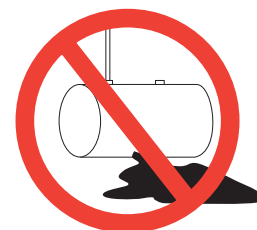


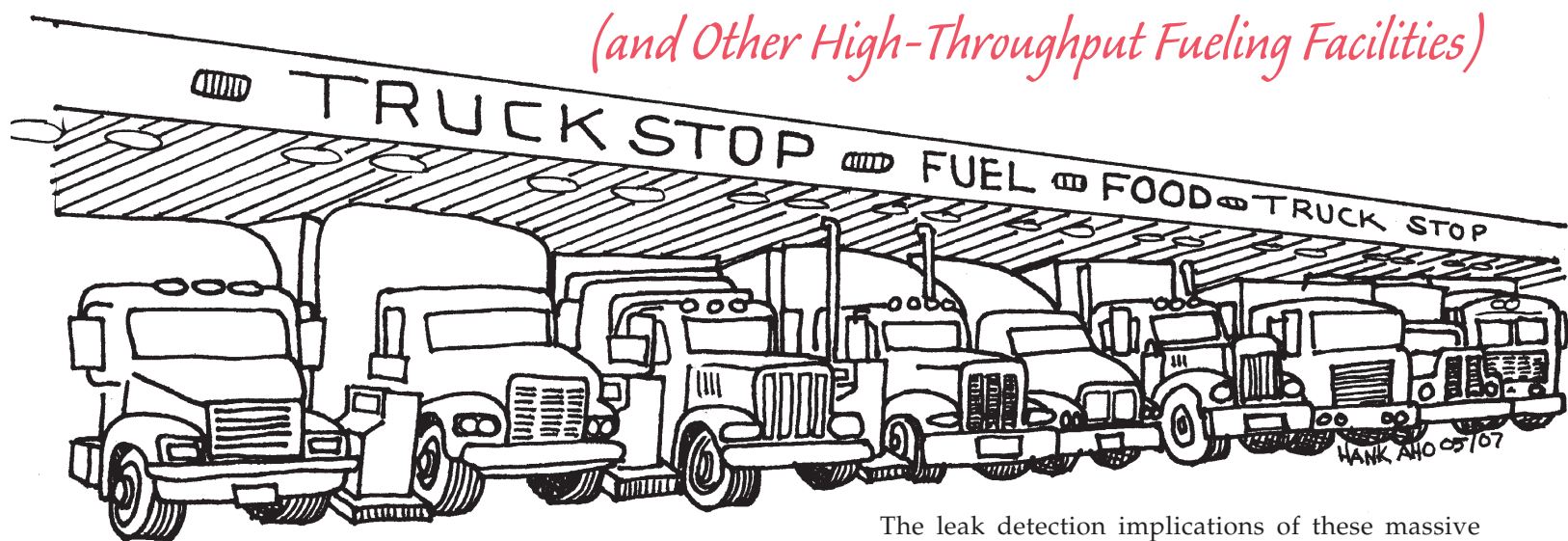
L.U.S.T.LINE



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

THE TROUBLE WITH TRUCK STOPS

(and Other High-Throughput Fueling Facilities)



By Marcel Moreau

The other day I spotted a tractor-trailer rig with a message on the side that caught my eye. It said, "You need it? It's in here." This message has often been stated another way, "America's needs move by truck." For better or for worse, these statements are no exaggeration. When was the last time you saw a Wal-Mart SuperCenter or a Home Depot or a Target or any other stadium-sized store located near a railroad track or a ship docking facility? The fact is that America's trucking industry is a cornerstone of our economy and our culture.

And all those trucks bringing all those goods within convenient reach of all our homes, guzzle oceans of diesel fuel that is dispensed at a relatively small number of fueling facilities. In 2004, U.S. vehicles consumed 37.3 billion gallons of diesel fuel. According to the National Association of Truckstop Operators (NATSO) website, three-quarters of this diesel fuel is pumped through facilities owned by their members. The average volume of fuel pumped at a typical large-scale NATSO facility is a million gallons per month. A throughput of a million gallons a month means that on average a facility pumps better than 33,000 gallons a day, or about 1,400 gallons an hour, or about 23 gallons each minute of every day.

The leak detection implications of these massive truck stop throughputs were the topic of a workshop presented by Steve Purpora of Purpora Engineering, LLC at this year's National Tanks Conference in San Antonio. Steve's dad, Bill, essentially founded the tank and piping testing industry in the U.S. back in the early 1970s and became the undisputed master of his trade. Steve began his career in UST testing at the tender age of eight and is passionate about leak detection. "Everybody can see that there's a huge potential for problems at truck stops," says Steve, "but because there are no simple answers, most

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everyone is content to be whistling Dixie and crossing their fingers. I can tell you from personal knowledge that this strategy is not working."

The problem is that this kind of very-high-volume-virtually-non-stop throughput leaves little time for leak detection. And because flowing fuel equals cash flow, there is little desire to interrupt fuel dispensing to allow leak detection to occur. And the fact is that traditional leak-detection methods are woefully inadequate to do their job in these high-throughput systems. Let's look at available leak-detection methods to find out why.

Leak-Detection Methods in a High-Throughput Environment

■ Inventory

A new facility less than 10 years old might still be able to use inventory control plus tightness testing every 5 years for leak detection. But with a million gallons of throughput, a vari-

ance of 10,000 gallons "passes" the federal standard of 1 percent of throughput plus 130 gallons. Clearly, though it may be legal, inventory control is not going to be protective of the environment at this level of throughput.

■ Automatic Tank Gauging (ATG)

Truck-stop tanks are never shut down at night and most are manifolded together, so ATGs that conduct periodic tests don't qualify as a leak-detection method. ATGs that conduct "continuous" testing still require quiet intervals when there is no pumping activity in order to gather the data required to conclude that a tank is tight or leaking. At throughputs of more than just a few hundred thousand gallons per month, however, these types of tank gauges typically do not have enough quiet time to do their leak-detection job. While ATGs can definitely help improve the quality of inventory data, at high-volume sites, they can serve no acceptable leak-detection function.

■ Statistical Inventory Reconciliation (SIR)

Traditional SIR methods rely on about 30 data points gathered on a daily basis to determine whether a leak is present. The SIR evaluation protocol does not put a throughput limit on the applicability of a SIR method as the continuous ATG protocol does. It would be foolish to conclude from this, however, that a SIR method can be used at a facility no matter how high the throughput. I do not see how a SIR method can reliably detect a 150-gallon loss in a million gallons of sales (that's 0.015 percent of the sales volume) using only 30 data points.

There is a more recently developed "real-time" SIR that can automatically gather thousands of data points by taking "snapshots" of the fueling activity at a site. One vendor of this approach has been certified for throughputs of up to 2.7 million gallons. This approach has promise, especially because it offers facility owners a means of keeping much tighter control over their fuel inventories and thus offers business advantages as well as leak detection.

SIR methods alone will not do the complete job of piping leak detection at a truck-stop facility. Truck

stops typically have satellite fuel dispensers that allow tanks on both sides of a truck to be fueled simultaneously in a single sales transaction. Satellite dispensers are typically connected to the master dispenser via a relatively short length of underground piping. Inventory-based methods of leak detection do not see any leakage that may occur after the fuel has passed through the metering mechanism in the master dispenser. Thus, no inventory or SIR-based method of leak detection can be used for leak detection on satellite-dispenser piping.

■ Secondary Containment

Secondary containment with interstitial monitoring is one of the few methods of leak detection whose efficacy is not affected by throughput and could realistically be expected to meet regulatory requirements for monthly leak detection. However, many existing truck stops do not have secondary containment. Replacing existing storage systems is a costly proposition, and not just because of the huge storage capacity and the extensive piping network required for the new system. The cost of interrupting the fueling operations in terms of lost profit as well as the loss of customers to competing facilities during the construction of the new storage system is likely to dwarf the cost of the storage system itself.

■ Soil-Vapor Monitoring

Diesel fuel is not nearly as volatile as gasoline, so soil-vapor monitoring is not a particularly sensitive method for detecting diesel-fuel leaks. Because fuel storage and dispensing systems at truck stops are spread out over a large area, it would also require a multitude of sampling points to achieve effective leak detection. Existing contamination at many sites could also pose problems in detecting new releases.

■ Groundwater Monitoring

The biggest restriction on groundwater monitoring is that it is only acceptable where the groundwater is less than 20 feet from the ground surface. Because of its questionable effectiveness in detecting releases and the difficulties encountered in distinguishing new leaks from old, groundwater monitoring is hardly anybody's favorite method of leak detection. Like soil-vapor monitoring,



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effectively monitoring an entire truck-stop fueling facility would also require an extensive network of wells.

■ Tightness Testing

Few facilities use inventory control plus tightness testing as a method of tank leak detection today. Tightness testing primarily plays a role in the annual testing plus line-leak-detection option for pressurized-piping leak detection. The biggest obstacle here is cost—not the cost of the actual tightness test but the cost of business lost during the time required to set up and conduct the test.

Few truck-stop designers had the foresight to design a facility so that a portion of the dispensers could be shut down while the rest continued to operate. “Truck-stop designers apparently never heard that saying about ‘putting all your eggs in one basket,’” says Steve Purpora. “So when something breaks down, the whole system is down and there’s a huge rush to get pumping again. Checking for leaks to be sure the work has been done right is not even a consideration.”

This philosophy places great pressure on the piping and distribution system to operate non-stop, because taking the time for maintenance, minor repairs (even of small leaks), and testing is unacceptably expensive due to the lost income from the interruption of sales.

Consequently, if tightness testing is done, facility operators want the testing to be conducted at night and they want it done fast to minimize costs and inconvenience to customers. While this is all very understandable, it puts substantial pressure on tightness testers to be quick rather than accurate. “And,” adds Steve Purpora, “tired testers working in the dark around tired truckers driving enormous rigs is hardly the ideal situation from a safety perspective.”

■ Line-Leak Detectors

Perhaps the biggest deficiency associated with truck-stop leak detection is the lack of line-leak detection on the pressurized piping. Remember that the regulatory definition of line-leak detector is “a device that can detect a leak rate of 3 gallons per hour at a pressure of 10 psi within one hour.” All line-leak detectors, whether mechanical or electronic, require that

the pump be cycled either from off to on (mechanical LLDs) or on to off (electronic LLDs) in order to conduct a test. At a facility where the pumps remain on for many hours at a time (at many facilities the pumps may not shut down for days at a time) the line-leak-detection requirement is not met because the pumps do not shut down on an hourly basis. If a sizable leak were to develop in a truck-stop piping system, it could very likely not be detected by a line-leak detector until many hours had passed.

