Tank-nically Speaking

by Marcel Moreau

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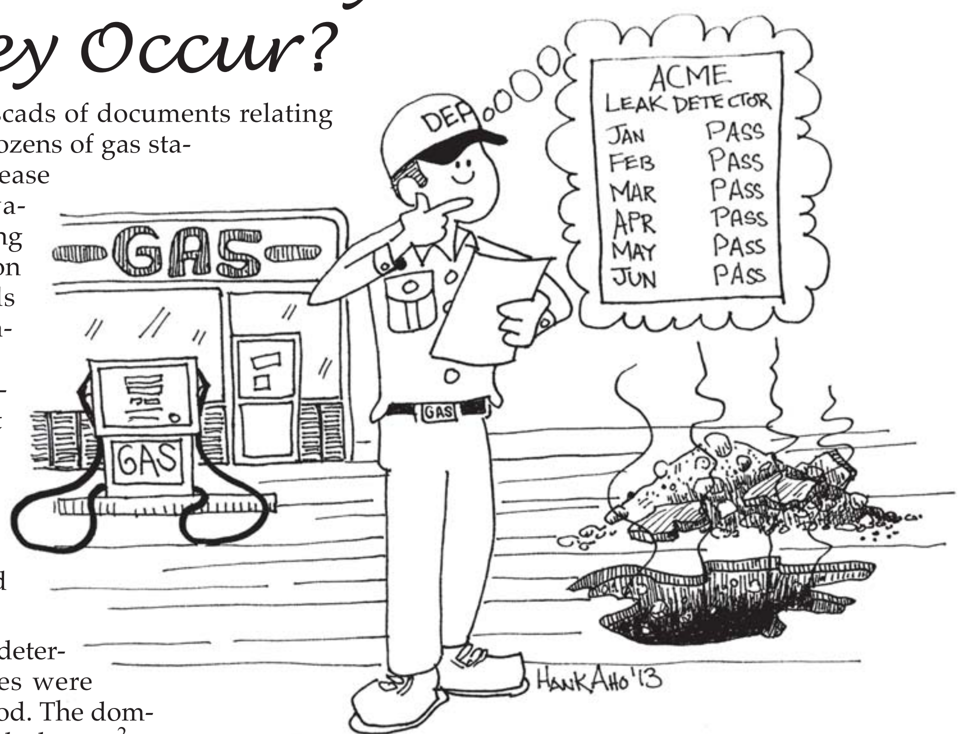
Why Are Releases Rarely Discovered at the Time They Occur?



In recent years I've had occasion to review scads of documents relating to releases of petroleum products at many dozens of gas stations. In the great majority of cases, the release is only discovered when some type of excavation activity is conducted such as a tank or piping upgrade or replacement. Although leak detection equipment is in place, and the existing records indicate "passing" results, significant contamination is more often than not present.

My observations are consistent with several studies that have shown that leaks are most often discovered via excavation rather than leak detection:

- A study conducted by the Florida Department of Environmental Protection found that only 51 percent of releases were detected using standard leak detection methods.[1]
- A California survey of 313 release incidents determined that only 15 (4.8%) of these releases were correctly identified by a leak detection method. The dominant method of discovering releases was tank closure.[2]
- A separate California study determined that out of 16,318 reported releases where the method of discovering the release was known, releases were discovered during field activities such as tank removal or piping replacement 92 percent of the time, while release detection activities discovered only 8 percent of the releases.[3]
- A study conducted by the New York State Department of Environmental Conservation investigated 52 facilities on Long Island with UST systems. The study uncovered 33 previously unreported releases of petroleum product into the environment.[4] The study concluded that "it is evident that repairs (to storage system equipment) are routinely conducted and spills are not reported."[5]

How does this happen? Doesn't leak detection work? I suspect that the details of why releases go unreported are many and varied, but here is my armchair overview of the broad principles that might be behind many of these "undetected" releases.

■ In most cases we are looking for a needle in a haystack.

Sales volumes at the majority of active facilities today are measured in thousands of gallons per day. Leaks are likely to be in the range of a few gallons per day or even less. The volume of product lost relative to the volume of product handled at the facility is a small fraction of a percent. Because accurately measuring large amounts of fuel is challenging, small discrepancies in accounting for the fuel are ignored. Because of this, the loss may persist for weeks to many months before it is noticed (often by accident) and corrected. While the leak rate is small, the cumulative volume of product released may be large—in the hundreds or thousands of gallons.

■ Most releases today are easily repaired.

Piping releases have always been a substantial portion of the leaking "tank" problem, and as tank corrosion issues have been addressed, I believe the proportion of releases originating in piping has increased. I include leaks from submersible pumps (e.g., functional elements) and leaks from dispenser components (e.g., filters, meters, shear valves, unions) in the broad category of "piping leaks." Some industry data indicate that leaks are more likely to occur near the pump and the dispenser rather than in the piping itself.

