Protecting Fueling Systems from Natural Disasters

Tanks, service stations and C-stores were gutted when Hurricane Floyd blew into town. Is there anything that could have been done to prevent the recent fueling system disaster in North Carolina? Bill Greer, Tim Laughlin, PE and Doug Howey, PG, report.

Hurricane Floyd's rude awakening

On September 16, 1999, Hurricane Floyd devastated Eastern North Carolina. More than 20 inches of rain fell within a 24-hour period. The rivers, ponds and creeks in the region were already to the point of overflowing from the downpours caused by Hurricane Dennis just ten days before.

Many flooded areas were beyond the 500-year floodplain.Whole towns and parts of several cities were submerged for more than a week. At last count, the death toll was at 48 with approximately 1,500 homes completely destroyed and an estimated 30,000 other homes damaged.

The wake-up call

For those of us involved in the design, construction and operation of fueling facilities, the effects of Hurricane Floyd sound an alarm that there are serious problems that require attention, as can be seen from the photos in this article. What can be done during the design and installation stage and the day-to-day operations of a fueling facility to minimize damages in the event of a disaster such as a hurricane or flood? What should be done in the aftermath of such an event?

Disaster preparedness is knowing what to do both before and after the disaster and can be divided into four stages: (1) installation; (2) routine maintenance; (3) between the warning and the disaster (if time allows); and (4) after the disaster.

Good installation is good preparation

The Petroleum Equipment Institute’s PEI RP100, Recommended Practices for Installation of Underground Liquid Storage Systems, covers the subjects of supports and anchorage of USTs in “areas subject to flooding.”

First, UST owners need to evaluate the disaster potential of the area where the site is to be located. Is the site subject to flooding? What if the site is in a city where there has never been a flood, such as in many of the sites flooded by Hurricane Floyd? It is hard for UST system owners to justify going to extra expense for something they don't think they need. If in doubt, anchor the tanks. Remember, it is far easier to do this during installation, before placing backfill.

In considering anchorage of USTs in areas subject to flooding, PEI RP100 states: "The calculation of tank buoyancy should be based on worst case conditions, that is, water level at finished grade and the tank empty." Appendix A of PEI RP100 has instructions for calculating the weight of backfill materials and paving necessary to overcome the buoyancy of the tank.

Another option is to use a bottom hold-down pad or deadmen anchors. Consult the tank manufacturer's installation in- structions to determine what will be needed.

These tanks that floated from their original locations (sites unknown) had been retrieved by North Carolina Emergency Management and stored in a field in Greenville, NC.

The latest edition of PEI RP200, Recommended Practices for Installation of Aboveground Storage Systems for Motor Vehicle Fueling, is hot off the press. A new paragraph entitled "Emergency Planning" was added. It states: "In areas subject to flooding, make provisions to prevent tanks from floating. In areas subject to hurricanes or other significant storm events, make provisions to secure tanks against anticipated wind loading. In all cases, consideration should be given to containment of releases."

It is obvious from the photos in this article that improperly anchored aboveground storage tanks caused a major problem. These photos were taken during a survey and tour made by Tim Laughlin and Doug Howey of the North Carolina Petroleum Marketers Association (NCPMA) on October 12, 1999, approximately four weeks after Hurricane Floyd. During this inspection, they observed two locations where USTs had floated out of the ground. Aboveground tanks that had floated away numbered in the hundreds!

PEI RP200 gives the method of calculating the weight required to secure an AST. This is determined by multiplying the capacity of the tank (below the maximum anticipated flood stage) by the weight of water (8.3 pounds per gallon) and subtracting the weight of the tank, equipment and attached supports.

"Out back" at a convenience store in Princeville, NC, was completely submerged. Water flowed through the vent pipes 12 feet above grade

Modifications after installation

What about existing UST and AST installations? The options are few and costly for UST installations in cases in which (1) no extra protection was provided for tanks subject to floating or (2) the anchoring condition of the tanks is unknown. And—short of excavating the tanks and reinstalling them with proper anchorage or uncovering the tanks completely and adding to the thickness of existing

pavement over the tanks—nothing can be done.

AST installations, on the other hand, can be modified to add anchoring to the tanks. Many ASTs are welded to steel saddles that can be bolted to the concrete. Others can be anchored by means of adding straps/cables and anchoring them to the concrete pad. As stated in PEI RP200, consult the tank manufacturer or other adequately qualified individuals. Unit tanks, which are ASTs mounted in their own steel containment dike, should also be anchored in place.

