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

Long Beach Pier T-121

Breakwater

Breakwater

3

2

1. Area of UKC concern

- 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 <u>Pitch Problem</u> in a Long Period Southerly Swell

With Zero Pitch there is 11' of under keel clearance

76' MLLW

Former 65' Max Draft per agreement with USCG COTP

11' Static Under Keel Clearance
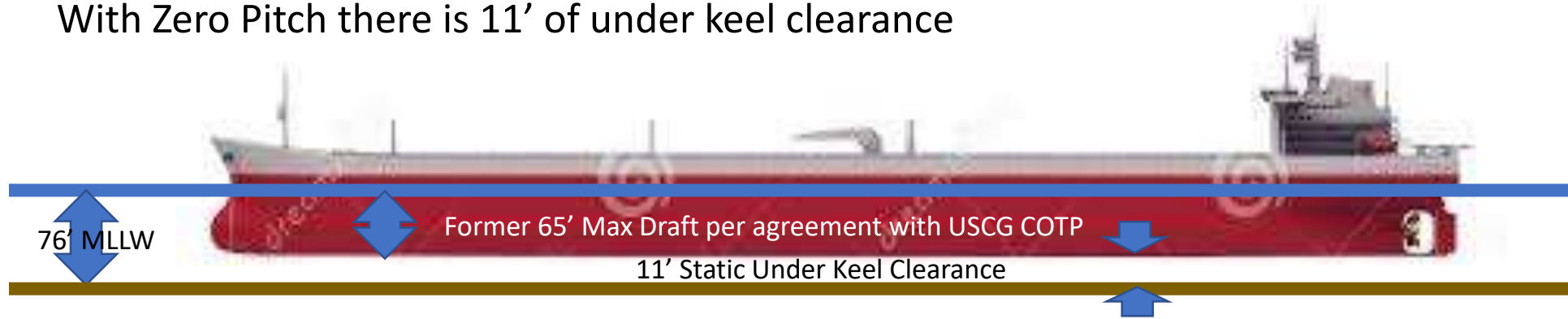
With 1 degree of Pitch there is a 10' increase in draft for a 1,100 foot tanker:

76' MLLW

Former 65' Max Draft per agreement with USCG COTP

1' UKC!!

1 degree of pitch reduces the UKC to 1 foot.

How can we predict this pitch motion and ensure a safe passage?

The Past:

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

Tue 9/4/2018 9:28 AM

CP CDIP Processing <uproc@proc.cdip.ucsd.edu>
Swell Warning - WW3 forecast

To ○ cdipsw UCSD; ○ Kip Louttit; ○ Vessel Traffic (VTS Primary Email); ○ Vessel Traffic (VTS Primary Email); ○ Swell-alert@jacobsenpilot.com

Prediction site: SP018

Date (PST)	14+ Hs (ft)	14+ Tp (secs)	14+ Dp (deg T)	Tot Hs (ft)	Tot Tp (secs)	Tot Dp (deg T)
2018-09-08 05:00 pm	2.85	22.22	176	3.25	22.22	176
2018-09-08 08:00 pm	3.08	22.22	175	3.45	22.22	175
2018-09-08 11:00 pm	3.45	20.00	175	3.74	20.00	175
2018-09-09 02:00 am	3.81	20.00	176	4.07	20.00	176
2018-09-09 05:00 am	3.77	20.00	176	4.00	20.00	176
2018-09-09 08:00 am	3.71	20.00	176	3.97	20.00	176

Prediction site: SP019

Date (PST)	14+ Hs (ft)	14+ Tp (secs)	14+ Dp (deg T)	Tot Hs (ft)	Tot Tp (secs)	Tot Dp (deg T)
2018-09-08 08:00 pm	2.92	22.22	175	3.38	22.22	175
2018-09-08 11:00 pm	3.31	20.00	175	3.71	20.00	175
2018-09-09 02:00 am	3.67	20.00	175	4.04	20.00	175
2018-09-09 05:00 am	3.61	20.00	175	4.07	20.00	175
2018-09-09 08:00 am	3.48	20.00	175	4.00	20.00	175