Fixing corrosion holes in tanks was a major operation, involving replacing the tank, or at a minimum, lining the tank. Releases from piping components are much more easily repaired, especially when they occur inside the dispenser or at the submersible pump where they can be readily observed and accessed without excavation.

Consider the following scenario. A technician opens a dispenser cabinet to replace the filters and sees that one of the union fittings connecting the below-grade piping to the dispenser piping is dripping fuel. He tightens the union with a wrench and the drip is stopped. He proceeds to replace the filters and notes that the outside surface of one of them is wet with fuel. He replaces the leaking filter along with the others, perhaps being a little more careful to be sure the new filter seals properly. The work order he completes to document his work notes only that he replaced the filters. The fact that he has discovered and repaired two leaks is not recorded.

Such a scenario is likely quite common. A survey of Petroleum Equipment Institute members, who service many of the nation's UST systems, estimated that for every 100 dispensers inspected, 47 leaks would be detected, and for every 100 submersible pumps inspected, 44 leaks would be identified.[6]

■ There is a widespread "don't ask, don't tell" policy regarding releases.

As I have just described, while performing a routine task a technician may note that a component is wet with fuel and simply tighten or replace it. Seldom is any effort made to determine how badly the component was leaking when the pump was on and the piping was under pressure or how long the leak may have been occurring. How much fuel may have been released is not investigated. The operator may not even be told that a release has been repaired.

Many such releases may occur over time. The person conducting the repair is not inclined to call attention to the release because he does not want to get the person who hired him in trouble. The presence of contamination is not documented until months or years later when renovation work is undertaken and contaminated soil and/or groundwater is discovered.

■ ATG test results are misunderstood.

Most tank owners live in a fairyland where automatic tank gauge (ATG) test results (whether for tanks or, when equipped with an electronic line-leak detector, the piping) can never bring bad news: a passing test result means that absolutely no leak is present, and a failing test result must be wrong. The truth resembles a nightmare much more than a fairy–tale. But first, let's be clear about the terminology. Table 1 defines the terms relevant to this discussion.

TERM	DEFINITION
Performance criterion	A requirement stated in regulations that specifies the size leak that must be reliably detected. For example, rules state that a monthly ATG test must be able to detect a leak rate of 0.2 gallons per hour (gph) with a probability of detection of at least 95% and a probability of false alarm of no more than 5%.
Probability of detection	The odds of detecting a leak of *a given size* when a test is conducted. A probability of detection of 95% for a leak rate of 0.2 gph means that if I were to test 100 tanks, *each of which was leaking at exactly 0.2 gph,* I would correctly identify 95 of these tanks as leakers and incorrectly pass 5 of the tanks as "tight." The probability of detection is tied to a specified leak rate. If a leak of greater than 0.2 gph is present, the probability of detecting the leak will be greater than 95%. *If a leak of less than 0.2 gph is present, the probability of detecting the leak will be less than 95%.*
Probability of false alarm	The odds of failing a tank test when the tank is absolutely tight and not leaking a drop. The rules specify a probability of false alarm of no more than 5%. This means that if I were to test 100 tanks, *each of which was absolutely tight,* I would incorrectly fail five of these tanks and call them leakers.
Threshold	The leak rate that a test method uses as the boundary between a passing and failing test is called the threshold leak rate. In order to be 95% sure of correctly identifying leaks of 0.2 gph, a test method must fail the tank when the leak rate measured during a test is somewhat less than the performance criterion. The threshold leak rate is typically about half the performance criterion. So an ATG monthly test with a performance criterion of 0.2 gph will typically have a threshold leak rate of 0.1 gph. This means that if the measured leak rate during a test is 0.1 gph or greater, the tank fails the test and is presumed to be leaking.

TABLE 1. *To understand any discussion of the effectiveness of leak detection, the terms used must be thoroughly understood. This table presents definitions of the terms commonly used when discussing leak detection in UST systems.*

Most tank owners and many regulators have a poor understanding of the behavior of ATGs when leaks significantly smaller than the performance criterion (0.2 gallons per hour for monthly testing) are present. The key fact to remember is that the probability of detection is only valid for a specified leak rate (see Table 1). It is true that leaks smaller than the performance criterion can be detected by many methods of leak detection. The issue is that the probability of detecting such a leak will decrease as the leak rate decreases.

For example, let's say I have a leak detection method with a probability of detection of 95 percent for a leak of 0.2 gph. My threshold for declaring a leak for this method is 0.1 gph. For the case where the actual leak rate is equal to the threshold, the probability of detection is 50 percent. This means that with my leak detection method there is a 50/50 chance that I will correctly identify a leak of 0.1 gph.

