In December 1983, *60 Minutes* shook things up with a story about leaking underground storage tanks (USTs). While the leaking UST (LUST) problem was by then known and being addressed by the petroleum industry and the blossoming environmental field, the *60 Minutes* story created a national public awareness. Congress subsequently passed legislation in 1984 to deal with LUSTs.

On May 7, 1985, the Environmental Protection Agency (EPA) published an "Interim Prohibition" which stated that new underground storage tanks had to be corrosion-resistant, structurally sound, and compatible with the stored product. A draft regulation was written in 1987 for public comment. By year-end 1988, a final rule was promulgated, 40 CFR Part 280, mandating tank owners to bring underground tank systems into total compliance by December, 1998. 40 CFR Part 280 dictated that regulated USTs be corrosion-resistant, incorporate ongoing leak detection and be equipped with spill and overfill prevention devices. The rule also established tank registration, release reporting and clean-up requirements, and financial responsibility provisions.

As we reach early 1998, less than a year remains before the compliance deadline. How is the underground storage tank program faring? What has happened to the nearly two million regulated USTs thought to be in existence in 1988? And what are the latest developments?

At its Ninth Annual UST/LUST National Conference in March, 1997, EPA announced that the number of tank closures had actually surpassed the number of active regulated tanks. Statistics released November 17, 1997 indicate 1,150,824 tanks have been retired from service, leaving 969,652 active regulated USTs. Most alarming, in March, the EPA estimated nearly 800,000 tanks still have not fully complied with the requirements of 40 CFR Part 280.

On the good-news front, the EPA states that the number of newly-reported contaminated sites has finally slowed down. EPA figures indicate 341,773 confirmed releases as of November, 17, 1997 and 60% of these releases have affected groundwater.
242,446 cleanups have been initiated to-date and 178,297 cleanups have been completed. EPA indicates that 461,507 tank systems have been equipped to meet leak detection requirements and 304,652 systems meet upgrade requirements.

The EPA has stressed that it will not extend the 1998 deadline. Many petroleum marketing associations support this position in the spirit of fairness to the majority of marketers who have already invested in tank upgrading. Petroleum marketers, of course, collectively own the greatest percentage of regulated USTs.

On the other side of the coin, compliance levels are believed to be substantially less in the government sector, from small municipalities to state fleets to very large military operations. Also lagging behind: institutions such as schools and hospitals; utilities; companies with their own fleets such as landscaping contractors and trucking firms; and other industrial/commercial operations. These types of companies will be scrambling during the next the remainder of the year to achieve compliance and will likely be turning to the engineering community for spec-writing and project management.

**Relocation**

Certain requirements of CFR 40 Part 280 have already passed deadline, such as leak detection provisions and demonstration of owner's financial wherewithal to cover any possible soil or groundwater contamination resulting from UST leaks. Although the industry has developed sophisticated inventory control methods, such as statistical inventory control - SIR, and in-tank probes attached to computer consoles, EPA will focus heavily on record keeping of inventory and leak detection/tank tightness test results. The new EPA Office of Underground Storage Tanks Director, Anna Virbick, has an enforcement background, having worked for the Inspector General's office, and has made this one of her top priorities.

In May, 1997, a further catalyst to drive tank compliance work was a nationwide state-EPA enforcement initiative aimed at identifying and correcting violations of regulations requiring the use of approved leak detection methods at UST facilities. Teams of federal and state EPA regulators inspected 10,050 facilities and found 3192 facilities in violation. Fines ranging from $50 to $300,000 were assessed by EPA.
The states are also dealing with enforcement and inspection in various ways. For example, Pennsylvania and Wisconsin use third-party inspectors to verify that USTs are properly meeting compliance. South Carolina has its own enforcement staff and has considerably increased its inspection activity with the intent to have inspected UST sites twice by mid-1998. Ohio has implemented a program whereby tanks which are in compliance will have a decal indicating compliance; those that do not have decals will not be allowed to be filled by delivery trucks. North Carolina has a similar "permitting" program. In 1999, the State of Michigan inspectors will "red tag" non-compliant facilities, essentially shutting them down until the system meets requirements. Other states, such as New Hampshire, target older tank sites near well-head protection areas and rely on detailed checklists to complete their inspections. An ASTM sub-committee, E50.01, is developing a checklist to assist third party inspection programs in evaluating compliance with UST regulations. Insurers, bankers, regulators, tank owners, and engineers are participating. The document, "ALICE-Guide for Conducting Inspection of USTs for Compliance with Federal Regulations", was balloted in December, 1997.

