HR Wallingford
Working with water

Genoa breakwater

Navigation simulation study

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Project manager	Terry Stewart
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1. Introduction

The Port of Genoa is one of the main ports in Italy. Situated in the north-west of the country, the port is part of the Western Ligurian Sea Port Authority (AdSPdMLO). The port deals with both passengers and cargo: 4.5 million passengers, 2.7 million TEUs and 15.3 tons of general cargo in the 2019.

According to Italian law (n.130/2018), which was issued to relaunch Genoa's infrastructure after the collapse of the Morandi's Bridge, interventions need to take place to assure the economic recovery of the region. To this extent, the port is preparing to accept Ultra Large Container Ships (ULCSs) with the construction of a new breakwater and development of the port infrastructure.

As part of the development plan for the port, different layouts have been selected as possible solutions to increase the port capacity. The AdSPdMLO commissioned the RTP (*Raggruppamento temporaneo dei progettisti* - Temporary grouping of the designers) to undertake the economic and technical feasibility study. HR Wallingford, as part of the RTP, was commissioned to undertake a ship navigation study to identify the advantages and disadvantages of the alternative solutions under consideration from a navigation perspective.

As part of the navigation simulation study, a 5 day duration simulation session was held at HR Wallingford's UK Ship Simulator Centre (UKSSC) from 21st to 25th September 2020, which examined manoeuvres at the Port of Genoa for three alternative layouts.

Figure 1.1: Existing layout – view from Levante Entrance

Source: HR Wallingford UK Ship Simulator Centre

2. Background to the study

2.1. Proposed solutions

Different solutions were identified to allow ULCSs to call at the Port of Genoa. After an economical and technical review and various consultations with the Harbour Masters, Coast Guard and the Chief Pilot, these solutions were reduced to three and were approved by the AdSPdMLO on the 21st April 2020.

Following analysis of the berth downtime, a minor variation on the layouts was made to reduce the wave agitation inside the port and at the entrance. These revised solutions (Figure 2.1 to Figure 2.3) were then included in HR Wallingford's ship simulation system in July 2020 and used for the simulation study described in this document.

In Solutions 2 and 3, the main access to the port is from the east (*levante*), while in Solution 4 the main access is from the west (*ponente*). There were two phases defined for each of the solutions, providing a total of six layouts to be considered in the navigation simulation study.

The three solutions were mainly characterised by a new turning circle (Phase A) and the widening of the Sampierdarena Basin (Phase B). Several elements differ from Phase A to Phase B. In Phase B, the Sampierdarena Basin is widened to 400m, the existing berths in the Sampierdarena Basin are reclaimed to create a continuous quay for the ULCSs with an orientation of 165-345°N and restrictions from the nearby airport are removed.

The length of the approach channel of Solution 2 and 3 is greater (about 800m) than the approach channel of Solution 4 due to the need to reduce the wave agitation inside the port for Solution 2 and 3. This made the layout comparable in terms of downtime of the operations while the ship was alongside.

Further details of the three solutions are:

- Solution 2:
  - Approach channel: 2,880m long to the end of the turning circle, 310m wide, orientation 295°N
  - Turning circle: 800m diameter
  - Porto Vecchio Entrance: 185m wide
  - Ponente Entrance Phase B: 150m wide
  - Bacino Sampierdarena Phase B: 400m wide.
- Solution4 3:
  - Approach channel: 2,725m long to the end of the turning circle, 310m wide, orientation 295°N
  - Turning circle: 800m diameter
  - Porto Vecchio Entrance: 400m wide
  - Ponente Entrance Phase B: 150m wide
  - Bacino Sampierdarena Phase B: 400m wide.
- Solution 4:
  - Approach channel: 2,000m long to the end of the turning circle, 310m wide, orientation 090°N
  - Turning circle: 800m diameter
  - Porto Vecchio Entrance: 400m wide
  - Ponente Entrance Phase B: 150m wide
  - Bacino Sampierdarena Phase B: 400m wide.

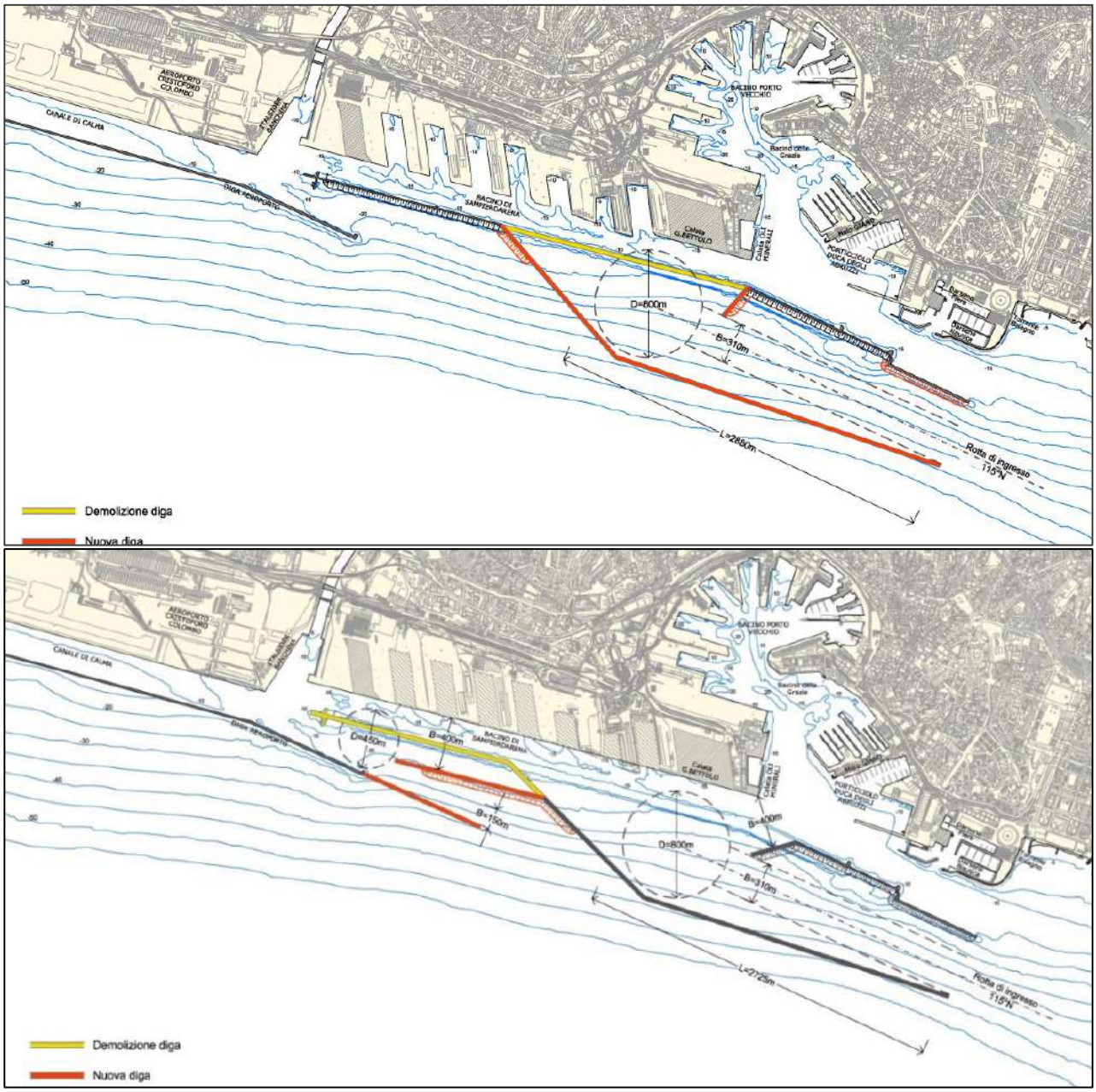


Figure 2.1: Solution 2: Phase A (top) and Phase B (bottom)

Note: Yellow – demolished structures; Red – new structures

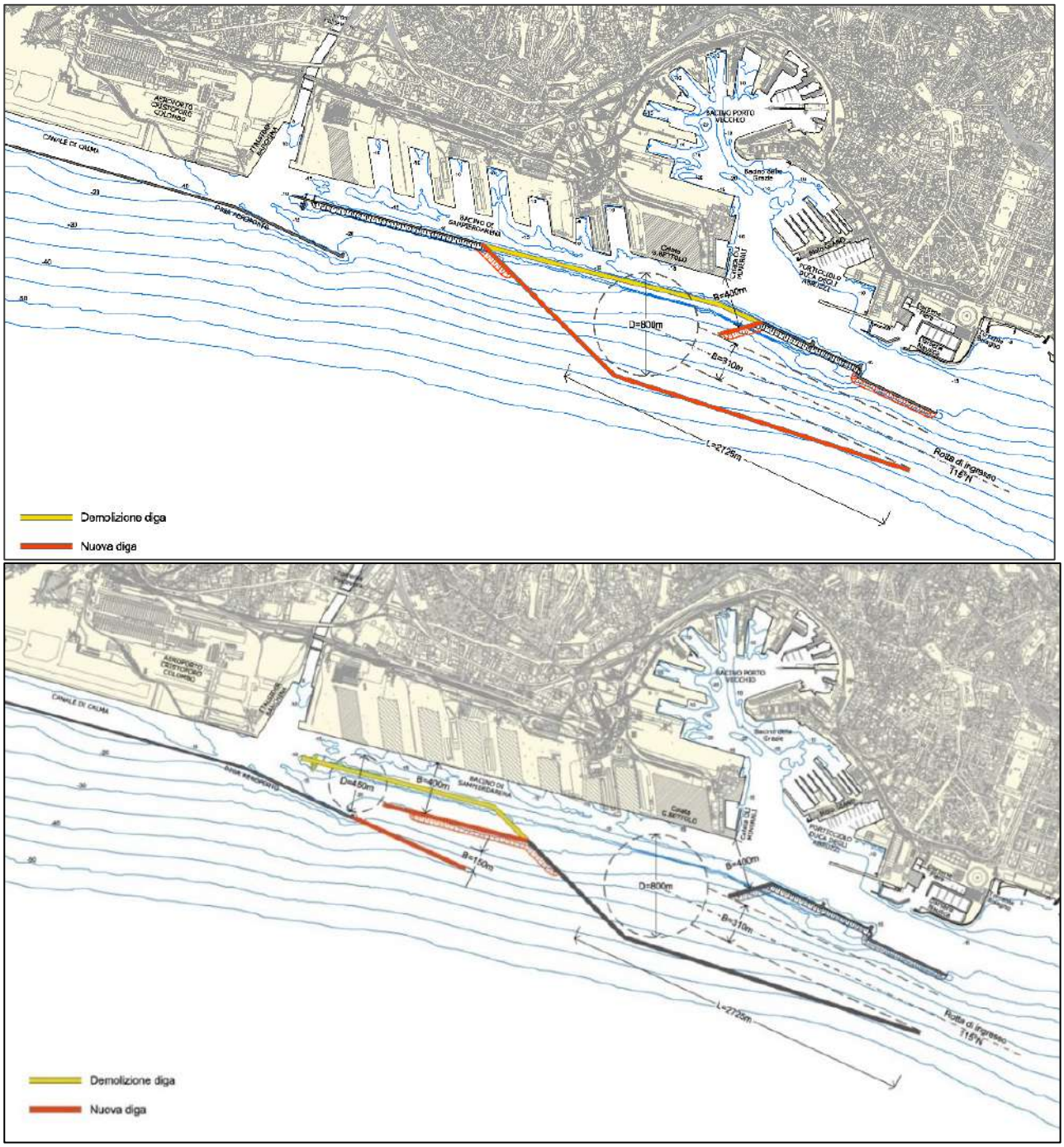


Figure 2.2: Solution 3: Phase A (top) and Phase B (bottom)

Note: Yellow – demolished structures; Red – new structures

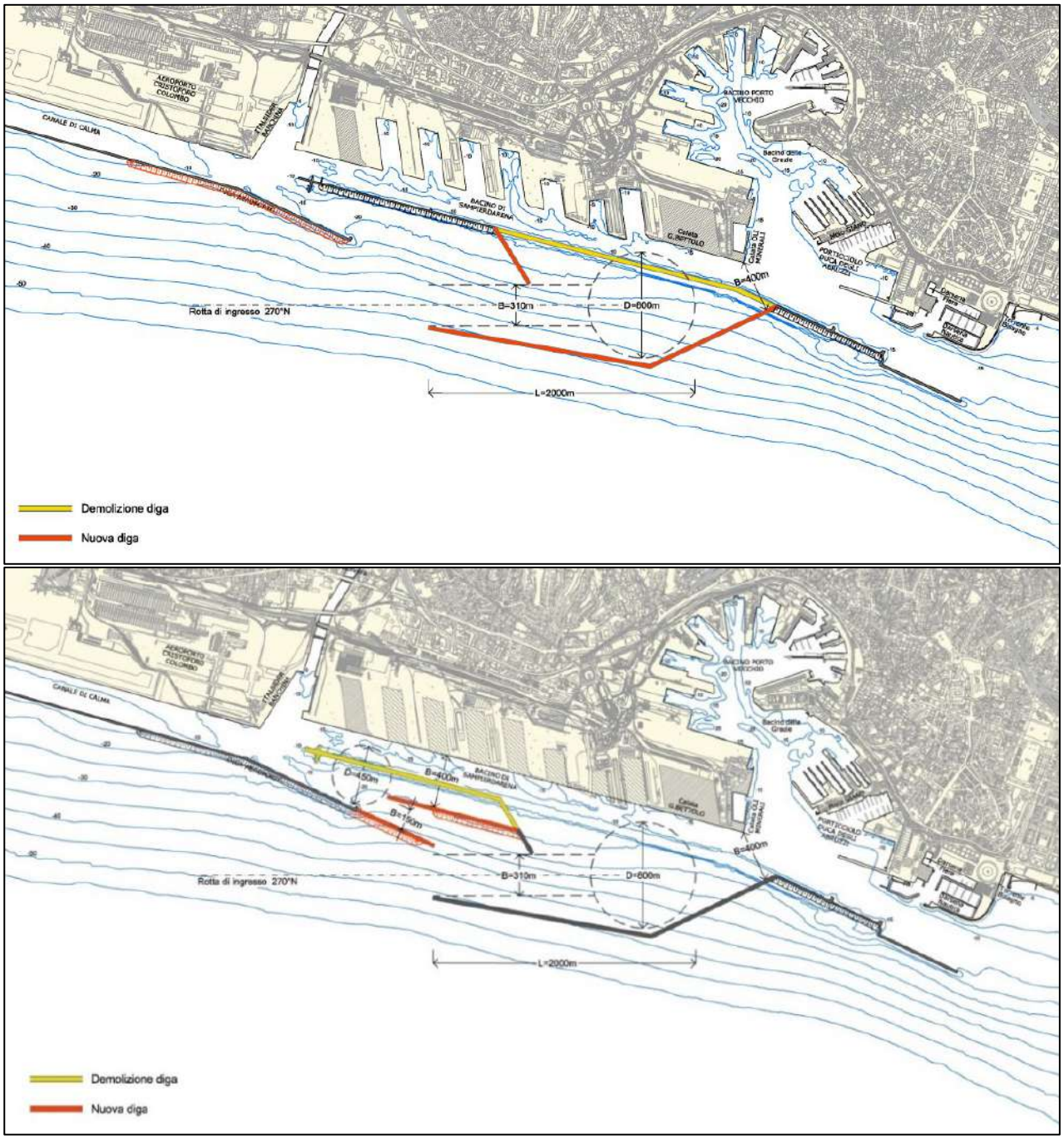


Figure 2.3: Solution 4: Phase A (top) and Phase B (bottom)

Note: Yellow – demolished structures; Red – new structures

Source: Technital

2.2. Layout downtime

Preliminary results of the downtime assessment (Reference 2) showed that the proposed layouts will not increase the wave agitation inside Porto Vecchio. For both Phases A and B, all the solutions tested during the simulation study were similar in terms of wave agitation inside the port.

2.3. Design ships

The design ships for Genoa Port are the widest range of existing ships which can access the port while maintaining the airport restrictions. The ships examined were selected and agreed prior the simulation session. In particular, the characteristics of the design ships were as follows:

- 400m x 62m Ultra Large Container Ship:
  - Length overall: 399.3m
  - Beam: 61.5m
  - Draught: 16.5m / 14.5m
  - Laden displacement: 293,000t.
- 330m x 48.2m Container Ship:
  - Length overall: 330m
  - Beam: 48.2m
  - Draught: 11.0m
  - Laden displacement: 113,000t
  - Single fixed pitch propeller
  - MAN BW 8G95ME C9.5 engine and bow thruster 3000kW (4020hp).

3. Navigation simulation

3.1. Simulator configuration

3.1.1. Simulated layouts

The layouts used in the simulation are taken from the proposed solutions. These include the variation of the breakwater to reduce the wave agitation inside the port as mentioned in Section 2.1. The layouts used in the simulation session are shown from Figure 3.1 to Figure 3.3.

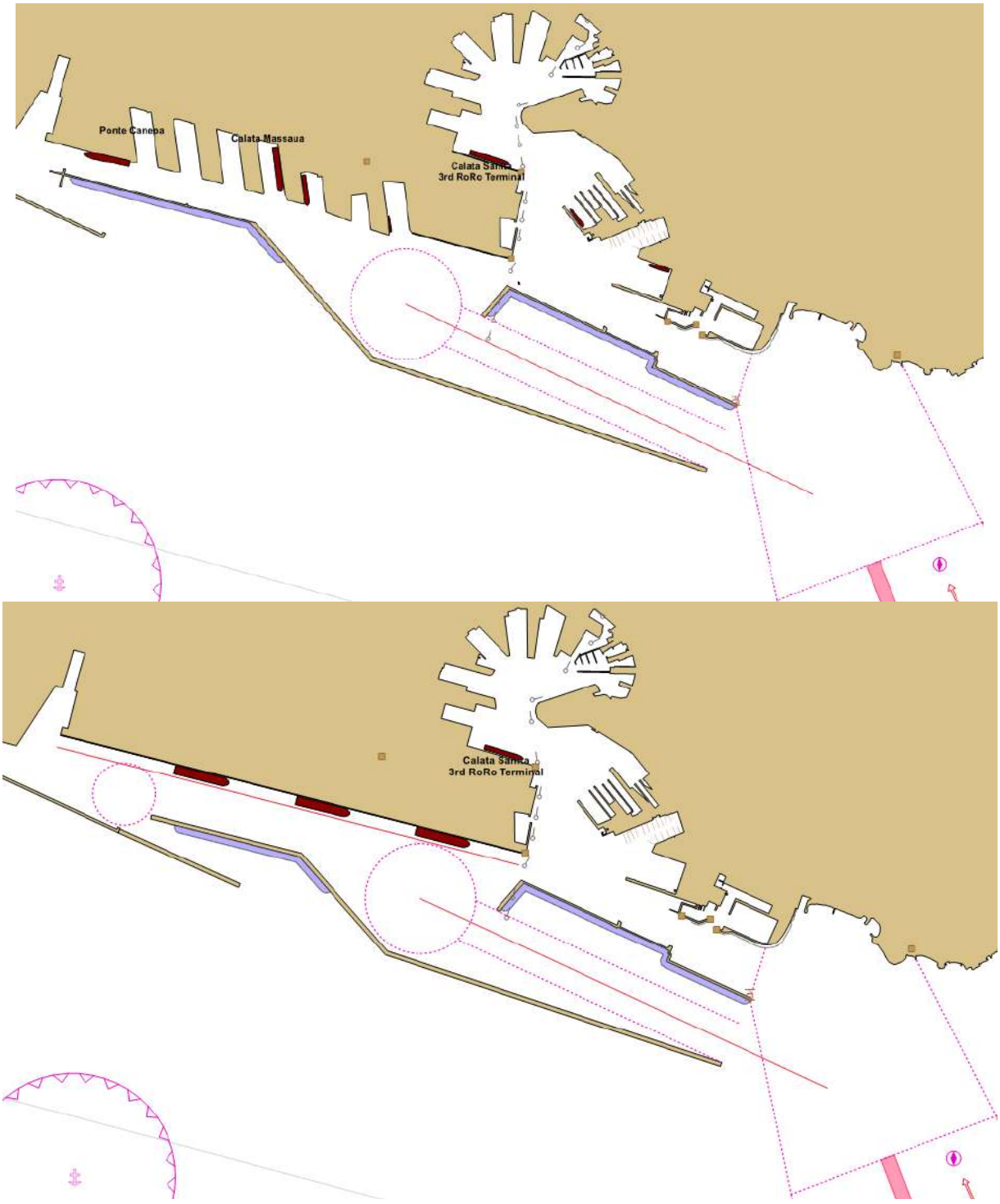


Figure 3.1: Solution 2: Phase A (top), Phase B (bottom)

Source: HR Wallingford Ship Simulation System

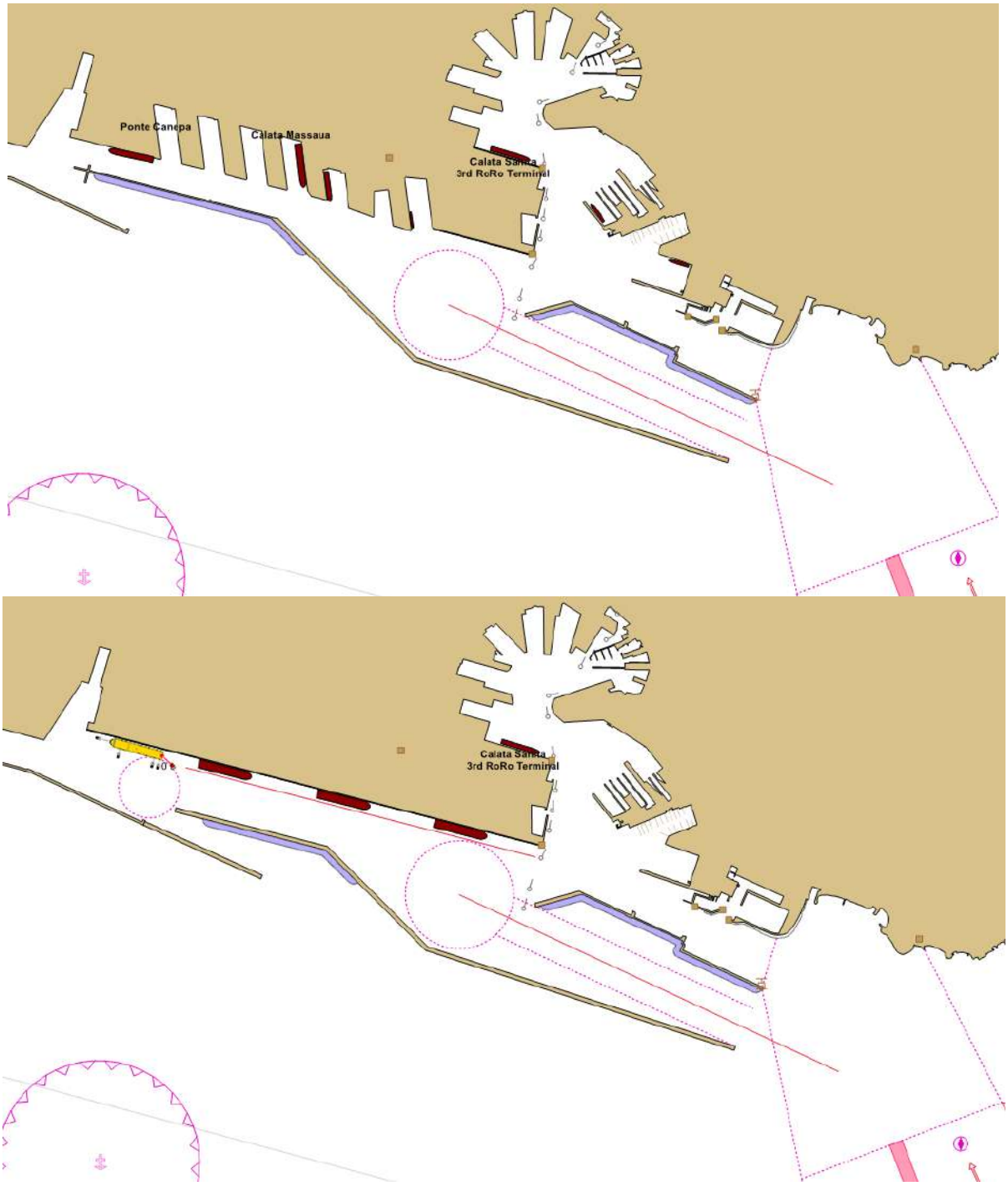


Figure 3.2: Solution 3: Phase A (top), Phase B (bottom)

Source: HR Wallingford Ship Simulation System

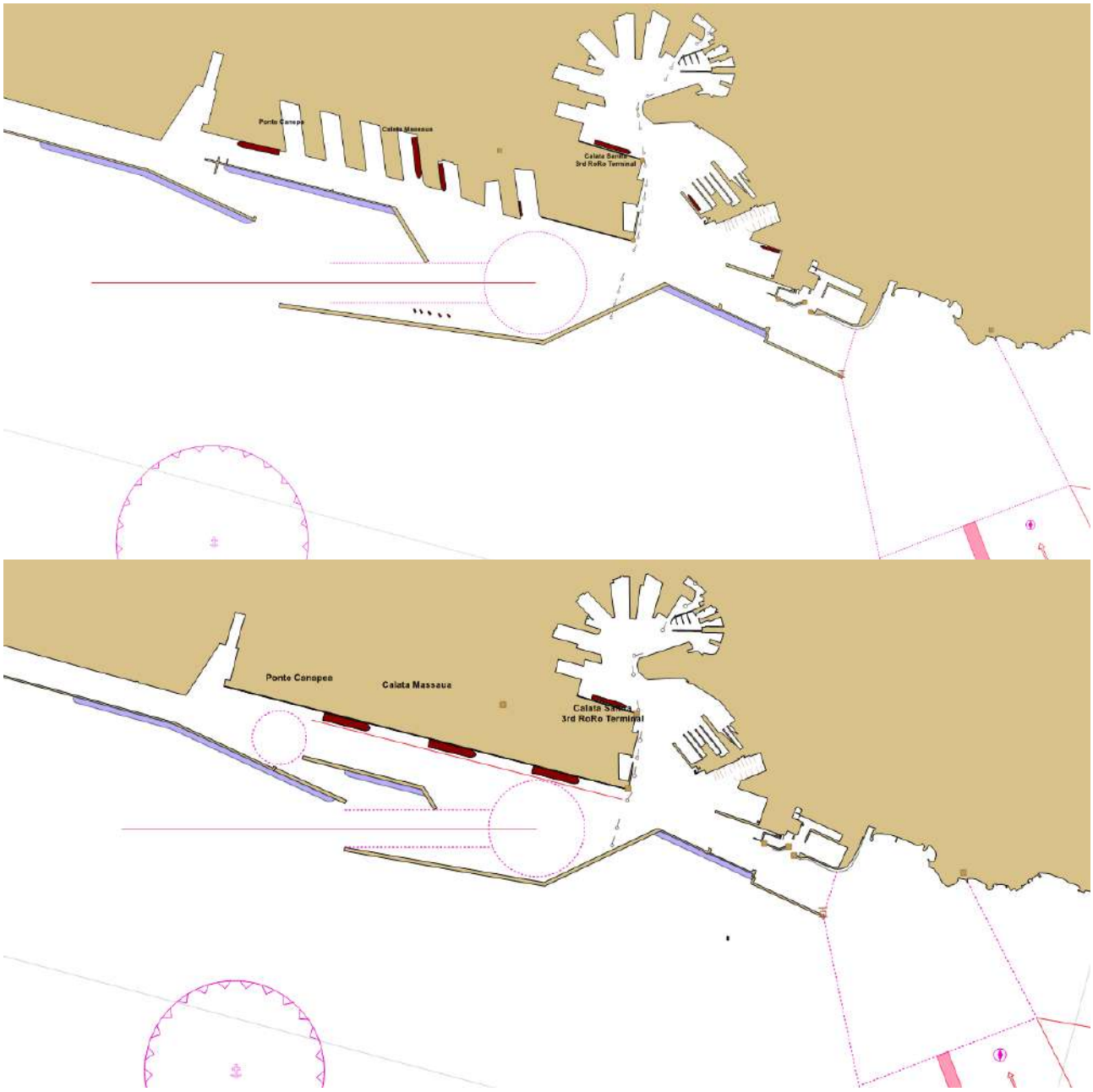


Figure 3.3: Solution 4: Phase A (top), Phase B (bottom)

Source: HR Wallingford Ship Simulation System

3.1.2. Visual scene

A visual model was created based on drawings, satellite imagery and photographs to represent the Port of Genoa and the proposed layouts. Examples of typical visual scenes are shown in Figure 3.4 to Figure 3.6. All the simulations were conducted in daylight.

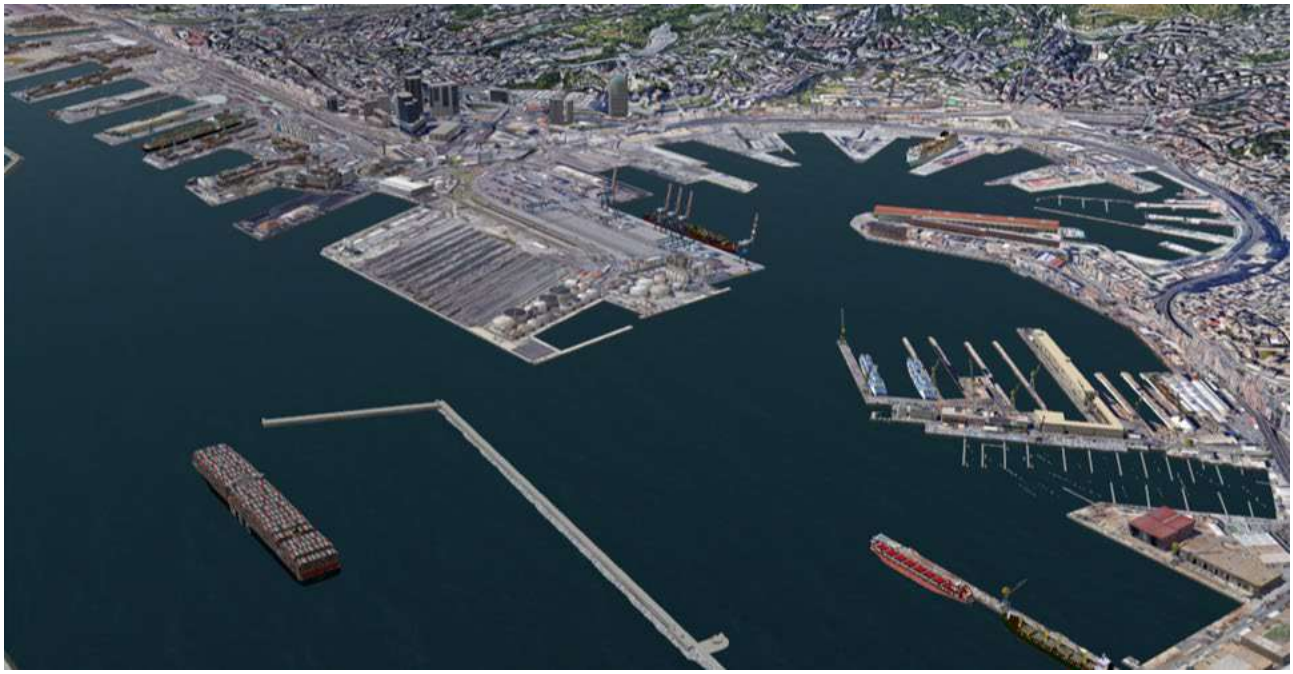


Figure 3.4: Aerial view of Solution 2

Source: HR Wallingford Ship Simulation System

Figure 3.5: Aerial view of Solution 3

Source: HR Wallingford Ship Simulation System

Figure 3.6: Aerial view of Solution 4

Source: HR Wallingford Ship Simulation System

3.1.3. Bathymetry and water depth

The bathymetric data was provided as per Reference 1 along with grids of current and wave conditions. The existing bathymetry was updated with a dredged depth of -18.5m in the turning circle, -17.0m from the turning circle to Calata Massaua and -15.5m in the Sampierdarena Basin beyond Ponte Eritrea. In Phase B, the same areas will all be dredged to -18.5m.

3.1.4. Wind

The wind in the area is mainly from the northeast (“Grecale”) and southeast (“Scirocco”) as shown in Figure 3.7. Figure 3.8 shows that wind speeds up to 14m/s at the port are only exceeded 0.2% of the time. The Port of Genoa Pilots also say they experience a strong component from the south-southwest (Mezzogiorno) that generates high waves due to the long fetch. This wind was tested as waves are considered to affect the navigability in the port.

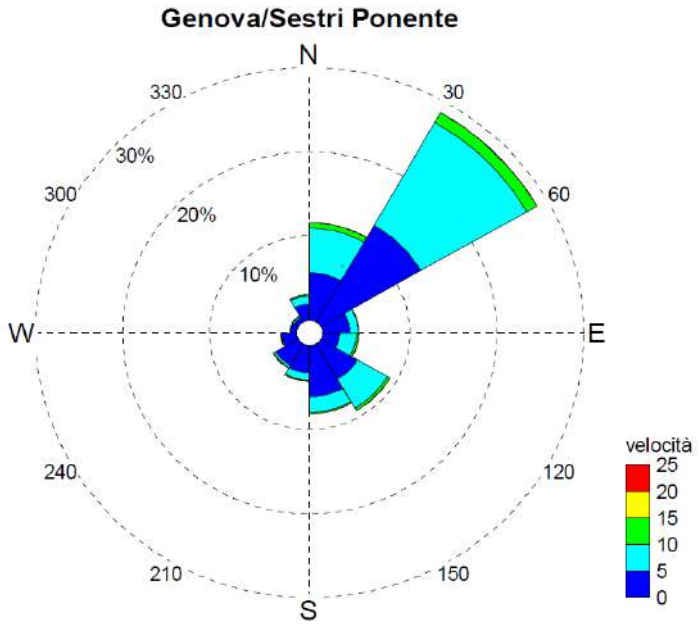


Figure 3.7: Genoa Airport wind rose 1963-2007

Source: "Vento e porti - Analisi statistica dei dati storici di vento registrati dalle stazioni anemometriche"

		Classi di Direzione °N													
		10	40	70	100	130	160	190	220	250	280	310	340		
U_w (m/s)		30	60	90	120	150	180	210	240	270	300	330	360	**Tot**	**Cum**
0	1	0.34	0.23	0.09	0.06	0.10	0.13	0.14	0.13	0.07	0.06	0.07	0.23	**1.6**	**1.6**
1	2	2.10	3.38	0.98	0.49	0.81	1.81	1.51	1.74	0.85	0.35	0.30	0.99	**15.3**	**16.9**
2	3	1.75	3.77	1.06	0.55	1.39	2.50	1.37	1.24	0.71	0.24	0.18	0.57	**15.3**	**32.3**
3	4	1.37	4.44	1.00	0.69	1.88	1.85	0.60	0.44	0.33	0.14	0.10	0.30	**13.1**	**45.4**
4	5	1.41	4.67	0.77	0.65	1.90	1.33	0.44	0.19	0.15	0.06	0.09	0.29	**12.0**	**57.4**
5	6	1.65	4.57	0.49	0.64	1.67	0.84	0.32	0.12	0.06	0.03	0.09	0.37	**10.9**	**68.2**
6	7	1.73	4.72	0.34	0.67	1.51	0.73	0.29	0.09	0.04	0.03	0.07	0.31	**10.5**	**78.8**
7	8	1.54	3.85	0.19	0.50	0.86	0.40	0.21	0.05	0.02	0.01	0.05	0.26	**7.9**	**86.7**
8	9	1.02	2.63	0.12	0.37	0.57	0.22	0.14	0.04	0.01	0.01	0.03	0.16	**5.3**	**92.0**
9	10	0.69	1.74	0.06	0.21	0.32	0.13	0.11	0.04	0.01	0.01	0.02	0.10	**3.4**	**95.5**
10	11	0.37	0.94	0.03	0.14	0.17	0.08	0.06	0.02	0.00	0.00	0.01	0.08	**1.9**	**97.4**
11	12	0.20	0.44	0.01	0.09	0.11	0.05	0.03	0.02	0.00		0.01	0.04	**1.0**	**98.4**
12	13	0.12	0.16	0.00	0.04	0.06	0.03	0.02	0.01	0.00	0.00	0.00	0.03	**0.5**	**98.9**
13	14	0.04	0.07	0.00	0.02	0.03	0.01	0.01	0.00		0.00	0.00	0.02	**0.2**	**99.1**
14	15	0.03	0.02		0.02	0.02	0.01	0.01	0.00			0.00	0.01	**0.1**	**99.2**
15	16	0.02	0.00		0.01	0.01	0.00	0.00	0.00			0.00	0.01	**0.1**	**99.3**
16	17	0.00			0.01	0.00	0.00	0.00	0.00				0.00	**0.0**	**99.3**
17	18	0.01	0.00		0.00	0.00							0.00	**0.0**	**99.3**
18	19	0.00	0.00		0.00							0.00	0.00	**0.0**	**99.3**
19	20	0.00				0.00						0.00	0.00	**0.0**	**99.3**
20	21								0.00					**0.0**	**99.3**
		14.42	**35.64**	**5.13**	**5.16**	**11.42**	**10.11**	**5.28**	**4.13**	**2.25**	**0.95**	**1.03**	**3.78**	**99.3**	
													Indefiniti	**0.7**	
													Totale	**100.00**	

Figure 3.8: Genoa Airport: Wind climate

Note: Data in parts per hundred thousand

3.1.5. Currents

The currents in the Port of Genoa are mainly wind driven. Due to the topography of the port, the currents were considered negligible when the wind comes from the north-northeast. Currents were taken from the data models provided in July 2020 based on the wind speed and direction, with a return period as in Section 3.1.4. These were converted into a fixed grid of 20m x 20m cells. The grid was scalable in the simulator accordingly to the data agreed prior to the run.

The currents were generated from the wind only, as a study conducted and presented in Reference 1 demonstrated that the Polcerva and Bisagno Rivers do not affect the currents in the relevant area of the port.

3.1.6. Waves

The waves configured in the simulator were taken from the data models provided in July 2020 (Reference 1). These were converted into a fixed grid of 10m x 10m cells and named by direction and wave height in the outer boundary of the grid.

In all the solutions, there is a large reflection of the offshore waves that increase the disturbance of the area in front of the breakwater. Wave conditions outside the port were limited to 2.5m as this is limit for pilot boarding as discussed with Port of Genoa Pilots.

3.1.7. Water levels

Water depth information is an important input to the ship manoeuvring models during the simulation exercises, as a ship's dynamic behaviour is influenced by the depth of water and the associated under keel clearance. The depth was taken from the data models and based on the specific current and wind condition (Reference 1).

3.2. Ship and tug manoeuvring models

3.2.1. Ships

During the navigation simulation, the behaviour and performance of the ships, in terms of the response to helm and engine settings, as well as the effects of the local wind, wave and current conditions, were governed by mathematical ship manoeuvring models. The mathematical models of the ships must behave in such a way that the position, velocity, swept path and heading of the simulated ship are always representative of real ship behaviour.

In the simulations two container ships were used as follows:

- 400m x 62m Ultra Large Container Ship ("MSC MegaMax" type) – to establish the safety of the port in terms of available plan area (approach channel width, manoeuvring area) in Phase A, the plan area of Sampierdarena Basin and the passing speed and distance in the basin in Phase B. This ship had the following main characteristics:
  - Length overall: 399.3m
  - Beam: 61.5m
  - Draught: 16.5m / 14.5m
  - Laden displacement: 293,000t

- Single fixed pitch propeller
- MAN BW 11G95ME C9.5 engine and bow thruster 6,000kW (8,040hp).

- 330m x 48.2m Container Ship – to establish the possibility to increase the ship size calling at Calata Massaua using the space available from the new breakwater in Phase A. This ship had the following main characteristics:
  - Length overall: 330m
  - Beam: 48.2m
  - Draught: 13.5/11.0m
  - Laden displacement: 143,000t
  - Single fixed pitch propeller
  - MAN BW 8G95ME C9.5 engine and bow thruster 3,000kW (4,020hp).

3.2.2. Tugs

HR Wallingford understands that there is a wide range of existing tugs available at the Port of Genoa, with a maximum bollard pull of 82t.

HR Wallingford's simulation system supports two methods for representing tug assistance, as follows:

Centrally-controlled tugs: The tug(s) assisting the ship are controlled by the Simulator Operator following the Pilot's commands, and in a manner similar to that which would be expected in practice, with realistic delays applied. The response of each centrally-controlled tug is governed by a tug performance model that ensures the response times and maximum force deliverable by each tug varies with tug type, winch type, ship water speed and assist mode (push, direct pull, powered indirect, indirect pull and transverse arrest) as well as the local wave conditions and any hull sheltering effects. For most of the runs, the Simulator Operator was supervised by the Port of Genoa Tug Master to ensure the tugs behaviour was as close as possible to the tugs at the Port of Genoa.

