Prevention First

Dynamic Under Keel Clearance (UKC) Project for the Port of Long Beach

25 September 2018

Captain Kip Louttit
USCG, Retired

Executive Director
Marine Exchange of Southern California
Challenge: Very Large Crude Carriers (VLCCs) entering POLB

M/V GEM 2 entering POLB 8 April 2017
1,082’ LOA 198’ Beam 302,783 DWT 66’ Draft
Ports of Los Angeles & Long Beach

- 50% of California’s oil
- Only 5 day supply of oil ashore
- Pier T-121 is the only VLCC berth on the West Coast

- Approach to POLB Channel dredged to 76 feet
- Area of concern:
  1. Approach channel
  2. Turn at breakwater,
  3. Little bit after the turn
The **Pitch Problem** in a Long Period Southerly Swell

With Zero Pitch there is 11’ of under keel clearance

With 1 degree of Pitch there is a 10’ increase in draft for a 1,100 foot tanker:

1 degree of pitch reduces the UKC to 1 foot.

How can we predict this pitch motion and ensure a safe passage?
GO/NO GO decision made using:

✓ CDIP Swell Warnings
✓ CDIP Buoy Reports
✓ Experience
✓ Seaman’s Eye
✓ Observed pitch & roll far enough offshore to permit “bail-out” before committing to channel
PROTIDE is used in the following ports in the Netherlands:
Rotterdam, Amsterdam & Eemshaven
Plus: Antwerp, Belgium

PROTIDE takes predicted:
• water levels,
• currents,
• wave conditions,
• channel depth,
• ship course and speed, and
• ship dimensions...

• Calculates vertical ship motion (Pitch, Roll, and Squat)...
• And then calculates predicted under keel clearance and probability of touching bottom
Key Success Factor
UKC Feasibility Study *Memorandum of Understanding*
Signed Nov-Dec 2014

**Interested Parties & Advisors**

- Purpose, Goals, Definitions
- Study, Evaluation, Pilot, & Implementation Phases
- Desired Outcomes & Measures of Success
- Roles and Responsibilities
- $flows

**Participants**

- Project Manager:
Goals of Dynamic Under Keel Clearance Project

1. **Increase safety** by reducing the risk of an accidental grounding caused by the pitch or roll of a large vessel causing it to impact the bottom.

2. **Increase efficiency** by enabling ship owners and masters to adjust arrival times based on the pitch and roll program being able to predict when pitch and roll will be out of limits to enter port due to unacceptable under keel draft clearance.

3. **Reduce emissions** by enabling larger ships to carry more cargo to enter the POLB, which could reduce overall stack emissions per ton of cargo arriving at the port.
Benefit:
Reduce overall risk of transporting oil on West Coast

1. SAFETY - Reduced personnel exposure & injury
   a. Line handlers
   b. Reduces hours crews are in demanding ops
2. ECONOMICS - More efficient use of port infrastructure & tugs
3. ENVIRONMENT - Reduce oil spill risk
   a. Fewer oil transfers
   b. Transfers in protected harbors rather than offshore lightering
   c. Reduced emissions due to less loitering and more barrels per movement
Protide only works if it has accurate environmental inputs.
Coastal Data Information Program (CDIP) Wave Buoys are critical
3 CDIP Wave Buoys in local area 68 CDIP Wave Buoys around U.S.

Hourly submission
Wave buoy display at Marine Exchange. Buoys update every 30 minutes
3 CDIP buoys near ports of Los Angeles and Long Beach.

- Old Wave Watch III model under-predicts (red)
- New Nearshore Wave Prediction System (NWPS) launched 1 Jan 2017 much better (green)
- Actual buoy motion is blue

Note reflection off breakwater and difference in wave direction in this small area. Need for 3 buoys validated.
Wave Models and Prediction Systems

- Nearshore Wave Prediction System (NWPS)
  - NOAA National Climate Prediction Centers (NCEP) developed the NWPS model for the San Pedro Bight.
  - Used for planning 2-72 hours in advance of arrival.

- CDIP wave model used within 2 hours of arrival to assist with final “go/no go” decision.
Precision navigation requires precise charts and accurate depths

Bottom Survey by NOAA Ship FAIRWEATHER Fall 2013
Being resurveyed By NOAA Ship RAINIER Aug-Sep 2018
Evaluation of ship motion

- Using Amarcon’s “OCTOPUS” system
- Extremely accurate motion sensor:
  - Brought on board by the pilots
  - Placed in exactly the correct location
  - Motion measurements recorded by laptop

Laptop records the motion readings
Roll and pitch angles diagram

Roll Prediction (pink)
1.0-2.1 degrees in transit
2.7 degrees at turn

Pitch Prediction (aqua)
0.25-0.4 degrees

Cosjade Lake
14 April 2017
Draft: 66 feet
Deadweight Tons: 298,000

Pink area is predicted roll
Red line is actual roll
Aqua area is predicted pitch
Blue line is actual pitch
Resulting UKC:

