MITAGS-PMI
MARITIME INSTITUTE OF TECHNOLOGY & GRADUATE STUDIES / PACIFIC MARITIME INSTITUTE

THE LEADERS IN MARITIME TRAINING

MARITIME INSTITUTE OF TECHNOLOGY & GRADUATE STUDIES / PACIFIC MARITIME INSTITUTE

Full-Mission Ship Simulation for Port Design Validation and Optimization

AAPA Harbors & Nav. Committee

WTC Baltimore

Oct 2, 2019

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MITAGS is internationally certified as a Maritime Simulation & Training Center by Det Norske Veritas

Maritime Institute of Technology and Graduate Studies Campus (MITAGS), Linthicum Heights, MD (Near BWI Airport)

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PMI Campus – Seattle, Washington State

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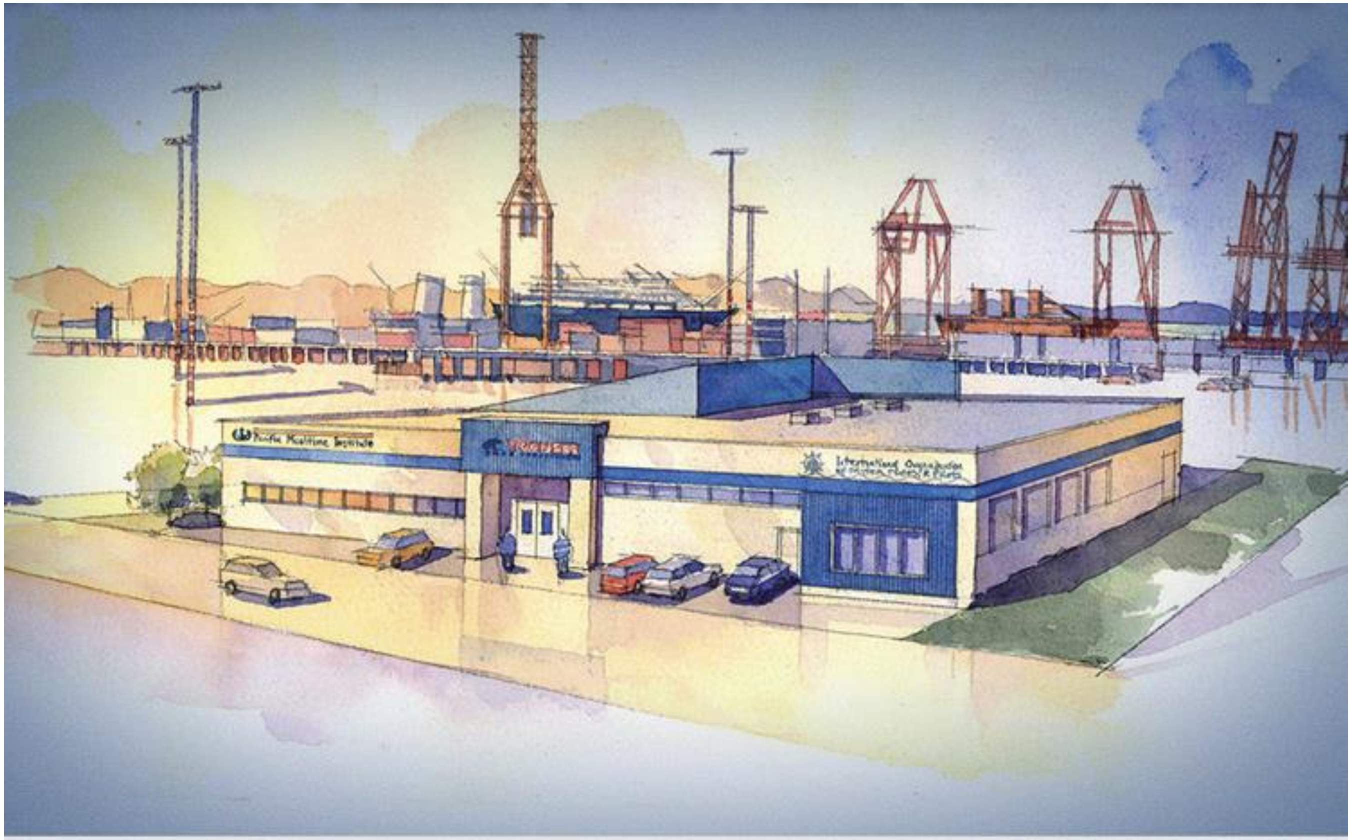

Experience

U.S. Ports	International	Canadian Organizations
• Seattle • Tacoma • Dutch Harbor • LA/Long Beach • Miami • Savannah • Charleston • Virginia • Maryland • NY / NJ • Philadelphia • Wilmington • Houston • Corpus Christi • Brownsville	• Costa Azul, Mexico • Itapoa, Brazil • T1 and T2 Acu, Brazil • Rio de Janeiro, Brazil • Sudeste, Brazil • Itaguai, Brazil • Columbo, Sri Lanka • Antofagasta, Chile • Bermuda • Bahamas • Mexico • Columbia	• Vancouver • Prince Ruppert • Saint Johns • Pacific Pilotage Authority **Escort Training** • BC Pilots • SMIT Towing • SEASPAN • BC Ferries

Uses of Ship Simulation

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Simulation has gained acceptance world-wide for assisting port designers, engineers, pilots, tug / ship operators for:

- Validating competing channel and terminal designs.
- Optimizing turning basin and channels dimensions.
- Establishing the ports maximum environmental operating limits (wind, current, sea) by vessel class.
- Determining tug package (#, size, type, location, etc.).
- Developing standard operating and emergency procedures.
- Collision / allision accident investigations.
- Pilot / tug master familiarization and establish new protocols.