Site 18

Site 19
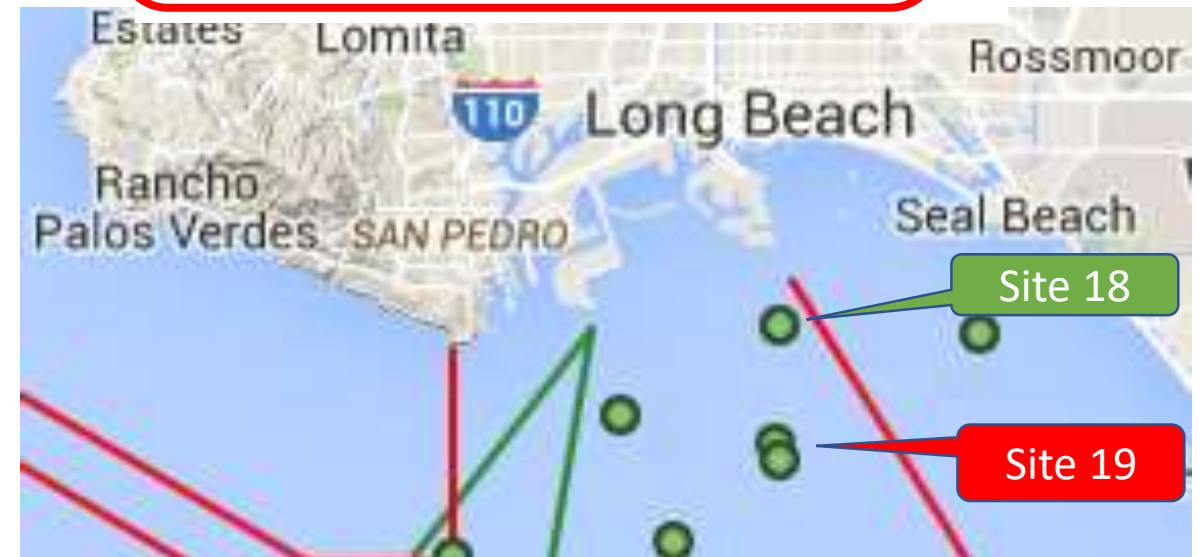
The Present: PROTIDE

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

PROTIDE is used in the following ports in the Netherlands:
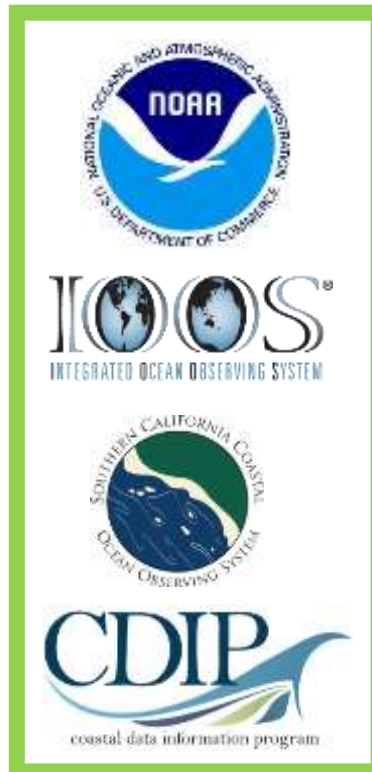Rotterdam, Amsterdam & Eemshaven
Plus: Antwerp, Belgium

Key Success Factor
UKC Feasibility Study *Memorandum of Understanding*
Signed Nov-Dec 2014