Consider what happens when a 0.1 gph leak is present in an UST system that is tested with my method. Half the tests that are run will identify the leak and half will not. What does the tank owner do? The standard response to a failed test (other than ignoring the test completely) is to run the test again. There is almost a universal belief among tank owners when faced with one passing result and one failing result that the passing result is the correct one and the failing result is in error.

The probability of detecting leaks smaller than 0.1 gph is even less than 50 percent. For example, the probability of detecting a leak of .025 gph might be only 10 percent. This means that out of each hundred tests that are run on the leaking tank or pipe, odds are that 10 tests will detect the leak and 90 tests will not. Faced with such results, the typical tank

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owner will conclude that his tank is tight and not leaking a drop, when in fact, the test results indicate that a small leak is present. This "small" leak will add up to 0.6 gallons a day, 18 gallons a month, and 216 gallons a year, more than enough to have had serious consequences when MtBE was present in gasoline.

This is how small leaks remain undetected. Because the probability of detection for these small leaks is quite low, most of the test results will be passing, and the few failing tests that do occur are considered to be erroneous. While there is no "allowable leak rate" as far as USEPA is concerned, the fact is that many small leaks go undetected because tank owners do not grasp the significance of failed test results interspersed with passing test results.

That said, it is also true that some tests may produce failing results for reasons that are not related to a leak, so that *every* failed test result is not necessarily an indication of a small leak. But determining the difference between an aberrant test and a small leak could cause a lot of hair loss among tank owners and tank technicians.

■ Tightness testing does not prove that a storage system is tight.

Tightness test documents are often produced to "prove" that a storage system did not leak. However, there are a number of ways that a *leaking* storage system can produce a *passing* tightness test result. Here are five of them:

a) Piping tightness tests most often do not test the entire piping system. The dispenser is most often isolated by closing the shear valve at the base of the dispenser; as a result, leaks inside the dispenser will not be detected. Likewise, the submersible pump is often isolated by closing a ball valve in the product piping; as a result, leaks in the submersible pump itself will not be detected by the test.

b) The test documentation generally represents the condition of the system when the technician left the site, not the condition of the system when he arrived at the site. For example, a test technician may begin to increase the pressure in a piping run and notice an immediate drop in pressure. He investigates and finds a dripping union at the submersible pump. He tightens the union, and pumps up the pressure in the piping again. If the pressure now holds and the test passes, the formal written record will show that the piping is tight.

This is a true description of the leak status of the piping at the end of the test, but it is NOT the true condition of the piping when the tester arrived at the site. This type of repair activity is sometimes documented in the handwritten paperwork that the tester completes in the field, but such repair activity rarely shows up in the formal paperwork sent to the owner and presented to the regulator.

This scenario is especially prevalent with vapor leaks. While the results of pressure-decay testing are most often "pass," the test results typically include a list of parts that were replaced. It is the list of replacement parts, not the "passing" test results, that is important in determining whether the storage system may have had a vapor leak when the tester first arrived at the site.

c) The test may not be properly conducted. Occasionally errors in the test procedure are obvious, such as failing to follow procedures required when the water table is above the bottom of the tank. More often a careful study of the test documentation is required to confidently state that the test results were falsified. Most often, the issue is that the test results are "too good to be true."

This is most frequently seen in piping test results where the measured leak rate for multiple piping tests is consistently zero. While zero volume change during a piping test is not an impossible event, it should be quite a rare event when normal test procedures are followed. Thus such results are suspicious, and I am reluctant to accept them as "proof" that a piping run has not leaked.

d) The test methodology is defective. Some tank testing methods apply a vacuum to the tank and rely on the detection of water entering the bottom of the tank to detect a leak when the water table elevation is above the bottom of the tank. The length of these types of tank tests is generally calculated to be the amount of time that it would theoretically take for a leak of 0.1 gallons-per-hour (gph) to produce a water depth sufficient to register on a water sensor positioned at the bottom of the tank.

This calculation is made assuming that the tank is a perfectly round cylinder that is perfectly horizontal in the ground, neither of which are reliable assumptions. The calculation also often ignores the presence of striker plates positioned at the bottom of the tank that typically cause the water sensor to be at least a 1/4 inch off the bottom of the tank. Such tests are unlikely to detect water ingress because the length of the test is too short to allow enough water to enter the tank and be detected by the sensor.

Another issue when the gasoline contains ethanol is that the water entering the tank may be absorbed into the fuel and not be present as a separate phase that can be detected by the sensor. Standard third-party evaluations, usually cited as "proof" that a test method is effective in indentifying leaks, do NOT evaluate the test method's ability to detect water. The equipment manufacturer's claim that the method works when water is present is the only evidence we have of the test method's effectiveness.