Truck stops stretch the limits of LLDs in other regards as well. The volume of the extensive, large-diameter piping runs may easily exceed the volume-limit restrictions on the line-leak detector as determined by the third-party evaluation. In addition, if the lengthy piping runs are sloped uniformly towards the tanks, the tanks may end up buried many feet below grade. For mechanical LLDs, this could create a scenario where the static head pressure produced by the product in the pipe would be sufficient to prevent the LLD from ever “tripping” and detecting a leak. (See *LUSTline* #29, “Of Blabbermouths & Tattletales – The Life & Times of Line Leak Detectors” for a more detailed discussion of this issue.)

While in some jurisdictions, double-walled piping with continuously monitored sensors in tank-top and dispenser sumps might be acceptable as line-leak detectors, this is not a position that I am particularly fond of. But given existing technology and the realities of truck-stop operations, this may well be the best that can be done to meet line-leak-detection requirements.

■ 0.2 Gallon per Hour Monthly Testing

Single-walled piping systems are increasingly using the automated 0.2 gph leak-detection capability of most electronic LLDs to meet the monthly piping leak-detection requirements. These tests require the temperature of the product in the piping to be stable in order for the test to be accurate, so most devices conducting this type of testing require a 30-minute or so period of no dispensing before they can run the test. Thirty-minute quiet periods are virtually nonexistent at truck stops, and so electronic LLDs cannot be relied upon to meet leak-

detection requirements by conducting monthly 0.2-gph tests.

The Bottom Line

Because of their extraordinary throughputs and extensive piping systems, truck stops present time-based and physics-based challenges to effective leak detection. While secondary containment with interstitial monitoring may be the most-likely-to-succeed method of leak detection, few regulatory agencies have the clout to force existing single-walled facilities to upgrade to secondary containment.

While it is true that the federal Energy Policy Act may by default impose secondary containment on most of the nation’s new storage systems, this is a double-edged sword. The increased replacement cost of new storage systems means that owners will keep their existing single-walled storage systems in service as long as possible. And because most state regulations have no mandatory retirement age for storage systems, “as long as possible” means until the storage system can be proven to be leaking. Coupled with the ineffectiveness of leak detection in detecting leaks, this is not a comforting prospect.

Real-time inventory analysis could provide leak detection relief for many facilities with throughputs less than 2.7 million gallons a month, while providing fuel-management benefits like verifying delivery volumes and checking the calibration of meters. Real-time inventory analysis may provide the least objectionable pathway for single-walled storage systems to achieve compliance with monthly leak-detection requirements. Keep in mind, however, that leak detection for satellite piping would still need to be addressed. Line-leak-detection requirements remain problematic under any leak-detection scenario that I can think of.

In the meantime, Steve Purpora is promoting a campaign of awareness and incremental improvement. “People need to know that just because the rest rooms at a high-volume facility are clean doesn’t mean that everything below ground is hunky-dory. Regulators need to pay more attention to truck stops and not be intimidated by their size or

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■ Trouble with Truck Stops from page 3

their complexity. Truck-stop operators need to be made aware of their responsibilities and have their feet held to the fire. At a minimum," continues Steve, "a detailed annual inspection, in daylight, should be conducted and fines assessed just like for any other noncompliant facility."

Our High-Throughput Challenge

The continuing increase in our nation's fuel consumption (we used 2 billion more gallons of diesel fuel in 2004 than 2003, and 2.5 billion more gallons of gasoline), together with the dramatic reduction in the number of fuel-storage systems since the onset of the federal tank rules has produced a substantial increase in the throughput volume of the "typical" storage system. As this trend of increasing throughput continues, the leak-detection methods formulated for the storage systems of the 1980s will be stretched to their effective limits at an increasing number of sites. While leak-detection issues associated with high throughput are most obvious at truck stops, they are present in a growing number of today's convenience stores as well.

So my crystal ball is as fuzzy as ever, but I see in its misty depths a growing need for "next-generation" leak-detection methods like real-time SIR and pressure-/vacuum-based interstitial monitoring, as is now required for new facilities in California, to meet the leak-detection challenges of today's (and tomorrow's) high-throughput fueling facilities. ■

NOTE: Curt Johnson chaired a session at the National Tank Conference in San Antonio entitled "Leak Detection — The Next Generation" that provided much interesting information on the state-of-the-art of leak detection. For a copy of the slides presented during this session of the conference, go to: <http://www.neiwpcc.org/tanks07/presentations/LeakDetectionSession-All-Handouts.pdf>

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Continual Reconciliation Applications for Active Fueling Facilities

by William P. Jones

While the population of regulated USTs has dropped dramatically since storage tank rules were first published in 1988, there has been a major trend in the retail petroleum industry toward the development of high-throughput fueling facilities. Hypermarket fueling stations with customers at each dispenser, convenience stores active at all hours of the day, and travel centers with delivery transports lined up to make their drops are now a common sight. The fueling public is drawn to these facilities because of their competitive fuel prices. The business model that supports these complex operations relies upon moving large amounts of fuel products on thin margins.

Naturally, operation of these high-tempo sites imposes wear and tear on fueling equipment. From a leak-detection standpoint, the concern is whether product containment has been compromised in the face of all this activity. (See "The Trouble with Truck Stops..." page 1.) From a business perspective, costly fuel-inventory losses can take place at active sites because of problems with meters drifting out of calibration or improper blending ratios, theft at the dispenser or upon delivery, or the effects of temperature fluctuations.

Many companies with high-volume sites have realized that the best way to manage their complex operations is to rely upon precise measurements of fuel inventory. Warren Rogers Associates (WRA) has worked with operators of such sites to develop a Continual Reconciliation System to enable them to manage their leak-detection requirements and all of the complex transactions and fueling equipment at high-throughput facilities where problems with fuel-inventory shrinkage are endemic.

The Continual Reconciliation System

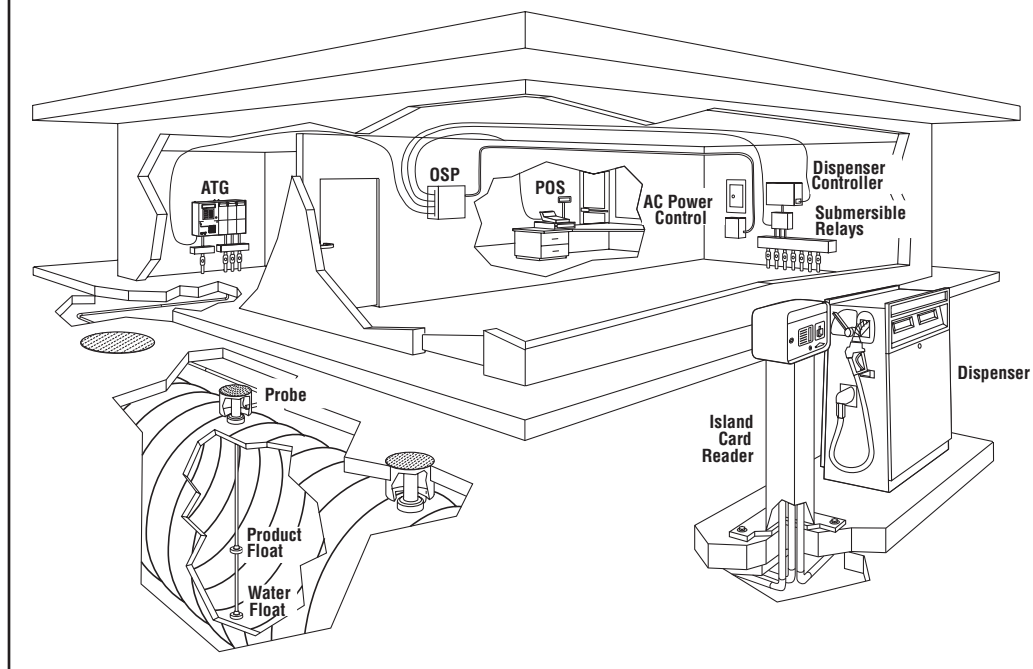
As shown in Figure 1, the Continual Reconciliation System uses a processor ("OSP") installed at each facility to acquire data from automatic tank gauges, dispenser controllers, and other related systems. The OSP records data for each dispenser and compiles refined inventory data at the conclusion of every sales transaction by querying the tank gauge for product height and temperature measurements. The OSP develops a complete and ongoing record of fluid flows, transfer, and storage occurring on-site.¹

Because the Continual Reconciliation System develops precise inventory measurements, it is capable of computing delivery volumes and meter calibration. Further, the system adjusts for the expansion and contraction of product due to temperature change on an ongoing basis. The system also identifies leakage as a continuous loss of product, as opposed to episodic delivery shortfalls, theft, or excess product dispensed due to meter miscalibration.

Given that the Continual Reconciliation System works while the UST system is active, its leak-detection applications function differently than conventional automatic-tank-gauge and line-leak detector monitoring. Typically, volumetric monitoring of tanks and associated lines has taken place when the tank systems are dormant, an infrequent occurrence at high-volume sites. The Continual Reconciliation System instead relies on data from both the static and dynamic operations of the tank so that ongoing monitoring of the tank system can occur.

Because the Continual Reconciliation System tracks product from the point of delivery to the dispenser meter, leaks from almost every component of the storage system can be detected. We have found that leaks originating in the tank shell or buried

1. U.S. and foreign patents apply.

FIGURE 1. OSP Site Communications Hub

Dispenser theft at a truck-stop facility, for example, is not a trivial event, since the losses of each individual event could be greatly in excess of 100 gallons of product. The Continual Reconciliation System can calculate on an ongoing basis the actual amount of product delivered to a tank system as well as identify theft events by date, time, and amount.

Marrying Business and Environmental Concerns

Continual reconciliation has an important role for volumetric leak-detection monitoring in high-throughput UST systems. It is a way to motivate tank owner/operators to pay attention to leak detection.

pipng runs are much less common today than leaks in flexible connectors, line-leak-detector components, and dispenser components such as impact valves, unions, and meters. Though common, many of these types of leaks are often missed by traditional methods of leak detection.

As a result of its ability to use all of the available data from a tank system, the Continual Reconciliation System is certified as an automatic tank gauge system method for monthly monitoring of tanks and associated lines for complex manifolded tank systems up to 100,000 gallons in capacity and nearly 3 million gallons in monthly throughput.

What about Non-Leak Losses?

The same data the system collects for leak detection purposes can also be used to quickly pinpoint and quantify non-leak losses. Operational problems such as miscalibrated meters, short deliveries, and theft at the pump occur with far greater frequency than leakage, and their costly effects can mount up quickly at a high-throughput site.

For example, an active dispensing position for diesel fuel could be checked for calibration by weights and measures standards and be found to be operating within the acceptable range. However, this same

dispenser at an active travel center can be dispensing in excess of 300,000 gallons monthly and during that time could be giving away 650 gallons of product worth nearly \$2,000.00 despite the fact that it's operating in conformance with required tolerances.

The Continual Reconciliation System is able to identify such meter-drift effects because measurements are being recorded at the end of every transaction and set of overlapping transactions. Therefore the contribution of each individual meter to inventory variations can be identified. Instances of both meter giveaway and holdbacks can then be identified to the owner/operator so that they can be corrected. Further, because the duration of transactions is also recorded, dispenser flow rates can be determined to identify clogged filters or problems with flow limiters.