Full-Mission Ship Simulation Projection Screen

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MITAGS FMSS Bridge #1

Assist Tug Bridges Integrated with FMSS

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Purpose Built Assist Tug Bridges (MITAGS)

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Hydrodynamic Ship Modeling

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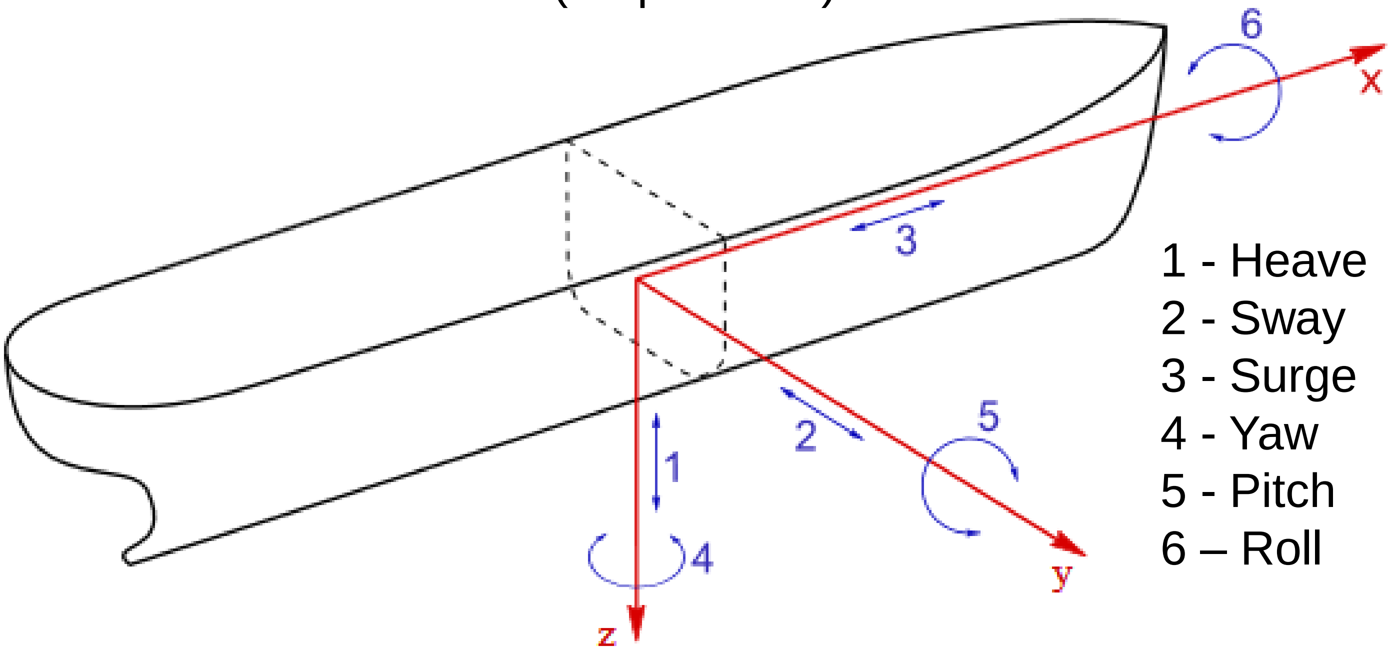
Six Degrees of Freedom
(Ship Motion)



1 - Heave
2 - Sway
3 - Surge
4 - Yaw
5 - Pitch
6 – Roll

Example of ULCV and Assist Tugs General Dimensions

Amaersk, Kalina, and Emma models were programmed with original source data provided by the ship operators for this and previous tests.

Simulator behaviors were also reviewed by company representatives and shiphandling experts on the MITAGS team from this and previous tests.

With the exception of the Montana, all models use a full load profile for wind area.

Ship Models	A Maersk	Container Ship Montana	MSC Kalina Class	Emma Maersk (Cont 22)	Assist Tug Robert Allen Z-Tech
Bridge Location	Aft	Aft	Forward	Mid	n/a
Displacement Loaded (tonnes) at 14m draft	129,527	116,692	188,981	164,858	n/a
Wind Area Loaded	8,241 m^2	10,033 m^2	14,171 m^2	14,805 m^2	n/a
Length (meters)	352 (1155’)	350 (1,148’)	366 1,200	397 (1,302)	30
Beam	43 (141’)	49 (161’)	51.2 (168’)	56 (184’)	12
Trim	even	even	even	even	even
Load Draft	14 (39’-04”)	14	14	14	5
Other Draft	n/a	12 and 13	12 and 13	n/a	n/a
Engine kW and Propeller	Low Speed Diesel, Single Screw, FPP	Low Speed Diesel, Single Screw, FPP	Low Speed Diesel, Single Screw, FPP	Low Speed Diesel, Single Screw, FPP	Two, high speed diesels
Bow Thrusters	One, 2220kW	One, 2200 kW	two, 1700kW each	two, 1750 kW each	n/a
Stern Thrusters	Two, 1110kW	Two, 1110 kW	n/a	two, 1750 kW each	n/a
Rudder Type	Semi suspended	Semi suspended	Semi suspended	Semi suspended	ASD 60 tons

