Gasoline is a flammable liquid. Gasoline is a hazardous liquid. Thanks to the advent of self-serve pumps, individuals with little or no knowledge of gasoline’s tremendous hazards dispense billions of gallons into motor vehicles every year.

In the early history of motorized vehicles, gasoline was stored aboveground, in the dispenser, but in very small quantities. As both highway systems and the automotive industry grew worldwide, so did the need for petroleum storage.

The need for public safety also has grown.

In the U.S., underground tank systems for decades have been the approach for storing gasoline at service stations (or forecourts, which are most common in the U.K.) The emphasis on underground storage tanks (USTs) was spurred by tragedy.

Several major fires and explosions from aboveground tanks in the U.S. during the 1960s and 1970s killed firefighters and innocent people. A typical event entailed the overfilling of an unattended tank, which would lead to the spill of combustible liquid around the vessel. The fluid ignited, which resulted in a major pool fire around the tank. Gasoline, being very volatile, would quickly vaporize due to the rise in temperature. Without adequate venting, the tank would over-pressurize and the tank heads would rupture outwards.

To avoid this circumstance, tanks were commonly buried underground. Soil is a great insulator around the tank. It removes the potential of a catastrophic storage tank failure. Placing a tank underground was a perfect spot for the storage of gasoline at forecourts or service stations. The public could dispense gasoline into their motor vehicles with virtually no risk of catastrophe.

**Market demand shifts**

By 1980, nearly all storage systems – both private and public retail – were underground. While fire-safety concerns for underground tanks had largely been addressed, the public’s awareness of environmental impact was only beginning to take root. Nasty spills and costly clean-ups of UST systems were reported in newspapers throughout the world.

The need for enhanced environmental protection caused underground storage systems to become considerably more sophisticated and expensive. As environmental regulations were enacted, innovative systems employing secondary containment, release detection, computerized inventory, overfill containment and spill prevention were designed by
manufacturers – and ultimately accepted by tank owners.

Ironically, while underground storage systems were becoming more reliable than ever, their popularity in the U.S. began to wane, particularly with private fleet users. Several reasons contributed to the change in demand:

- The cost to meet environmental regulations for USTs
- Tank owners’ fears of not being able to see (until it was too late) any problems occurring with the underground system
- The development of new technology for aboveground systems, including numerous forms of secondary containment
- Changing attitudes of fire-code officials, who saw the introduction of new aboveground storage equipment that would address their fire-safety concerns

Seeing is believing
As the trend took hold, many storage system owners chose to install their tank aboveground, which enabled the tank owner to avoid reliance on electronic release detection equipment and inventory control. They could see their tank system at any and all times of the day. Aboveground tank owners perceived that aboveground tanks were less regulated and less expensive (even though that was not always the case).

The end result of all this has been a boon in aboveground tank installations in the U.S. for motor vehicle fuel dispensing. Some tank fabricators report building two to three times more ASTs than USTs of late. Ten years ago, the majority of their production was focused on USTs. In addition, while secondary containment ASTs were very rare a decade ago, such tanks have become a common part of the manufacturers’ product lines.

The fleet example
One market sector was quick to seize the new opportunities unfolding during the ‘90s, the private fleet fueling facilities in the U.S. Leery of underground storage tank systems, fleet operators had three options for environmental compliance: close and remove their underground tanks, upgrade their equipment, or install a tank aboveground.

Fleets in all segments – long-haul freight carriers, school-bus companies, taxis, golf courses, governmental and military vehicles and many others – began to uproot their underground systems to pursue aboveground storage solutions. Aboveground storage tank systems have also become very popular at small and intermediate-sized airport facilities.

Fire code modifications paved the way for the fleets, which often could meet requirements for locating fueling tanks far away from adjoining property lines, buildings or public thoroughfares.

However, new AST technologies and standards surfaced that extended demand for aboveground storage – and enabled code-making bodies to decrease setback requirements. In addition, dispensers could be mounted directly atop or adjacent to the
tank when additional tank protective measures were provided.

**Fire code revisions**
As more and more tanks in the U.S. were installed above grade, the fire codes added significant safety requirements to assure the disasters of yesterday were not repeated.

In the western half of the United States, by the mid-1990s a "protected tank" was the only acceptable type of aboveground tank that could be installed for motor vehicle fuel dispensing. In the eastern half of the States, codes called for installation of "fire resistant tanks".

The protected tank is an insulated tank tested for two hours at 2000°F (1093°C). During that time the interior surface temperature of the primary tank must not increase over 260°F (127°C). The tank must include integral secondary containment. Additional features normally include resistance to impacts from vehicles and bullets.

Fire-safety officials – and developers of building codes – expressed a common rationale for the protected-tank testing requirement. If a tank was to be installed aboveground, it should emulate an underground tank as much as possible. Therefore, the tank was insulated to slow down the generation of vapors during a pool fire and to give firefighters a greater sense of security in case the tank had inadequate venting.