State programs are a key component of the EPA initiative and each state program must eventually be approved by the federal EPA as complying with the EPA's minimum requirements. Today, only 25 programs, including the District of Columbia, satisfy EPA's criteria.

As far as state-by-state compliance figures, there's wide divergence from state to state. Some states have been quite aggressive. Maine, for example, has accelerated the deadline to year-end 1997 and further mandated that all single-wall tanks be replaced with secondary-contained tanks. Iowa also accelerated the deadline and provided financial incentives to tank owners, prompting a rash of upgrades in 1994-96. Other states are clearly behind the 8-ball in achieving 100% compliance by December, 1998 (statistics from each or any state is available as a sidebar). For example, on October 24, 1997, the Bureau of National Affairs reported that only 21% of Georgia's 47,197 active tanks and 16% of Alabama's 22,401 active tanks are in compliance. Comparing theses statistics against the national average of 50% suggests that many tank owners have yet to address the requirements. North Carolina officials expect 10% of small business owners to simply close their business.

Industry Happenings

During the past eight years, a tremendous number of changes have taken place in the industry, particularly with site assessment, remediation, and new equipment. In March, 1997, the EPA published "Expedited Site Assessment (ESA) Tools for UST Sites: A
One significant development was the ASTM E-1739-95 standard for Risk-Based Corrective Action (RBCA), commonly termed "Rebecca". The ASTM standard applies site-specific, risk-based assessment criteria to identify higher-priority sites for clean-up. In addition to directing clean-up efforts (and money) towards areas where releases have the greatest environmental impact, RBCA has helped the regulatory community maintain sensible control of their limited funding and manpower. Prior to RBCA, many extensive and costly clean-ups were being undertaken which were actually unnecessary based on the environmental risk. RBCA will place a heavier emphasis on the tank owner and his consultant engineer in the decision making process. While some states have had some hurdles in re-orienting their approach to include RBCA standards, others have already established RBCA training programs. EPA has developed some new collateral materials available on this subject - see sidebar [at the end of this article].

Natural attenuation is the use of naturally occurring physical, chemical, and biological processes to achieve clean-up goals and has been recognized as a scientifically-sound approach to cleaning up certain product releases - providing the release is not spreading and poses no immediate or near-future threat to human health and the environment. For example, Lawrence Livermore National Laboratories in California documented its research of tanks installed in less permeable soils in forming this conclusion.

Several guidance documents are being developed on natural attenuation. EPA OSWER's 9200 Series Directive, "Use of Monitored Natural Attenuation at Superfund, RCRA, and UST Sites", issued on November 17, 1997, will describe when and where NA can be used. Internet users can access this document at www.epa.gov/swerust1/directiv/9200_417.htm.

The ASTM standard "Remediation by Natural Attenuation" (RNA) is expected to be approved on January 10, 1998 and emphasizes three lines of evidence to determine the status of a contaminant plume from petroleum products only - either increasing, decreasing, or stable. Plumes found to be stable or decreasing demonstrate that RNA is sufficient. It should be noted, however, that the required long-term monitoring of a RNA site comes at a cost. This is probably the major drawback of RNA and may actually position an immediate clean-up as the most cost-effective.
It should be stressed that not all substances are suitable for natural remediation. Methyl Tertiary Butyl Ether, MTBE, for example, is more soluble in water, slower to biodegrade and migrates more quickly than traditional fuels. The percentage of LUST sites with MTBE contamination has been growing, discovered at 90% of sites in Maine, 80% in Vermont, 70% in Florida, 60% in Maryland, and 10% in Michigan. The city of Santa Monica, CA recently lost two-thirds of its water supply due to MTBE contamination. Since MTBE constitutes nearly 4% of all gasoline sold and can represent as much as 15% of the volume of the gasoline in carbon monoxide non-attainment zones, MTBE contamination concerns are understandable. MTBE can be remediated through pump and treat, air sparging, vapor extraction and other methods, but it is much more expensive to treat, because it is 10 times more difficult to volatize from the dissolved phase.

What Needs to be Done

Tank owners have three principal options with respect to existing USTs: retire the tank; replace the tank; or upgrade the tank. Owners who have elected to retire their tank(s) have simply found other options to meet their particular needs. For example, some have found the need for on-site vehicle fueling unnecessary in light of their operations and today's abundant fuel supplies. On the other hand, some businesses which have closed tanks, later found that decision to be a costly one in terms of lost productivity and higher-than-anticipated costs of fuel and in unauthorized use of cardlock systems for filling of personal vehicles. Some of these businesses have elected to reinstall their tanks.