Simulator operated tugs: The independently controlled tugs are operated by a Tug Master from separate, but linked, simulator bridge(s) configured as a tug. The behaviour and performance of each independent tug model, in terms of the response to any helm, engine and towline/fender forces, along with the effects of the local wind, wave and current conditions, is governed by a full mathematical tug manoeuvring model. The tug model represents motions in all six degrees of freedom (6DOF), i.e. surge, sway, heave, roll, pitch and yaw motions, and includes tug interactions with waves, the tow line, winches and fenders. Independent tugs can be used in conjunction with centrally-controlled tugs to complete the full tug complement required for a manoeuvre.

Both types of tug model were used in this simulation session.

With the simulator operated tugs, the operating delays and performance degradation were automatically taken into account. The centrally-controlled tugs were subject to operating delays as shown in Table 3.1, and tug performance curves as shown in Figure 3.9 and Figure 3.10.

Table 3.1: Simulated tug response delay times

Tug response delay			Delay
Time to attach and secure			5 minutes (+ 3 minutes line pay-out)
Time to react to new thrust level command			1 minute
Time to react to change in thrust level			20 seconds
Time to change thrust direction	Direct	up to 90°	Up to 1 minute
		90 to 180°	Up to 2 minutes
	Indirect	Roll into assist	Up to 30 seconds
		quarter to quarter	Up to 1 minute
Time to detach	Push/pull mode		1 minute
	Working on line		3 minutes

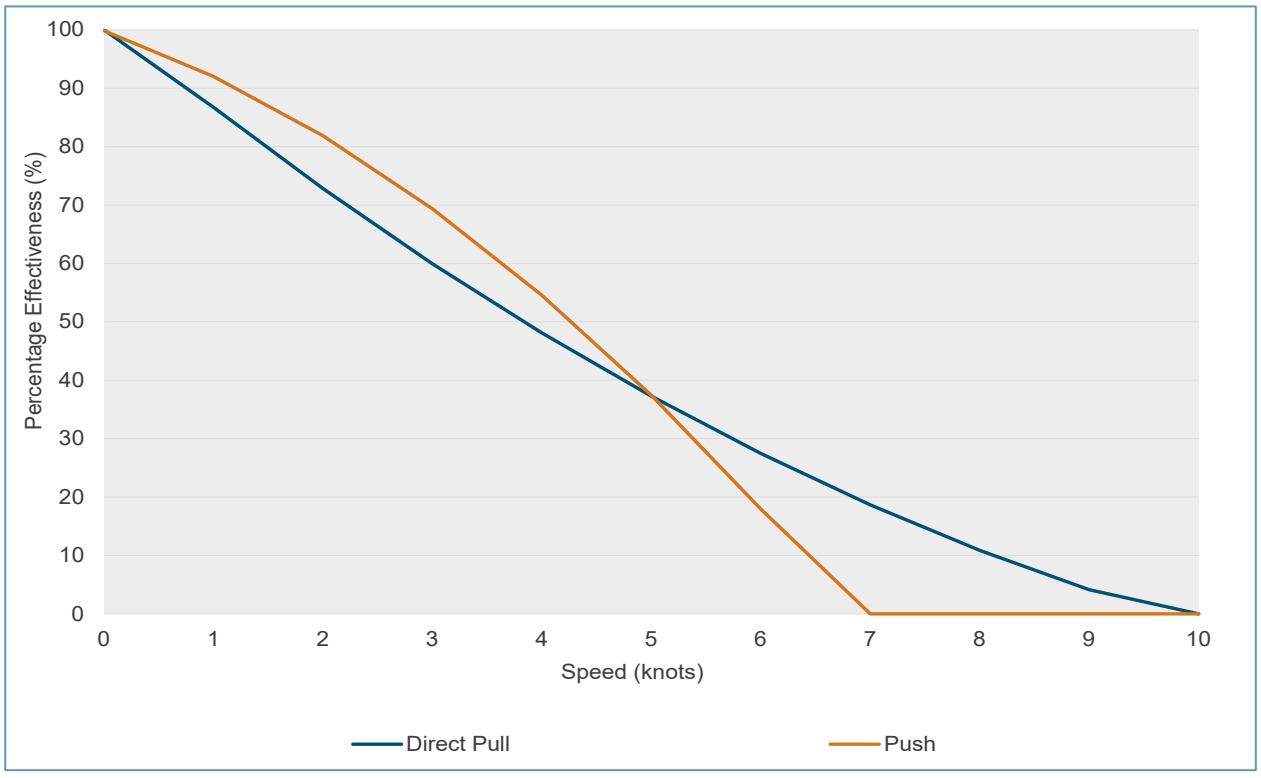


Figure 3.9:Degradation of tug power with speed

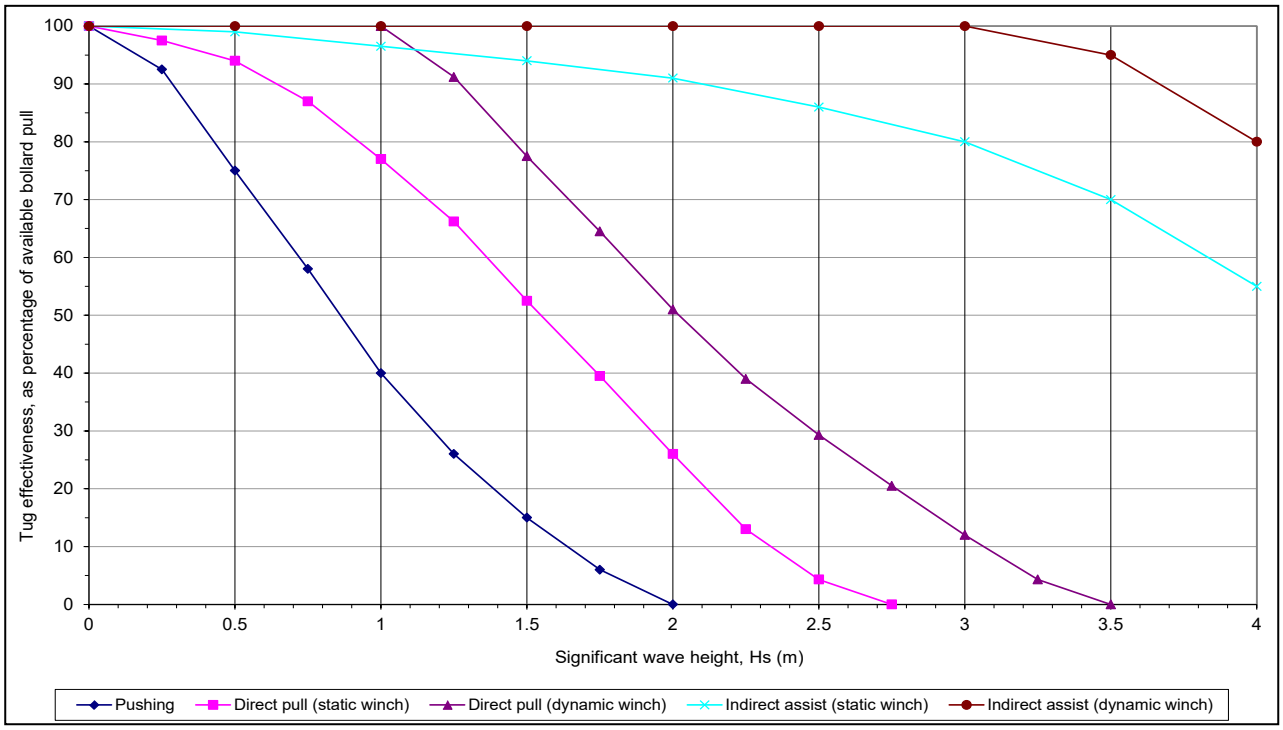


Figure 3.10:Tug effectiveness in waves

3.3. Verification of simulation configuration

HR Wallingford routinely performs a series of internal simulator configuration checks and tests, in order to ensure that the simulation worked in line with expectations.

The ship manoeuvring models were tested using standard trials such as turning circle and emergency stop tests to ensure the model behaviour was consistent with the known and assumed behaviour of similar ships. An HR Wallingford Pilot also verified the performance of each of the modelled ships using a series of test manoeuvres in a range of environmental conditions.

A series of standard simulator set-up verification tests were undertaken to confirm that all components of the simulation were configured correctly and were interacting as expected. These included:

- Engine and helm control tests
- Effect of wind, waves and/or current on stationary ships
- Wind force on ship
- Spatial and orientation checks on the relative positions of the infrastructure, channel boundaries and aids to navigation etc.
- Spatial checks on water depths
- Confirmation of the ship footprint and location with the simulation visual scene and situation display.

3.4. Navigation simulation session

3.4.1. Overview

The Genoa real time navigation simulation session was held in HR Wallingford's UK Ship Simulator Centre in Wallingford over five days from 21st September and 25th September 2020. A total of 31 simulation runs were performed. The simulations runs, design ships and layouts were agreed in advance by the Port of Genoa representatives and only minor changes to the runs conditions were made based on the results of the simulations.

The objective of the simulation session were to assess the safety and the feasibility of navigation at the three proposed layouts with a particular attention on requirement and improvement of:

- Approach channel
- Manoeuvring area
- Berthing to Calata Bettolo, Calata Massaua and Ponte Canepa.

3.4.2. Participants

The simulation session participants were:

Western Ligurian Sea Port Authority – Port of Genoa

Marco Vaccari	AdSPdMLO
Alberto Battaglini	Harbour Master Coast Guard
Valerio Berardi	Harbour Master Coast Guard
Danilo Fabricatore	Chief Pilot and Pilot Manager
Albert Sturlese	Tug Master
Paolo Oneto	Linesman.

Technital

Antonio Lizzadro	Project Manager.

Modimar (remotely)

Paolo De Girolamo	Modimar – Project Manager
Marco Tartaglini	Modimar – Project Engineer.

HR Wallingford

Captain Ian Love	HR Wallingford Pilot
Roberta Riva	Project Engineer
Jonathan Woodhams	Principal Engineer
Jessica Carter	Simulator Operator
Giulia Sforzi	Principal Engineer
Dr Mark McBride	Task Manager.

The HR Wallingford Pilot selected for the study had considerable experience of a wide range of container ship operations, including extensive experience of both of the container ships represented, as well as extensive experience of navigation simulation based work.

In this study, the simulation runs were performed using mostly one ship bridge, but occasionally with two linked simulator bridges (one ship bridge and one tug bridge). Furthermore, all the runs were conducted by

the Port of Genoa's Chief Pilot. In these runs the Pilot controlled the ship manoeuvres from the one of the Ship Simulation Centre's ship bridge simulators. The Pilot's view position was typically from any position on the bridge of the ship, and the Pilot gave orders to the tug(s) using a radio, in the usual manner. One of the tugs (the stern/brake tug) was controlled from one of the centre's tug simulator bridges for some of the runs. Other tug(s) assisting the ship were modelled as centrally-controlled tugs (see Section 3.2.2).

Observers were able to monitor the manoeuvres from any of the simulator bridges, or from an independent and interactively controllable displays in the Ship Simulation Centre's Observation Room.

The general simulation session procedures were as follows:

- Before each run, the Pilot(s) and Tug Master were briefed and the run conditions were discussed with the Simulation Team;
- At the start of each run, the ship's position, heading, forward and transverse speeds were set by the Simulation Team, based on the manoeuvring scenario and on the environmental conditions selected;
- During departures the ship was positioned with zero ground speed and no mooring lines attached;
- Typically a run was terminated once the manoeuvring objective had been achieved and/or the Simulation Team considered no further insight would be gained by continuing the run;
- Immediately after each run, the Pilot and Tug Master were debriefed and the run was discussed with the Simulation Team.

The run scenarios were selected in a flexible manner during the simulation session, to maximise the time available, with each run taking account of the outcomes of previous runs.

3.4.3. Presentation of the results

The data and results from each real time simulation run are presented in a range of formats.

Run summary

Following each run, a summary table entry was completed. This is presented in Appendix B.

The table details the set-up of the run including the reference to the previously agreed run, the ship used, the manoeuvre conducted, the environmental conditions used, and also describes key aspects of the manoeuvre and captures the remarks and comments made by the Pilot and the rest of the Simulation Team.

Pilot debrief

Immediately after each simulation run, there was a debrief at which comments and insights on various aspects of the run were discussed and recorded. Relevant comments captured in these debriefs are included within the "Comments and pilot/tug master remarks" column of the run summary presented in Appendix B.

Grading of the runs

Each simulation run was graded as Successful, Marginal or Fail according to the following evaluation criteria:

Successful — Arrival/departure manoeuvres:

- The ship remains under control at all times retaining a margin of unused controllability.
- The ship and any assisting tugs maintain an acceptable clearance from all port structures, and other ships berthed at the port, where an acceptable clearance is considered to be

when sufficient horizontal separation between the manoeuvring ship and adjacent structures exists to the satisfaction of the Pilot.

- The ship's water and ground speed is appropriate for the nature of the fairway/channel e.g. to avoid adverse interactions with other moored ships, to allow for safe tug assistance.
- For berthing manoeuvres, the ship ends the run alongside, or in such a position that lines would be ashore without appreciable difficulty, at controlled lateral, with an acceptable sway velocity and no appreciable yaw rate.
- For departure manoeuvres the ship exits smoothly, without risk of being blown or set onto port structures or other ships.

Marginal — Arrival/departure manoeuvres:

- The Pilot considers the ship is at the limit of control during the manoeuvres.
- The ship stays within the fairway, but with unacceptable clearances, or inappropriate ship speed.
- The ship clears all port structures, and other ships berthed at the port, but with unacceptable clearances.
- For approach manoeuvres, the ship ends up alongside, but may have a high approach velocity. The manoeuvre can be concluded, but with the potential for minor damage.
- On departure, the ship may get off the berth only with some difficulty. The manoeuvre is completed with the potential for minor damage only.

Failure — Arrival/departure manoeuvres:

- The Pilot loses control of the ship.
- The ship strays outside the fairway and/or grounds.
- The ship either contacts, or has a near-miss, with port structures, and/or other ships berthed at the port.
- On departure, the ship either cannot lift off the berth at all, or encounters significant difficulty in manoeuvring, such that severe damage may have occurred.

Simulation track and data plots

The results of each navigation simulation runs are available in the form of plots of the ship tracks and graphs of key data parameters recorded during the run. These data are presented in Appendix C.

The ship data and track plots show:

- The position of the ships at 2 minute intervals is indicated by a succession of different hue blue ship outlines. Red ship outlines indicate the ship's position every 10 minutes from the start of the run. The grey shading indicates the total swept path of the ship and tugs throughout the manoeuvre.
- The positions of port structures and aids to navigation.
- The direction and severity of the metocean conditions during the run, presented in the form of metocean symbols for wind, waves, and current.
- A north arrow.
- A scale bar.

The data graphs plot the variation of various key parameters against elapsed simulation time and graphs have been included for the design ship in all of the runs. The ship ID is identified in the text block on the bottom right of each page.

The ship data graphs comprise:

- Current speed in knots acting on the ship along the ship's track.
- Speed (knots) and direction (°N) of the wind acting on the ship.
- Significant wave height (meters) and direction (°N).
- Ship's rate of turn in °/minute and heading in °N.
- Ship's course over ground (CoG) in °N and drift angle in degrees.
- Ship's speed (over the ground and through the water) in knots, expressed in terms of longitudinal and lateral components relative to the ship's head.
- Ship's under keel clearance(s) (UKC) in metres. The data plotted in these UKC graphs does not take account of wave-induced ship motions.
- Ship's propeller RPM (RPM).
- Ship's rudder angle in degrees.
- Ship's bow thruster (%).

Track animations

"Track animations" were generated for each run based on the data recorded. The track animations have been supplied separately as .mp4 format files.

Images captured during the simulation runs

During the simulations runs, observers were able to capture images from the visual scene at key points of the manoeuvres. A selection of these images have been included in this report.

4. Discussion of results

4.1. Overview

As previously mentioned, a total of 31 simulation runs were completed during the real time navigation simulation session. Of these:

- 9 considered Solution 2, of which 7 were with a ULCS and 2 emergency scenarios with a ULCS in Phase A;
- 9 considered Solution 3, of which 1 was with a ULCS using the existing entrance, 3 with a ULCS in Phase B and 5 with the small container ship in Phase A;
- 13 considered Solution 4, of which 5 were with a ULCS in Phase B and 4 with the small container ship.

The layouts all have similar areas and therefore some runs were used to determine conclusions for more than one layout. In particular these common areas were:

- Channel approach for Solution 2 and Solution 3 for ULCS: Runs 1 to 7, 20 to 23 and 31 (Figure 4.1);
- Calata Massaua in Phase A for all solutions for 330m Container Ship: Runs 13 to 20 (Figure 4.2);
- Sampierdarena Basin in Phase B for all the solutions: runs 21 to 26 (Figure 4.3).

The pilot used the same general manoeuvring methods throughout the simulation runs, as follows:

- The tugs were always made fast (connected to the ship's bitts by a tow-line) when the ship was entering the channel adjacent to the south breakwater, prioritising the aft tug with the aim of controlling the ship's speed. It was noted that the pilot generally did not make use of the tug to slow down the ship in the approach channel, using only the ship's engine astern once the aft tug was fast, and mainly while approaching the manoeuvring area.
- The turns were generally carried out using "dynamic manoeuvres" (so turning whilst still carrying headway) using the space available and reducing the duration of the manoeuvre by turning close to the berth.
- Whilst a channel and a turning circle were marked on the electronic chart, a larger area with natural depths greater than the design depths was also available and so was used to perform the manoeuvres, especially when in proximity to the manoeuvring area.

Each run is described individually in the summary table presented in Appendix B and simulation track plots are available in Appendix C. Some additional explanation of the runs grouped by berth and solutions are shown from Sections 4.2 to 4.4. Consideration of future ship sizes is contained in Section 1.

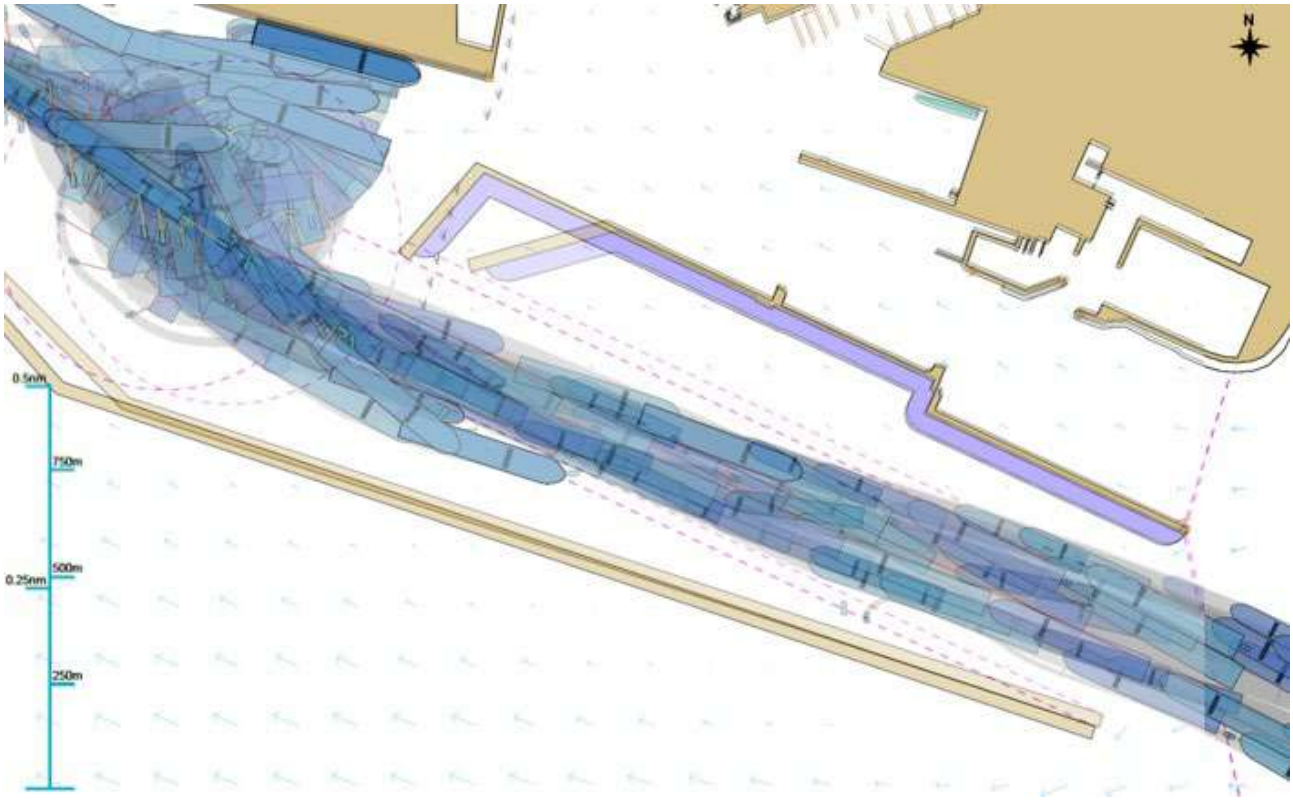


Figure 4.1: Multi-track plot: Channel and manoeuvring area for Solution 2 and 3

Note: Solution 2 layout is overlapped to Solution 3 layout in the picture

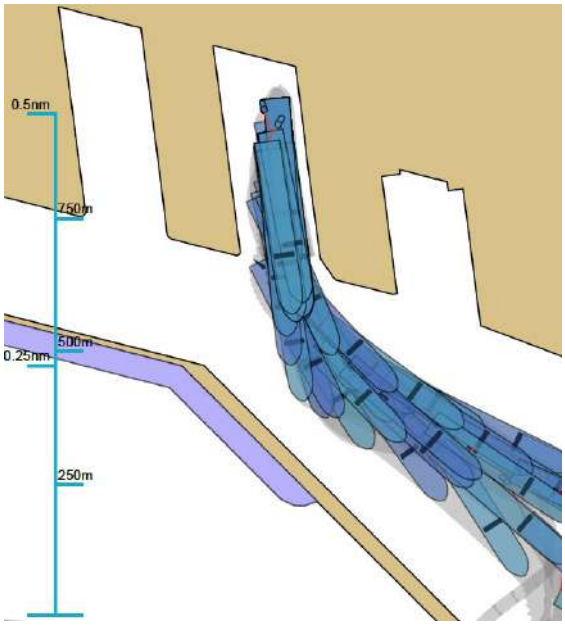


Figure 4.2: Multi-track plot: Calata Massaua in Phase A for all solutions

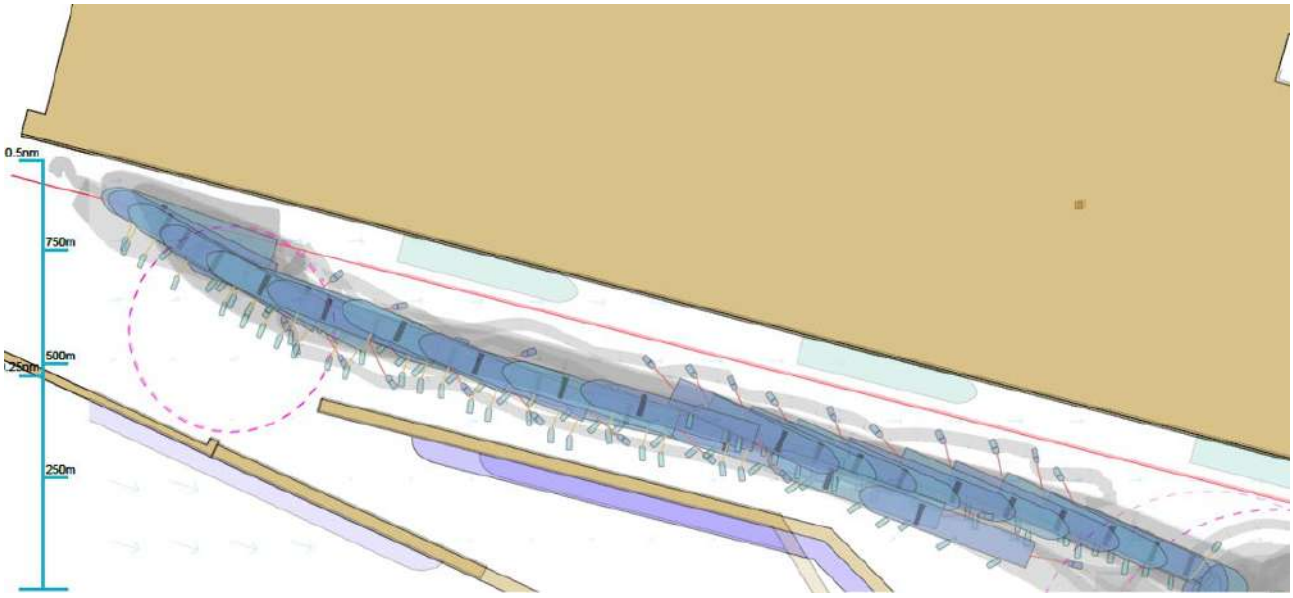


Figure 4.3: Multi-track plot: Sampierdarena Basin in Phase B for all solutions

Note: Solution 3 layout is overlapped to Solution 4 layout in the picture

4.2. Solution 2

Runs 1 to 6 and Run 27 simulated manoeuvres of the Ultra Large Container Ship at Calata Bettolo in its ballast condition to test the higher windage exposure. Runs 28 and 29 simulated emergency manoeuvres in the laden condition.

Solution 2 provides a defined traffic separation between Porto Vecchio and the Sampierdarena Basin, as no access to Porto Vecchio is possible for larger ships from the new entrance.

Runs 1 to 6 and Run 27

Runs 1 to 6 and Run 27 investigated all the main wind conditions for a ULCS in Solution 2.

The ship generally entered the channel with a speed of up to 7.5 knots and was kept at a transit speed higher than 4 knots with a maximum drift angle of 11°. The ship was kept on the up-wind side of the channel entrance through the breakwaters to ensure a good position, which is a normal procedure anticipating that the ship will drift based on the wind direction while the ship's speed is reducing. The pilot was aiming to have the lowest drift angle possible and was therefore keeping as much forward speed as possible, leaving sufficient space from any nearby infrastructure (135m minimum distance, Figure 4.4).

For Solution 2, the channel length was optimised to bring the wave agitation inside the port to a reasonable value. This resulted in a sufficient area in which to make the tugs fast ready for use in the manoeuvring area for both ballast and laden conditions. It was also noted that the large available space allowed the ship to manoeuvre using the minimum tug power up to the manoeuvring area, with the exception being the aft tug which was used to control the ship's speed.

The tugs were used at up to full power in conjunction with the ship's bow thruster to perform the manoeuvres in the manoeuvring area. Given the available space, the pilot manoeuvred such that the space used on the final approach to the berth was minimised (Figure 4.5).

The minimum clearance for this solution was recorded departing from the northern breakwater, Run 5 (77m, see Figure 4.6). It has to be noted that the relatively low clearance was due to the pilot anticipating the ship drifting to the south of the channel in case the ship's speed decreased during the channel transit, due to the strong beam-on wind. The relative position of the ship exiting the manoeuvring area in Run 6 showed the same strategy as in Run 5, but with a south-southwesterly wind.

In some conditions, the tugs were considered on the limit with no spare capacity to overcome possible failures. In northerly winds, 5 tugs of more than 70t BP were considered on the limit for arrival and departure manoeuvres. In particular, the ship used an initial tug fleet of 4 tugs of 70t BP (Run 3). The available power was just about sufficient to perform the manoeuvre. A repeat of Run 3 with 5 x 70t BP tugs resulted in a lateral speed of 0.3 knots, while the ship was brought alongside the berth parallel to the berthing line and no power was left to stop the ship. As a result, the strong beam-on wind requires more than 5 tugs of 70t BP.

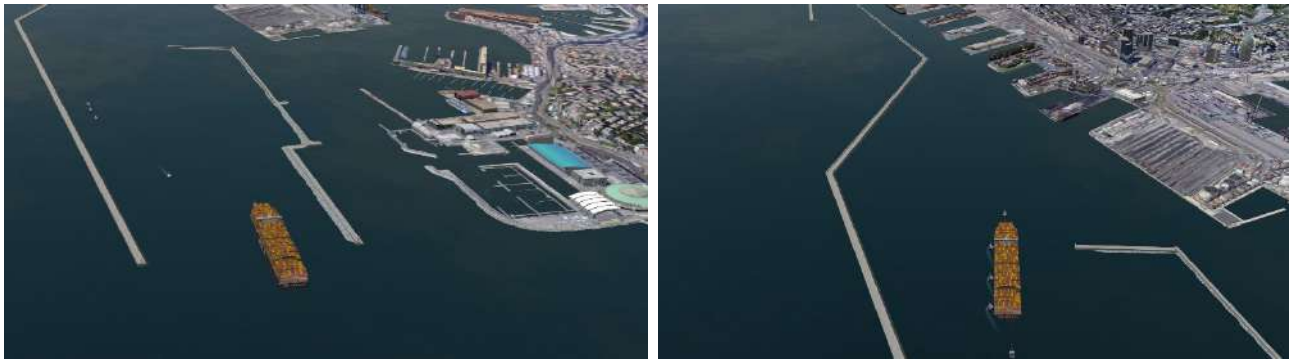


Figure 4.4: ULCS entering the channel (left hand side) and entering the manoeuvring area (right hand side) – Run 4

Source: HR Wallingford Ship Simulation System

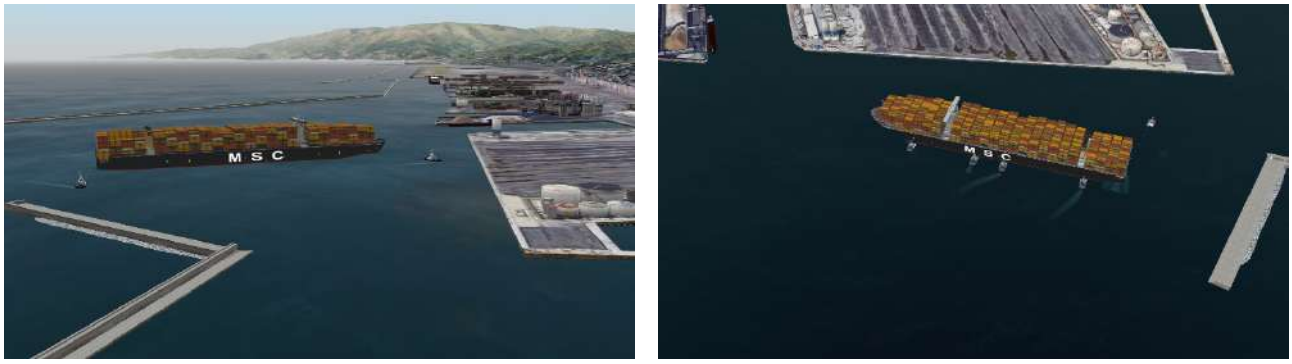


Figure 4.5: ULCS performing a dynamic turn (left hand side) and berthing to Calata Bettolo (right hand side) – Run 4

Source: HR Wallingford Ship Simulation System

Figure 4.6: ULCS departing from Calata Bettolo (left hand side) and leaving the port (right hand side) – Run 5

Source: HR Wallingford Ship Simulation System

Runs 28 and 29

An emergency scenario was performed using the ship in its laden condition. The emergency was a complete blackout of the ship while the ship was entering the manoeuvring area. The tugs provided were 5 x 70t BP tugs. The pilot unsuccessfully used the aft tug to control the ship speed and the other tug to induce the ship to turn. The manoeuvre ended with the ship making contact Ponte Etiopia and Ponte Idroscalo. The run was repeated with a more powerful tug fleet of 5 x 80t BP tugs and a different methodology. In addition to the aft tug pulling on full power, the tugs on the side were used at 45° off the ship to slow the ship in the manoeuvring area. The ship was under control inside the manoeuvring area.

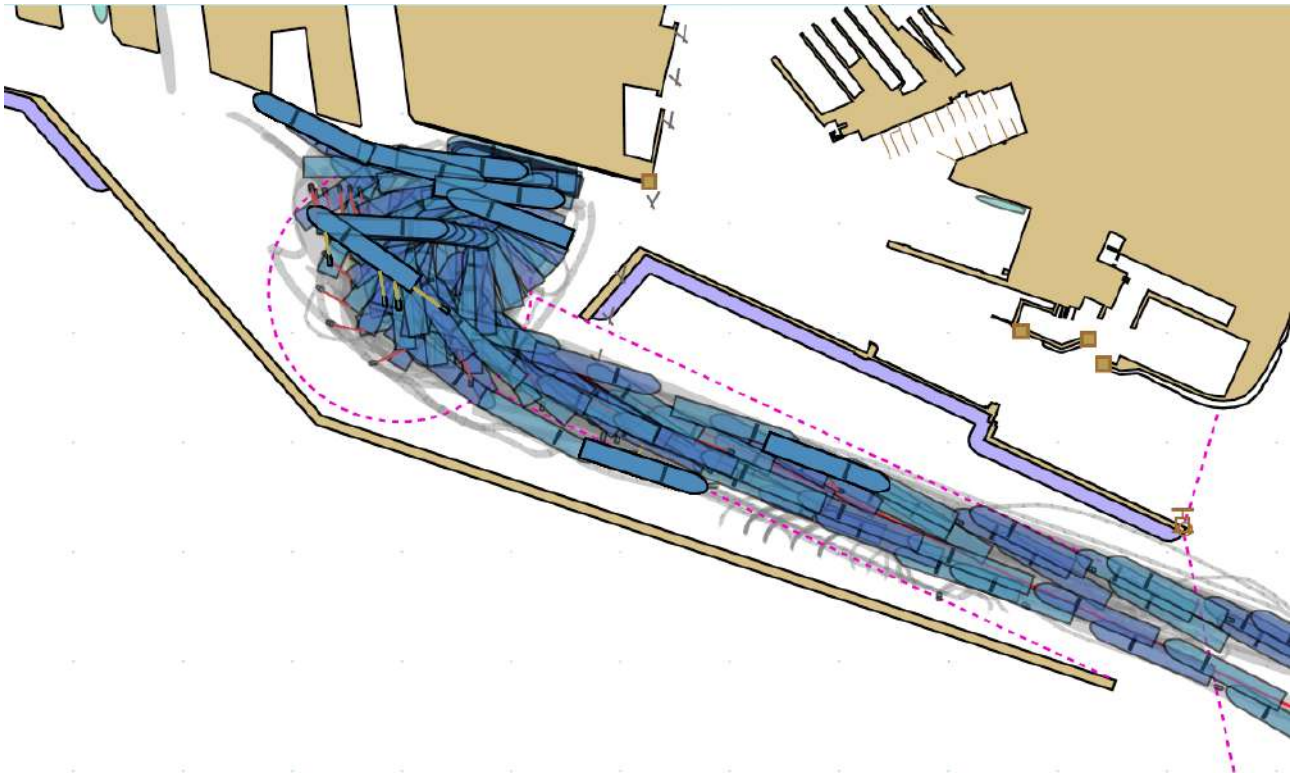


Figure 4.7: Multi track plot of ULCS manoeuvring in Solution 2

Source: HR Wallingford Ship Simulation System

4.3. Solution 3

Solution 3 has common elements to Solution 2 in the approach channel and manoeuvring area, and therefore, the conclusions in this regard for Solution 2 also apply to Solution 3, as mentioned in Section 4.1.

Run 7 simulated an arrival and a departure of a ULCS using the old entrance. Runs 21 to 23 simulated manoeuvres of the Ultra Large Container Ship at Ponte Canepa in ballast and an arrival in the laden condition to test the channel entrance with a laden ship.

Runs 13 to 16 and Run 31 simulated a 330m long container ship with a 48m beam both arriving and departing Calata Massaua in Phase A.

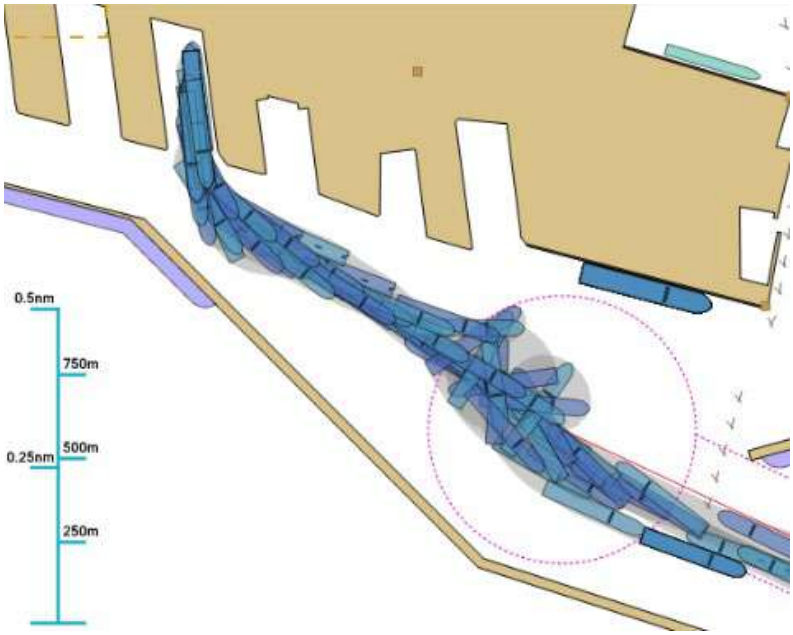


Figure 4.8: Multi track plot of 330m Container Ship manoeuvring in Solution 3 to and from Calata Massaua

Run 7

Solution 3 is differing to Solution 2 for the opening to Porto Vecchio, increasing flexibility in the traffic management between the new and the old port entrance. This run was performed to test an arrival and departure of a ULCS using the old entrance. This was considered as emergency situation where the ship is not able to enter the port from the new entrance.

The ship was not under control in the transit, although the tug power was considered sufficient to bring the ship alongside (Figure 4.9). The impact of passing ship interaction on adjacent moored ships, given the speed and ship's displacement, may also be significant. Nonetheless, a slow speed transit is also a high risk manoeuvre due to the likely vessel drift. The existing approach channel was therefore deemed unsuitable for manoeuvring the design ship.

Run 7 conclusions were considered valid for both Solution 3 and 4.

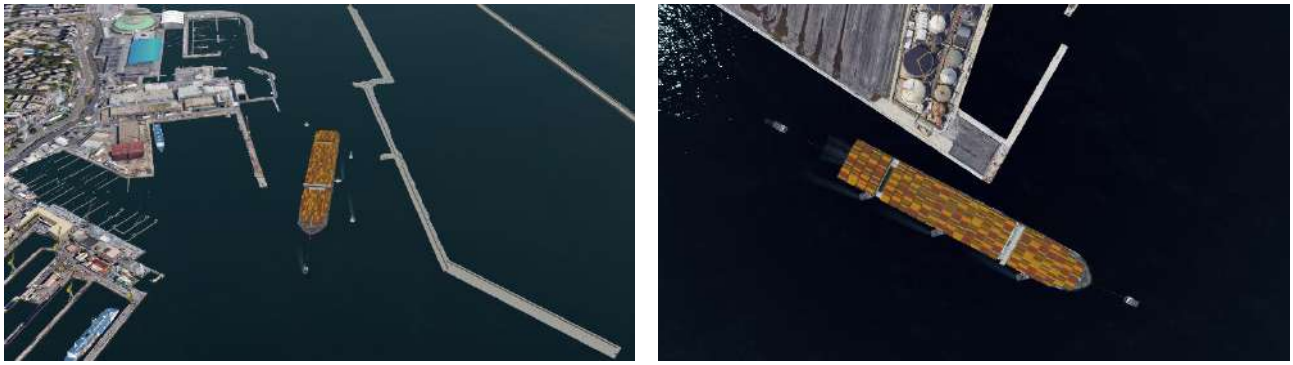


Figure 4.9: ULCS arriving from existing entrance (left hand side) and leaving to the existing entrance (right hand side) – Run 7

Source: HR Wallingford Ship Simulation System

Run 21

Run 21 was performed to test the feasibility of entering the port in a laden condition. This was proved to be feasible and sufficient distance was kept from the infrastructures with a minimum clearance of 88m from the north breakwater. The ship was kept under control and able to stop in the manoeuvring area.

Figure 4.10: Arrival of ULCS in laden conditions – Run 21

Source: HR Wallingford Ship Simulation System

Runs 22 and 23

A ULCS was simulated both arriving and departing port and starboard sides alongside Ponte Canepa in Phase B, with the widening of the Sampierdarena Basin. This was shown to be feasible for all the solutions. With Runs 17 to 20 carried out with the Solution 4, this showed that a suitable passing speed and distance from the other moored ships was kept by the ULCS.

The tug fleet used was up to 5 x 80t BP tugs. The conditions with these tugs were considered to be on the limit, due to the natural decrease in tug efficiency while the ship was keeping speed during the transit in the basin (Figure 3.9). The impact on the moored ships should be considered to determine if the passing effects of a ULCS, with a displacement up to 280,000t, would impact the operations of the moored ship. The similarity in the available manoeuvring area for Sampierdarena Basin, made these runs acceptable also for Solution 2 and 4.

