GCT GLOBAL CONTAINER TERMINALS

stack analysis to determine maximum wind force that containers can withstand at different heights and positions

the challenge

In 2020, GCT Canada identified the need to refine the wind policy at Deltaport. GCT Deltaport is exposed to largely unobstructed Pacific Ocean winds via the Strait of Juan de Fuca. Wind delays had a significant business impact on operations and customer service, and most importantly, safety.

Prior to implementing a comprehensive wind policy, operations lacked clear references, leaving unplanned shutdowns as the only course of action. Even with precautionary shutdowns in place, sudden wind gusts could still create unexpected challenges. Adding to these challenges was the terminals transition to a new yard planning model that does not allow the isolation of empty containers, empty containers being a higher risk to slide or topple. Empty containers can fall into roadways and other areas of operations causing damage and hazard to personnel.

With this wind system upgrade, GCT now benefits from a more accurate wind forecasting model, enhanced insights into which containers and areas are most vulnerable to wind, and an intuitive risk visualization tool available to operations. By anticipating severe winds the day before, operations can proactively plan for early shutdowns and keep people clear from potentially unstable containers. The improved wind system allows GCT to base its wind response decisions on data rather than reactive measures.

Additionally, the system's real-time alerts provide enough lead time to notify incoming vessels of potential delays, allowing for better preparation and minimizing the overall impact on customer service. Ultimately, this upgrade enhances both safety and customer service.

the innovation

Deltaport's operational equipment has been designed with wind resilience in mind, but empty containers remain vulnerable to strong gusts. To tackle this risk head-on, GCT developed the Site Wind Analysis and Monitor (SWAM)– - by cross-referencing a dynamic container stack analysis model fed by GCT's TOS (Terminal Operating System) with advanced wind forecasting technology.

The stack analysis determines the maximum wind force that each container can withstand at different heights and positions in 16 cardinal wind directions. The hourly wind speed and direction forecasting model tailored for Deltaport is 7% more accurate than other sources, and is considered reliable for advanced shutdown planning. This level of precision supports planning and yard reorganization, giving operations the lead time and foresight to keep workers out of harm's way.

In SWAM, a color-coded system is used to display warnings and alerts, enabling operators to monitor conditions closely and take immediate, informed action as needed. This system allows close observation and proactive response. With the included Sandbox module, teams can simulate container adjustments, test responses, and ensure the safest possible yard configuration ahead of gusts. By enabling real-time risk visualization and proactive mitigation, SWAM is a game-changer for safety at Deltaport. An auxiliary benefit of this analysis is the cross checking of physical stacks and known positions in TOS. If a container is lost or out of place there is an exception/alert list used until the issue is rectified in TOS.

how it was implemented

GCT partnered with the Weather Forecast Research Team (WFRT) at the University of British Columbia (UBC) to improve wind speed and direction forecasts for Deltaport. The WFRT combined the outputs of multiple diverse models and averaged them to minimize potential errors. WFRT's new offering included the maximum wind speed predictions from all models for any given day, allowing GCT to act proactively to gusts.

