the source zone, and the total length of the benzene plume may increase by 30-35 percent. This is similar to what would be expected from gasoline/ethanol releases.

Remediation and Treatment

Methanol spills should biodegrade relatively quickly in the environment, therefore natural attenuation is likely to be an acceptable and cost-effective remediation strategy. If, however, the methanol spill becomes commingled with a gasoline plume, rapid biodegradation of methanol may deplete the surrounding soil

■ continued on page 15



Changes in FFVs compared with straight gasoline models.
(http://www.methanol.org/pdfFrame.cfm?pdf=MethanolUseinTransportation.pdf)

Biodiesel: A Multimedia Evaluation Case Study

Learning to Play Well with Others When the Ground Rules Change

by Robert Hodam

California statutes require new fuels and fuel additives to undergo a multimedia evaluation prior to receiving regulatory approval by the Air Resources Board of the California Environmental Protection Agency. (See LUSTLine *#61, "MtBE? Never Again!") The California Air Resources Board (CARB) chairs a Multimedia Working Group (MMWG) within CalEPA comprised of the Department of Toxic Substances Control, the Office of Environmental Health Hazard Assessment, and the UST Program of the State Water Resources Control Board (State Water Board). Normally, the applicant is a prospective producer of a fuel or fuel additive. Normally, the applicant finances and conducts testing at the direction of the MMWG, which then reviews the applicants work.*

Long before biodiesel came along the MMWG adopted a Multimedia Evaluation Guidance Document that sets the ground rules for the process, which are normally followed closely. However, biodiesel changed the ground rules.

Changing the Ground Rules

The first departure from the ground rules was the fact that there was no industry applicant. The biodiesel "industry" collectively has included backyard biodiesel chemistry projects and independent but small refining facilities using waste vegetable oil and animal fats, as well as biodiesel produced at larger refineries in the Midwest. By mid 2007 biodiesel and biodiesel/petroleum-diesel blends were being sold, albeit at a small scale, at various retail, commercial fleet, and military facilities statewide without all the appropriate regulatory approvals. Consequently, because no representative of the biodiesel industry came forward as an applicant for a multimedia evaluation, the MMWG chose to assume the role of applicant in order to accommodate the public interest in biodiesel availability.

The second ground-rule change was the source of financing. For biodiesel, the state assumed the cost of the multimedia evaluation that would otherwise be borne by an industry applicant. State financing meant the evaluation was operating under a much more limited budget than normal.

By taking on the role of applicant, the MMWG was also on new ground in terms of the relationship between its members. For example, the MMWG was no longer just a passive reviewer of an applicant's data; it was now also an active manager of the process responsible for developing the data it would review. Lacking the internal resources to fill the statutory requirement for a three-tiered multimedia evaluation, and concerned about an apparent conflict of interest, the MMWG hired the University of California (UC) to conduct the Tier I literature search and to design and execute a Tier II Experimental Plan to fill the data gaps in the literature search.

The Importance of Playing Well with Others

UC designed the Tier II experiments to include extensive air emission and water quality testing. Since this was the first time the MMWG had managed the Tier II experimental design process in-house, our respective new roles were at times somewhat less than coordinated—and coordination is the operative word in a multiagency multimedia evaluation!

In this case, for example, hundreds of gallons of soy and animal-fat-based B100 test fuel were purchased directly from two manufacturers for use in the air emission testing, but without adequate consideration of testing requirements for material compatibility, fate and transport, biodegradability, and aquatic toxicity. In addition, antioxidants were added to virtually all of the soy and animal-fat biodiesel—not a good idea, as it turned out.

This caused two problems. First, some of the MMWG were interested in testing "real-world" samples (i.e., biodiesel stored in and dispensed from a UST). The thinking was that "unadditized" biodiesel stored in and dispensed from a UST might better represent the fuel actually used in vehicles. However, once the fuel was purchased directly from manufacturers and "additized," the option of testing "real-world" samples was effectively foreclosed for budgetary reasons.

Second, initially there was not enough fuel set aside to test other parameters (i.e., material compatibility, fate and transport, biodegradability, and aquatic toxicity tests) besides air emissions requirements.

This kerfuffle happened because the MMWG had taken on the unfamiliar role of applicant, and because we were financing the evaluation on our own nickel with no room for cost overruns—*because as everyone east of the Sierras knows, the State of California has no extra nickels!*

Current Status of the Biodiesel Multimedia Evaluation

The Tier I literature search covering air emissions, aquatic toxicity, fate and transport, and biodegradability has been published: *California Biodiesel Multimedia Evaluation Tier I Report (http://www.arb.ca.gov/fuels/multimedia/multimedia.htm).*

Despite the confusion at the beginning, the Tier II experiments are nearing completion using only the "additized" fuel samples and stretching the fuel supply by dropping the material compatibility testing. UC Riverside has completed the air emissions testing, and the marine and freshwater toxicity tests were recently completed at UC Davis.