Figure 4.11: ULCS arriving from existing entrance - Run 22

Source: HR Wallingford Ship Simulation System

Runs 13 to 16 and Run 31

Runs 13 to 16 and Run 31 simulated a 330m long container ship with a 48m beam both arriving and departing Calata Massaua in Phase A, in all the predominant wind conditions. These runs were considered representative also for both Solution 2 and Solution 4 due to the similarities in the layouts.

A run with northerly wind was also conducted with a 222m long and 20m beam general cargo ship at Ponte Eritrea (Figure 4.12 - Run 14). This would have been a run where the tugs on the side were use in the push position, so occupying less space around the ship. Nonetheless, the available space was not considered to be sufficient for the design ship to enter the basin. A wind speed of 25 knots from SSW, using 4 x 70t BP tugs, was considered to be at the limit.

In conclusion, the runs showed that manoeuvring to and from Calata Massaua is feasible for all the Solutions, provided there is no other ship berthed on Ponte Eritrea, opposite Calata Massaua.

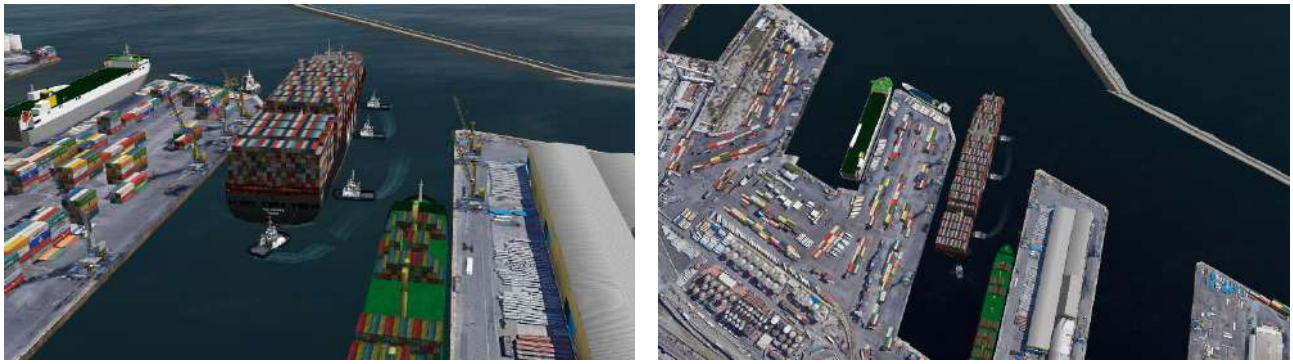


Figure 4.12: 330m container ship entering Calata Massaua with 222m ship at Ponte Eritrea – Run 14

4.4. Solution 4

Runs 8 to 12 simulated manoeuvres of the Ultra Large Container Ship at Calata Bettolo in its ballast condition to test the higher windage exposure. Runs 24 to 26 simulated the same design ship manoeuvring to Ponte Canepa in Phase B and Run 30 simulated an emergency scenario in a laden condition.

Runs 17 to 20 simulated a 330m long container ship with a 48m beam both arriving and departing Calata Massaua in Phase A.

The Pilot Boarding Stations (PBS) and anchorage areas outside the new channel entrance must be re-examined. A run was carried out to provide an indication of the duration of the transit from the existing PBS to the new entrance. This took 32 minutes from the existing PBS to being aligned for the approach to the new entrance, which was approximately 1.5nm from the entrance.

A multi-track plot of all the runs in Solutions 4 are shown in Figure 4.17.

Runs 8 to 12

Runs 8 to 12 investigated all the main wind conditions for a ULCS in Solution 4. The ship generally entered the channel with a speed up to 8 knots and kept a transit speed higher than 4 knots, with a maximum drift angle of 15°. A ULCS was able to enter the channel maintaining more than a beam width from any infrastructure (minimum clearance of 68m – Run 10). The ship was drifting slightly before approaching the channel entrance. In particular in a southerly wind, the ship's northerly position was using the available area in the north of the channel before entering the narrowest area of the channel (Figure 4.13). The pilot was aiming to have the smallest drift angle possible and found a speed between 7.5 and 5.5 knots to be the best to perform the manoeuvre.

As the wave agitation inside the port was not a restraint for Solution 4, the channel length was optimised to control the ship's speed and therefore resulted in a lower available time to make fast the tugs than Solutions 2 and 3. Nonetheless, the channel length, from the outer extent of the south breakwater was sufficient to make the tugs fast ready for use in the manoeuvring area, for both ballast and laden conditions. Furthermore, the large space available permitted the ship to manoeuvre up to the berth with a minimum usage of the tugs. These were needed only to assist during the turning and to berth alongside (Figure 4.15).

In SE winds the Pilot was able to use the wind in his favour to perform the manoeuvre and berthing on the port side (Run 08). In SSW and N winds, the tugs were considered on the limit with no spare capacity to overcome possible failures. In the worst condition, 5 x 70t BP tugs were considered on the limit to bring the ship alongside the berth. In particular, the ship used an initial tug fleet of 4 x 70t BP tugs (Run 9), which were just about sufficient to control the lateral speed of the ship while berthing alongside with a 25 knot beam-on wind. With a northerly wind, 5 tugs and the bow thrusters used on full power were just sufficient to hold the ship in position (Run 10).

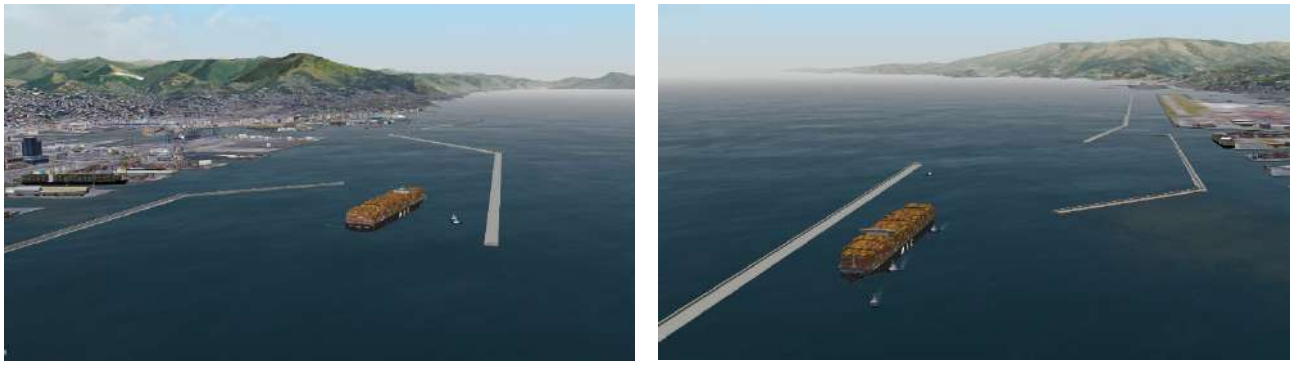


Figure 4.13: ULCS entering the channel (left hand side) and entering the manoeuvring area (right hand side) – Run 12

Source: HR Wallingford Ship Simulation System

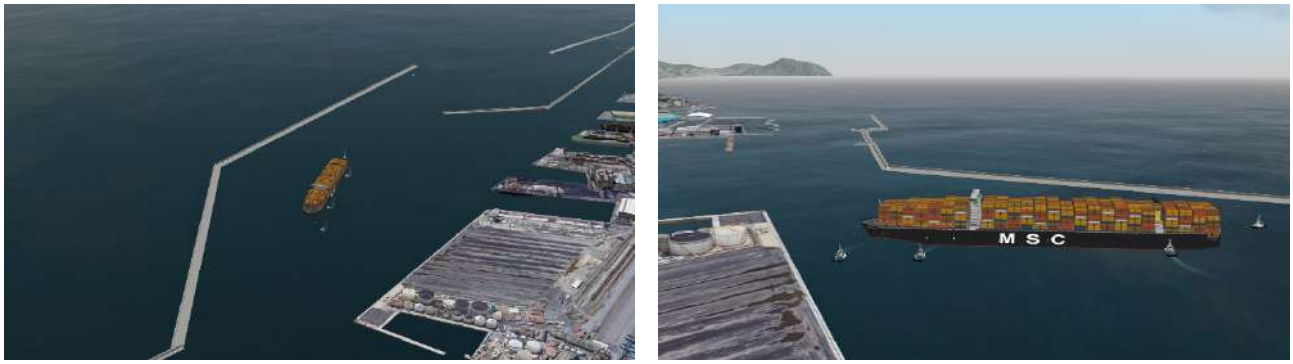


Figure 4.14: ULCS performing a dynamic turn – Run 12

Source: HR Wallingford Ship Simulation System

Figure 4.15: ULCS departing from Calata Bettolo (left hand side) and leaving port (right hand side) – Run 11

Source: HR Wallingford Ship Simulation System

Runs 17 to 20

Runs 17 to 20 simulated a 330m long container ship with a 48m beam both arriving and departing Calata Massaua in Phase A in all the predominant wind conditions.

Compared to Solution 3, Solution 4 showed a higher usage of tug power in the final approach and less in the manoeuvring area (see Run 17 and Run 16).

In conclusion, the runs showed that manoeuvring to and from Calata Massaua is feasible for all the solutions, provided there is no other ship berthed on Ponte Eritrea, opposite Calata Massaua.

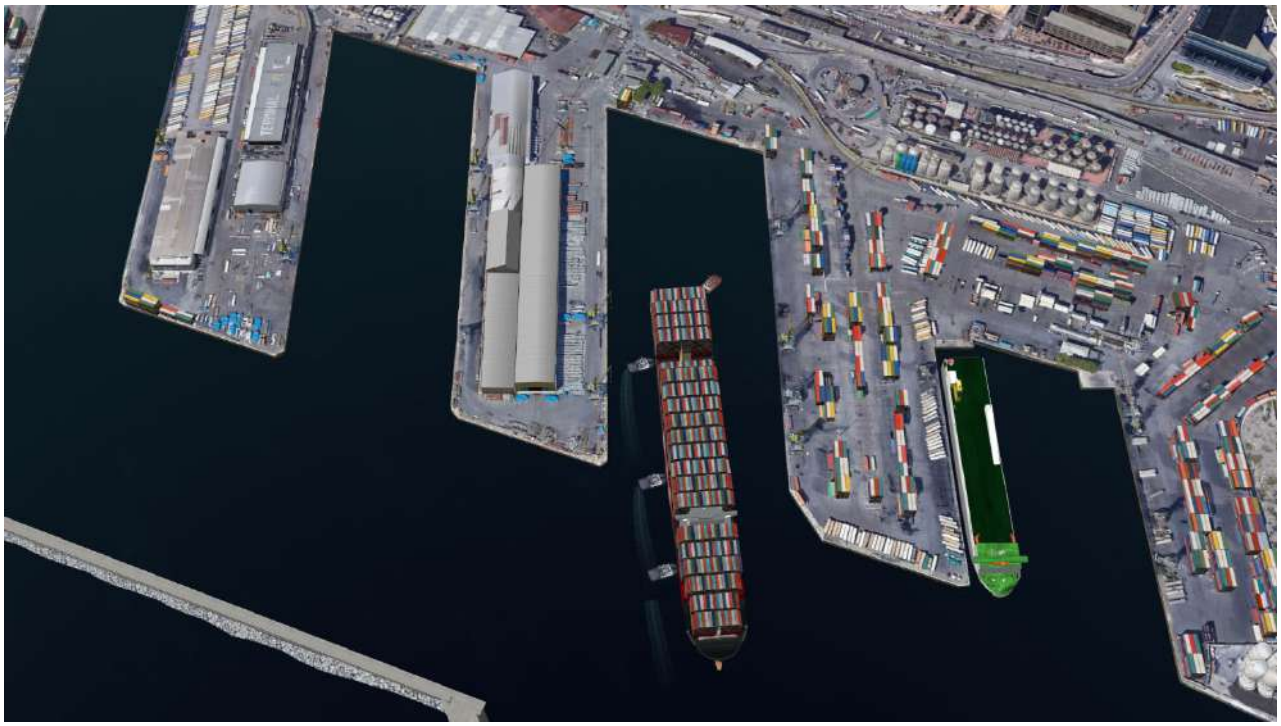


Figure 4.16: 330m x 48m container ships entering to Calata Massaua stern first – Run 19

Run 30

Similarly to Solution 2 and 3 (Run 29), an emergency scenario was examined also for Solution 4. The emergency was again a complete blackout of the ship while the ship was entering the manoeuvring area with 5 x 80t BP tugs. The methodology used was the same as Run 29. So in addition to the aft tug pulling on full power, the tugs on the side were used at 45° off the ship to control the ship in the manoeuvring area. The ship was kept under control in the eastern side of the manoeuvring area, so remaining away from any infrastructure.

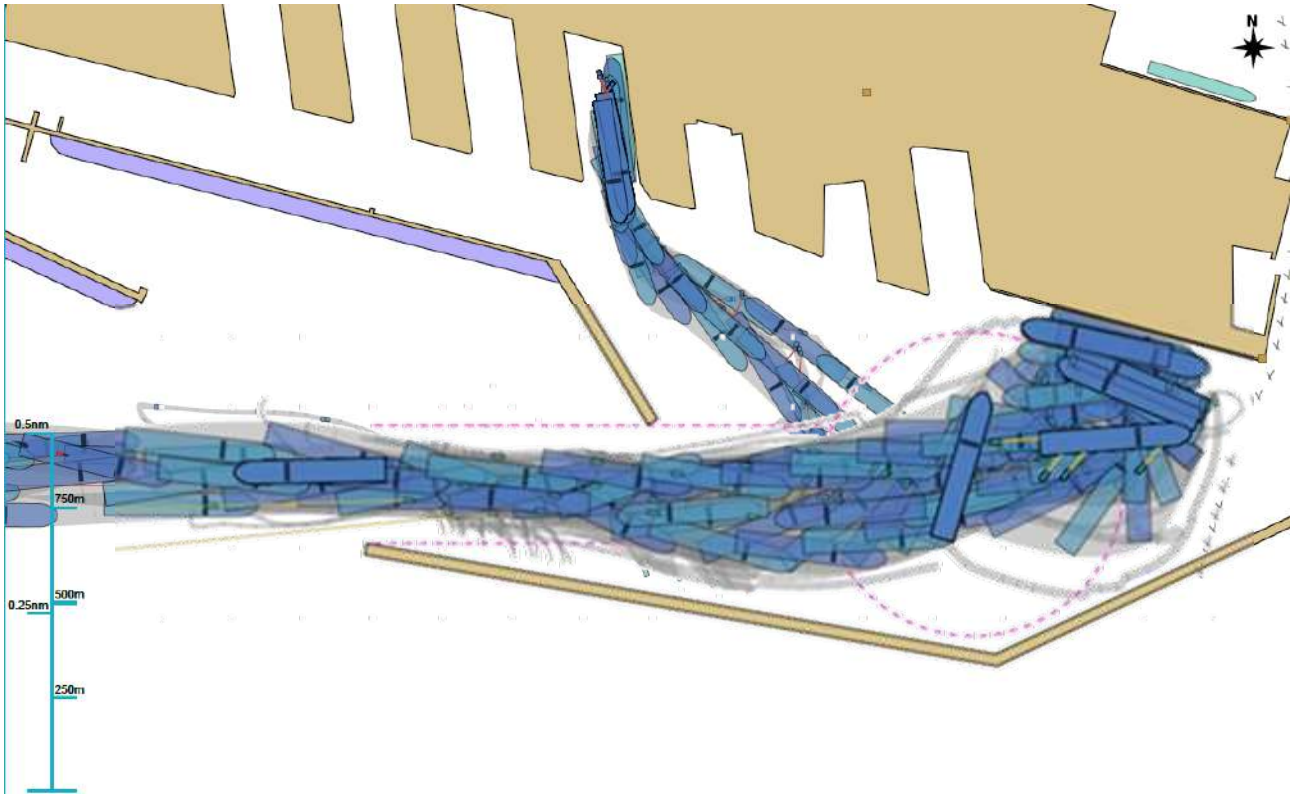


Figure 4.17: Multi track plot: Channel and manoeuvring area for Solution 4

5. Conclusions and recommendations

General

A total of 31 runs was performed by the Port of Genoa Chief Pilot, Captain Danilo Fabricatore and the tugs were operated under the supervision of the Genoa Tug Master, Albert Sturlese. The session covered three proposed layouts using the corresponding wave and current numerical models (as approved by the AdSPdMLO on the 21st April 2020), each with a Phase A and B, as defined in Section 3.1:

- Solution 2, with eastern approach
- Solution 3, with eastern approach
- Solution 4, with western approach.

The PIANC channel design guidelines, for use in conceptual design, were previously used to design the layouts, which provided a manoeuvring area with minimum dimensions of 2 times the length of the design ship, an approach channel with a minimum width of 310m (5 times the design ship's beam) and a minimum stopping distance of 2,000m (5 times the design ship's length).

The runs performed during the session followed the scheduled runs discussed with AdSPdMLO during the different meetings and approved on 21st April 2020. Only minor changes to the run conditions were made based on the results of the simulations and approved by the participants prior the execution of each run.

The following general conclusions were drawn from the navigation study:

- All of the solutions examined were shown to be safe from a navigation standpoint.
- Whilst a channel and a turning circle were marked on the electronic chart, a larger area with natural depths greater than the design depths was also available and so this area was used to perform the manoeuvres, especially when in proximity to the manoeuvring area.
- The tugs were always made fast (connected to ship's bitts by a tow-line) when the ship was entering the channel adjacent to the south breakwater, prioritising the aft tug with the aim of controlling the ship's speed. It was noted that the Pilot generally did not make use of the tug to slow down the ship in the approach channel, using only the engine astern once the aft tug was fast, mainly while approaching the manoeuvring area.
- The manoeuvres were generally carried out using "dynamic manoeuvres" using the space available and reducing the duration of the manoeuvre by turning close to the berth.
- An Ultra Large Container Ship (ULCS) was simulated both arriving and departing port and starboard sides alongside Calata Bettolo. This was shown to be feasible for all the solutions in Phases A and B.
- A 330m long container ship with a 48m beam was simulated both arriving and departing Calata Massaua in Phase A. This was shown to be feasible for all the solutions, provided there was no other ship berthed on Ponte Eritrea, opposite Calata Massaua.
- A ULCS was simulated both arriving and departing port and starboard sides alongside Ponte Canepa in Phase B, with the widening of the Sampierdarena Basin. This was shown to be feasible for all the solutions.
- ULCSs manoeuvring in the widened Sampierdarena Basin in wind conditions of up to 25 knots passed moored ships with more than a 1.5 beam separation at a speed of between 2.3 and 3.0 knots. The impact on the moored ships should be considered to determine if the passing effects of a ULCS, with a displacement up to 280,000t, would impact the operations of the moored ship.
- For manoeuvring with the ULCS, a tug fleet of 4 or 5 x 70tBP ASD tugs (or tugs with similar manoeuvring characteristics) were required for draughts up to 14.5m and 5 x 80tBP ASD tugs for draughts greater than 14.5m. For the 330m x 48m container ship 4 x 70tBP ASD tugs were required.
- A distance of 1.5nm from the outer breakwaters was considered sufficient for the pilot to board the ship on the approach to the port. The position of the Pilot Boarding Station should be determined based on a consultation carried out by the Port Authority.
- The Aids to Navigation considered during the simulation were considered appropriate, although additional marks on the breakwater are required.
- All solutions are expected to improve the traffic management in the port, as each solution offers two possible entrances to the port. It is expected that the traffic will be separated depending on the ship size and the berth to which they are calling.
- It is recommended that real time navigation simulation training and familiarisation is carried out to allow the Pilots to familiarise themselves with the new port layout and design ships, and refine their manoeuvring strategies as required before the new development is constructed.

Solution 2

The conclusions drawn from the study for Solution 2 were as follows:

- A ULCS was able to enter and exit the channel maintaining more than one beam width from any infrastructure (minimum clearance of 77m).

- The ship generally entered the channel with a speed of up to 7.5 knots and keeping a transit speed higher than 4 knots with a maximum drift angle of 11°.
- The channel length, from the outer extent of the south breakwater, was sufficient to make the tugs fast ready for use in the manoeuvring area for both ballast and laden conditions.
- The ship used most of the manoeuvring area available, maintaining a good distance from all the infrastructure. The tugs were used at up to full power in conjunction with the ship's bow thruster to perform the manoeuvres. Given the available space, the Pilot manoeuvred such that the space used on the final approach to the berth was minimised.
- In certain conditions, the tugs were considered on the limit with no spare capacity to overcome possible failures.
- Emergency scenarios showed that sufficient space was available to control the ship. A tug fleet consisting of up to 5 x 80tBP ASD tugs were required to adequately deal with credible emergency scenarios.
- Solution 2 provides a defined traffic separation between Porto Vecchio and the Sampierdarena Basin, as no access to Porto Vecchio is possible for larger ships from the new entrance.

Solution 3

The conclusions drawn from the study for Solution 3 are as follows:

- Solution 3 has common elements to Solution 2 in the approach channel and manoeuvring area, and therefore the conclusions in this regard for Solution 2 also apply to Solution 3.
- Solution 3 differs from Solution 2 as the opening to the Porto Vecchio is increased which allows more flexibility between the new and the old port entrance. An emergency scenario using the existing entrance for an arrival and departure of a ULCS was examined in a 25 knot northerly wind. The displacement of the ULCS, the control of the ship and the speeds required when passing the Ponente Superbacino Jetty and marina meant that the manoeuvre was at high risk of making contact with other moored ships and port infrastructure in the vicinity. It may be possible to use the existing entrance at lower wind speeds or with smaller ships, however, this entrance is not recommended to be used by the ships using the Sampierdarena Basin berths in normal conditions.

Solution 4

The conclusions drawn from the study for Solution 4 are as follows:

- A ULCS was able to enter the channel maintaining more than a beam width from any infrastructure (minimum clearance of 68m).
- The ship generally entered the channel with a speed up to 8 knots and kept a transit speed higher than 4 knots with a maximum drift angle of 15°.
- The channel length, from the outer extent of the south breakwater was sufficient to make the tugs fast ready for use in the manoeuvring area for both ballast and laden conditions, although it was noted that the channel length is reduced when compared with Solutions 2 and 3.
- The ship used most of the manoeuvring area available, maintaining a good distance from all port infrastructure. The tugs were used at up to full power in conjunction with the ship's bow thruster to perform the manoeuvres Given the available space, the Pilot manoeuvred such that the space used on the final approach to the berth was minimised.
- In certain conditions, the tugs were considered on the limit with no spare capacity to overcome possible failures.

- Emergency scenarios showed that sufficient space was available to control the ship. A tug fleet consisting of up to 5 x 80tBP ASD tugs were required to adequately deal with credible emergency scenarios.
- The Pilot Boarding Stations and anchorage areas outside the new channel entrance must be re-examined. A run was carried out to provide an indication of the duration of the transit from the existing Pilot Boarding Station to the new entrance. This took 32 minutes from the existing Pilot Boarding Station to being aligned for the approach to the new entrance, which occurred approximately 1.5nm from the entrance.

6. References

1. RTP, “Le condizioni meteomarine per le manovre di navigazione per le soluzioni di intervento”, MI046R-PF-D-Z-R-016-00.
2. RTP, “Verifiche dell’agitazione ondosa nell’area portuale per le soluzioni d’intervento”, MI046R-PF-D-Z-R-015-00.

Appendices

A. Ship manoeuvring model characteristics

HR Wallingford
Working with water

400m x 62m Container Ship – 14.5m draught

PILOT CARD

Ship's name **400m x 62m MSC Container Ship** Date **14/05/2019**

Call sign **----** Year built **2019** Deadweight **225,000** tonnes

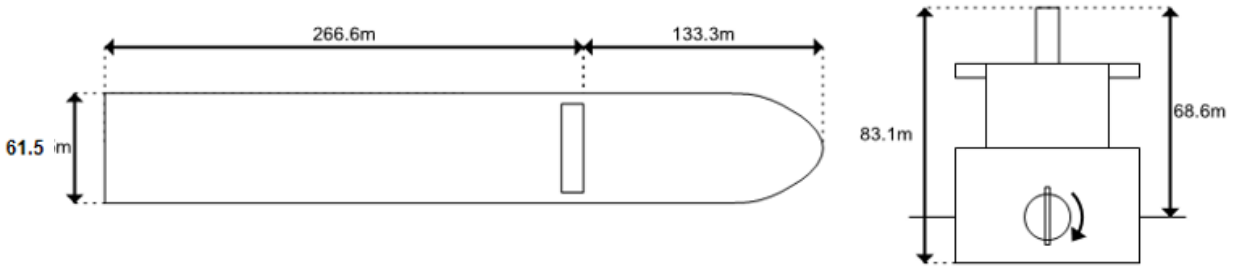
Draught aft **14.5** m Forward **14.5** m Displacement **256,118** tonnes

SHIP'S PARTICULARS

Length overall **399.9** m Anchor chain: Port **14** shackles Starboard **14** shackles

Breadth **61.5** m Stern **--** shackles

Bulbous bow **Yes** Yes/No (1 shackle = **27.432** m / **15** fathoms)



Type of engine **MAN BW 11G95 ME-C9.5** Propeller type **1 x FPP** Maximum power **66,650** kW (**90,619** HP)

Manoeuvring engine order	RPM/Pitch	Speed (knots)
Full Ahead	49	14.2
Half Ahead	39	11.0
Slow Ahead	29	7.7
Dead Slow Ahead	19	4.5
STOP	0	0.0
Dead Slow Astern	-19	Time limit astern ---- min
Slow Astern	-29	Full ahead to full astern ---- s
Half Astern	-39	Max. no of consec starts **18**
Full Astern	-49	Maximum RPM ---- knots
Critical RPM	57 - 57	Astern power **100** % ahead

STEERING PARTICULARS

Type of rudder **Full Spade** Maximum angle **35** °

Hard-over to hard-over **26** s

Rudder angle for neutral effect **0** °

Thruster: Bow **6000 kW (8040 hp)** KW Stern **none fitted** KW

400m x 62m Container Ship – 16.5m draught

PILOT CARD

Ship's name **400m x 62m MSC Container Ship** Date **14/05/2019**

Call sign **----** Year built **2019** Deadweight **225,000** tonnes

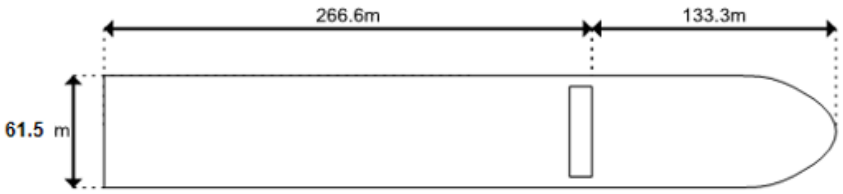
Draught aft **16.5** m Forward **16.5** m Displacement **292,958** tonnes

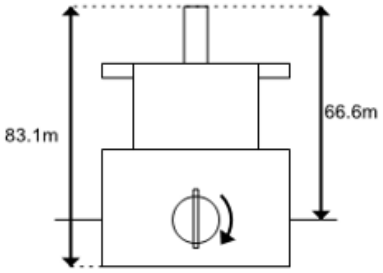
SHIP'S PARTICULARS

Length overall **399.9** m Anchor chain: Port **14** shackles Starboard **14** shackles

Breadth **61.5** m Stern **--** shackles

Bulbous bow **Yes** Yes/No (1 shackle = **27.432** m / **15** fathoms)





Type of engine **MAN BW 11G95 ME-C9.5** Propeller type **1 x FPP** Maximum power **66,650** kW (**90,619** HP)

Manoeuvring engine order	RPM/Pitch	Speed (knots)
Full Ahead	49	13.5
Half Ahead	39	10.4
Slow Ahead	29	7.4
Dead Slow Ahead	19	4.3
STOP	0	0.0
Dead Slow Astern	-19	Time limit astern ---- min
Slow Astern	-29	Full ahead to full astern ---- s
Half Astern	-39	Max. no of consec starts **18**
Full Astern	-49	Maximum RPM ---- knots
Critical RPM	57 - 57	Astern power **100** % ahead

STEERING PARTICULARS

Type of rudder **Full Spade** Maximum angle **35** °

Hard-over to hard-over **26** s

Rudder angle for neutral effect **0** °

Thruster: Bow **6000 kW (8040 hp)** KW Stern **none fitted** KW

330m x 48m Container Ship – 11.0m draught

PILOT CARD

Ship's name **330m Container** Date **19/03/2020**

Call sign **----** Year built **2016** Deadweight **95,300** tonnes

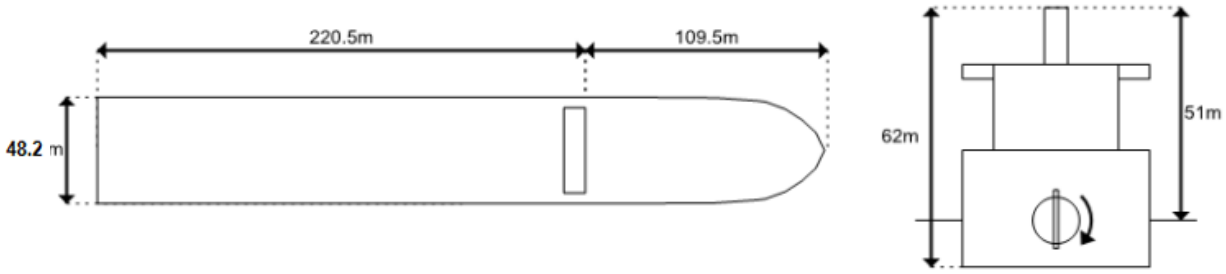
Draught aft **11** m Forward **11** m Displacement **113,486** tonnes

SHIP'S PARTICULARS

Length overall **330** m Anchor chain: Port **14** shackles Starboard **14** shackles

Breadth **48.2** m Stern **--** shackles

Bulbous bow **Yes** Yes/No (1 shackle = **27.432** m / **15** fathoms)



Type of engine **MAN BW 8G95ME C9.5** Propeller type **1 x FPP** Maximum power **42,310** kW (**57,526** HP)

Manoeuvring engine order	RPM/Pitch	Speed (knots)
Full Ahead	61	17.8
Half Ahead	52	15.2
Slow Ahead	38	11.1
Dead Slow Ahead	25	7.3
STOP	0	0.0
Dead Slow Astern	-25	Time limit astern **----** min
Slow Astern	-38	Full ahead to full astern **----** s
Half Astern	-52	Max. no of consec starts **----**
Full Astern	-61	Maximum RPM **----** knots Astern power **100** % ahead

STEERING PARTICULARS

Type of rudder **Standard** Maximum angle **35** °

Hard-over to hard-over **18** s

Rudder angle for neutral effect **0** °

Thruster: Bow **3000 kW (4020 hp)** KW Stern **none fitted** KW

330m x 48m Container Ship – 13.5m draught

PILOT CARD

Ship's name **330m Container** Date **15/08/2018**

Call sign **----** Year built **2016** Deadweight **95,300** tonnes

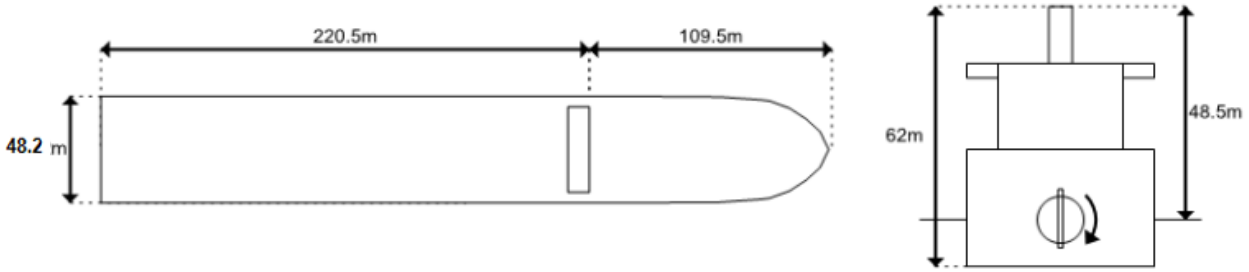
Draught aft **13.5** m Forward **13.5** m Displacement **143,499** tonnes

SHIP'S PARTICULARS

Length overall **330** m Anchor chain: Port **14** shackles Starboard **14** shackles

Breadth **48.2** m Stern **--** shackles

Bulbous bow **Yes** Yes/No (1 shackle = **27.432** m / **15** fathoms)



Type of engine **MAN BW 8G95ME C9.5** Propeller type **1 x FPP** Maximum power **42,310** kW (**57,526** HP)

Manoeuvring engine order	RPM/Pitch	Speed (knots)
Full Ahead	61	17.0
Half Ahead	52	14.5
Slow Ahead	38	10.6
Dead Slow Ahead	25	7.0
STOP	0	0.0
Dead Slow Astern	-25	Time limit astern **----** min
Slow Astern	-38	Full ahead to full astern **----** s
Half Astern	-52	Max. no of consec starts **----**
Full Astern	-61	Maximum RPM **----** knots
		Astern power **100** % ahead

STEERING PARTICULARS

Type of rudder **Standard** Maximum angle **35** °

Hard-over to hard-over **18** s

Rudder angle for neutral effect **0** °

Thruster: Bow **3000 kW (4020 hp)** KW Stern **none fitted** KW

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Working with water

Table: Vessel Particulars

Model name	Unit	330m x 48m Container Ship			400m x 62m Container Ship		
Length overall	m	330.0			399.9		
Length between perpendiculars	m	316.4			383.0		
Beam overall	m	48.2			61.5		
Distance bridge to stern	m	220.5			266.6		
Modelled conditions			**Laden**	**Ballast**		**Laden**	**Part Laden**
Draught forward	m		13.5	11		16.5	14.5
Draught aft	m		13.5	11		16.5	14.5
Block coefficient			0.68	0.66		0.73	0.73
Displacement	t		143,000	113,000		293,000	256,000
Propulsion							
Main engine type		MAN BW 8G95ME C9.5			MAN BW 11G95 ME-C9.5		
Engine power (total)	kW	42,310			66,650		
No. of propellers, type		1 x fixed pitch			1 x fixed pitch		
Bow thrusters	t	46			80		
Stern thrusters	t	None			None		
Rudder type		Standard			Full Spade		
Max rudder angle	°	35			35		
Manoeuvring engine order		**RPM**	**Speed (knots)**		**RPM**	**Speed (knots)**	
Full Ahead		61	17.0	17.8	49	13.5	14.2
Half Ahead		52	14.5	15.2	39	10.4	11.0
Slow Ahead		38	10.6	11.1	29	7.4	7.7
Dead Slow Ahead		25	7.0	7.3	19	4.3	4.5
STOP		0	0.0	0.0	0	0.0	0.0
Dead Slow Astern		-25	-4.2	-4.4	-19	-3.5	-3.7
Slow Astern		-38	-6.3	-6.7	-29	-5.3	-5.6
Half Astern		-52	-8.7	-9.1	-39	-7.2	-7.6
Full Astern		-61	-10.2	-10.7	-49	-9.0	-9.5
Windage							
Windage lateral	m²		12,314	13,104		20,454	21,232
Windage frontal	m²		1,903	2,024		3,529	3,652
Wind Speed (knots)		**Beam wind force (t)**			**Beam wind force (t)**		
15			45	48		75	77
20			80	85		132	138
25			125	133		207	215
30			179	191		298	309
35			244	260		406	421

Source: HR Wallingford Ship Simulator Centre

B. Navigation simulation run summary

Genoa New Breakwater – Navigation simulation run summary

Run ID	Scenario/ objective of run [1]	Ship	Layout	Tugs [2]	Moored ships	Tide/ current	Wind	Waves H_s, T_p, θ [3]	Outcome	Comments and pilot/tug master remarks
01	Familiarisation Arrival to Calata Bettolo Port side to	400m x 62m 14.5m	Sol 2 -A	4 x 70t: 1: Centre lead forward 2: Port shoulder 3: Starboard quarter 4: Centre lead aft	None	SE (135°N)	10 knots SE (135°N)	0.2m, 4s, 135°N 1.5m, 6.3s, 135°N	Successful	Familiarisation run. The ship met the tugs at the breakwater entrance with a speed of approximately 7 knots and 1 degree off to the defined channel heading. The distance from the southern breakwater at the entrance was approximately 135m. The ship was slowed using only the engine with the tugs made fast before entering the manoeuvring area. The ship was positioned to the south of the channel to gain a good position and to keep away from the stub breakwater to the north (193m clearance). The ship entered the manoeuvring area at 3.8 knots with the aft tugs used to swing to starboard assisted by the transverse thruster with the engine astern. The stern came within 20m of the marked channel edge although there was sufficient water depth to the breakwater. Tugs 2 and 3 where used to push on whilst performing the swing with Tug 4 to control the ship's rate of turn. The speed ahead decreased to about 2.5 knots in the middle of the manoeuvring area. Tug 3 was used on full power throughout the turning. Tug 2 was moved to the starboard shoulder once the vessel was about 95m from the quay heading 060°N. The approach channel was sufficient to allow the ship to perform the manoeuvre and whilst allowing 10 minutes for the tugs to make fast. The manoeuvring area was sufficient to carry out a dynamic swing. Good control was kept throughout the run. The power was more than adequate for the given conditions. Whilst a channel and turning circle is marked, naturally deep water between the breakwaters and the channel can be utilised for manoeuvring.
02	Arrival to Calata Bettolo Port side to (Run 01)	400m x 62m 14.5m	Sol2-A	4 x 70t: 1: Centre lead forward 2: Port shoulder 3: Starboard quarter 4: Centre lead aft	None	SE (135°N)	25 knots SE (135°N)	0.2m, 4s, 135°N 1.5m, 6.3s, 135°N	Successful	Repeat of previous run with wind increased to 25knots. The run started at the end of the traffic separation scheme. The ship carried a speed of about 7.5 knots at the channel entrance and passed 93m from the southern breakwater where the ship met the tugs. The ship had about 2° drift angle while in the channel with the engine half ahead to control the ship's speed in the channel. The tugs were made fast and ready to assist before the ship entered the manoeuvring area. The ship was positioned close to the south of the defined channel edge, but maintained a large clearance from the breakwater (more than 200m). The ship entered the manoeuvring area at about 5 knots. The ship made a dynamic turn to starboard with Tugs 2, 3 and 4 on full power. The ship reached a rate of turn of 16°/min. When the ship bridge passed the corner of the quay, Tug 2 was moved to the starboard side to assist in berthing the ship. The ship kept a clearance of 74m from the quay following the turning. Tug 3 was left to push on full power instead of pulling. This was corrected once the ship was close to the berth. The space was sufficient to recover from the misunderstanding. The increased wind from the stern resulted in a higher approach speed (2 knots higher than Run 1) generating a larger turning path. Whilst the manoeuvre was suboptimal there was sufficient reserve power. If the swig had taken place in the centre of the turning circle, the manoeuvre would require more power and time to be completed.
03	Arrival to Calata Bettolo Port side to (Run 02)	400m x 62m 14.5m	Sol2-A	4 x 70t: 1: Centre lead forward 2: Port shoulder 3: Starboard quarter 4: Centre lead aft	None	None	30 knots N (0°N)	None	Successful	The ship entered the channel at about 6 knots keeping a clearance of 189m from the southern breakwater and a drift angle between 9° and 11°. The tugs were made fast and were ready to assist when the ship entered the manoeuvring area. The ship entered the manoeuvring area at about 4 knots and commenced turning to starboard. The Pilot performed a dynamic turn with the help of the aft and shoulder tugs. Once the ship was in the middle of the manoeuvring area, the shoulder tug was moved to the starboard side amidship to help berthing the ship. During the turning, the ship was kept a clearance of 40m from the quay. The Pilot needed to use the bow thruster and all four tugs on full power with Tug 1 repositioned on the starboard shoulder to maintain control. The ship was about 1 knot slower than Run 2 when entering the manoeuvring area. This and the northerly wind helped to reduce the swept path of the ship. Four 70t tugs were identified as the minimum required with a 30 knot beam wind. No power was left in reserve.
04	Arrival to Calata Bettolo Starboard side to (Run 04)	400m x 62m 14.5m	Sol2-A	5 x 70t: 1: Centre lead forward 2: Port shoulder 3: Port amidship 4: Port quarter 5:Centre lead aft	None	None	30 knots N (0°N)	None	Successful	The ship entered the channel at 6.4 knots, keeping to the north. The ship maintained a drift angle of about 8° in the channel and initially turned to starboard once the ship's bow passed the western end of the north breakwater. The ship speed approaching the turning area was about 4 knots, reduced following the turn. The bow tug was used on full power with Tug 3 pushing on the ship's port side to turn the ship to starboard in the eastern part of the manoeuvring area. Once the ship's heading was about 0°N, the tugs were reposition to bringing the stern round to starboard. The bow tug was repositioned amidship to push the ship alongside. The ship was kept under control throughout the manoeuvre although five 70t tugs were not adequate to berth alongside with 30 knots of wind. Five tugs of greater power than 70t BP are required.