Minimum Tug Forces for Holding and Controlling

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	Load Condition	Windage Area (m2)	Wind Velocity (knots)	Wind Force (N)	Wind Force (t)	Current Velocity (knots)	Current Force (N)	Current Force (t)	Required Effective Bollard Pull (t)
Container Kalina_Miami	Loaded (14m)	14171	15	425661.4	47.85	0.00	0.00	0.00	74.6
House Forward			20	756731.4	85.06	0.00	0.00	0.00	132.7
Block Coef: 0.74			25	1182392.8	132.91	0.00	0.00	0.00	207.3
(366 x 51.2 meters)			30	1702645.7	191.39	0.00	0.00	0.00	298.6
Container AMaersk	Loaded (14m)	8241	15	278133.8	31.27	0.00	0.00	0.00	48.8
Aft House			20	494460.0	55.58	0.00	0.00	0.00	86.7
Block Coef: 0.63			25	772593.8	86.85	0.00	0.00	0.00	135.5
(352.2 x 42.8 meters)			30	1112535.0	125.06	0.00	0.00	0.00	195.1
Container Montana_Miami	Loaded (14m)	10033	15	345386.0	38.82	0.00	0.00	0.00	60.6
Aft House			20	614019.6	69.02	0.00	0.00	0.00	107.7
Block Coef: 0.59			25	959405.6	107.85	0.00	0.00	0.00	168.2
(350 x 49 meters)			30	1381544.1	155.30	0.00	0.00	0.00	242.3
Container Emma Maersk	Loaded (14m)	14805	15	444705.2	49.99	0.00	0.00	0.00	78.0
Aft House			20	790587.0	88.87	0.00	0.00	0.00	138.6
Block Coef: 0.62			25	1235292.2	138.86	0.00	0.00	0.00	216.6
(397 x 56 meters)			30	1778820.8	199.96	0.00	0.00	0.00	311.9
Container Arthur Maersk	Loaded (12m)	7700	15	236486.3	26.58	0.00	0.00	0.00	41.5
Panamax			20	420420.0	47.25944	0.00	0.00	0.00	73.7
Block Coef: 0.58			25	656906.3	73.84288	0.00	0.00	0.00	115.2
(292 x 32.2 meters)			30	945945.0	106.33	0.00	0.00	0.00	165.9

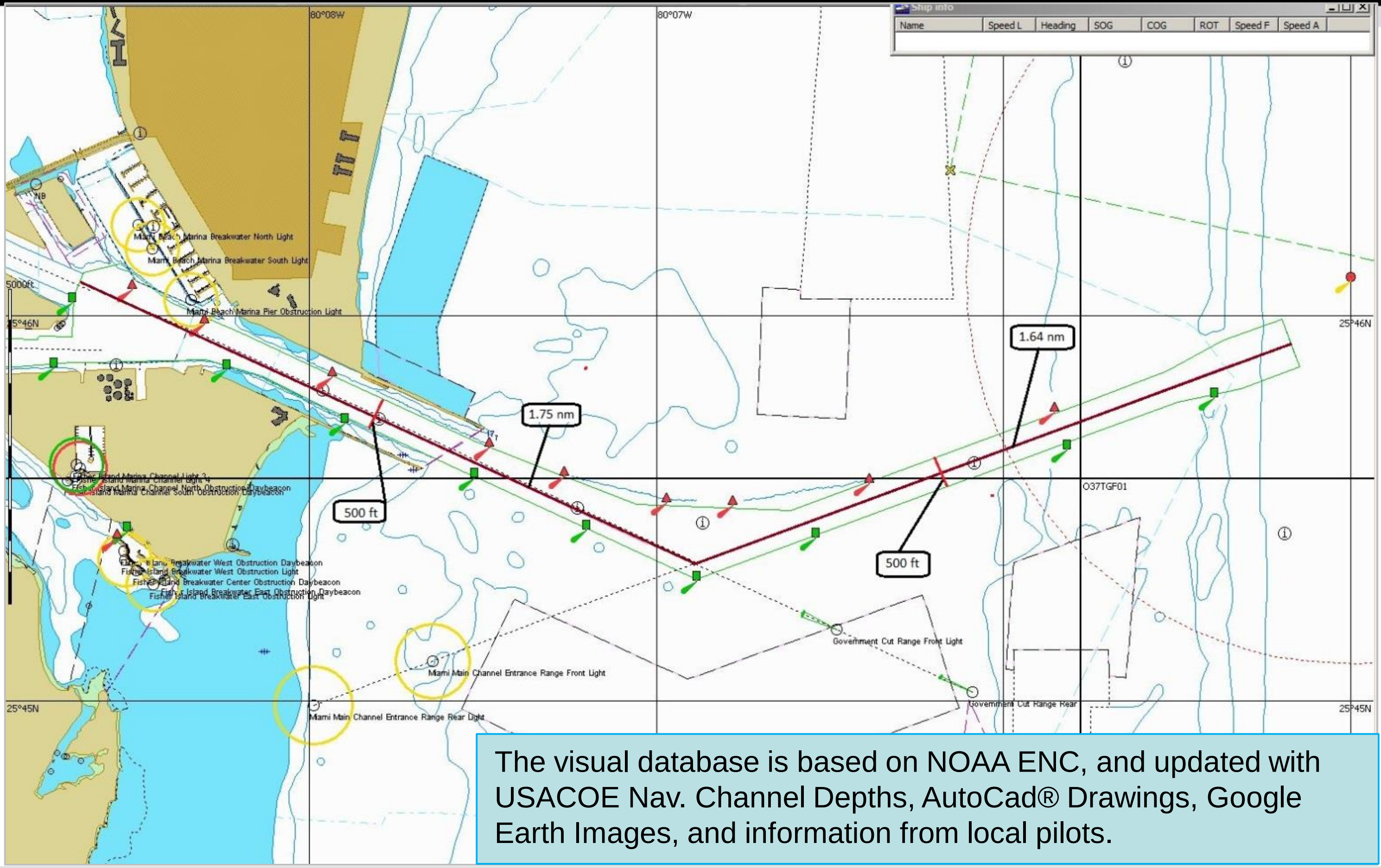
**Formulas Used

Thoresen, C. (2003). Tugboat Assistance. In *Port designer's handbook recommendations and guidelines*. London: Thomas Telford.