Interested Parties & Advisors

Participants

Memorandum of Understanding

Feasibility Study for Dynamic Under Keel Clearance Assurance Program

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

**& PIER 121 USERS**

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
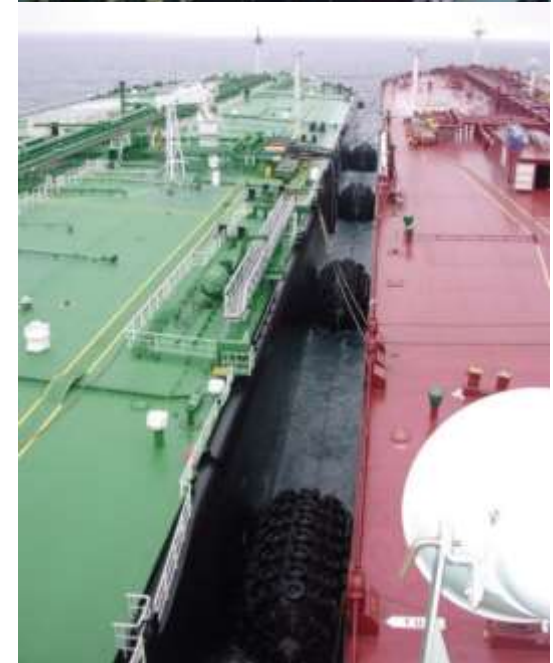
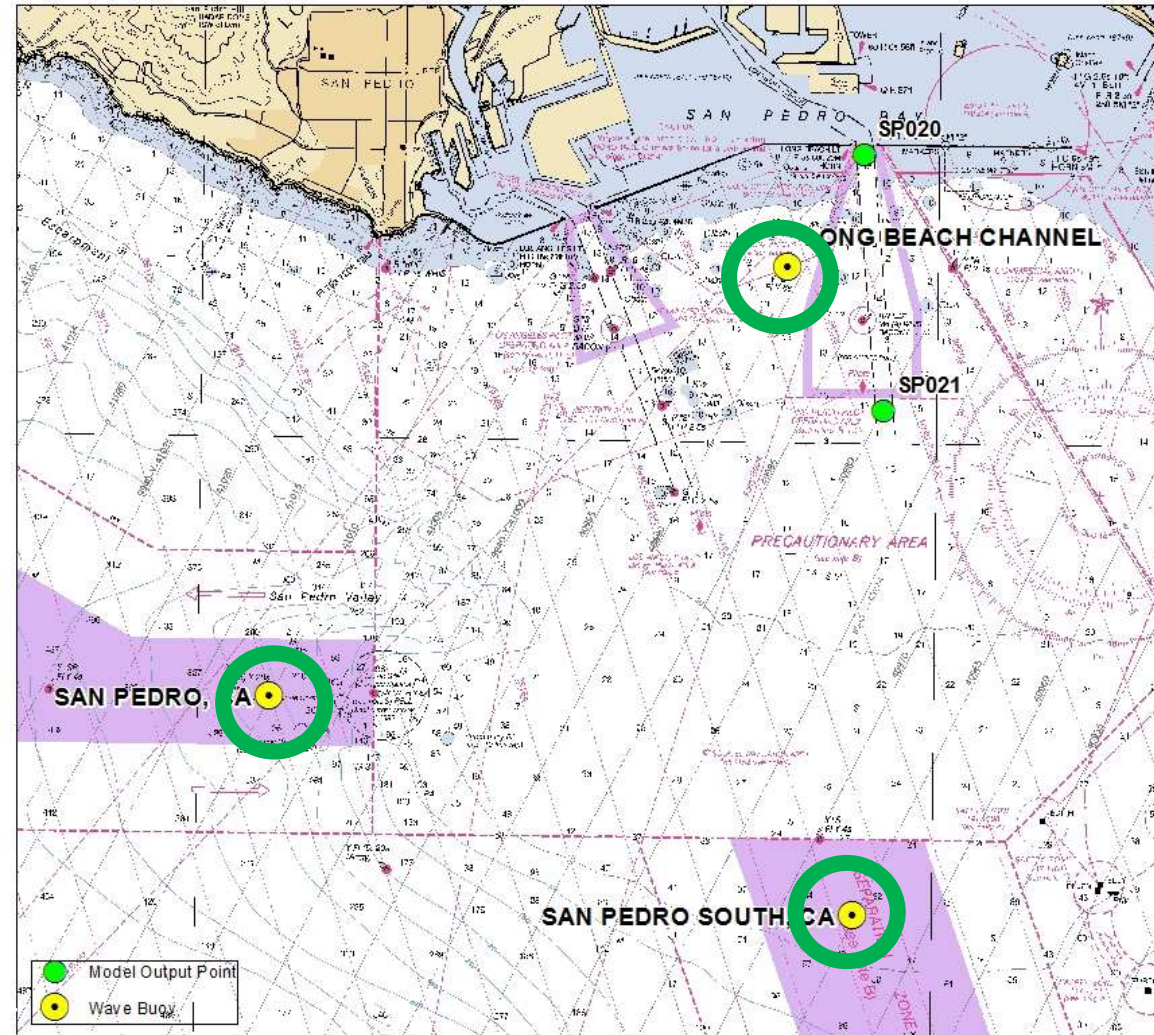# Protide only works if it has accurate environmental inputs.
Coastal Data Information Program (CDIP) Wave Buoys are critical
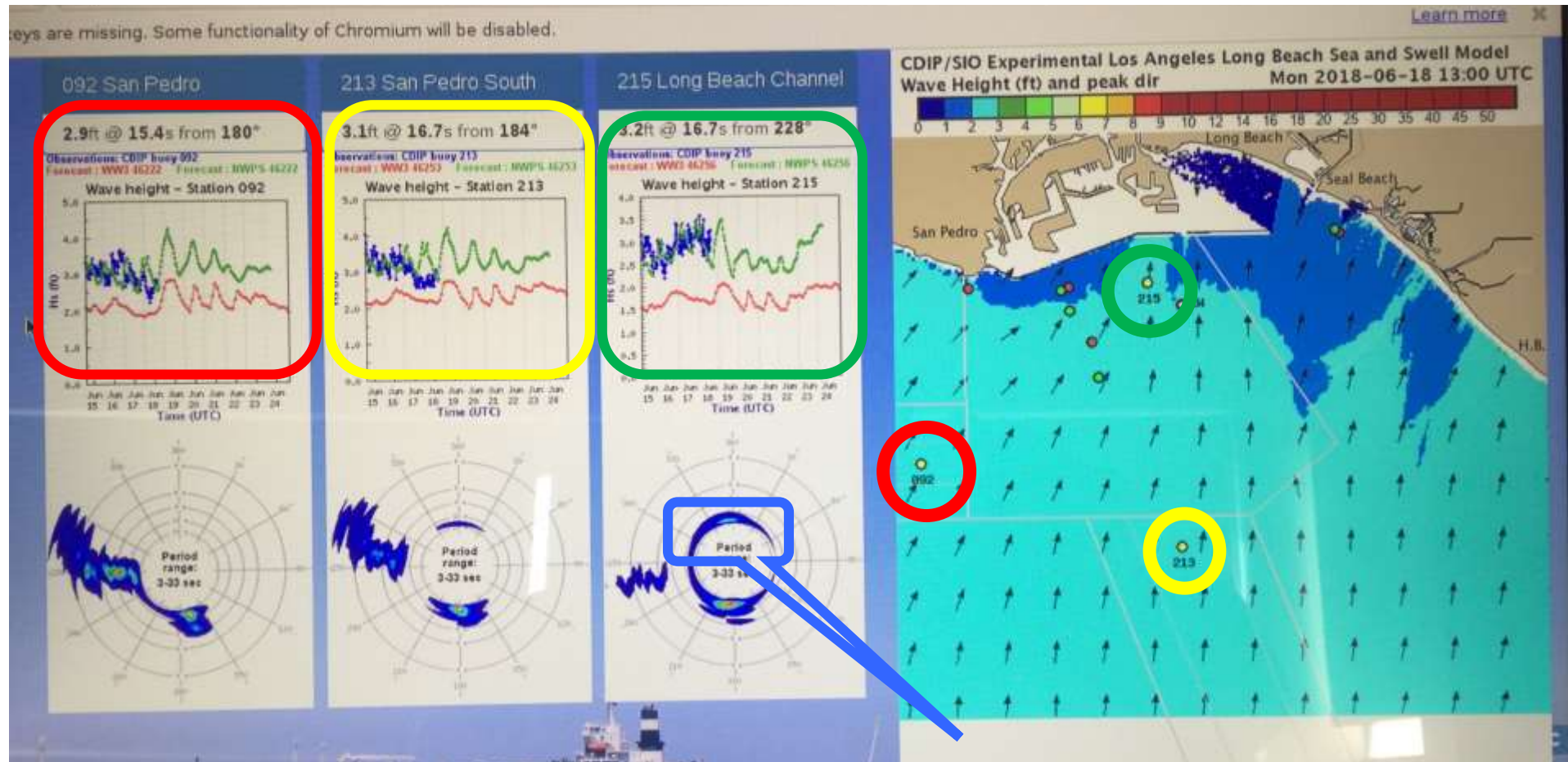### 3 CDIP Wave Buoys in local area   68 CDIP Wave Buoys around U.S.

