StormGeo

Steam Maintenance

A Decision Guide for the Downstream Oil & Gas Industry

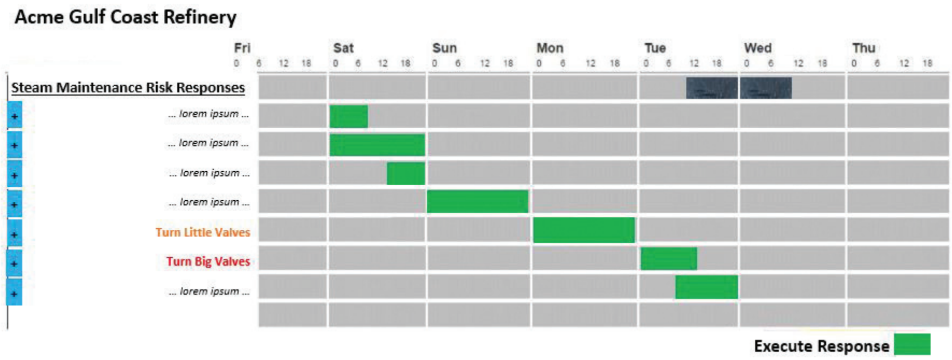
Steam Cushion at “Acme Refinery”

How does the StormGeo Business Risk Response Modelling solution apply to oil and gas refineries in the case of steam maintenance? To answer this question, we’ve created a hypothetical scenario:

Client: Acme Refinery

Data used: Acme has supplied StormGeo with the historic data for their refinery’s steam cushion. StormGeo is also using it’s own vast archive of historic weather hazards data, in which we have identified and correlated various weather hazards’ impact on the refinery’s ability to maintain a sufficient steam cushion.

Weather-related cause of steam degradation: A rainfall rate of two inches/hour or more. (Temperature, wind, and other weather elements are also likely at work here, but, we will assume only a rainfall rate correlation in this example.)

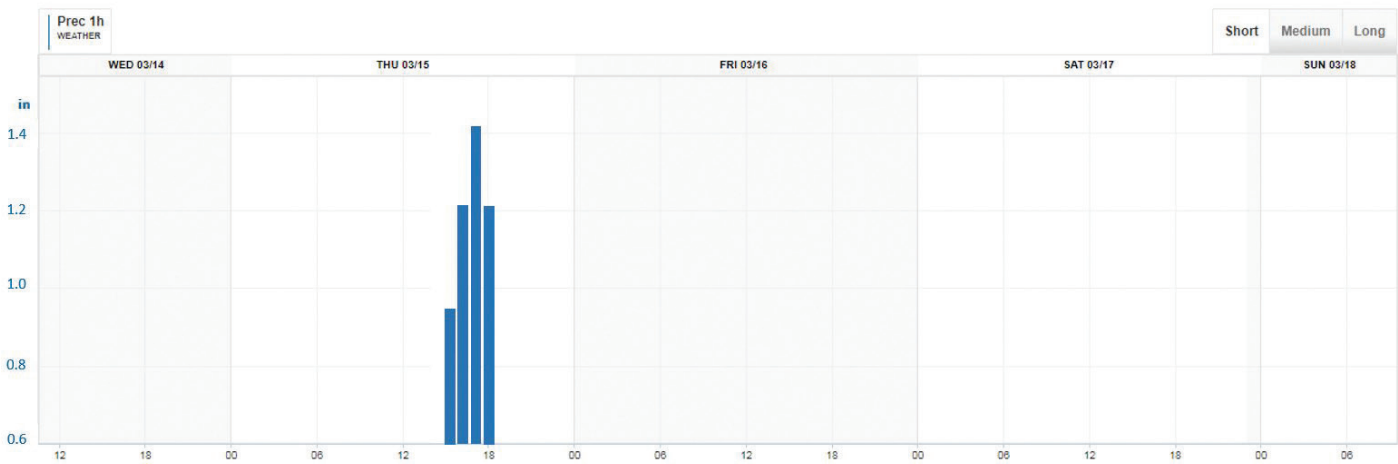


In this scenario, if rainfall rates equal or exceed two in/hr, Acme experiences costly steam cushion challenges; if less than two in/hr, there is no negative impact to steam cushion.