Wind Force = 0.5 x Cy x 1.2 (air density) x Wind Velocity^2 x Windage Area
Current Force = Rule of 1:30 was used. For every 1 knot of current, the force exerted will be equal to that exerted by 30 knots of wind
Required Effective Bollard Pull = Sf x [(Wind Force x Fg) + Current Force], where Sf = Tugboat bollard pull factor = 1.3, Fg = gust factor = 1.2
Newton-to-Ton Conversion Factor = 1 ton/8896 Newton

At 30 knots of wind, it takes 300 tons of bollard pull for the 14,000 TEU MSC Kalina versus 167 for Panamax Class Arthur Maersk.

Visual Database Programming

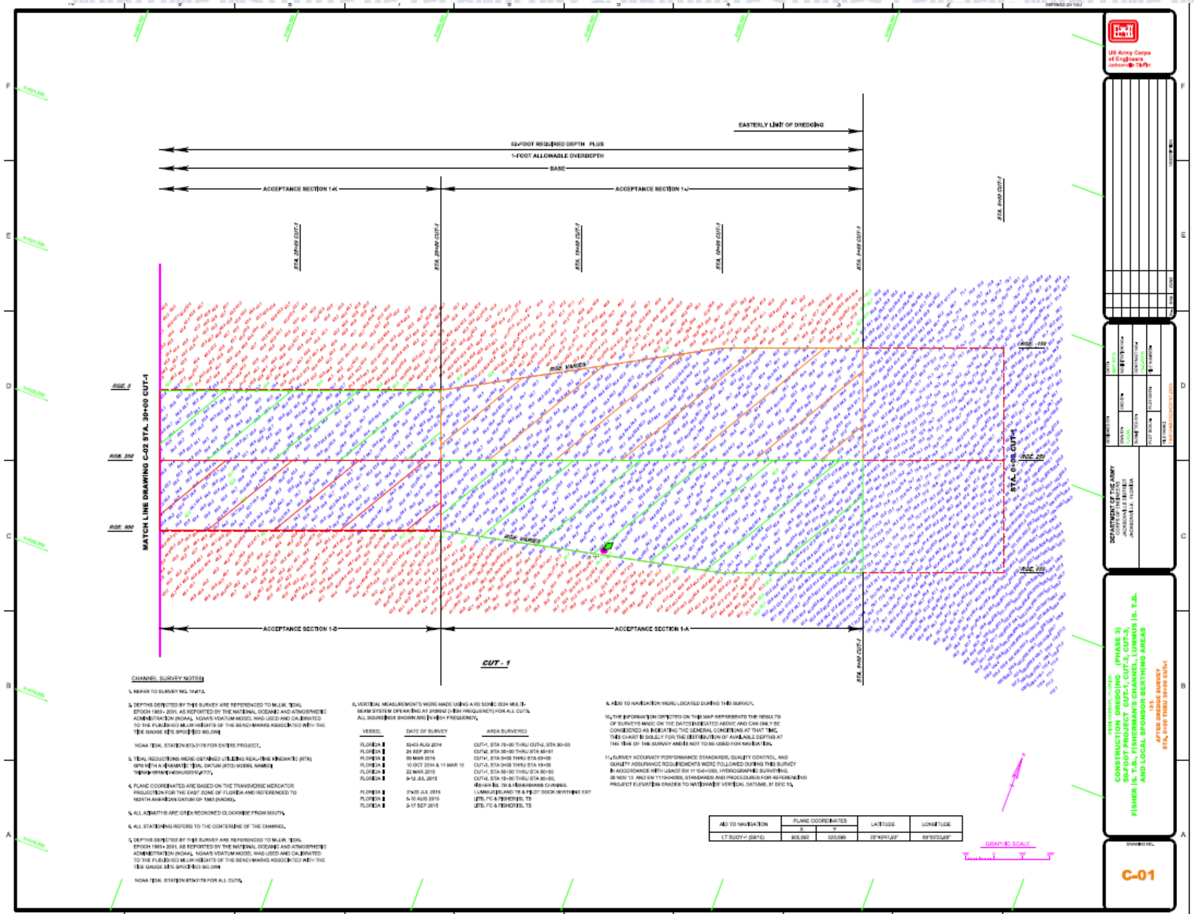


The visual database is based on NOAA ENC, and updated with USACOE Nav. Channel Depths, AutoCad® Drawings, Google Earth Images, and information from local pilots.

Depth Soundings in the Navigation Channels

The depth profiles of the navigation channel are based on government or private surveys.

This data is used to enhance the accuracy of the depth soundings and bank slopes.



Visual Database Programming

Graphic Fidelity

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Lift Bridges and Underwater Projections