The initial air emissions indicate higher NOx and CO_2 with B20, B50, and B100 compared with ultra-low sulphur diesel (CARB diesel). The initial aquatic toxicology test results indicate that both soy and animal-fat B20 are significantly more toxic than ULSD for all six species of organisms tested.

However, in both cases the "additized" biodiesel contained the antioxidant *"Bioextend"* (TBHQ, tertiary butylhydroquinone); consequently, the extent to which the TBHQ additive affected the outcome is not clear. Because the biodiesel test samples contained TBHQ, we have no way of knowing whether the toxicity is the result of a combination of TBHQ+ULSD+B100, ULSD+B100, or the B100 alone. Consequently the entire aquatic toxic tests are being repeated with "unadditized" B20+ULSD and B100 alone, although as of this writing we aren't sure how we're paying for it.

The next steps are the Peer Review of the Tier III Report drafted by the MMWG followed by a submission of the findings and the Tier III Report to the California Environmental Policy Council for a determination of whether there are any "significant" adverse impacts that may affect the transport, storage, and use of biodiesel as a motor fuel in California.

Lessons Learned

One test of any procedure or process is its ability to adapt to unusual situations. The MMWG was able to do that, despite a few missteps.

Lessons learned include:

- It makes sense and saves cents to require the producer of the fuel product to conduct and finance the required multimedia evaluation.
- Avoid, if possible, conducting a multimedia evaluation in-house; but if the evaluation must be conducted in-house, pay close attention to coordinating activities when differing testing protocols are required. In our case, the entire toxicity testing had to be repeated. Both composition and quantity of B100 was inadequate due to internal miscommunications.
- The multimedia-evaluation process works, despite a kerfufflesque learning curve due to ground-rule changes. ■

Robert Hodam is a chemical engineer with the UST Section of the California Water Resources Control Board. He is currently responsible for alternative fuels issues and represents the Board on the CalEPA Multimedia Working Group. He can be reached at rhodam@waterboards.ca.gov

■ Water in Ethanol-Blended Fuels *from page 6*

fuels, one has to question if the leak-detection equipment and methodologies available to us today are capable of detecting water ingress at the 95 percent confidence level. Research is needed to supply the data necessary to properly evaluate the issues in this discussion and provide clarity rather than the murky uncertainty that now exists.

The increasing use of ethanol as part of our energy-independence efforts seems unstoppable for the foreseeable future. Certainly, energy independence is a vital concern and a laudable goal. The purpose of this discussion is not to cast aspersions on any leak-detection methodology or to dissuade the use of ethanol. Rather, the intent is to stimulate thought and foment constructive discussion relative to potential issues that may arise from the introduction of ethanol into our fuel storage and dispensing infrastructure. Protection of human health and the environment from the threat posed by leaking USTs through prudent and responsible regulation to prevent and detect leaks is in everyone's best interest. ■

Kevin Henderson is the UST Compliance & Enforcement Manager with the Mississippi Department of Environmental Quality. He can be reached at Kevin_Henderson@deq.state.ms.us.

SNAPSHOTS FROM THE FIELD

Photo courtesy of Chip Hughes

Photo courtesy of Ben Thomas

Another Spill-Prevention Device!

by Stephen Sturdivant

In the September 2008 issue of *LUSTLine*, Marshall Mott Smith, former administrator of the Florida Department of Environmental Quality Storage Tank Regulation Section, wrote that currently most UST leaks originate from the spill-bucket area where delivery drivers deliver fuel. Delivery spills are usually small and are often considered a normal part of the fuel-delivery process. But when spill buckets fail, the spilled product enters the environment and can add up over time—and cleaning it up is expensive. While delivery spills can happen when the driver forgets to empty the hose after the drop, loose connections between the hose and the fill port are also a common cause of small spills.

Loose connections may have several causes (e.g., the delivery driver improperly latches the elbow, worn assemblies, worn fill-port adapters, worn rubber gaskets on the inside of the delivery hose assembly). Worn gaskets may become more common because of the growing use of ethanol in fuels. Since ethanol might corrode rubber much faster than petroleum, the useful lifespan of these gaskets might decrease. Worn gaskets are seldom noticed.

When delivery spills happen, the delivery driver might use spill pads to soak up the spill. These pads may require special hazardous material disposal, an added expense. If the spill bucket does not contain debris and/or rainwater, the driver may drain or pump the fuel into the tank.

However, since ethanol is becoming more common in our fuel, the introduction of water can cause a host of problems, and it is almost impossible to tell by simply looking whether the fuel in a spill bucket has been contaminated with rainwater, because the ethanol absorbs the water. Water combines with the ethanol until the ethanol phase-separates from the gasoline, and even then the water is at the bottom of the bucket. Moreover, conductivity probes have a hard time differentiating between ethanol and water. Many ATG probes can only detect the presence of water after phase separation has occurred. Finally, few spill buckets have drain valves.