One of the biggest areas of damage was electrical junction boxes. These pump motor starters at a bulk plant in Greenville, NC, are completely ruined.

Good maintenance adds to readiness

The performance of routine maintenance will take care of some of the obvious problems that could occur with a hurricane or flooding. This includes:

• Making sure fill caps are seated properly with
o-rings/seals that are in good condition and secured. This will help keep water from entering the tanks.

• Ensuring that impact valves are in good condition and that trip levers work properly.

• Maintaining accurate inventory records to help determine how much product is lost if anything causes a release.

• Taking measurements of tank diameters and recording them as reference points for future measurements to determine damage.

Responding to warnings

If we are talking about earthquake disasters, there is no warning. For hurricanes and floods, however, there may be enough advance warning to take some actions without jeopardizing personal safety and protection. If time allows:

• Record manual or automatic tank gauge readings of the tank before you take it out of service.

• Check fill caps and adapters for tightness, and make sure they are locked in place.

• Check any other possible openings where water could enter, including the interstitial space of a double wall tank.

• If there is a ball valve or other block valve on the product piping at the submerged pump, close and secure it.

• At the dispensers, close all impact/emergency valves by tripping the lever. Even if your dispensers don’t get submerged, the force of flood waters or other floating objects could knock dispensers loose.

• Turn off all power to pumps and dispensers, automatic tank gauges and other components.

• For USTs, the product level in the tank doesn't matter as long as you are sure they have adequate anchorage to prevent floating. Consider filling the tanks with product if you are uncertain that your tanks are anchored. However, the risk you take is that no matter what you do, you can not ensure the integrity of the system, and water may enter the tanks and displace product into the environment.

• If there is any possibility that flood levels could reach higher than the tank vents (12 feet), extend them with PVC pipe or other means.

• Unit aboveground storage tanks (steel tanks mounted in their own steel containment dikes) should have the dike drainage valves opened. This will allow flood waters to enter the diked area to help keep the unit tank from moving.

The "footprint" of this vertical tank in Princeville, NC, shows how far it was moved by the flood waters and the resulting damage to the piping connection.

After the flood

After flood waters have receded, many things can and should be done to check out equipment and get it back into working condition. The following list of things to do, or not to do, was developed primarily by Tim Laughlin and Doug Howey as part of their effort to help NCPMA members who were hit by Hurricanes Dennis and Floyd.

General precautions:

• Do not turn on electrical power to any equipment until it has been checked out. Copper wiring in contact with water can quickly corrode. Have a technician and electrician check the condition of the equipment and AC power service and make any needed repairs before restoring power. This includes fueling systems, leak-detection equipment, and corrosion prevention (im-pressed current) equipment.

• Open all electrical junction boxes, dispenser heads and pulser boxes and allow them to completely dry out before powering up. Check for water in conduit. Test for possible insulation damage, shorts or opens. Vacuum conduit to remove water. Replace defective wires.

• Do not use emergency generators except for lighting. Emergency generator power fluctuations can destroy the electronic components of a fueling system.

• Do not operate the submerged pump or dispenser if there is any chance that water may enter the system. Pumping water will damage hydraulic components.

AST-UST systems:
If flooding (e.g., surface water in excess of one foot over the ground surface) has caused tank surface settlement or heaving, excavation will be necessary to properly inspect UST system component conditions. However, the following recommendations may help evaluate UST system integrity where movement is not obvious.

• Piping systems may be stressed from soil movement during periods of high water. Severe movement may place stress on piping runs and lesser movement may loosen threaded connections.

Pipe and vent risers should be inspected to determine if they are higher, lower or more tilted than originally. If this inspection indicates movement, conduct a precision pipe tightness test. Also,in double wall piping systems, make sure all water has been evacuated from the interstitial space.

• Tanks may be stressed due to the additional weight of water during flood conditions. Standard allowable fiberglass and steel tank installation depths (i.e., distance from tank top to ground pavement surface) currently are seven and five feet, respectively. Tanks at near-maximum burial depths and in high flood waters may be overstressed and suffer wall failure. Tank backfill stability may be affected when the surrounding soil has been disturbed by floodwaters, which results in excessive tank deflection. Owners should stick their tanks for the first few weeks, documenting product height and the presence of water. Excessive water accumulation may indicate failure of product piping, vent piping or tanks.

