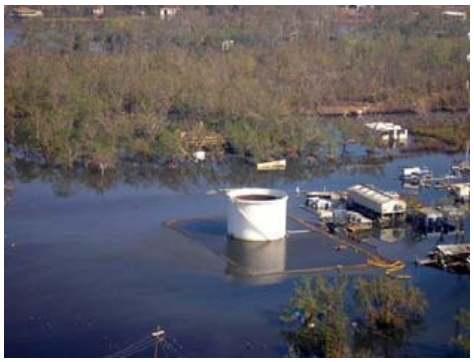
Flood Preparedness
Recommended Best Practices

Region 6 RRT

- State of Arkansas
- State of Louisiana
- State of New Mexico
- State of Oklahoma
- State of Texas
- U.S. Environmental Protection Agency
- U.S. Coast Guard
- U.S. Department of Agriculture
- U.S. Department of Commerce/NOAA
- U.S. Department of Defense
- U.S. Department of Energy
- U.S. Department of Health and Human Services
- U.S. Department of the Interior
- U.S. Department of Justice
- U.S. Department of Labor
- U.S. Department of Transportation
- Federal Emergency Management Agency/DHS
- U.S. General Services Administration
- U.S. Nuclear Regulatory Commission
- U.S. Department of State

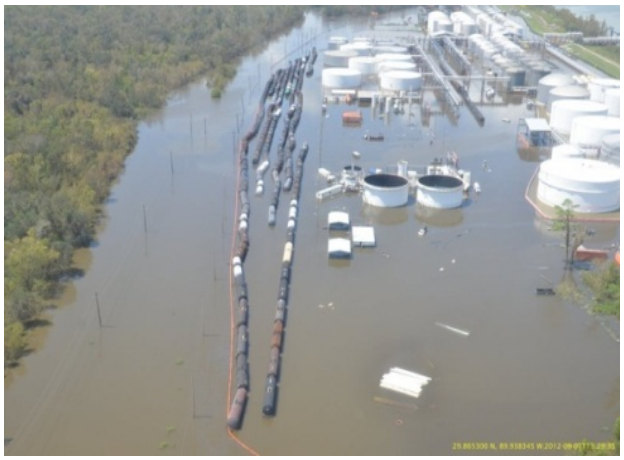
Due to the large number of spills generated by hurricanes Katrina and Rita, the RRT-6 Executive Committee charged the Science and Technology Committee to assess the reasons why, when subjected to the same set of circumstances, some above ground storage tanks failed and others did not. Nearly four years later following the floods in Colorado, Texas and elsewhere, the Response Committee reviewed lessons learned to understand how to best safeguard cylinders, containers and other tanks against these types of events. The results of these two efforts are presented here as recommended best practices for flood preparedness.



Aboveground Storage Tanks

After looking into the spills caused by the major hurricanes of 2005, it was found that the aboveground storage tanks which had failed did so due to one of three reasons. These were: 1) exposure to storm surge, 2) exposure to flooding, or 3) impact from debris. Tank failure took the form of flood induced displacement (floating), shell buckling or rupturing of the tank.

1) Storm Surge. This abnormal rise of the sea is created as water pushes towards land due to an incoming hurricane or tropical storm. A storm surge's severity is affected by the shallowness of a water body and the timing of the tides. A storm surge can penetrate well inland from the coastline. During Hurricane Ike in 2008, the surge moved inland nearly 30 miles in some parts of SE Texas and SW Louisiana. During Hurricane Katrina, the storm surge was measured at over 28ft.



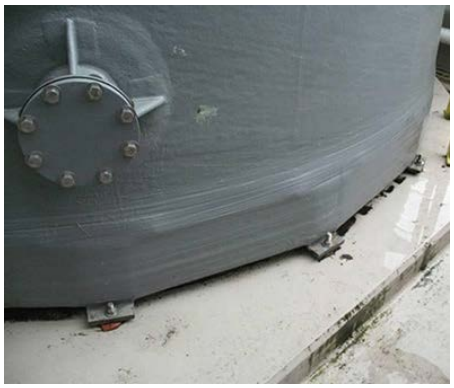
2) Flooding. While flooding may occur at any time, heavy rainfall ahead of a hurricane or tropical storm can cause problems well inland. As heavy rain accumulates, an area's ability to shed water diminishes and flood threats can quickly build. Flooding can also be caused by rapidly melting snow, backed-up storm drains, compromised levees or saturated ground due to extended periods of rain. During Hurricane Isaac in 2012, heavy rainfall overwhelmed protection systems and resulted in over 7ft of water in some areas.

3) Debris. Storm generated debris is a common hazard and difficult to safeguard against as it can be brought onto the facility by the storm or be created by gear and other miscellaneous items already there. The greatest debris threat comes from when a tank has begun to float (becoming "debris") and threatens to damage other tanks. This specific threat underscores the need to prevent a tank from floating in the first place.

In those instances where an aboveground storage tank successfully survived exposure to these three hazards, the following was discovered:

- The tank had a greater height of product inside than the floodwaters outside and/or;
- The tank had been securely anchored to its foundation

As a general rule of thumb, to avoid floating and reduce the chances of a tank buckling or rupturing, the height of the product inside should be at least equivalent to, but preferably greater than, the height of the water level outside. The exact amount needed to prevent floating, buckling or rupturing will vary depending on the product's density. For example, a tank of gasoline would require higher content volume than a tank of asphalt due to gasoline's lower density.