Theft is also common at the point of delivery or at the dispenser, particularly in this era of volatile fuel pricing. While delivery shortfalls may be apparent to the operator of a low-throughput site, they are difficult to identify at a very active facility taking more than one delivery a day. Similarly, dispensers can be jiggered at remote fueling positions of high-throughput sites, resulting in unauthorized fueling transactions.

As a result of the reconciliation system's ability to identify specific reasons for loss of product—be it piping or dispenser or theft or meter drift—a report of leakage becomes more visible and understandable to the businessperson who owns or operates that site. Leak detection is enfolded into everyday business practices. If a situation develops at a high-throughput site, the operator can quickly direct his/her attention to the problem at hand rather than undertake a protracted "hit-or-miss" investigation that could allow a leak to persist. It is a win-win solution for both the businessperson and the environment.

Currently the Continual Reconciliation System is in use at over 400 active travel centers nationwide as well as at high-volume convenience stores and truck terminals. To find out more about this leak-detection option, go to www.warrenrogersassociates.com or consult the National Work Group on Leak Detection Evaluation's website at www.nwglde.org and look under the methods listed for Continuous In-Tank Leak Detection Systems. ■

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Florida's Leak Autopsy Study for Storage Tank Systems: An Enlightening Work in Progress

by Marshall T. Mott-Smith

The Florida Department of Environmental Protection's (FLDEP's) Storage Tank Regulation Section has been interested in obtaining field data on the sources and causes of discharges from underground and aboveground storage tank systems since the program began in 1983. As early as 1986, the department entered into a contract with a university engineering department to evaluate the department's Discharge Report Forms. Things came to a halt when the contract was cancelled due to poor performance.

A second study was initiated in 2001-2002 with the USEPA Office of Underground Storage Tanks (the "Florida Cause of Leak Study"). This joint effort collected 642 valid data points from 2,280 file reviews. FLDEP used USEPA funding to pay for County Tanks Program inspectors under contract with the department to perform file reviews of closure inspection documents of UST and AST systems.

The study focused on single-walled and double-walled systems and excluded data from unprotected steel systems or those where the source of the discharge was unknown. The final data correlated well with USEPA Region 4's leak autopsy data, and echoed the findings that the main source of leaks from UST systems was single-walled piping systems. (Contact EPA's Office of Underground Storage Tanks if you are interested in obtaining a copy of the draft report.)

FLDEP decided to continue the Florida Cause of Leak Study, making several revisions learned from the previous effort. Since January 1, 2003, all 145 of the FLDEP County Tanks Program inspectors have been required to submit a leak autopsy form for any new discharge.

This new study is called the Florida Leak Autopsy Study for Storage Tank Systems. We believe it has more credibility than the previous study because the data from this effort is field-verified and submitted

FIGURE 1. UST Leak Sources in Florida

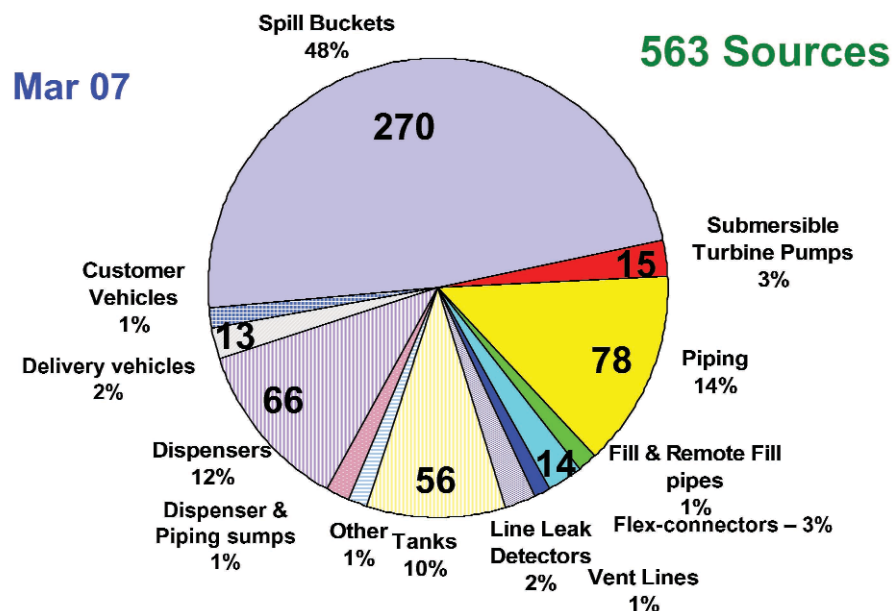
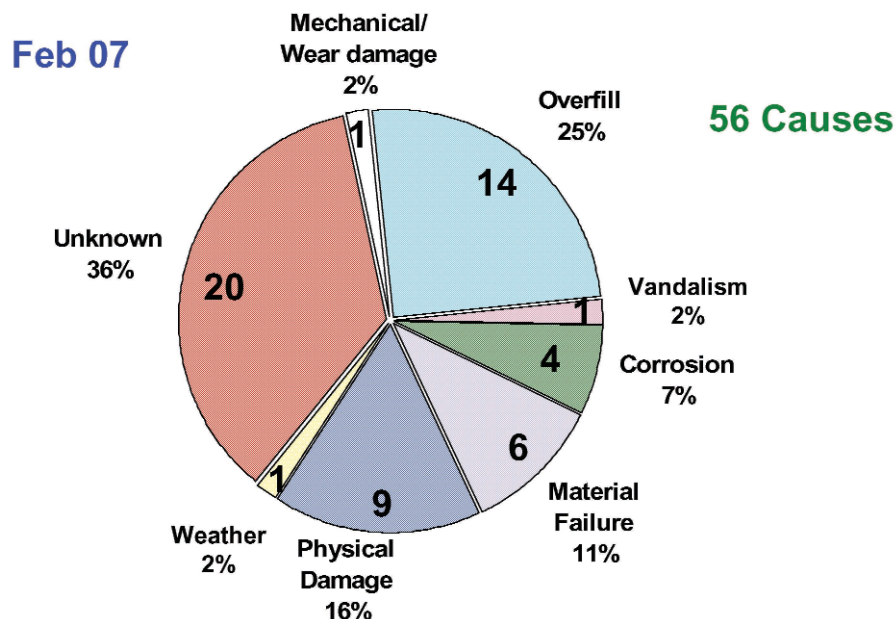


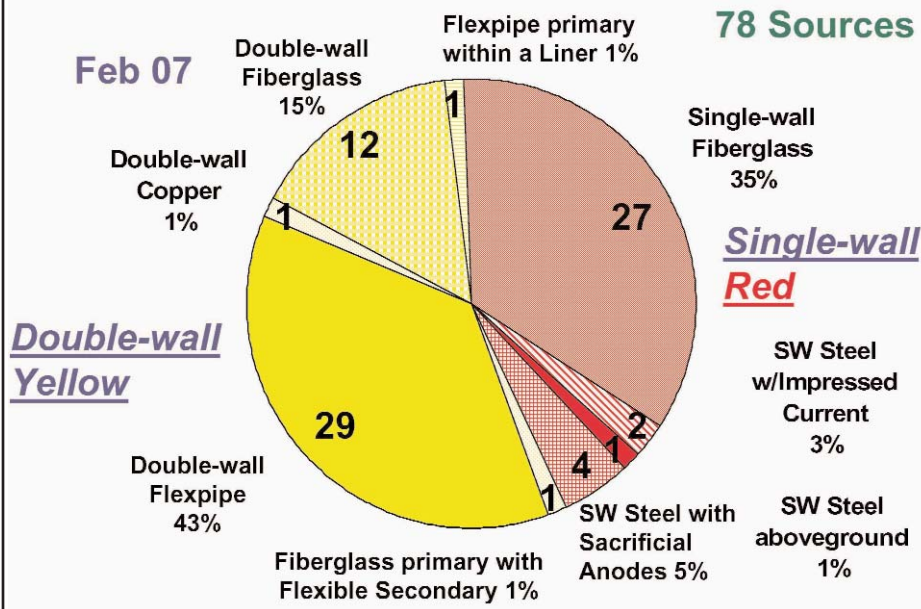
FIGURE 2. USTs, Tanks as the Source, All Causes



by the inspector. In addition to the form, each discharge file has a copy of the Discharge Report Form, the facility inspection report, and usually contains photographs or supporting data such as lab analyticals or test results.

After four years of data submital, some interesting trends have

emerged. Where underground piping associated with USTs used to be the major source of leaks in Florida, the current most common source of discharges is the spill bucket. Nearly half of all new leaks are coming from spill-prevention systems, with material failure (cracking or splitting) being the major cause.

FIGURE 3. USTs – Piping as the Source, Type of Piping

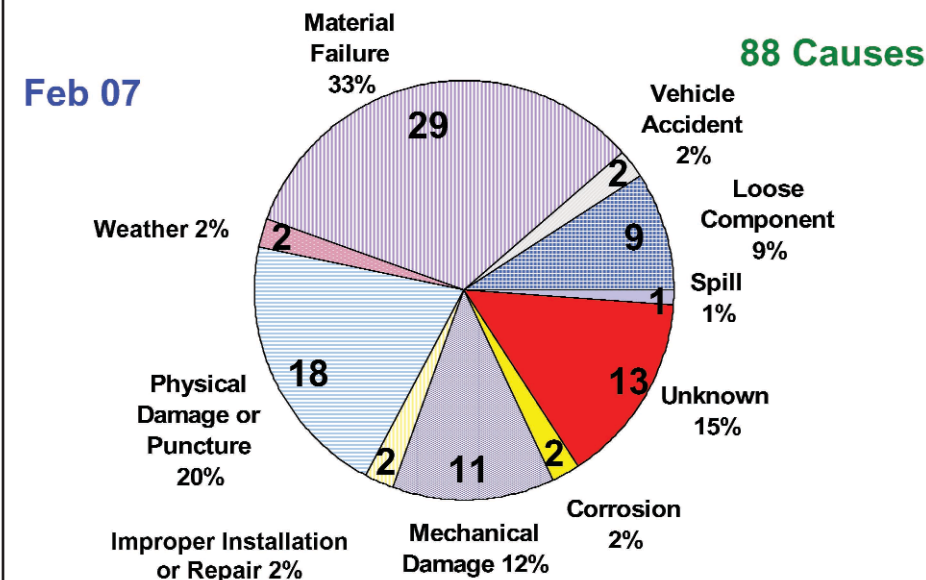
discharges for large field-erected tanks (greater than 50,000 gallons) is underground bulk-product (larger than three inches in diameter) steel piping that is in contact with the soil. If you include pumps, valves, and other systems associated with these steel piping systems, then nearly two thirds of all discharges from these types of tanks come from piping. For smaller shop-fabricated tanks, the most frequent source of discharges is the tank, and the major cause is overfills.

