MARY KAY O'CONNOR PROCESS SAFETY CENTER
TEXAS A&M ENGINEERING EXPERIMENT STATION

22nd Annual International Symposium
October 22-24, 2019 | College Station, Texas

Hurricanes Versus Tropical Storms Impacts – Shut-down? Recovery?

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Abstract

During the summer and fall seasons, regions along the US coastline face the threat of being hit by Tropical storms and Hurricanes. While Hurricanes are known for their impacts, the sites are typically well prepared to brace such weather conditions, with adequate planning prior the event occurring, and recovery measures, should the area be hit by the Hurricanes. Often, when forecasts indicate a Tropical storm as opposed to a Hurricane measures, there is a tendency to reduce the preparedness by a few notches as compared to the advent of a Hurricane. Should the storm pass by quickly or its intensity reduces further, the sites are not impacted by this lower level of preparedness. However, in the event of the forecast changing, or the storm gaining intensity or slowing down its progress, often sites will not have enough time to elevate the preparedness, e.g. the pattern of hurricane Harvey and its anomalous intensity, speed and path of progress.

Preparedness during those transition hours, posed further challenges, thereby hampering the recovery measures. At those times, while recovery measures are essentially, sites may often run into the situations of not having the right rescue equipment and other essential supplies. Hence, recovery may now pose additional threats to the people and the process.

This paper will discuss thoughts and views of the authors of how much of the preparedness must be common be it hurricanes or tropical storms, and what challenges will be different. The authors will share their view of what measures are independent of the storm intensity and what measures can be avoided during tropical storms, what becomes essential prior to the storms, and how can the risks to the people and process during the recovery measures be minimized. Key to remember is irrespective of the conditions and planning, the threat will always exist to human lives. Appropriate mitigation measures will weaken the impacts

Keywords: Inclement weather, Emergency Response, Operations Shutdown, Recovery Measures

Introduction

Tropical storms and subsequent Hurricanes [1] are natural phenomena that occur in the North Atlantic Ocean, Caribbean Sea, Gulf of Mexico, and Eastern North Pacific Ocean. When these named storms make land impacts, they bring about a lot of damage to people and property, due to the excessive winds and water. In recent times Hurricanes Katrina, Rita, Harvey, Irma, and Dorian have brought about tremendous amounts of damages to the USA and nearby islands [2,3,4].

Hurricane Dorian

With the onset of such events, one must realize the transient state of such phenomena, where the weather forecast is constantly changing. In the recent times, Hurricane Dorian has been once such classic example. The initial predicted path was to make landfall to Florida, for the USA, after devastating the Bahamas. As it made its progression, the hurricane categories changed from a 1 going up to 5 and then several iterations between 1 and 3, until this got converted into a tropical storm by the east coast of Canada. The figures 1- 3 below, indicate the model predictions, and how the predictions changed based on the storm progression.

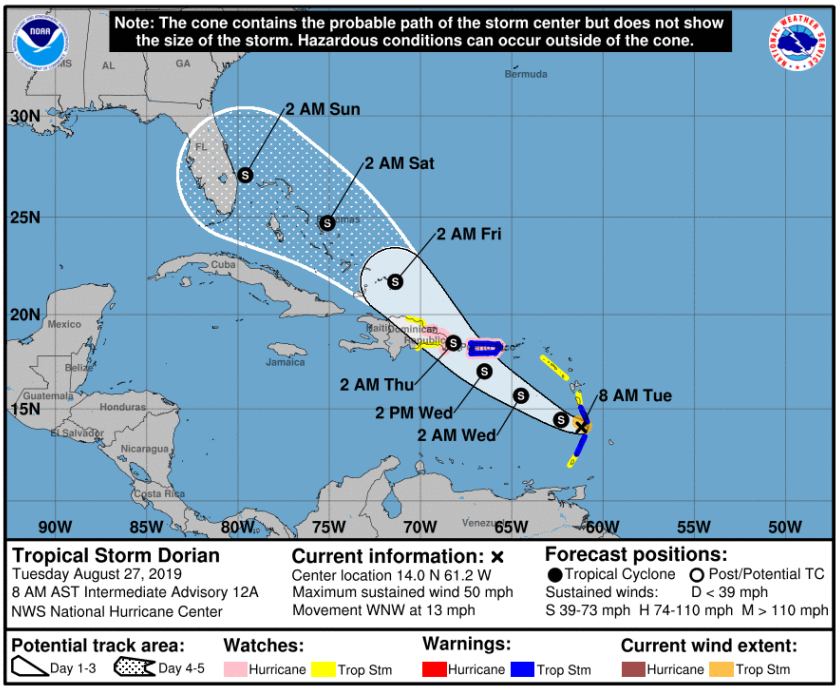

Figure 1. Dorian Projected Path – August 27, 2019 [5]