Water Current Modeling

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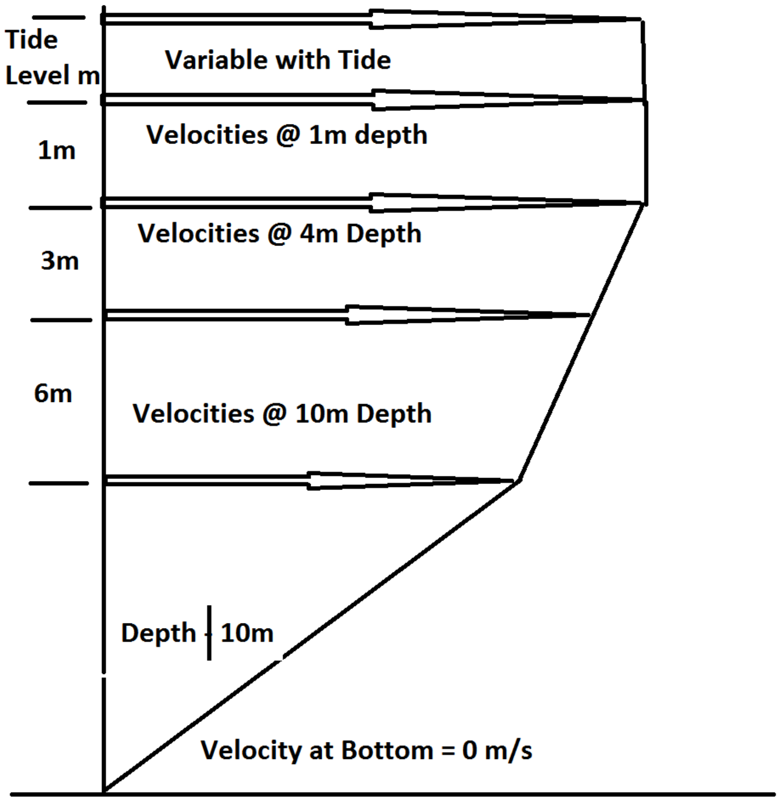
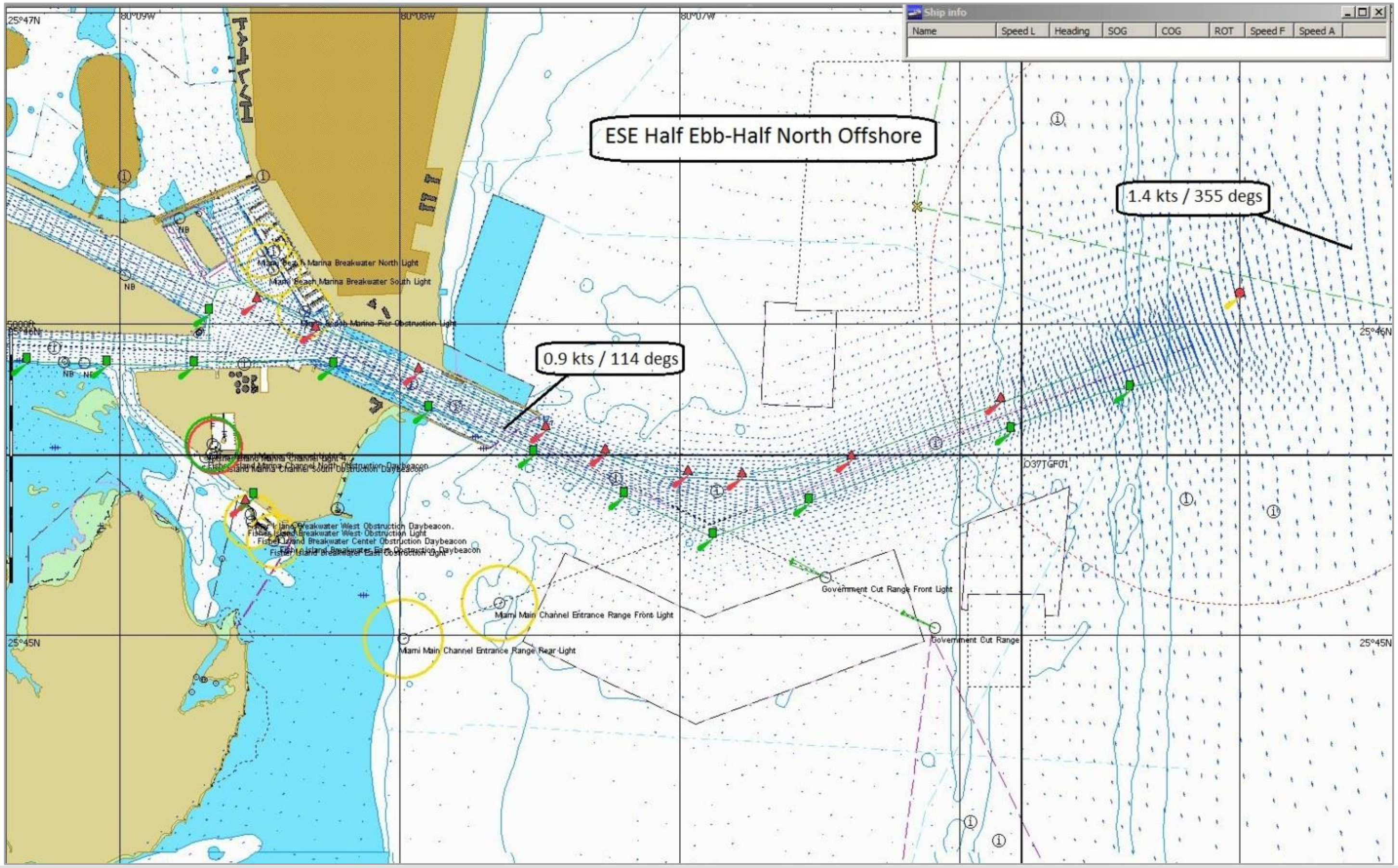


Water current velocities and directions throughout the water column are depth averaged,

or

3-D currents depending on the simulation objectives.