Test methods that use this water ingress approach for leak detection are also vulnerable to another error when free product resulting from a large leak in the tank is present in the excavation. If the free product is outside the perforation in the tank, product will be drawn into the tank rather than water when the vacuum is applied during the test. Since these test methods generally do not look for ingress of product, the test result will be "pass" even though a substantial leak may be present.

e) **Tightness testing does not establish that there is no leak, only that the leak is likely to be less than 0.1 gph.** As with the ATG test results discussed above, small leaks may be present, but if they are significantly less than the test method's threshold, the probability of detecting the leak will be quite small. Tightness testing only establishes that a storage system is tight enough to pass the test, not that it is absolutely tight.

■ Inventory records do not prove that a storage system is tight.

Occasionally inventory records will be produced to "prove" that a storage system did not leak. There are a number of ways a storage system can leak, however, and still produce acceptable inventory records. In addition, there are a number of factors that complicate the review of inventory records.[7]

a) **Inventory records are typically evaluated using the regulatory standard that allows a loss of one percent of the sales volume plus 130 gallons over a period of a month.** This standard is very crude, and is only designed to detect leaks of about a gallon per hour.[8] Inventory records could have abundant evidence of a small release but still successfully pass this regulatory criterion.

b) **Inventory data by themselves will only reveal that there is a certain amount of product that is unaccounted for.** The possible causes for the loss are varied and include temperature effects, evaporation, theft, and leakage. The most useful technique to identify a leak in the inventory records is to have service records available so the timing of the loss in the inventory data can be correlated to the timing of work done at a facility.

For example, a significant loss rate in the inventory records that ends on the day when the repair records indicate a flexible connector was replaced would provide a reasonably clear indication of a leaking flexible connector. A loss rate in the inventory records accompanied by an increase in contamination in monitor wells adjacent to the storage system may be another avenue for concluding that the unaccounted for inventory variance was due to a release. Without corroborating information, however, a loss trend in inventory data by itself is not conclusive evidence of a release.

c) **Relevant inventory records may not be produced.** Because releases are most often discovered long after they have occurred, the inventory records that document the release may be many months or years in the past. A regulatory agency may request inventory records for the previous several months or even a year, but if the release occurred two years ago, the inventory records produced will not provide evidence of the release.

d) **Inventory records may be altered.** Sometimes the alteration can be detected. A typical example is when the volume of fuel in the tank recorded on the first day of the month is not the same as the volume of fuel recorded on the last day of the previous month. This is often an indication that records for the entire month have been fabricated. This type of falsification is not unusual at facilities where company policy or regulatory requirements specify that inventory variances must be kept small. Frustrated at not being able to meet the strict requirements using actual inventory data, operators simply create inventory records that will meet the requirements.

Some modifications of inventory records cannot be detected. For example, there would be no way to tell if the daily sales numbers were routinely adjusted to reduce the daily variance unless there was some independent record of the daily sales volume.

e) **Inventory recordkeeping is not done carefully.** When daily variances average many tens of gallons, with frequent variances of hundreds of gallons, the inventory records are unlikely to be able to reveal anything but massive leaks. Even when carelessly conducted, inventory records may still pass the regulatory criterion of having a monthly variance of less than one percent of the sales volume plus 130 gallons, and so be considered evidence of a "tight" storage system.

What's to Be Done?

As a result of the Energy Policy Act of 2005, most states are heading down the road of secondary containment for new storage systems. Properly installed and maintained secondary containment addresses many of the issues discussed here, but it will be a long time in most states before today's single-walled storage systems are replaced. In the meantime, keep a critical eye on leak detection records of all stripes and colors, and be on the lookout for contamination whenever you see an excavation at an UST site. ■

Endnotes

1. Florida Leak Autopsy Study, as of February 2005. Unpublished data based on survey of 889 releases between 1995 and 2005.
2. "Are Leak Detection Methods Effective in Finding Leaks in Underground Storage Tank Systems?" by Shahla Dargahi Farahnak, P.E., and Mary M. Drewry, California State Water Resources Control Board, January 1998.
3. *Analysis of California UST & LUST Programs and the Impacts of MtBE and Ethanol to California*, prepared by Anne Happel for the U.S. Department of State, Office of the Legal Adviser, December 2003, p. 27.
4. *USEPA MTBE Pilot Project – Objective 2 Investigate Potential Sources of MTBE Contamination on Long Island That Could Impact Water Supplies or Environmentally Sensitive Areas*, New York State Department of Environmental Conservation, February 2008, p. 5.
5. Ibid., Appendix D, p. 3.
6. "PEI Members Weigh in on UST System Performance," *LUSTLine* Bulletin #41, June 2002, p. 5.
7. For a more detailed discussion of how to look at inventory records, see "Baffled by a Leak? Check the Inventory Records," *LUSTLine* Bulletin #44, July 2003.
8. *Analysis of Manual Inventory Reconciliation*, Entropy Limited, EPA 510-S-92-802, March 18, 1988.