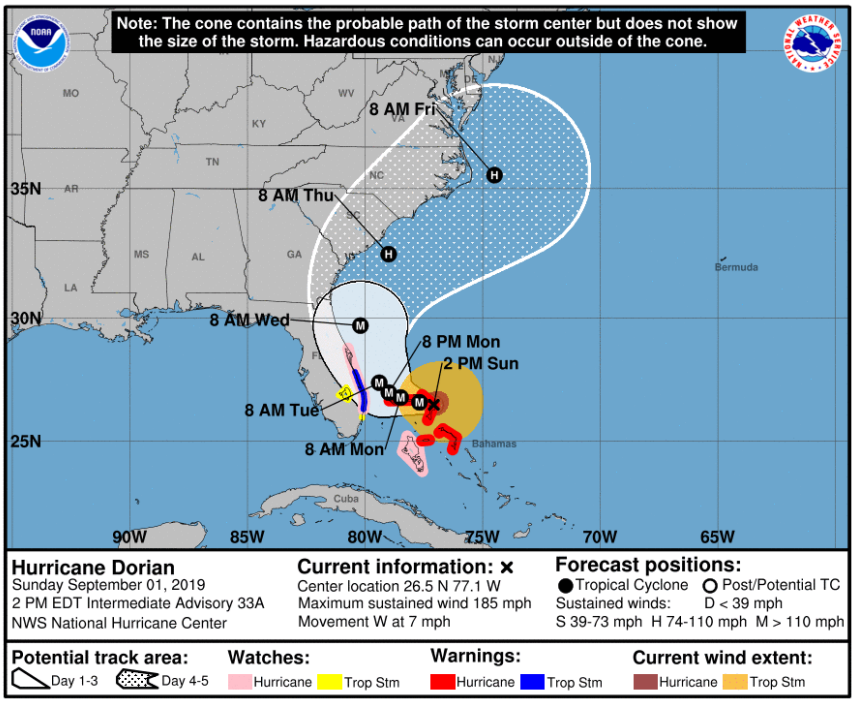

Figure 2. Dorian Projected Path – September 1, 2019 [5]

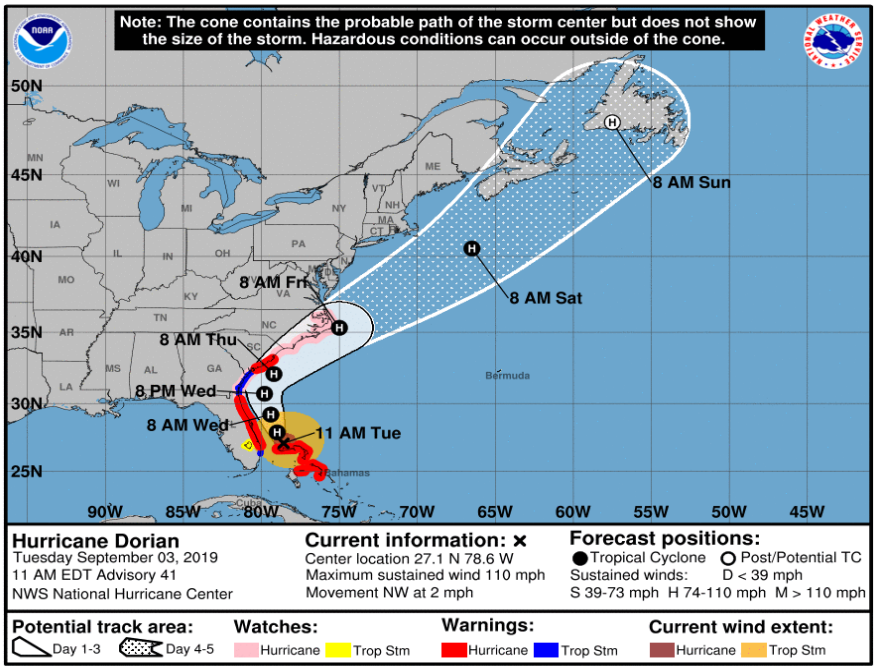

Figure 3. Dorian Projected Path – September 3, 2019 [5]

Weather Forecasting, Preparedness and Aftermath

The above illustration of the recently occurred Hurricane Dorian, indicates how uncertain the paths and the intensity of the storm may be; making it very critical to rely on weather forecasting.