Hourly submission

SP020

LONG BEACH CHANNEL

SP021

PRECAUTIONARY AREA

San Pedro Valley

SAN PEDRO, CA

SAN PEDRO SOUTH, CA

Model Output Point
Wave Buoy

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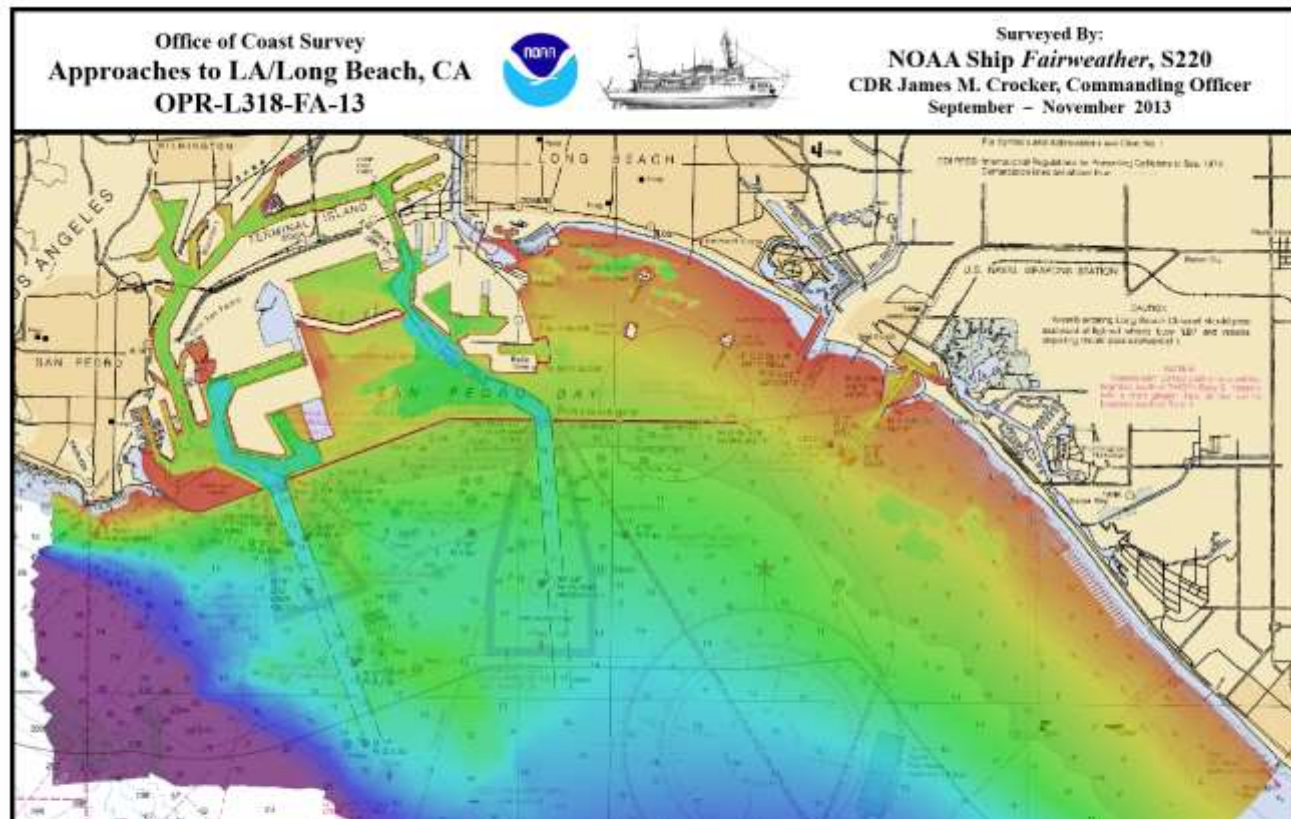

- Old Wave Watch III model under-predicts (red)
- New Nearshore Wave Prediction System (NWPS) launched 1 Jan 2017 much better (green)
- Actual buoy motion is blue

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.

Office of Coast Survey
Approaches to LA/Long Beach, CA
OPR-L318-FA-13

Surveyed By:
NOAA Ship *Fairweather*, S220
CDR James M. Crocker, Commanding Officer
September – November 2013

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

RAINIER 7 Sep in San Pedro

SURVEY STATION IN RAINIER LAUNCH

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
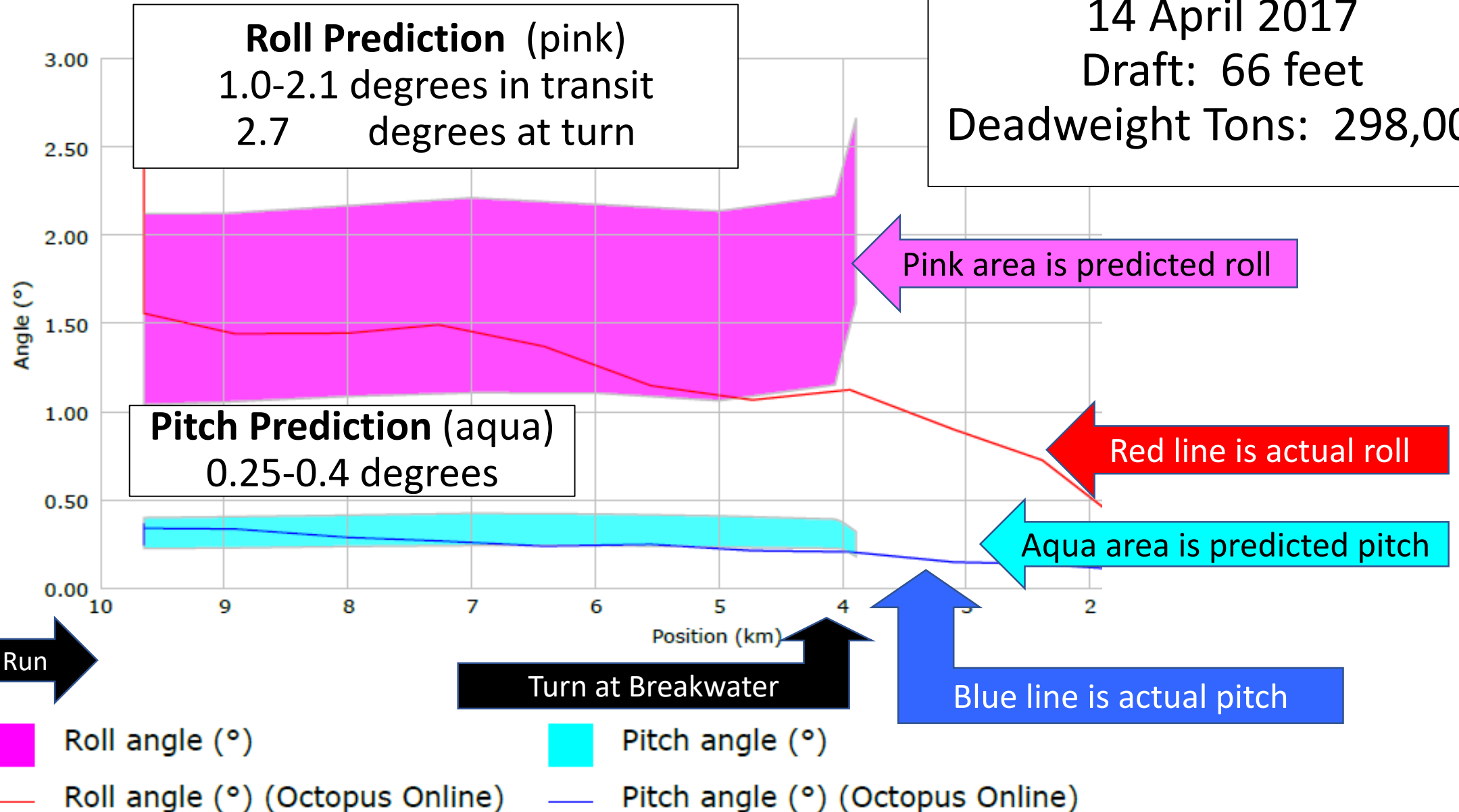 - Motion measurements recorded by laptop

