FIELD REPORT

Some European Perspectives on Prevention of Leaks from Underground Petroleum Storage Systems

by Marcel Moreau

Author's Note

While the threat posed to our ground water resources by leaking underground petroleum storage tanks has only recently been recognized in this country, several European countries recognized the problem more than 20 years ago and have developed considerable practical experience in effectively preventing underground storage system leaks. With financial support provided by the German Marshall Fund of the United States and with the cooperation of the Institute for European Environmental Policy, I was fortunate to be able to spend five weeks in November-December 1985 visiting petroleum marketing personnel, tank installers, and regulatory agencies in West Germany, France, the Netherlands and England. It was a fascinating trip which will soon be described in a written report and a videotape based on slides taken while in Europe. This article is a summary of some of the more salient observations that resulted from this journey.

West Germany

Tank Standards

All new underground petroleum storage tanks in Germany must be of double wall construction. Tanks are built to more stringent standards than in the United States, having domed ends and welds which penetrate the full thickness of the metal, in order to withstand the test pressure of 29.4 psi, which every tank must hold (American tanks are built to withstand only 5 psi). The outer wall does not cover the entire tank but extends upward only to a level equal to 97 percent of the tank's capacity. Thus, the top of the tank is single walled to facilitate the installation of the manhole. This does not pose a leakage problem because it is illegal to fill the tank above 95 percent of the tank's capacity in Germany (this is controlled by a high level shut-off system, described later). The outer wall is fitted directly over the primary container, so that the interstitial space between the walls is very small. This space is filled at the factory with a leak detection fluid which is a mixture of antifreeze and water. A small reservoir of about a gallon capacity is installed above the tank and connected by tubing to the interstitial space of the tank. This reservoir is filled with leak detection fluid and is fitted with a liquid level sensor which triggers an audible and visual alarm in the service station whenever the level of fluid in the reservoir drops below a specified level. Should either the inner or outer wall fail, the level of the leak detection fluid in the reservoir above the tank will drop and an alarm will sound before any of the contents of the primary container have a chance to escape into the environment. Thus, the design of the tank is not so much that of a dual containment system, where a secondary barrier is constructed to contain any spillage from a primary container, as a single-walled tank with a built-in leak detection system.

Tanks are then coated with an asphaltic coating with a minimum thickness of 4mm. The coating is tested electrostatically at the factory at 14,000 volts and again at the installation site just prior to burial. Epoxy coatings are known, but the asphalt is preferred because it is cheap, easily repaired, and does not chip as easily as epoxy. Cathodic protection is required only under exceptionally corrosive conditions. Although asphalt coatings have been a dismal failure in the United States, they appear to work in Germany because they are carefully applied and tested, and are much more than the thin black paint, which, until recently, has been the standard tank coating in the United States.

All German tanks are fitted with manholes and all of the piping connections are made through the manhole cover. This means that the fill pipe, vent and suction lines, and gauge opening are all conveniently located in a single location. All tank/piping connections can be inspected at any time merely by lifting a steel manway cover to view the manhole below.

Fiberglass tanks are not used at retail marketing facilities. They are not deemed suitable for the storage of gasoline, because of a perceived explosion hazard which might result from the buildup of static electrical charges. It does appear that fiberglass tanks are extensively used for the storage of heating oils at consumptive use facilities. These consumptive use tanks are also of double-walled construction, but with a vacuum in the interstitial space that is used to monitor the integrity of the containers rather than a leak detection fluid.

Piping

Piping at service stations is always steel, usually with a factory-installed plastic or PVC coating. Pipe fittings and joints are covered with an asphalt coating applied in the field during installation. Joints may be welded or threaded, but welding appears to be the preferred technique. Flanged couplings that bolt together are preferred to threaded unions. Changes in direction in the piping are accomplished by bending the pipe. This minimizes the number of fittings and reduces the opportunities for leaks. Pleated copper flexible connectors are used to connect pumps to piping and to connect the piping to the tank. These connectors are always exposed so that they can be visually inspected. They have flanged ends and are used with insulating gaskets to prevent electrolytic reactions between the copper and steel. These flexible connectors eliminate alignment problems between the piping and tanks or dispensing equipment, and allow for easy movement between the piping and other storage system components.

Pumps

Most all petroleum dispensers at retail facilities in Germany are of the suction type. Pressure pumping systems are known, but when they are installed they must be used with double-walled piping with leak detection fluid between the walls and a continuous monitor. Line leak detectors, similar to those used in the U.S. to monitor pressurized product delivery lines, are not deemed adequate to prevent problems. In contrast, suction pumping systems need only be single walled, with a single check valve located directly underneath the pump. This is so that if any problems in the piping should occur, product will drain back into the tank, but product will not leak into the environment. This was termed "intrinsically safe" construction, and seems to have effectively eliminated underground piping as a source of petroleum leaks at retail facilities.