Run ID	Scenario/ objective of run [1]	Ship	Layout	Tugs [2]	Moored ships	Tide/ current	Wind	Waves H_s, T_p, θ [3]	Outcome	Comments and pilot/tug master remarks
05	Departure from Calata Bettolo Starboard side to (Run 05)	400m x 62m 14.5m	Sol2-A	5 x 70t: 1: Port shoulder 2: Port shoulder 3: Port amidship 4: Port quarter 5:Centre lead aft	None	None	30 knots N (0°N)	None	Successful	The Pilot used the off berth wind to depart from the quay. When the ship was 30m from the quay, both the bow thruster and Tug 5 were used to increase the lateral speed. Tug 5 was used to perform the starboard swing while the other tugs were relocated on the ship's starboard side. Once repositioned, the tugs were used up to full power to control the ship's rate of turn. The ship turned to starboard and exited the manoeuvring area keeping a clearance of 77m from the western end of the north breakwater. While good control was kept throughout the run, the power was considered on the limit and no spare capacity available.
06	Departure from Calata Bettolo Starboard side to (Run 06)	400m x 62m 14.5m	Sol2-A	4 x 70t: 1: Centre lead forward 2: Port shoulder 3: Port quarter 4:Centre lead aft	None	SSW (210°N)	25 knots SSW (210°N)	0.2m, 4.0s, 210°N 2.5m, 9.1s, 210°N	Successful	The tugs were used to pull the ship off the berth. The Pilot started a turn to port when the stern was 20m from the quay using the engine slow ahead. The aft tugs, the bow thruster and the engine half ahead were used to perform the turn in the manoeuvring area. The ship passed 145 m from the southern breakwater in the area with natural depth. There was adequate space to keep more distance from the quay while swinging to port. The tug capacity was felt to be at the limit.
07	Arrival and departure to Calata Bettolo using existing entrance Starboard side to (Run 07 variation)	400m x 62m 14.5m	Sol3-A	5 x 70t: 1: Centre lead forward 2: Port shoulder 3: Port amidship 4: port quarter 5:Centre lead aft	None	None	25 knots N (0°N)	None	Marginal	The ship entered using the existing approach channel with a speed of 6 knots using the engine between slow and dead slow ahead whilst keeping a clearance of 80m from the entrance to Darsena Fiera Basin. The ship passed the Ponente Superbacino Jetty at about 5 knots at a distance of 70m. The aft tug and the bow thruster were used to control the bow towards the Sampierdarena basin. The ship passed the opening to the Porto Vecchio keeping a minimum clearance of 66m on the starboard side and 170m to the port side. Tug 1 and Tug 5 were used to pull the vessel away from the quay while the other tugs were repositioned on the ship's starboard side to perform a starboard swing. The ship kept a minimum clearance of 62 m from the Calata Bettolo quay during the swing using the engine half ahead. The ship left the manoeuvring area keeping close to the quay (minimum clearance of 17m) with the engine full ahead and a speed of 5.8 knots. Exiting the channel, the ship reached 9.0 knots. The ship was not under control in the transit although the tug power was considered sufficient to bring the ship alongside. The impact of passing ship interaction, given the speed and ship displacement is likely to be significant. Nonetheless, a slow speed transit is a high risk manoeuvre due to the leeway of the ship. The existing approach channel was therefore deemed unsuitable for the manoeuvring of the design ship. The Chief Pilot preferred this solution considering it more safe than the others due to the long channel and the opening towards the Porto Vecchio.
08	Arrival to Calata Bettolo Port side to (Run 09)	400m x 62m 14.5m	Sol4-A	4 x 70t: 1: Centre lead forward 2: Port shoulder 3: port quarter 4:Centre lead aft	None	SE (135°N)	25 knots SE (135°N)	0.2m, 4s, 135°N 1.5m, 6.3s, 135°N	Successful	The ship started from the existing pilot boarding station and transited west to enter in the west entrance. The ship kept a distance between 1nm and 1.5nm from the breakwater and a speed of about 10 knots through the water following the existing speed restrictions in place, with a transit time of 32 minutes to the start of the approach to the port. The ship was realigned at 1.5nm from the entrance with a speed of about 6 knots, entering the channel with the engine slow ahead and with a drift angle of about 8°. About 9 minutes after passing the southern breakwater, the ship passed the end of the northern breakwater with a speed of 4.5 knots keeping the bridge on the centre of the channel. This led to a minimum clearance from the northern breakwater of 77m and 125m from the southern breakwater. No tugs were used to reduce the ship's speed. The ship entered the manoeuvring area with a speed of 3 knots and drifted close to the quay with a speed of 2.3 knots with the engine on dead slow to maintain position opposing the south-easterly wind. No tugs were used up to when the ship was about 150m from Calata Bettolo. The ship engine was stopped at 116m from the quay and berthed alongside using the bow thrusters and the tugs.
09	Arrival to Calata Bettolo Starboard side to (Run 10)	400m x 62m 14.5m	Sol4-A	4 x 70t: 1: Centre lead forward 2: Port shoulder 3: port quarter 4:Centre lead aft	None	SSW (210°N)	25 knots SSW (210°N)	0.2m, 4.0s, 210°N 2.5m, 9.1s, 210°N	Successful for the layout	The ship started at 7.5 knots to the south of the defined channel centreline with a drift angle of 4° and the engine slow ahead. When the ship was about 700m from the channel entrance the engine was reduced to dead slow. The engine was stopped before the ship passed the north breakwater. The ship entered the channel at 8.2 knots with wind on the ship's quarter and kept a clearance of 82m from the southern breakwater. The engine was used full astern when the ship's stern passed the end of the northern breakwater and before the tugs were made fast. The aft tug was used to pull full power astern and the ship entered the turning circle at 6 knots. The Pilot performed a dynamic starboard swing on the eastern side of the manoeuvring area. During the swing the engine was "kicked" astern to maintain the position, keeping a minimum clearance of 55m from the quay. The Pilot used the tugs to berth alongside. The tugs were considered on the limits, nonetheless, a slower approach speed at the breakwater would mean less power required to stop the ship. The Pilot recognised that the speed was quite hight on the approach and that less speed would have brought to a more controllable manoeuvre.

Run ID	Scenario/ objective of run [1]	Ship	Layout	Tugs [2]	Moored ships	Tide/ current	Wind	Waves H_s, T_p, θ [3]	Outcome	Comments and pilot/tug master remarks
10	Arrival to Calata Bettolo Starboard side to (Run 11)	400m x 62m 14.5m	Sol4-A	5 x 70t: 1: Centre lead forward 2: Starboard shoulder 3 : Port quarter 4 :Port quarter 5 : Centre lead aft	None	None	30 knots N (0°N)	None	Successful	The ship entered the channel at 5 knots with a 12° drift angle and cleared the southern breakwater by 68m. The ship passed the northern breakwater at 4.2 knots and a 15° drift angle. The engine was kept on dead slow ahead until the ship's bow was in the middle of the manoeuvring area when it was stopped. Tugs 2, 3 and 4 were used on full power to perform the port swing while Tugs 1 and 5 were used on half power. The ship was kept a minimum clearance of 87m from the southern breakwater and 100m to Calata Bettolo while swinging. Tug 1 was repositioned on the port side to assist pushing the ship alongside. The slow speed in the channel caused the ship to have a large drift angle, nonetheless the space was sufficient and the vessel was under control throughout the all run.
11	Departure to Calata Bettolo Port side to (Run 13)	400m x 62m 14.5m	Sol4-A	5 x 70t: 1: Centre lead forward 2: Starboard shoulder 3: Port quarter 4:Port quarter 5: Centre lead aft	None	SSW (210°N)	25 knots SSW (210°N)	0.2m, 4.0s, 210°N 2.5m, 9.1s, 210°N	Successful	The tugs were used on full power to lift off the ship from the berth. Once the ship was at about 70m from the quay, the bow thruster was used on full power with the engine slow astern to swing the ship to port and aligned with the wind. Once the ship was about 170m from the quay, the Pilot performed a starboard swing using the bow thrusters and the forward tugs on full power. During the swing the engine was kept on half ahead to manoeuvre the ship ahead, away from the quay. The ship's stern was kept a minimum clearance of 55m from the berth while swinging. The ship left the manoeuvring area at about 7.6 knots. The manoeuvre was safe but a refinement of the methodology would increase the clearance aft when swinging. The Pilot preferred to swing to starboard using the bow thrusters. Nonetheless, he recognised that going further out towards the centre of the manoeuvring area before performing the swing would have provided a larger clearance from the berth.
12	Arrival to Calata Bettolo Starboard side to (Run 10)	400m x 62m 14.5m	Sol4-A	4 x 70t: 1: Centre lead forward 2: Port shoulder 3: Port quarter 4: Centre lead aft	None	SSW (210°N)	25 knots SSW (210°N)	0.2m, 4.0s, 210°N 2.5m, 9.1s, 210°N	Successful for the layout	Repetition of run 09 with reduced ship's speed. The ship approached at 5.5 knots and a drift angle of 9° on the north side of the defined channel. A minimum clearance of 150m from the southern channel was achieved. The ship maintained a position to the south when passing the end of the north breakwater, keeping a minimum clearance of about 105m from the southern breakwater. Tug 1 was used on full power to bring the bow towards the middle of the manoeuvring area with a ship speed of 3 knots in to the swing to port. The ship was kept a minimum clearance of 51m from the berth using all tugs and the bow thruster on full power, but no engine power. The engine was used to finalise the position of the ship before coming alongside. The pilot felt the ship was not under control in the approach due to the low speed of the ship and judged the drift angle as excessive.
13	Arrival to Calata Massaua Port side to (Run 14)	330m x 48m 13.5m	Sol3-A	4 x 70t: 1: Centre lead forward 2: Port shoulder 3: Starboard quarter 4: Centre lead aft	None	None	30 knots N (45°N)	None	Successful	The ship entered the port at 8 knots keeping to the north side of the channel (52m from the rock armour of the north breakwater). The ship had a drift angle between 5° and 8° in the channel, entering the manoeuvring area at about 5.8 knots. Tug 3 was used on the starboard quarter on full power to swing the ship to starboard. Tug 2 was repositioned on the port shoulder to help control the bow when close to the quay. The ship was manoeuvred astern to the berth at about 2 knots. Tugs 1 and 4 were used on half power and Tug 3 on full to control the ship's position. The ship was kept a minimum clearance of 28m from the east corner of Ponte Eritrea and about 47m from Ponte Eritrea east quay. The vessel was kept under control throughout the run.
14	Arrival to Calata Massaua Port side to (Run 15)	330m x 48m 11.0m	Sol3-A	4 x 70t: 1: Centre lead forward 2: Port shoulder 3: Port quarter 4: Centre lead aft	Calata Bettolo: 400m x 62m Testata Ponte Etiopia: 100m x 15m Ponte Eritrea East: 222m x 30m	SE (135°N)	25 knots SE (135°N)	0.2m, 4s, 135°N 1.5m, 6.3s, 135°N	Marginal Due to ship on adjacent berth	The ship was swung to starboard in the turning circle with the help of the bow thruster, and Tugs 1, 2 and 4 before being manoeuvred astern to the berth keeping a heading of 120°N. Tug 1 was moved amidship after Tugs 2 and 3 were repositioned on the starboard side. The ship was kept about 25m from the vessel at Ponte Eritrea East and used the engine to manoeuvre astern. The small space between the two ships was a concern for the safety of the tugs. The run would have been considered safe and successful if Ponte Eritrea East was clear.
15	Departure from Calata Massaua Starboard side to (Run 18)	330m x 48m 11.0m	Sol 3-A	4 x 70t: 1: Centre lead forward 2: Port shoulder 3: Port quarter 4: Centre lead aft	Calata Bettolo: 400m x 62m	SE (135°N)	25 knots SE (135°N)	0.2m, 4s, 135°N 1.5m, 6.3s, 135°N	Successful	The ship departed using the shoulder and quarter tugs to push on and control the lateral speed. The engine was used on dead slow astern to leave Calata Massaua. The ship was kept a minimum clearance of 81m from the south breakwater departing Calata Massaua. The ship was swung to port in the manoeuvring area using the bow thruster and tugs between 75% and full power. The ship's heading was aligned to the channel following the swing and departed. Good control was kept throughout the run. The additional space of the layout improves the access to Calata Massaua.

Run ID	Scenario/ objective of run [1]	Ship	Layout	Tugs [2]	Moored ships	Tide/ current	Wind	Waves H_s, T_p, θ [3]	Outcome	Comments and pilot/tug master remarks
16	Arrival to Calata Massaua Port side to (Run 15 with worst wind condition)	330m x 48m 11.05m	Sol3-A	4 x 70t: 1: Centre lead forward 2: Starboard shoulder 3: Starboard quarter 4: Centre lead aft	Calata Bettolo: 400m x 62m	SSW (210°N)	25 knots SSW (210°N)	0.2m, 4.0s, 210°N 2.5m, 9.1s, 210°N	Marginal Wind speed at limit	On the Pilot's suggestion, these conditions were considered the worst case to entering Calata Massaua. The ship was brought to a more central position in the manoeuvring area before starting to manoeuvre astern. The tugs were used to tow on full power to keep the ship in a good position entering Calata Massaua, while the tugs had to stay about 25m from the ship's hull in order not to make contact with the Ponte Eritrea quay. The wind speed was considered to be on the limit.
17	Arrival to Calata Massaua Port side to (Run 19)	330m x 48m 11.0m	Sol4-A	4 x 70t: 1: Centre lead forward 2: Starboard shoulder 3: Starboard quarter 4: Centre lead aft	Calata Bettolo: 400m x 62m	SSW (210°N)	25 knots SSW (210°N)	0.2m, 4.0s, 210°N 2.5m, 9.1s, 210°N	Successful	The ship entered the channel at about 9 knots with the engine on dead slow ahead and a drift angle of 5°. The engine was stopped when the bow passed the end of the north breakwater and the rudder was used hard to port. When the ship's bow was in the middle of the manoeuvring area, the ship's engine was used full astern. The wind was used to help swing to starboard. Tug 2 and 4 were used to keep the ship in position against the south-southwesterly wind. The ship was manoeuvred astern to Calata Massaua keeping an heading of 115°N using the tugs on full power. The ship was turned to starboard entering Calata Massaua using the tugs and the wind. The layout was considered safe and provided adequate space to manoeuvre. It required a different usage of the tug power than Sol 3-A.
18	Arrival to Calata Massaua Starboard side to (Run 19)	330m x 48m 11.0m	Sol4-A	4 x 70t: 1: Centre lead forward 2: Starboard shoulder 3: Starboard quarter 4: Centre lead aft (tug simulator)	Calata Bettolo: 400m x 62m	SE (135°N)	25 knots SE (135°N)	0.2m, 4s, 135°N 1.5m, 6.3s, 135°N	Successful	The ship entered the channel at 7.6 knots keeping to the north of the defined channel using the engine on dead slow. The engine was stopped as the ship passed the end of the north breakwater at about 6.3 knots. The aft tug was used to decrease the ship's speed while entering the manoeuvring area with the engine slow astern before bringing the stern round to port. Once the ship had come round to 130°N, the ship's engine was used to manoeuvre astern to the berth. The ship's engine was stopped in front of Ponte Idroscalo and the aft tugs were used to control the ship's direction. The ship kept a central position while manoeuvring astern to Calata Massaua. Good control was kept throughout the run. The south-easterly wind allowed a less challenging manoeuvre than the south-westerly wind. The manoeuvre was straightforward.
19	Arrival to Calata Massaua Port side alongside (Run19)	330m x 48m 11.0m	Sol4-A	4 x 70t: 1: Centre lead forward 2: Starboard shoulder 3: Starboard quarter 4: Centre lead aft (tug simulator)	Calata Bettolo: 400m x 62m	None	30 knots NE (45°N)	NE	Successful	The ship entered the channel at about 8.7 knots with the engine on slow ahead and passed the north breakwater with a speed of 6.8 knots and a drift angle of 12°. The engine was used on half astern with Tug 4 used on full power to help control the ship's speed once the stern passed the end of the north breakwater . The stern was swung to port using the aft tug on full power with the engine at dead slow astern. Once the ship was heading about 145°N, it was manoeuvred astern using the tugs and the bow thruster to maintain position. Tug 1 was repositioned at midships to control the ship's lateral speed while entering Calata Massaua. The tug power was considered on the limit. Good control was kept throughout the run.
20	Departure from Calata Massaua Starboard side to (Run 21)	330m x 48m 11.0m	Sol4-A	5 x 70t: 1: Centre lead forward 2: Port shoulder 3: Port quarter 4: Port quarter 5: Centre lead aft (tug simulator)	Calata Bettolo: 400m x 62m	SE (135°N)	25 knots SE (135°N)	0.2m, 4s, 135°N 1.5m, 6.3s, 135°N	Successful	The tugs were used to push on to control the ship's lateral speed on departing the berth. The engines were then used on dead slow astern to leave Calata Massaua. The stern was then taken to starboard, keeping to the middle of the available area and manoeuvred astern to the manoeuvring area at 3.8 knots. The tugs were repositioned on the starboard side to assist in manoeuvring the ship. Once in the middle of the manoeuvring area, the ship was swung to port with the help of the tugs before departing. The tug power was considered as on the limits although the ship had good control throughout the run.
21	Arrival to Ponte Canepa Port side alongside (Run22)	400m x 62m 16.5m	Sol3-B	5 x 70t: 1: Centre lead forward 2: Port shoulder 3: Port amidship 4: Starboard quarter 5: Centre lead aft (tug simulator)	Calata Bettolo: 400m x 62m	None	30 knots N (0°N)	None	Successful	The ship entered the channel with a speed of 7.5 knots and kept a minimum clearance of 88m from the north breakwater. The engine was stopped when the bridge passed the north breakwater at 6.2 knots and then used astern to slow the ship without the use of tugs. The Pilot performed a dynamic starboard swing using all the tugs on full power. Tug 2 and 3 were repositioned on the starboard side to maintain the ship in position while manoeuvring astern towards the Sampierdarena Basin. The tugs were sufficient, but on the limits to arrest the lateral speed of the ship when it was stopped. No concern was expressed by the Pilot to slow, stop and swing the ship.

Run ID	Scenario/ objective of run [1]	Ship	Layout	Tugs [2]	Moored ships	Tide/ current	Wind	Waves H_s, T_p, θ [3]	Outcome	Comments and pilot/tug master remarks
22	Arrival Ponte Canepa Port side alongside (Run 22)	400m x 62m 14.5m	Sol3-B	5 x 80t: 1: Centre lead forward 2: Starboard shoulder 3: Starboard mid-ship 4:Starboard quarter 4: Centre lead aft (tug simulator)	Calata Bettolo: 400m x 62m Extended berth: 2 x 400m x 62m	None	30 knots N (0°N)	None	Marginal Tug power	The run started from the end of Run 21. The engine was used on dead slow astern to manoeuvre astern to the berth. The moored ships were passed at about 0.5 knots with 180m clearance, 1.6 knots with 110m clearance and 2.3 knots with 90m clearance. No reserve capacity was available. It is important that the port impose wind limits until the Pilots have gained experience with the ship.
23	Departure from Ponte Canepa Starboard side to (Run 23)	400m x 62m 14.5m	Sol3-B	5 x 80t: 1: Centre lead forward 2: Port shoulder 3: Port quarter 4:port quarter 5: Centre lead aft (tug simulator)	Vessel alongside Calata Bettolo. 3 vessels (no sheltering)	SSW (210°N)	25 knots SSW (210°N)	0.2m, 4.0s, 210°N 2.5m, 9.1s, 210°N	Successful	The tugs were used on full power to lift the ship off the berth. The Pilot used all the tugs and bow thrusters on full power, along with the engine on slow astern to manoeuvre astern from Ponte Canepa. The moored ships were passed at about 2.7 knots with 110m clearance, 3.8 knots with 126m clearance and 3.3 knots with 200m clearance. The ship was swung to port in the middle of the manoeuvring area using all the tugs on full power except for Tug 4. The ship exited the channel keeping to the southern side with a clearance of about 119m from the south breakwater, anticipating the drift due to the wind. If the ship needs to pass Calata Massaua stern first, there is need to consider both the tug power and wind limits.
24	Departure from Ponte Canepa Starboard side to (Run 25)	400m x 62m 14.5m	Sol4-B	5 x 80t: 1: Centre lead forward 2: Port shoulder 3: mid-ship 4:port quarter 5: Centre lead aft (tug simulator)	Vessel alongside Calata Bettolo. 3 vessels (no sheltering)	None	25 knots N (0°N)	None	Successful	Departure in northerly 25 knot wind, reduced from 30 knots from Run 22. The moored ships did not provide wind sheltering. The tugs were used to push on full power to control the lateral speed induced by the wind. The engine was used on slow astern to manoeuvre astern with the assistance from the aft tug. The moored ships were passed at about 2.7 knots with 100m clearance and 3.8 knots with 165m clearance. Once in the manoeuvring area, the bow was brought to port. The ship entered the approach channel keeping to the south of the channel and a minimum clearance of 88m from the south breakwater. The Pilot reported the ship is slow to increase speed and gain steerage. With more experience the Pilot would steady up after the swing on a westerly heading to increase speed.
25	Arrival to Ponte Canepa Starboard side to (Run 26)	400m x 62m 16.5m	Sol4-B	5 x 80t: 1: Centre lead forward 2: Port shoulder 3: Port mid-ship 4:port quarter 5: Centre lead aft (tug simulator)	Vessel alongside Calata Bettolo. 3 vessels (no sheltering)	SSW (210°N)	25 knots SSW (210°N)	0.2m, 4.0s, 210°N 2.5m, 9.1s, 210°N	Successful	The ship entered the channel at 7.5 knots with a drift angle of about 5° and the engine on dead slow ahead. A minimum clearance of about 111m was kept from the south breakwater and 124m from the north breakwater. At the inner north breakwater, the engine was used astern and the ship was stopped within the turning circle. The speed was decreased to 6.2 knots when entering the manoeuvring area with a drift angle of 6.5° without using any tug assistance. This was reduced to 3.6 knots when the ship's bow was in the middle of the manoeuvring area. Once there, all tugs were used to turn the ship to port on the eastern side of the manoeuvring area keeping a minimum clearance of 114m from the ship berthed at Calata Bettolo. The ship entered the Sampierdarena Basin with the engine on slow ahead. Tugs were used on half and full power to keep the ship in position while entering the basin. The moored ship at Ponte Eritrea was passed at 3.5 knots at a minimum clearance of 120m. The moored ship at Ponte Libia was passed at 3.3 knots with a minimum clearance of 93m. The tugs were used on full power with the bow thrusters to control the ship's lateral speed. The ship was slowed slightly earlier than in previous runs and despite entering the manoeuvring area at above 6 knots and not using the aft tug, it was able to stop and turn within the manoeuvring area. Good clearance was achieved from all infrastructure. With a higher speed the environmental conditions would have felt on the limit.
26	Arrival to Ponte Canepa Starboard side to (Run 22 Sol 4-B)	400m x 62m 16.5m	Sol4-B	5 x 70t: 1: Centre lead forward 2: Port shoulder 3: Port mid-ship 4: Port quarter 5: Centre lead aft	Vessel alongside Calata Bettolo. 3 vessels (no sheltering)	None	25 knots N (0°N)	None	Successful	The ship entered the channel without using the engine at 5.6 knots and kept to the north side of the defined channel. The Pilot applied corrections with the rudder up to 10° through the channel and the ship remained on a steady heading for 5 minutes. The ship passed the end of the north breakwater with a speed of 4.1 knots on the southern side of the defined channel and the Pilot came hard to port on the rudder. The ship kept a clearance of 100m from the breakwaters while entering the manoeuvring area. The Pilot performed a port swing in the manoeuvring area, applying a port helm and turning the ship into the strong wind. The strong northerly wind helped keep the ship in the middle of the manoeuvring area while turning. No tugs were used to perform the run.

Run ID	Scenario/ objective of run [1]	Ship	Layout	Tugs [2]	Moored ships	Tide/ current	Wind	Waves H_s, T_p, θ [3]	Outcome	Comments and pilot/tug master remarks
27	Arrival to Calata Bettolo Starboard side to (Run 03)	400m x 62m 14.5m	Sol 2-A	5 x 70t: 1: Centre lead forward 2: Port shoulder 3: Port quarter 4:port quarter 5: Centre lead aft	None	SSW (210°N)	25 knots SSW (210°N)	0.2m, 4.0s, 210°N 2.5m, 9.1s, 210°N	Successful	The ship entered the channel with a 7° drift angle at 7.6 knots, using the engine slow ahead. The engine was stopped at 280m from the manoeuvring area and was started again immediately after. When the ship's bridge passed the breakwater, the engine was dead slow ahead and the ship was at 6 knots. When the ship's quarter passed the north breakwater, the ship's engine was used full astern and the ship stopped when the bow passed Ponte San Giorgio. The ship was manoeuvred using the rudder, the engine and the bow thruster and manoeuvred astern to the berth allowing the south-southwesterly wind to set the ship toward the quay. The ship had a lateral speed of 0.5 knots one beam from the quay.
28	Arrival to Calata Bettolo Starboard side to (Run 03 with emergency black out)	400m x 62m 16.5m	Sol 2-A	5 x 70t BP 1: Centre lead forward 2: Port shoulder 3: Port quarter 4:port quarter 5: Centre lead aft	None	SSW (210°N)	25 knots SSW (210°N)	0.2m, 4.0s, 210°N 2.5m, 9.1s, 210°N	Failure Insufficient tug power	The run started at minute 10 of the previous run to execute an emergency scenario. The ship had a black out at minute 4 with the rudder locked at 17° to starboard. Tug 5 was used to tow at full power to control the ship's speed and to start the port swing when the ship's bow passed the northern breakwater. The ship entered the turning area with a speed of 5 knots. Tug 1 and 2 were used on full power to induce a turn to port unsuccessfully, while the aft tug was pulling on full power. Tug 3 and 4 were not used. The aft tug was not sufficient to reduce the ship's speed and Tug 1 and 2 were unable to induce sufficient rate of turn to port in the environmental conditions.
29	Arrival to Calata Bettolo Starboard side to (Run 03 with emergency black out)	400m x 62m 16.5m	Sol 2-A	5 x 80t BP 1: Centre lead forward 2: Port shoulder 3: Port quarter 4:port quarter 5: Centre lead aft	None	SSW (210°N)	25 knots SSW (210°N)	0.2m, 4.0s, 210°N 2.5m, 9.1s, 210°N	Successful	Repeat of Run 28 with higher tug power. The aft tug was used to pull astern on full power with Tug 2, 3 and 4 used to reduce the ship speed by pulling at 45° astern. The ship entered the manoeuvring area just below 6 knots, but once in the middle of the manoeuvring area, the speed had reduced to 2.6 knots. The forward and aft tugs were repositioned to control the ship's heading towards the Sampierdarena Basin. The ship was under control in the western part of the manoeuvring area before the end of Ponte San Giorgio. The change in methodology and the increased tug power meant that the ship was kept under control and reached a point of safety.
30	Arrival to Calata Bettolo Port side to (Run 29 Emergency black out in Sol 4-A)	400m x 62m 16.5m	Sol 4-A	5 x 70t BP: 1: Centre lead forward 2: Starboard shoulder 3: Starboard quarter 4: Starboard quarter 5: Centre lead aft	None	SSW (210°N)	25 knots SSW (210°N)	0.2m, 4.0s, 210°N 2.5m, 9.1s, 210°N	Successful	Repeat of Run 29 with a Solution 4-A. The ship started at the end of the northern breakwater at about 7 knots. The ship suffered of a black out at minute 1. Tug 5 was used to tow full astern to reduce the ship's speed with the help of Tug 2, 3 and 4 towing 45° astern. The ship's speed had reduced to 2.6 knots when the ship's stern was in the middle of the manoeuvring area. The ship was stopped once the ship was 148m from the end of Calata Bettolo. The ship was kept at a clearance of more than 200m from Calata Bettolo. The ship remained under control and reached a point of safety. The wind and current were pushing the ship forward, therefore more power was required than Run 29.
31	Arrival to Calata Massaua Starboard side to (Run 16)	330m x 48m 11.0m	Sol 3-A	4 x 70t: 1: Centre lead forward 2: Port shoulder 3: Port quarter 4: Centre lead aft	Vessel alongside Calata Bettolo	SSW (210°N)	25 knots SSW (210°N)	0.2m, 4.0s, 210°N 2.5m, 9.1s, 210°N	Successful	The ship approached the Sampierdarena Basin at 2.2 knots and the tugs were used on full power to maintain the ship in position. The ship was slightly to the west compared to the other runs. The ship entered Calata Massaua at 1.6 knots.

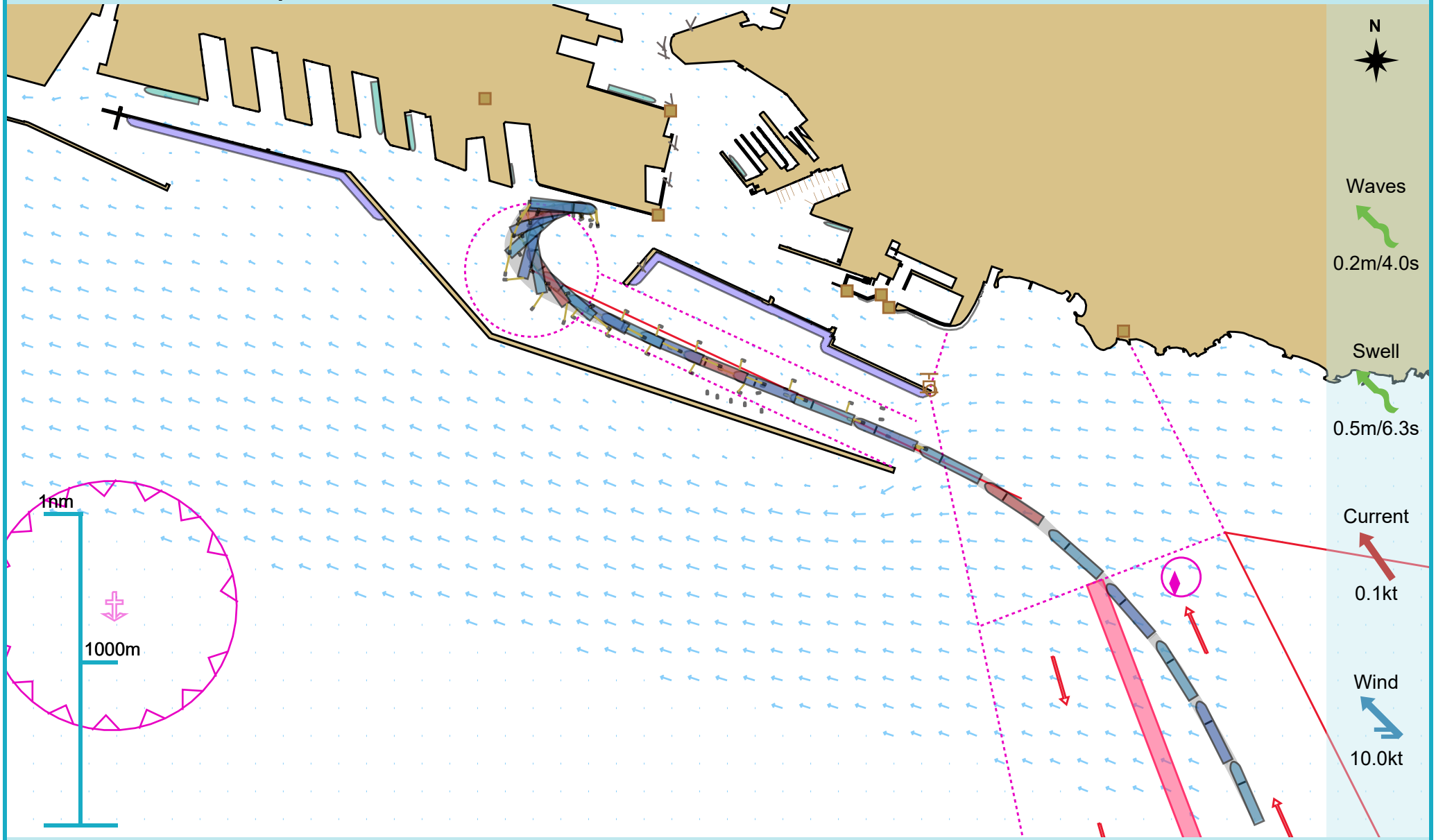
Notes: [1] Reference to the preliminary run schedule shown in brackets.

[2] All tugs were centrally controlled unless stated otherwise as manned.

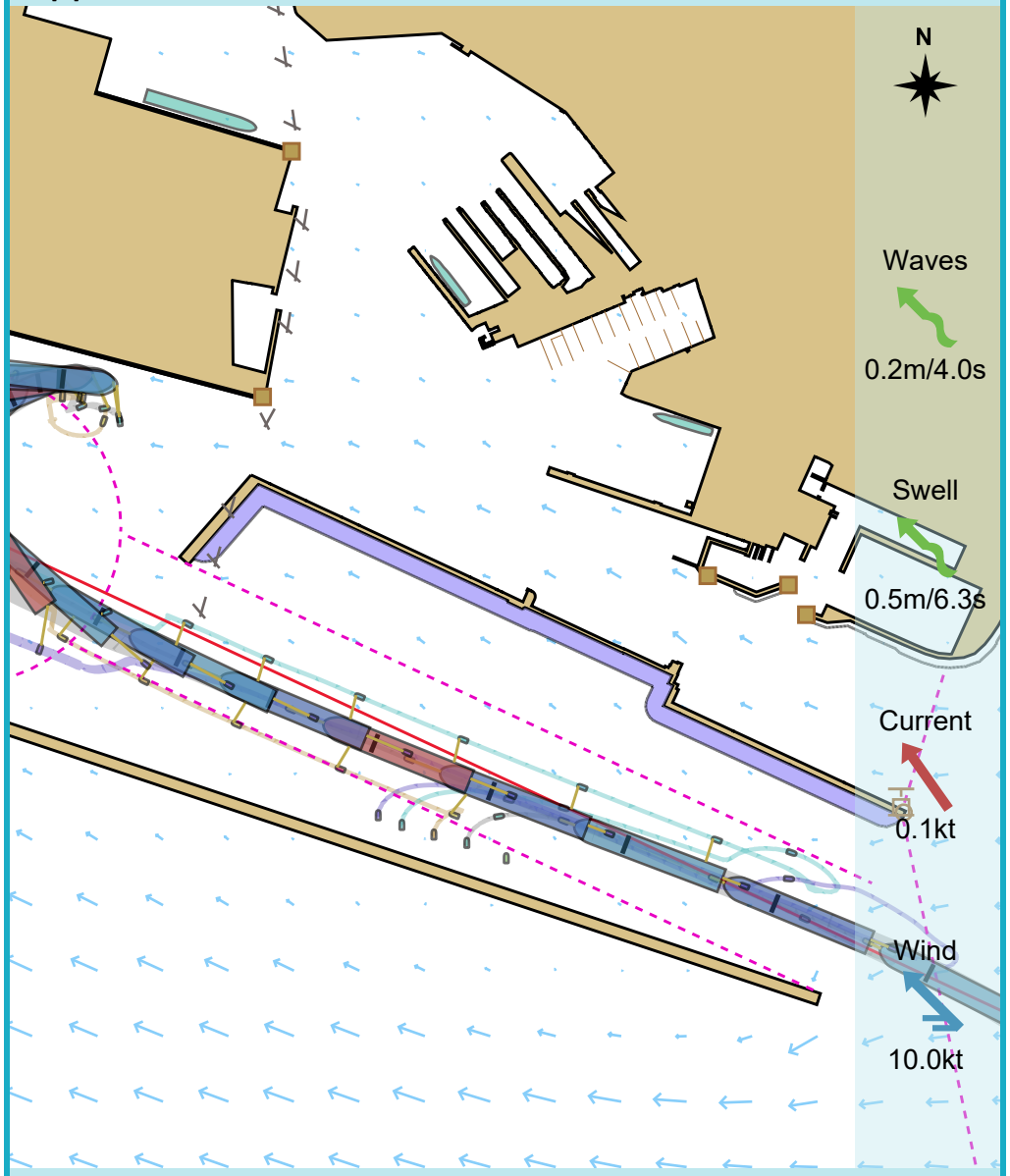
[3] The waves refers to the waves outside the port.