The information obtained from the Florida Cause of Leak Study has been extremely valuable for program management and rule-making decisions and enables the department to concentrate on the problem areas. Whether it is an enforcement case before a judge or hearing officer, or before a state rulemaking board, we are now able to do something that we were unable to do in the past—show actual data to support our positions instead of anecdotal information obtained from our inspectors.

We hope that other state and federal tanks programs will benefit from this ongoing study, which will become even more statistically valid as time goes on. We are open to suggestions from interested parties to help us refine and improve the process. We will continue to provide updated data on our Tanks Program website at:

<http://www.dep.state.fl.us/waste/categories/tanks/default.htm> ■

Marshall T. Mott-Smith is Administrator of the Storage Tank Regulation Section Bureau of Petroleum Storage Systems at the Florida Department of Environmental Protection. He can be reached at marshall.mott-smith@dep.state.fl.us

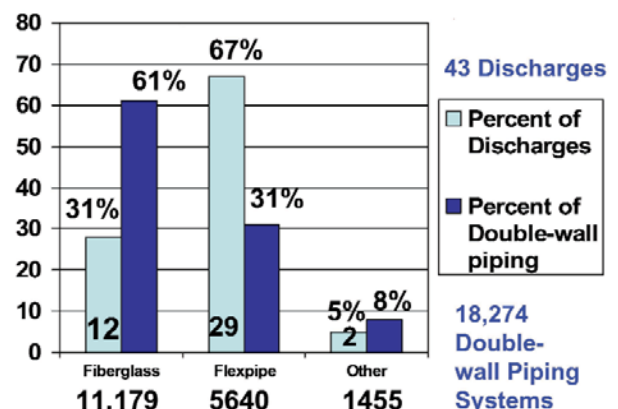
FIGURE 4. USTs – Piping as the Source, All Causes

Piping is the second most common source of discharges, with, unfortunately, almost as many discharges from double-walled systems as from single-walled systems. This finding can largely be attributed to flexible polyethylene piping systems. Tanks are the source of discharges in only 10 percent of all discharges, and most of those are associated with tank overfills where the tank was the source of the discharge, but the cause was an overfill.

For ASTs (aboveground storage tanks), the most frequent source of

FIGURE 5.

Performance of Double-Walled Piping Compared to Percent of Usage



The Impact of Ethanol on the Natural Attenuation of BTEX and MtBE

A research team comprised of members from University of California-Davis, Geomatrix Consultants, and USEPA conducted controlled field experiments at a typical fuel spill site to assess the impact of ethanol on natural attenuation of BTEX and pre-existing MtBE contamination. Because most fuel-contaminated sites in the United States overlie aquifers in which the dominant electron acceptor is sulfate (1), a sulfate-dominated site was selected for this research. The research was originally published in *Environmental Science and Technology* as two articles by D. M. Mackay, N. de Sieyes, M. Einarson, K. Feris, A. Pappas, I. Wood, L. Jacobson, L. Justice, M. Noske, K. Scow, and J. Wilson—"Impact of Ethanol on the Natural Attenuation of Benzene, Toluene, and o-Xylene in a Normally Sulfate-Reducing Aquifer," Vol. 40 (2006), pp. 6123-6130, and "Impact of Ethanol on the Natural Attenuation of MtBE in a Normally Sulfate-Reducing Aquifer," Volume 41 (2007), pp. 2015-2021. These papers have been edited for *LUSTLine* by Ellen Frye.

Ethanol's Subsurface Underbelly

As ethanol replaces methyl *tert*-butyl ether (MtBE) and becomes an increasingly common component of automobile fuels, it is important to determine if it will pose any significant direct or indirect risks as a groundwater contaminant. Ethanol is expected to degrade rapidly and without any acclimation period under most redox conditions, unless present at very high concentrations such as might occur adjacent to fresh spills (2). Thus, ethanol itself is unlikely to pose much direct risk as a groundwater contaminant, except perhaps in unusual cases.

However, an ethanol release could pose an indirect risk due to its impact on the natural bioattenuation of other petroleum-associated contaminants caused by the rapid preferential biodegradation of ethanol and consequent depletion of electron acceptors and/or modification of the microbial community (2-5). Ethanol would be expected to influence the natural biodegradation of fuel components, notably the BTEX compounds (benzene, toluene, ethylbenzene, and xylene isomers), due to rapid preferential biodegradation of ethanol causing (a) depletion of readily available electron acceptors, thus slowing or stopping BTEX biodegradation by native microbes, due to slower kinetics compared to more energetically favorable metabolic pathways, and/or (b) reduction of the fraction of the native microbial community able to biodegrade BTEX (2-10).

Release of ethanol may also create and sustain strongly anaerobic and sometimes methanogenic condi-

tions in groundwater. Studies have provided evidence of transformation of MtBE to *tert*-butyl alcohol (TBA) and other intermediates, both in microcosms under highly reduced (including methanogenic) conditions and in the methanogenic zones near fuel spills (1, 11-16). Laboratory studies measuring fractionation of stable isotopes during anaerobic metabolism of MtBE implicate acetogenic bacteria in the process (14,15). Molecular hydrogen produced by the fermentation of BTEX compounds may produce the hydrogen that can support anaerobic metabolism of MtBE by acetogenic micro-organisms (13, 16).

On the other hand, at sites where natural attenuation has depleted BTEX compounds from a gasoline spill that originally contained MtBE, anaerobic biotransformation of MtBE may slow or stop altogether. This could lead to conditions where fermentation of ethanol dominates and where acetate and molecular hydrogen are generated as fermentation products which may, in turn, support microbial communities that accelerate the biotransformation of any pre-existing MtBE to TBA and other intermediates.

To gain a clearer picture of the indirect risk posed by an ethanol release, the research team conducted side-by-side experiments in a sulfate-reducing aquifer, at a former fuel station at Vandenberg Air Force Base (VAFB), California, to evaluate the effect of an ethanol release (a) on biodegradation of benzene, toluene, and o-xylene (which will be referred to as BTEX) and (b) on the fate of pre-existing MtBE contamination.

The Site and Pre-experimental Conditions

The goal of this study was not to examine the worst conditions that might occur for a large and catastrophic gasohol spill, but rather to examine the likely more common case of long-term, small-volume releases of gasohol to the subsurface at an operating fuel service station with no ongoing active remediation of past spills.

A gasoline leak was noted at the VAFB site in 1994, tanks and piping were excavated in 1995, and the excavation was backfilled with materials more permeable than the native surficial media. Figure 1 depicts the surface boundary of the excavated area and location of monitoring wells installed before and during the experiments. The square demarks the area of focus.

In the vicinity of the backfilled excavation, several thin, essentially horizontal, sandy layers exist within 8 meters of ground surface. (See Figure 2.) These include the S2, within the zone of water table fluctuation, and the S3 and S4, always fully saturated. Another layer, the S1, lies above the range of water table fluctuation and is not depicted since it is unrelated to this research. Layers of silt or clayey silt separate these sandy layers and are of considerably lower permeability. The S2 sand pinches out somewhere under Monroe Street, whereas the S3 sand is continuous for several hundred feet downgradient of the source area (i.e., beyond the upper right corner of Figure 1). Monitoring well screens span the full vertical interval of the sand unit.

Pre-experimental BTEX concentrations in the S3 were very low

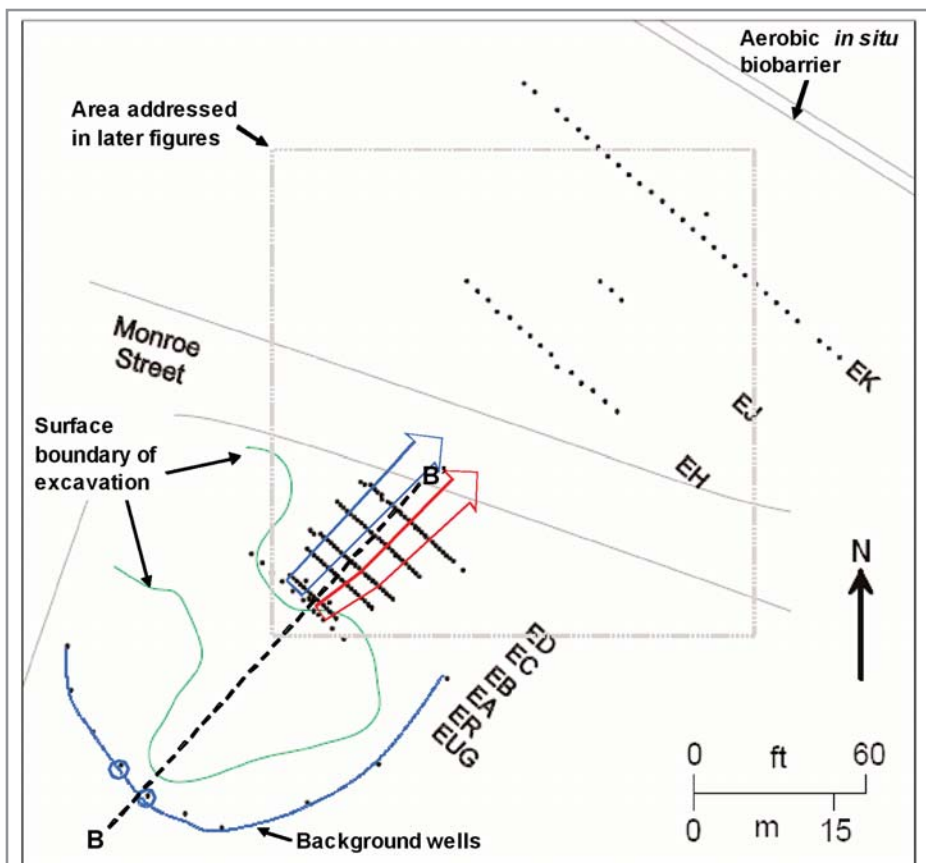


FIGURE 1. Map of the experimental zone at the fuel station site, Vandenberg Air Force Base (VAFB), CA, showing the source excavation, the locations of various transects of monitoring wells, etc. The dashed line B-B' shows the location of the schematic vertical section in Figure 2.