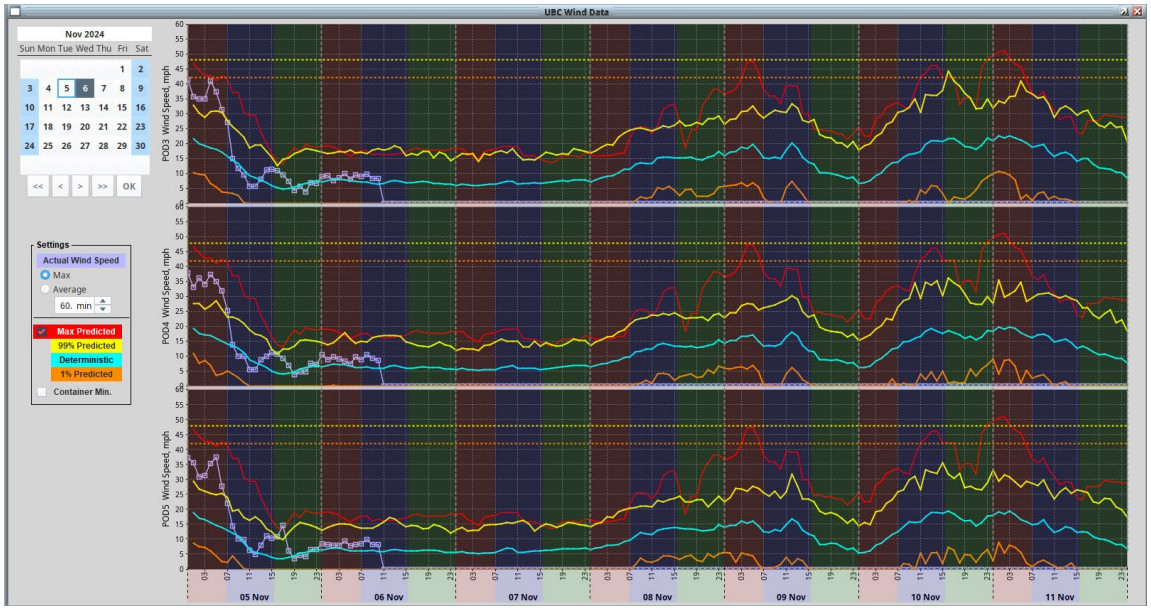

Figure 1. Wind Forecasting and Real-Time Monitoring

CPA Engineering assisted GCT in developing a software tool that analyses the stability of over 18,000 containers on site, assessing both sliding and toppling risks. Considering Deltaport's proximity to a coal-handling operation, the impact of coal dust was also factored into the analysis. An innovative friction test was designed to measure the coefficient of friction between standard shipping containers. GCT can now calculate stack stability on all containers in the terminal with all possible wind directions per container.

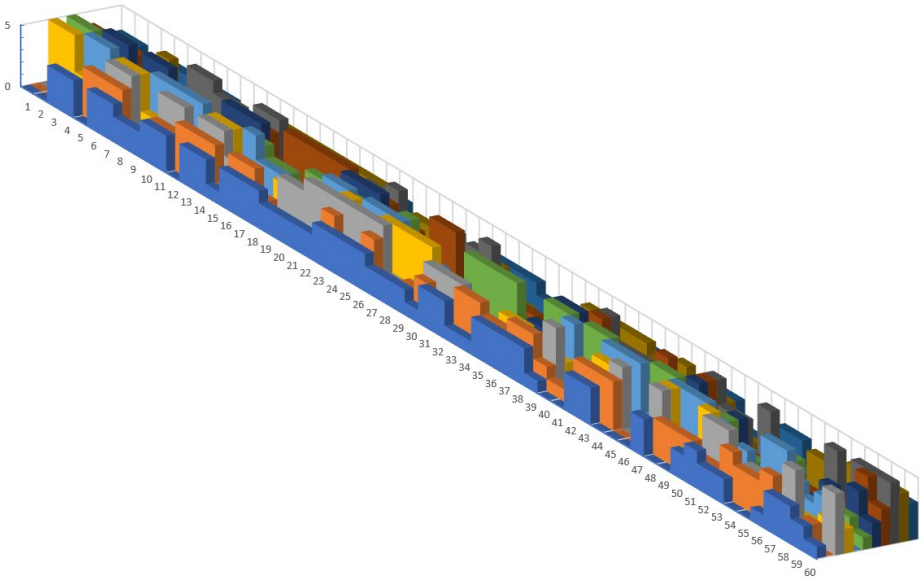

Figure 2. Digital Twin – Stack Profile Simulation

To capture real-time wind data, three new ultrasonic anemometer systems were installed in each yard, positioned to avoid wind obstructions. This data directly feeds back into the WFRT's computing model, which continuously improves forecast accuracy. The wind data can be played back in the software for historical analysis on events after the fact. A real-time sandbox mode offers a virtual environment for testing risk mitigation strategies, where operations can simulate container movements, experiment with different adjustments, and identify actions that can eliminate risks. The analysis model runs every 10 minutes or on demand using the same yard stack data GCT's TOS uses to run the operation.

