Community Vulnerabilities at Aboveground Storage Tanks Due to Climate Change and Extreme Events

United States Environmental Protection Agency

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Communities interested in the oversight and management of aboveground storage tanks (ASTs) can benefit from increased awareness of an AST's vulnerabilities, risks, and increased environmental impacts associated with climate change. This fact sheet focuses on these physical and environmental vulnerabilities and associated vulnerabilities arising from existing economic and social conditions.

ASTs are affected by many factors ranging from the type of equipment, its age and components stored, to the inspection status, maintenance history, and geographic location. The physical conditions of an AST are influenced by its environment, which in light of climate change and extreme events could include increased heat, wind, rain, and flooding. These stressors on an AST are depicted in Figure 1.

Storms cause all types of issues. Winds and water can impact the tank, and if it causes a flood or wave of water the impacts can lead to the tank being lifted off its pad. Impacts can also damage the tank, either directly or due to flying or floating debris. One aspect, shown in Figure 1, is the storm with a lightning strike. Lightning is known to cause tank fires. In fact, it's the most common source of ignition.

Storms can produce tremendous bursts of rainfall that can flood an external floating roof (EFR). As pictured in Figure 1 by the cutout of the tank wall, the EFR sits on the surface of the liquid product and rises and falls with the liquid level. An EFR can flood if the rainfall is too much for any drain in place to divert the water. This added weight to the roof can lead to the EFR sinking into the stored components, leading to contamination.

Another way that water can affect an EFR is when an unexpected cold snap occurs, which could relate to climate change or an extreme weather event. An example is the cold weather experienced in Houston and all of Texas in February 2021. With a high number of ASTs, a mix of cold weather and precipitation can affect tank components and unevenly weight roofs, leading to tilting or a taco, i.e., when the EFR buckles.

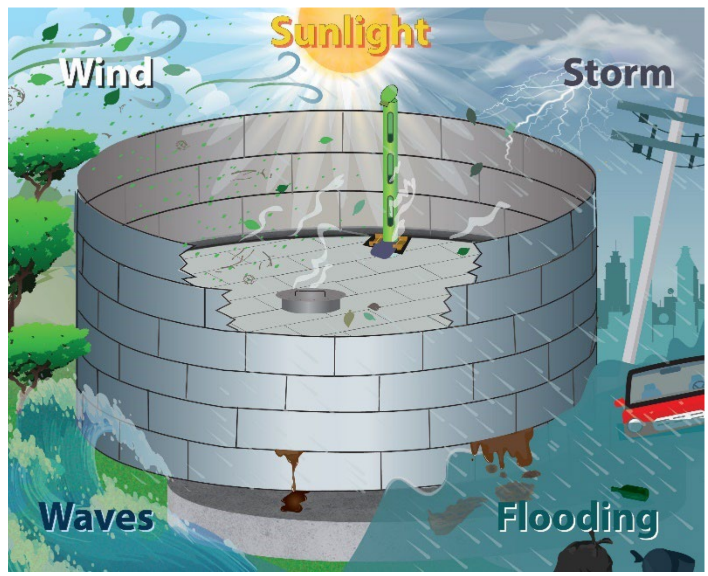

Figure 1. Potential issues at ASTs from wind, sunlight, storms, floods, and waves. Effects can include increased emissions, fires, flooded roofs, leaks, and tanks lifted off pads.

Another rarely considered aspect is the effect climate and extreme weather can have on the physical properties of components, including their interactions with the AST's infrastructure. Example effects of this consideration are listed in Table 1.

There are many other aspects in need of further evaluation when communicating the vulnerabilities of an AST when subjected to climate change and extreme weather events. Wind can affect the

Table 1. Effect of component properties on AST infrastructure

Chemical Property	Potential Effects on Stored Components and Infrastructure
Hygroscopic	Chemicals attract moisture leading to contamination. Tank components attract moisture; component deterioration and tank corrosion and rust.
Melting Point	Colder than usual temperatures may lead to chemical solidification, e.g., biodiesel. Piping rupture; rim seal and gasket deterioration; chemical volume change.
Boiling Point	Hotter than usual temperatures increase evaporation, odors, and exposures. Increased headspace volume; increased chemical contact with tank components.
Acidity / Basicity	Weather fluctuations may increase or decrease chemical acidity / basicity. Tank corrosion, need to change metallurgy; degradation of tank components.
Runaway Reaction	Chemicals like ethers and monomers can autoreact; power is needed to maintain control technologies. Tank explosions and chemical releases.

emissions arising from EFR tanks. Using EPA's AP-42 Chapter 7, which describes emissions from EFR storage tanks, the wind contributes to emissions from rim seals, deck fittings, and deck seams. In fact, the purpose of a fixed roof above a floating roof is to minimize the effects of wind.

A fixed roof positioned above a floating roof also limits the sunlight that would beat down upon an EFR (see Figure 1). An EFR, exposed to the sun, has higher component temperatures which leads to higher emissions. The vapor pressure of each component is a function of temperature, so higher temperatures from climate change or a shorter-term extreme event increase the emissions from the AST.

To demonstrate the effects from weather on an EFR AST, Figure 2 shows results from model emission calculations using TankESP™ software (Trinity Consultants). The large increase in temperatures and wind velocity shown are intended to demonstrate that weather could change for a time (less than a year) and that the emissions during such extreme events could be substantial. Another result to consider is for the high temperature / high wind scenario the increase in total emissions is 146%. A speciated calculation of total aromatics found that they increased by 174%. If aromatics represent higher human health impacts, then these details could impact fenceline analyses and potential effects on nearby communities.

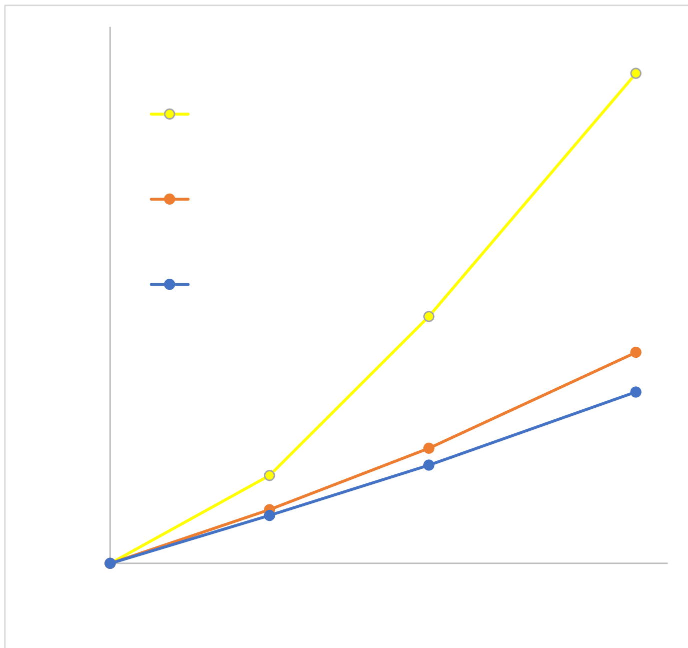

Figure 2. Calculations for a Greensboro, NC, storage tank (diameter = 85 feet, height = 40 feet) holding 34,000 bbl of gasoline with a steel-pontoon EFR.

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