DYNAMIC UNDER KEEL CLEARANCE PROJECT

JPS and Tesoro will analyze twenty transits to compare the Protide prediction to the actual motion. At press time, four transits have been analyzed with favorable results.

By Captain Kip Louttit

The flow of oil into the Port of Long Beach by ship is critical to California and the Nation. 50 percent of California's oil enters through the Ports of Los Angeles and Long Beach and there is only a five-day supply ashore at any given time. The number of tankers entering the two ports has been increasing during the past 4 years, with 589 tankers entering the Ports of Los Angeles and Long beach in 2012, 592 in 2013, 606 in 2014, and 632 in 2015.

The Port of Long Beach has the only supertanker berth in the port complex and the US West Coast. Navigating supertankers into the port safely requires special training and the use of modern technology. At 1,200 feet long, 200 feet wide, and weighing more than 320,000 tons, they are the largest moving objects constructed by humans on the planet. The ships aren't just big and heavy, they have deep drafts and float deep in the water. The Coast Guard Captain of the Port of Los Angeles and Long Beach set the maximum draft for tankers entering the Port of Long Beach at 65 feet. The channel into Long Beach is 76 feet deep.

Most of the year, the swells approach the Ports of Los Angeles and Long Beach from the west, and since the approaches to the ports are from south to north, the swells are on the ship's beam and they cause the ship to roll during the approach. This is not a problem with under keel clearance during westerly swells, but during the late summer the storms and hurricanes in the Pacific and off the coast of Mexico create a long swell from the south. This causes ships entering the ports to pitch as they approach, and 1 degree of pitch on a 1,100-foot tanker is a 9.6-foot increase in draft. Thus, a tanker with an even-keel draft of 65 feet increases draft to 74.6 feet under these conditions, leaving only 1.4 feet of water under the keel.

Presently, the go/no-go decision on bringing these tankers into port is made using swell warnings from the Coastal Data Information Program

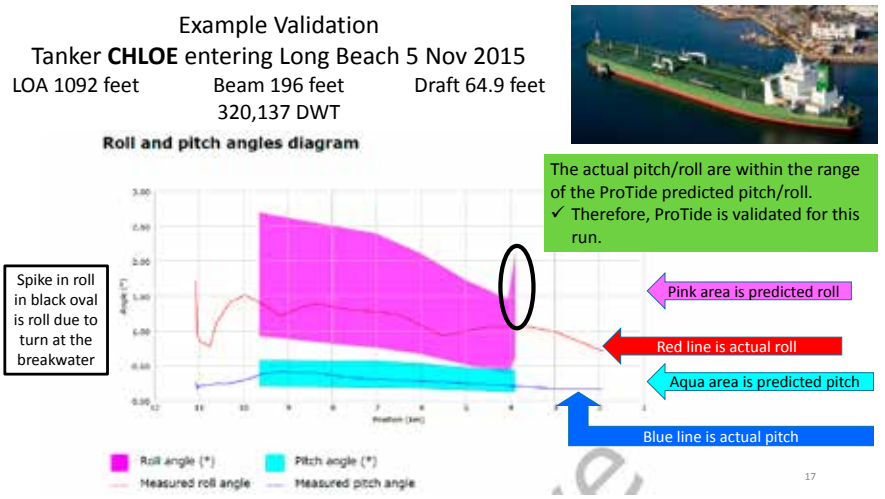
(CDIP), real-time CDIP wave buoy observations, experience, seaman's eye, and observing pitch and roll of the tanker offshore – before committing to the channel entrance.

CDIP is an extensive network of offshore buoys for monitoring waves along the coastlines of the United States operated by the Scripps Institution of Oceanography at the University of California San Diego and part of the Interagency Ocean Observing System (IOOS). When defined swell period and height parameters are met, CDIP automatically sends a warning to the ship pilots at the Jacobsen Pilot Service (JPS), which provides piloting services for the Port of Long Beach. JPS use these warnings as one of their inputs to make the go/no-go decision.