C. Simulation track and data plots

Manoeuvre track plot

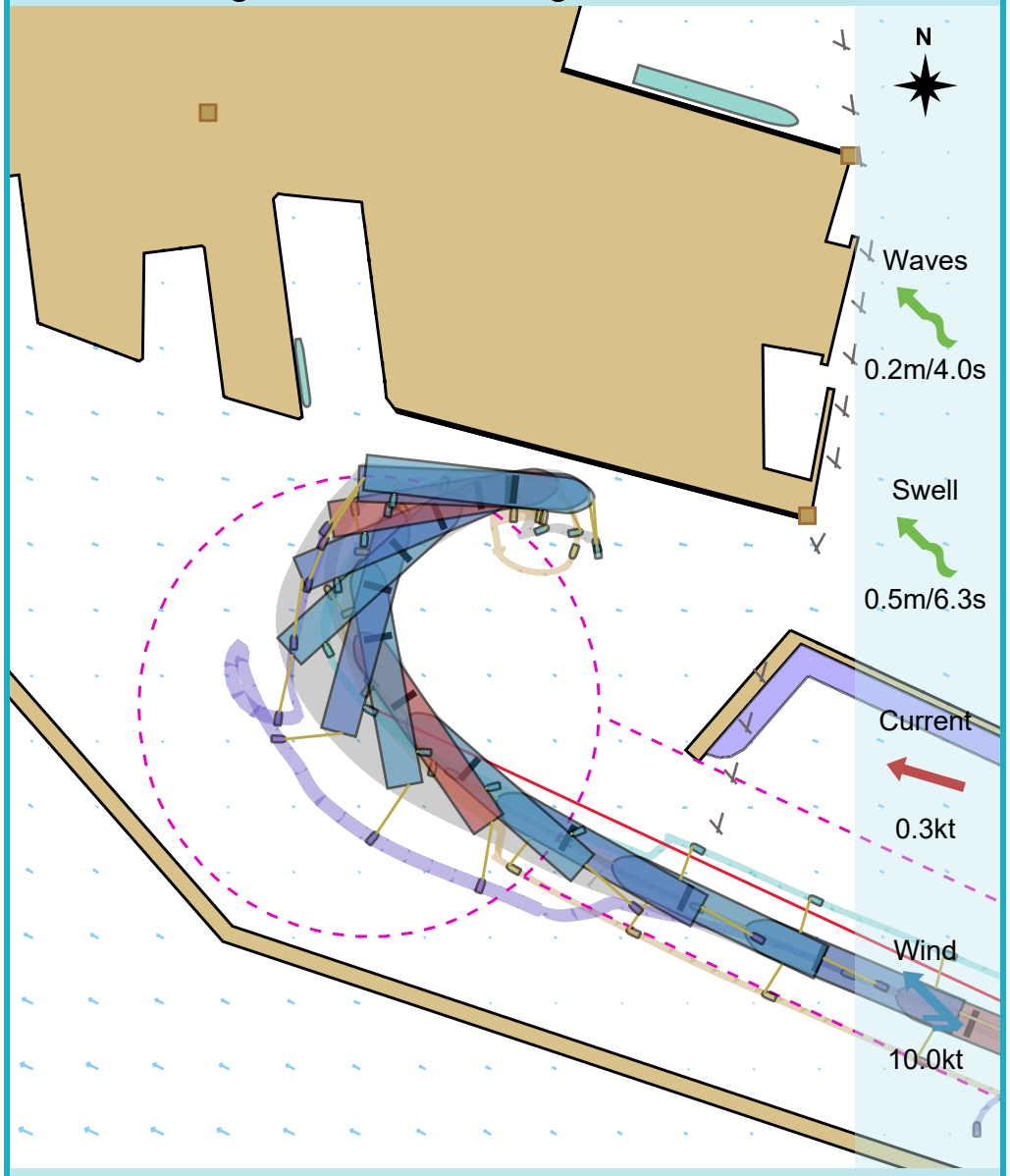


Approach Channel

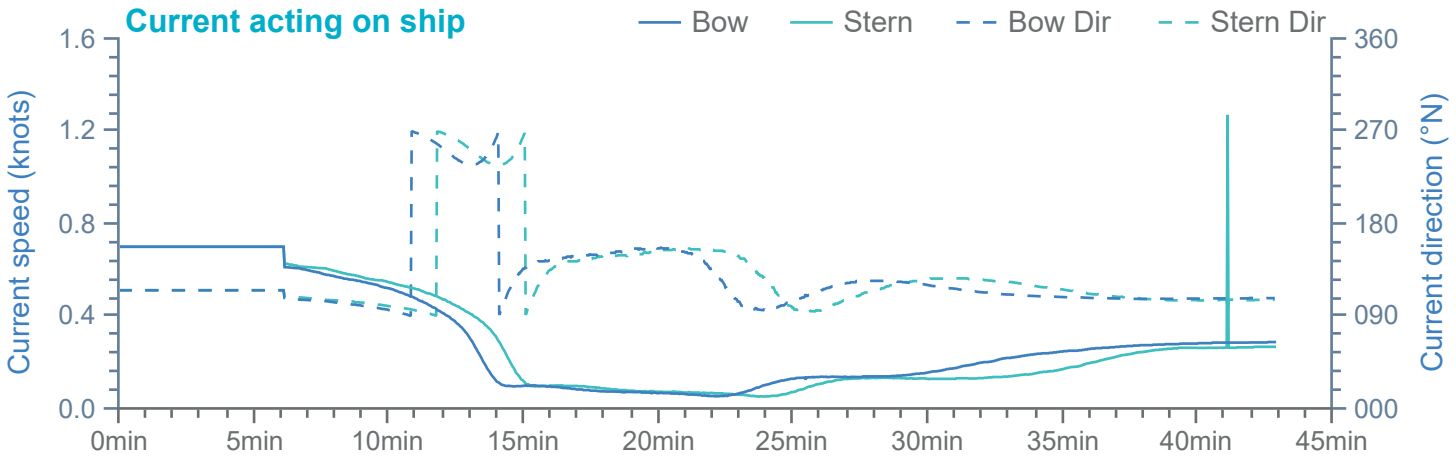


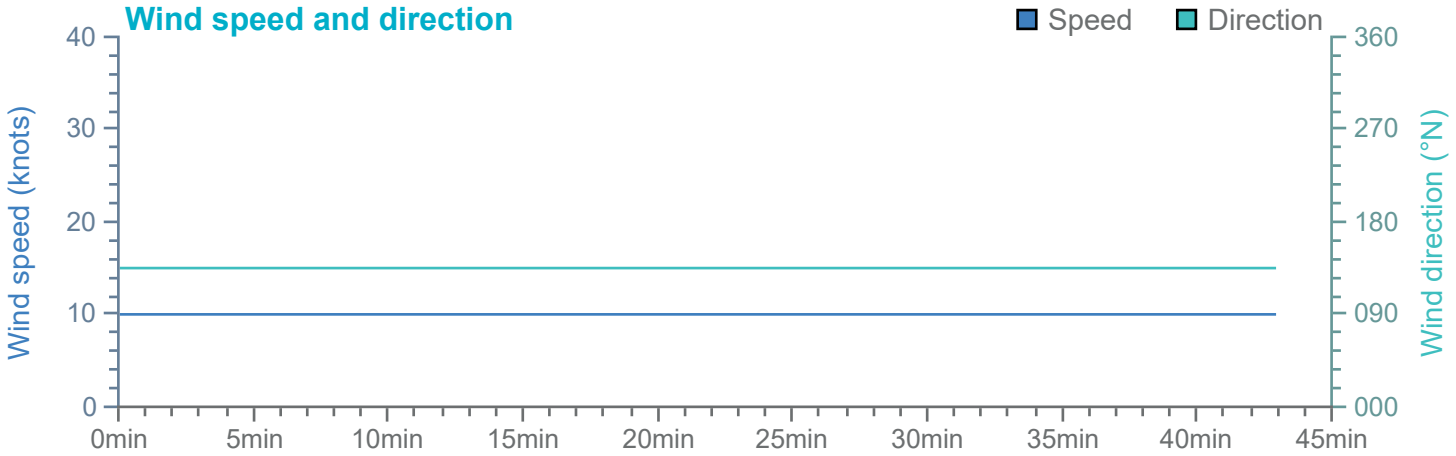
Ships plotted every 2 mins, highlight every 10 mins

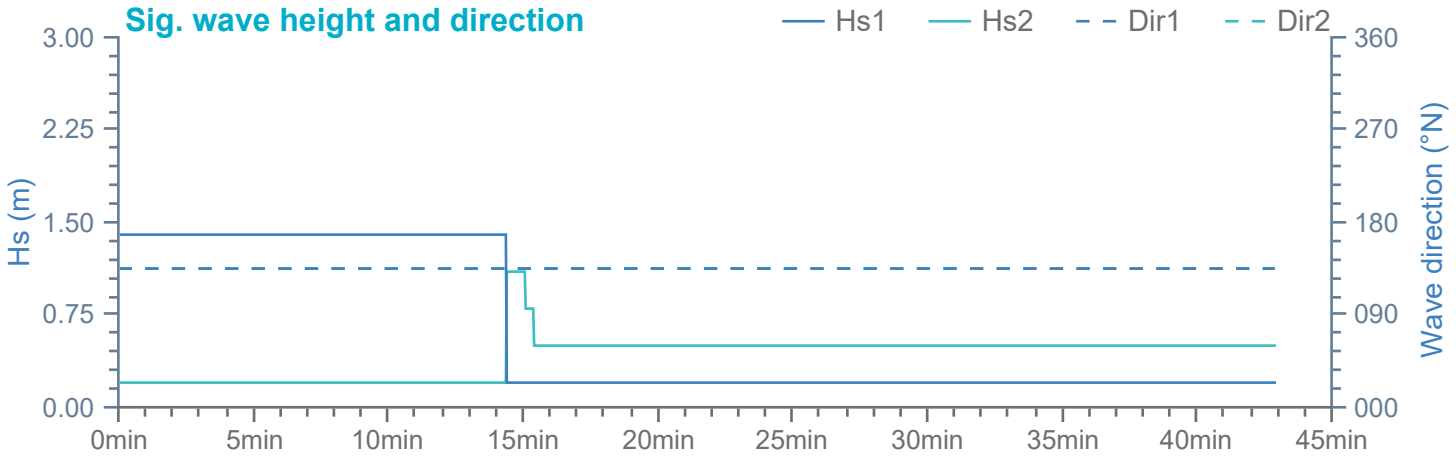
Manoeuvring area and berthing

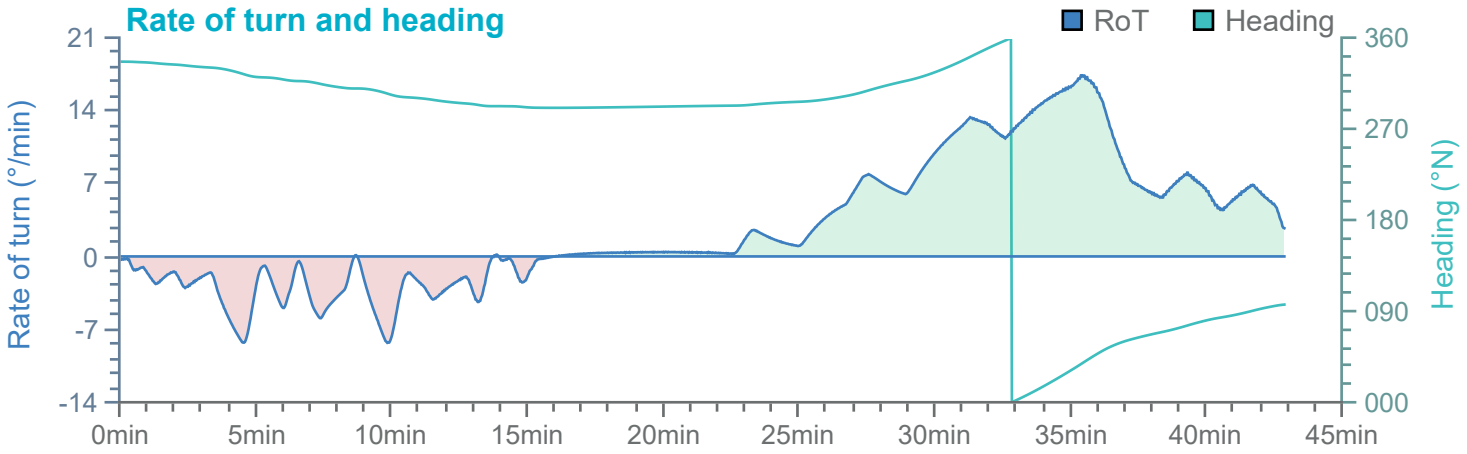


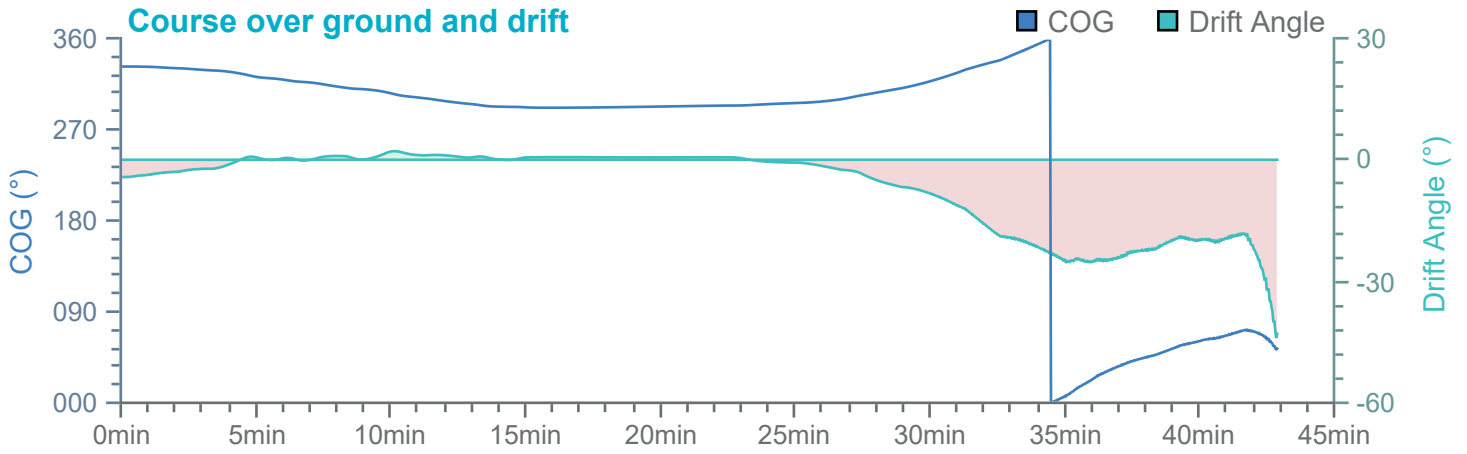
Ships plotted every 2 mins, highlight every 10 mins

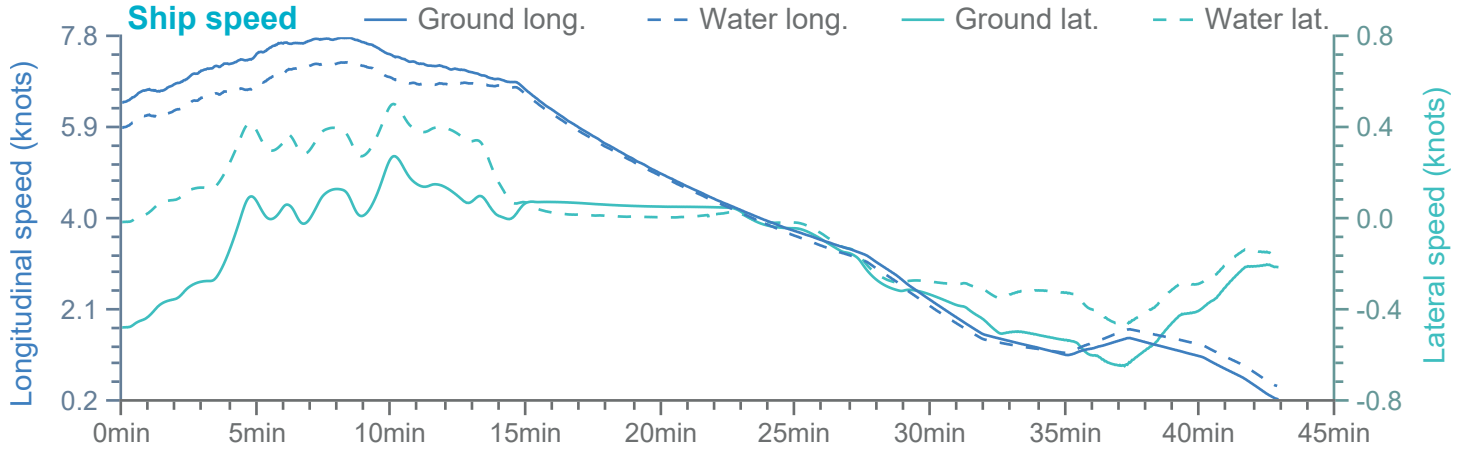

Current acting on ship
Bow
Stern
Bow Dir
Stern Dir
Current speed (knots)
Current direction (°N)
1.6
1.2
0.8
0.4
0.0
360
270
180
090
000
0min
5min
10min
15min
20min
25min
30min
35min
40min
45min

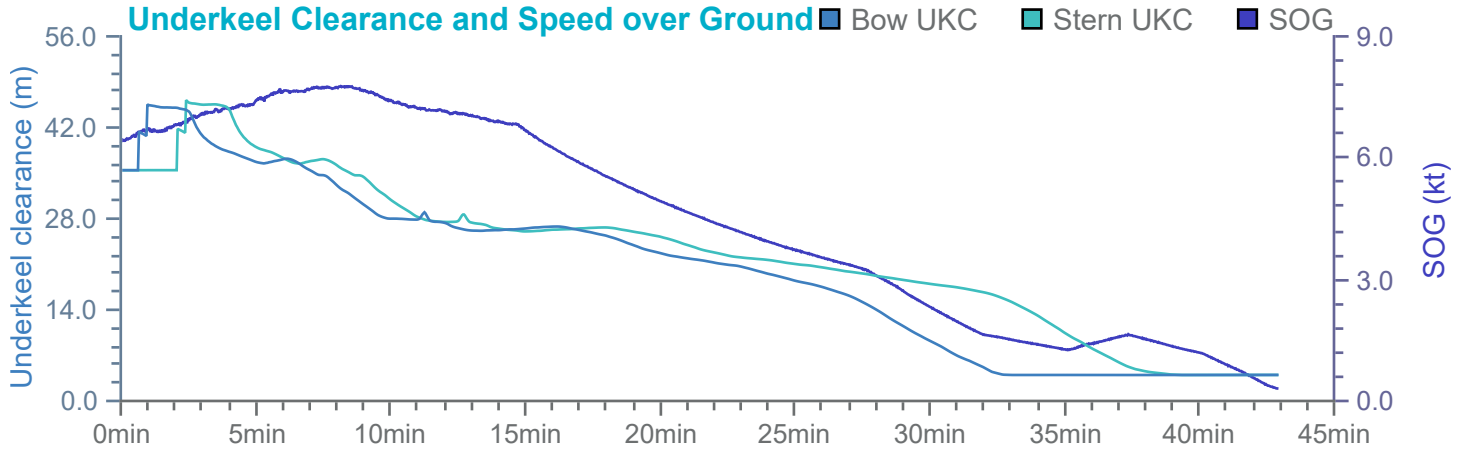

Wind speed and direction
Speed
Direction
Wind speed (knots)
Wind direction (°N)
40
30
20
10
0
360
270
180
090
000
0min
5min
10min
15min
20min
25min
30min
35min
40min
45min

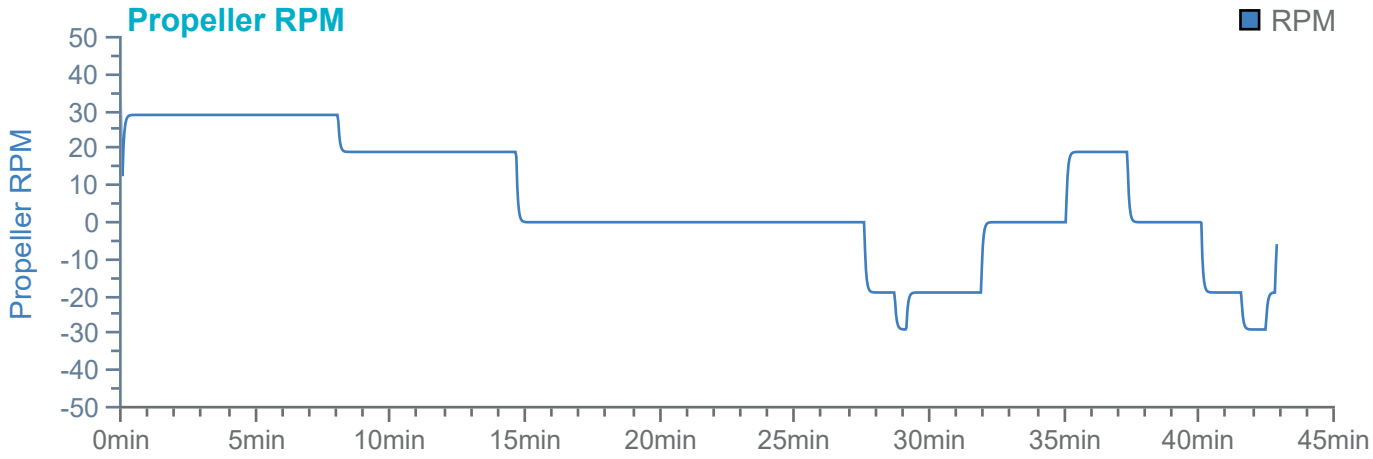

Sig. wave height and direction
Hs1
Hs2
Dir1
Dir2
Hs (m)
Wave direction (°N)
3.00
2.25
1.50
0.75
0.00
360
270
180
090
000
0min
5min
10min
15min
20min
25min
30min
35min
40min
45min

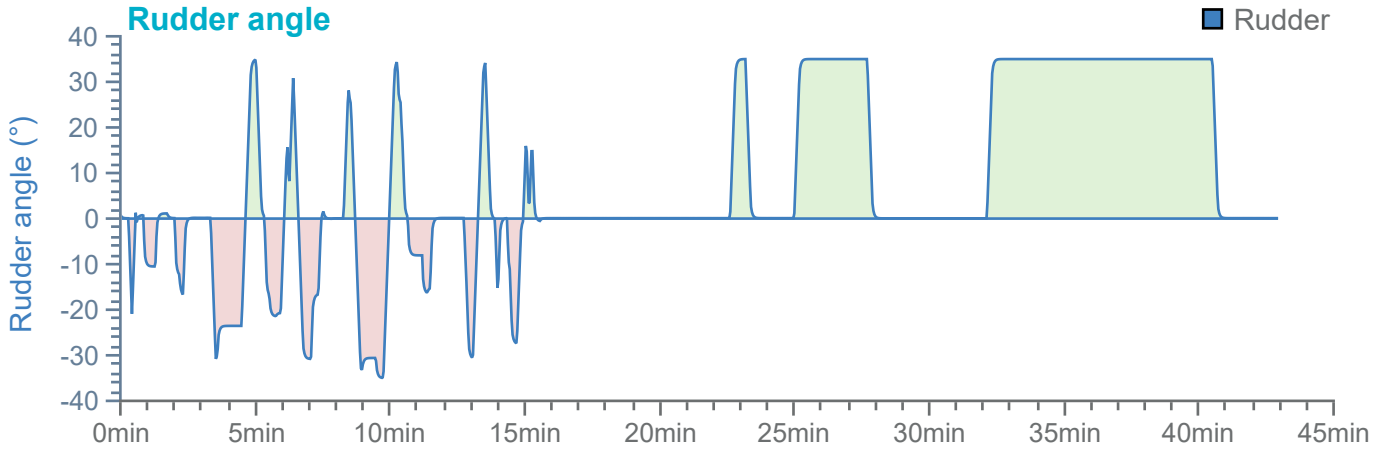

Rate of turn and heading
RoT
Heading
Rate of turn (°/min)
Heading (°N)
21
14
7
0
-7
-14
360
270
180
090
000
0min
5min
10min
15min
20min
25min
30min
35min
40min
45min

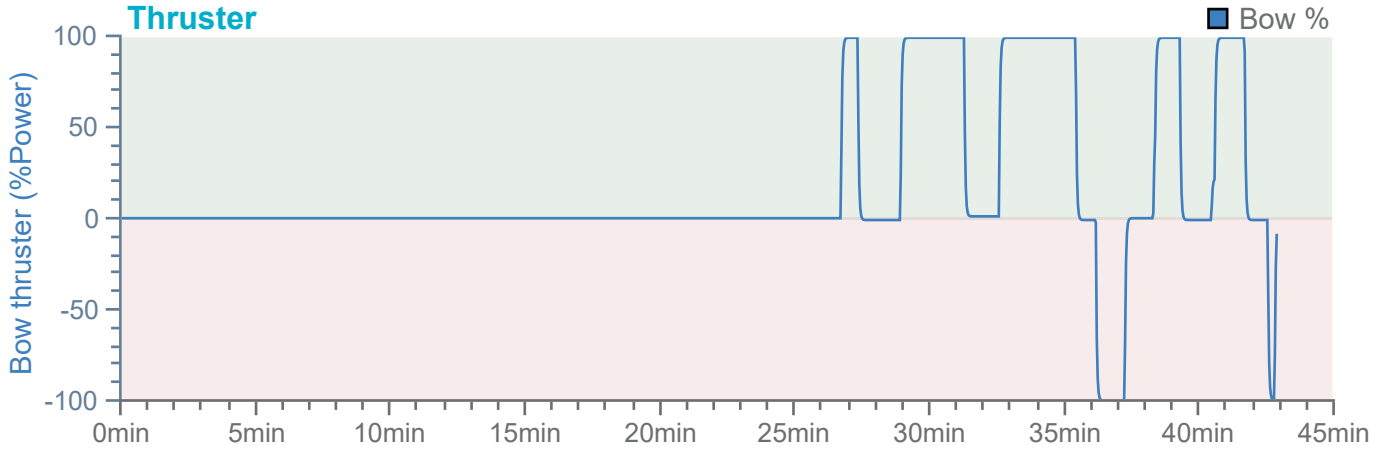

Course over ground and drift
COG
Drift Angle
COG (°)
Drift Angle (°)
360
270
180
090
000
30
0
-30
-60
0min
5min
10min
15min
20min
25min
30min
35min
40min
45min


Ship speed
Ground long.
Water long.
Ground lat.
Water lat.
Longitudinal speed (knots)
Lateral speed (knots)
7.8
5.9
4.0
2.1
0.2
0.8
0.4
0.0
-0.4
-0.8
0min
5min
10min
15min
20min
25min
30min
35min
40min
45min

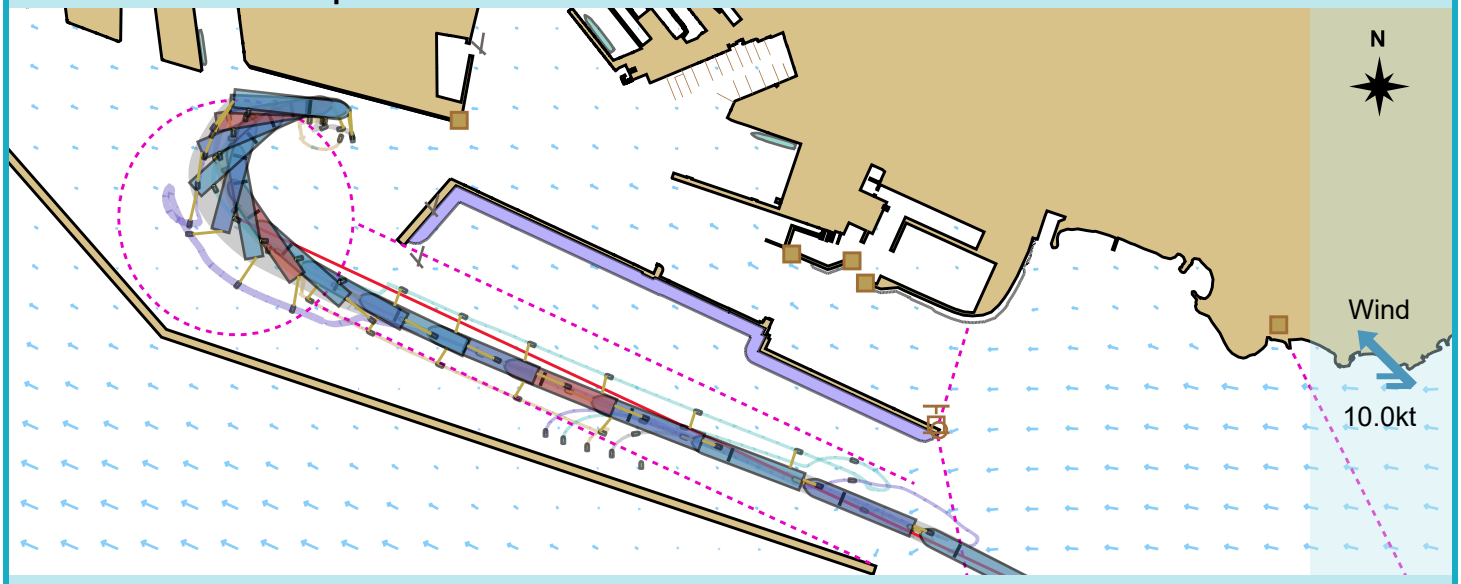

Underkeel Clearance and Speed over Ground
Bow UKC
Stern UKC
SOG
Underkeel clearance (m)
SOG (kt)
56.0
42.0
28.0
14.0
0.0
9.0
6.0
3.0
0.0
0min
5min
10min
15min
20min
25min
30min
35min
40min
45min


Propeller RPM
RPM
Propeller RPM
50
40
30
20
10
0
-10
-20
-30
-40
-50
0min
5min
10min
15min
20min
25min
30min
35min
40min
45min


Rudder angle
Rudder
Rudder angle (°)
40
30
20
10
0
-10
-20
-30
-40
0min
5min
10min
15min
20min
25min
30min
35min
40min
45min

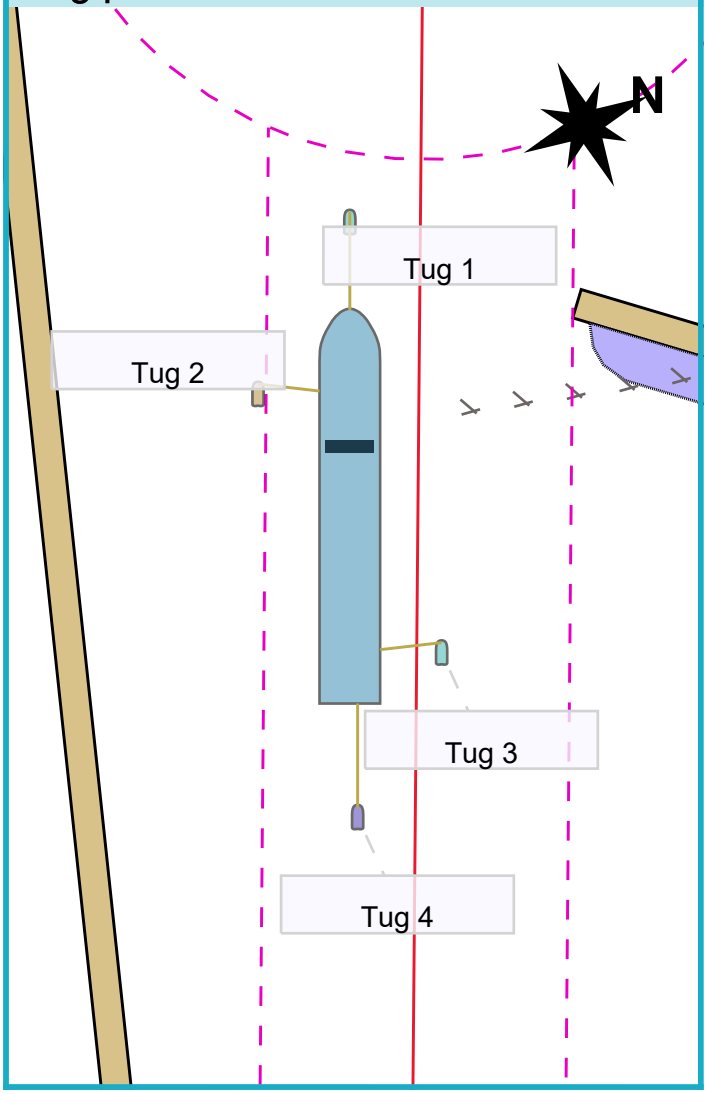

Thruster
Bow %
Bow thruster (%Power)
100
50
0
-50
-100
0min
5min
10min
15min
20min
25min
30min
35min
40min
45min

Manoeuvre track plot

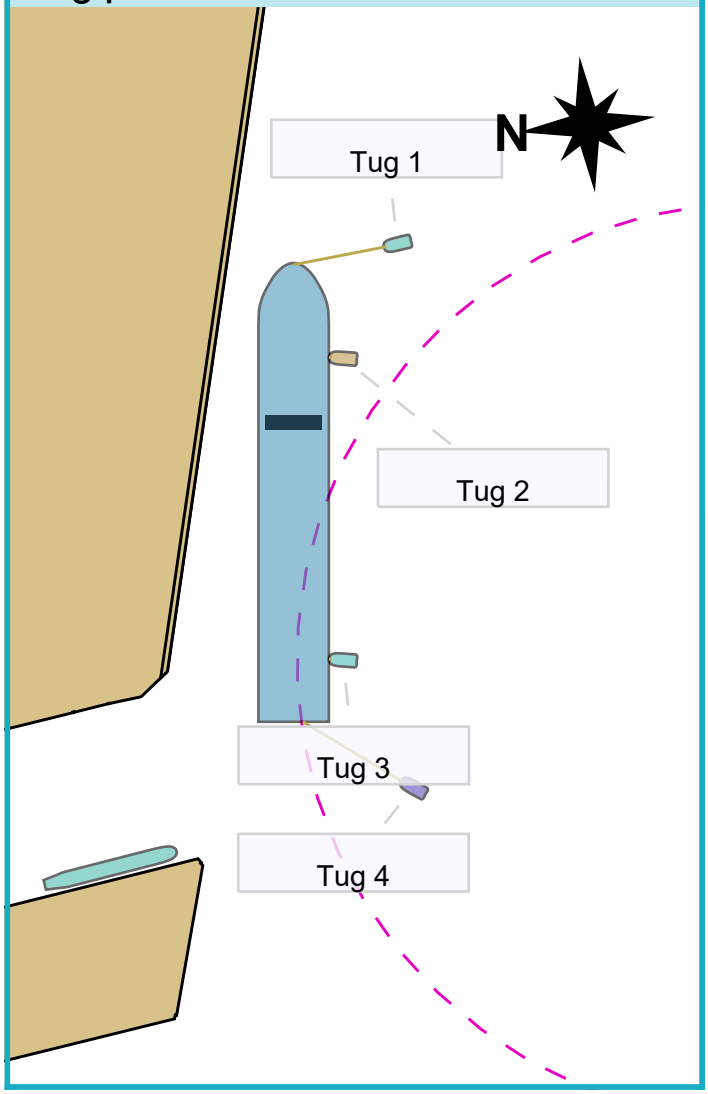


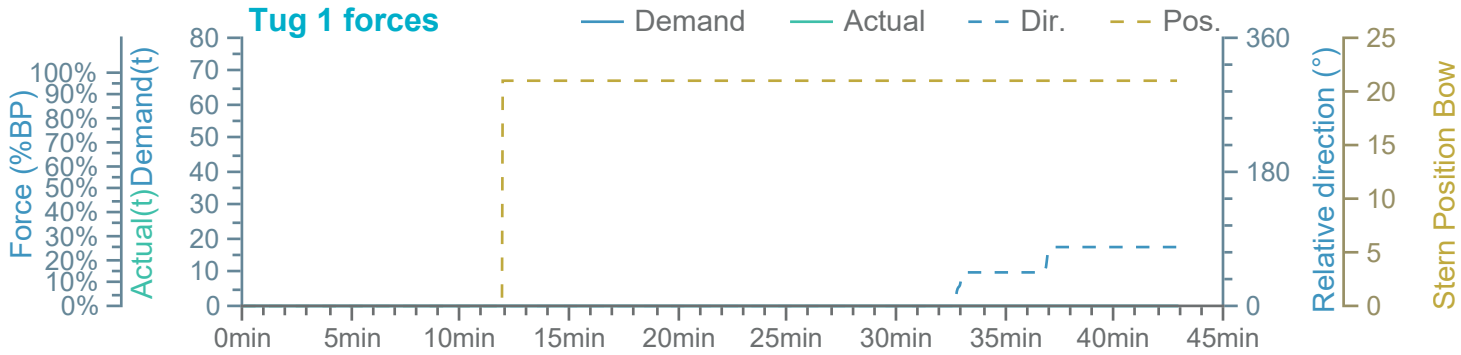
Ships plotted every 2 mins, highlight every 10 mins

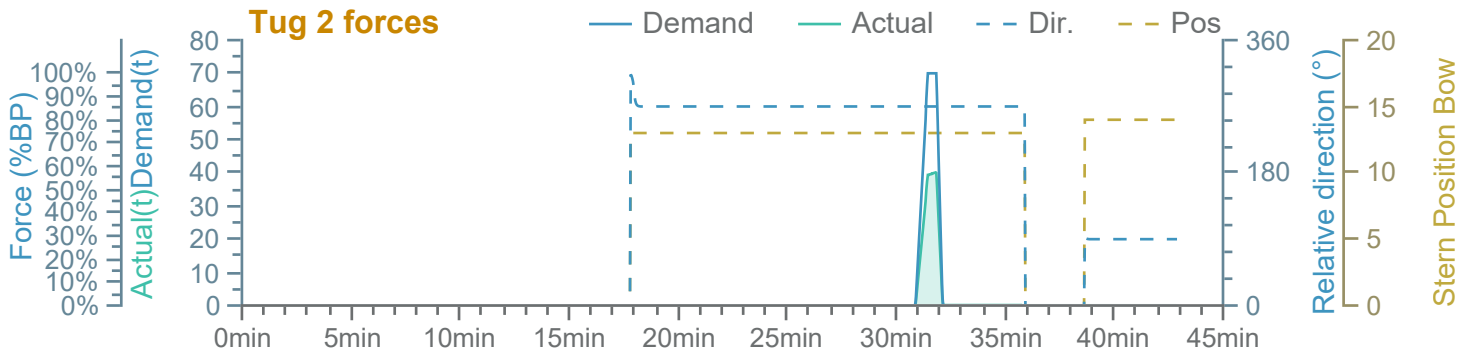
Tug position: Initial

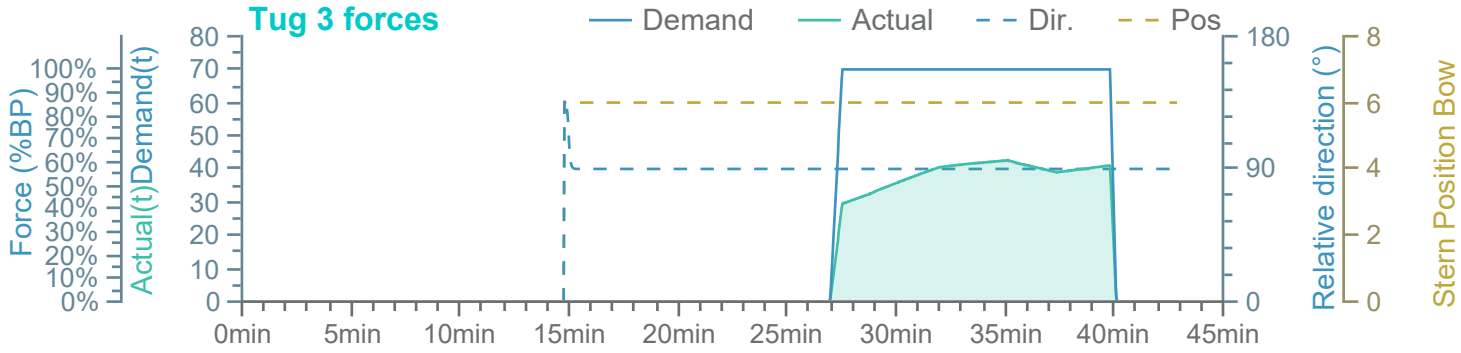


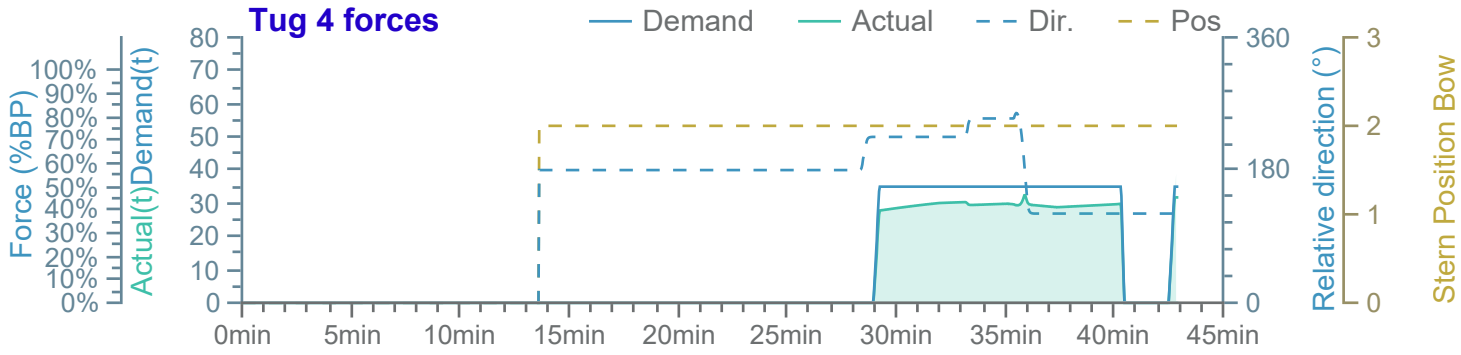
Tug position: Final



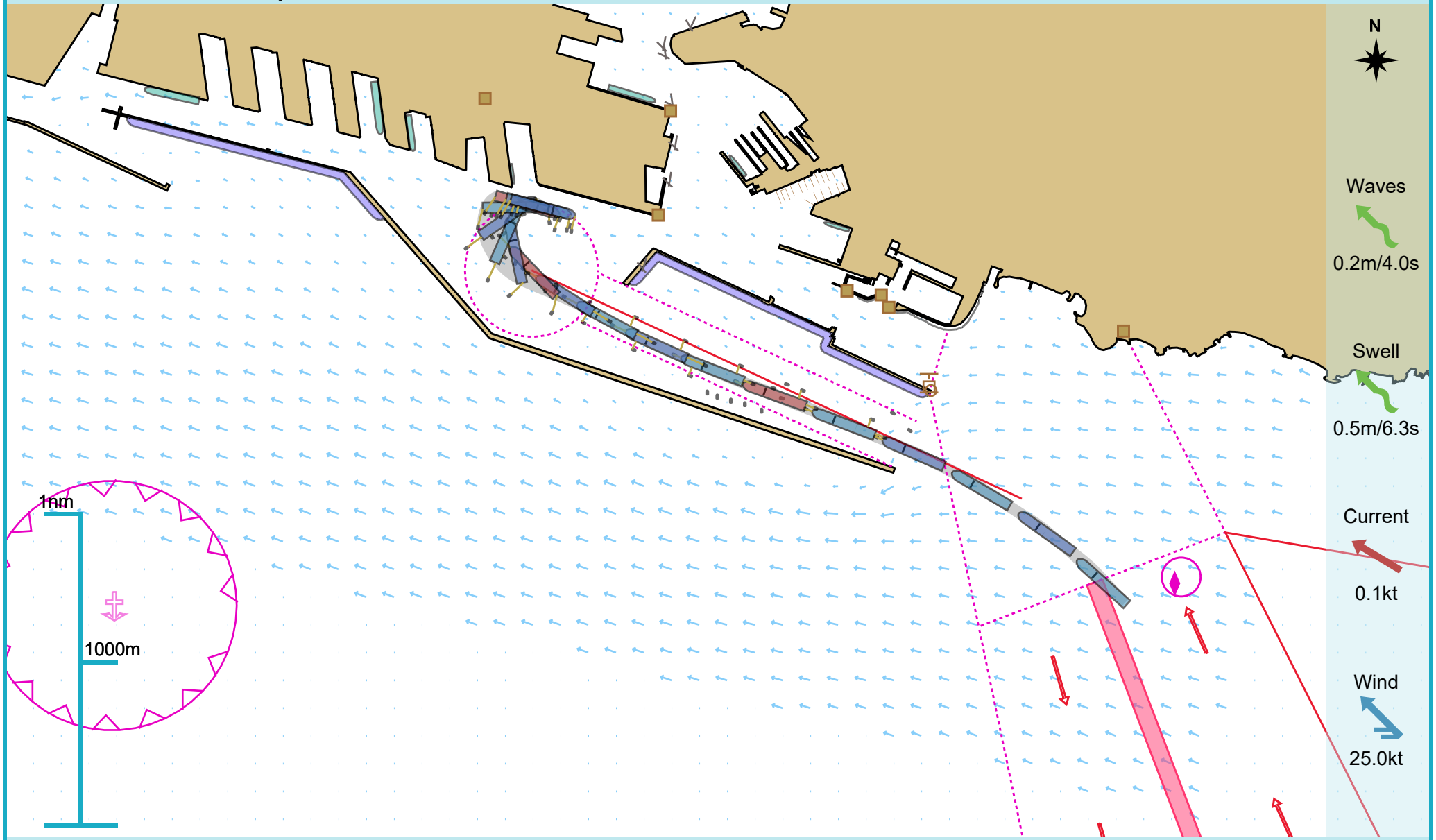

Tug 1 forces
Demand
Actual
Dir.
Pos.
Force (%BP)
Actual(t)Demand(t)
Relative direction (°)
Stern Position Bow
0min
5min
10min
15min
20min
25min
30min
35min
40min
45min