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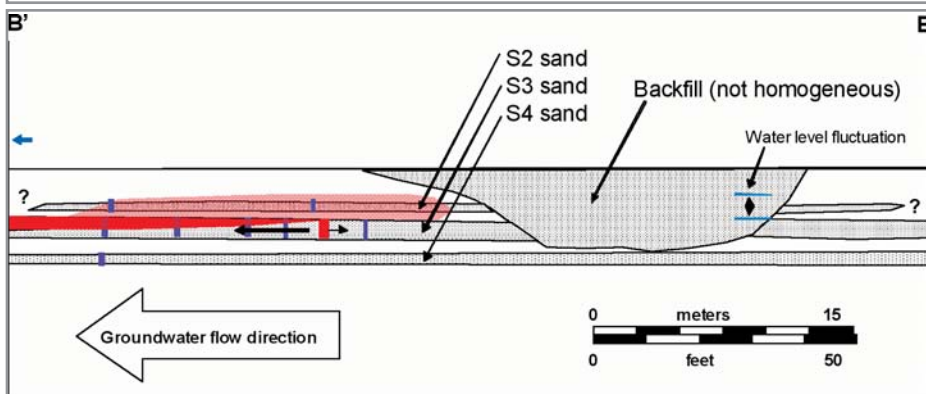


FIGURE 2. Conceptualization of the subsurface in and around the backfilled excavation. Locations of screened sections of wells are shown as blue or red rectangles. Note that the ER transect, including the injection wells, was several meters downgradient of the contact of the S3 with the backfill. The red shading depicts the authors' conceptualization of the distribution of contaminants in strata shallower than the S3, and also their hypothesis that the organic contaminants still migrating from the source area via the S3 aquifer (mainly MtBE and lesser amounts of TBA) are introduced to the groundwater flowing in the S3 from above by diffusion and/or slow advection.

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(most <10 µg/L) and discontinuous due to previous bioattenuation activity under the predominantly sulfate-reducing conditions. In contrast, a

significant reservoir of MtBE mass remains in the strata above the S3 sand and mass flux downward into the S3 sustains a nearly continuous

MtBE plume therein. Prior to the experiments MtBE concentrations were quite high in the S2, with a maximum detected value of 72,900 µg/L. Nevertheless, the maximum MtBE concentration in the S3 was much lower (1,260 µg/L). The mean groundwater velocity during these experiments was estimated to be 50 to 75 cm/d, with seasonal fluctuations lessening with distance downgradient of the backfill. Dissolved sulfate is the predominant electron acceptor controlling microbiological reactions.

The Lingering Affect of Ethanol on BTEX

In the experiment conducted to determine the impact of ethanol on BTEX biodegradation, the team injected groundwater amended with 1-3 mg/L BTEX on one side, or lane, over a nine-month period. On the other side they injected the same amount of BTEX, adding about 500 mg/L ethanol. Initially the BTEX plumes on both lanes extended approximately the same distance. Thereafter, the plumes in the "No Ethanol Lane" retracted significantly, which the team hypothesizes was due to an initial acclimation period followed by improvement in efficiency of biodegradation under sulfate-reducing conditions.

In the "With Ethanol Lane," the BTEX plumes also retracted but more slowly and not as far. The preferential biodegradation of ethanol-depleted dissolved sulfate, leading to methanogenic/acetogenic conditions. The researchers hypothesized that BTEX in the ethanol-impacted lane was biodegraded in part within the methanogenic/acetogenic zone and, in part, within sulfate-reducing zones developing along the plume fringes due to mixing with sulfate-containing groundwater surrounding the plumes due to dispersion and/or shifts in flow direction.

Overall, this research confirms expectations that ethanol may reduce rates of in situ biodegradation of aromatic fuel components in the subsurface, in both transient and near steady-state conditions. In the ethanol-impacted lane, rapid degradation of ethanol removed most of the sulfate within a short distance

■ continued on page 10

■ Impact of Ethanol *from page 9*

from the injection wells, causing a shift in redox and geochemical conditions. (See Figure 3.) A result of this shift was that the established, and otherwise effective, natural attenuation of BTEX under sulfate-reducing conditions was substantially reduced.

As discussed in the published research, implications of this experiment for future assessments of potential impacts of ethanol on the fate of BTEX species in the subsurface suggest the importance of determining the *location* of various reactions of interest and utilizing *rates* of reactions that are relevant to these redox reactions. Though specific to the experimental site and conditions, these

contamination in groundwater. In an attempt to better understand this, the research team compared the influence of ethanol on the existing MtBE by spiking groundwater with side-by-side injections into the S3 in two ways: (a) groundwater spiked continuously with BTEX (the No Ethanol Lane), and (b) groundwater spiked continuously with BTEX and ethanol (the With Ethanol Lane).

Over a period of 9 months, approximately 200 mL/min of spiked groundwater was injected into each lane (split into thirds directed to three injection wells in each lane). Ethanol was added to the groundwater injected in the With Ethanol Lane at approximately 500 mg/L. Tracers (SF_6 or bromide) were added to one or both lanes for short periods of time.

During the injections, the input of MtBE to the injected water migrating in the S3 was sustained by advection or diffusion from a significant reservoir in shallower strata. Although introduction of MtBE to the lanes was not controlled in the experiments, the team hypothesized that careful analysis of the experimental data could yield valuable insights into MtBE fate under the very different geochemical conditions generated in the two lanes.

As the experiments progressed, an MtBE-depleted zone developed in the With Ethanol Lane, but there was no similarly clear depletion of MtBE in the No Ethanol Lane. A substantial increase in *tert*-butyl alcohol (TBA) in the With Ethanol Lane strongly suggests that MtBE was biotransforming in the ethanol-impacted lane during the experiments. An increase in TBA did not occur in the No Ethanol Lane. TBA concentrations observed during the experiments ranged up to 1,200 $\mu\text{g/L}$, whereas prior to the experiments the maximum detected value was 120 $\mu\text{g/L}$ with most measured values below 20 $\mu\text{g/L}$. The increase in TBA concentrations is consistent with the hypothesis that MtBE was transformed by native microbial communities under the methanogenic and acetogenic conditions created in the ethanol-impacted lane after depletion of sulfate by preferential degradation of injected ethanol.

By 2 months, transformation of MtBE to TBA was already evident, suggesting a rapid acclimation time

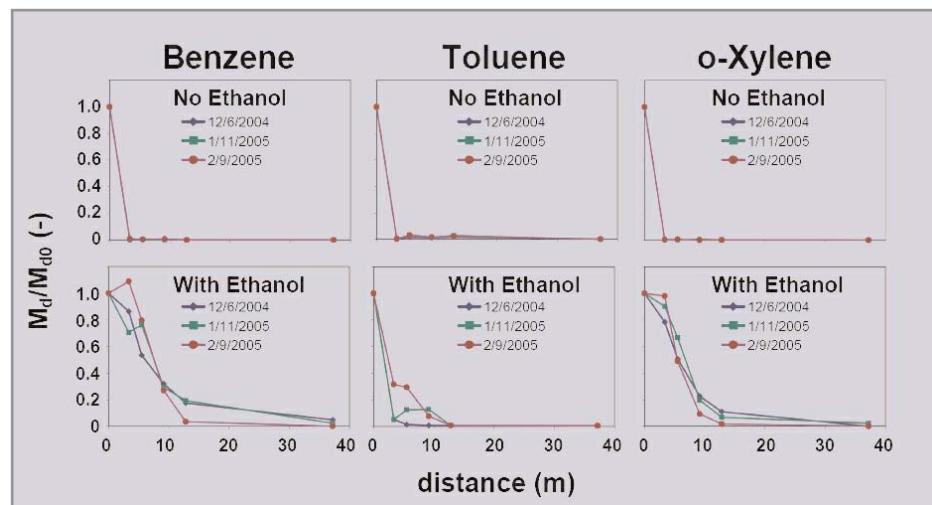


FIGURE 3. Normalized mass discharge (M_d/M_{d0}) for benzene, toluene, and *o*-xylene versus distance along the flowpath in both lanes for the three final snapshot sampling times.

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The team hypothesized that biodegradation of BTEX was possible under the newly established methanogenic conditions created downgradient of the injection wells; however, it took many months to reach a steady-state rate for each of the species, and the new rates were slower than those observed under sulfate-reducing conditions.

They hypothesize that overall degradation rates for the mixed redox conditions created in the ethanol-impacted lane were slower than those observed under sulfate-reducing conditions in the No Ethanol Lane. Consequently, under steady-state conditions, BTEX migrated further in the With Ethanol than in the No Ethanol Lane. Ultimately, it appeared that biodegradation at the lateral boundaries of the lane, under sulfate-reducing conditions created by mixing due to dispersion or flow direction changes, controlled the ultimate extent of the benzene and *o*-xylene plumes in the With Ethanol Lane.

results are useful in guiding future modeling efforts to examine other scenarios of interest, including wider sources, discontinuous sources, and different concentrations of electron acceptors and/or contaminants.

Clearly, modeling should consider the importance of anaerobic biodegradation processes, both within the plume, where electron acceptors may be depleted, and at boundaries where replenishment of electron acceptors may occur by mixing with surrounding electron-acceptor-rich groundwater. The results also indicate that such predictive modeling should consider mixing during periods of steady flow direction as well as enhanced mixing that may occur due to shifts in flow direction.

Ethanol + MtBE = TBA...Sometimes

While research has demonstrated more certainty about the effect of ethanol on attenuation of BTEX, less has been understood about how or if ethanol influences pre-existing MtBE

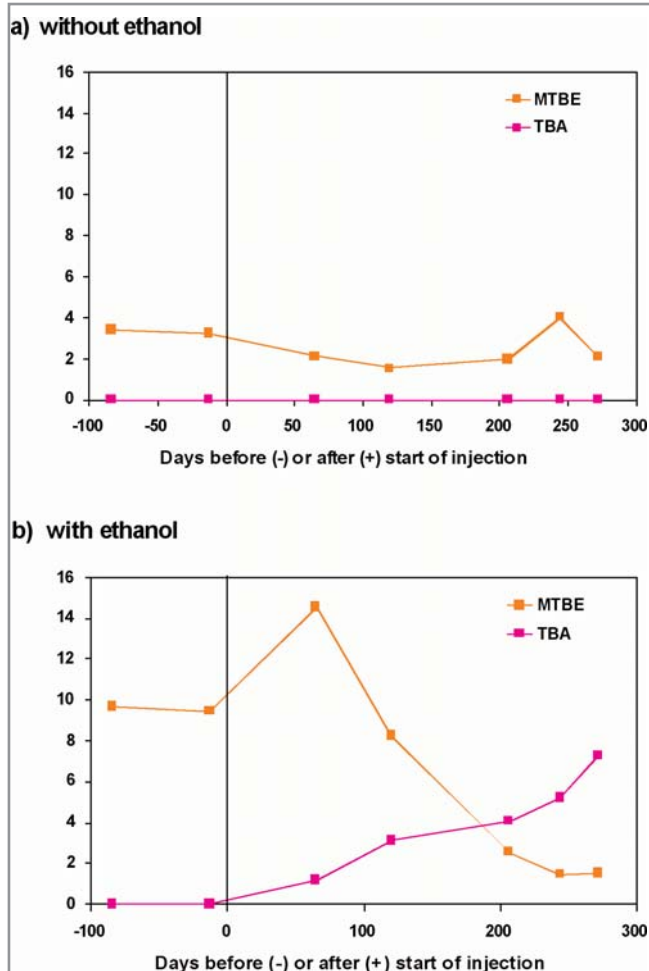


FIGURE 4. Mass discharge (M_d , mmol/d) of MtBE and TBA crossing the EH transect over time in the "Without Ethanol" and "With Ethanol" lanes. The location of the EH transect is noted in Figure 1.