As a precautionary measure, regions in the Gulf coast, East coast and West coast of the USA, have their hurricane preparedness plans initiated, typically by June of each year. Every state comes up with their plan providing the residents suggestions on path forward, in the event of such inclement weather conditions [6 – 9]. These plans get updated on an annual basis, based on the lessons learned of the previous year's conditions and happenings. Hurricanes such as Katrina, Harvey and Irma have been indicative of such changes [2,3].

Industries that fall under such zones also have regulatory aspects, leading to mandatory hurricane preparedness plans as laid down by OSHA [10]. Under these requirements, it is the employers responsibility to ensure that the employees are safe during the occurrence of such events.

Let's take the examples of Hurricane Katrina (occurred in 2005) and Hurricane Harvey (occurred in 2017), that had devastating impacts on the regions of landfall. Each of these events involved massive preparations for the respective cities, towns, and also the industries in those regions. The weather forecast for Hurricane Katrina changed very rapidly [11], and despite the efforts taken the by the respective sites, the aftermath was devastating [12]. Data collected from the event, on the aftermath, also led to additional research by various groups such as [13], to get into more accurate predictions on the commercial impacts to refineries.

Similarly summarizing the formation of Hurricane Harvey [14] which began on August. 17, 2017 as a slow-moving tropical storm in the Gulf of Mexico, weakened to a tropical wave August. 19, 2017. However, this Tropical Depression Harvey reformed on August. 23, 2019. It grew into a Category 1 hurricane with 80-mph winds August 24, 2019 and continued to gain strength as it slowly progressed towards Texas. The National Hurricane Center upgraded the storm to a Category 4 hurricane with sustained winds up to 130 mph Aug. 25. It made the first landfall over, in south-central Texas, late August 25, 2019 as a Category 4. It stalled around southern Texas for days as a weakening hurricane, producing catastrophic flash and river flooding. Harvey then downgraded to a tropical storm August. 26, 2019. By the next day, the winds died down to as much as 40 mph, but the storm dumped a year of rain in less than a week on Houston and much of southeastern Texas. Tropical storm Harvey made its third and final landfall August. 30, 2019 near Port Arthur, Texas, and Cameron, Louisiana, bringing widespread flooding. Tropical Storm Harvey was then downgraded to a tropical depression but it continued to dump large amounts of rain on parts of eastern Texas, Louisiana, and southern Arkansas.

What do we know about Emergency Response ?

Emergency response during such transient conditions as illustrated above with Hurricane Harvey, can we very tricky and challenging, especially for industry sites. A straight-forward conservative approach would mean, a complete shutdown of the site, in anticipation of such inclement weather. The focus here would be protection of human lives, in anticipation of any potential disastrous situations. At the same time this results in downtime, implying drop in production and thereby revenue/profitability.

On the other hand, another approach may be to ignore the potential impacts of an upcoming storm/hurricane. In such cases, evaluating potential financial impacts, a site may be inclined to

continue production in a limited but safe manner. These are two ends of a spectrum, and a site may not necessarily resort to either end. Rather the emergency response plan would be based on the assumption, that the existing plan is robust and resilient. Meaning, that the associated hurricane preparedness plan might include various scenarios involving rapid decision making and rapid adaptations to changes in these decisions, due to changing weather conditions.

This challenge is prevalent for all the sites that fall in such hurricane prone regions. However, that is essentially the truth is that the employer is responsible for the safety of their staff while on site [15].

What did we learn from Harvey pertaining to sites?

The intensity of the Hurricane Harvey [14], was every changing. A slow moving hurricane, that was downgraded to a tropical storm, however it continued to move at a very slow pace, and bring a massive downpour of rain along its path. This resulted in severe localized flooding. A key factor that dominates the entire situation here is the ever changing weather condition. For sites in that region, it comes very critical to have rapid decision making for response plans, and communicating that information for a seamless implementation.