Current Model Integration



Current Model Fidelity

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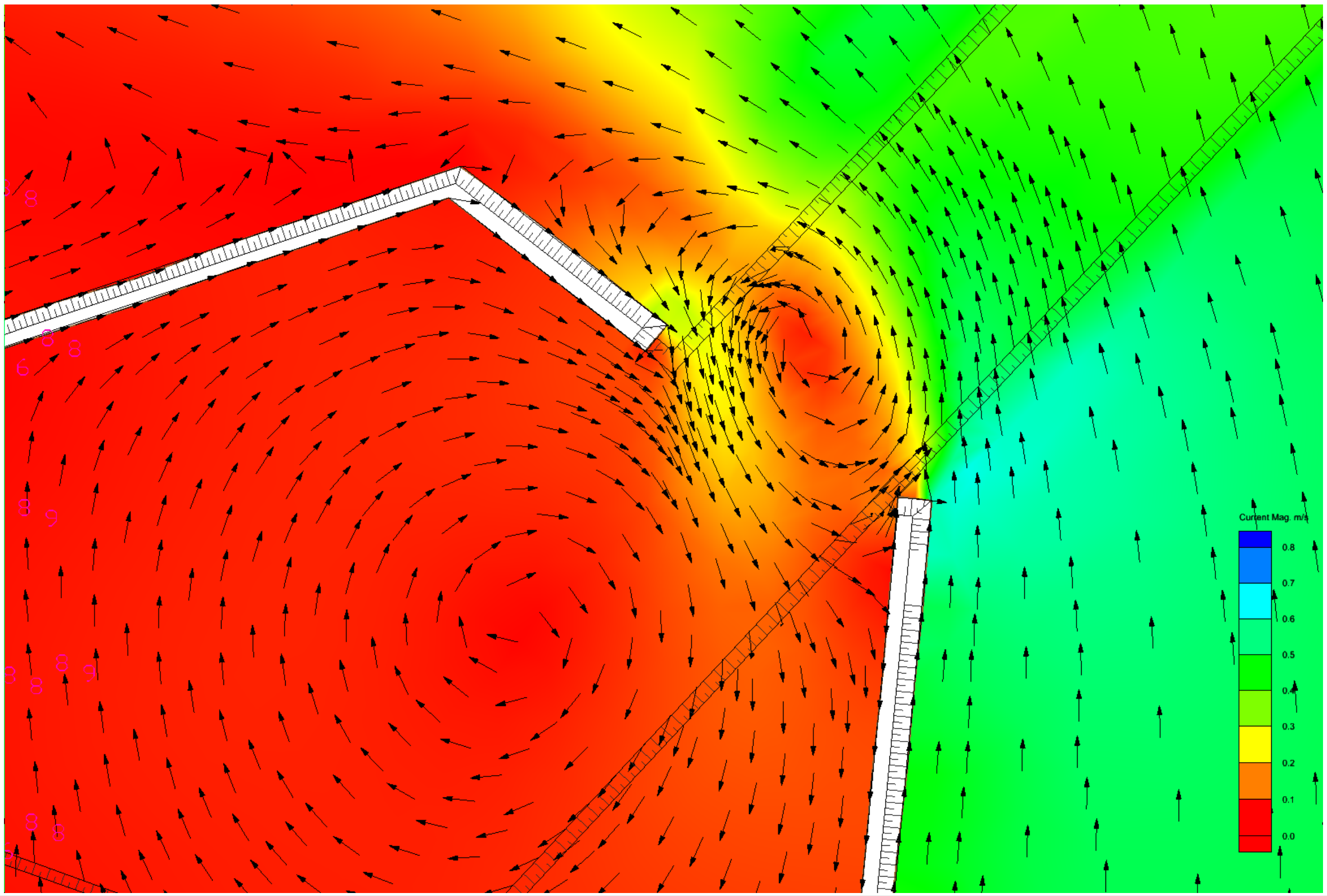
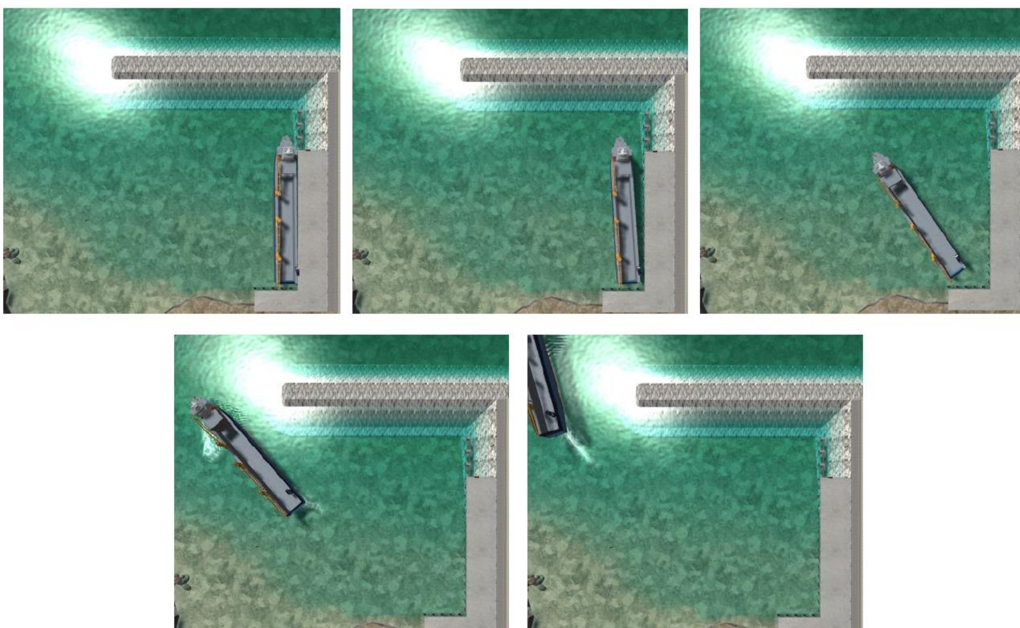