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for this process. TBA was detected, albeit at much lower concentrations, in the S3 prior to the experiment, suggesting that microorganisms capable of transforming MtBE to TBA may already have been present in the S3. Thus the primary limit on the overall rate of transformation of MtBE at this site may have been availability of a readily degradable substrate and, upon release of ethanol, a much broader zone of strongly reduced conditions was quickly established within which the acclimated population could flourish.

Figure 4 presents mass discharge (M_d) estimates, based on monitoring data at the EH transect (approximately 40 meters downgradient of the injection wells), for MtBE and TBA over time in the two lanes. The contaminant M_d is presented in mmol/d to facilitate comparison of

This suggests that MtBE disappearing in the ethanol-impacted lane was transformed to TBA quantitatively, or nearly so.

Based on these results, the investigators hypothesize that products of ethanol metabolism (acetate, propionate, possibly molecular hydrogen) were carried downgradient from the very limited zone of ethanol degradation to zones that supported biotransformation of MtBE to TBA. Rapid subsurface transformation of MtBE to TBA may be expected where strongly anaerobic conditions are sustained and fluxes of requisite nutrients and electron donors support development of a biologically active, possibly acetogenic, zone.

To better evaluate the potential for ethanol-blended fuels to impact MtBE transformation, we need more measurements of the fate and indi-

MtBE and TBA values, since stoichiometric anaerobic biotransformation of one mole of MtBE yields one mole of TBA. Frame (a) indicates no significant change in the M_d for MtBE or TBA in the Without Ethanol Lane, and that the M_d of TBA is essentially zero. Thus there is no evidence of biotransformation of MtBE under sulfate-reducing conditions in the absence of ethanol at any time in the experiments.

In the With Ethanol Lane in frame (b), although the M_d for MtBE and TBA remain constant for two snapshots prior to the experiments, during the experiments the M_d for MtBE generally decreases with time while that for TBA increases. The decrease in M_d for MtBE (~11 mmol/d) was similar to the increase in M_d for TBA (~10 mmol/d).

rect effects of ethanol associated with a broad range of anticipated sources (neat spills, and gasohols ranging from low to high percent ethanol) and typical site conditions. ■

Disclaimer

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The Results of NEIWPCC's 2006 Survey of State Tank Programs Can Be Found at a NEIWPCC Website Near You

by Ellen Frye

Okay, the survey was long. Some of the questions were really irritating. A few state respondents plowed through a preternatural cyberspace logjam. A few didn't have much to say. Several poured the heart and soul of their program's database into the questions at hand. It was the best of times. It was the worst of times, but we got through it. And it was good. And now the results of this survey called *State Experiences with Petroleum and Hazardous Substance Releases at LUST Sites, Heating Oil Tanks, and Out of Service Tanks*—this ponderous, magnificent snapshot in history—is there for you to inhale and behold at <http://www.neiwpcc.org/mtbe.asp>.

Remember 2000 and 2003, when the New England Interstate Water Pollution Control Commission (NEIWPCC) conducted surveys on state experiences with MtBE and oxygenate contamination at LUST sites? Well in an effort to outdo itself, in 2006, NEIWPCC bit into a grant from the USEPA Office of Underground Storage Tanks to develop and conduct a new survey that would address primarily topical LUST-related issues but also other programmatic areas that would help provide insight into state experiences.

And yes, I, Ellen Frye, developed and conducted the survey for NEIWPCC, but not without accomplices. For one, I worked closely with Patricia Ellis, a hydrologist with the Delaware Department of Department of Natural Resources and Environmental Control's Tank Management Branch and *LUSTLine's* "Wander-LUST" columnist, to develop a draft set of survey categories and questions. (Pat has provided invaluable input for all three NEIWPCC surveys.)

The draft was circulated for comments and further refinement to the following dedicated group of state LUST program staff members: Gary

Lynn and Fred McGarry (NH), Read Minor (SC), Richard Spiese (VT), John Menotti (UT), Jeff Kuhn (MT), Greg Hattan (KS), Bruce Hunter (ME), Tim Kelley (CO), and Kevin Graves (CA). Input was also solicited and received from Kara Sergeant, NEIWPCC's project manager for the survey; Mike Martinson, Delta Environmental (standards and cleanup issues); Bruce Bauman, American Petroleum Institute; and Blayne Hartman, H&P Mobile Geochemistry (for soil vapor issues). Thank you one and all!

The completed questionnaire consists of the following 12 topic sections within which there are a number of questions and subparts:

1. **State Standards for Specific Gasoline Additives/Blends**
2. **Fuel Blend/Additive Analysis**
3. **Site Assessment**
4. **Drinking Water Impacts**
5. **Remediation**
6. **Remediation Costs Impacts**
7. **Vapor-Intrusion Pathway**
8. **Hazardous Substance USTs**
9. **Heating Oil Tanks**
10. **Out of Service Tanks**
11. **Ethanol**
12. **Miscellany**

The Nature of the Beast

The survey differs from the previous ones in that it is entirely electronic. State LUST program contacts (or other appropriate personnel) were asked to complete it online by logging in, protecting their information by using their own password. Marcel Moreau Associates of Portland, Maine, handled the electronic and data management aspect of the sur-

vey. Although it was beta tested, the substantial length of the survey, as well as glitches that were not anticipated, made for a challenging journey to closure. A few questions posed problems because answers entered did not register. A considerable amount of time was spent reviewing the survey responses in order to follow up state submissions with supplications for either clarifications or answers for the unanswered. Betty Snowman of Marcel Moreau Associates graciously and patiently worked with me to manage the database and address problems as they popped up.

All 50 state LUST program contacts or their designees logged in to the survey. Keep in mind that responding to this survey was entirely voluntary. Hence, we are pleased to report that all states completed at least Section 1. Only three states (IN, GA, LA) left the survey less than half completed. Forty-seven states substantially answered the questions, and some gave us an amazingly thorough level of detail and thought. The goodwill and professionalism of the state personnel who worked on the survey and responded to our questions and glitches was truly remarkable!

It is important to note that by their nature, many questions lend themselves to judgments/estimates based on the professional experience of the respondent and should be taken as an indication of trend. All state representations are taken directly from the database, except in the rare instance when a personal clarification was needed. All states were given an opportunity to check their answers.

Given the fact that this survey was designed to provide states with a *snapshot* of what their peers in other states are doing about relevant issues at this point in time, we hope that those in the state UST/LUST programs will take the time to find out how each other answered. Others in

the industry may also find the information provided in the survey helpful in understanding state responses to areas of interest. Some questions parallel those asked in 2003, and some of the results are compared in the "State Response Summary" attachment. The many comments states made regarding these questions are of particular interest because they provide nuance that underlines the uniqueness of these 50 programs. (Unfortunately, some comments were cut off due to character limits programmed within each question.) We hope that by conducting this survey, more states will begin to seek answers to the kinds of questions we've asked.

Besides finding out about what kind of information states can provide, it is also worth pointing out that there are many "don't know" responses that also tell us something. It is not always clear whether a state database does not have this information, whether it is difficult to access...or what. When a state does keep a thorough database, it has the invaluable ability to call up informational and programmatic profiles that can serve many purposes...like filling out surveys.

To see the full report go to:
<http://www.neiwpcc.org/mtbe.asp>

The report has three important Attachments:

- Attachment 1 – "State Response Summary"
- Attachment 2 – "State Standard Summaries"
- Attachment 3 – "Contact List for State LUST Site Action Levels, Cleanup Levels, and Drinking Water Standards"
- Attachment 4 – "Compiled 2006 Survey Results" for all the states.

A Brief Overview of the Results

■ State Standards for Specific Gasoline Additives/Blends

Section 1 of the survey consists of 17 questions, most of which with subparts, that focus on gasoline additives and blends. Why do we care about this? Those who have been dealing with LUSTs for more than 15 years will probably remember that

MtBE was barely, if ever, mentioned in cleanup discussions in the early days of the LUST programs. But that changed as states began looking for and finding MtBE in soil and groundwater, particularly in RFG areas.

Despite the fact that there wasn't and still isn't a federal MCL for MtBE, many states tried to address the problem by adopting action and cleanup levels based on the USEPA Drinking Water Advisory or some toxicity or risk-based criteria. Now, because of lawsuits, state bans, the removal of the 2 percent oxygenate mandate for RFG as part of the Energy Policy Act of 2005, and USEPA's subsequent rule to amend the RFG regulations in order to eliminate regulatory standards requiring the use of oxygenates in RFG, MtBE is fast disappearing from gasoline. But that doesn't mean that we're off the hook and back to analytical basics.

If there is one thing we should have learned from MtBE it is that it is a very good idea to pay attention to the kinds of compounds that are being added or blended into our gasoline, not only from a specific health risk point of view, but also in terms of how that compound interacts with or affects another compound in that gasoline in a groundwater/soil setting.

Through this survey, we have sought to better understand how much states are paying attention to certain components of a gasoline release, the occurrence and extent of potentially harmful fuel additives and blends in LUST-related soil and groundwater environs, and what states have learned. The first section of the survey asks questions about state action levels, cleanup levels, or drinking water standards for 12 different compounds—MtBE, TBA, ethanol, TAME, ETBE, DIPE, EDB, 1,2 DCA, lead, TBF, ETBA, and TAA—and if states have standards, what are they?

Except for EDB, 1,2 DCA, and lead, the compounds of interest in this survey do not have federal MCLs and thus may or may not have standards. If they do have standards, they are either risk-based or highly variable state-specific standards. Regarding MtBE, 41 states have standards of some kind. This time around, Vermont has set the lowest

groundwater action level of 1 ppb for MtBE, TBA, ethanol, TAME, ETBE, and DIPE.

Regarding TBA, ethanol, TAME, ETBE, and DIPE, more states have standards today than in 2003—for TBA, 15 states indicated they have standards versus 7 in 2003; for ethanol, 7 states indicated they have standards versus 4 in 2003; for TAME, 11 states indicated they have standards versus 4 in 2003; for ETBE, 10 states indicated they have standards versus 3 in 2003; and for DIPE, 11 states indicated they have standards versus 6 in 2003. A few more states indicated that action levels for some of these compounds are in the works.

■ Fuel Blend/Additive Analysis

According to state responses in this section, 11 states receive information on the composition of fuels in their state, and that information comes primarily from state weights and measures offices. This section seeks more information on if, when, and for what fuel blends/additives states require sampling and analysis in groundwater and soil. Again, MtBE gets the most attention, although EDB, 1,2 DCA, and lead are getting some attention on a site-specific basis in gasoline. When asked how often, during sampling events at their LUST sites, groundwater samples are analyzed for each of the group of compounds of interest, 31 states selected the option of 81%–100% of the time for MtBE; the other compounds were substantially lower in frequency.