For a successful site, its operational excellence (OE) program must be sustainable that is depicted via the model[17] below in Figure 4

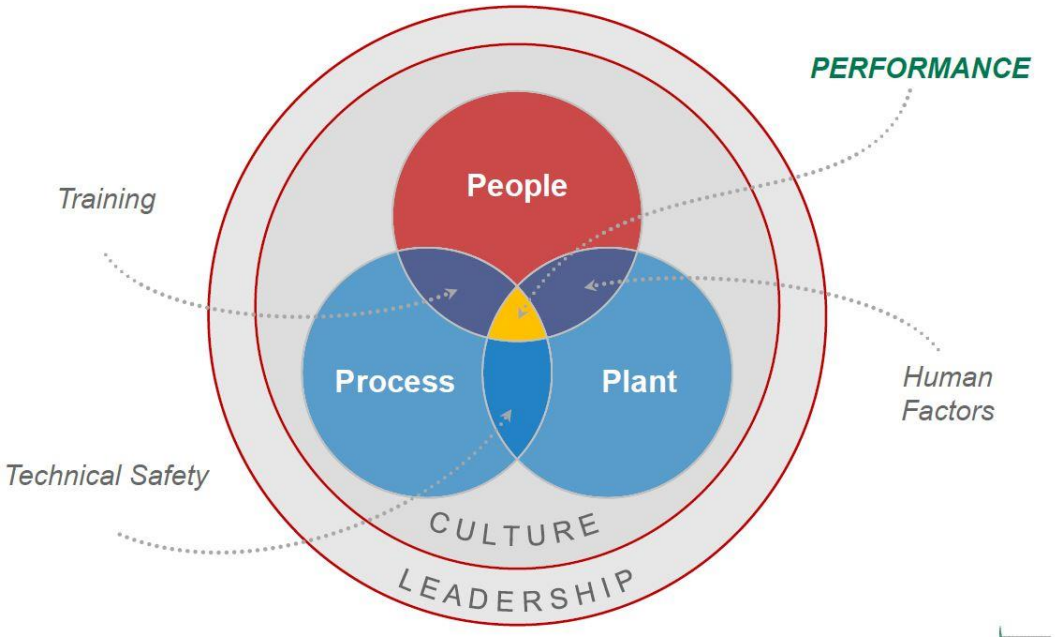

Figure 4. Explanation for Sustainable Safety [17]

This success in OE is also attained when the technical safety involved follows a risk based process safety (RBPS) approach [17]

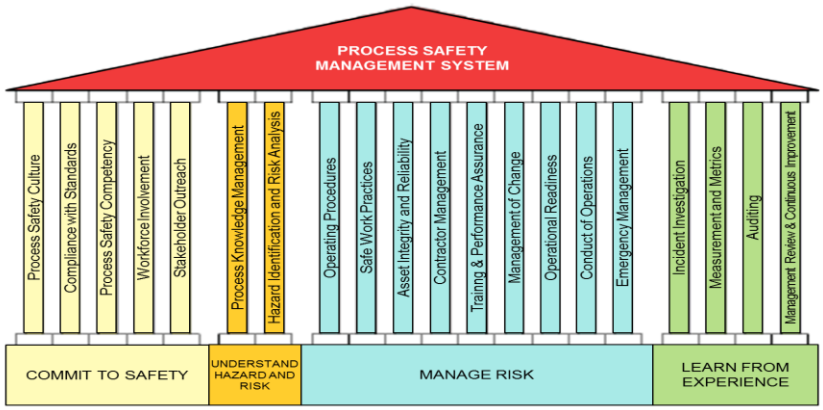

Figure 5. Illustration of Risk Based Safety [17, 18]

While the concepts of OE and RBPS are followed during regular operations, and operational upset conditions such as planned and unplanned shutdowns, the same can be applied evening during pre-disaster and post disaster type of situations as was with Harvey (Hurricane and Tropical storms).

For a site, the decision making is always a challenge as they have to keep evaluating the changing conditions, keeping in mind people safety and production, hazards associated with the shutdowns, startups and recovery (in the event that the storm strikes).

Based on the experience of the authors in assisting sites for assessment of their post disaster reviews, the authors have come up with the following areas that assist in minimal impacts to a site, during such tropical inclement weather. These factors are:

1. Management Systems and Safety Culture: A strong and robust prevalent safety culture helps in the decision making process. This brings about ownership, and involvement of relevant teams, that assist in making the right decisions, constantly emphasizing that it is always people over production.

