As owners of underground storage tanks face an upcoming compliance date, the aboveground storage tank market continues to heat up. This assortment of tank topics may answer some of the questions tank owners need to resolve now or in the near future.

Environmental Technology recently interviewed Wayne Geyer of the Steel Tank Institute (STI) to get an update on the issues and activities in the dynamic storage tank industry. Geyer, executive vice president of STI, served as its technical director from 1986 to 1990. STI is a trade association representing over 80 fabricators of factory constructed underground and aboveground steel storage tanks. The institute is active in developing standards and recommended practices for the storage tank industry, such as corrosion control requirements, secondary containment designs and installation recommendations.

Q: What is the status of compliance with new regulations by underground storage tank (UST) owners?

A: As most tank owners know, all existing regulated tanks must add some means of corrosion protection as well as release detection and spill and overfill prevention devices by December 1998. A recent survey undertaken by one state agency of 26 state environmental agencies found that only 26 percent of all underground storage tanks were in full compliance with 40 CFR Part 280. Approximately 42 percent of tank owners were in compliance with corrosion protection requirements and 37 percent were in compliance with release detection requirements. EPA believes that there may be nearly 700,000 USTs which still need to be brought into compliance.

Q: How have the regulations affected the market for underground and aboveground storage tanks (ASTs)?

A: Demand for USTs has been flat for the past six years, mainly because of the recent regulations, but there have been surges in UST installations from time to time. For instance, Iowa experienced a lot of activity a few years ago due to accelerated deadlines on UST regulations prompted by state insurance requirements and incentives granted to tank owners.

By comparison, there has been a dramatic increase in AST demand during the same period. In 1990, most tank fabricators were producing at least twice as many USTs as ASTs. Today, the inverse is true in many tank shops.
While ASTs are replacing USTs in many instances, ASTs are generally of smaller capacity than the USTs they are replacing. One of the most common applications with ASTs, for instance, is for private fleet fueling - managers are realizing that they don't require as much storage capacity as the UST afforded. Also, because fire codes usually restrict AST size, fleet managers make a compromise in capacity for the sake of realizing benefits they perceive with an AST.

A corollary phenomenon is that larger-capacity USTs are being built. STI's database indicates that UST average capacities have increased by 12 percent since 1993. A primary reason is that service stations (the most common UST application) are typically installing 12,000 gallon tanks today, compared to the average 8,000-gallon tank of the past. This is being driven by significant consolidation in the industry which results in more business for the remaining stations.

Q: What other factors are having a bearing on the storage tank market?

A: Large companies, particularly major oil companies, completed the "re-tanking of America" several years ago. Large non-retail tank facilities are removing their USTs and/or replacing them with ASTs. One petroleum marketer survey indicated that half of non-compliant UST owners will upgrade their system and another 20 percent will close down their tank systems. Most of the business owners who are shutting down UST systems are taking one of three actions:

Installing a fueling system with an AST.

Sending their fleet to a local service station for fueling.

Participating in an unmanned cardlock system, available to a number of industrial and commercial accounts.

With the remaining 30 percent replacing USTs, along with the aforementioned AST activity, we project that storage tank capacity will be in high demand over the next two years. Beyond our own projections, the petroleum equipment industry anticipates that demand will far exceed supply as the December 1998 compliance deadline approaches.

Small business owners are the least likely to comply unless enforcement is increased or additional money becomes available. Some are still expecting the deadline to be extended, but EPA has emphatically stressed that this will not happen.

Q: Regarding ASTs, is their use as hot a trend as it seems?

A: In a recent survey of our STI members, fabricators indicated that they were building three aboveground tanks for every underground tank. Without a doubt, the new UST requirements have led many tank owners to consider ASTs more strongly than they might have otherwise. Tank owners feel that an aboveground tank is less regulated, plus there
are currently no federal laws regarding financial responsibility or cleanups.

On the other hand, greater demands continue to be placed upon AST tank owners, including the requirements of the new emergency response planning rules. Proposed legislation can mandate soil cleanups and shut a facility down when human health and safety is at risk.

Although these facts are fairly well known, many businesses continue to seek that warm, fuzzy feeling in placing their storage facility aboveground.

There are also new standards for the construction, maintenance and operation of AST systems, including Standard 653 of the American Petroleum Institute.