This section asks about detection limits/analytical methods for the various compounds of interest in groundwater and soil. The "State Response Summary" provides a chart that shows the state responses for groundwater. For example, the chart shows that USEPA SW-846 Method 8240/8260 (GC/MS) is the most widely used method for all of the analytes. Within this method, detection limits range from 0.2 to 70 ppb for MtBE. For EDB, however, this method is used as well as USEPA Drinking Water Method 524 (GC/MS), SW-846 Method 8011, and USEPA Method 504.

■ continued on page 14

■ NEIWPC's 2006 Survey from page 13

■ Site Assessment

This section asks states about various aspects of site assessment. Asked if they are using USEPA TRIAD or similar expedited site-characterization approaches, 10 states said "yes," 2 said "most of the time," 22 said "no," 15 said "rarely," and one "don't know." Asked if they use advanced site characterization technologies (e.g., MIPS, geophysical investigation), 12 states said "yes," 1 said "most of the time," 10 said "no," and 26 "rarely." With regard to questions on considering diving plumes and conducting vertical characterization of groundwater at LUST sites, most states do this on a site-specific basis. Fourteen states say they see constituents other than MtBE in diving plumes. Thirty-one states say they use a 10-foot monitoring well screen interval. Other questions address cross-contamination incidents, changes in observed MtBE levels as the compound exits gasoline, and frequency with which contaminants exceed action levels. This section also contains a series of charts that document hotspot levels for the compounds of concern, levels at receptors, and distances between hotspots and receptors.

■ Drinking Water Impacts

Due to the very mutual interests of drinking water/groundwater protection and UST/LUST programs, this section has a line of questioning meant to ascertain how much state drinking water and LUST programs communicate and share information. The survey responses indicate that there is communication between programs at some level, but it doesn't appear that many states have made a concerted effort to connect. Thirty-four states say they give cleanup priority to sites located in source water protection areas, another seven say they do sometimes.

In 2003, 24 states reported that their drinking water program requires routine analysis for MtBE in drinking water. (This number was the same in 2000.) In this 2006 survey, 21 states say their drinking water program requires routine analysis for MtBE. But there is another option in this survey that wasn't in the previ-

ous surveys—"not required, but analyzed"—which eight states checked off.

A summary chart for questions 4-6 provides information on numbers of private, public community, and private non-community wells that have been contaminated with MtBE. Fifteen states did not know or did not have access to information. In comparing the results from the 2003 and 2006 surveys, the 2006 numbers were slightly lower in the private and public community well categories, except for numbers of wells ranging from 500 to more than 900. In 2003, two

Through this survey, we have sought to better understand how much states are paying attention to certain components of a gasoline release, the occurrence and extent of potentially harmful fuel additives and blends in LUST-related soil and groundwater environs, and what states have learned.

states answered that they had more than 500 MtBE-impacted private wells. In 2006, three states had 501 to 700 MtBE-impacted wells and two states had more than 900 MtBE-impacted wells. One state had more than 900 impacted public community wells and one state had 501-700 impacted public non-community wells.

We attempted to find out if any of the other compounds of interest had impacted wells. While most responses were "don't know," there were a few cases of impacts by TBA, TAME, EDB, and 1,2 DCA. Two questions address whether or how many private well users have been provided with bottled water or point-of-use treatment or if private wells have been replaced with new wells or public water because of fuel blends/additive contamination.

■ Remediation

In this section we attempted find out about state experiences with remediating EDB, 1,2 DCA, and E10 and E85. While this section is heavy

with "don't knows," this was expected because, especially for ethanol, states don't have much experience. For example, eight states have remediated sites with EDB and/or 1,2 DCA contamination and provide information on technologies used (primarily pump and treat and soil vapor extraction) and if they worked (looks good). With regard to ethanol releases, a few states have noted fate and transport characteristics associated with cosolvency, anaerobic groundwater, methane gas generation, and remobilization of NAPL. This section also has a group of questions concerning NAPL removal and allowable levels for closure. We asked respondents to rate effectiveness of free-product removal technologies. Excavation, multiphase extraction, and soil vapor extraction had the highest ratings.

■ Remediation Cost Impacts

We asked states to indicate the percentage of sites where MtBE has had a noticeable impact on the cost of remediation. This set of answers is provided in a table. While a large portion of states feel MtBE has caused no increase in the cost of remediation, there are a number of states that feel that MtBE increases costs at some sites a little bit, significantly, and very significantly. We asked about increased cleanup costs associated with other compounds of interest. Again, while most states said "no," a few others said "yes," especially for TBA, EDB, 1,2 DCA, and lead. Top factors that drive up costs include longer plumes, longer monitoring period, and substance recalcitrance.

■ Vapor-Intrusion Pathway

Forty-one states say that vapor intrusion is a concern at LUST sites in their state. Twenty-eight states have guidance/policy for evaluating the vapor-intrusion pathway. Ten states say they are considering implementing vapor-intrusion pathway guidance. States provided websites if they have guidance.

■ Hazardous Substance USTs

When asked how many federally regulated hazardous substance (non-

petroleum) USTs are registered in their state, 18 states answered, "don't know" or didn't answer. This is partly because these tanks are sometimes regulated under a different state program. But with 18 states answering "don't know," all hopes of getting any sense of the total number of hazardous substance USTs in the United States faded. Nevertheless, 34 states have provided this information. They also provided state websites if the state has developed guidance/regulations for hazardous substance USTs (at least 32 have) and an indication of how frequently these tanks are inspected. Very few releases from these tanks have been reported and thus there was little information about product released and no information on fate and transport. We asked about these tanks because there is so little at all said about them; however, most are now aboveground.

■ Heating Oil Tanks

Many states do not rely on heating oil and therefore do not have to worry about heating oil tanks. Northern states are most likely to have substantial numbers of heating oil tanks, especially home heating oil tanks. Some of these tanks are buried underground, some are outdoors aboveground, and others are indoors in a basement or shed. There is no question that heating oil tanks leak. In many cases realtors and/or banks have pushed for the removal of buried tanks, instead placing them indoors or outdoors in a well-constructed system where owners can see them. But to the extent that we were able to get information from the states on heating oil tanks for this survey, we have to admit it is sketchy from a big picture perspective. The fact that most heating oil tanks either are not regulated or are minimally regulated explains why so many states couldn't really answer the questions in this section.

On the heating oil cleanup side, 18 states have a state fund that covers heating oil tanks in some form or fashion. Five states have some other type of fund that helps out when needed. There is a little bit of information on the percentage of cleanup fund monies spent on heating oil tanks and the percentage of UST

releases that come from heating oil tanks.

■ Out of Service Tanks

We asked states about numbers of tanks in the following categories of out-of-service tanks—Temporarily Closed (legal), Permanently Closed (closed in place or removed) (legal), and Orphaned/Abandoned (out of service but not properly closed with or without known responsible party). We got very good hard data from most of the states. We wanted to provide a national snapshot of where the states are now with these tanks. Nine state answered "don't know" for temporarily closed and seven for permanently closed; however, the remaining state responses give us a good sense of the magnitude of tanks that have been permanently closed and the large number of temporarily closed tanks that are being monitored and inspected pretty much in the same way as in-service tanks. A few states noted that these tanks can be problematic during property transfer or if owners/operators don't follow the rules when they put tanks in temporary status. The orphaned/abandoned tanks are less well documented, but 22 states have estimates or hard numbers for these tanks as well. Seventeen states indicated that they have programs to remove orphaned/abandoned tanks.

■ Ethanol

One thing seems clear with regard to ethanol and USTs: we are in the early stages of understanding what this substance will mean to fuel storage systems and the potential for releases and the effect of a release on the environment. In this survey, 34 states said that E85 is used in their state. Clearly, there are just a few here and there in each case. Only two states, Iowa and Minnesota, knew of E85 releases in their state. On a more general level, 14 states said they knew of ethanol releases in their state, from E10 to neat ethanol. On ethanol compatibility issues states still know more about concerns they have read about than that they have seen. Michigan expressed concern that tank owners would not consider compatibility issues before filling tanks with E85 and that not all E85 tanks are registering as required.

■ Miscellany

We asked states to rank the primary ways releases are identified/reported in their state. Tank removal was ranked highest, followed by property transfer and leak detection. We asked states to rank tank leak-detection methods. Top ranking was interstitial monitoring, followed by automatic tank gauges and tank tests. We asked states to rank piping leak-detection methods. Top ranking was electric LLDs, followed by piping tests, interstitial monitoring, and mechanical LLDs.

Seventeen states said they have a pay-for-performance (PFP) program. Delaware is just getting started. But it doesn't appear that PFP is chugging along in most of those states. Only two states indicated they use PFP at 76-100 percent of their sites. The remaining states said they used it at 1-25 percent of their sites.

Only five states said their UST leak-prevention rules address MtBE vapor releases. However, 16 states said they have sites where vapor releases are believed to be the source of contamination.

Finally, responses to the last question in the survey show that more than 30 states consider the compounds of concern in this survey other than MtBE to be a current, impending, potential, or unknown problem. ■

■ Impact of Ethanol from page 11

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A MESSAGE FROM CLIFF ROTHENSTEIN

Director, U.S. EPA Office of Underground Storage Tanks

Two Years After the Energy Policy Act

It seems like only yesterday, but on August 8, 2007, we celebrated the two-year anniversary of the signing of the Energy Policy Act, a law

that included about 40 pages of new requirements that have significantly changed the Underground Storage Tank (UST) program. Since that time, it has been a very interesting, exciting, and busy two years for all of us.

At EPA, we have been issuing guidelines, while throughout the country, state UST managers have been working overtime to meet the new requirements. Our tribal partners have also been busy helping us implement our new tribal strategy. All of our state and tribal partners as well as many other stakeholders deserve kudos for their tireless efforts to meet the numerous deadlines and requirements of the Energy Policy Act.

I know it hasn't been easy to inspect all previously uninspected tanks in your states by this August, while at the same time also running your existing programs. But because of your efforts, much has been accomplished during this short period. So I will briefly highlight just some of our accomplishments with regard to our grant guidelines and our new tribal website.

EPA's New Energy Policy Act Grant Guidelines

Over the past two years, OUST staff and managers were hard at work developing new grants guidelines. With the help of EPA regions, states, and other stakeholders, we have met every statutory deadline so far and have issued more than a half dozen new guidelines. These guidelines provide the foundation for states to develop their own specific programs for meeting the Energy Policy Act requirements.

Many of the new guidelines are aimed at further reducing UST petroleum releases to the environment. For instance, the Secondary Containment guidelines we issued in November 2006 require new or replaced USTs, piping, and dispensers within 1,000 feet of drinking water to be secondarily contained. The Operator Training guidelines we issued in August 2007 require that those who operate UST systems, including emergency responders, be trained by 2012.

The Inspection guidelines we issued in April 2007 require that all federally regulated USTs be inspected every three years. The Delivery Prohibition guidelines we issued in August 2006 spell out the process and procedures for prohibiting fuel delivery to USTs that are out of compliance. And

finally, the Financial Responsibility and Installer Certification guidelines that we issued in January 2007 outline the financial responsibility requirements for UST installers and manufacturers.