2. Shutdown and Startup Procedures: The importance of having adequate of shutdown/start-up procedures, decisions, and the execution of such procedures during inclement weather, make the implementation process easy, and eliminate any potential confusion in times of turmoil

3. Hazard Identification & Intervention and Safe Work Practices (SWP): Presence of a comprehensive permit to work (PTW) system that includes a combined hazard assessments, which incorporates maintenance and operations disciplines, helps in such situations. This must also involve field verification of identified safeguards and mitigations before the equipment intervention begins.

4. Hurricane/Tropical Storm Preparedness: While it may seem obvious that sites will have such preparedness plans in place, the key is that these plans be revisited every year, incorporating the principles of lessons learned based on field observations, real-time data and the concepts of

RBPS. Another factor while preparing the sites is to remember that while the typical approach may be to focus only on Hurricanes, it should be noted that tropical storms come with their set of impacts too, that could impair a site.

5. Emergency Response and Recovery Logistics: While updating the preparedness plans, the site must be prepared to handle disasters with recovery measures as well. Take a situation of potential flooding that involves the need of flood response resources being readily available, for example light boats, waders, occupied building unperishable food supply, bedding, standalone kitchen/laundry facilities, clothing changes, and personal hygiene supplies.

6. Emergency Response and Recovery Tactical Communications: While performing emergency response and associated recovery measures, the importance of clear tactical communication is priceless. This helps personnel understand their roles, and the roles of others involved in response measures. It also assists in maintaining and improving morale of the employees, keeps them involved in the decision making process, and helps to improve perceptions.

References

[1] Weather related definitions, https://kestrelmeters.com/pages/weather-glossary , accessed on 24 August 2019

[2] Hurricanes in History, https://www.nhc.noaa.gov/outreach/history/, accessed on 9 September 2019

[3] What was the largest hurricane to hit the United States, https://geology.com/hurricanes/largest-hurricane/, accessed on 15 September 2019

[4] Dorian – Atlantic Ocean, https://blogs.nasa.gov/hurricanes/tag/dorian-2019/, accessed on 15 September, 2019

[5] DORIAN Graphics Archive: 5-day Forecast Track,Initial Wind Field and Watch/Warning Graphic, https://www.nhc.noaa.gov/archive/2019/DORIAN_graphics.php?product=5day_cone_no_line_and_wind, accessed on 16 September, 2019

[6] Hurricanes, https://texashelp.tamu.edu/browse/by-type/naturally-occurring/hurricanes/, accessed on 9 September 2019.

[7] Disaster preparedness guide, Mayor's Office, City of Houston, TX, Office of Emergency Management, 2019

[8] Hurricane preparedness South Carolina, https://www.scemd.org/, accessed on 9 September 2019

[9] Florida Emergency Preparedness Guide, Florida Health Publication, 2019

[10] Occupational Safety and Health Administration. "Emergency Action Plans." U.S. Department of Labor, Occupational Safety and Health Administration. 1910.38

[11] "Service Assessment – Hurricane Katrina Aug 23-31, 2005" U.S. Department of Commerce, NOAA, June 2006.

[12] Case Study – Hurricane Katrina, https://www.metlink.org/other-weather/miscellaneous-weather/case-studies/case-study-hurricane-katrina/ accessed on 15 September 2019.

[13] Park, J; Moore, J and Gordon, P "The regional economic impacts of Hurricanes Katrina and Rita on Oil refinery operations in the Gulf of Mexico, and the rest of the US : Applying a flexible multi regional Input-Output Model " https://www.researchgate.net/publications/242186880, published January 2007.

[14] 2017 Hurricane Harvey: Facts, FAQs, and how to help, https://www.worldvision.org/disaster-relief-news-stories/2017-hurricane-harvey-facts, accessed on 10 September 2019

[15] Emergency Response Plans, https://www.ready.gov/business/implementation/emergency, accessed on 12 September 2019

[16] General Duty Clause, Section 5A OSH Act of 1970.

[17] Israni, C, "Attaining operational excellence via a sustainable approach to safety", presented at MKOPSC, 2018.

[18] CCPS. *Guidelines for Risk Based Process Safety.* Center for Chemical Process Safety, American Institute of Chemical Engineers, New York, NY, 2007.

[19] Process Safety Management, OSHA 3132, US Department of Labor, Occupational Safety and Health Administration.