"Ready to handle even the biggest ships" is the credo of Jacobsen Pilot Service, the only ISO 9001-certified pilot organization in the United States. JPS, which has been providing pilot services to the port for more than three generations, has developed a tried-and-true protocol that has resulted in an accident-free record for bringing large ships into the Long Beach harbor safely. "Big ships can't afford any delays; they need reliability. They need to arrive on time and be moved safely every time, which is exactly what we do," said Captain Tom Jacobsen, President of JPS.

JPS has been innovative throughout its 92-year history. They were first to use shore-based radar to assist in piloting, and to use on-board portable piloting units. JPS asked the question, "Is there a system that uses modern science and technology to help the pilots and ship's captain make the go/no-go decision for supertankers entering Long Beach?"

Jacobsen Pilot Service did their research and found the answer at a firm based in the Netherlands, Charta Software, which developed a product called Protide that showed promise. Protide's inputs are predicted water levels (tides), currents, wave conditions, channel depth, course and speed of the ship, ship dimensions, and the ship's arrival/departure loading condition. Protide then calculates the predicted ship motion, taking into account roll, pitch, and squat for that vessel at the time of transit including weather. Protide plots the predicted motion along the planned route, and calculates the under keel clearance and the probability of touching bottom. The system is currently in use successfully in the Netherlands for the ports of Amsterdam, Rotterdam, and Eemshaven. Captain John Strong, Vice President of Jacobsen Pilot Service, rode with the Dutch pilots, saw the system work in the Netherlands, and brought the concept back to Long Beach. The next question was, could a system designed to work in the Netherlands and North Sea be modified to work in Long Beach and the Pacific?



This chart shows the predicted roll and pitch of the tanker ***Chloe*** entering Long Beach, as well as the actual observed roll and pitch.

To answer the question, a unique partnership was formed during the summer of 2014 between the Port of Long Beach, California Office of Spill Prevention and Response (CA OSPR), Tesoro – the Operator of the supertanker berth 121, and Jacobsen Pilot Service who, together, teamed with the National Oceanic and Atmospheric Administration (NOAA), US Integrated Ocean Observing System (IOOS), Southern California Coastal Ocean Observing System (SCCOOS), and CDIP. A Memorandum of Understanding was drafted and signed, and the Marine Exchange of Southern California was selected as Project Manager.

The overarching goal of the project was to develop a scientific method of predicting the pitch and roll of large deep draft vessels calling at the Port of Long Beach to manage under keel clearance. The three potential benefits of a successful program were identified as increased safety and efficiency, and reduced emissions. Increased safety would be achieved through the reduced risk of accidental grounding caused by the pitch or roll of a large vessel. Ship owners and masters would have the ability to adjust arrival times based on pitch and roll predicted to be outside of port entrance safety margins, thus increasing efficiency. Emissions would be reduced by enabling larger ships carrying more cargo to enter the POLB, which will reduce overall stack emissions per ton of cargo arriving at the port.

Protide's ability to predict safe transit windows will result in more efficient use of the port infrastructure and reduce emissions. Benefits to industry and the public would be to reduce the risk of transporting oil on the West Coast because science and technology would be used to validate the observations of the pilots and ship's captains when making the go/no-go decision. Additionally, the ability for deeper draft ships to be brought directly into Long Beach would reduce the need for lightering, lessening the risk of an oil spill on the coast.