Tug 2 forces
Demand
Actual
Dir.
Pos
Force (%BP)
Actual(t)Demand(t)
Relative direction (°)
Stern Position Bow
0min
5min
10min
15min
20min
25min
30min
35min
40min
45min


Tug 3 forces
Demand
Actual
Dir.
Pos
Force (%BP)
Actual(t)Demand(t)
Relative direction (°)
Stern Position Bow
0min
5min
10min
15min
20min
25min
30min
35min
40min
45min


Tug 4 forces
Demand
Actual
Dir.
Pos
Force (%BP)
Actual(t)Demand(t)
Relative direction (°)
Stern Position Bow
0min
5min
10min
15min
20min
25min
30min
35min
40min
45min

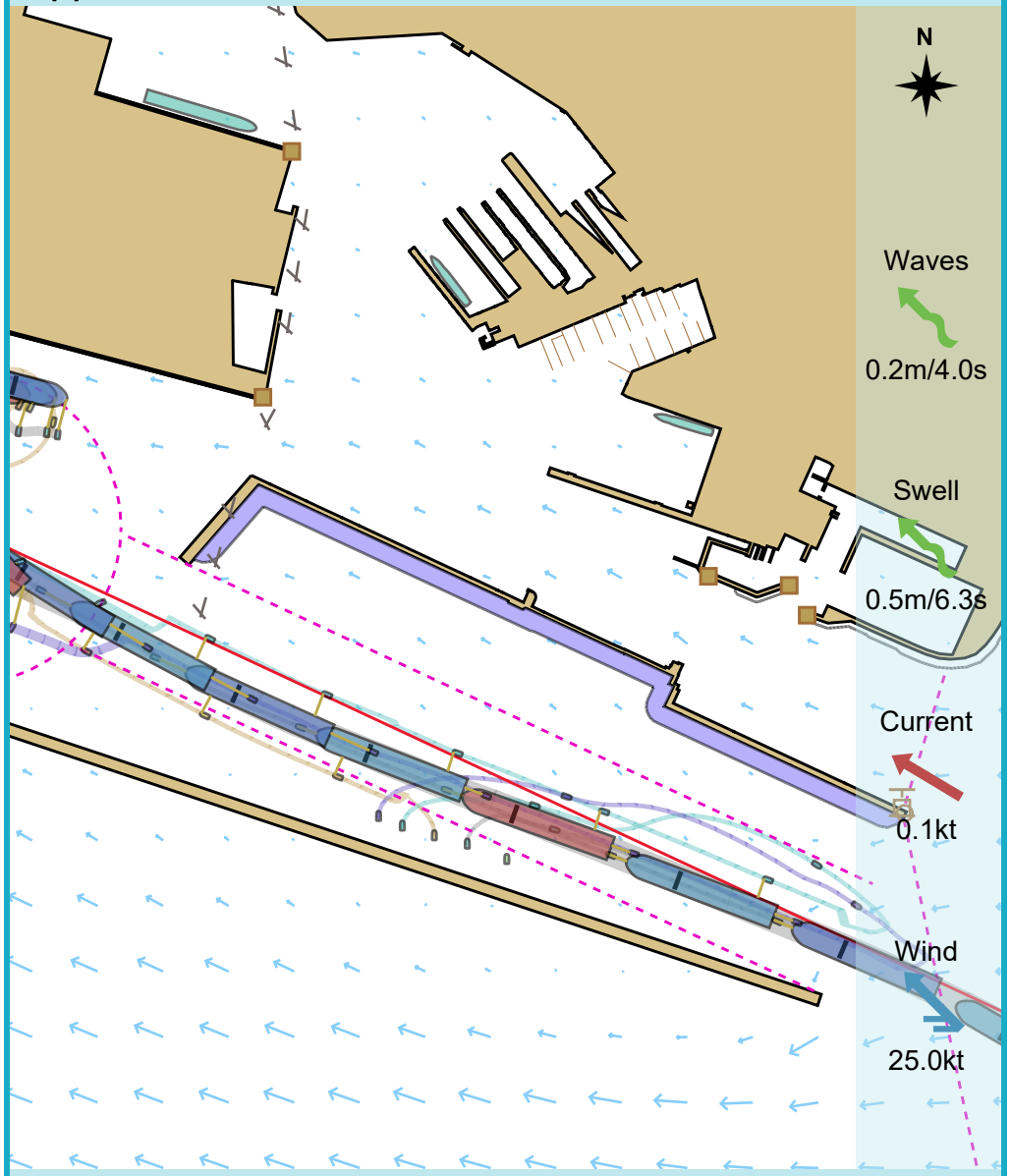
Manoeuvre track plot



0.84 kts

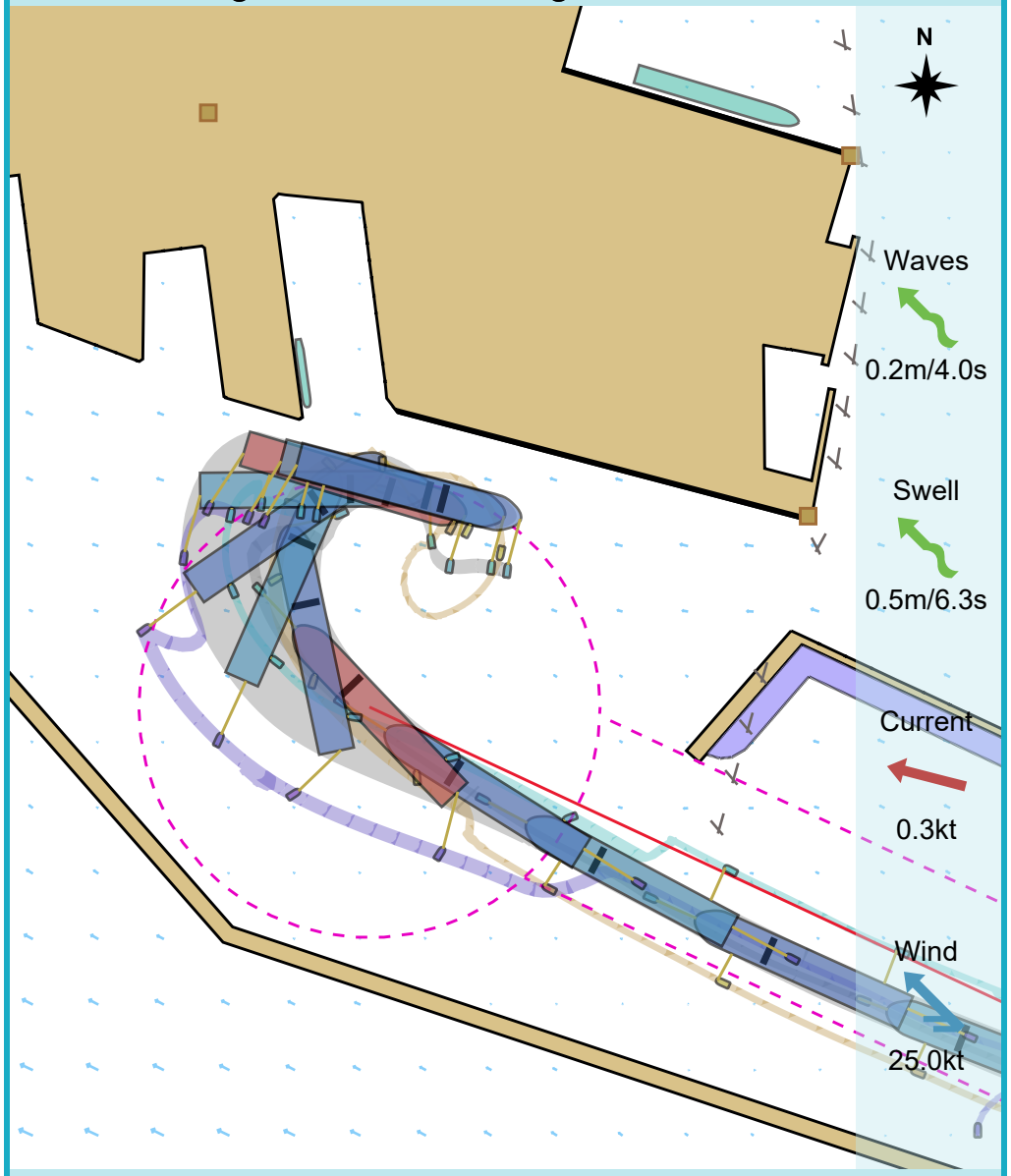
Ships plotted every 2 mins, highlight every 10 mins

Approach Channel

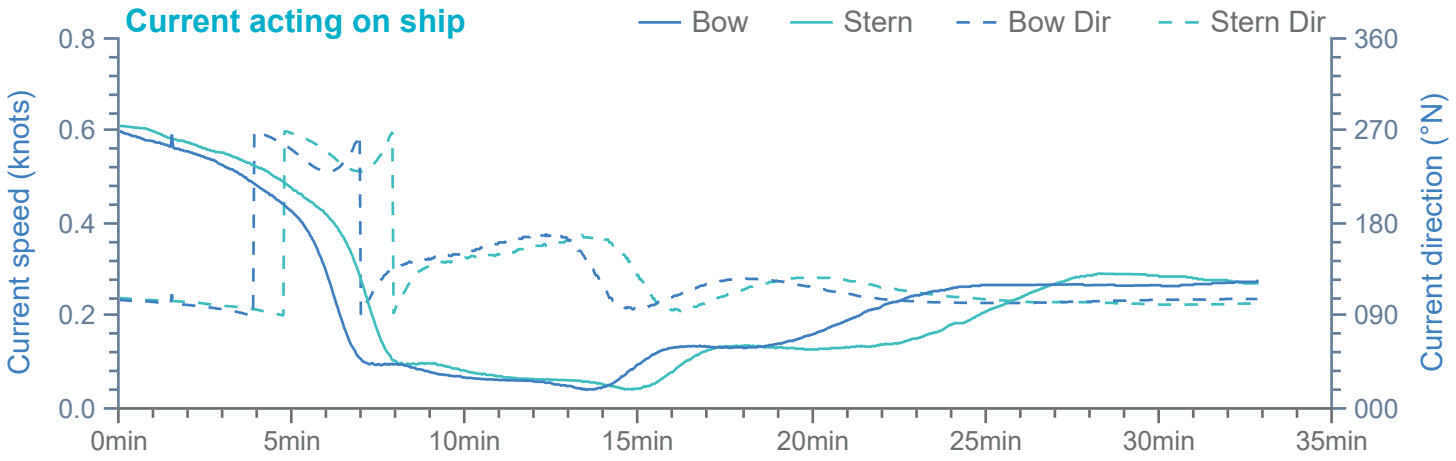


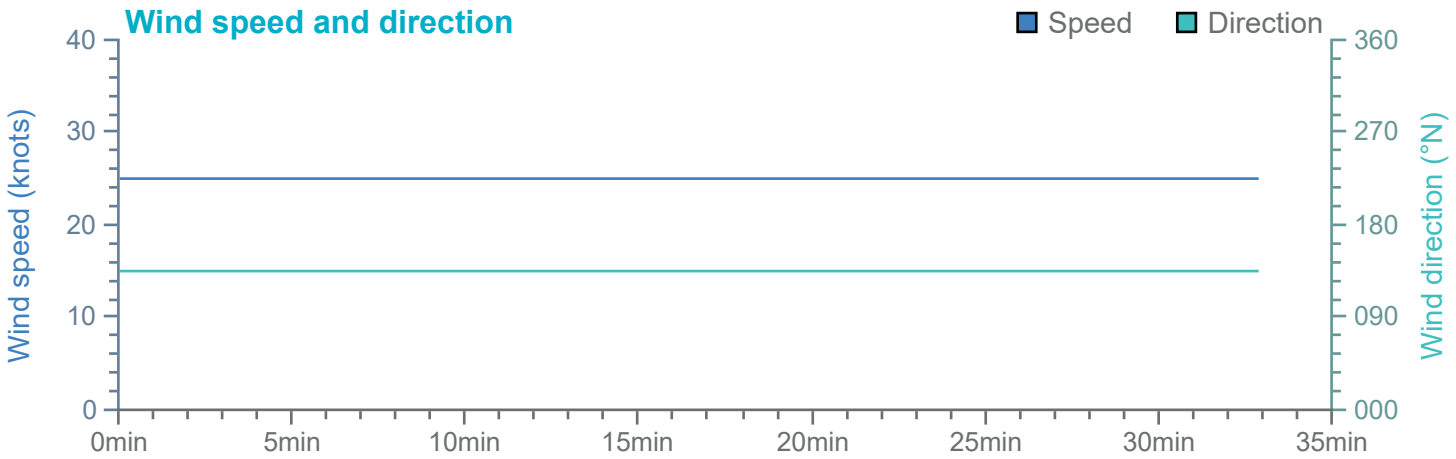
Ships plotted every 2 mins, highlight every 10 mins

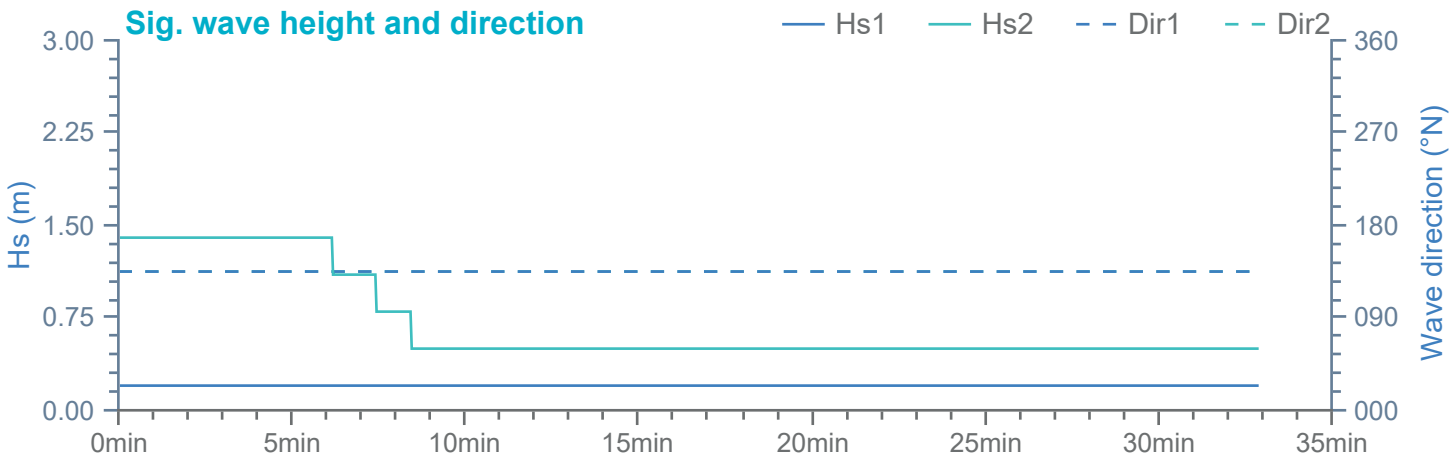
Manoeuvring area and berthing

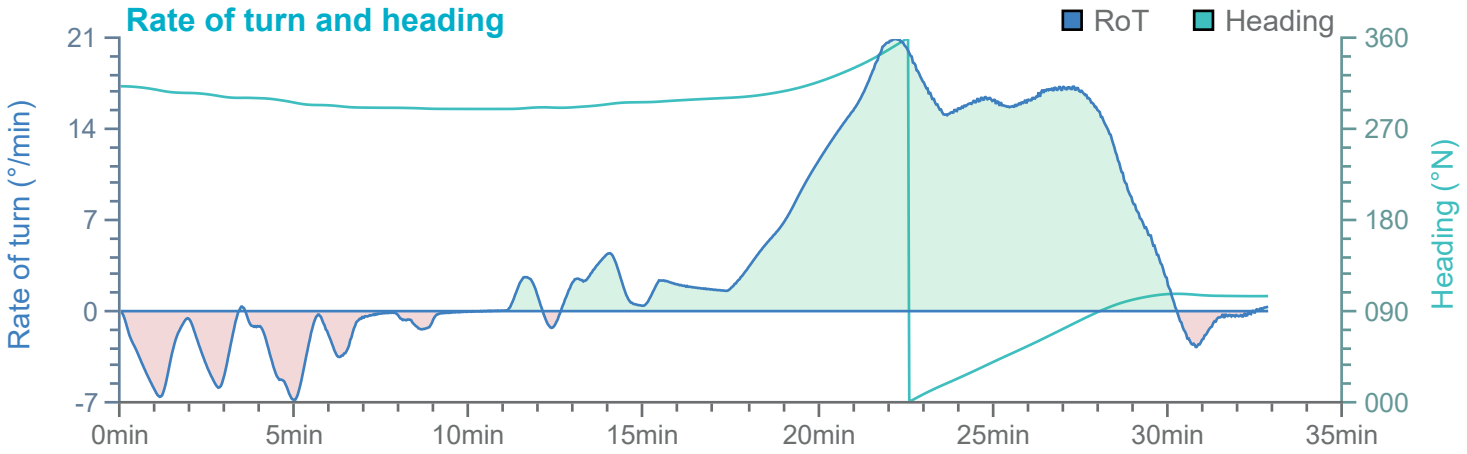


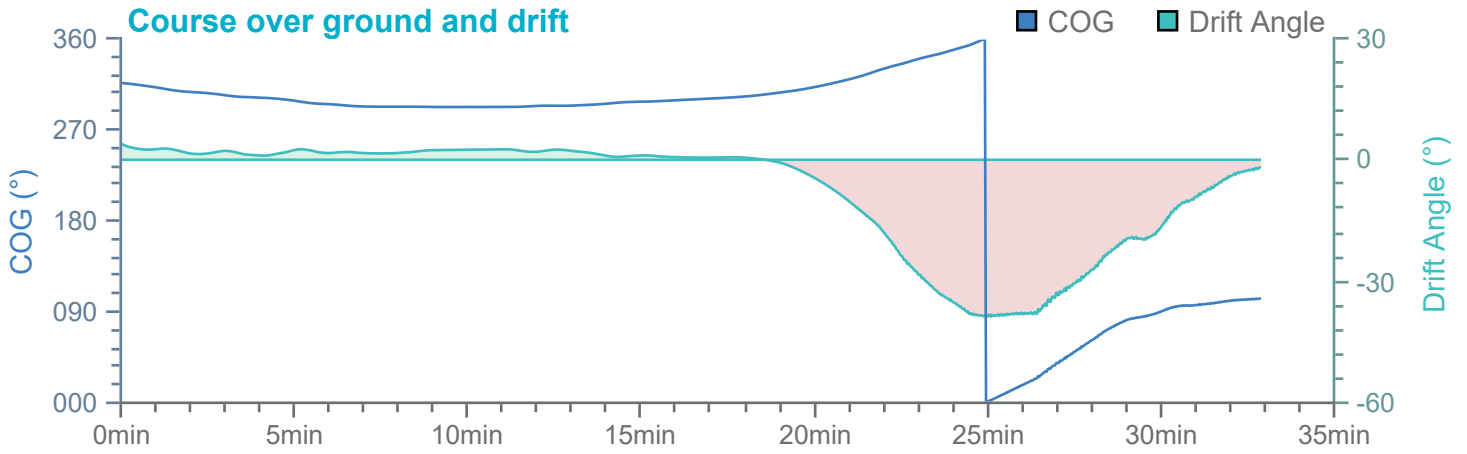
Ships plotted every 2 mins, highlight every 10 mins

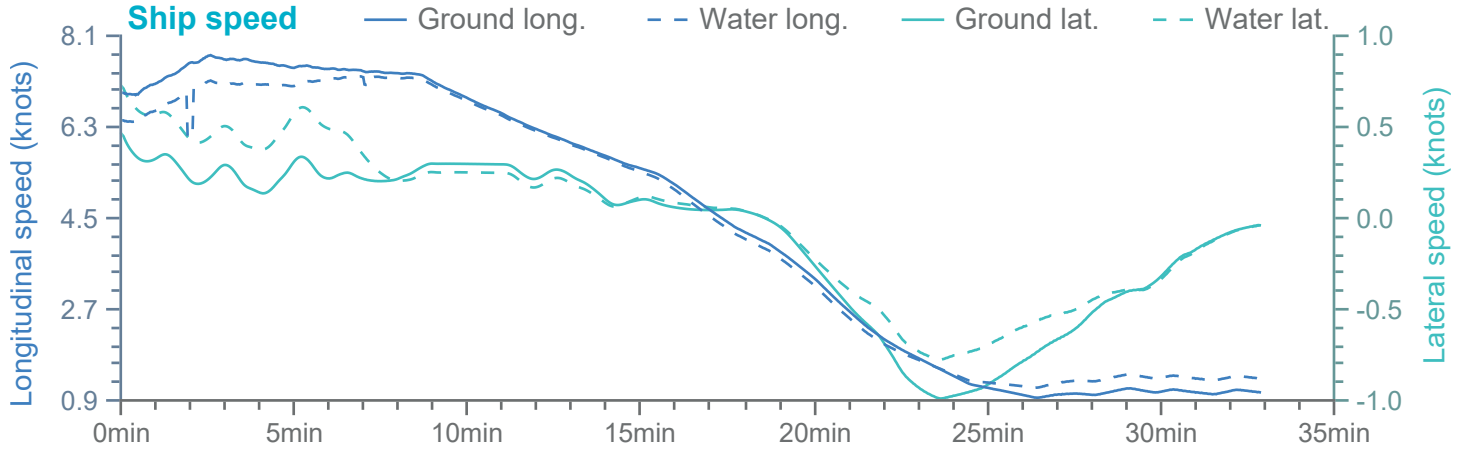

Current acting on ship
Bow
Stern
Bow Dir
Stern Dir
Current speed (knots)
Current direction (°N)
0.8
0.6
0.4
0.2
0.0
360
270
180
090
000
0min
5min
10min
15min
20min
25min
30min
35min

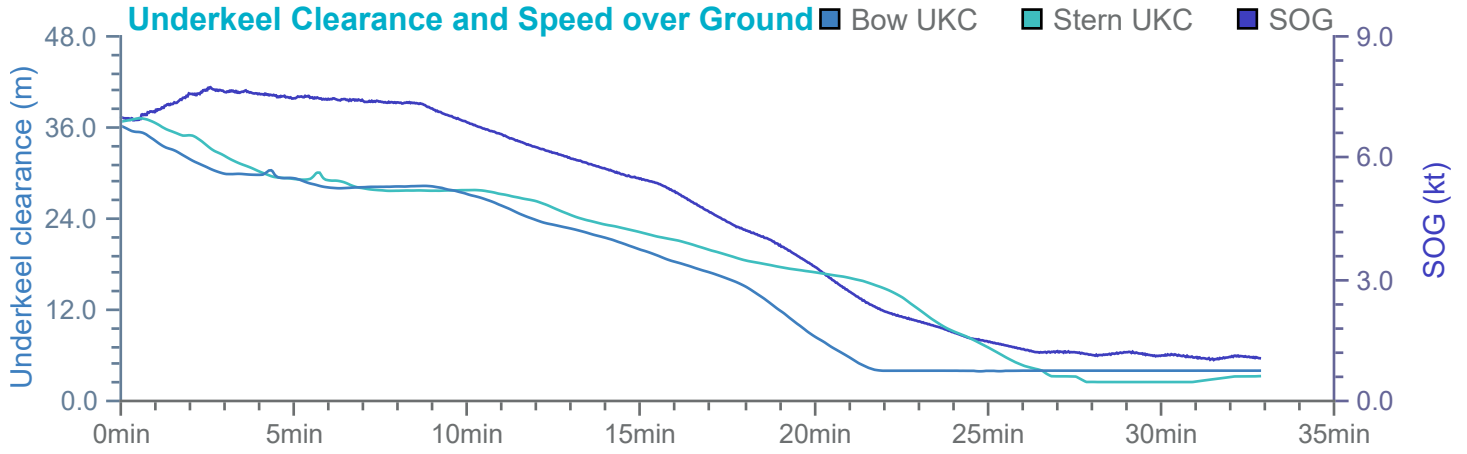

Wind speed and direction
Speed
Direction
Wind speed (knots)
Wind direction (°N)
40
30
20
10
0
360
270
180
090
000
0min
5min
10min
15min
20min
25min
30min
35min

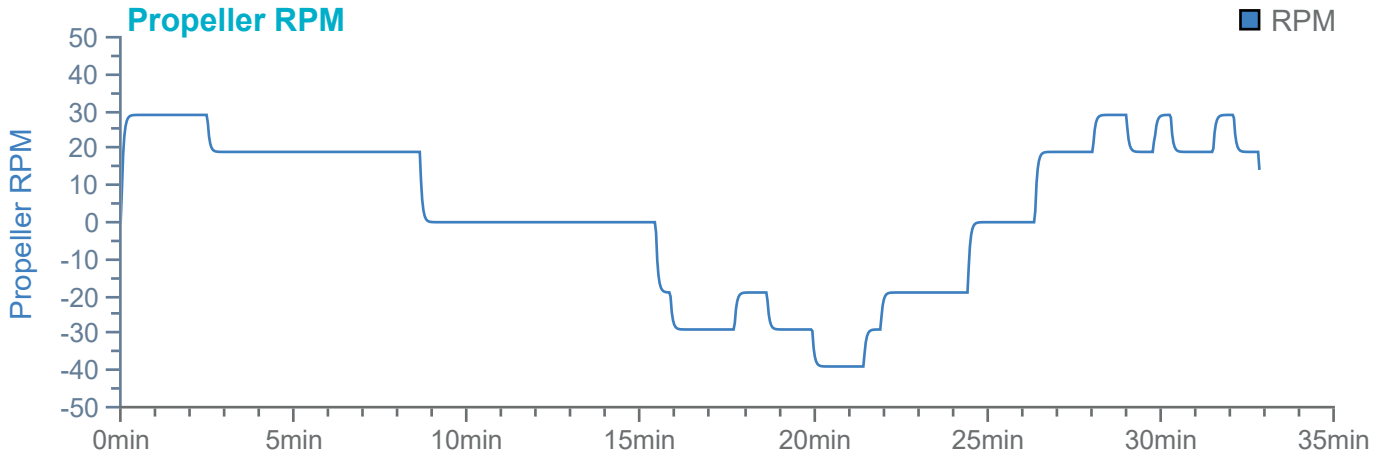

Sig. wave height and direction
Hs1
Hs2
Dir1
Dir2
Hs (m)
Wave direction (°N)
3.00
2.25
1.50
0.75
0.00
360
270
180
090
000
0min
5min
10min
15min
20min
25min
30min
35min

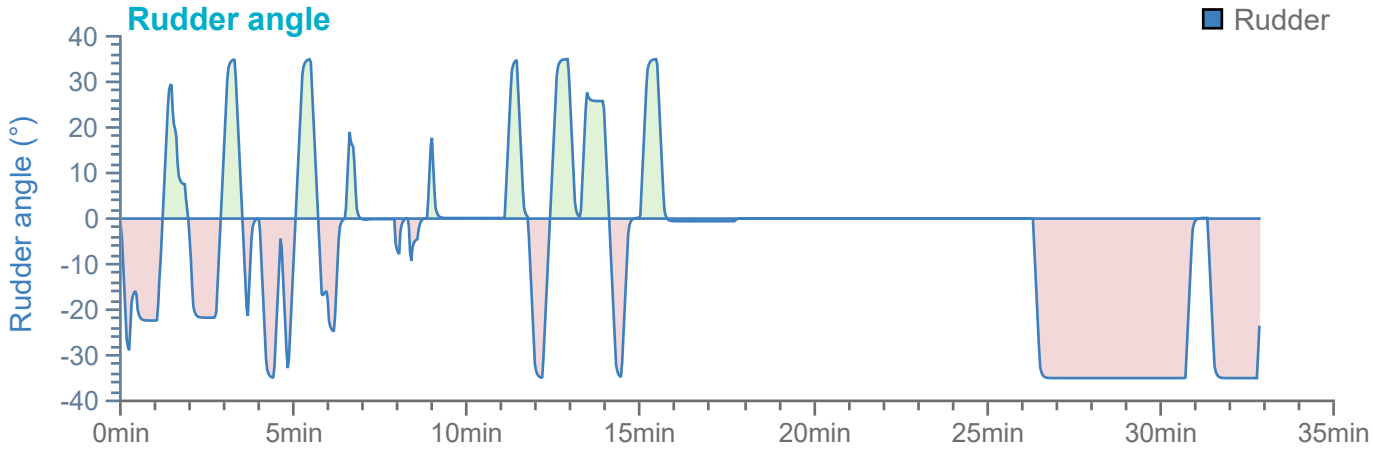

Rate of turn and heading
RoT
Heading
Rate of turn (°/min)
Heading (°N)
21
14
7
0
-7
360
270
180
090
000
0min
5min
10min
15min
20min
25min
30min
35min

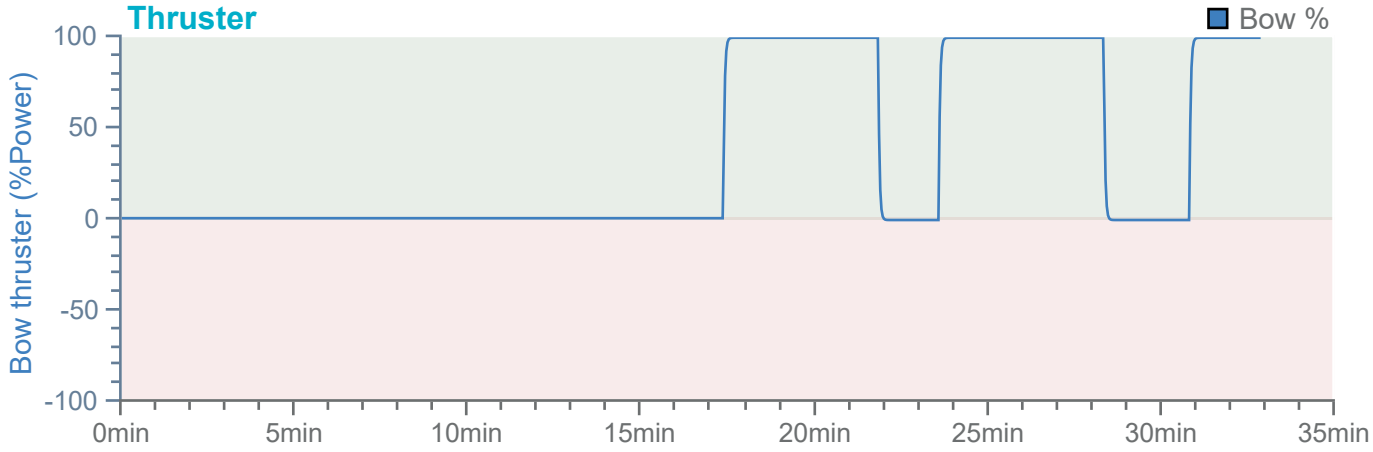

Course over ground and drift
COG
Drift Angle
COG (°)
Drift Angle (°)
360
270
180
090
000
30
0
-30
-60
0min
5min
10min
15min
20min
25min
30min
35min


Ship speed
Ground long.
Water long.
Ground lat.
Water lat.
Longitudinal speed (knots)
Lateral speed (knots)
8.1
6.3
4.5
2.7
0.9
1.0
0.5
0.0
-0.5
-1.0
0min
5min
10min
15min
20min
25min
30min
35min

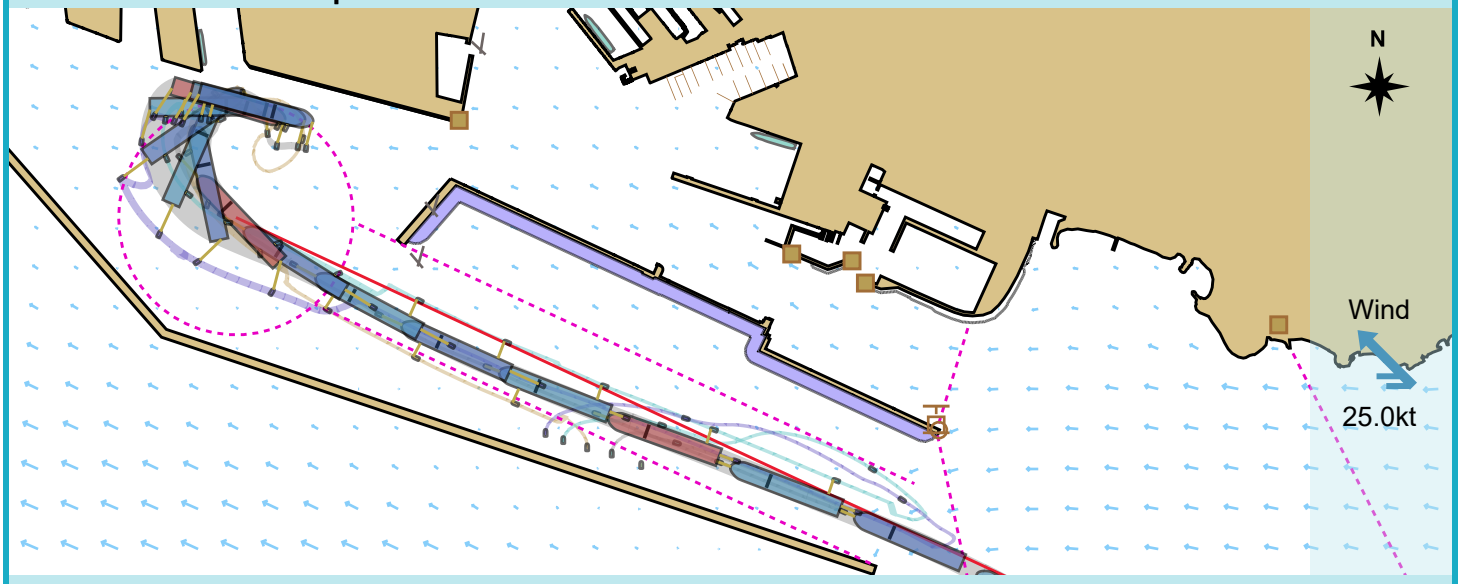

Underkeel Clearance and Speed over Ground
Bow UKC
Stern UKC
SOG
Underkeel clearance (m)
SOG (kt)
48.0
36.0
24.0
12.0
0.0
9.0
6.0
3.0
0.0
0min
5min
10min
15min
20min
25min
30min
35min


Propeller RPM
RPM
Propeller RPM
50
40
30
20
10
0
-10
-20
-30
-40
-50
0min
5min
10min
15min
20min
25min
30min
35min


Rudder angle
Rudder
Rudder angle (°)
40
30
20
10
0
-10
-20
-30
-40
0min
5min
10min
15min
20min
25min
30min
35min

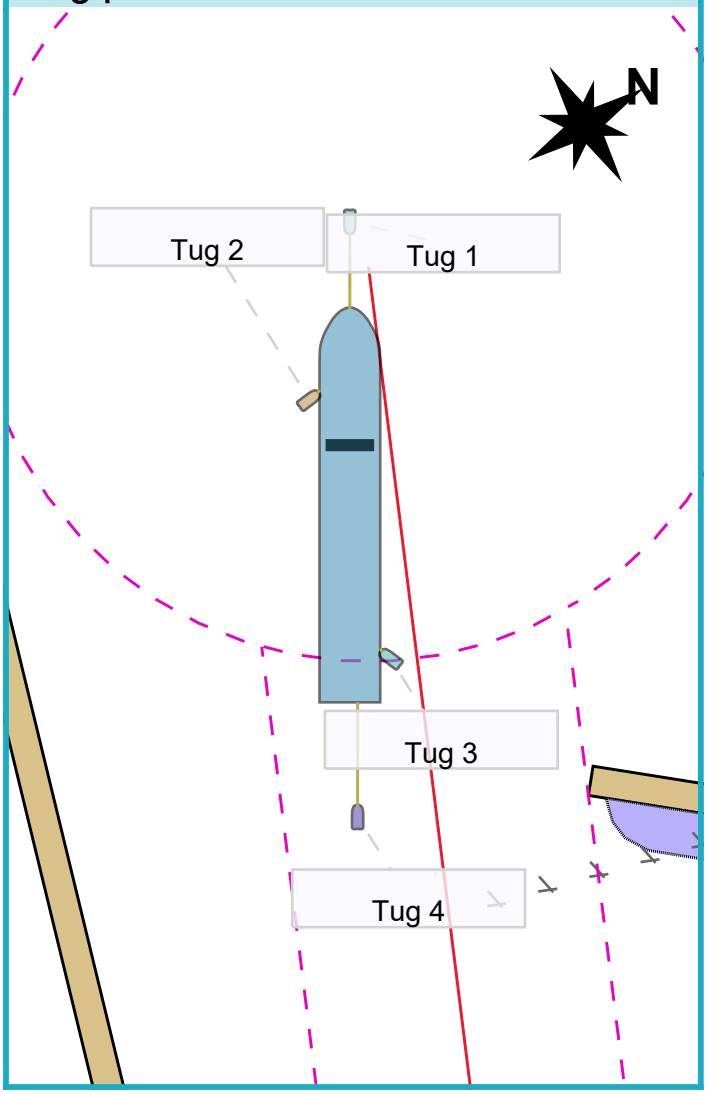

Thruster
Bow %
Bow thruster (%Power)
100
50
0
-50
-100
0min
5min
10min
15min
20min
25min
30min
35min