Many are replacing their USTs with aboveground storage tanks (ASTs) - an option which again provides opportunities for civil engineers to assist tank owners in evaluating and specifying AST designs.

Those who choose to upgrade their USTs have two choices: line the interior of the tank, or install external impressed current cathodic protection system. These options are fairly specialized and represent services provided by a niche group of companies. In most cases, the tanks are not disturbed, but all tanks must be assessed for tank integrity prior to upgrading with either option. For upgrading tanks by internal lining, physical inspection of the tank interior is required for proper tank assessment. For upgrading tanks by impressed current cathodic protection (CP), most states allow non-invasive methods of assessing the tank.
It should be noted that recently, an emergency ASTM standard, ES-40, was in place which provided other "non-invasive" means of tank assessment: statistical analysis of soil corrosion characteristics, internal robotics which measured wall thicknesses, and internal video of the tank. However, ES-40 was not reapproved in 1996, leaving a void in tank assessment methods. Nevertheless, some states continue to recognize the procedures established under ASTM ES-40, as an alternative to internal inspection, citing concerns of safety for those who must physically enter a tank. Other states are uncertain or uneasy with the controversy of ASTM ES-40, yet mistrust the reliability of tank tightness testing. On July 25, 1997, EPA issued a memorandum entitled "Guidance on Alternative Integrity Assessment Methods for Steel USTs Prior to Upgrading with Cathodic Protection" recommending state agencies approve either integrity assessment methods complying with national standards OR vendor supplied procedures which receive third party evaluation and certification that the procedure meets criteria for establishing tank integrity.

The best advice to those contemplating upgrading options: closely scrutinize vendors of these services. Check their track records, experience, and product/service warranties. Also, if the state(s) has a certification program for UST upgrades, testers and/or installers, check to see if the vendor is certified. Some voluntary certification programs exist which generally require that certain minimum criteria be met by contractors, such as experience, references, passing a test and continuing education. These programs may be under the auspices of state petroleum contractor associations, code groups such as the International Fire Code Institute (IFCI), or local or national trade associations.

From a financial standpoint, there are pros and cons with upgrading, like there are for any alternatives. Some tank owners may be uncertain about the future of the business or the long-term need for on-site storage and find the lower cost of upgrading vs. replacement appealing. However, one must understand that over the long term, the cost differential between upgrading and new tank replacement may actually be quite minimal. Both internal lining and impressed CP systems require regular monitoring. In the case of lining, tanks must be emptied, cleaned and shut-down for an internal inspection after the first 10 years and every 5 years thereafter. The impetus for this time frame stemmed from the typical lining warrantee of 10 years - which leads to another comparison a tank owner should weigh: warrantees. New tank systems are generally warranted for 30 years.

Finally, upgrading a tank or pipe system with which the owner has little information on its current condition can create a feeling of uneasiness. In some cases, existing contamination may remain as an undiscovered entity. Strangely, this is usually touted as
an advantage by those who line tanks or install impressed CP systems, who put a spin on
the adage "out of sight, out of mind" with the addition of "out of regulatory hands and
clean-up needs". But to cite another adage, eventually the "hens come home to
roost"...clean-ups must be addressed if the real estate is to maintain its value over time.
Keep in mind too that very few releases have emanated from new underground storage
tank systems. The systems are safe because of technological advances, regulatory
enforcement, and greater care with installation. In fact, the few releases which states have
reported upon were caused by improper installation.

Advances and Trends in Tank
Technologies

In the mid-1980s, there were basically two types of USTs: non-metallic fiberglass-
reinforced plastic (FRP) tanks built to Underwriters Laboratories UL 1316 standard, and
pre-engineered, cathodically-protected tanks built to the Steel Tank Institute sti-P 3 ®
standard. Both were, and still are today, available in either single-wall or double-wall
configurations. However, the recognition of the merits of secondary containment have
partially been a catalyst in the development of additional UST technologies. Also driving
technological advances was the desire for other means of corrosion protection, while still
providing structural integrity and product compatibility.

The sti-P 3 ® technology, developed in 1969, utilizes zinc or magnesium anodes (welded
or wired-on) plus an exterior coating of urethane, coal tar epoxy or FRP. Nearly a quarter
million tanks have been installed to-date, with a phenomenal track record of zero failures
due to improper design. The sti-P 3 ® is the only shop-fabricated UST corrosion control
design which provides for monitor ability of the corrosion protection system.