Let’s look into how StormGeo is able to create rainfall forecasts for Acme that provide decision support and potentially save millions of dollars.

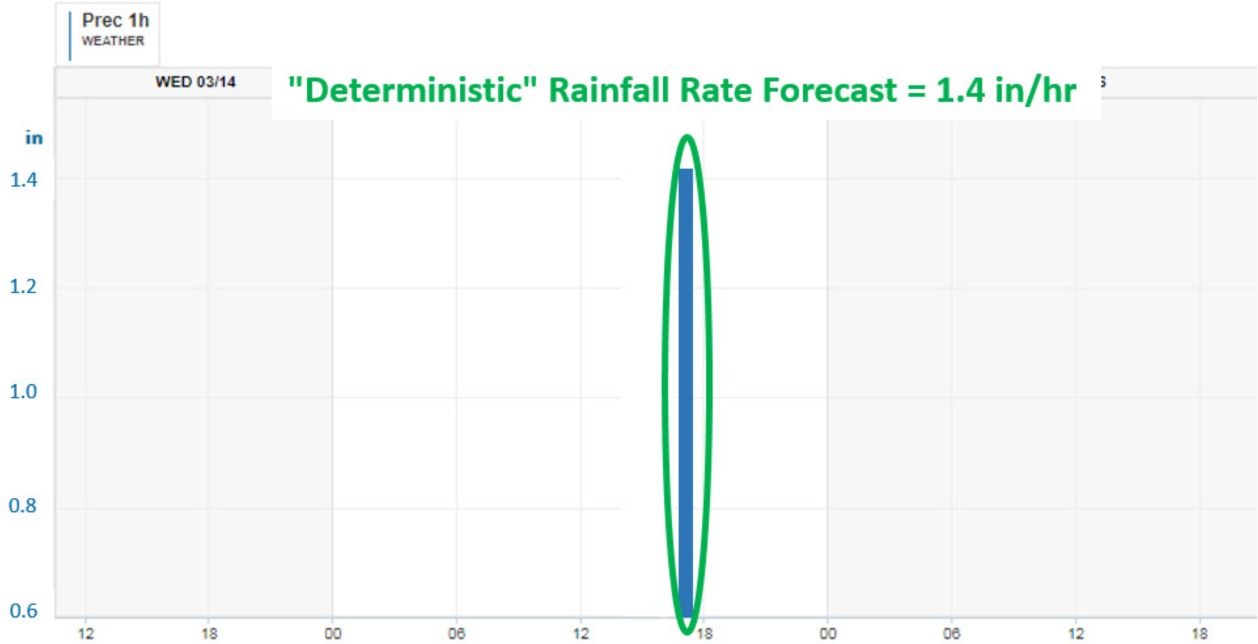
Probabilistic vs. Deterministic Forecasts

Acme Gulf Coast Refinery Forecast Rainfall Rate



In the figure above, we have what meteorologists would refer to as a deterministic time series of hourly rainfall rates. “Deterministic” simply means that there is only one possibility forecasted for each hour.

Let's zero in on one of these deterministic hourly forecasts:

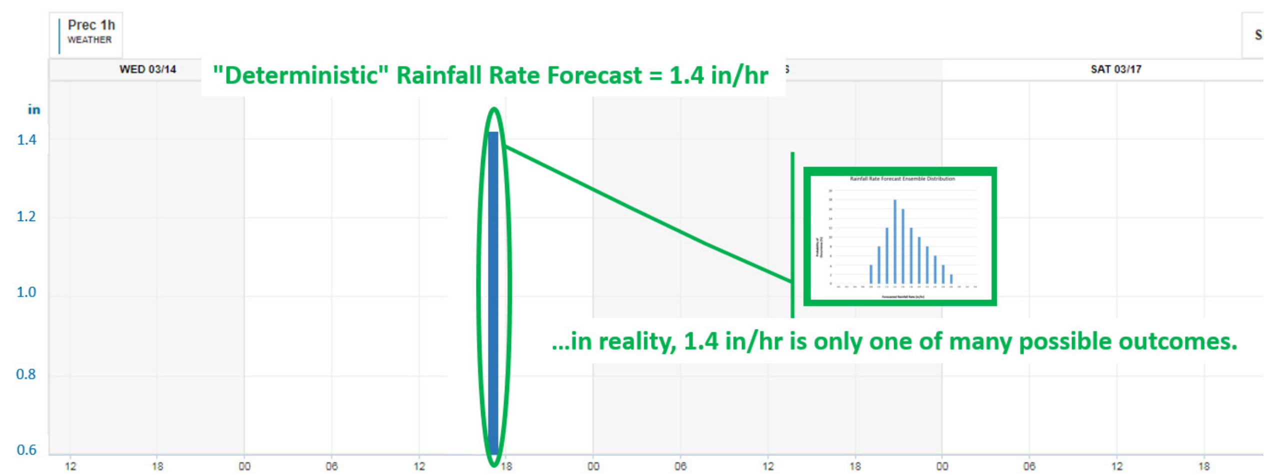


The figure above highlights the 16:00-17:00 hour's deterministic forecast, which shows an expected rainfall rate at Acme Refinery of 1.4 inches during that hour.

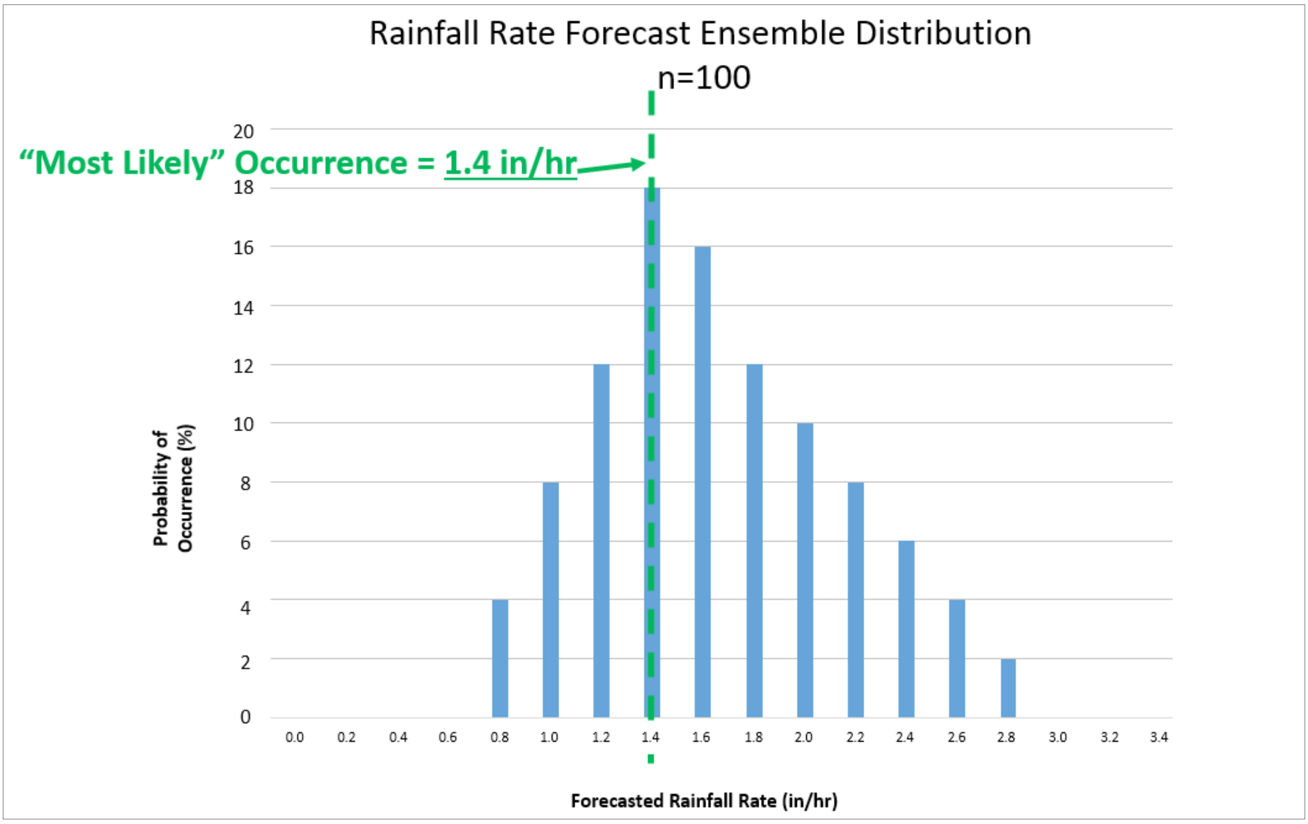
Taking the above parameters and this deterministic forecast of rainfall rates into consideration, one may be tempted to consider this weather event to be unimpactful to Acme's business. The rainfall rate is forecasted to be less than two in/hr, meaning there will be no impact on steam cushion.