Spill Buckets Have Issues

While spill buckets are meant to capture small leaks and drips, they have drawbacks that owners, operators, delivery drivers, and inspectors should be aware of. For example, delivery drivers often just leave spilled fuel in the bucket, and if the bucket isn't watertight, the fuel slowly leaks into the environment. Even if the bucket is watertight, leaving spilled fuel in the bucket can corrode it, allowing leaks. Many spill buckets fail within a few years and are no longer watertight. While these failed buckets may appear to be containing spills, they are more likely slowly leaking fuel into the ground with every delivery. These small, slow leaks may go undetected for years.

Some failure points in the spill bucket may be obvious (e.g., cracks, tears), but many problems are hard to see by simply looking into the spill bucket, a common practice for many inspectors. Furthermore, many allowable tank and piping release-detection methods will not detect releases from spills.

Even when spill buckets are liquid-tight and functioning properly, they must be cleaned periodically. Unless spill buckets are kept clean and dry, their contents can't simply be poured into the tank, as that may introduce contamination from water and/or debris. Additionally, spill-bucket contents such as water, fuel, or debris may be considered hazardous material and must be disposed of properly.

The Sleeve

Preventing delivery spills will prevent costly and damaging leaks. One spill-prevention method involves the installation of a sleeve that fits inside the elbow assembly of the delivery hose and extends into the fill port transforming the hose end into the male end of the connection, thus stopping delivery spills before they happen. Depending on the manufacturer, these sleeves are sold either as an option for a new assembly or as an inexpensive retrofit.

Surprisingly, it seems as though many fuel distributors and even manufacturer sales representatives are not aware that such an add-on is available. One manufacturer told me that these inner sleeves are seldom sold.

Figure 1. *Two views of an elbow with a sleeve (left) and an elbow without (right)*

He speculated that drivers, many of whom are paid by the drop instead of by the hour, are concerned about the sleeves being difficult to use and slowing their deliveries and drop times.

I accompanied a delivery driver with five of years experience to gauge firsthand if these concerns were valid. The driver used two elbow assemblies, side by side, one with a sleeve and one without. (See Figure 1.) I watched the driver hook up each elbow to a different fill port. He found no disadvantages to using the assembly with the sleeve. Handling each elbow required the same effort, and he found that attaching and detaching them to the fill ports was not a problem.

I also noted the time it took to deliver fuel into the tanks for each elbow. The diameter of the sleeve was about the same as the inside of the elbow, so the sleeve did not interfere with the flow of fuel. Each elbow delivered the same amount of product, and both drops were completed at the same time.

Both spill buckets were empty and dry before the driver hooked up. After deliveries I found that the standard assembly without a sleeve leaked fuel into the spill bucket. The elbow with the inner sleeve left the spill bucket dry. (See Figure 2.)

So it seems to me that it would be a good idea to get the word out that these anti-spill sleeves exist. Purchasing elbow assemblies equipped with these sleeves, or adding them as a retrofit, appears to be a simple and cost-effective way to prevent delivery spills at the source instead of having to spend time cleaning them up. I am aware of at least three anti-spill-sleeve manufacturers: Dixon Bayco - part # 6200-17 and 6200X-17; PT Coupling - part UTF40 Anti-Spill Assy; and Civacon "OPW" – part T88 has the sleeve as an option. ■

Stephen Sturdivant is an engineer in the Underground Storage Tank program at the U.S. Environmental Protection Agency Region 6 in Dallas. He can be reached at Sturdivant.Stephen@epamail.epa.gov.

Disclaimer

This article was prepared by Stephen Sturdivant as a result of performing his official duties for the U.S. EPA. However, it has not been formally reviewed by the Agency, and it does not necessarily reflect the views of the U.S. EPA. EPA does not endorse, nor make any claim regarding the accuracy, validity or effectiveness of any company, technology, process, service or product that may be identified in this article. The effectiveness or appropriateness of any technology, process, product or service is the sole responsibility of the user. This information may not reflect the most current information.

Figure 2. Side-by-side comparison of a delivery with a sleeve (left) and one without.

Before—with sleeve

Before—without sleeve

After—with sleeve

After—without sleeve. Notice fuel in bucket

■ What if Methanol? *from page 11*

and groundwater of electron acceptors and nutrients required for the degradation of gasoline. Therefore a successful natural attenuation strategy for all constituents may require that the natural environment be enhanced with the addition of oxygen, nutrients, or other amendments to facilitate biodegradation of other gasoline constituents.

The high vapor pressure of methanol suggests that soil-vapor extraction should effectively remove methanol from soil, and once extracted, it can be treated using vapor-phase bioreactors. If the methanol is present in the groundwater at levels of concern, air stripping is not likely to be effective due to methanol's low Henry's constant; however, heated air stripping can be effective.