Composite steel tanks and jacketed steel tanks evolved significantly between 1985-1990.
Composite tanks are "holiday-free" thick-clad FRP or urethane-coated steel. The coatings
are tested for pinholes and defects with a high voltage "spark holiday" tester. This
technology was first standardized by STI in 1968 as the STI-LIFE tank, but by 1987 it
was coined the ACT-100® tank. Built to ACT-100® or UL 1746 standards, composite
tanks are protected from corrosion by preventing soil and groundwater from coming in
contact with the steel surface.

Jacketed tanks are so termed due to the use of "jackets" of FRP or high-density
polyethylene wrapped around the primary steel tank, acting as both a corrosion barrier
and a secondary containment. There is a measurable, albeit small, interstice between the two tank walls for leak detection monitoring. The STI fabrication standard in this genre utilizes a FRP jacket and is entitled the Permatank® system, also referencing UL 1746 and UL 58 in its fabrication criteria. Jacketed and composite tanks have seen a steady market share growth.

One noted trend in today's UST market is the increasing capacity of many installed tanks. STI statistics show a 15% increase in the average UST capacity over the past three years.

Another trend is the use of compartment tanks - tanks divided into two or more compartments to store several liquids within one large vessel. By eliminating one or more tanks, tank owners save installation costs, state registration fees, and often-times, insurance premiums. Some fabricators report compartment tanks account for 40-50% of their business today! The use of compartment tanks applies to both USTs and ASTs - a recent installation of an aboveground chemical tank had 7 compartments!

Perhaps the most significant trend in the tank industry has been the proliferation of aboveground storage tank installations. Some tank manufacturers have seen a 2:1 ratio of USTs to ASTs change during the past five years to a 1:3 ratio. Applications range from standby-generator tanks to heating oil to waste oil storage, but a huge increase has been experienced in the use of ASTs in the non-retail fueling market. Reasons often cited by owners include the visual monitoring ability of aboveground tanks and the relief from the financial responsibility criteria under the EPA's UST requirements.

Again, as with underground storage tanks, the number of choices for ASTs has grown exponentially. Single-wall UL-142 tanks and non-labeled farm-type skid tanks were the norm in 1990. Today, fabrication shops are busy producing steel diked tanks, protected (insulated) tanks, fire-resistant tanks, and double-wall tanks.

Secondary containment is incorporated in over one-third of shop-built ASTs today. The Seventh Edition of UL 142 was published in 1993, which included these various alternative tank constructions. STI standardized two such constructions with its F911 for steel dike construction and its double-wall AST standard F921®. The reasons for this tremendous growth in the use of secondary containment is largely attributable to well-publicized AST releases and structural tank failures (i.e., incidents in Fairfax, VA and Pittsburgh, PA) which caused a greater awareness of potential AST environmental
dilemmas.

Fire codes, which closely dictate AST installations, have also recognized the merits of AST secondary containment and have been revised over the years to allow secondarily-contained ASTs greater leeway - further driving the use of secondary containment for ASTs. Both the Uniform Fire Code (UFC) and the National Fire Protection Association (NFPA) codes now allow secondary containment tanks of 12,000 gallons or less to be installed without the normal spill control requirements of diking or remote impoundment. Also, in 1992, EPA's Office of Solid Waste and Emergency Response issued an interpretation on shop-built tanks, stating that secondary containment tanks with capacities 12,000 gallons or below and with overfill prevention measures, are equivalent to a standard dike.

As an important side note, civil engineers need to be aware of the requirement that spill prevention plans for regulated tanks which can impact waterways must be developed for tank owners. This is under the Clean Water Act, 40 CFR Part 112, and is entitled the Spill Prevention Control Countermeasure Plan (SPCC). Registered professional civil engineers will be needed to develop SPCC plans for aboveground tanks larger than 660 gallons and storing oil, which can release product into surface waters (via groundwater, ponds, creeks, rivers, wetlands, etc). In October, 1991, EPA proposed SPCC revisions strengthening secondary containment provisions, tank integrity testing requirements, and creating more mandatory language within the rule.

