

HURRICANE HARVEY – ENERGY ENGINEERING CONSIDERATIONS



Hurricane Harvey made landfall along the Texas Coast on 25 August, unleashing unprecedented rainfall and flooding on widespread coastal regions. While the full scale of the impact may not be determined for weeks or months to come, catastrophic property damage is expected across large areas.

As well as considering the immediate property and casualty risks from this event, consideration should be given as to whether the energy industry has learned from previous flood losses and what significant risks may still lie ahead.

Much of US refining capacity, as well as petrochemical and LNG production, is concentrated along the Gulf Coast, in or close to areas severely affected by Harvey. There are also several LNG and petrochemicals mega-projects currently under construction in the region, capitalizing on the shale gas feedstock boom.

Two further hurricanes, Irma and the emerging Jose, are traveling up through the Caribbean, leaving significant damage in their wake. Although this may not affect the energy industry directly, it will likely add further strain on the insurance industry.



A KNOWN RISK FOR THIS LOCATION

The Marsh Energy Loss Database holds a wealth of loss information associated with flood and storm perils at Gulf Coast energy facilities.

MARSH ENERGY LOSS DATABASE	
Flood	Major losses in October 1994; June 1996; February 1998; April 1998; and January 1999
Storm	Losses have occurred almost annually since Marsh records began in 1970. Major losses of particular note in the Gulf Coast region include Tropical Storm Allison in June 2001 and Hurricane Ike in September 2008.

MITIGATION

With any storm or flood event, immediate flood-related risk mitigation is heavily dependent upon:

- Hardware features:
 - Location.
 - Drainage design.
 - Construction standards applied.

These and other factors play a role in protecting a facility from flood. However, given the aging of facilities in the region, any flood poses a significant challenge.

- Planning:
 - Emergency response plans.
 - Adverse weather procedures.
 - Standard operating procedures (unit shut-down procedures).
 - Emergency operating procedures (loss of power, steam, cooling water, etc. due to flood).
- Preparedness:
 - Training and refresher training (including use of a high-fidelity operator training simulator).
 - Drills and exercises.
 - Competency assessment.

LEARNING FROM LOSSES

While details about losses continue to emerge, our experience tells us that, in addition to flood damage, “fire-following” due to hydrocarbon spread from overwhelmed drainage is a foreseeable risk.

A precursor to a “fire-following” event is usually a loss of site power, followed by failure of the emergency diesel generators. Often, these critical services can be located at grade or in low-lying areas, leaving them susceptible to flood. Already, we are seeing reports of exactly this; a chemical plant near Houston shut down production before the hurricane made landfall. However, massive ensuing rainfall (in excess of 40 inches) in the area flooded the site and cut off its power. The emergency diesel generators were also flooded, leading to loss of cooling, critical to prevent a fire or explosion. This incident continues to unfold and evokes memories of the, albeit much more significant, disaster at Fukushima in 2011, where loss of emergency diesel generators proved to be a key failure in the chain of events. In the Fukushima case the assumptions around placement and protection of the generators were subsequently proven to be unsound.

It is said that corporate memory typically extends no further back than 10 years or so. With this in mind, we should consider whether lessons have been learned from these previous incidents. A trawl through Marsh’s *The 100 Largest Losses in the Hydrocarbon Industry’ 24th Edition 1974 – 2015* provides the following information on flood/storm incidents to have taken place in recent decades.

FROM MARSH PUBLICATION THE 100 LARGEST LOSSES IN THE HYDROCARBON INDUSTRY 24TH EDITION 1974 - 2015:

1994 Cedar Bayou Petrochemical plants, Texas, US – Mechanical Damage, leading to US\$245 million property damage loss.

Texas floods along the San Jacinto river shut down the site’s ethylene LLDPE and LDPE plants and utilities. The loss of utilities affected further downstream clients. Floodwater breached dikes and inundated the main substation, control rooms, and offices.

2002 Port of Mohammedia Refinery, Morocco – Fire, leading to US\$200 million property damage loss.

Rising floodwater from torrential rain allowed floating waste oil to contact hot equipment, causing explosions and fire. A second blaze broke out damaging several storage tanks. Two fatalities and extensive property damage.

2013 La Plata Refinery, Argentina – Fire, leading to US\$230 million property damage loss.

A widely known incident. Fire broke out in the refinery, caused by flash floods during heavy rain. Rain overwhelmed the refinery storm drain system, resulting in hydrocarbons being washed out and around the site. There were two fires in the CDU, one in the coking plant and two in the topping distillation plant. Coking furnaces had been shut down but were still hot enough to form an ignition source.