There are other factors that encourage the use of ASTs. Many owners like that feeling of extra security in that they can physically see that an AST is not leaking. Further, AST designs have become more sophisticated, with an emphasis on safety, which in turn has increased AST acceptance by regulatory officials and tank owners. Finally, fire codes have been modified to allow AST usage for motor vehicle fueling applications. Many private and commercial fleets are now using ASTs at their fueling facilities, and we're even seeing more ASTs at retail sites.

**Q: What is the status of federal environmental regulations for ASTs?**

**A:** There is a popular misconception that ASTs are unregulated. ASTs are regulated, but not to the same rigorous extent that USTs are regulated. Whereas federal UST regulations extensively dictate tank design, certain components, and financial responsibility requirements, AST regulations primarily pertain to plan development to prevent the pollution of navigable waterways.

Spill Prevention Countermeasure Control (SPCC) plans are normally required on aboveground tanks that store hydrocarbons. Depending on tank size and/or location, there may be other applicable regulations as well. But there are presently no far-reaching federal regulations on ASTs comparable to those for USTs.

AST legislation has been proposed in two different sessions of Congress so far. In 1993, spurred by a major petroleum release in Fairfax, VA, Rep. James Moran (D-VA) introduced the Safe Aboveground Storage Tank Act, H.R. 1360. This prescriptive bill would have established rules that closely parallel rules for USTs, including mandates for corrosion control, release detection, compatibility, structural integrity, inspections, reporting of releases, and clean-ups. While the 1993 act did not make it to a floor vote in the 103rd Congress, it did kick around in subcommittee for awhile and generated significant interest.

In the current 104th Congress, Rep. Moran and Sen. Robb (D-VA) each sponsored a Bill - H.R. 3283 and S. 1537, respectively - covering ASTs. The objective of the new bill, called the Aboveground Petroleum Storage Tank Consolidation and Regulatory
Improvement Act, is to consolidate and streamline all of the various federal requirements on ASTs - now coming from OSHA, DOT, RSPA and EPA - into one regulation to be overseen by one federal agency. The bill proposes establishing a new Office of Storage Tanks within the EPA.

Although it is primarily environmental legislation, the bill also addresses safety provisions that are missing from various existing rules. It would add detection, spill prevention and corrective action regulations as needed to protect human health and the environment. It would also require EPA to determine if other deficiencies exist, specifically in areas such as secondary containment and overfill. And they would adopt by reference the model fire codes that now exist in various state, regional and local fire and building codes. These codes are often quite specific on AST design, site planning and certain equipment.

Q: What fire and building codes are important for AST owners?

A: The best answer is to check with the local authority having jurisdiction (AHJ). Most, but not all, local authorities will follow one of the four (4) national model fire codes which dictate AST design and installation for flammable and combustible liquids. These are:


Even if an AHJ follows a particular national code to the letter, verify the date of the code revision which the AHJ has adopted. The national model codes are revised every few years, but the local authorities may not have yet adopted the most recent revision.

Q: Could you elaborate on significant code requirements and the types of AST systems that meet them?

A: Around 1990 - soon after EPA issued its UST regulations and at a time when considerable media coverage was given to leaking USTs - the trend towards aboveground shop-fabricated tanks first developed. At the time, fire codes required spill control around aboveground tanks. The requirement was meant to prevent a fire from spreading by containing and controlling spills around the tanks. Concrete and clay dikes were common for this purpose, but methods used ultimately evolved toward steel dikes as well, because steel is impermeable to hydrocarbons. The UL 142 tank installed within a steel dike became very common. Since then, STI also developed a national standard for a diked
design, F911®.

In October 1991, proposed revisions to the SPCC requirements accelerate that trend - even though the proposal still has not been finalized. The proposal would require a permeability factor in which no leakage is acceptable around diked areas for 72 hours. Owners of large field-erected tanks objected because the rule would have required many retrofits with expensive liner systems with questionable benefit. A revised SPCC final rule may be forthcoming later this year, after EPA completes analysis of its survey of 30,000 AST owners.

Another concern arose regarding the fire risk of dikes containing the spills they are designed to catch. This led to new innovations for AST overfill prevention and containment. Fire codes mandated that all openings be atop the tank and that anti-siphon devices be included.

Essentially, the codes were prescribing language in an attempt to eliminate spills and, hence, the associated fire risks.

This opened the door for double-wall aboveground tanks, which in a sense are "dikes" wrapped over and around the primary tank. Fire codes and EPA recognize this form of spill containment as an alternative to diking for tanks of 12,000 gallon capacities or less, as long as other safety features such as vents and overfill prevention devices are incorporated. STI developed a double-wall tank standard in 1992 entitled F921®.