However, does this interpretation of a deterministic forecast line up with a general understanding of how the weather actually works? For example, how many gardeners among us, upon learning that tomorrow morning's forecasted minimum temperature is 34° F, would think that there is absolutely no risk of temperatures falling to 32° F? Most of us would rush to cover our tomato plants in such a situation! Why? Because we understand, through personal experience, that a deterministic forecast of 34° F is only the most likely outcome of many possibilities.

StormGeo's Business Risk Response Modelling solution for Acme Refinery accounts for the fact that a deterministic forecast of 1.4 in/hr is simply one value that is representative of a "spectrum" of many possible outcomes — some of which could be hinder Acme's ability to maintain sufficient steam.

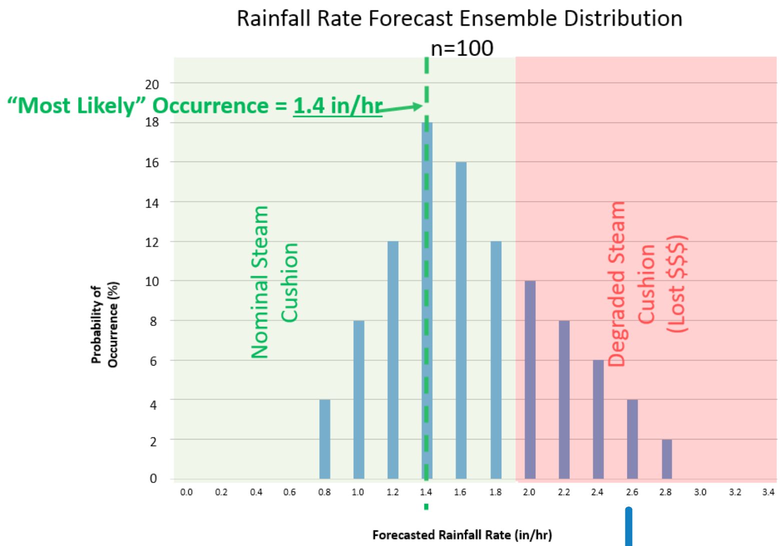


If we look further within this "spectrum," we see that the 1.4 in/hr value is chosen to represent a full distribution of possible rainfall rate events because it is the event which carries the greatest likelihood of occurring. This is a common technique used to draw a deterministic value from a probabilistic distribution.



If we superimpose our steam cushion critical values (two inches of rainfall per hour) onto this probabilistic distribution, we see that in spite of a deterministic forecast of only 1.4 in/hr, Acme's steam cushion may in fact be at risk:

Our probabilistic forecast shows that there is actually a 30% chance of two or more inches of rainfall per hour and therefore, an almost 1-in-3 chance of a critical steam cushion loss for Acme.