"Octopus" Motion sensor

Laptop records the motion readings
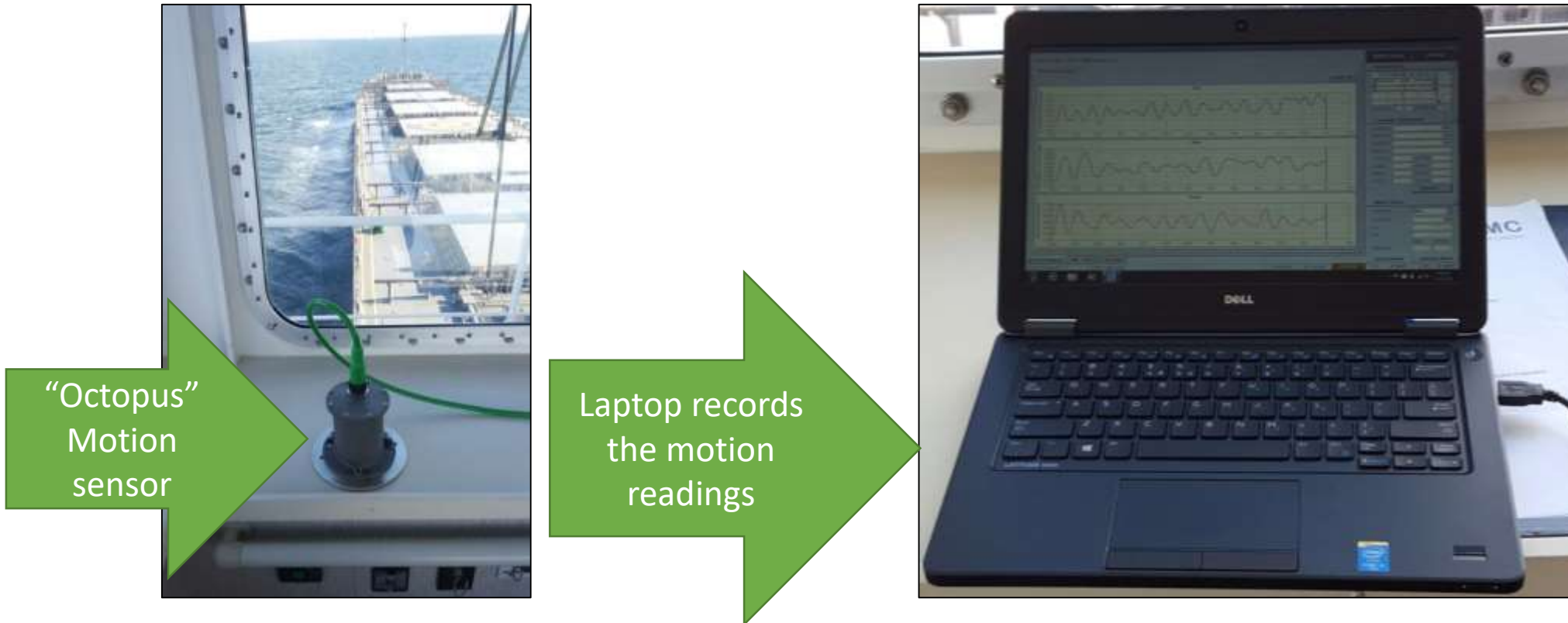
Roll and pitch angles diagram

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

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

Pitch Prediction (aqua)
0.25-0.4 degrees

Pink area is predicted roll

Red line is actual roll

Aqua area is predicted pitch

Start of Run

Turn at Breakwater

Blue line is actual pitch

Roll angle (°)

Pitch angle (°)

Roll angle (°) (Octopus Online)

Pitch angle (°) (Octopus Online)

15

Resulting UKC:

Under keel clearance curve diagram

Static UKC Prediction

Dynamic UKC prediction:
2.1 - 2.8 meters

Actual UKC 2.2 - 2.8 meters
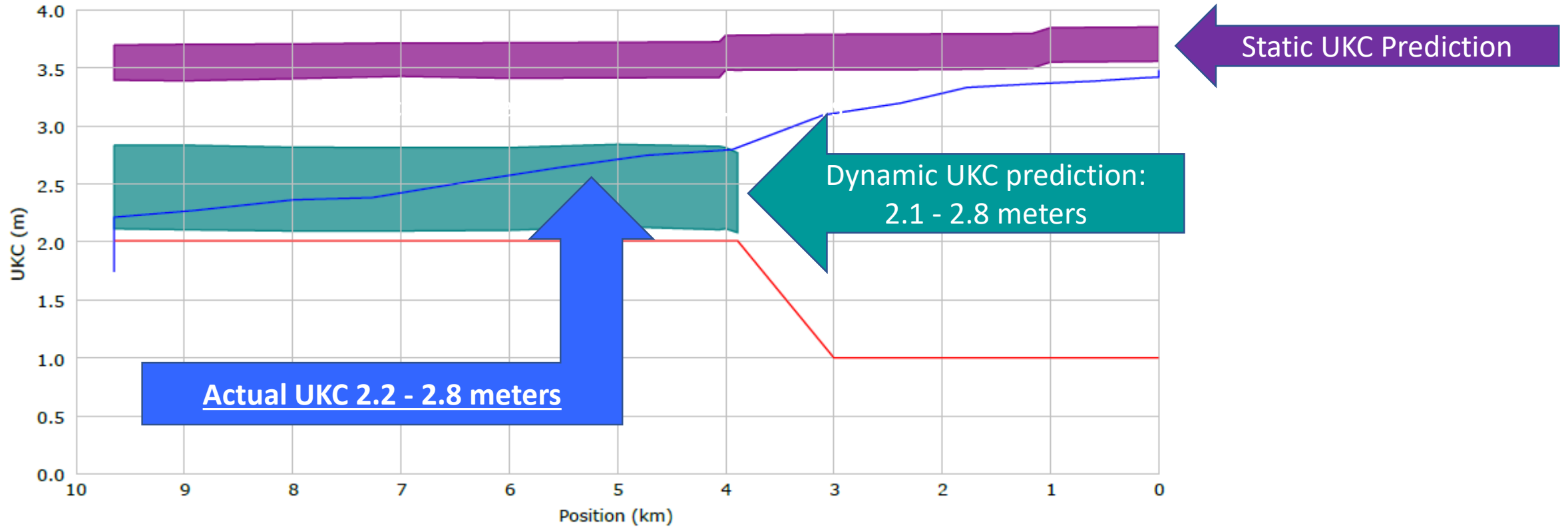
Legend:
- UKC (minus squat)
- UKC (minus vertical motion, squat)
- Safety criterion UKC (minus squat)
- UKC (minus vertical motion, squat) (Octopus Online)

Eagle Varna entering Long Beach Harbor
May 22, 2017 – 67 feet

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'

Bunga Kasturi Empat on first transit at 68 foot draft
15 November 2017

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.

Ship entering Long Beach with new cranes

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)

18,000 TEU CMA CGM Benjamin Franklin

Thank you!

Protide & Dynamic Under Keel Clearance Project:
Increase Safety
Increase Efficiency
Reduce Emissions

Backup slides

# 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
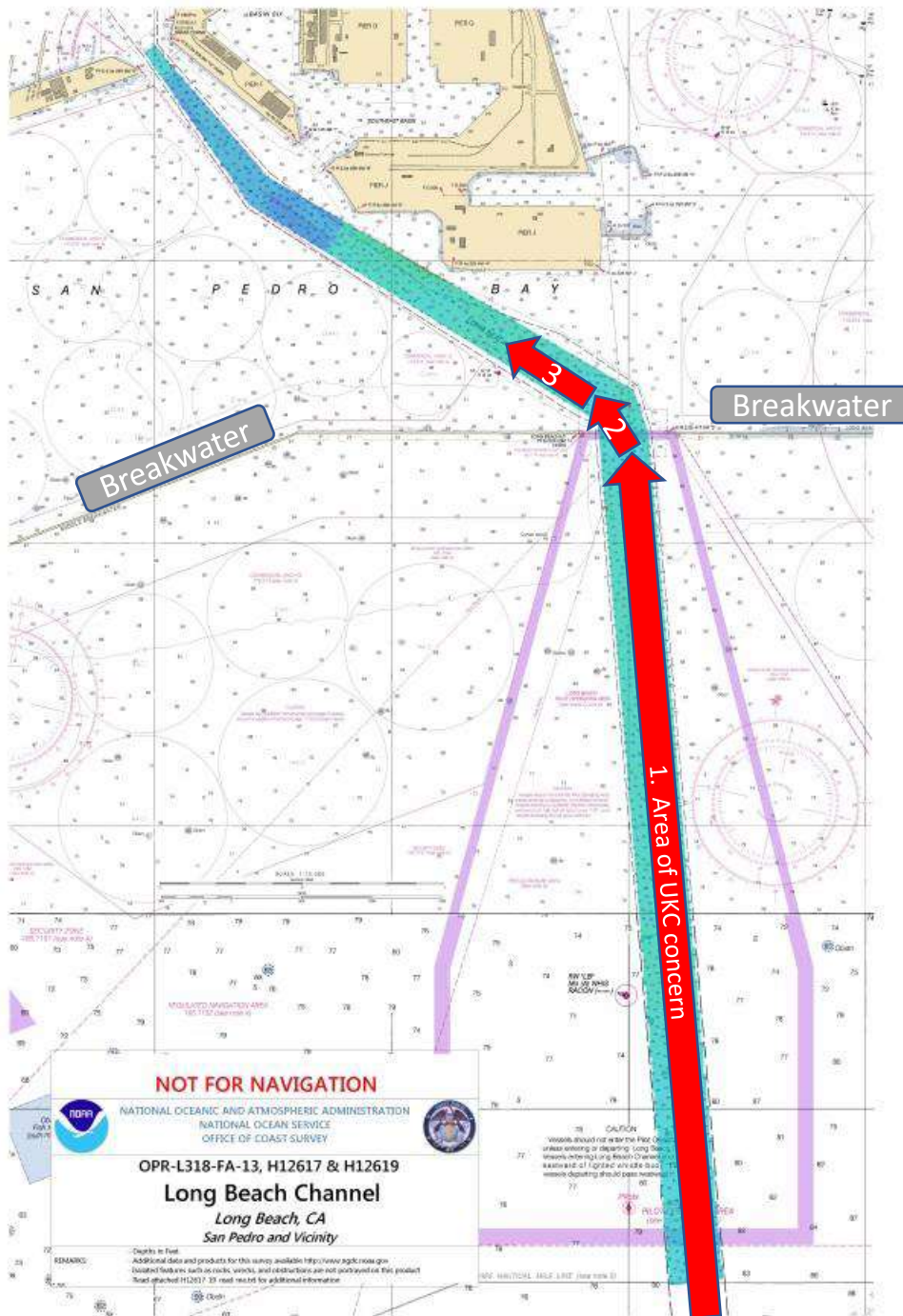
Approach to port of Long Beach…