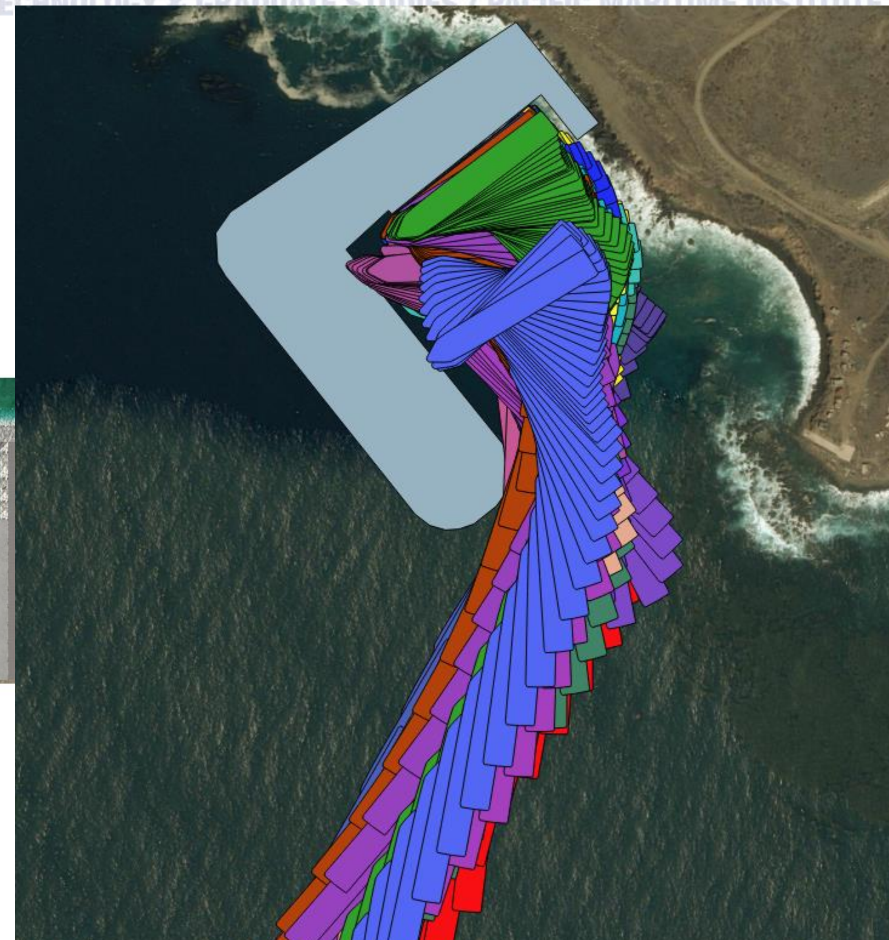
Simulation Analysis and Output

Output used in several ways:

- Determine limiting environmental conditions
- Determine maneuvering strategies/tug configurations
- Determine if channel modifications need to be made via swept path analysis



Maneuvering strategy



Swept path analysis

Swept Path with Google Earth® Overlay

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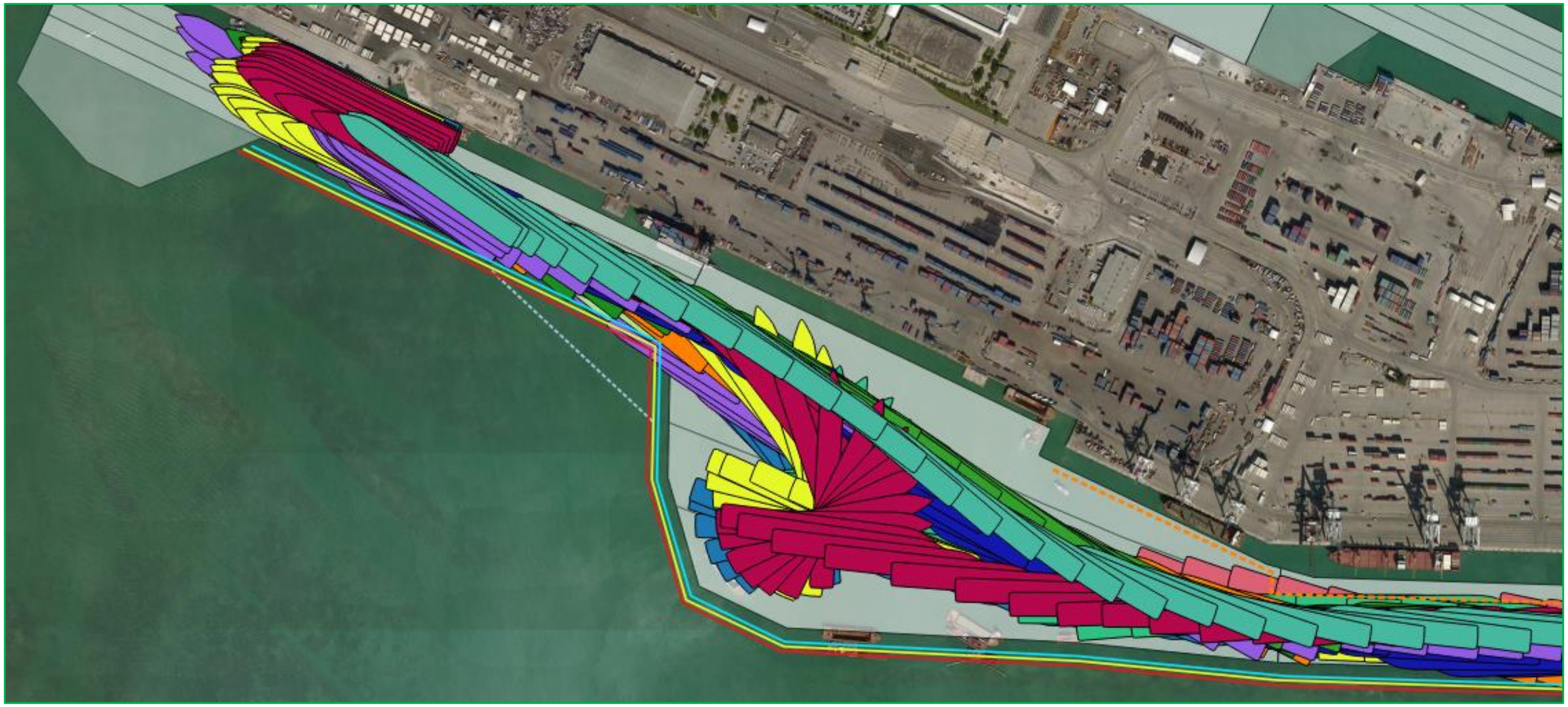