The fire resistant tank had to undergo a similar two-hour pool fire test, but the internal temperature was not as limited. Secondary containment also was not mandatory. The fire resistant tank "is a construction that provides the fire resistive protection that prevents release of liquid, failure of the primary tank, failure of the supporting structure, and impairment of venting for a period not less than two hours when tested using a fire exposure that simulates a high intensity pool fire, such as that described in UL 2085," according to the National Fire Protection Association. (NFPA).

The NFPA code focused very heavily on prevention of the release of flammable or combustible liquids so that no pool fire would ever occur. This insistence led to the adoption of significant new language for tank accessories. As with protected tanks, all fittings had to be at the top of the tank. Even aboveground storage tanks installed in below grade vaults became a viable option. Codes gave very prescriptive language with vaults, due to confined-space issues.

Overfill warning alarms, overfill-shutoff valves, spill containers, and anti-siphon devices or solenoid valves had to be installed. Sophisticated mechanical and electronic gauges were developed. Important shear valves were required under dispensers. Pressure relief valves were added to aboveground piping to relieve excessive pressure by returning product back to the tank. Regulatory officials even requested a special "system listing" to identify tanks equipped with all such important appurtenances.

**Environmental regulations**
Also during the 1990s, U.S. environmental regulations took aim at aboveground tanks.

Large-capacity refinery tanks, for example, had for many years provided secondary containment through earthen dikes. Because of an incident where large amounts of petroleum migrated more than a kilometer from a storage-tank farm to a residential neighborhood near Washington, D.C., federal environmental regulators escalated their concerns to propose additional regulations to make AST diking virtually impermeable.

New AST owners also discovered that their facilities, if they were near navigable waterways, would have to comply with environmental policies that called for facility response plans (in case of a release) and other significant amounts of paperwork.

**New technologies and standards**

Steel Tank Institute maintains a database on several AST technologies that its members are licensed to build. In each of the last two years, STI has seen greater than 40% growth in AST technologies such as F921 and Fireguard. The F921 is a double-skinned AST. The Fireguard tank is a lightweight, 3-inch (7.62 cm) thick insulated protected tank. The insulation is sandwiched between two walls of steel, enabling communication of releases within the interstice and essential emergency venting in case of a pool fire.

Both F921 and Fireguard followed in the footsteps of an AST built and installed in a steel dike, or a bunded tank, as it’s more commonly known in the U.K. The dikes were completely impermeable and could catch overfills and any other releases from nearby pipe and valves. When tank operators became concerned with contaminated rainwater, rain shields were built into the diked tank design as a unitized system. This prevented rainwater and snow from collecting in the dike. Rain shields came in all sizes and forms, some even completely encapsulating the tank. But a rain shield had a major handicap; it also prevented overfills from flowing into the dike, unless special design methods were incorporated.

Fortunately, the makers of underground overfill-prevention valves were able to create a suitable valve for pressurized fill operations with ASTs. This enabled the safe use of rain shields. But soon tank owners figured out that they could obtain the same level of containment from a simple tight-wrapped double-skin tank construction (F921) – or an insulated protected tank (Fireguard).

Third-party testing laboratories have produced a number of new standards to address all of the new construction types. The Underwriters Laboratories UL 142 Standard for Flammable and Combustible Liquid ASTs nearly tripled its page length during 1993 to cover requirements for bunded tanks, double skin tanks, rectangular tanks, and other new performance standards. Both UL and Southwest Research Institute created standards for fire resistant tanks and protected tanks. These laboratories went in different directions with the means to meet the NFPA fire resistive tank definition, as some tanks could be insulated and others could be uninsulated. It is important for authorities having jurisdiction to distinguish between laboratory test protocols. More information on
standards is included in Table A.

The end users
So, who is buying these tanks? Fewer than 5% are going into retail forecourts. In addition to fleets, the growth in AST demand has come from such institutions as schools and hospitals, military bases, golf courses, and other commercial and industrial users.

The other trends worth noting in the U.S. tank market is the increase in average capacity and the growth in demand from businesses that wanted to control the fueling of their autos, trucks and other vehicles.

For example, underground storage tanks increased threefold in average capacity from the early 1960s until today at a typical retail station. A 12,000-gallon (45,420-liter) tank is now the norm. But during this same period, privatized commercial, industrial, institutional and governmental fleets increased in size and significance. Many businesses installed their own storage tank system for dispensing petroleum into their motorized vehicles using Petroleum Equipment Institute’s RP 200 as guidance.

So, the U.S. petroleum-storage industry has witnessed both revolutionary and evolutionary changes in tanks – and the liquids stored.

What hasn’t changed?

Good question.

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