INSTITUTE FOR HOMELAND SECURITY

Sam Houston State University

THE IMPACT OF WINTER STORM URI ON CHEMICAL FACILITIES:

LESSONS LEARNED AND RECOMMENDATIONS FOR IMPROVED RESILIENCE IN THE PRIVATE SECTOR

Institute for Homeland Security

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Technical Paper #1

Abstract

This technical paper explores the impact of Winter Storm Uri (February 2021) on chemical facilities in Texas. It indicates why the loss of power was problematic for chemical facilities, and explains the danger this posed for these facilities and nearby communities. The paper also discusses various response challenges including communications and transportation. Recommendations for improvement are provided along with suggestions on how to make the chemical sector more resilient to extreme winter weather.

Introduction and Overview

In February 2021, winter storm Uri coupled with a statewide power crisis created a cascading Natech (natural/technological) disaster that impacted scores of chemical facilities and refineries in Texas. This not only impacted the bottom line of relevant chemical companies in Texas, but it also had a ripple effect on corporate partners and customers throughout the United States.

With this in mind, the following report identifies what caused this significant problem, why it was problematic, and what can be done to mitigate and prepare for extreme winter weather. It illustrates a variety of measures that can be taken to minimize impacts on operations and more effectively respond and recover in the future.

Problem Statement

The challenges chemical companies faced during Winter Storm Uri in February 2021 were trigged by a combination of two factors: an extreme winter storm that last several days combined with a major power outage throughout the state of Texas. These issues presented notable challenges for those operating chemical facilities in Southeastern Texas.

For its part, Winter Storm Uri was far worse than anticipated. The National Weather Service initially projected a moderate cold front that would pass quickly through Texas like most of these weather systems do in December, January, February, and March. This event was different than the major winter storms that occurred in the past (e.g., 1983 and 1989). First, the trough of the storm dropped much further south than expected with significant snow and ice. Second, the temperatures dropped much lower than anticipated with records being broken in the teens and even single digits (NWS 2022). Third, the windchill was also significant and only compounded the snow, ice, and cold temperatures. Finally, the storm lasted much longer than was estimated. In fact, "there was a total of 8 days, 23 hours, and 23 minutes of winter highlights between the first Winter Weather Advisory issues on Thursday, February 11th\at 9:37 am to when the last Hard Freeze Warning expired at 9:00 a.m. on Saturday, February 20th" (NWS 2022).

But the storm itself was not solely to blame for this unusual disaster. The high demand on power coupled with a very weak electrical gride were also responsible. Because of the extreme winter weather, people were trying to stay warm at home or in their businesses and this put a significant burden on the power grid. Meanwhile, the power grid was not able to keep up with this demand. To understand why this is the case, it is important to recognize the unique aspects of the Texas power system. In 1935, the Federal Power Act created three power grids in the United States, with Texas operating as a virtually independent system. In 1970 the Electric Reliability Council of Texas (ERCOT) was formed to manage the grid, but it did not always follow Federal Energy Regulatory Commission requirements. The Texas power grid is not standardized and some of the recommendations issued in 2011 and 2018 to update the system were not acted upon (see Sharpe 2018 and Federal Energy Regulatory Commission & North American Electric Reliability Corporation 2011). Consequently, there was a lack of maintenance on insulators and distribution systems were not fortified to increase capacity.

Because of the high demand and low supply of electricity, the entire grid in Texas was dangerously close to complete failure (Douglas 2021). ERCOT therefore decided to implement rolling blackouts to conserve power and save the system from collapse and what would have been a lengthy restart process. Unfortunately, many locations across the state lost power for days while others witnessed brief restoration of power that would not permit buildings from warming up. This combination of factors was particularly challenging for the chemical/refinery industry.

For instance, the rapid and in most cases sustained loss of power resulted in a situation where an emergency shutdown of refineries and chemical plants was inevitable or required. But the circumstances were not optimal, and the urgency was even dangerous. Normally, a planned shutdown takes 2-3 days to implement. In this case, the dire need to turn off things too quickly or out of order could have caused flaring, loss of containment, fire and even explosion. Fortunately, those problems were minimized with a quick but step-by-step process to ensure everything is isolated or turned off in a logical manner.