The evolution of aboveground shop-fabricated tanks continued, when in 1993, the three primary codes for flammable and combustible liquids - NFPA 30, NFPA 30A and UFC - referenced the insulated tank. "Protected" tanks or "fire-resistant" tanks are insulated ASTs and typically meet a two-hour fire rating after the manufacturer passes a third-party laboratory test, such as the Underwriters Laboratories' UL 2085 standard.

The UFC recognizes protected tanks while the NFPA recognizes fire-resistant tanks. More than semantics, there are some differences in the test criteria for each. For example, each definition involves a two-hour test at 2000 degrees Fahrenheit. A protected tank cannot exceed a 400-degree change at any one point and 260-degree average change on the inside tank wall. For a fire-resistant tank, these temperature limits are 1,000 degrees at any one point and an average of 800 degrees. The tanks of most suppliers will meet the more stringent protected tank criteria.

The UFC permits motor vehicle fueling from an AST only if the protected tank has built-in secondary containment. Systems with built-in secondary containment include:

Steel inner tank, insulation, steel outer tank.

Steel inner tank, steel secondary containment tank, insulation, steel weather shield.
Steel inner tank, plastic membrane for containment, concrete, steel weather shield.

Steel inner tank, plastic membrane for containment, concrete insulation.

The insulation layer can be high compressive strength concrete, cementious perlite mixture or mineral fiber. The selling feature of the insulation is usually its weight for portability and the impact resistance of the entire assembly.

Under NFPA, fire-resistant ASTs can be placed closer to buildings and property lines than non-fire-resistant ASTs. The thought here is that the farther a tank is from public access, the safer the system will be. This limitation impacts the amount of real estate required for a tank placement to meet code. In 1994, STI developed the Fireguard®, a protected tank with UL 2085 listing that incorporates a lightweight monolithic thermal insulation between two walls of steel to minimize heat transfer from the outer tank to the inner wall. The unique feature is the insulation's porosity, which allows liquid communication to release detection devices and for rapid venting.

**Q: How many ASTs do you estimate now incorporate some form of secondary containment?**

**A:** Before 1990, secondary containment of shop-built aboveground tanks was quite rare. Today, however, over a third of all ASTs made have secondary containment - and that percentage is growing rapidly.

Here's another perspective: In 1995 alone, tanks built to STI standards totaled nearly 100 million gallons of tankage. Nearly 50 percent of these tanks incorporated secondary containment. While this number applies to both underground and aboveground storage tanks, it indicates the overall prevalence of secondary containment. Compare this to the mid-1980s, when less than 10 percent of tanks had secondary containment.

**Q: What kind of technological developments have there been for USTs?**

**A:** The most recent significant developments have been jacketed tanks and composite tanks. Using recently developed STI standards as a benchmark, we've seen tremendous market growth in use of our ACT-100® composite standard and our Permatank® jacketed tanks. Both incorporate a primary steel wall but differ in exterior corrosion protection. ACT-100® tanks are coated on the outside with fiberglass-reinforced plastic (FRP), while Permatank® jacketed tanks are double-wall tanks with the entire outer tank being FRP. Neither requires use of cathodic protection (CP), nor the associated monitoring requirements as mandated by the EPA.

Even the sti-P3®, which has been around since 1969, has undergone product enhancements such as coatings and user-friendly CP systems. In fact, after experiencing a six-year downward trend in registrations (all tanks fabricated to STI standards are registered), demand is rebounding for the sti-P3®. Prominent features that increase popularity of the "old" technology include self-testing cathodic protection stations and
new anode options.

**Q: You mention cathodically-protected (CP) tanks. How do they work?**

**A:** Cathodic-protected tanks are coated with urethane, fiberglass-reinforced plastic (FRP) or coal tar epoxy and incorporate sacrificial zinc and/or magnesium anodes to protect the steel against rust wherever steel is directly exposed to the soil. By maximizing the effectiveness of the coating and minimizing the damage to the coating, the anodes can be designed to last well past 30 years in various types of soil environments.

The goal of the cathodic protection design is to energize the steel to an energy level or "electrical potential" where corrosion will simply not occur. This is handled galvanically with anodes or electrically with a rectifier. In both cases, the objective is to bring the electrical potential of steel up to -850 millivolts or more negative with respect to a copper-copper sulphate (Cu-CuSo4) reference cell.