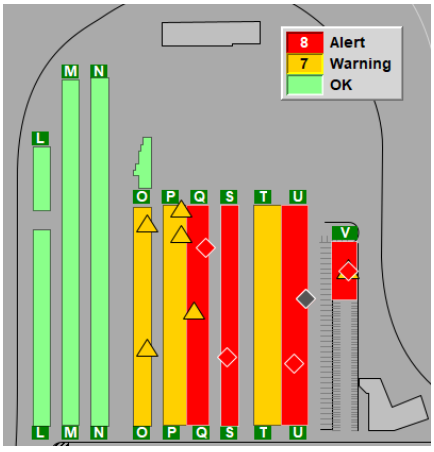

Figure 3 Location Illustration of Containers in Risks

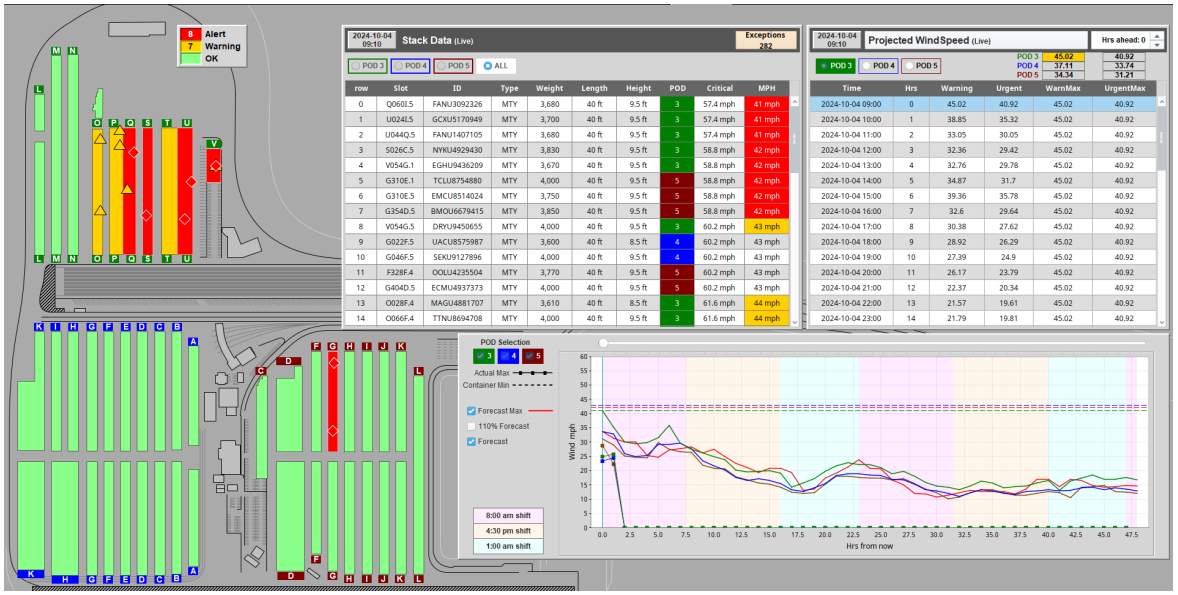

Figure 4 Integrated SWAM System

result

The implementation of the upgraded wind system at GCT Deltaport has significantly enhanced both operational safety and customer service. By integrating advanced forecasting technology, container dynamics studies, and real-time wind monitoring, GCT has shifted from reactive measures to a proactive, data-driven approach in managing wind-related risks. This transformation has been instrumental in preventing potential safety incidents, such as toppling or sliding containers, which pose serious risks to personnel, equipment and customer cargo.

Validity of the model was proven early on in the development of the stack analysis tool. A container was toppled in a stack during a high wind event. The model accurately predicted the wind speed at which this would occur. At this time our terminal was shut down from high winds and so no injuries or near misses were observed but it was a good opportunity to put the software to test and run it through our historical analysis.

With the ability to predict severe weather conditions ahead of time, GCT has successfully reduced the likelihood of wind-related accidents, allowing for well-coordinated shutdowns and adjustments to container placements. These safety measures are not only preventing accidents but are also providing workers and operations teams with the necessary time and information to take appropriate actions, such as evacuating vulnerable areas, securing containers, and ensuring that operations resume safely after severe conditions subside.

conclusion

Managing Deltaport's unpredictable weather has led to a breakthrough in safety assurance, while also improving customer service and contributing to academic advancements. GCT.

views this as a project well worth ongoing enhancement, having established a solid foundation but recognizing areas for future development. The collaboration with the University of British Columbia's Weather Forecast Research Team has also paved the way for further innovations in safety, including the potential integration of AI and machine learning to refine the forecasting models.

Safety is at the heart of every decision and development at GCT, and we are committed to continuously improving our wind risk management strategy. As we move forward, we will continue to gather user feedback, refine our systems, and explore new technologies to ensure the highest level of safety for our team members, customers, and operations. This ongoing focus on safety and innovation reinforces our commitment to operational excellence and the well-being of everyone at our terminals

Additionally, GCT is developing a user manual for this wind risk monitoring software, with the goal of creating a highly intuitive UI that allows operations to use the system to its potential. We are actively gathering feedback from users to refine the software and improve its functionality. At GCT, safety remains our top priority. Stay tuned for updates on our continued progress.

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