Overfill Prevention

Because petroleum deliveries in Germany are typically pumped at high pressure (as opposed to the gravity drops which are standard at retail outlets in this country), tank overfill protection is extremely important in preventing spills. The Germans use a two-part system that consists of a petroleum-sensitive switch, which is mounted in the tank such that it triggers when the level in the tank has reached 95 percent of the tank capacity. Every delivery truck has an electrically operated valve that must be plugged into the switch at the tank in order for the delivery to be made. Should the petroleum level in the tank reach the petroleum-sensing switch in the tank, the valve at the truck will automatically be shut off and the delivery terminated. At this point, the tank is only 95 percent full so that the driver still has plenty of room to empty the contents of the hose into the tank.

France

Tank Standards

The French have two basic tank standards. The first is copied directly from the German double-walled tank standard just described. The second is a single-walled design identical to the inner container of the double-walled design. French tanks are tested at the factory to a pressure of 44.1 psi. All tanks have domed ends to withstand the factory test pressures, and all are equipped with manholes. All of the tank fittings pass through the manhole cover. The French have adopted epoxy-based coatings to replace the traditional asphalt. Cathodic protection is not a regulatory requirement.

The single-walled tanks may be installed in one of two ways: (1) inside a masonry vault, or (2) simply buried in the ground. The masonry vault standard has been in existence since about 1940. Some regions of France where ground water is extensively used have outlawed the single-walled tank buried directly in the ground, allowing only vaulted or double-walled installations. The official I spoke with in the French Ministry of the Environment indicated that the prohibition on single-walled tanks buried directly in the ground may become a national standard in the near future.

Fiberglass tanks are known, but they are not in common use.

Piping

Piping at service stations is typically steel with an asphaltic coating which is checked electrostatically just prior to burial. Piping is generally welded, although threaded piping is allowed. Flanged couplings are used exclusively to connect piping. Three piece threaded unions, which are the standard piping connectors in the U.S., are not legal for underground service in France because they are prone to leakage. Pleated copper flex connectors are used for tank piping connections as they are in Germany.

Pumps

Suction pumping systems are the rule, but there are no specifications as to the placement of the check valve. An angle check valve on the top of the tank appears to be the most common type of check valve used.

Overfill Prevention

Overfill prevention is an area in which the French have excelled. All petroleum storage tanks, new and existing, must be equipped with an overfill prevention device. The most popular French design fits entirely within the tank and is entirely mechanical in operation. It consists of a valve that is located in the fill pipe drop tube several inches below the top of the tank. The valve is actuated by a float mechanism, very much like our old float-activated toilet tank shut-offs. When the product level nears the top of the tank, it lifts the float, which closes the valve and shuts off the flow. After the driver shuts off the valve on his truck, he reopens the valve so that the product in the hose can be drained into the tank. Even some of the German folk I spoke with admitted that the French device was simpler, less trouble-prone and more tamper-resistant than the German design.

The Netherlands

Tank Standards

I did not obtain detailed tank standards from the Netherlands, but it would appear that the construction details are much like the German tanks, except that they

Figure 1. On the surface, European gas stations look very similar to their American counterparts. "Selbst Tanken" or "self serve" is the rule, and convenience store/gasoline stations are common.

Figure 2. Under the ground, however, European petroleum storage facilities are quite different from their American counterparts. Note the domed ends and manholes on these German tanks.

Figure 3. A German double-walled, dual compartment, asphalt-coated tank arrives at an installation site. The tank is white because of a chalk coating applied over the asphalt. The tank coating is electrostatically tested at the installation site prior to installation.

are only required to be of single-walled construction. Tanks are covered with an asphaltic coating. Cathodic protection is required whenever soil resistivity is below 5000 ohm/cm. This condition occurs more than 50 percent of the time in the Netherlands. Sacrificial anode systems are the most common, with a single anode used to protect the entire storage system, both piping and tanks. This is feasible because of the low soil resistivities.

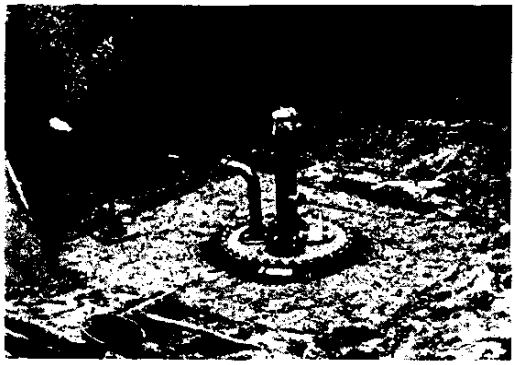

Figure 4. All piping connections on European tanks are made through the manhole cover.

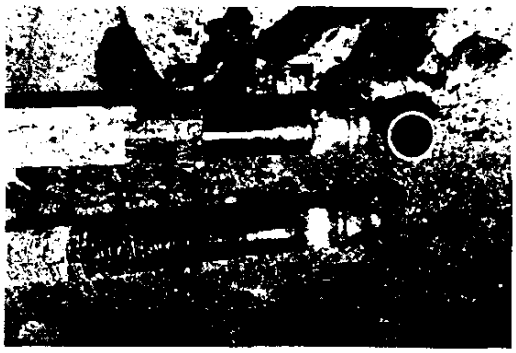

Figure 5. French piping is coated with asphalt; fittings are often welded and then coated at the site. All piping coating are electrostatically tested prior to burial.