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:

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

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

Jul 24, 2009
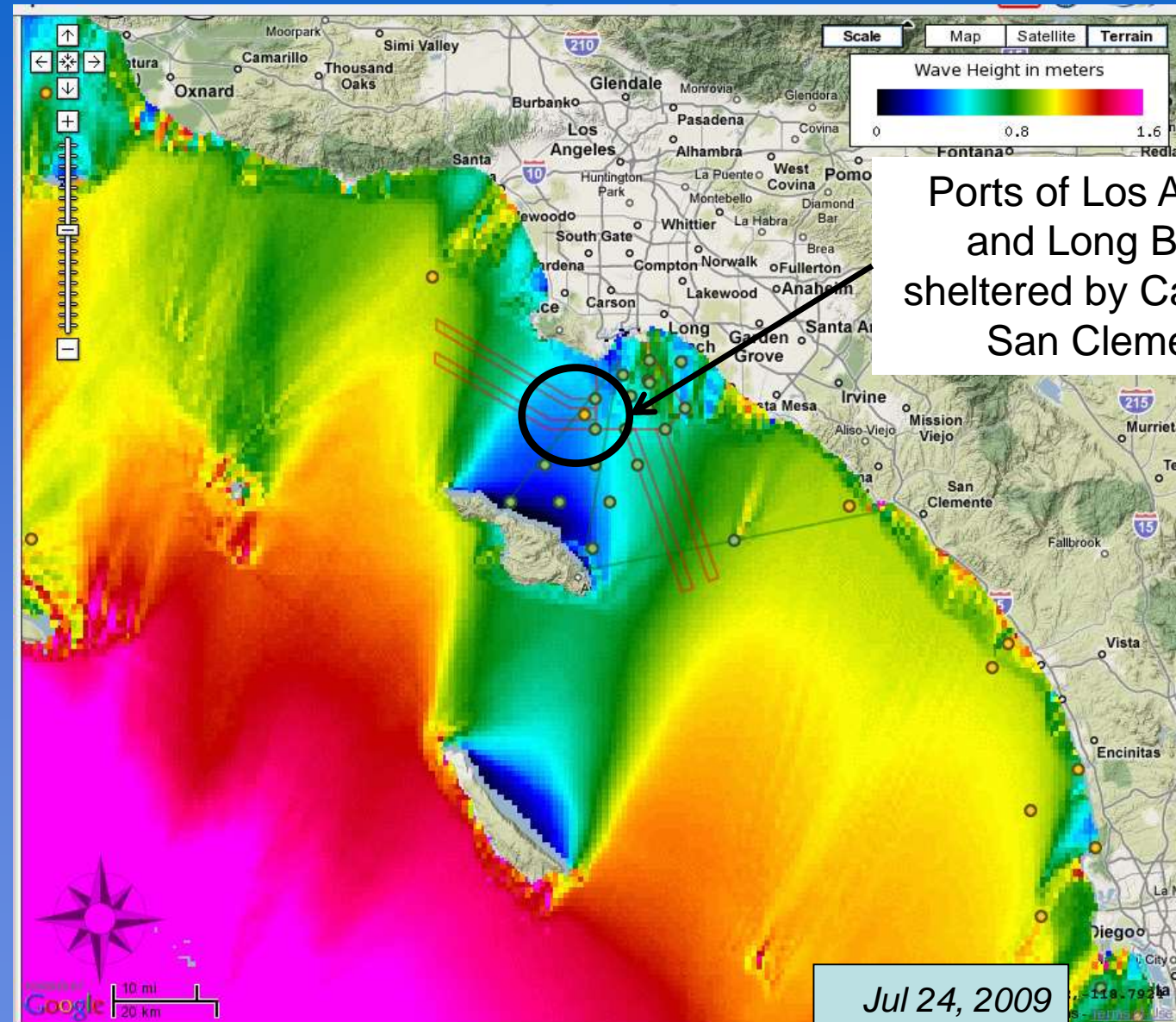
Sheltering by San Clemente & Catalina Islands

Operational Process: 2 inputs from each tanker

#1: Data Sheet

PROTIDE ARRIVAL/DEPARTURE CONDITIONS DATA SHEET
Port of Long Beach

Version 20171025

Good day Captain

Vessels with a draft greater than 16.7m are required to provide stability information prior to transiting within the POLB.

The following condition values should be submitted for:

Arrivals: Please provide values for your vessel at the arrival to the Long Beach Pilot Station.
Departures: If you vessel's draft will remain greater than 16.7m, please provide values for your vessel at departure from berth or anchorage.

Provide as accurate information as possible as well as a snapshot of the stability program results from the loading computer showing these values.