Zinc and magnesium which have normal potentials of -1100 and -1600 millivolts, respectively, relative to the Cu-CuSo4 reference cell, will corrode in place of the steel when connected electrically to the steel.

To help understand this process, think of a flashlight battery which uses a copper rod and a zinc casing. The differences in potential between the two is -1.5 volts which creates sufficient amperage to light a flashlight. But what's also happening is that the zinc is protecting the carbon rod. The zinc casing will corrode.

In the case of both the flashlight battery and a storage tank, a further required element is an "electrolyte". The electrolyte provides a pathway for the electrochemical process of corrosion to occur. The moist soil is the electrolyte with underground structures.

Through coating, anode design and electrical isolation of the tank from other structures, the tanks are cathodically-protected and designed for long life.

**Q: You mentioned the desired level for a sti-P3® reading. What does it mean if you don't get the -850 millivolt reading?**

**A:** It may mean the tank is shorted to another metallic object, which can be easily located. Or it can mean that the monitoring equipment or procedures are producing errors and need to be evaluated.

Another possibility is simply that the surrounding soil is currently dry. In order for anodes to function and the system to work properly, the soil must be sufficiently conductive. In dry soils, corrosion of the anodes may not occur to initiate protection of the steel and a protective reading. Fortunately, the steel will not corrode in such circumstances.
Q: What kind of track record does the sti-P3® system have?

A: Over a quarter million sti-P3® tanks have been installed since 1969. Failure rates of this system are near zero as substantiated by warranty claims and third party audits. In fact, during various site re-hab projects, we've witnessed sti-P3® tanks which had been in service for many years being pulled from the ground looking as good as the day they were installed.

One real benefit of the sti-P3® system is that it is the only UST design which can be monitored for corrosion resistance once it's buried. With a buried reference cell, an owner can test the CP system in less than 5 minutes. Also, the sti-P3® system can be specified as a double-wall tank and subsequently, need not be monitored as far as the federal EPA is concerned, although some states may have more stringent requirements.

Q: Despite the merit of being able to monitor cathodically-protected tanks such as the sti-P3®, many tank operators don't want to bother with periodic CP monitoring. Is this where the composite or jacketed tanks come into play?

A: Exactly. EPA regulations accept thick-film clad steel tanks, or composite tanks, as an alternative to single-wall, cathodically-protected tanks. (Composite tanks can be single or double-wall).

The exterior cladding is typically 100 mil FRP. The UL 1746 standard provides a testing protocol for cladding to be eligible and labeled as composite tanks. Most recently, urethanes have been approved for this usage also. The STI standard for composite tanks is the ACT-100®.

The theory behind the corrosion protection offered by the composite tank is that the coating, which completely envelopes the steel tank, prevents contact with the soil (the electrolyte) and thus the steel cannot corrode. The coating is thick enough to prevent damage in transit or during installation or tank operation. Manufacturers perform a spark test on the tank to make sure there are no microscopic voids in the coating. With FRP coatings, this test uses a 36,000 volt holiday test. Also, installers will inspect the coating on-site.

Q: How does a jacketed tank differ from a composite tank?

A: Jacketed tanks evolved somewhat from the composite tank. They employ a primary tank made of steel and an outer secondary tank made from non-metallic materials such as FRP or high-density polyethylene. In between these two walls is some sort of system which provides interstitial separation. For example, the Permatank® standard incorporates a polypropylene mesh with a mylar film as the means of interstitial separation.

The driving factor in this technological development was that the exterior wall provides secondary containment and corrosion resistance at a cost savings over two walls of the
same material, particularly since the overall weight of the structure is reduced. Hence, it is no surprise to see that this type of product is growing.

Most jacketed tanks are shipped from the factory with a vacuum applied between the two walls. The vacuum assures the integrity of the secondary containment system from time of production to the time the tank is backfilled. Obviously any significant loss of vacuum is an indication that the system requires further investigation before the product is put into use. The vacuum may be left intact after installation as an ongoing means of leak detection monitoring.

**Q: Considering all the choices, how would an engineer determine the right tank for a specific project?**

**A:** There are, indeed, many variables and options to examine. Obviously, the engineer must begin by ensuring adherence to environmental regulations and local safety and fire codes. Some jurisdictions mandate secondary containment for USTs. I believe many engineers today will opt for secondary containment of a tank system if given a free reign in the project design.