• Changes, over time—in measurements of the fill adapter/ tube in relation to some non-moveable reference point— may detect tank movement. Tank movement, in addition to possibly damaging the tank, can cause the piping connections to the tank to fail. Tank movement can also cause the tank to be tilted and cause water to accumulate in the lower end.

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• Check for tank deflection. Remove the submerged pump (check electrical systems for water beforehand) and the fill pipe drop tube. Measure for deflection at these two locations as follows:

1. Drive a non-sparking nail halfway into a wooden dipstick at the one-inch mark.

2. Measure and record the distance from the tank bottom to the top of the fitting.

3. Pull the dipstick up until the nail catches on the inside top of the tank and measure to the top of the fitting. Subtract one-inch from this measurement.

4. Subtract the measurement in Step Two from that in Step Three and compare to the standard tank diameter.

5. If the tank has deflected greater than two percent of the inside diameter, call the tank manufacturer for recommendations.

This vertical tank floated from its original position causing piping connections to break loose. Other pipe and valve failures apparently occurred when the tanks rocked back and forth in the floodwater current.

• Double-wall tanks with a brine-filled interstitial space should not be affected by water flooding, since brine is heavier than water. Check the brine level in the reservoir standpipe to verify that it is within the manufacturers' recommended range.

• For double-wall tanks with a dry interstitial space, the probe should be removed and the interstitial space inspected for water. If present, water should be removed. However, this may prove difficult in most tanks. One option would be to convert the dry annular space to a hydrostatic system. This should only be done with the approval of the tank manufacturer and according to their instructions.

• USTs that have floated out of the ground should be re-certified by the tank manufacturer to make sure they are still suitable for service before re-installing. On an sti-P3 tank, for example, the tank manufacturer will inspect the nylon bushings, anodes, exterior coating and welds. If testing the tanks with air pressure is necessary, the tanks will require cleaning and vapor freeing before adding air.

• Check tanks for water and sediment. If any is found, tanks should be drained, cleaned and filled with fresh product. Remember, petroleum- contaminated water is a hazardous waste and must be disposed of properly. Contact a licensed hazardous waste transporter to pump water out of your tanks.

• A precision test of the entire UST system should be conducted before restarting.

• A qualified petroleum equipment contractor should be contacted to correct any damage to petroleum storage systems.

Five USTs floated up and out of the ground at this convenience store in Greenville, NC.

Dispensers:

• Remove lower panels to expose the hydraulics section to the air. Replace panels only when section is cleaned and fully dried.

• Dirt and silt may be washed away with clean water. Air-dry the washed components before replacing.

• Remove cover from junction boxes. Remove silt and other impurities. Disconnect each wire nut connection, scrape away any corrosion from wires or cut wires before wire nut connection. Restore connections with new wire nuts. Air-dry the junction boxes. When dry, replace covers.

• Remove pulsers; discard and replace.

• Examine the IS Barriers (Intrinsically Safe) and connectors. If there is any sign of corrosion, replace.

• On self-contained pumps, remove the motor. Take it to a motor repair shop for cleaning, drying and lubrication. Wash away any dirt accumulation from the pumping unit and air-dry.

• Wash, clean and air-dry entire hydraulics area.

• Wash and wax external dispenser surfaces. Use automotive cleaning and waxing preparations.

• Pumps and dispensers that have been completely submerged may require complete refurbishment. Use a qualified petroleum equipment contractor or return the equipment to the manufacturer for refurbishment. In some cases, it may be practical to send the pump head only and restore the hydraulic section on site.

Other electronic equipment:
Consoles that have been submerged should be replaced. All tank level probes and sensors should be inspected for physical damage. Debris should be removed from all sensing elements. Sensors that have been embedded in mud, or sensors that do not actuate freely, should be replaced.

Sensors should be actuated, and alarm results noted at the console. Sensors that do not operate properly should be replaced. Line leak tests should be completed and recorded for systems with electronic line leak detection.

What do you think?

While much research has gone into this article and several individuals have provided input, there is undoubtedly something that we have omitted. Please write to us at PE&T with your questions, comments and suggestions.

Photos courtesy of the North Carolina Petroleum Marketers Association (NCPMA).

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Last update: December 1, 1999
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