Due to methanol's lack of attraction to organic carbon, granular activated carbon will be ineffective. Advanced oxidation can be an effective remedial technology, but costs may be very high. Also, oxidation technologies can lead to undesirable changes in groundwater (e.g., bromate from bromide, which is naturally present in the water, and mobilization of metals). Biofilters can be an effective treatment technology, but they may not be acceptable for treatment of drinking water supplies (Malcolm Pirnie, 1999).

So Is Methanol a "Good" Fuel?

I guess you have to sit down and compare all the pros and cons for methanol. What are you going to make it from, imported or domestic gas, biomass material? Does it cost more to produce methanol from biomass, and if so, how much more? Will it run in an E85-certified FFV, or do we have to create a whole new FFV certification with different modifications? What will the costs be to make the fuel distribution and storage infrastructure compatible with methanol? What happens when it is released to the environment, and how much will it cost to clean it up? How much more of a health and safety problem will it be? Will we take income from our farmers by possibly taking away from the amount of ethanol used? Time will tell…… ■

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.

■ *continued on page 18*

■ Tank-nically Speaking
from page 17

■ 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*. ■

Field Notes

from Robert N. Renkes, Executive Vice President, Petroleum Equipment Institute (PEI)

At Long Last, Recommended Practices for Marina Fueling Systems

Marina fueling facilities must perform safely, reliably, and economically in a very challenging environment. Corrosion, ultraviolet radiation, heat, cold, and constant movement—which can range from a few inches to many feet—each present engineering challenges that must be understood and addressed. In addition, marina fueling systems may have to incorporate design elements to cope with hurricanes, floods, or dramatic water-level changes that are unusual but foreseeable.

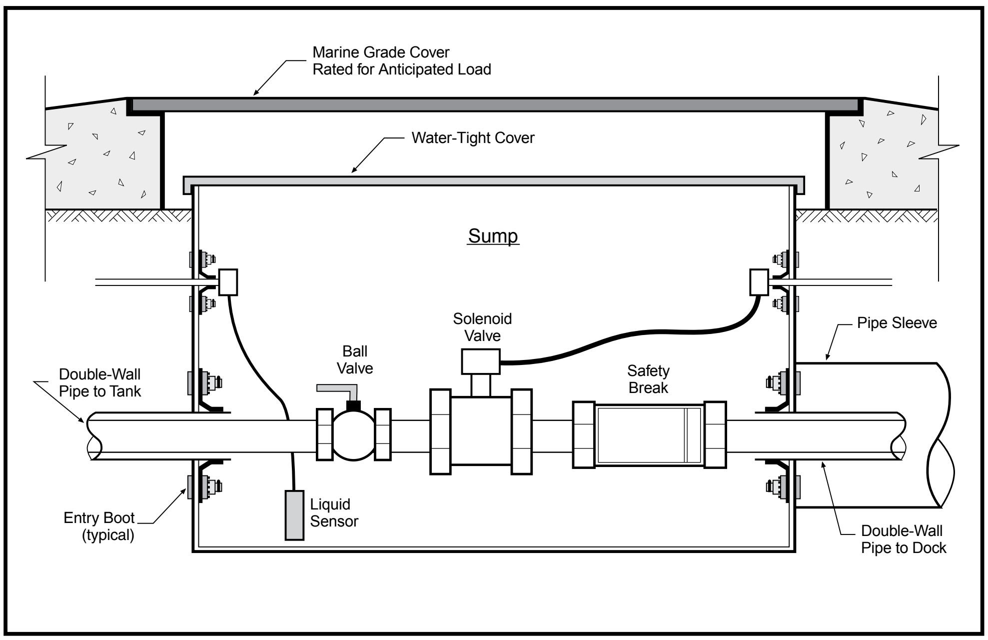
In the petroleum equipment industry, the typical fuel-system installation contractor does not construct marina fueling facilities on a frequent basis. As a result, there is often little internal company experience to draw on when a marina project is undertaken. My guess is that the same can be said about tank inspectors.

To date, no industry standard exists that describes how to construct a marina fueling facility that is protective of human health and the environment, simple to construct, easy to maintain, and user-friendly.

PEI is in the processing of developing a document (*Recommended Practices for the Installation of Marina Fueling Systems* PEI/RP1000-09) to provide a basic reference that conveys concrete, authoritative guidance on how to deal with the challenges of constructing safe, environmentally protective marina fueling facilities that will provide reliable and economical service for many years. PEI/RP1000 offers recommendations for materials, designs, and installation procedures suitable for a wide variety of marine environments, including fresh and salt water; still and moving water; and stable, tidal, and fluctuating water levels. Both fixed, onshore underground, and aboveground tanks are referenced.