One very practical reason for that choice is that it minimizes their liability because they specified state-of-the-art equipment designed to minimize risk. Another reason, from the tank owner's point-of-view, secondary containment is "cheap insurance". The additional cost of secondary containment over a single-wall tank - typically less than $1 per gallon of capacity - is insignificant next to the cost of soil or groundwater cleanups. For example, a recent publication from the National Association of Convenience Stores (NACS) indicated that the average cleanup at their member sites was around $100,000.

It's very important that an engineer understand that risk is not limited to the tank. Equal design consideration must be given to the piping system. Pipe system leaks historically have been the major cause of UST system releases. Filling operations are another. Also, maintenance activity at dispensers and other critical equipment, where the human element comes into play, can tremendously impact operations and control over spills or catastrophic occurrences. If an engineer can spell out prudent procedures, or at least reference accepted industry practices, all the better.

Finally, it's vital that engineers learn and stay abreast of the plethora of codes, regulations and the equipment which provides means of compliance. There are a number of forums where this education can be attained or refreshed. One such opportunity is the annual conference and expo of the Petroleum Equipment Institute (PEI), "Convex". This next Convex will be held October 8-10 in Orlando, FL. For more information, call PEI at (918) 494-9696.

**Q: Are there any "tried and true" criteria which help in deciding whether to use an AST or an UST?**

**A:** First and foremost, local and national regulations and codes will be a factor and may
prohibit an aboveground tank in certain circumstances. A site without enough real estate to properly separate the tank from important buildings and public ways is a likely candidate for an underground tank. If the tank is placed aboveground, will it be considered acceptable aesthetically? This obviously depends on the surrounding area. Aboveground tanks are always found in very heavily concentrated industrial areas, but will be frowned upon in residential areas.

Q: What other aspects will help guide the UST-AST decision?

A: The environmental risk factor must always be weighed against the threat of fire and explosion. An aboveground tank will always pose a greater fire risk because it stores flammable and combustible liquids which are so accessible. Yet as stated earlier, ASTs can be monitored visually for leaks, a definite advantage over USTs. On the other hand, USTs have evolved considerably during this past decade, so that leak-free systems are easily obtainable.

Another consideration may be the "portability" of a tank. If a company plans on future expansion or relocation, an aboveground tank may more easily accommodate relocation.

Q: With ASTs being a more recent trend, are there any other factors which an engineer should weigh when designing an aboveground tank system?

A: The tank system will need to be protected from pranks and vandalism via a good security system. Also, as traffic flow is common in areas where tanks are installed, protection from vehicular impact is a necessity. Adequate spill control is a must. Any fire at a tank or delivery vehicle should not spread to a building because of inadequate spill control.

Q: Is wall thickness of underground steel tanks an issue?

A: Yes. In fact, the requirements for steel USTs may be revised in the near future. The UL 58 standard has mandated the same wall thicknesses since its inception in 1925.

For example, both 4,000-gallon and 12,000-gallon tanks would be made with 1/4-inch thick steel. Another UL standard published in 1989, UL 1746, allowed this wall to be reduced to 3/16-inch steel on composite tanks when certain performance tests were met. STI was concerned with this change, particularly with larger tank sizes.

For instance, with deep burials of 8,000- and 12,000-gallon tanks (the most common sizes at service stations) and high water tables, hydrostatic pressure can push the tank bottom inward and cause a buckling effect if the tank is not thick enough.

NFPA recently accepted UL 1746 for its corrosion standard, but rejected it as a structural standard. Some states, such as Michigan, still accept only UL 58 wall thickness.

STI research suggests a revised standard that could accommodate different design
approaches by using calculations to establish thicknesses as a function of burial depth. The thickness derived is the minimum wall thickness to prevent tank buckling from hydrostatic loads.

We anticipate that this will have some bearing on the marketplace if adopted into UL standards. Engineers should watch for changes in this and other design criteria.

**Q: What changes in ASTs do engineers need to watch for?**

A: In May, NFPA membership approved a revision to NFPA 30. The code, to be published soon, will require that ASTs with enclosed secondary containment be able to be tested for tightness before placing them into service. Some existing AST designs, such as those using standard concrete as the secondary encasement, cannot be tested easily in the field, due to the concrete's inability to hold a vacuum. The revised NFPA 30 will also require emergency venting on the primary and the secondary containment area of an aboveground storage tank.