Tug & Thruster Analyses

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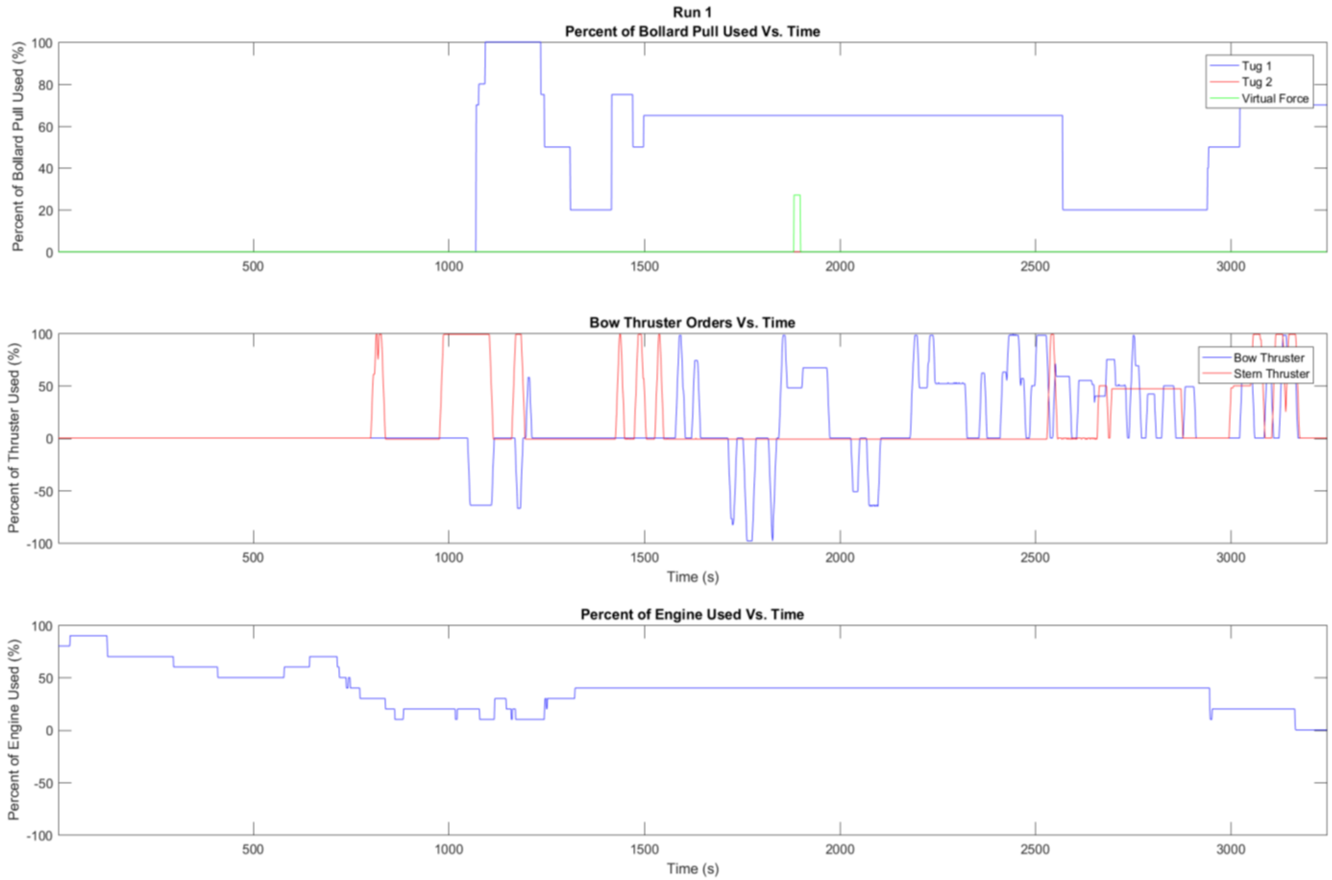
Run	Transit Dir.	Power Used at 100% Simultaneously?			Tug 1 Z-Tech 8500 Bollard Pull		Tug 2 Z-Tech 8500 Bollard Pull		Virtual Force 85 t			Bow Thruster		Stern Thruster		Ship's Engine	
		All Sources ?	Both Tugs?	Dur. (sec)	Max (%)	Dur. (sec)	Max (%)	Dur. (sec)	Max (%)	Dur. (sec)	Virtual Force Used in Place of	Max (%)	Dur. (sec)	Max (%)	Dur. (sec)	Max (%)	Dur. (sec)
1	In	No	No	--	100	143	0	--	27	--	Tug 2	99	15	99	116	90	--
2	Out	No	No	--	5	--	65	--	47	--	Tug 1	99	310	100	231	50	--
3	In	No	No		100	41	80	--	--	--	--	99	170	100	63	60	--
4	In	No	No	--	75	--	75	--	--	--	--	99	60	99	169	70	--
5	In	No	No	--	100	142	100	19	100	9	Tug 1 & Tug 2	98	29	100	49	60	--
6	Out	No	No	--	0	--	75	--	100	564	Tug1	99	293	100	73	70	--
7	In	No	No	--	80	--	100	31	--	--	--	99	185	100	66	70	--
8	In	No	No	--	75	--	80	--	--	--	--	99	204	99	226	80	--
9	Out	No	No	--	75	--	0	--	100	270	Tug 2	99	328	100	307	70	--
10	In	No	No	--	80	--	75	--	--	--	--	99	109	99	46	70	--
11	In	No	No	--	80	--	80	--	97	--	Tug 1 and 2	99	114	100	192	70	--
12	Out	No	No	--	75	--	80	--	--	--	--	99	394	100	342	70	--
13	Out	No	No	--	75	--	75	--	--	--	--	99	87	100	69	50	--
14	Out	No	No	--	80	--	55	--	--	--	--	99	105	100	102	100	488

Tug Power Graphs



Thank You

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