One of the most challenging aspects of marina-fueling-system design is the routing of piping between the shore and a floating dock. This portion of the fueling system is especially challenging when the elevation of the floating dock changes significantly due to water-level changes. PEI/RP1000 has separate chapters that describe design factors to consider and recommend materials, valves, fittings, and installation techniques for the fuel piping at:

- the shore-to-gangway and the gangway-to-shore transition
- a fixed pier extending out over the water or a wharf or quay paralleling the shore
- floating docks.



Example of a diagram from PEI/RP1000-09. *The onshore transition sump provides containment and leak detection for several important components of a marina piping system.*

The draft document and comment form are available at *www.pei.org/RP1000*. PEI accepts comments to its draft recommended practices from anyone with an interest in the subject. Written comments offering changes to the document must be returned to PEI by September 30, 2009, to be considered by the PEI Marina Fueling System Installation Committee. Comments can be submitted either online or on the comment form that can be downloaded at the above website. ■

A MESSAGE FROM CAROLYN HOSKINSON

Director, USEPA's Office of Underground Storage Tanks

The Energy Policy Act Is Strengthening UST Prevention Programs

USEPA, state (including territorial), and tribal underground storage tank (UST) programs have long realized that a significant part of the UST program's success hinges on our ability to increase compliance and prevent USTs from leaking. When Congress passed the Energy Policy Act on August 8, 2005, USEPA, state, and tribal UST programs were presented with a mandate that focused on reducing UST releases. The Energy Policy Act contained numerous requirements that fundamentally changed UST programs and gave USEPA the authority and new ways to increase compliance and reduce leaks.

Approximately 50 percent of Americans—99 percent in rural areas—rely on groundwater as a primary source of drinking water. In addition, states report that petroleum leaking from underground storage tanks is one of the major threats to our country's groundwater. These facts reinforce what has long been a priority for USEPA and state UST programs—we need to prevent UST releases.

August 2009 marks the four-year anniversary since the Energy Policy Act became law. In addition, August 8, 2009, is also an important Energy Policy Act deadline: the requirement to develop state-specific operator training regulations. As I look at what UST programs have done over these past four years, I see much progress in meeting major milestones to increase compliance and prevent leaks:

- All states and territories have grant agreements in place to implement UST provisions of the Energy Policy Act.
- 56 states and territories met the two-year inspection deadline.
- 56 states and territories reported on UST compliance in their jurisdictions.
- 51 states and territories posted public records.
- 42 states and territories implemented additional measures to protect groundwater.
- 37 states and territories have delivery prohibition requirements.

I know that the remaining states have also made substantial progress in meeting the prevention requirements. States and territories have invested a great deal of energy and resources to get this point, and I applaud your efforts!

Tribal Progress

Additionally, I am pleased to see all that EPA and tribes achieved by working together to address tribal-related mandates in the Energy Policy Act. In August 2006, USEPA and tribes developed a strategy to further enhance our relationship, strengthen communication, and further the goals of the UST program in Indian country. The next year, USEPA reported to Congress on progress in implementing and enforcing the UST program in Indian country. Over the past years, USEPA and tribes have been implementing the goals and objectives of the strategy. A few of the key accomplishments include: meeting annually to identify tribal issues, build collaboration, and work toward continued partnerships; developing federal credentials for tribal inspectors; establishing a national tribal assistance agreement to provide tribal governments with compliance assistance and training; and launching a USEPA-based tribal Web area that provides information about training, funding, publications, and regulations. These successes are an important component to the tank program's goal of reducing underground storage tank releases.

Industry Cooperation

The prevention provisions of the Energy Policy Act have an impact on industry, too. I commend the underground storage tank industry (e.g., tank owners and operators, equipment manufacturers, tank service providers, delivery personnel) for their support and assistance with USEPA's efforts associated with the Energy Policy Act. Industry's real-world experiences and input were extremely valuable as USEPA developed the grant guidelines. I am aware, too, of industry's part in implementation. For example, I appreciate their creativity in identifying training ideas and approaches for meeting the operator training requirement. As I see industry's ongoing cooperation and support in meeting the prevention requirements, I appreciate their important role as partners in helping to protect our land and groundwater from underground storage tank releases.

The Job Ahead

As we pause to celebrate our accomplishments, we also need to keep sight of the work that still lies ahead. States are facing an ongoing workload to implement the Energy Policy Act's prevention provisions.

The on-site inspection requirement is a good example of the ongoing work states and territories will continue to face. They undertook the large workload necessary to meet the initial two-year August 2007 inspection requirement. Now there's a huge task ahead to meet the three-year cycle of inspecting all 235,000 active UST facilities by August 2010. And the three-year inspection cycle will continue into the future. The operator training requirement is yet another example of states' and territories' continuing implementation work. By August 2012, states need to ensure that operators are trained according to the newly established standards.