The first phase of the project, funded by the Port of Long Beach and

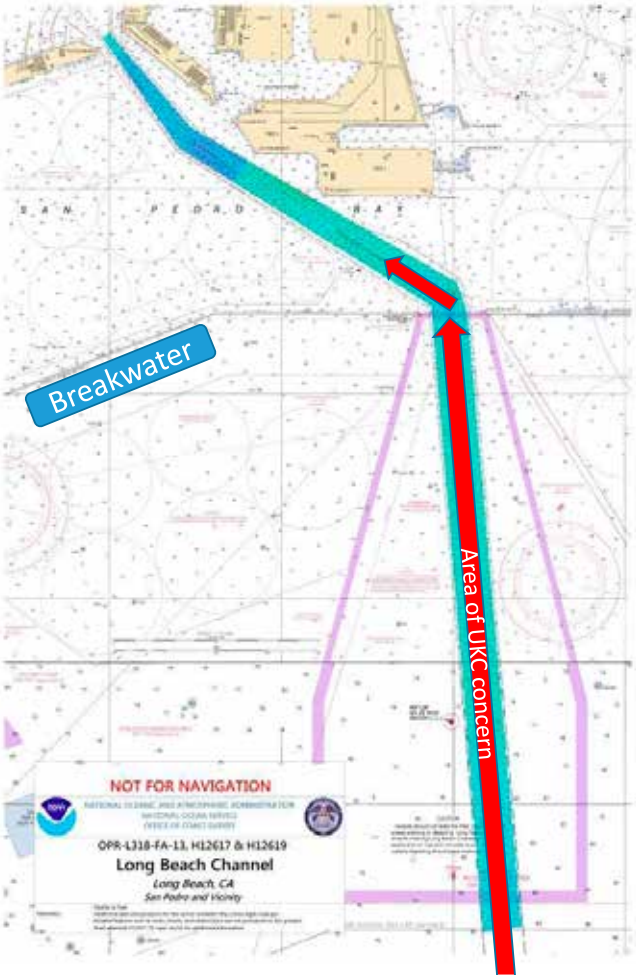
CA OSPR, was to determine if the Protide system would work for the Port of Long Beach using data sources available in the United States. Charta Software was chosen to conduct the study using the Pacific Ocean wave model from the National Weather Service, charts from the National Ocean Service, and wave buoy input from CDIP. A successful study with Charta Software was completed in February 2015 using the locally available data inputs.

CA OSPR, the Port of Long Beach and Tesoro are funding the rental and use of a highly accurate motion sensor called Octopus made by Amarcom that is being placed aboard each supertanker entering Long Beach to validate Protide's outputs.

"Tesoro is committed to safety, environmental stewardship and reliable operations," said Captain Rob McCaughey, Manager Marine Operations for Tesoro Refining and Marketing Company. "And we're excited to take the next step forward in developing an operational Protide system."

The operational Protide system for Long Beach was completed in September 2015. JPS and Tesoro conducted a test period where a Protide prediction was calculated for each supertanker arriving in Long Beach using the Octopus system to record the actual motion of the ship. Twenty transits will be analyzed to compare the Protide prediction to the actual motion. As of the writing of this article, four transits have been analyzed and the results are favorable that the Protide predictions are accurate. Unfortunately, the weather did not cooperate and only westerly swell and wave motion could be recorded.

In 2016, the next step will be to refine the Protide system in order to verify that Protide can be used operationally. The NOAA's NWS National Center for Environmental Prediction (NCEP) is refining and making operational a Nearshore Wave Prediction system for the San Pedro Bight, which will improve the accuracy of the wave and swell forecast inputs to Protide. Swell and wave model outputs will be analyzed and compared with actual wave buoy measurements to validate the model. Octopus will again be used in late summer of 2016 and record ten transits in southerly swell conditions.



This chart shows the approach to the Port of Long Beach, where the channel is dredged to 76 feet. The area of concern is the approach channel, the turn, and just after the turn.

This project is focused primarily on supertankers entering Long Beach, but there are other potential benefits of dynamic under keel clearance prediction systems that can be shared with the maritime industry. This shared value includes cruise ships, Very Large Container Vessels (VLCVs) that have similar characteristics to supertankers, unique vessels such as heavy lift ships, large bulk carriers, ships transiting the channel in bad weather, and ships inside the breakwater at docks that are heavily influenced by large southerly swells. The development of the Protide model is already being looked at by other ports that have similar under keel clearance challenges.

The dynamic under keel clearance project in Long Beach is an example of shared value and powerful collaboration between the public and private sectors to form a partnership using modern science and technology to increase safety, environmental stewardship, and efficiency, for large deep draft vessels entering Long Beach. PMM

Captain Kip Louttit is the Executive Director of the Marine Exchange of Southern California. A graduate of the United States Coast Guard Academy, he served in the United States Coast Guard (USCG) for 30 years prior to retiring with the rank of Captain. His career included 10 years at sea including six years in command of three different Coast Guard cutters and two years as commanding officer of USCG Integrated Support Command in San Pedro.

Captain Louttit was a Sloan Fellow at the Massachusetts Institute of Technology (MIT) and holds Masters Degrees from MIT and Golden Gate University.