Manoeuvre track plot

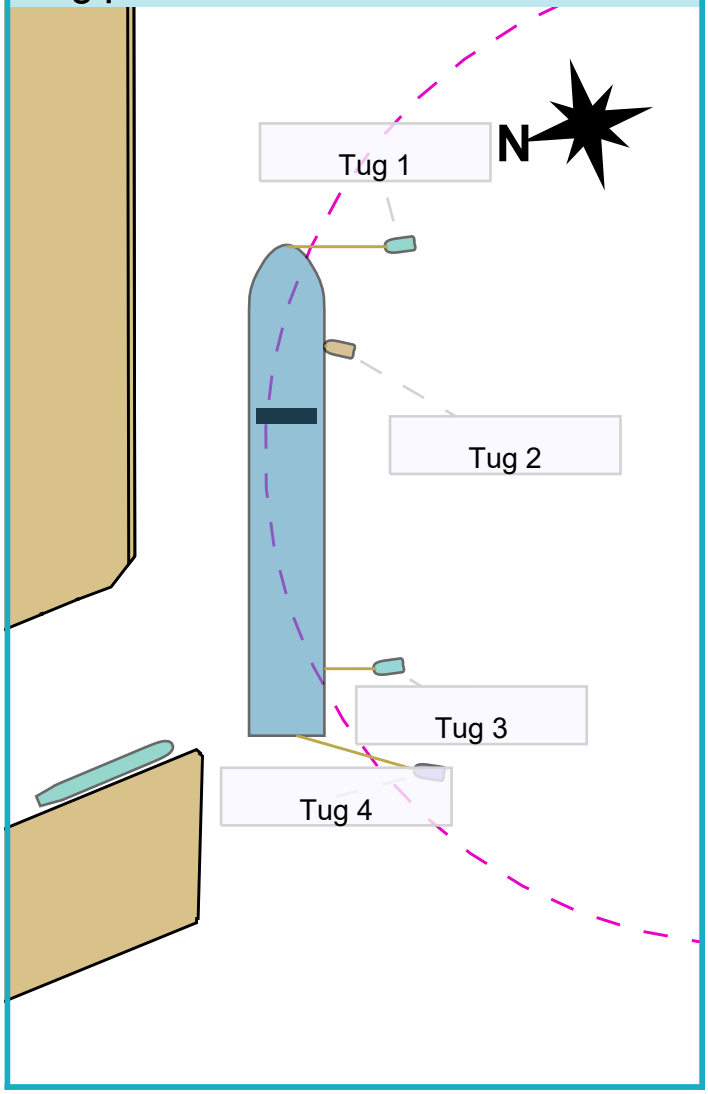


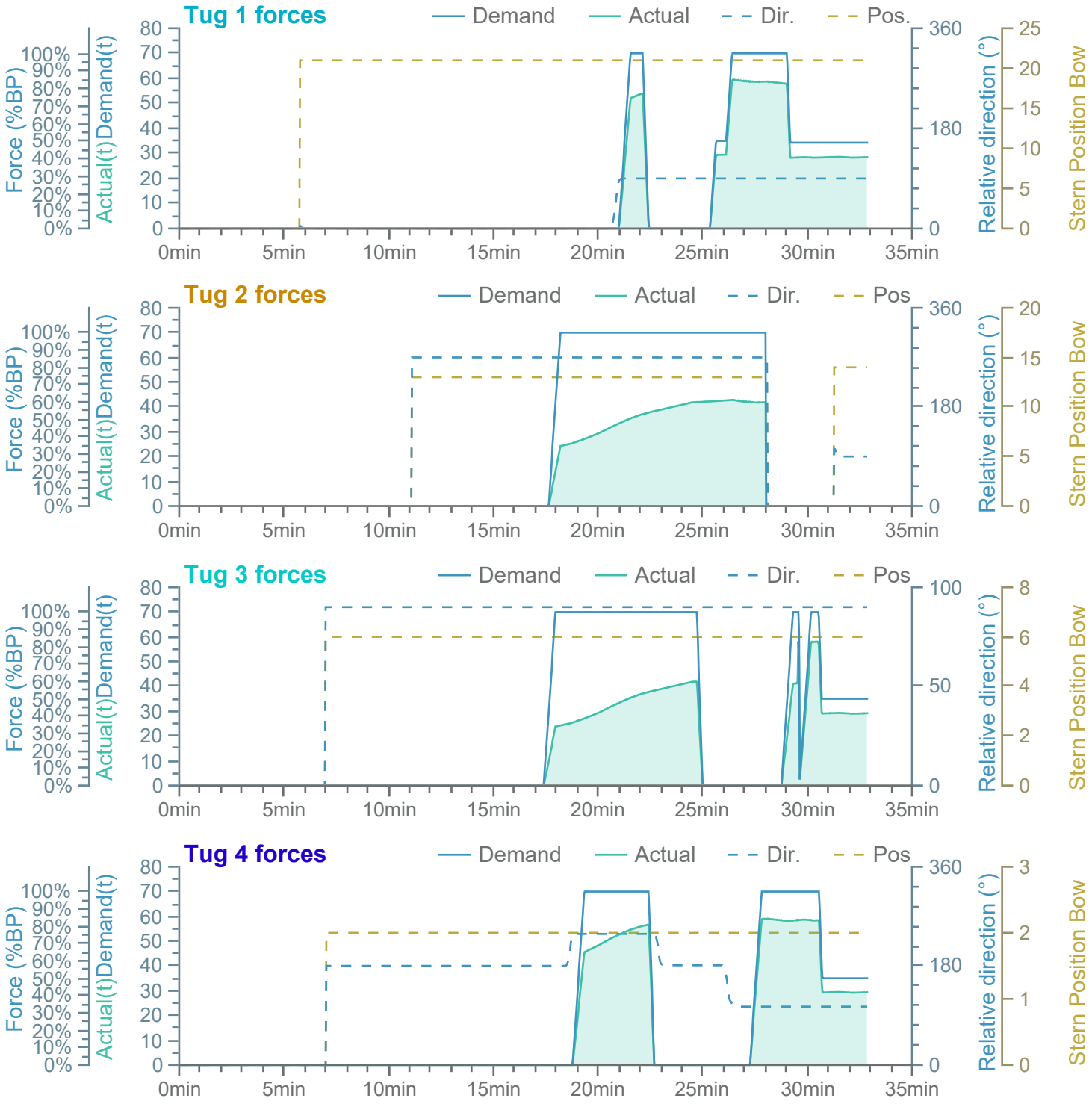
Ships plotted every 2 mins, highlight every 10 mins

Tug position: Initial

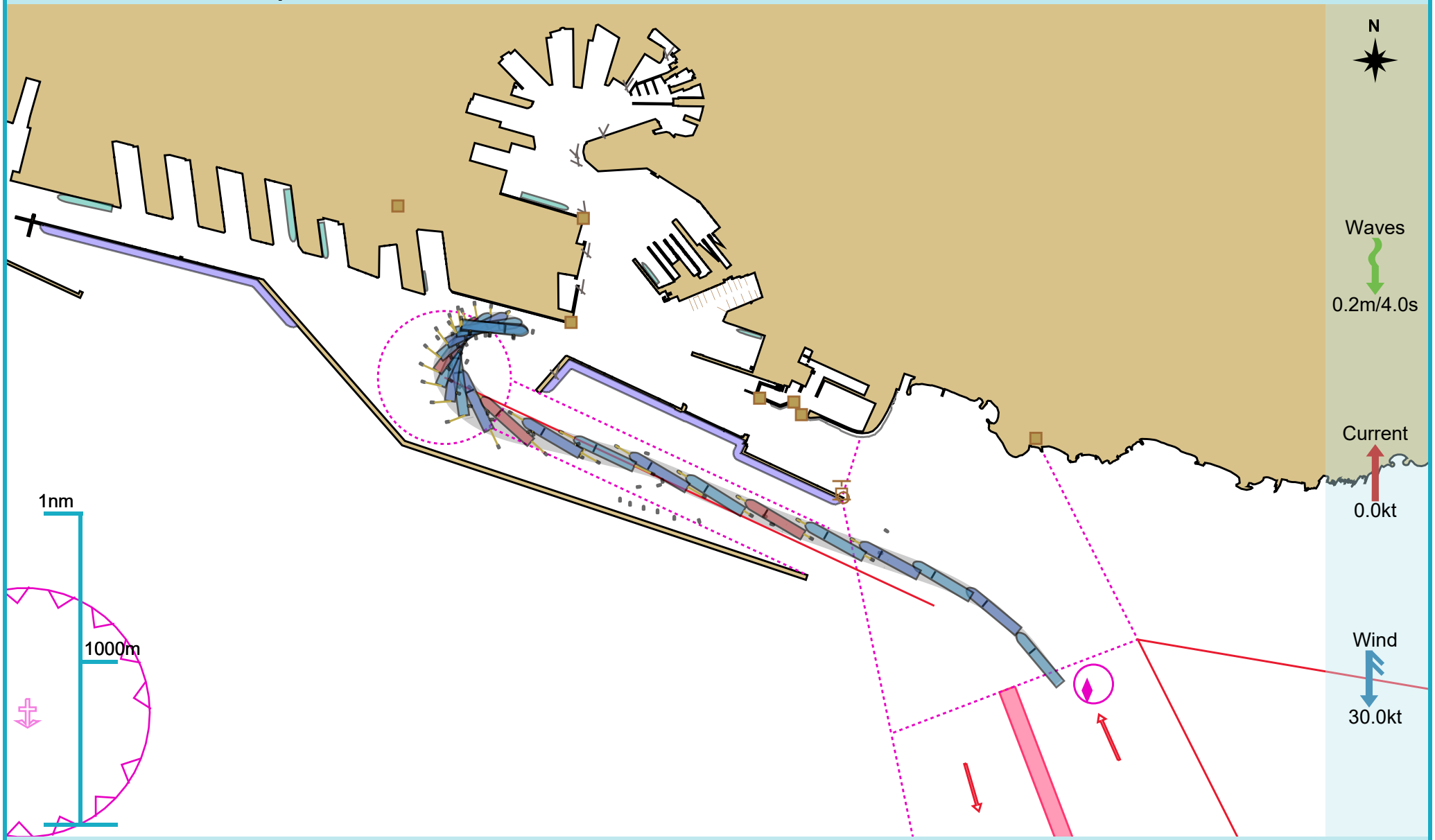


Tug position: Final

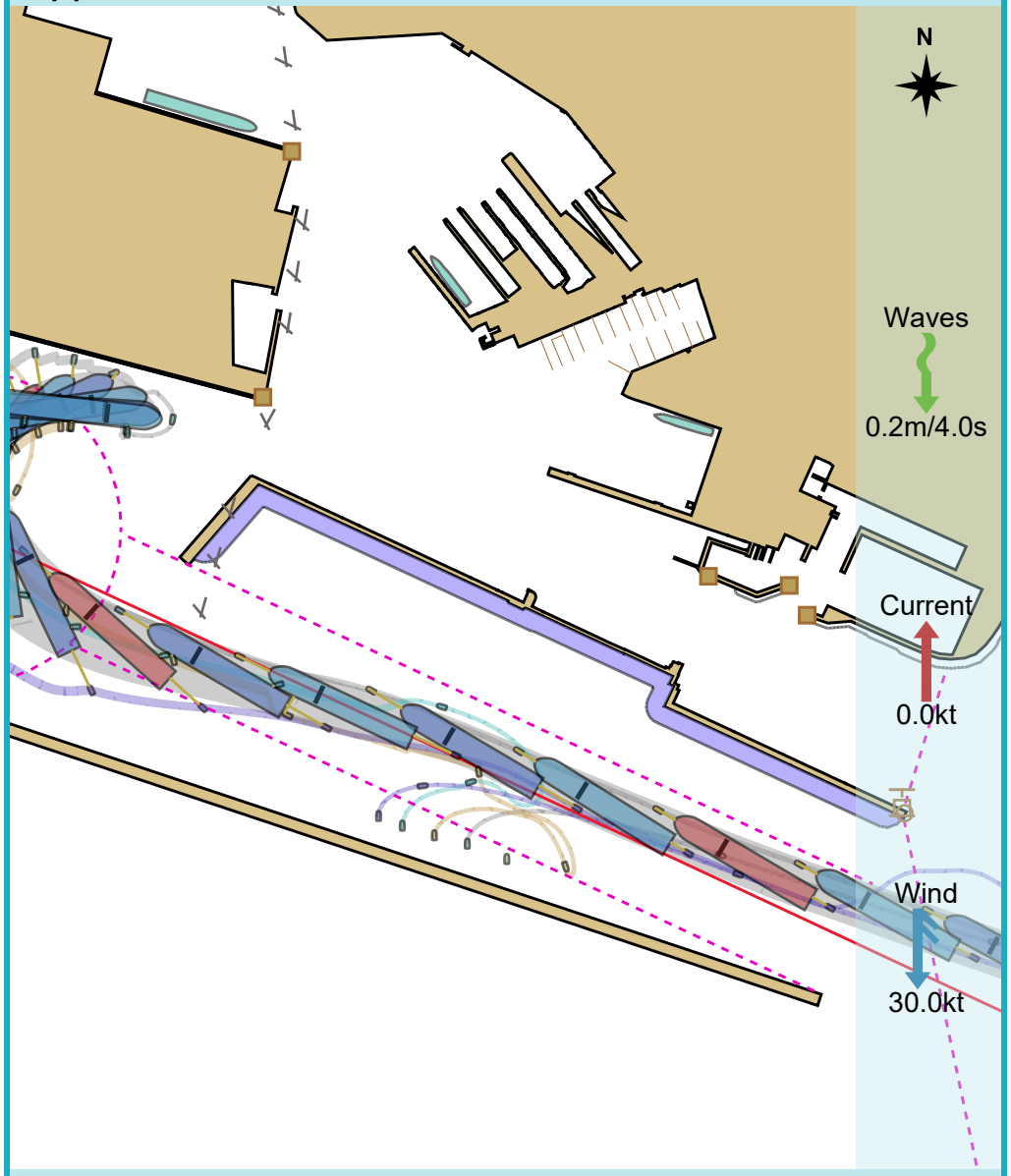



Tug 1 forces
Demand
Actual
Dir.
Pos.
Force (%BP)
Actual(t)Demand(t)
Relative direction (°)
Stern Position Bow
0min
5min
10min
15min
20min
25min
30min
35min
Tug 2 forces
Demand
Actual
Dir.
Pos
Force (%BP)
Actual(t)Demand(t)
Relative direction (°)
Stern Position Bow
Tug 3 forces
Demand
Actual
Dir.
Pos
Force (%BP)
Actual(t)Demand(t)
Relative direction (°)
Stern Position Bow
Tug 4 forces
Demand
Actual
Dir.
Pos
Force (%BP)
Actual(t)Demand(t)
Relative direction (°)
Stern Position Bow

Manoeuvre track plot

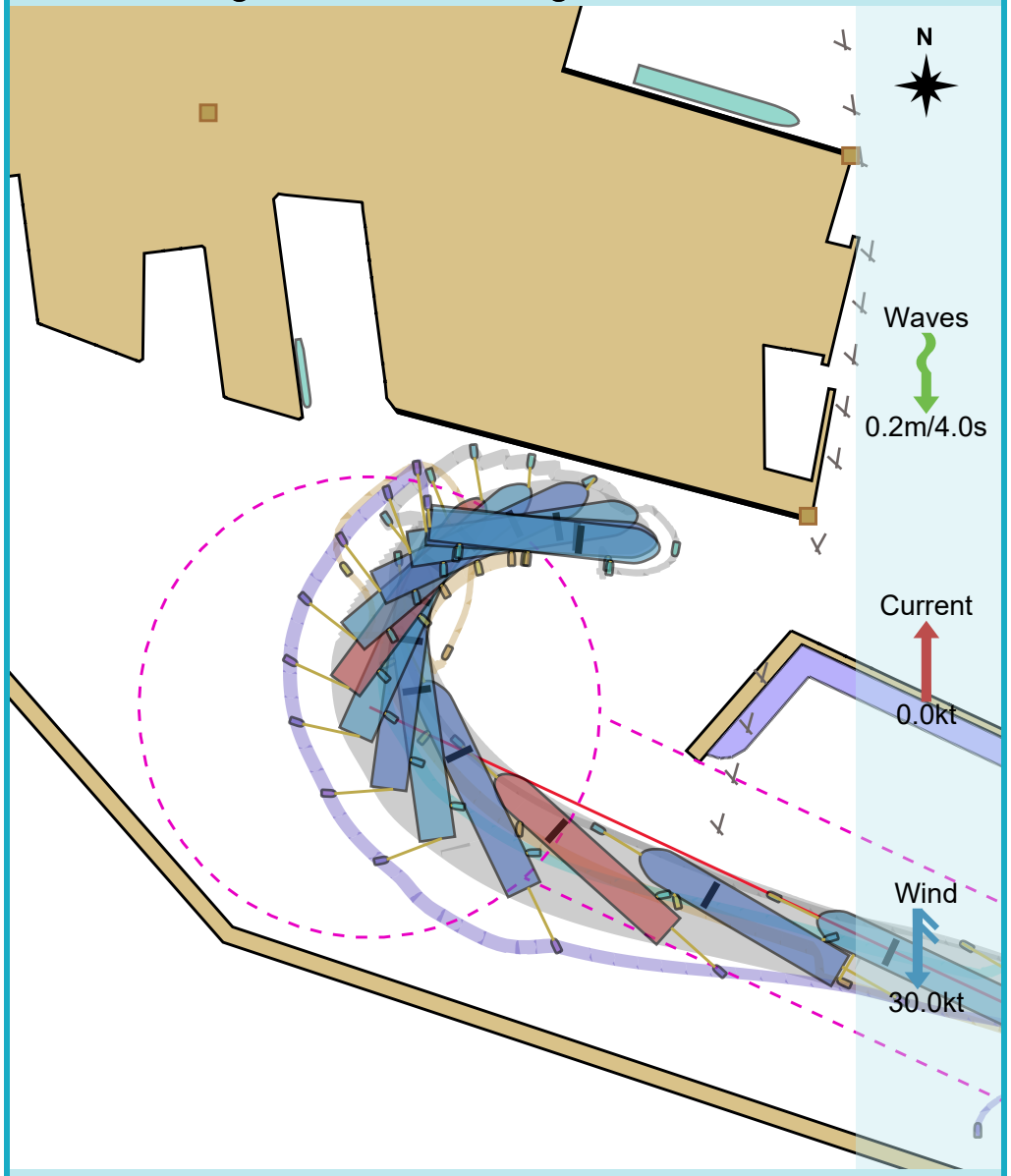


Approach Channel

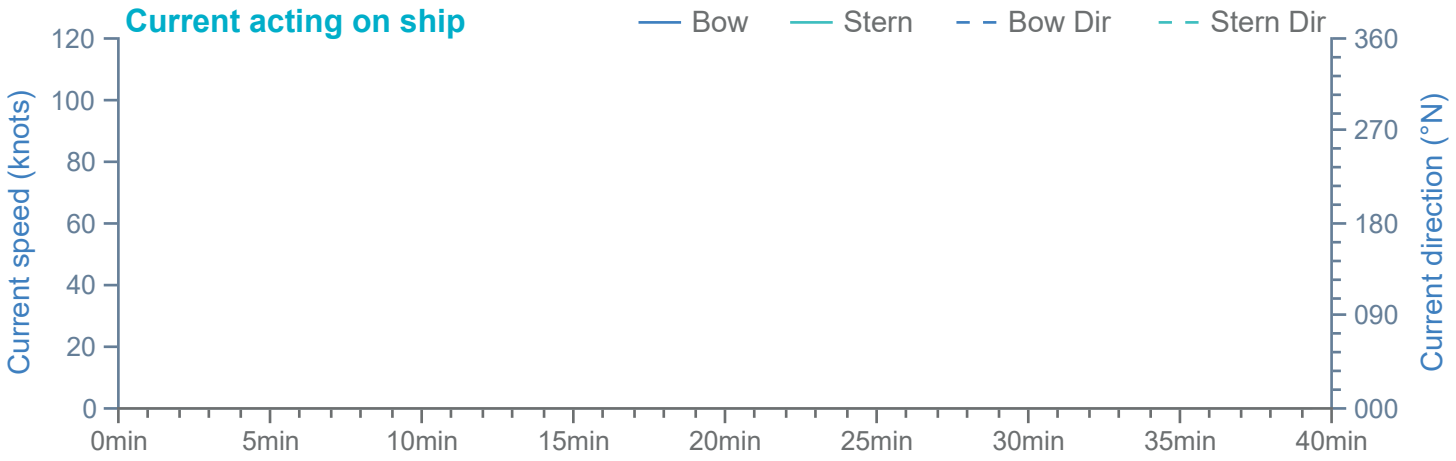


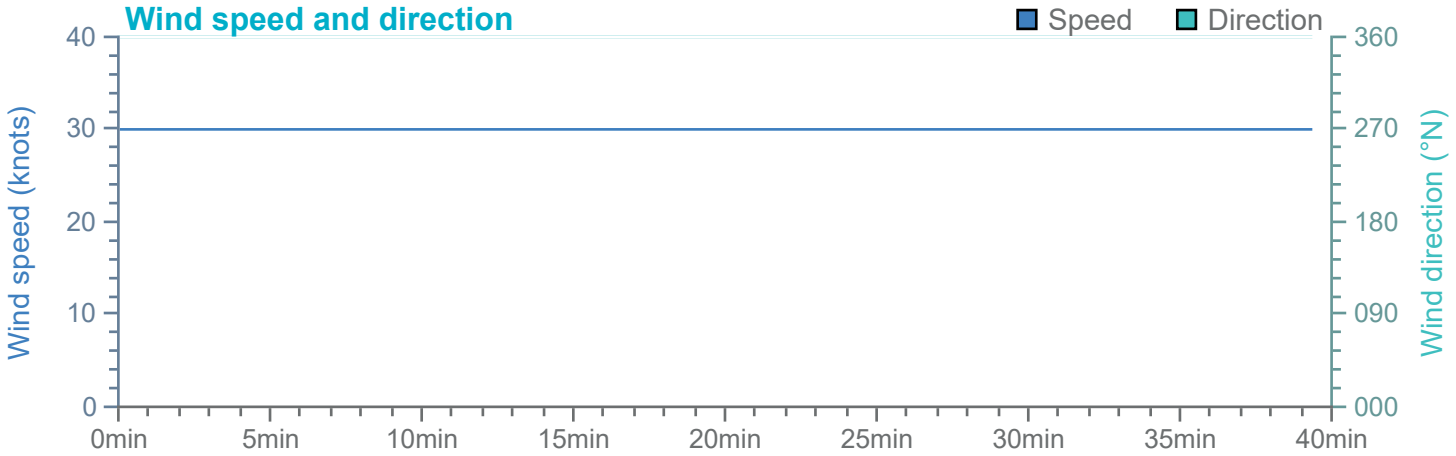
Ships plotted every 2 mins, highlight every 10 mins

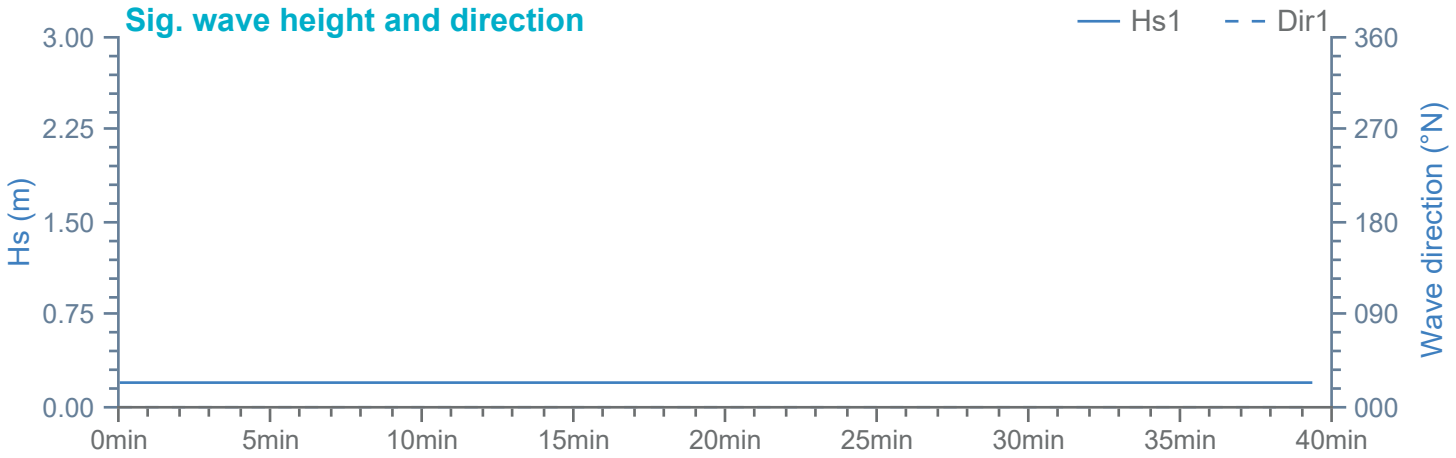
Manoeuvring area and berthing

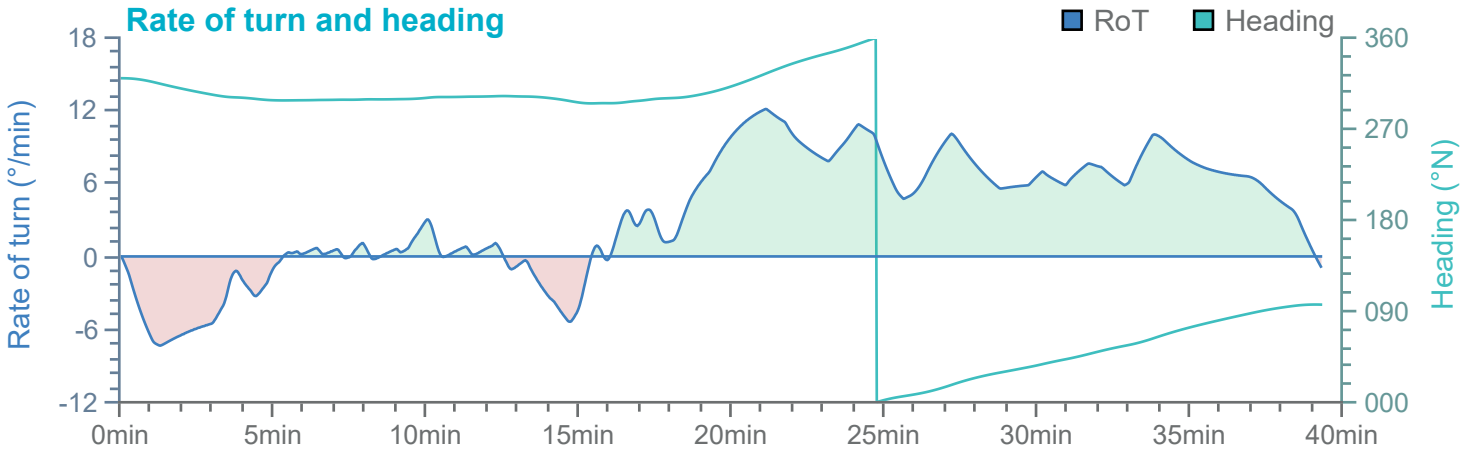


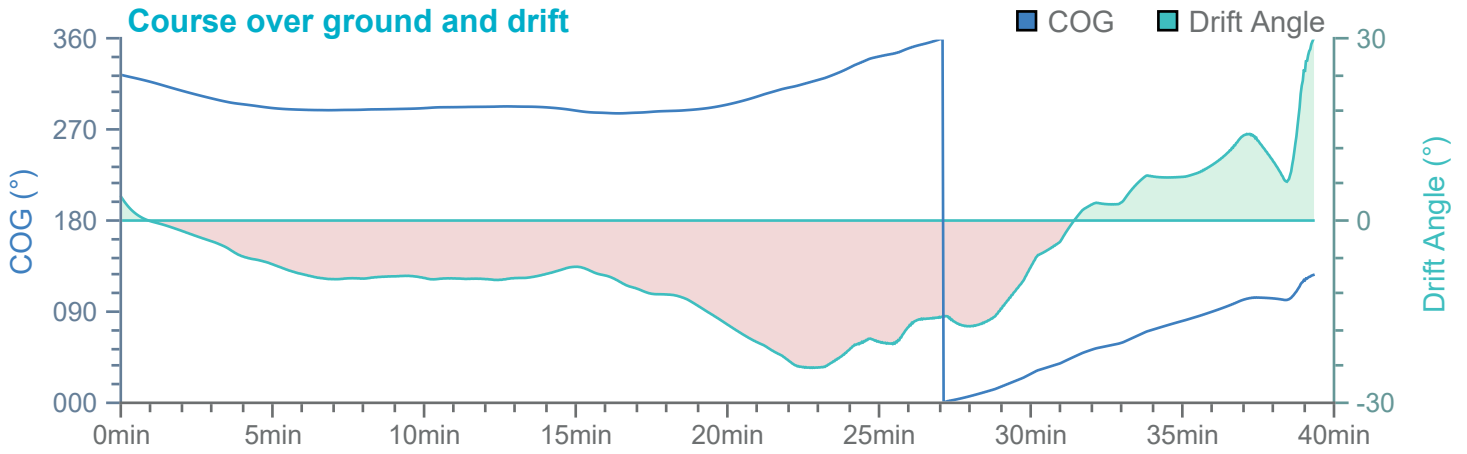
Ships plotted every 2 mins, highlight every 10 mins

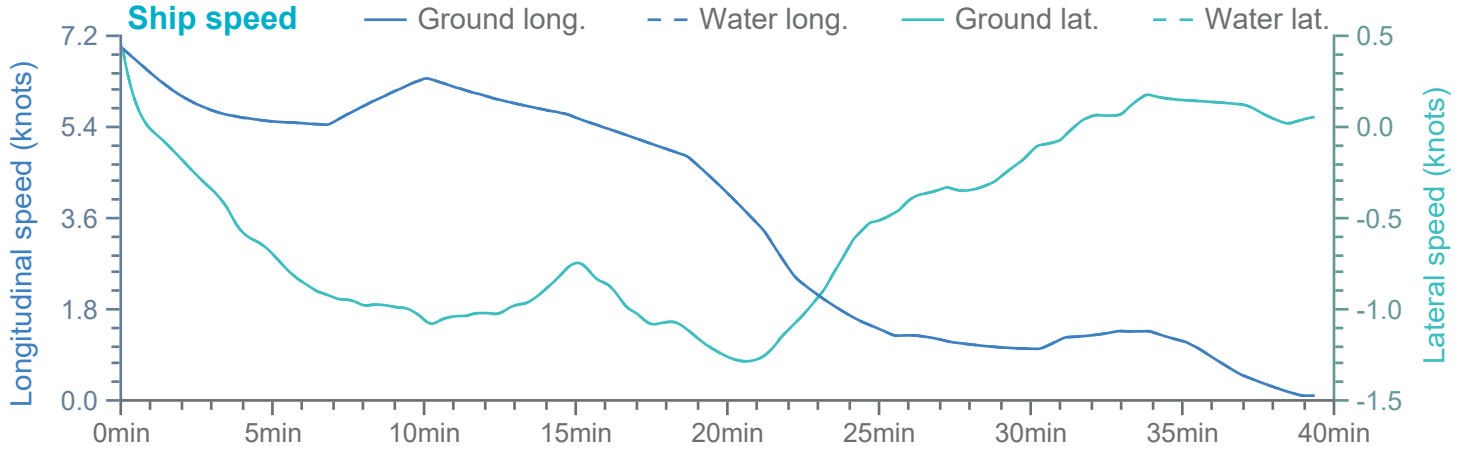

Current acting on ship
Bow
Stern
Bow Dir
Stern Dir
Current speed (knots)
Current direction (°N)
120
100
80
60
40
20
0
360
270
180
090
000
0min
5min
10min
15min
20min
25min
30min
35min
40min

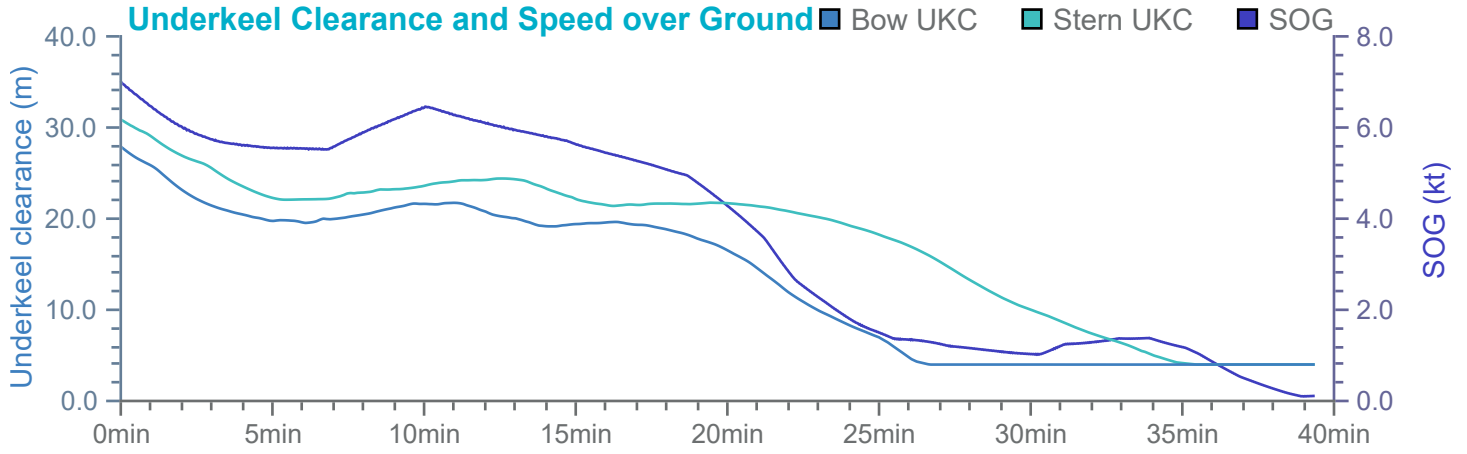

Wind speed and direction
Speed
Direction
Wind speed (knots)
Wind direction (°N)
40
30
20
10
0
360
270
180
090
000
0min
5min
10min
15min
20min
25min
30min
35min
40min

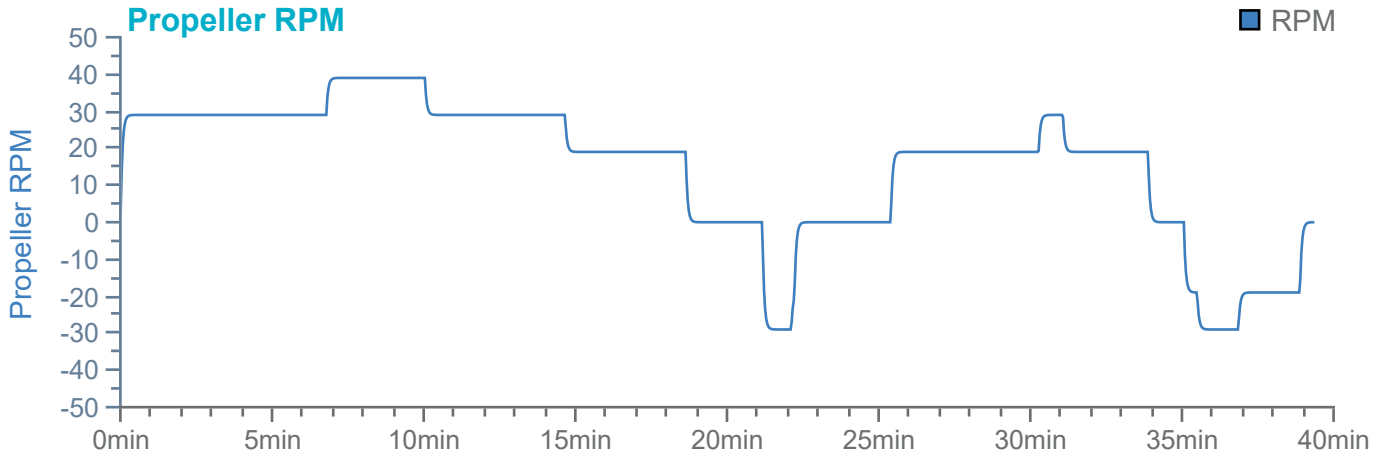

Sig. wave height and direction
Hs1
Dir1
Hs (m)
Wave direction (°N)
3.00
2.25
1.50
0.75
0.00
360
270
180
090
000
0min
5min
10min
15min
20min
25min
30min
35min
40min

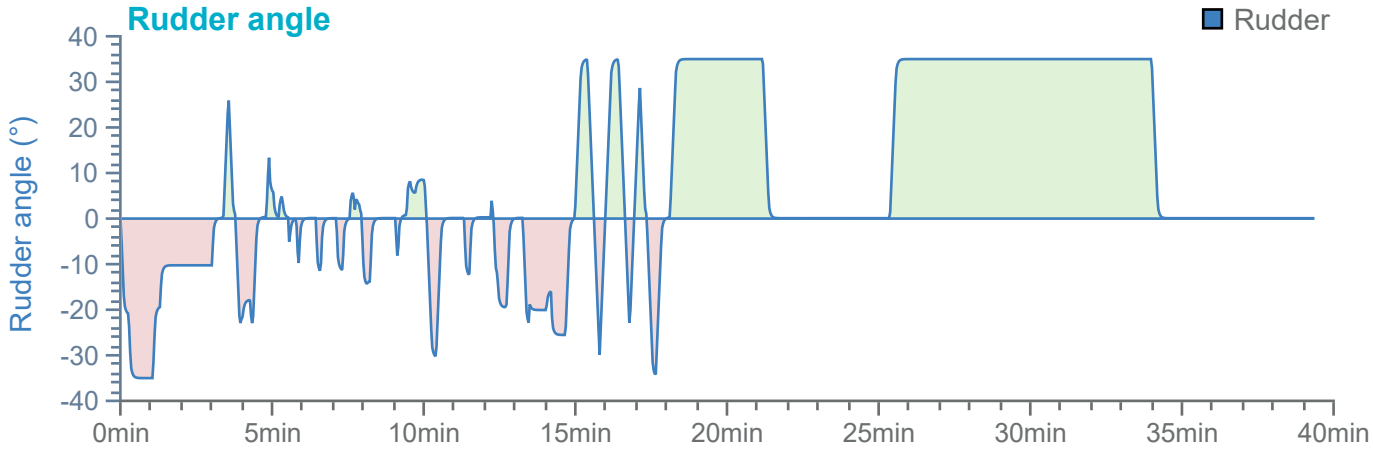

Rate of turn and heading
RoT
Heading
Rate of turn (°/min)
Heading (°N)
18
12
6
0
-6
-12
360
270
180
090
000
0min
5min
10min
15min
20min
25min
30min
35min
40min

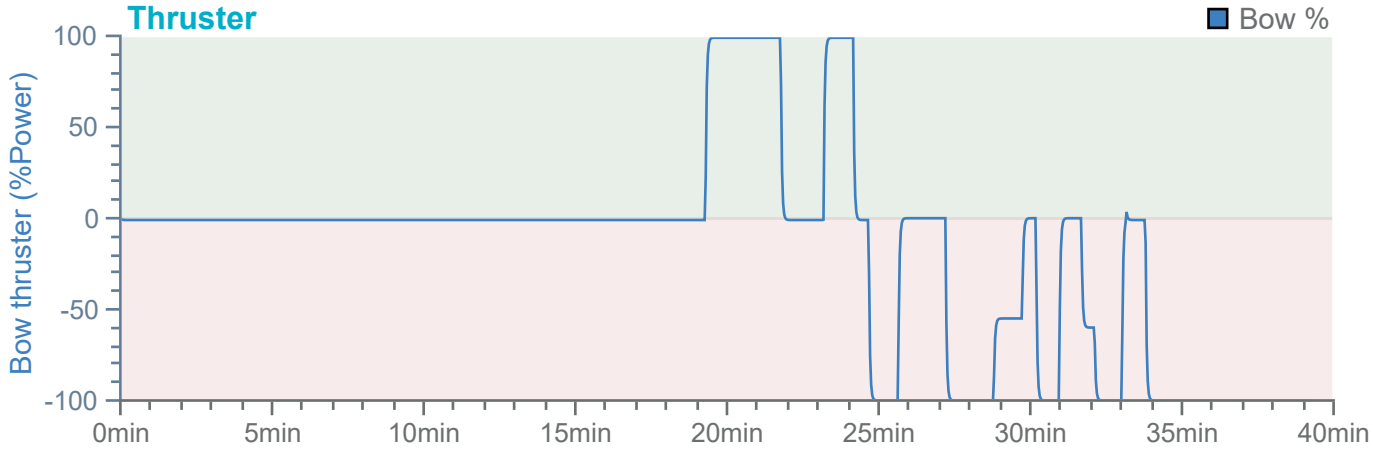

Course over ground and drift
COG
Drift Angle
COG (°)
Drift Angle (°)
360
270
180
090
000
30
0
-30
0min
5min
10min
15min
20min
25min
30min
35min
40min

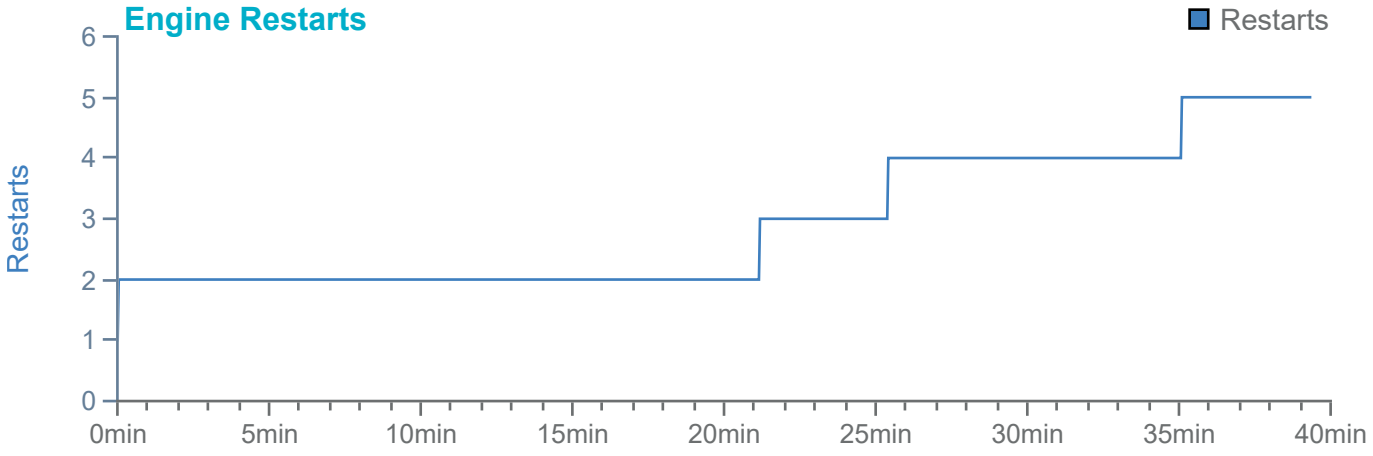

Ship speed
Ground long.
Water long.
Ground lat.
Water lat.
Longitudinal speed (knots)
Lateral speed (knots)
7.2
5.4
3.6
1.8
0.0
0.5
0.0
-0.5
-1.0
-1.5
0min
5min
10min
15min
20min
25min
30min
35min
40min


Underkeel Clearance and Speed over Ground
Bow UKC
Stern UKC
SOG
Underkeel clearance (m)
SOG (kt)
40.0
30.0
20.0
10.0
0.0
8.0
6.0
4.0
2.0
0.0
0min
5min
10min
15min
20min
25min
30min
35min
40min