Although the deterministic forecast of 1.4 in/hr is within the green, "acceptable conditions" range, it fails to highlight the fact that there is a 30% chance of rainfall rates that will hinder the ability to maintain sufficient steam.

Questions:

- Even though the deterministic forecast in the scenario above is only 1.4 in/hr, might the additional knowledge that there is an almost 1-in-3 chance of >= 2in/hr rainfall rate affect Acme's decision to mitigate?
- If so, at what specific level of risk (30% as shown above? Higher risk? Lower risk?) should Acme Refinery consider executing a specific mitigating action?

When should Acme consider executing a steam cushion loss mitigating action?

Continuing our hypothetical scenario, let's focus on one hypothetical mitigating response available to Acme Refinery when facing a degradation in steam due to high rainfall rates: **Turn Big Valves**.

This specific action can act as a reference to a protocol that includes many separate actions. For the purposes of our discussion, it is only critical that we understand the **costs** and **efficacy** of this "Turn Big Valves" response.

Based on initial discussions with Acme, we will assume some "order of magnitude" cost and efficacy estimates:

a. Total potential loss if "Turn Big Valves" mitigating action is not executed when needed = $10,000,000

b. Total costs to execute "Turn Big Valves" action = $400,000

c. Efficacy of "Turn Big Valves" action = 80%, therefore potential loss even after correctly-executed "Turn Big Valves" action = $2,000,000

So, let's now consider all of the possible outcomes related to a "Turn Big Valves" decision:

Turn Big Valves or Not?	Cost to Turn Big Valves	>= 2"/hr Occurs?	Cost w/Big Valves Turned	Final Cost
Don't Turn	$0	No	-	**$0**
Turn	$400,000	Yes	$2,000,000	**$2,400,000**
Turn	$400,000	No	$0	**$400,000**
Don't Turn	$0	Yes	-	**$10,000,000**

In the **first case**, likely because the threat of a two in/hr rainfall is deemed minimal or non-existent, Acme chooses to not execute the "Turn Big Valves" mitigating action. Indeed, this rainfall event does not occur, so there is no loss associated with the event, and Acme's business is not impacted.

In the **second case**, the "Turn Big Valves" action is executed and the two in/hr rainfall does occur. In fact, because "Turn Big Valves" is only 80% effective, the costs to Acme are $400,000 to execute the action plus $2,000,000 in loss. However, this amount is less than 25% of the $10,000,000 Acme would have lost had it not executed the "Turn Big Valves" action, so this outcome, too, is considered much more preferable than a total loss.

In the **third case**, Acme chooses to "Turn Big Valves" at a cost of $400,000, but the two in/hr rainfall event fails to materialize. We might refer to this as a "false alarm." However, as long as the number of these occurrences do not get out of hand, Acme advises that they are "willing to take a number of smaller $400,000 'hits' than take one $10,000,000 hit."

The **fourth case** is the worst possible scenario — a rainfall of two in/hr occurs, but Acme has not executed the "Turn Big Valves" mitigating action and has therefore sustained a $10,000,000 loss.

Conclusions

Cost incurred to execute “Turn Big Valves” response = \$400,000 = C_{ETBV}

Cost of >= 2”/hr occurrence even after “Turn Big Valves” response = \$2,000,000 = C_{OTBV}

[Costs (total) of the “Turn Big Valves” response = \$400,000 + \$2,000,000 = \$2,400,000 = C_{TTBV}]