And... 1998 La Plata Refinery, Argentina – Fire

A lesser known smaller yet similar incident had happened previously at the same refinery. The El Niño event led to flooding in low area of platformer, where oil from drains washed out and ignited near a furnace. Poor design cited - new drainage system installed with automatic pump out to safe area.

In the coming months, operators could do well to question previous assumptions on flood defences. Are they current and correct, or perhaps overly optimistic in terms of rainwater intensity and floodwater levels?



DO THE BIG RISKS STILL LIE AHEAD?

US gasoline prices have risen after a key network of pipelines was shut in the wake of Harvey, sparking fears of a squeeze on fuel supplies in the region and to major US cities.

Within a week, Harvey had forced the closure of nearly a quarter of US oil refining capacity, and major pipelines delivering diesel, gasoline, and aviation fuel along the East Coast were being shut down; meanwhile, European traders scrambled to provide additional supplies.

Against this backdrop, subsiding floodwater will inevitably be followed by commercial pressure to start-up, as a priority, those units shut down ahead of and during the storm.

Yet, start-up mode is inherently risky... Marsh Energy's Loss Database identifies more than 130 losses, occurring during start-up. Many of these were significant in terms of property damage, business interruption, and injuries/fatalities. Incident frequency has not reduced significantly over the last 40 years.

The Lloyd's Market Association (LMA) 2016 paper *An Analysis of Common Causes of Major Losses in the Onshore Oil, Gas & Petrochemical Industries*¹ identifies start-up as by far the most important precursor to transient event losses.

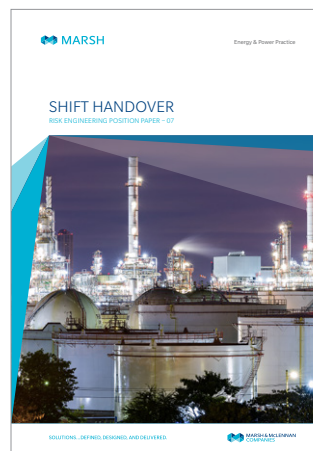
Start-up risks will likely be heightened following Harvey and, also to an extent, influenced by how the preceding shut down was managed, for example, was it controlled or was there a unit crash shut down upon loss of utilities during the flood?

Operating procedures and their use during start-up are commonly found to be lacking... High-quality and well-practiced operating procedures are seen as a key mitigation to start-up losses; yet Marsh Energy's Risk Recommendations Database identifies inadequate operating procedures as one of the top formal risk improvement recommendations given during underwriting surveys carried out by Marsh Energy risk engineers at US energy facilities.

The LMA paper also cites operating procedures "not being followed" and a "lack of the use of checklists" as some of the most common failings during major start-up losses.

Shift manning and communications following Harvey may be compromised...The LMA paper further cites "inadequate staffing" as another common failing leading to losses during the demanding activity of start-up.

Operations employees' own personal exposure to Harvey – affecting their family, friends and property – may lead to human resource shortages and pressures that distract operators from a safe start-up of their facilities.

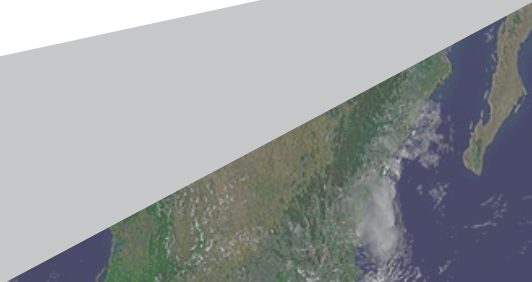


Marsh Energy's recently published *Shift Handover Risk Engineering Position Paper*² identifies that "clear and effective communication during shift handover provides a key layer of protection in the prevention of major incidents". This will be all the more pertinent during start-up at these facilities, where the distracting pressures of Harvey will need to be understood and managed.

The occurrence of Hurricane Harvey provides us with a real window of opportunity to consider actions to lower future losses as the industry focusses its attention on flood risk. Yet we should also be cognizant of the consequential risks that may lie ahead of such events once the direct impacts abate.

1 Bloomberg. 'Harvey is pushing gasoline prices higher, even as oil remains cheap', available at https://www.washingtonpost.com/news/get-there/wp/2017/08/29/harvey-is-pushing-gasoline-prices-higher-even-as-oil-remains-cheap/?utm_term=.76d7ae817e08, accessed on 5 September 2017.

2 Bloomberg. 'Harvey Recharges Offshore as Crippled Houston Counts the Cost', available at <https://www.bloomberg.com/news/articles/2017-08-28/harvey-threatens-louisiana-with-flooding-after-crippling-houston>, accessed 5 September 2017.



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