When we add the ongoing implementation work required by the other Energy Policy Act provisions (e.g., delivery prohibition, public record), I am well aware of how states' workload is different today than it was four years ago. From our side, USEPA has worked to provide states and territories with help in the way of additional resources, such as an increase in grant funding, USEPA inspections, and implementation tools.

■ *continued on page 21*

MESSAGE FROM CAROLYN HOSKINSON *continued*

In addition, USEPA and tribes still have many tasks ahead as we continue implementing the tribal strategy's objectives and work to further the goals of the UST program in Indian country. Over the coming years, USEPA and tribes will continue our ongoing work to increase compliance and cleanup rates in Indian country.

I am quite confident that state, territorial, and tribal UST programs, working with the regional UST programs, are up to this challenge. I know that together we will continue to make strides in keeping our land and groundwater safe from petroleum UST releases.

Additionally, I am eager to see whether, as we expect, the Energy Policy Act prevention requirements will result in increased UST compliance and a reduction in releases from USTs. I am optimistic that these requirements will assist us in our goal of reducing the annual number of UST releases reported.

I greatly appreciate your efforts thus far, and thank all of you who have contributed in so many ways to the success of our efforts in meeting the UST prevention provisions of the Energy Policy Act.

For more about the UST prevention requirements in the Energy Policy Act, see *www.epa.gov/oust/fedlaws/epact_05.htm* ■

It's Official, Hoskinson Is OUST's New Director

Carolyn Hoskinson is now Office Director of USEPA's Office of Underground Storage Tanks. She has been acting in that position since February 2009; prior to that she served as Deputy Office Director.

"I am honored to accept this responsibility and look forward to working with our partners on underground storage tank issues," said Hoskinson.

Carolyn has been with USEPA's Office of Solid Waste and Emergency (OSWER) for more than 18 years. In 1993, she was selected as OSWER's Analyst of the Year and has consistently put those analytical and leadership skills to good use.

Under her recent leadership at OUST, Carolyn has not only been responsible for leading and overseeing the core program to prevent and clean up releases from USTs, but also managing efforts to strengthen UST prevention as required in the Energy Policy Act of 2005, revise the I998 UST regulations, and implement the LUST Recovery Act—with associated new policies and unprecedented accountability and transparency expectations.

Congratulations, Carolyn!

Determining Hydraulic Conductivity at LUST Sites While Conducting Low-Flow Sampling

by Gary Robbins

It is almost universal for monitoring wells at LUST sites to be constructed in a manner in which their screens and sand packs bridge the water table. Although positioning wells in this manner may be useful for mobile product detection, it makes hydraulic conductivity values determined from slug testing such wells dubious. Twenty years ago Herman Bouwer recognized problems that arise owing to backfill zone drainage in such wells (Bouwer, 1989).

The typical equations for solving slug tests are based on log-linear recovery of the slug (in or out). In wells that bridge the water table, sand-pack drainage in slug out tests leads to a complex recovery curve that is multisegmented. The early segment of the curve is dominated by backfill-zone drainage. The late segment of the curve is dominated by the development of a cone of depression. To solve for hydraulic conductivity you have to pick out an intermediate portion of the curve that you think is representative of formation recovery. Such a choice is subjective, and the answer is very sensitive to where you pick the curve. Furthermore, sand-pack drainage requires that the effective radius of the well is corrected using a porosity value for the sand pack that is generally unknown.

As a means of circumventing this problem and reducing the need for an extra phase of investigation, we came up with the idea of determining hydraulic conductivity using the steady-state drawdown and flow rate achieved during low-flow sampling (Robbins et al., 2009). At steady state, backfill drainage no longer occurs. The method involves using steady-state versions of the equations used to derive the slug-test solutions (Hvorslev or Bouwer and Rice). The equations can be readily programmed in a spreadsheet. Since the method entails using only a single pair of parameters, they must be determined accurately. Check out our article that appeared in the recent issue of *Ground Water* for technical details at *http://www.water.uconn.edu/papers.html.* ■

References:

Bouwer, H. (1989). The Bouwer and Rice slug test—an update, *Ground Water,* 27, no.3: 304-309.

Bouwer, H. and R.C. Rice (1976). A slug test method for determining hydraulic conductivity of unconfined aquifers with completely or partially penetrating wells, *Water Resources Research,* 12, no. 3: 423-428.

Hvorslev, M.J. (1951). Time lag and soil permeability in groundwater observations. Vicksburg, MI: U.S. Army Corps of Engineers Waterways Experiment Station, Bull. 36.

Robbins, G.A., Aragon-Jose, A. T., and Romero, A., (2009. Determining hydraulic conductivity usin pumping data from low-flow sampling, *Ground Water* 47, no. 2, p. 271-276.

Gary Robbins, PhD, is with the Department of Natural Resources and the Environment, University of Connecticut. He can be reached at: gary.robbins@uconn.edu.