Cathodic protection systems are checked by regulatory officials once a year, and a report noting any deficiencies is then sent to the tank owner who must correct any problems.

Some of the major oil companies are now installing double-walled tanks, but at most sites, the water table is so high that any leaks in the tank will result in ground water flowing into the tank. Thus, the ground water itself serves as the leak detection fluid.

Fiberglass tanks are not generally used at retail outlets, the primary concern in the Netherlands being that the unstable soils would make installations very difficult.

Piping

The standard piping is steel, with a plastic or PVC coating. Joints are typically screwed together and then covered with an asphaltic coating.

Pumps

All pumps are suction pumps with piping sloped uniformly back to the tank and a single check valve located directly beneath the pump. This technique, as in Germany, was billed as "intrinsically safe."

Overfill Protection

No overfill protection is officially required, but the

major oil company whose representative I spoke with was in the process of retrofitting all of its installations with the French type of overfill device.

England

Tank Standards

All English tanks are made of ¼-inch-thick steel and coated with asphalt paint. Upon installation, the tank, as well as all piping, must be surrounded by no less than 6 inches of concrete. No one I spoke with could tell me the origin or reasoning behind this requirement. Oil companies had little good to say about this technique for installation because it made installations very expensive and replacements or removals nearly impossible. The Petroleum Inspectorate of the London Fire Brigade indicated to me that despite these standards, leak incidents were not uncommon.

Fiberglass tanks were not allowed for motor spirit storage as of December 1985, but the Petroleum Inspectorate was investigating them to determine if they would be acceptable.

Piping

Piping is usually galvanized and threaded connections are used. When installed, piping is surrounded on all sides by a minimum of 6 inches of concrete, from the tank all the way to the top of the pump island.

Pumps

Suction pumping systems are the most common. There are no specifications as to the location of the check valve, and an angle check on the top of the tank is the most common.

Overfill Protection

England has no overfill protection requirements as such. However, all stations must have the drainage sloped such that any liquid running off the property must flow through a 600-gallon capacity oil/water separator. This regulation dates back to a time when the maximum compartment capacity on a tank truck was 600 gallons. The original intent of the regulation was to assure that a worst case delivery spill (or tank overfill) would be retained on site. However, the regulation has not been updated to keep pace with the increasing capacity of tank truck compartments.

Miscellaneous Observations

Here are a few more observations I made in Europe that contrast with American petroleum storage practices:

- Volumetric tank testing as practiced in the United States (Petro-Tite, Leak Lokator, Ezy Check, etc.) is unknown in Europe. Tank tests are generally hydrostatic or a combination of pneumatic/hydrostatic (tank is filled full of liquid, then pressurized with air or nitrogen at pressures of 29 to 44 psi). Tests are generally quick (15 to 30 minutes after pressure is applied), and there is generally little doubt as to whether a tank is tight or not. Tank construction standards in this country probably preclude such testing here.
- Outside-the-tank leak detection technology (electronic monitoring of ground water wells, soil vapor monitors, etc.) is not known in Europe. Where leak detection technology has been developed, it has focused more on keeping product inside the storage system in the first place, rather then detecting a problem once contamination has already occurred.
- Inventory control is recognized as a good business practice, but it is not generally regarded as a leak detection technique.
- There is no single "European" approach to underground petroleum storage. While we tend to think of Western Europe as a single entity, each country is as different in its petroleum storage practices as its people are in culture and traditions. There is a correlation, however, between the level of ground water usage and the degree of underground tank regulation in European countries. For example, West Germany depends on ground water resources for about 70 percent of its water needs. In England, only about 30 percent of water supplies depend on ground water.
- Petroleum storage standards within a country are uniform, regardless of ownership or use. There are no exemptions for farm or privately owned tanks, or tanks below a certain capacity. Europe is perhaps more democratic in this respect than America.
- Tank installers in West Germany and the Netherlands must be certified. In Germany, this means passing an eight-hour written exam plus a one-hour oral exam. Quality of installations was cited as a problem area in France and England, but not in countries with certification programs.

Postscript

Strategies and techniques for controlling leakage from underground petroleum storage facilities have been molded in Europe by the value of the resource being protected, and cultural and regulatory traditions. There is no single set of standards in Europe because environments differ, and perhaps even more importantly, people differ. In Germany, a problem was perceived, a solution devised, and it was dealt with relatively rapidly and thoroughly. This is the German way of doing things. In the other countries I visited, the process has been more evolutionary, with stepwise changes occurring at intervals. The length of the interval has been determined by patterns of petroleum and ground water use and by evolving perceptions of the seriousness of the problem.

Clearly, there are sound, time-tested, technological solutions to the leaking underground storage system problem. How these solutions will fit into American cultural, regulatory and business traditions remains to be seen.

For information on how to obtain a copy of the full report or the videotape, please write: Marcel Moreau, RFD 1, Box 2050, Winthrop, Maine 04364.

The author, Marcel Moreau, is an independent consultant providing a broad range of informational and advisory services in the fields of underground petroleum storage technology, management and regulation.