Best Practices

- Prior to the storm, empty tank of product and fill entirely with water.
- If removing the product is not possible, add more product to the tank so its height is 3-6 feet higher than the expected storm surge or predicted reach of flood water. Close valves associated with piping and dispensing
- Anchor tanks and all piping to prevent uplift or floatation
- Use stiffener rings to prevent buckling from storm surge and wind loads
- To the greatest extent possible, remove or secure all possible projectile hazards from the facility grounds
- Ensure all storm drains and dewatering intakes are clear and free of debris.
- Shut off the power to the fuel system
- Inventory and record the level of product in each tank to account for any loss or water entry
- Conduct a detailed risk assessment of the facility and evaluate the impact of mitigation strategies; include these assessments in the Spill Prevention, Control and Countermeasure Plan, Facility Response Plan, Risk Management Plan or other pollution prevention plan, as applicable. Develop a detailed timeline for preparing tanks in advance of an event

Here are some additional steps to consider:

- Move product out of the flood location; sell product from those stock tanks which are accessible by truck
- Seal thief hatches with locks and sand-bags
- Modify vent lines on the tanks by placing a check valve at the exit point so flow can only go inward
- Stay in contact with responsible authorities such as the US Army Corps of Engineers, US Coast Guard, EPA, state and local agencies. Monitor water levels closely
- Alert the local and state health departments if there has been a release or discharge
- Facility personnel will need to know the hazards involved; this may require an assessment to identify spilled or released substances. Sampling, monitoring, as well as personal protective equipment may also be required (for more information, see OSHA's Hurricane eMatrix)

Cylinders, Drums, and other Tanks and Containers:

Steps should also be taken to safeguard compressed gas cylinders, containers and other storage tanks during a storm or flooding event. Cylinders and tanks holding gases or toxic chemicals such as propane, anhydrous ammonia, bulk liquid fertilizer and pesticides can become a serious hazard if damaged. Risks include the release of flammable or toxic gas into the atmosphere, fire, or explosion. To reduce these risks, follow these best practices before and after a flood event.

Best Practices: Before the event

- Move small portable tanks to higher ground, ensure valves are tightened. Do not leave tanks in unventilated sheds or buildings
- Palletize individual compressed gas cylinders together using straps, chains or rope and move to higher ground
- Larger storage tanks on wheels should be disconnected and also moved to higher ground with all valves tightened, locked and secured
- If moving a larger storage tank to higher ground is not possible, secure the tank to an immovable object
- Lash storage containers together, then anchor and secure in the same manner as a large storage tank
- To prevent underground tanks from being hydrostatically lifted, fill completely with either product or water. Secure all openings to the tops of the tanks, ensuring that the fill cap, vapor recovery cap, and tank probe are all sealed or capped. Shut off the power to the fuel system
- Close the shear valves below the dispensers on each underground tank's pressurized piping system. Inventory and record the level of product in each underground tank to account for any loss or water entry
- Any tanks left online for last minute use should be secured and the supply valve shut off prior to the arrival of the storm or flood waters
- Be sure to avoid securing tanks, cylinders, or containers to power or telephone poles
- Inventory all stored products and have this available for response personnel post-event
- Accelerate or postpone any product shipments as the timeline of the event demands
- **Ensure the facility name, contact phone number and contents are prominently displayed on all tanks, cylinders and containers**

Best Practices: After

- Carefully check all tanks, cylinders and containers for damage or leaks
- Look specifically for dents, torn or disconnected supply lines, broken valves, or evidence that its condition is compromised in any way
- Conduct a post-event inventory; report any discrepancies
- Use certified inspectors, as required, to inspect tanks and equipment before reconnection and use
- Alert the local and state health departments if there has been a release or discharge

General Flood Loss Prevention:

Best Practices: Before the event

- Separate and make safe all water-reactive chemical products and flammable liquids. In case of spillage, they would create a pollution issue and a fire hazard with potentially catastrophic consequences
- If possible, make sure that vents from tanks and containers are extended above the maximum anticipated flood level
- Raise facility utility equipment above the maximum anticipated flood level. This equipment might include transformers, switchgear, electrical cabinets, gas and oil control valves, critical control equipment and critical drive motors
- Avoid installing critical equipment (such as computer servers) in basements or other flood-prone areas of the facility
- Close any unnecessary building openings with masonry and seal any cracks in floors and walls with hydraulic cement
- Check for the possibility of water entering into buildings from backup of sewer or drainage lines. Provide valves or check valves on underground sewer or drainage lines to prevent flood water from backing up into the building
- Indicate valve and hydrant positions on walls or on indicating panels at a level higher than the maximum anticipated flood level
- Consider constructing a reinforced concrete floodwall or earthen levee to protect the facility
- Provide sandbags or other provisional alternatives to protect window and door openings

Best Practices: After

After the storm, contact local emergency organizations as needed (e.g., fire department, emergency management) and those companies able to provide services and equipment for cleanup, salvage or alternative production. If the entire region was subjected to flooding, such services will be in heavy demand.

Once cleanup operations are completed, a more in-depth assessment of flood damage to equipment will be necessary. The degree of damage to mechanical or electrical equipment may not be immediately apparent. A quick check of equipment such as transformers, compressors and electric motors may lead to a hasty conclusion that the flood did little damage. Here are some examples of damage that may not be readily observed after a flood:

- Compressor intakes filled with water
- Water contaminated oil in transformers
- Electric motors with water-soaked and debris-filled windings
- Large machines which may be misaligned due to undetected damage
- Foundations of buildings and machines damaged from water washout
- Loss of potable water
- Damage to telephone lines or roads to the facility

Report Oil or Chemical Spills to the National Response Center: 800-424-8802