FAQs from the NWGLDE

...All you ever wanted to know about leak detection, but were afraid to ask.

A Short History of the NWGLDE

In this issue's FAQs from the National Work Group on Leak Detection Evaluations (NWGLDE), we look back on how the work group got started back in 1993. Please note: The views expressed in this column represent those of the work group and not necessarily those of any implementing agency.

Q. ***How did the NWGLDE get its start?***

A. USEPA set a December 22, 1990, deadline that required leak-detection equipment (other than interstitial, groundwater, and vapor monitoring) to detect 0.1 gph (annual test) and 0.2 gph (monthly test) leaks with a probability of detection of 0.95 and a probability of false alarm of 0.05. The agency also wrote several protocols that manufacturers could use to prove that their equipment met this standard. When Alabama's UST program started receiving equipment evaluations, staff members noticed that some were not performed strictly in accordance with the USEPA protocols. They came to the realization that there was no system in place to make sure these evaluations were performed properly. Therefore, Alabama's UST program made it a point to review the evaluations and not allow the use of equipment in the state if the protocol was not performed properly. This resulted in the formation of a list of Alabama-recognized leak-detection equipment.

It occurred to Curt Johnson, supervisor of the Alabama UST program at the time, that if other states became aware of this same problem, there was the potential that 50 states would be reviewing these same evaluations and there could possibly be 50 lists of recognized leak-detection equipment! This seemed like a very inefficient and potentially very confusing situation. While attending a regional USEPA meeting Johnson approached Lisa Lund, then Director of USEPA's Office of Underground Storage Tanks (OUST), and presented her with a plan to set up a national work group that would review the evaluations and prepare a list of equipment that was properly evaluated and that could be used by all the states. Lund liked the idea, and formation of the work group began. Curt Johnson and David Wiley of OUST worked out the details, such as number of people in the group and member representation.

At the 1993 Annual UST/LUST National Conference in San Antonio, Texas, prospective members were polled to determine the date and location of the group's first official meeting. As a result, the first meeting took place in Kansas City, Missouri, on June 4, 1993. This location was chosen so that the work group could visit Midwest Research and Ken Wilcox Associates, the companies that performed the majority of the equipment evaluations at that time. During the first meeting, rules were established and the name National Work Group on Leak Detection Evaluations was chosen.

The original work group members were Curt Johnson (Alabama), who was and still is the Chair; Lamar Bradley (Tennessee), current Vice Chair; David Wiley (OUST); Tony Ritcherson (Alabama); Allen Martinets (Texas); Russ Brauksiek (New York); Randy Nelson (Region 7 USEPA); Harold Scott (Region 10 USEPA); Beth DeHaas (Maine); Shahla Farahnak (California); and Mike Kadri (Michigan). At this first meeting, the list format had to be determined. California, Region 10 EPA, Alabama, and several other states all had lists at that time. The NWGLDE decided that the California list had the best format, so with California's blessing, the group began using the California format and continues to use that format today.

Now that it has been 16 years since the beginning of the NWGLDE, it appears that the concept has been very successful in providing the leak-detection evaluation information that USEPA and states need—without the necessity of every state having to review every evaluation. Also, through the years, the group has received comments from leak-detection-equipment vendors saying that they are very pleased with the concept of the NWGLDE, because instead of dealing with 50 states on each leak-detection-equipment issue, they just have to deal with the NWGLDE.

The big challenge of putting together that first NWGLDE List (copies of every edition of the List are available at NWGLDE.org) of 257 pages is well behind the NWGLDE. However, new challenges continue to arise, such as recent issues associated with the use and increases in the nonpetroleum composition of alternative fuels, innovations in leak-detection-equipment methods, and changes in state and federal underground storage tank rules. It appears that the NWGLDE may continue to help states address UST leak-detection issues for many years to come. ■

About the NWGLDE

The NWGLDE is an independent work group comprising ten members, including nine state and one USEPA member. This column provides answers to frequently asked questions (FAQs) the NWGLDE receives from regulators and people in the industry on leak detection. If you have questions for the group, please contact NWGLDE at *questions@nwglde.org*.

NWGLDE's Mission:

- Review leak-detection system evaluations to determine if each evaluation was performed in accordance with an acceptable leak-detection test method protocol and ensure that the leak-detection system meets USEPA and/or other applicable regulatory performance standards.
- Review only draft and final leak-detection test method protocols submitted to the work group by a peer review committee to ensure they meet equivalency standards stated in the USEPA standard test procedures.
- Make the results of such reviews available to interested parties.