Ship Details

IMO number:	
Ship name:	
Call sign:	
Ship type:	
Length overall (m):	
Length between perpendiculars (m):	
Beam (m):	
Maximum design dead weight:	
Draft forward (m):	
Draft middle (m):	
Draft aft (m):	

Optional Details

Maximum design draft (m):	
Light ship / light displacement:	
Maximum water displacement:	

Load specific data

Water displacement:	
(Solid transverse) metacentric height (m):	
Free fluids surface correction, GG' (m):	
Roll period (s):	

Optional load specific parameters

Current deadweight (t):	
Center of gravity cargo / KG cargo (m):	
Distance keel to bridge (m):	
Distance aft perpendicular to bridge (m):	

Have you provided a stability snapshot?

Once completed, click 'Submit by Email' below, then attach stability snapshot to the generated email and send to: Protide@mxsocal.org

Submit by Email

#2: Snapshot of Stability Program Results from Loading Computer

DEAD WEIGHT	277223.7	Mt
LIGHT WEIGHT	42843.6	Mt
DISPLACEMENT	320067.3	Mt
LCG	174.638	m
TCG	0.006	m
LCB	174.638	m
MTC	3965.453	Mt-m
TPC	177.112	Mt/cm
LCF	162.745	m
SEA S/G	1.0250	t/m3

DRAFT	at Perpendiculars	
EQUIVALENT	20.235	m
FORE	20.245	m
MEAN	20.235	m
AFT	20.224	m

Trim	-0.020	m
Heeling Angle	0.049	deg.
Propeller immersion ratio	188.697	%
KMT	25.204	m
VCG	16.029	m
GM	9.175	m
GGo	1.677	m
GoM	7.498	m
Vert. Moment	5130351.694	Mt-m
FS. Moment	536739.758	Mt-m

Advice - Bunga Kasturi Empat - Average

Planned start of transit

Example Protide pre-transit "Advice"

White areas Not safe

Low Tide

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.

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
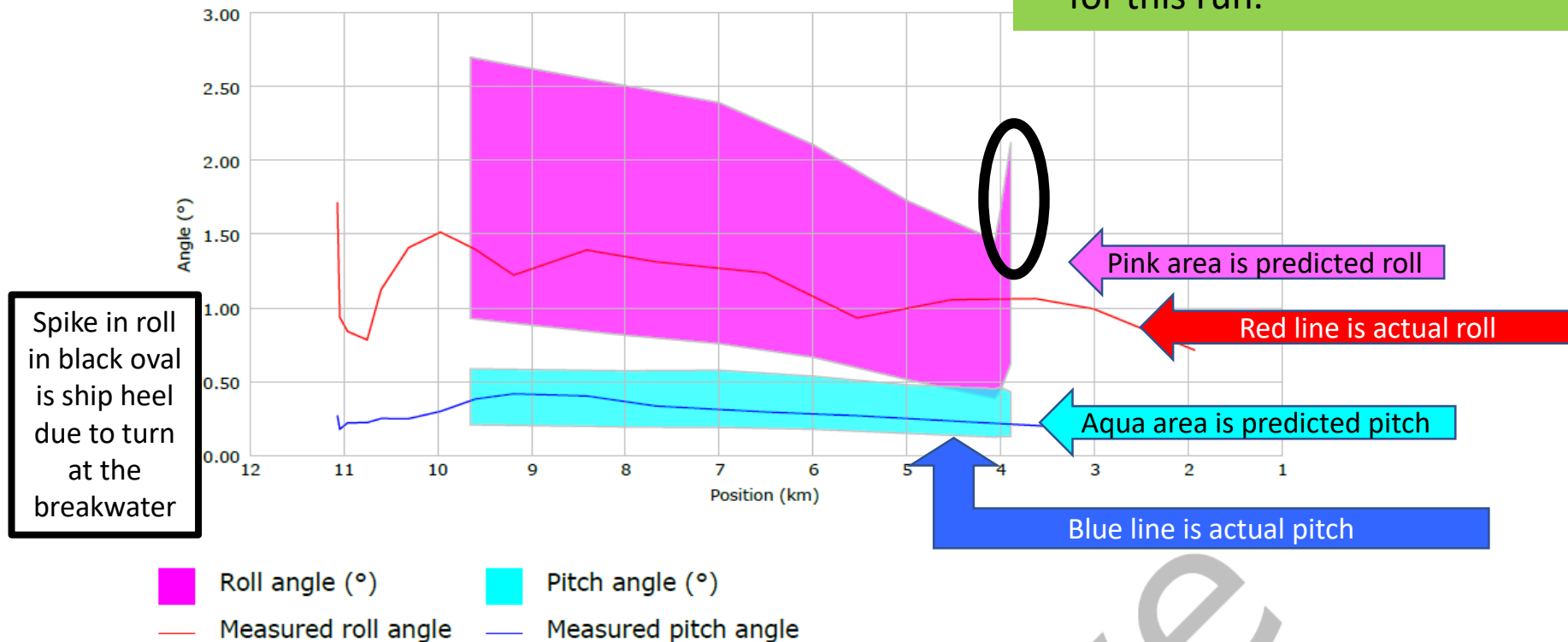
LOA 1092 feet   Beam 196 feet
Draft 64.9 feet   320,137 DWT
Transit at mean lower low water

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

Roll and pitch angles diagram

Pink area is predicted roll

Red line is actual roll

Aqua area is predicted pitch

Blue line is actual pitch

Spike in roll in black oval is ship heel due to turn at the breakwater

■ Roll angle (°)   ■ Pitch angle (°)
— Measured roll angle   — Measured pitch angle

Point of Contact:

CAPT Kip Louttit
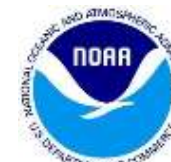**USCG, Retired**
Project Manager, Dynamic UKC Project

Executive Director, MX SoCal & VTS LA/LB
San Pedro, CA

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