Cost (total) due to no “Turn Big Valves” response = \$10,000,000 = C_{TNTBV}

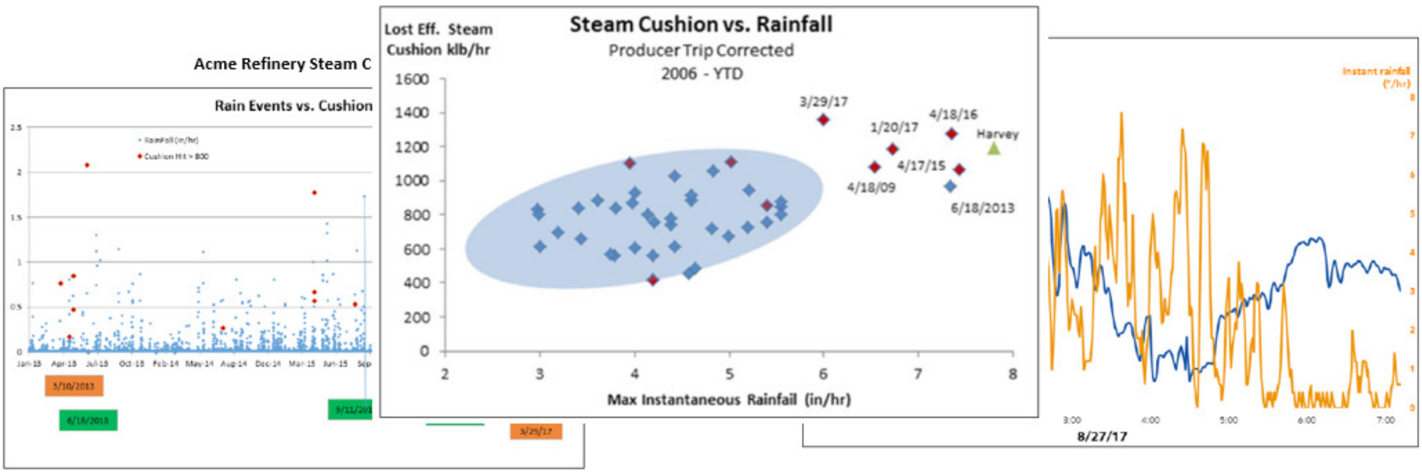
To find the optimal risk threshold for executing the “Turn Big Valves” mitigating response, we use basic economic cost/loss theory:

$$\text{Optimal 2”/hr Rainfall Rate Risk Threshold for “Turn Big Valves” Response} = \frac{C_{ETBV}}{C_{ETBV} + C_{FNTBV} - C_{TTBV}} = \frac{\$400{,}000}{\$400{,}000 + \$10{,}000{,}000 - \$2{,}400{,}000} = 0.050 = 5\%$$

Putting this into words, we find that the “Turn Big Valves” mitigating action is most cost-effectively executed when the probability of a >= 2 in/hr rainfall rate is greater than or equal to 5%.

In the scenario above, you assume that the only weather hazard affecting Acme Refinery’s ability to maintain sufficient steam cushion is rainfall rate, yet you state that other weather elements such as temperature, wind, etc. are also likely impacting steam cushion. How can we establish what is really happening?

It all begins with the data.



Acme Refinery has historic onsite rainfall and steam cushion data going back over a decade. This is a great start and, combined with StormGeo’s petabytes of historic meteorological data, will provide the foundation upon which data scientists can deploy StormGeo’s DeepStorm machine learning platform.

"We really appreciate the forecasts specific to our areas of operation and, when freezing conditions or a hurricane is imminent, we find these specific forecasts very useful to make our plans and consider the need for site closure or schedule adjustments."

Steve Moskowitz
ConocoPhillips, Houston

Get in touch
www.stormgeo.com | info@stormgeo.com

StormGeo StormGeo is a global provider of advanced weather intelligence and decision support services—relied upon to maintain business continuity, avoid supply chain disruption, protect assets and maximize productivity for industries including energy, manufacturing, electric utilities, construction, healthcare and retail. Our products and services help clients manage risk, optimize performance, reduce costs and increase revenue. As a participant in the UN Global Compact for Sustainable Ocean Business, our passion for weather and the protection of natural resources motivates us to support our clients in making informed, environmentally responsible business decisions. StormGeo is an ISO-9001 certified company.
For more information email info@stormgeo.com.

LLOYD'S REGISTER · LRQA
ISO 9001