The use of ASTs for fueling applications and the associated concerns when storing flammable and combustible liquids aboveground has virtually bred a new AST shop-fabricated market: the insulated tank for fire protection. For the most part, these tanks are called protected tanks or fire-resistant tanks and must pass a third-party laboratory standard. UL 2085 is the most widely-recognized standard. In order to obtain a UL 2085 listing, tanks are placed in a 2,000 degree furnace for two hours and internal thermocouples must indicate a minimal internal tank temperature rise. Most protected tanks on the market today have met the UL 2085 standard. The second edition of UL 2085 was issued on December 30, 1997.

In effect, the protected tank is trying to emulate an underground environment where the tank and its flammable liquid is surrounded by soil. Firefighters want an extra level of security should they ever have to battle a tank fire. By minimizing the temperature inside
the tank during a pool fire, the amount of vapors and pressure build-up inside the tank is minimized. Most important, however, is the emergency vent, which removes (vents) these vapors during a pool fire - regardless of whether the tank is an insulated design. Of course, the key to pollution prevention and fire safety is to prevent the release from ever occurring. That is why both fire codes and environmental rules require overfill prevention devices, such as alarms, shut-off devices, and gages.

Most protected tanks are surrounded by 6" of insulation. However, in March of 1997, the Steel Tank Institute Fireguard® standard set a new pace by obtaining UL 2085 listing for 3" of insulation. The significance of this is dramatic reduction of the overall weight of the tanks, which impacts shipping, installation and potential later portability of the tank.

Another trend within the AST market is greater demand for rectangular tanks. Owners like the flat top for its workability function. Also, most of the new generation of shop-built ASTs are horizontal tank types, whereas vertical ASTs continue to be used for bulk storage applications and at terminal facilities.

**Other Pertinent Notes for the Civil Engineer**

Besides the already referenced Steel Tank Institute and Underwriters Laboratories standards, readers will want to procure important installation guidelines established for underground tanks, aboveground tanks, and vapor control systems from the Petroleum Equipment Institute (PEI). PEI's Recommended Practices (RP-100, RP-200, RP-300) spells out the importance of backfilling, testing of tanks and the outer containment, and other critical installation elements. The American Petroleum Institute, API, also has established standards for both shop-fabricated tanks and field-erected tanks. Another reference is the National Association of Corrosion Engineers (NACE), which has developed standards for corrosion protection of tanks and piping.

As noted earlier, fire codes play a large role in aboveground tank design and installation, but also address underground tanks as well. National model codes are published by four groups: NFPA, UFC, the Building Officials and Code Administrators (BOCA), and the Southern Building Code Congress International (SBCCI). Different regions and states will follow different model fire codes, so it is incumbent upon the civil engineer to determine which code is followed. Also, as each of the codes are revised periodically, the engineer must verify which revision is followed by the local authority having jurisdiction.
(AHJ) - who holds the ultimate authority. In addition to the various issues discussed earlier, codes will address items such as separation distances of tanks to buildings, public ways, dispensers, etc.; tank openings; anti-siphon devices and other valves; vehicle impact protection; and ballistics protection. Due to the concern fire authorities having jurisdiction have that ASTs be installed with all important tank appurtenances, Underwriters Laboratories is providing new listings on prefabricated tank systems, under its Subject UL 2244. The first listings were issued in October, 1997.

With tanks requiring extensive design parameters, project engineers should avail themselves of various reference materials available today. Computerized interactive specification programs are available from many manufacturers to help engineers develop specifications and drawings. Many associations and manufacturers are now on the Internet, providing exhaustive technical and reference materials for engineers. STI's website at www.steeltank.com is one which engineers will find quite valuable in both content and links to other organizations.

December, 1998 is not all that far away and the engineering community is expected to have a key role in assisting tank owners with UST compliance and new AST installations. It should be an exciting 18 months.

SIDEBAR - RBCA

1. Perform qualitative risk assessment to identify sources of contamination, its spread, and its consequences
2. Classify site in terms of urgency
3. Develop an appropriate response action based on site classification
4. Compare containment data against a table of risk based screening levels
5. Establish site specific clean-up target levels based on state or federal exposure limits
6. If needed, collect additional site specific information
and develop remedial action plan

**SIDEBAR EPA**

**Documents**


**EPA 510-B-96-007 UST Program Facts: Implementing the Federal Requirements for USTs**

**EPA 510-H095-001 Don't Wait Until 1998: Spill, Overfill, and Corrosion Protection for Underground Storage Tanks**

**EPA 510-F-96-006, July 1996 Closing Underground Storage Tanks: Brief Facts**

**EPA OSWER's 9200 Series Directive, November, 1997 Use of Monitored Natural Attenuation at Superfund, RCRA, and UST Sites**