While these guidelines are aimed at improving our UST programs and helping to prevent future releases, issuing these guidelines is just the tip of the iceberg. The hard work really begins as states develop their own programs and regulations to implement the guidelines. We are also crafting a process to develop regulations that will help ensure consistency of the implementation of the Energy Policy Act requirements in Indian country. So while we have all been busy during the past two years, the next two years promise to be just as eventful.

OUST's New Tribal Website

Access to information is among the most important steps we can take to ensure a successful program. So, to provide better and more readily available information to our partners in Indian country, OUST launched a new UST tribal website in July 2007. The website at www.epa.gov/oust/tribal provides tribes and others with UST program, resource, and training information in one convenient place. Most importantly, it is a central information resource about the UST program in Indian country.

The website includes links to EPA's August 8, 2007, report to Congress on the status of implementing the UST program in Indian country. In addition to facts about cleanup and compliance progress, the report highlights several tribal success stories that we can all be proud of.

While the report to Congress is essentially a snapshot of our past accomplishments, the new website includes a link to OUST's tribal strategy, which describes our plans for the future. The strategy, published in August 2006, identifies the objectives and numerous actions that EPA and tribes can take to further tank program cleanup and compliance in Indian country.

Besides important information on funding, training, and other available resources, the website also provides a convenient compilation of UST laws, regulation, guidance, policies, and OUST's "how to" publications, information for UST inspectors, and information from other EPA offices, including the American Indian Environmental Office (AIEO).

While OUST's new tribal website provides a wealth of information, primarily about USTs, AIEO's new website www.epa.gov/indian, and the new Tribal Portal on EPA's website www.epa.gov/tribalportal, will further enhance the information flow so we can more effectively run our programs. ■

Field Notes

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

New AST Overfill Prevention Document Available from PEI

Early in January 2005, freezing rain and snow fell in the Midwest for days. The precipitation caused the normal and emergency vents at a bulk plant to freeze shut. As the transport driver was making his delivery into a 15,000-gallon aboveground tank at the bulk plant, the tank ruptured, forcing gasoline out a 9-inch gash. Product went over the dike wall and into the intake of the transport truck engine. It also covered the driver, who was standing near the truck. The engine ignited the gasoline. The fire spread from the refined-fuel storage area to propane delivery trucks. Officials estimated that over 10 million gallons of water were used to cool the storage vessels. The transport driver died as a result of his injuries.

Error in judgment resulting in tank overfills or over-pressurization is the most common cause of a fuel release to the environment from an aboveground storage tank. In many cases, the volume of fuel released is small and the consequences are minor, although cleaning up a release can still be costly. Occasionally, however, the volume released is very large and the consequences are catastrophic, resulting in personal injuries, large fires, and extensive property damage.

Filling an aboveground storage tank offers several unique challenges. First, the transfer of large quantities of fuel into the tank usually involves a variety of pumps, pipes, valves, and controls, which are often unique to each storage-tank facility. Second, the only person typically on site to manage the fuel-transfer

operation is the tank-vehicle driver. Finally, there have not been adequate industry standards for fuel-transfer procedures and equipment for the driver and facility owner to reference.

The Petroleum Equipment Institute, recognizing the need for a comprehensive reference guide that the industry and regulators could use to minimize aboveground tank overfill incidents, has published a new document entitled Recommended Practices for Overfill Prevention of Shop-Fabricated Aboveground Tanks (PEI/RP600). The goal of the document is to:

- Prevent loss of life
- Protect the environment
- Promote best practices for safely transferring fuel into tanks
- Prevent overfills
- Prevent damage to property resulting from overfills
- Minimize costs from cleanups and remediation.

The recommended practice is limited to the installation, operation, inspection, maintenance, and testing of overfill-prevention equipment used on shop-fabricated, stationary, and atmospheric aboveground tanks intended for the storage or supply of liquid petroleum and alternative fuels. The recommended practices may be applied to tanks used for:

- Bulk storage
- Motor-fuel dispensing
- Emergency-generator systems
- Residential and commercial heating-oil supply systems
- Used-oil storage systems.

If you either regulate or manage aboveground storage tanks, this publication will serve as a valuable reference. PEI/RP600-07 is copyrighted and may not be photocopied or otherwise reproduced. Order copies online at www.pei.org/shopping or request an order form by calling PEI at 918-494-9696. ■

Overfilling of tanks can have catastrophic consequences. Proper delivery procedures and overfill-prevention equipment are required to protect against overfill incidents.



FAQs from the NWGLDE

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

What Is CITLDS Leak Detection All About?

In this issue of FAQs from the National Work Group on Leak Detection Evaluations (NWGLDE), we follow-up on a FAQ from LUSTLine #50 (August 2005). At that time we discussed protocols used for evaluating CITLDS without explaining what CITLDS leak detection is all about. We now present the rest of the story. (Please note: the views expressed in this column represent those of the work group and not necessarily those of any implementing agency.)

Q. What exactly is a CITLDS?

A. CITLDS stands for "Continuous In-Tank Leak-Detection System." It is a volumetric leak-detection method that does not require an extended shut-down period in order to conduct a leak test. The system gathers pieces of data from all designated input devices during tank "quiet time" and then performs the leak-test calculations when enough data have been recorded. The term continuous, in this situation, implies that data are collected on a regular basis and when available. Most CITLDS methods employ the use of an Automatic Tank Gauge ("ATG") to gather product-level data and some use additional information from input devices such as the dispenser totalizers and point-of-sale records.

CITLDS are well suited to facilities that are open 24/7, as long as the volume of product sold from the storage system does not exceed the throughput limit of the CITLDS method. There must be sufficient data collected in order to perform the leak-test calculations. For example, if there is not enough "quiet time," then not enough data will have been collected to complete a test. If enough suitable data have not been collected during the month to perform a leak test, the tank system must be shut down and a "static" test performed.

Q. Why are there two separate line entries in the "List" index for Continuous In-Tank Leak Detection Systems?

A. Currently there are two types of CITLDS methods on the NWGLDE List. These types are referred to as CITLDS "Continuous Automatic Tank Gauging" and CITLDS "Continual Reconciliation." The primary distinction between these two is that the ATG systems use only product-level data to conduct a test and are most similar to standard, or static, ATGs that test only the tank. Reconciliation systems use both product-level data and sales data to see if the volume of fuel dispensed from the tank, as measured from ATG readings, is equal to the volume of fuel measured by the meter in the dispenser.

"Continuous Automatic Tank Gauging" systems use an ATG probe to collect data during tank "quiet time." An algorithm then combines data from a number of such periods until there is enough evidence to make a determination about the leak status of the tank. Because these systems typically monitor only the liquid level in the tank, they test only the tank, not the piping. This type of system functions

like an ATG, except that it does not require the tank to be taken out of service for a set period of time whenever a test is conducted. Instead, it uses data from shorter, stable time periods and combines the results to estimate a leak rate. If sufficient good-quality data has not been obtained over the month, the system may be programmed to default to a static or shut-down ATG test which requires the tank to be out of service for a few hours.

"Continual Reconciliation" systems combine continuous product-level and temperature monitoring from the tank with data from dispensing meters. Data from delivery and point-of-sale records may also be included. Because of multiple-device data input, the system is capable of detecting leaks or unexplained losses of product from the tank, pressurized lines, or even dispensers. In addition, it can combine data from times when the tank is static (no dispensing activity) as well as when the tank is active to monitor the system for a leak. (For a more in-depth discussion of "Continual Reconciliation," refer to "Continual Reconciliation Applications for Active Fueling Facilities" on page 4 of this issue of LUSTLine.

All CITLDS methods are volumetric and designed to operate continuously or nearly continuously in order to collect the necessary data for the determination of a quantitative leak rate. They may use different combinations of data and inputs but they share the same characteristic of monitoring tank and/or other data continuously for days, weeks, or months, and then providing leak-detection capabilities and leak status on demand once the initial data requirements are met. ■

About the NWGLDE

The NWGLDE is an independent work group comprising 10 members, including 9 state and 1 U.S. EPA 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 them 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.

STI-Labeled UST Warranty to be Reduced to 10 Years

The Steel Tank Institute/Steel Plate Fabricators Association (STI/SPFA) has changed the limited warranty requirements of all STI-labeled USTs, effective January 1, 2008, from a 30-year to a 10-year warranty duration. The new warranty was to take effect on July 1, 2007; however, the organization determined that "an industry-wide backlog of orders made it prudent to postpone the start of the new warranty and eliminate marketplace confusion," according to Wayne Geyer, Executive Vice President of STI/SPFA.

Geyer explains that the need for a 30-year warranty duration on STI-labeled USTs has diminished as the storage tank market has changed,

moving away from predominantly single-walled USTs to increased demand for aboveground storage tanks (ASTs) and, with regard to USTs, a trend to larger-capacity tanks, fewer tanks overall, and an elevated demand for production of secondary-containment USTs and compartmented tanks.

A 30-year warranty is almost unheard of for any manufactured product. As Geyer explains in the STI/SPFA newsletter *Tank Talk*, even a 10-year warranty is a very substantial guarantee for a specific product line. According to Geyer, "In an industry that is manufacturing underground tanks for hazardous substance storage, particularly in this time of new and evolving fuels, a

10-year limited warranty is a very proactive approach in showing support for steel tank owners and is consistent in length with other petroleum equipment warranties."

The warranty only covers either the replacement of the warranted tank with a new tank of the same size and design, the repair of the tank, or a refund of the original purchase price. While most tank manufacturer warranties are similar, with STI-labeled tanks the manufacturer purchases a warranty policy from a third-party insurance company. The tank is not self-warranted by an individual manufacturer. Third-party coverage is significant, since many tank manufacturers have come and gone since 1988.

To read the details as explained by STI/SPFA, see the June 2007 issue of *Tank Talk* at www.steeltank.com. ■



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Update on USEPA Progress and State Deadlines Regarding Implementing the Underground Storage Tank Provisions of the Energy Policy Act of 2005

Energy Policy Act Requirement	EPA Issued Grant Guidelines/ Tribal Strategy and Report	Deadlines for States to Implement Requirements
Inspections	4/24/07	8/8/07 – first inspection deadline 8/8/10 – three-year inspection deadline
Secondary Containment <i>or</i> Financial Responsibility	11/15/06 1/22/07	2/8/07 – implement <i>either</i> secondary containment <i>or</i> financial responsibility
Delivery Prohibition	8/7/06	8/8/07 – implement delivery prohibition
State Compliance Reports on Government-Owned USTs	4/24/07	8/8/07 – report on the compliance status of federal, state, and local-government owned and operated USTs
Public Record	1/22/07	10/1/07 – develop a program for gathering information and begin gathering data 12/08 – make the public record available to the general public
Operator Training	8/8/07	8/8/09 – develop state-specific operator training requirements 8/8/12 – ensure all three classes of operators are training according to state-specific requirements
Tribal Strategy	8/7/06	(not applicable to states)
Indian Country USTs Report to Congress	8/8/07	(not applicable to states)

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