However, another problem reared its ugly head in that many of these refineries needed at least some electricity to maintain safety during shut down periods. Virtually all refineries and chemical plants began to run some of their machinery on generators. However, the duration of the storm and power outage caused them to run out or run low on diesel fuel. This could have proven catastrophic in two cases. Plant operators that contacted a central Texas emergency management office to explain that they were hours away from running out of diesel. If this occurred, a fire, chemical release or explosion would occur and put the surrounding community at risk. This prompted the local and county government officials to scramble to find diesel from the state. Fortunately, the fuel was acquired and escorted to the appropriate chemical facilities so dire consequences would not occur.

As the extremely cold weather and loss of power continued over a period of days, virtually all chemical plants and refineries began to suffer frozen pipes and valves (whether they were chemical or water related). Workers did their best to protect facility assets, but it was a losing

battle due to the cascading consequences of the storm and loss of utilities. But they also faced extreme circumstances due to the loss of power. Additional personnel could not be sent or arrive at the facilities to help because the roads were closed or otherwise impassible due to the snow and ice. Those on site could not leave for the same reasons, so they had to stay at the facility on a 24/7 basis. Most locations had some alternative living arrangements including cots, blankets and pillows. Although they had some food and water, that was quickly depleted. In these cases, the workers either went without these necessities or walked to nearby convenience stores to get the food and water they needed to sustain themselves.

About the same time, the leaders and managers over these facilities wanted to implement contingency and emergency response operations plans. But a few barriers stood in their way. Although warnings were shared through a variety of sources (i.e., National Weather Service, new media, corporate meteorologists, etc.), there may have been a cognitive bias that Southeastern Texas does not experience winter storms or a belief that the storms that do occur are mild and temporary at best. Consequently, there were perhaps insufficient consideration for the value of mobilizing crisis management teams in advance. Meanwhile, the loss of power resulted in communication difficulties or an inability to share and receive information via phone or through the internet. Thus, coordination was nonexistent or problematic at best.

The leaders and managers also realized that, in some cases, the storm and loss of power had taken away corporate's ability to pay workers on the 15th of the month. There was no way to transfer money to electronic accounts and even if checks could be printed, most banks were not open to cash them. This situation prompted one facility to find access cash and then develop an improvised way to distribute and track it at a designated off-site location. This would allow the workers to pay for any routine monthly expenses or emergency bills due to the storm.

As time proceeded, it became clear that recovery operations were also highly problematic and consequently delayed as a result. A great deal of this can be attributed to the broad impacts of Winter Storm Uri that were far worse than most of the hurricanes that affect the Gulf Coast Region of the United States. Hurricanes often strike one or a handful of states when they make landfall, and they then dissipate in strength as they move inland. In contrast, Winter Storm Uri had a much larger footprint since it came in from the Pacific Northwest, dropped down into the central portion of the country, and then exited over East coast (Machemer 2021). It dumped snow on 73% of the lower 48 states, which is the highest percentage since the National Oceanic and Atmospheric Administration began tracking this statistic in 2011.

Many sectors around the nation, including energy and transportation, were affected by the storm. But the consequences on the chemical industry were especially notable. According to a recent report of the Independent Commodity Intelligence Service (ICIS), 25% of the basic industrial chemical capacity was immediately taken offline in the United States after Uri impacted Texas and many other surrounding states. The negative consequences of the storm and loss of power on chemical industries also lasted far longer than anticipated. For instance, 18% of the capacity was still offline 2 months after the freezing weather. Most of the facilities

were operating after 4-5 months, but it took others a year to resume full capacity. (See ICIS report on impacts).

A good case in point for the delayed resumption is the relationship between styrene and polystyrene. Styrene is made along the Gulf Coast and is needed to make polystyrene in the Midwest. However, because Texas plants could not produce styrene initially, this delayed the creation of polystyrene elsewhere around the nation.