New Products from USEPA's OUST

See OUST's New and Improved Homepage

USEPA's Office of Underground Storage Tanks (OUST) has redesigned its Web home page to more clearly reflect program priorities. Links to information about preventing releases; cleaning up releases; biofuels; petroleum brownfields; and USTs in Indian country are now more prominent on the home page and easier to access. The homepage is still at the same address: *www.epa.gov/oust.*

Two New Petroleum Brownfields Products from USEPA

USEPA has produced two new products devoted to fostering the reuse of petroleum-contaminated properties. One is a new and more comprehensive website devoted to petroleum brownfields. The other is a document, *Petroleum Brownfields: Developing Inventories,* EPA 510-R-09-002, May 2009, designed help to states, tribes, and local areas trying to create or enhance an inventory of petroleum brownfield sites

The website *(www.epa.gov/oust/petroleumbrownfields/index.htm)* provides a framework for the organization of petroleum brownfields information. It is designed to make information more accessible for those working to foster the cleanup and reuse of petroleum-impacted properties. It provides easy access to information that both new users and those familiar with brownfields will find useful. For instance, the site provides access to:

- "How-to " guides
- Ways to find petroleum brownfields sites
- Assessment and cleanup information
- Financial guides and USEPA Brownfields program and grants information
- Public/private partnership information
- Sustainability and petroleum brownfields.

The site also provides "Success Stories" with links to state, tribal, local, USEPA, and private petroleum brownfields success stories. The stories are organized by:

- State and local area
- Type of reuse—housing, commercial and business, public, and environmental and recreational
- Opportunities for small businesses —examples of cleaned up petroleum sites where small businesses have been established.

Petroleum Brownfields: Developing Inventories (www.epa.gov/oust/pubs/pbfdevelopinventories.pdf) is intended to help states, tribes, USEPA Brownfields Assessment grant recipients, and others develop an inventory of relatively low-risk, petroleum-contaminated brownfield properties. The publication has three sections:

- Section I identifies petroleum brownfields inventories as a tool for building and promoting a brownfields program.
- Section II outlines considerations for building an inventory.
- Section III discusses best practices from stakeholders that have implemented a petroleum brownfields inventory.

OUST Issues Updated Booklet Listing Insurance Providers for UST Owners

OUST issued an updated version of List Of *Known Insurance Providers For Underground Storage Tank Owners And Operators,* EPA 510-B-09-002, June 2009. This booklet provides UST owners and operators with a list of insurance providers who may be able to help owners and operators comply with financial responsibility requirements by providing a suitable insurance mechanism. OUST periodically updates this booklet and makes it available to stakeholders via its website at: *http://www.epa.gov/oust/pubs/inslist.htm.* ■

ASTSWMO Has a New Web page for Tank Newsletters

The Association for State and Territorial Solid Waste Management Officials (ASTSWMO) has set up a dedicated web page that places state tanks newsletters (and *LUSTLine*, too) in one centralized location. It can be accessed at *http://www.astswmo.org/resources_statetanksprograms-tanks_newsletters.html.* If you think of any newsletters from other tanks program-related organizations that should be added to this web page, contact Julius Shapiro at jshapiro@astswmo.org.

L.U.S.T.LINE
New England Interstate Water Pollution Control Commission
116 John Street
Lowell, MA 01852-1124

New Class C UST Operator Training Now Online

Petroleum Training Solutions (PTS) has developed the nation's first online training course for Class C underground storage tank system operators. A class C operator is anyone who is employed at a UST site whose duties may include identifying or responding to an alarm or emergency situation such as a spill or fire.

The PTS course, called *Fueling Station Safety*, is designed specifically for convenience store employees but is suited for anyone who may response to an alarm or spill incident at an UST system with fueling dispensers.

Class C operators are required to be trained in most states by August 2012. In Oregon and California, that requirement is already in effect. By the end of 2009, Wyoming and Colorado Class C operators must be trained as well. Utah and New Mexico are also looking to adopt earlier training deadline.

PTS created the course to fill the need for Class C training where UST owners needed a simple, standardized online solution. The course takes about 20 minutes and covers the basics of fueling hazards and emergency and alarm response. Students answer a series of questions, interact with scenarios, and take a quiz at the end. Those who pass the quiz can print a certificate of completion. User data and scores are maintained in the PTS online database.

The course retails for $12.99 per user. However, the Colorado Wyoming Petroleum Marketers Associations (CWPMA) and the Oregon Petroleum Association (OPA) have teamed up with PTS to help sponsor the course in their states. Members of those groups get a $3.00 per user discount. PTS offers bulk discount for companies with large numbers of class C operators.

"Because of the turnover retailers experience with employees, the Class C operator training will be the most frequently utilized program," says Mark Larson, executive director of CWPMA. "PTS understands this and has developed a comprehensive, yet simple—and almost entertaining—product that anyone can use anytime, day or night."

Recently, Petroleum Training Solutions launched the nation's first ever state-approved online operator training for Class A and B operators in Colorado. To learn more about the Class C operator course, go to *http://www.petroleumtrainingsolutions.com/classc.html* ■