Under keel clearance curve diagram

Resulting Under Keel Clearance Predictions
Static: About 3.5 meters
Dynamic: 2.1 to 2.8 meters

Static UKC Prediction
Dynamic UKC prediction: 2.1 - 2.8 meters
Actual UKC 2.2 - 2.8 meters
As of 7 Sep, 43 tankers with draft greater than 65 feet have safely entered Port of Long Beach
11 at 66’
12 at 67’
12 at 68’
4 between 68’ & max of 69’
4 at 69’

Goals:
1. Increase Safety
2. Increase Efficiency
3. Reduce Emissions

OUR SUCCESS IN MEETING THESE GOALS CONTINUES TO BE DEMONSTRATED
Safer & More Efficient Ship Movements based on precision Science & Technology

- Protide enhances safety
- Jacobsen Pilot Service (Long Beach Pilots) Team Piloting Procedures enhance safety
- Protide reduces or eliminates the number of aborted runs
- If a very deep draft tanker is out of limits, a smaller tanker may still be able to enter.
Goals of this project are met:
✓ Tanker focus
✓ Increase safety & efficiency, & reduce emissions

Future potential applications:
❑ Unique vessels
❑ Bad weather
❑ Other Ports
❑ Larger Cruise Ships
❑ Larger Container Ships (Pier J Long Beach)

Ship entering Long Beach with new cranes

18,000 TEU CMA CGM
Benjamin Franklin

Thank you!
Protide & Dynamic Under Keel Clearance Project:
Increase Safety
Increase Efficiency
Reduce Emissions
Support by California Office of Spill Prevention and Response

“The California Department of Fish & Wildlife was very pleased to help sponsor Phase I of the “Dynamic Under Keel Clearance Project” in the Port of Long Beach.

“We believe that this first-of-a-kind capability in a United States port will leverage emerging technologies to better protect our sensitive coastal environment by reducing the number of offshore oil transfers from supertankers to smaller “lightering” vessels.

“This project has been very successful to date and we eagerly anticipate it going fully operational in the near future. Our congratulations and thanks to the entire project team for a job WELL DONE!”

Thomas M. Cullen, Jr.
Administrator
17 November 2016
Approach to port of Long Beach...

Channel dredged to 76 feet

Area of concern is:

1. Approach channel,
2. Turn at breakwater
3. Little bit after turn
### Summary of Inputs PROTIDE needs:

<table>
<thead>
<tr>
<th>Measurement</th>
<th>Source</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Water Level</td>
<td>NOAA Ports System Sensor on Terminal Island</td>
<td></td>
</tr>
<tr>
<td>2 Current</td>
<td>n/a</td>
<td>None of consequence</td>
</tr>
<tr>
<td>3 Wave Conditions</td>
<td>a. CDIP wave buoys &lt;br&gt;b. CDIP wave model &lt;br&gt;c. NOAA wave model</td>
<td>0-2 hours before arrival &lt;br&gt;2-72 hours before arrival</td>
</tr>
<tr>
<td>4 Channel Depth</td>
<td>NOAA Survey Fall 2013 &lt;br&gt;Ongoing NOAA Survey Fall 2018</td>
<td>NOAA Ships Fairweather &amp; Rainier &lt;br&gt;Subsequent updates of soundings by POLA/POLB</td>
</tr>
<tr>
<td>5 Ship Course &amp; Speed</td>
<td>Jacobsen Pilot Service (Long Beach Pilots)</td>
<td>Fixed/Defined Route, Courses &amp; Speeds</td>
</tr>
<tr>
<td>6 Ship Dimensions</td>
<td>Protide Database</td>
<td></td>
</tr>
<tr>
<td>7 Ship Loading Condition</td>
<td>Ship</td>
<td></td>
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</tbody>
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Challenges of developing a wave model for Southern California

- Spatial variation due to island shadowing allows coastal variability.
- Wave heights differ according to direction of the waves.

Ports of Los Angeles and Long Beach sheltered by Catalina & San Clemente

Sheltering by San Clemente & Catalina Islands
Operational Process: 2 inputs from each tanker

#1: Data Sheet

#2: Snapshot of Stability

Program Results from Loading Computer
Buga Kastui Empat entered 16 Nov 2017
1st tanker at 68’ draft

White area NOT SAFE to enter

Top graph Light Blue
Safe transits
~1800-2200 & ~0400-0700

Middle Graph Aqua
Predicted dynamic UKC
1.5 to 2.2m through route except 1.1 to 2.0m at the turn.

Low Tide
Example PROTIDE VALIDATION RUN
Tanker Chloe 26 Oct 2015 ... it works!

30 test runs 2015-2016 validated model predictions with the on-board motion sensor.
Example PROTIDE Validation
Tanker **CHLOE**
Entering Long Beach 26 Oct 2015
LOA 1092 feet        Beam 196 feet
Draft 64.9 feet       320,137 DWT
Transit at mean lower low water

The actual pitch and roll are within the ProTide predicted range.
✓ Therefore, PROTIDE is validated for this run.

Spike in roll in black oval is ship heel due to turn at the breakwater
Point of Contact:

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