There were other reasons why recovery was so challenging, and these were often related to supply chain issues. For instance, even if the facility was fortunate enough to have minimal damage from the storm, it could only restart operations if there were sufficient quantities of nitrogen on hand. (Nitrogen is required to flush the system and ensure there is nothing in the pipes so the start-up procedures can be safe enough to initiate). Unfortunately, many chemical plants did not have enough nitrogen, and it could not be acquired from suppliers since they were also impacted by the storm. Even if suppliers could get their own systems up and running, the demand far outpaced the supply of nitrogen.

Other delays were more directly related to the need to replace vital equipment at the facility. Large quantities of piping and valves froze at countless facilities and therefore required repair or replacement. Unfortunately, there simply was not enough piping and specialty valves on hand to meet the demand initially. Part of this may have been due to the fact that vital industrial components were already in short supply due to the decline of manufacturing that resulted from Covid-19. Shipping was also backlogged due to the global pandemic which added to the length of distribution. Making matters worse, much of the tubing and machinery is also highly specialized and requires considerable time for precise manufacturing.

Gap Assessment

The aforementioned case illustrates several weaknesses facing chemical facilities, their operations, and safety and well-being of personnel. Five will be mentioned here:

1. *Facilities and equipment*. The extreme winter weather damaged vital piping, valves and other machinery that are necessary for proper refining processes.
2. *Resources and supplies*. The loss of power resulted in a lack of fuel to protect buildings and keep essential equipment running.
3. *Plant operations*. The unplanned emergency shutdowns were extended because of the challenges of acquiring necessary utilities from suppliers (e.g., nitrogen) to restart systems in a timely manner.
4. *Leadership communications*. The interruption of phone and internet capabilities hindered Managers' ability to share and receive information about the crisis and emergency.
5. *Personnel safety and well-being*. Insufficient sleeping arrangements, food and water created hardships for the workers who are essential for safe plant operations.

Discussion

The challenges experienced during the February 2021 extreme weather and weaknesses identified provide an opportunity to improve operations and emergency planning at chemical facilities in Texas and throughout the United States. Listed below are 11 considerations that will help chemical facilities mitigate, prepare for, respond to, and recover from extreme winter weather disasters like the one experience in February 2021 in Texas.

1. Anticipate worst case scenarios - even if they seem improbable.
2. Foster relationships with the National Weather Service to better understand advisories, watches, warnings and verify contact information related to message distribution, online chats, etc.
3. Educate public officials and utility providers about your critical operations and needs in terms of electricity and water. Emphasize your priorities and stress the importance of joint decision making to avoid the dangerous consequences of unanticipated shutdowns.
4. Review vulnerabilities associated with equipment at your industrial facility, and find ways to mitigate damages due to cold weather going forward.
5. Increase stocks of piping, valves, generators, fuel, nitrogen, water and food to be better prepared for emergency situations and/or revisit the capability of vendors to supply these critical supplies when disasters occur.
6. Acquire alternative means of communication (e.g., satellite phones) and ensure personnel are familiar with their operation.
7. Update continuity of operations plans and emergency response plans, paying particular attention to remote/online/virtual operations.
8. Increase training with personnel to safely shut down and restart operations.
9. Conduct exercises with internal organizational units and external stakeholders to augment the ability to coordinate and operate under uncertain and dynamic conditions.
10. Revisit recovery priorities, strategies, and capabilities - particularly as they relate to cross-sectoral vulnerabilities and dependencies.
11. Communicate with upstream and downstream producers to ensure everyone is aware of how to restore the supply chain in an efficient manner.

The Way Forward

There is no single solution to rectifying the problems that chemical facilities witnessed in February 2021. Obviously, weather fluctuations will continue in the future and cannot be prevented. In addition, the state must work closely with ERCOT to update and standardize the power grid in Texas. That being said, chemical facilities and refineries can and must implement mitigation and preparedness measures to minimize the impact of extreme winter weather and improve response and recovery operations. In particular, more emphasis should be placed on: 1). winterizing chemical facilities, 2). increasing stocks of or access to necessary equipment and resources, and 3). improving planning, training and exercises for emergency operations, and enhancing disaster communications and recovery strategies. To the extent that these measures

are taken, the consequences witnessed in February 2021 can be averted or minimized in the future.

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