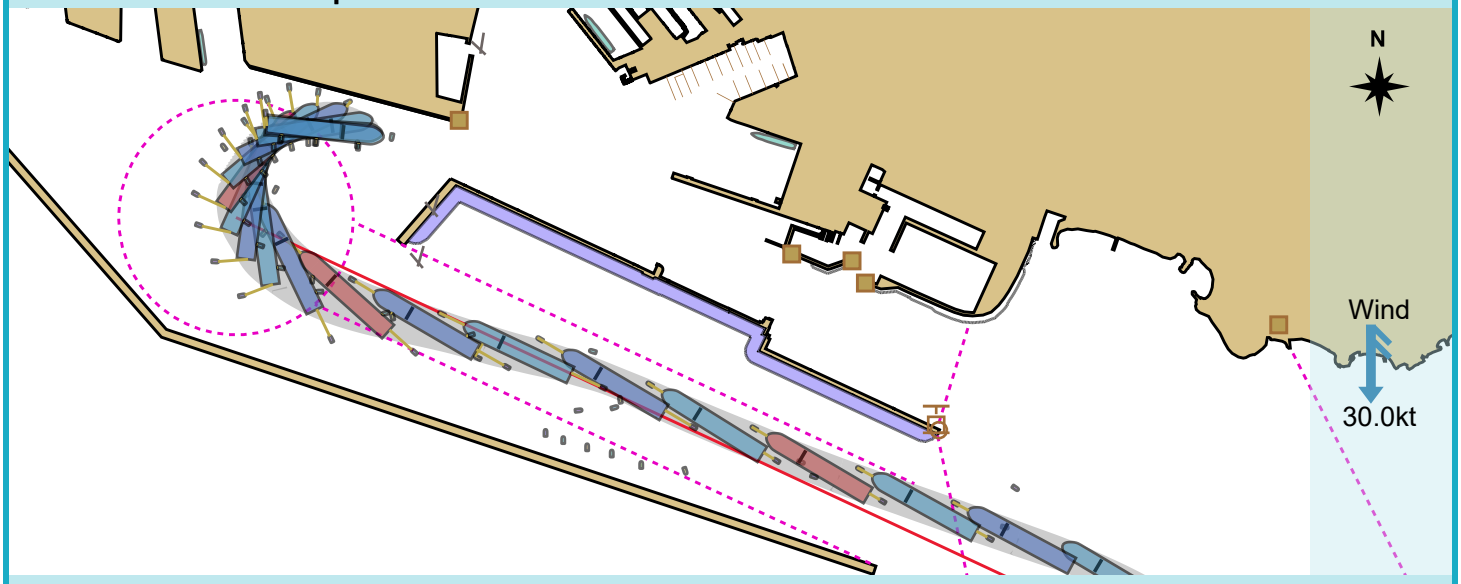

Propeller RPM
RPM
Propeller RPM
50
40
30
20
10
0
-10
-20
-30
-40
-50
0min
5min
10min
15min
20min
25min
30min
35min
40min


Rudder angle
Rudder
Rudder angle (°)
40
30
20
10
0
-10
-20
-30
-40
0min
5min
10min
15min
20min
25min
30min
35min
40min


Thruster
Bow %
Bow thruster (%Power)
100
50
0
-50
-100
0min
5min
10min
15min
20min
25min
30min
35min
40min

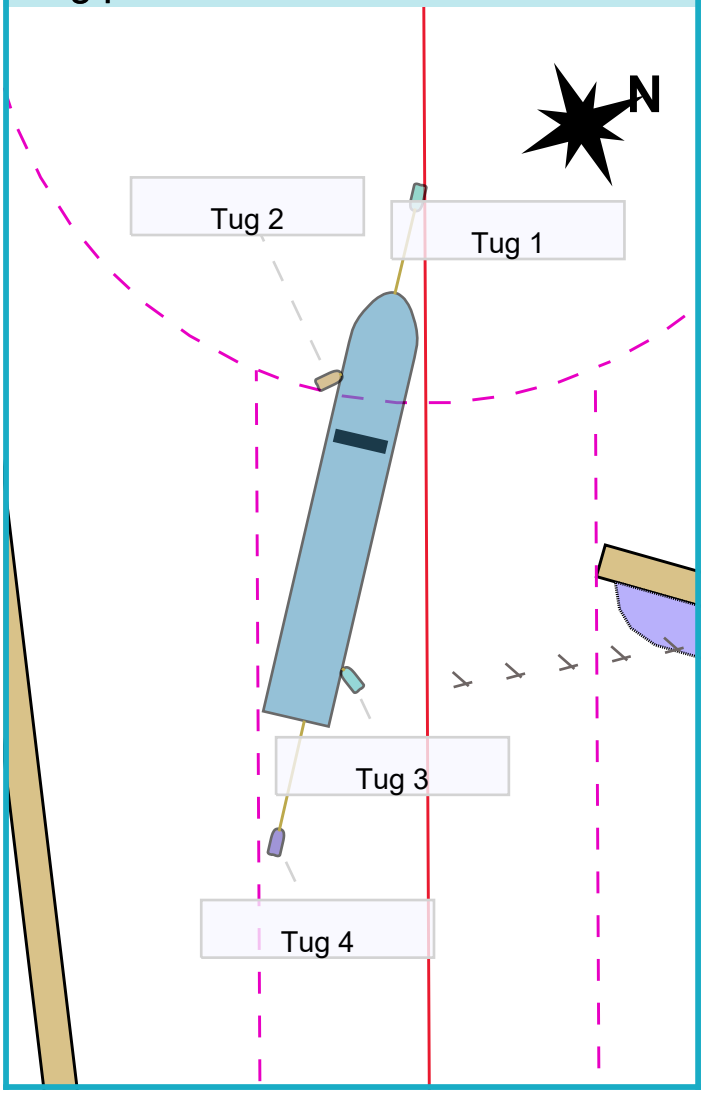

Engine Restarts
Restarts
Restarts
6
5
4
3
2
1
0
0min
5min
10min
15min
20min
25min
30min
35min
40min

Manoeuvre track plot

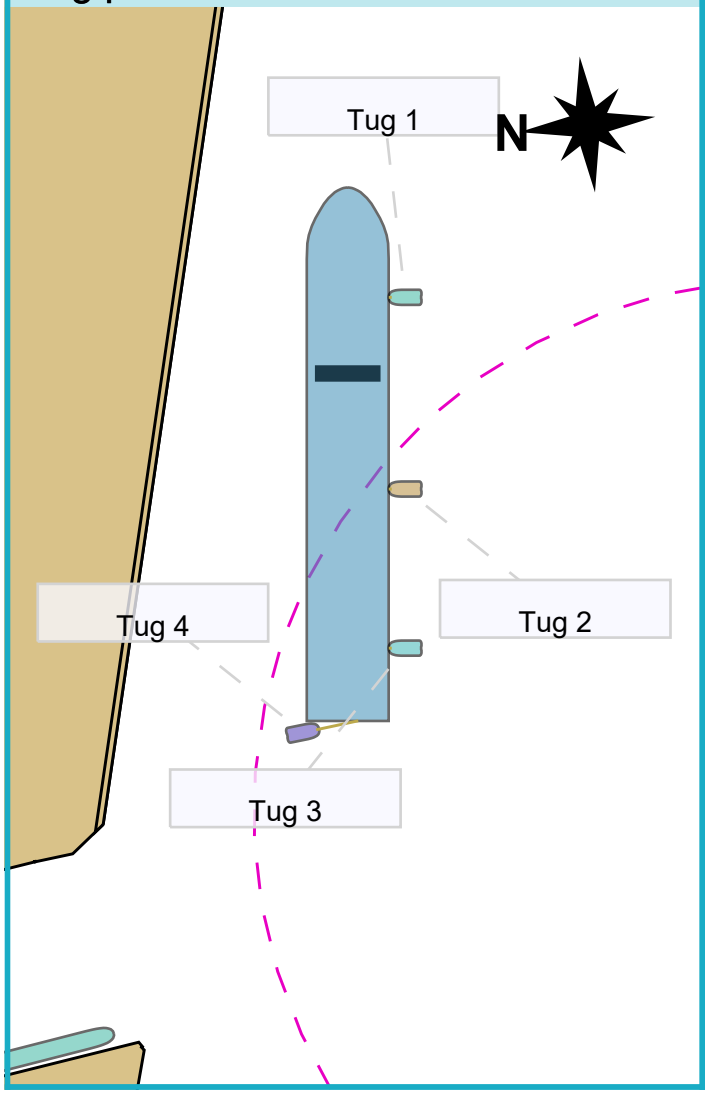


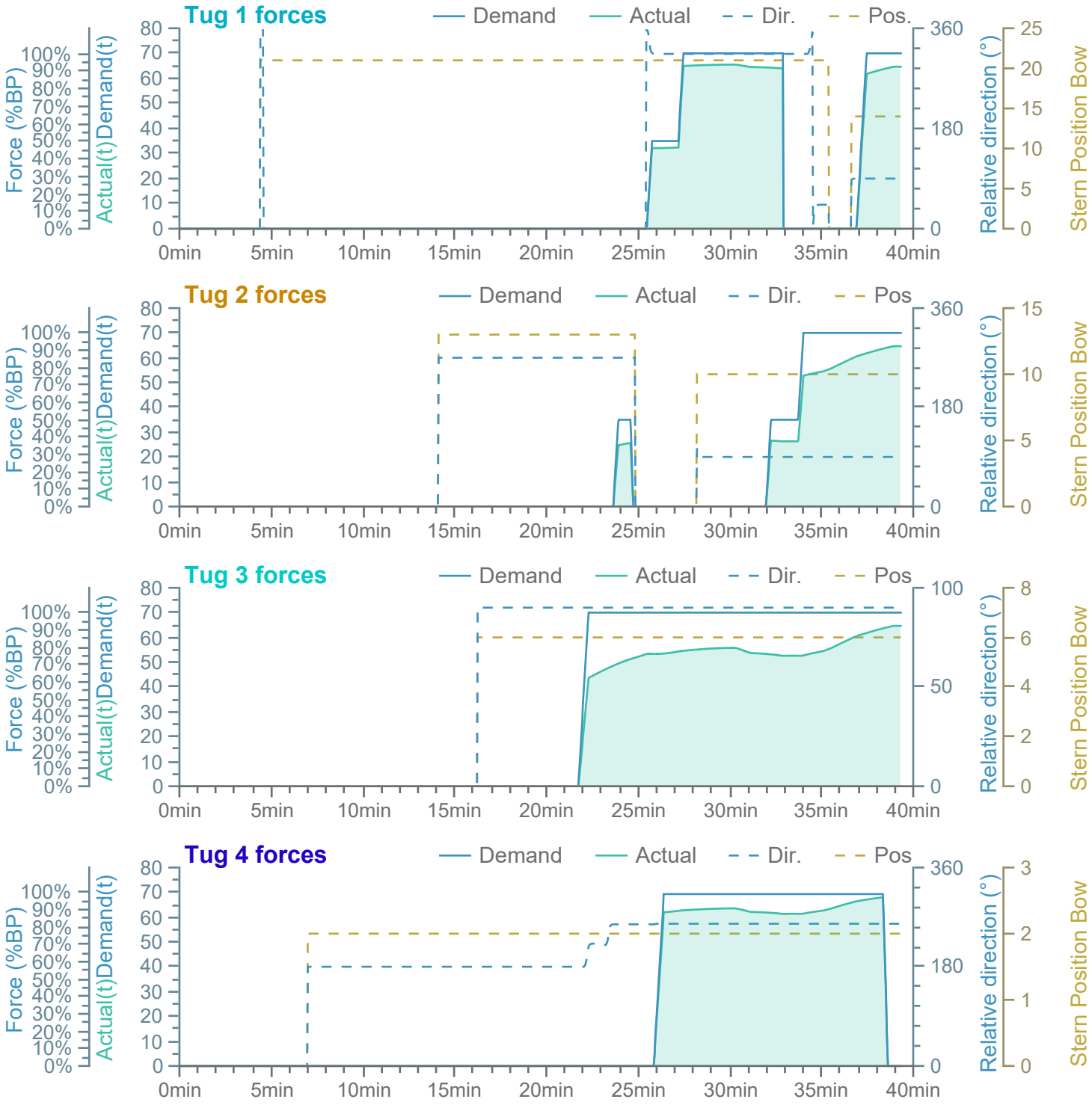
Ships plotted every 2 mins, highlight every 10 mins

Tug position: Initial



Tug position: Final



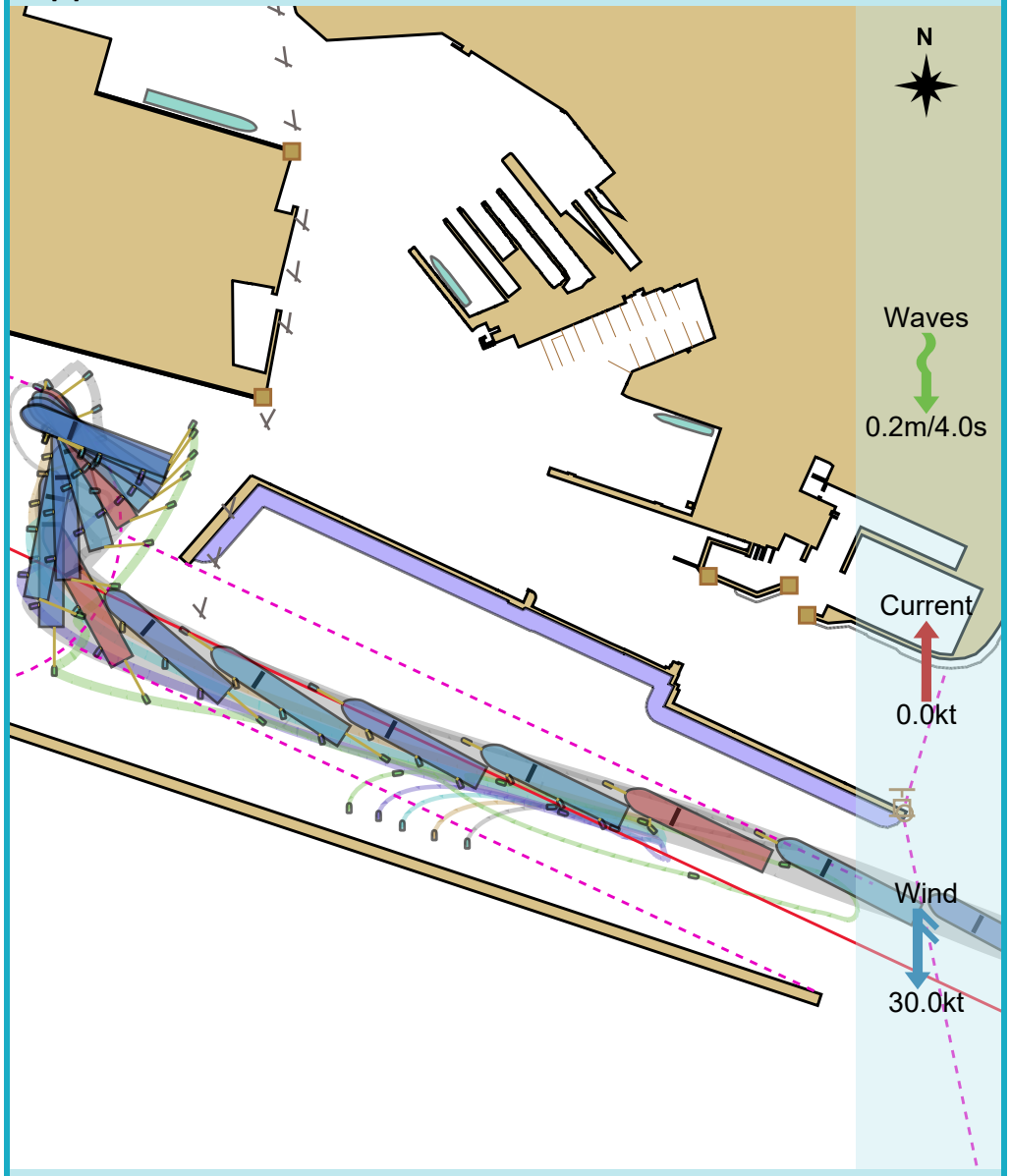

Tug 1 forces
Demand
Actual
Dir.
Pos.
Force (%BP)
Actual(t)Demand(t)
Relative direction (°)
Stern Position Bow
0min
5min
10min
15min
20min
25min
30min
35min
40min
Tug 2 forces
Demand
Actual
Dir.
Pos
Force (%BP)
Actual(t)Demand(t)
Relative direction (°)
Stern Position Bow
Tug 3 forces
Demand
Actual
Dir.
Pos
Force (%BP)
Actual(t)Demand(t)
Relative direction (°)
Stern Position Bow
Tug 4 forces
Demand
Actual
Dir.
Pos
Force (%BP)
Actual(t)Demand(t)
Relative direction (°)
Stern Position Bow

Manoeuvre track plot

0.00 kts

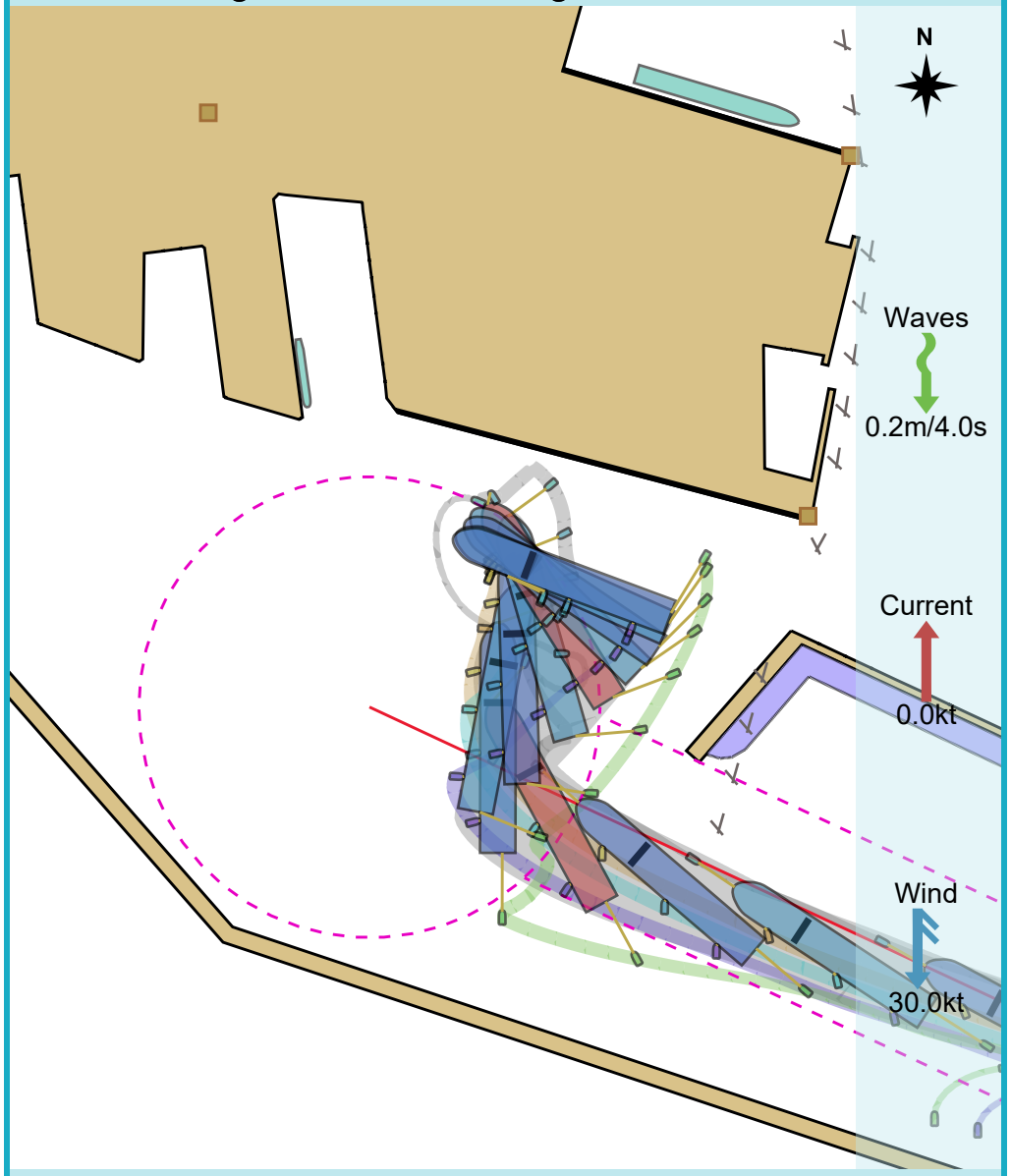
Ships plotted every 2 mins, highlight every 10 mins

Approach Channel

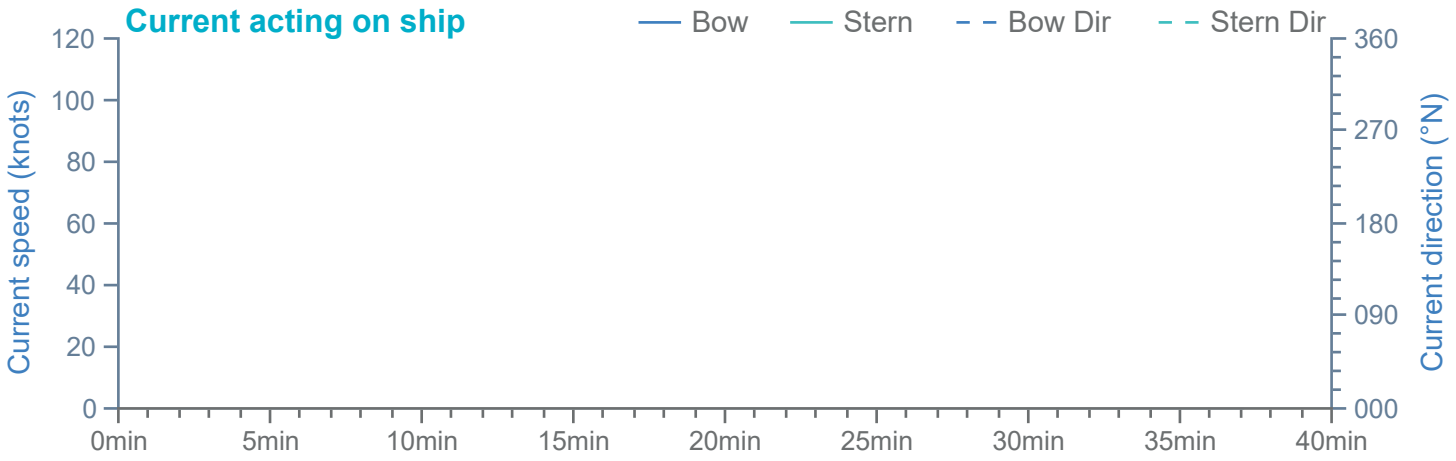


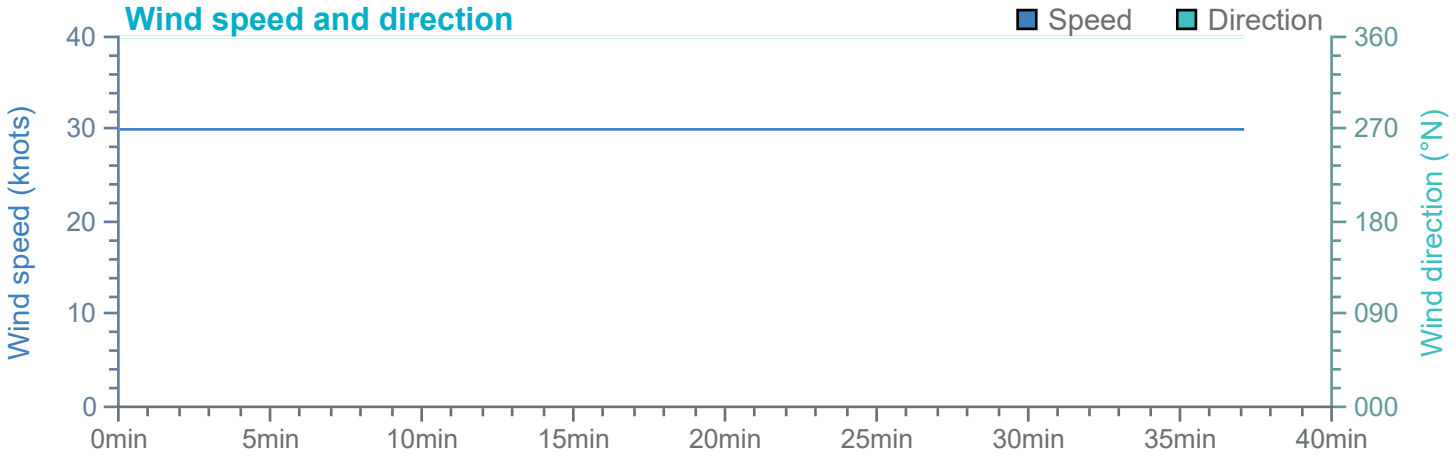
Ships plotted every 2 mins, highlight every 10 mins

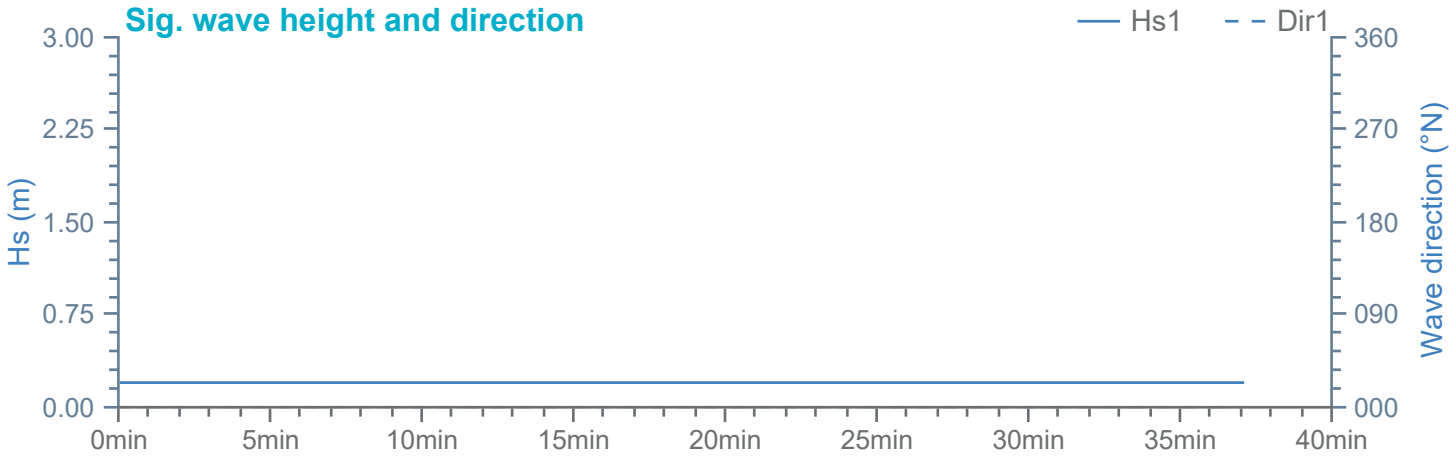
Manoeuvring area and berthing

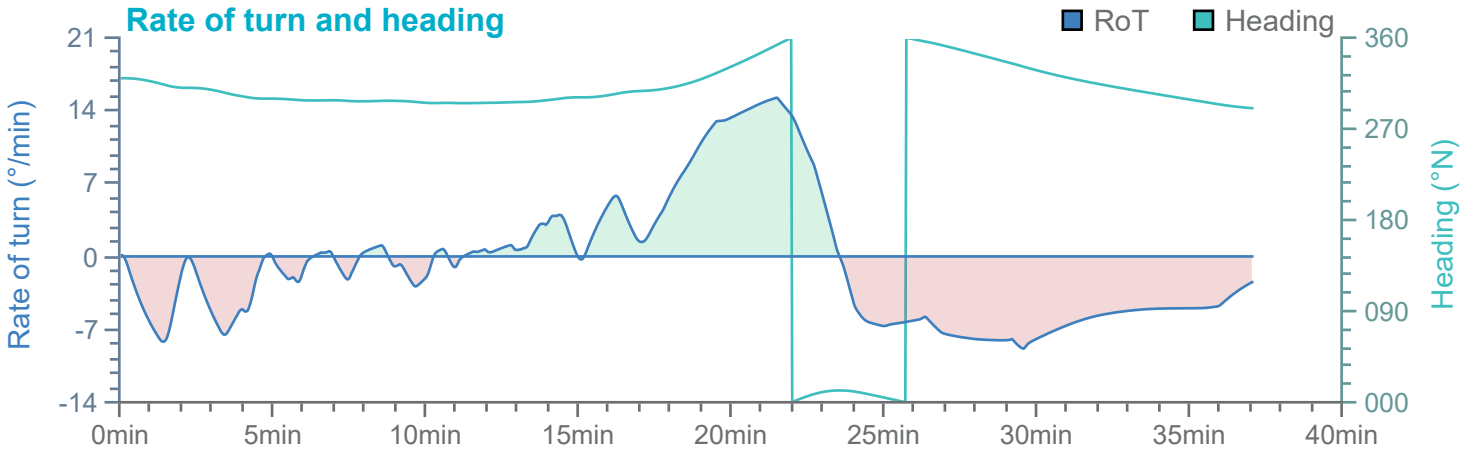


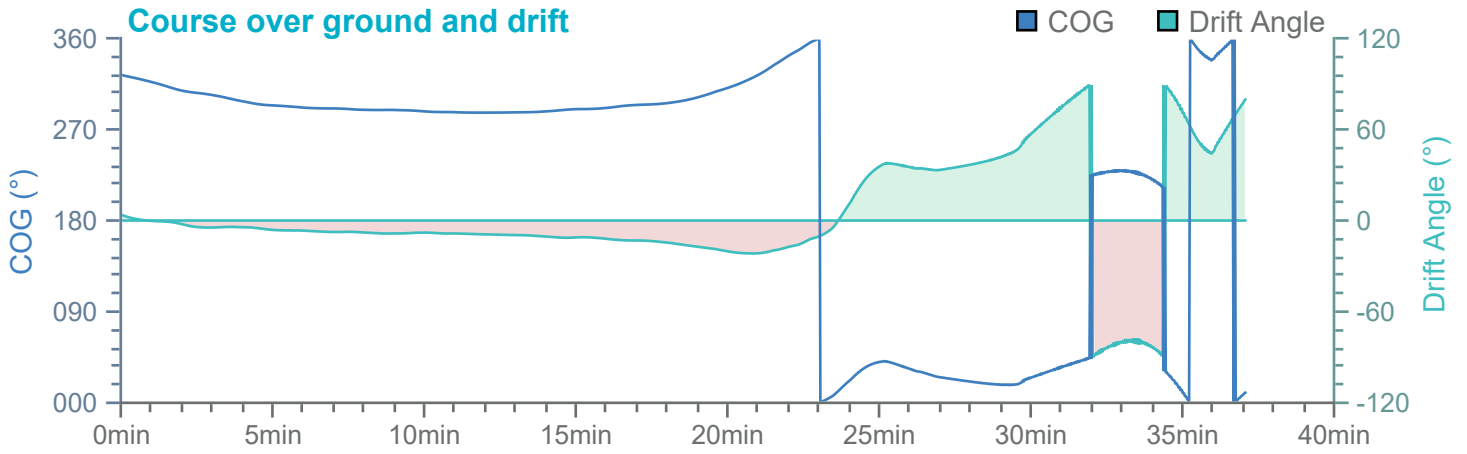
Ships plotted every 2 mins, highlight every 10 mins

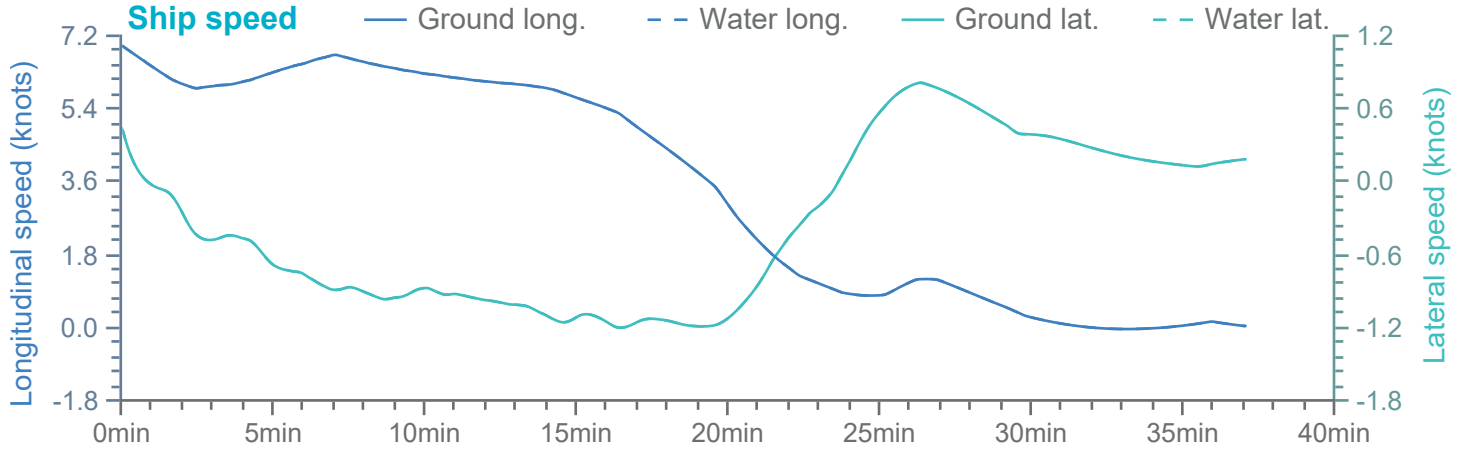

Current acting on ship
Bow
Stern
Bow Dir
Stern Dir
Current speed (knots)
Current direction (°N)
120
100
80
60
40
20
0
360
270
180
090
000
0min
5min
10min
15min
20min
25min
30min
35min
40min

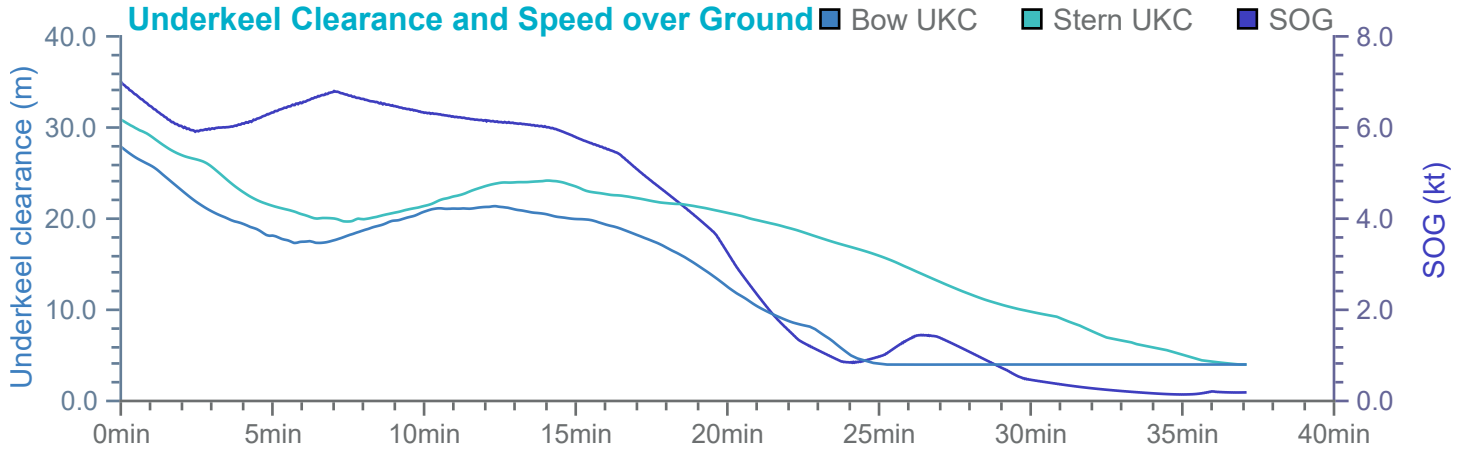

Wind speed and direction
Speed
Direction
Wind speed (knots)
Wind direction (°N)
40
30
20
10
0
360
270
180
090
000
0min
5min
10min
15min
20min
25min
30min
35min
40min

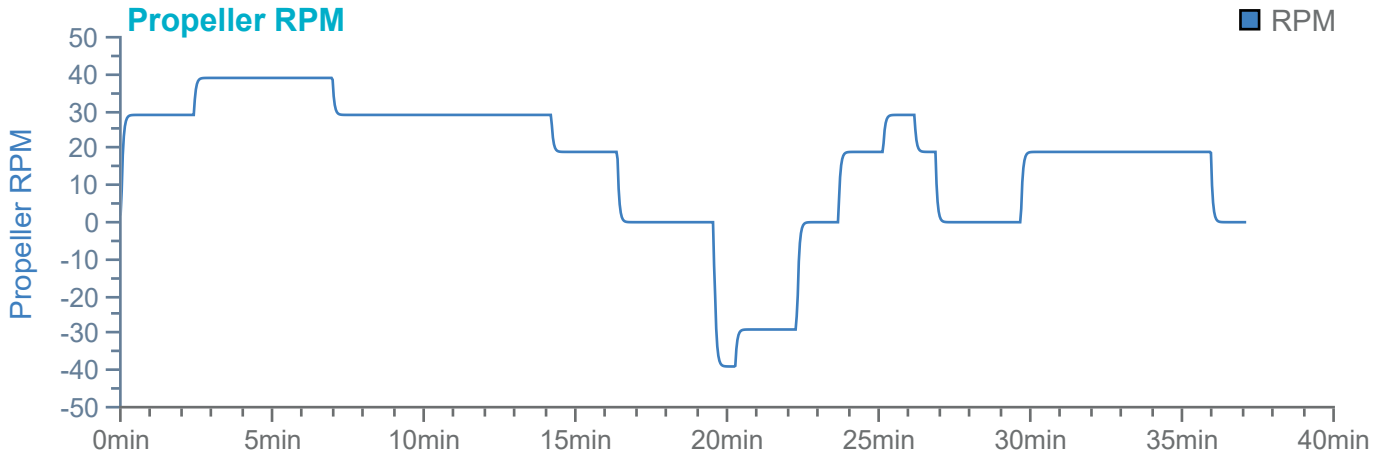

Sig. wave height and direction
Hs1
Dir1
Hs (m)
Wave direction (°N)
3.00
2.25
1.50
0.75
0.00
360
270
180
090
000
0min
5min
10min
15min
20min
25min
30min
35min
40min

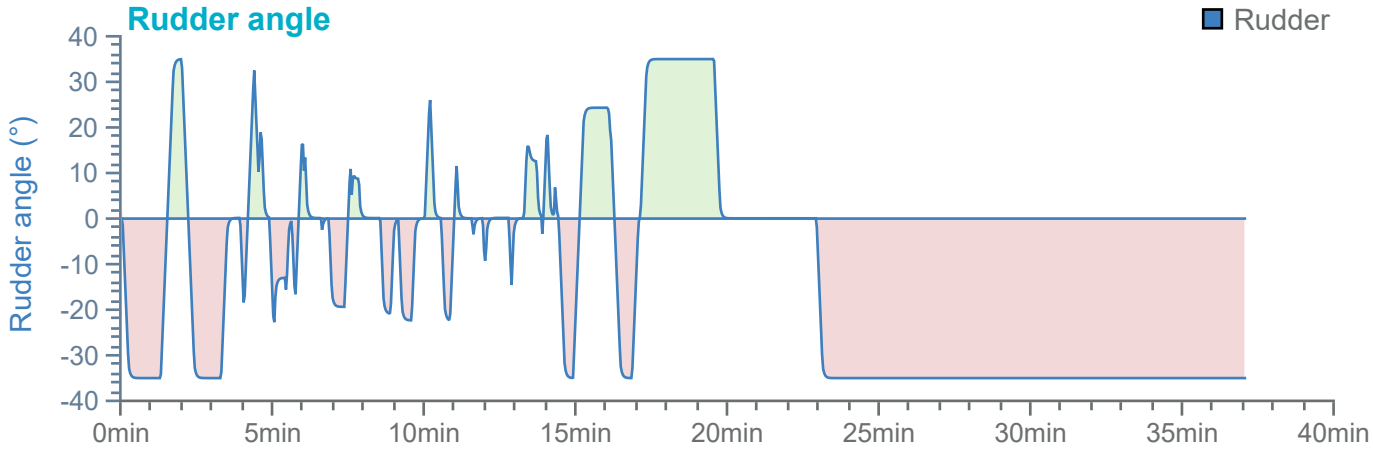

Rate of turn and heading
RoT
Heading
Rate of turn (°/min)
Heading (°N)
21
14
7
0
-7
-14
360
270
180
090
000
0min
5min
10min
15min
20min
25min
30min
35min
40min

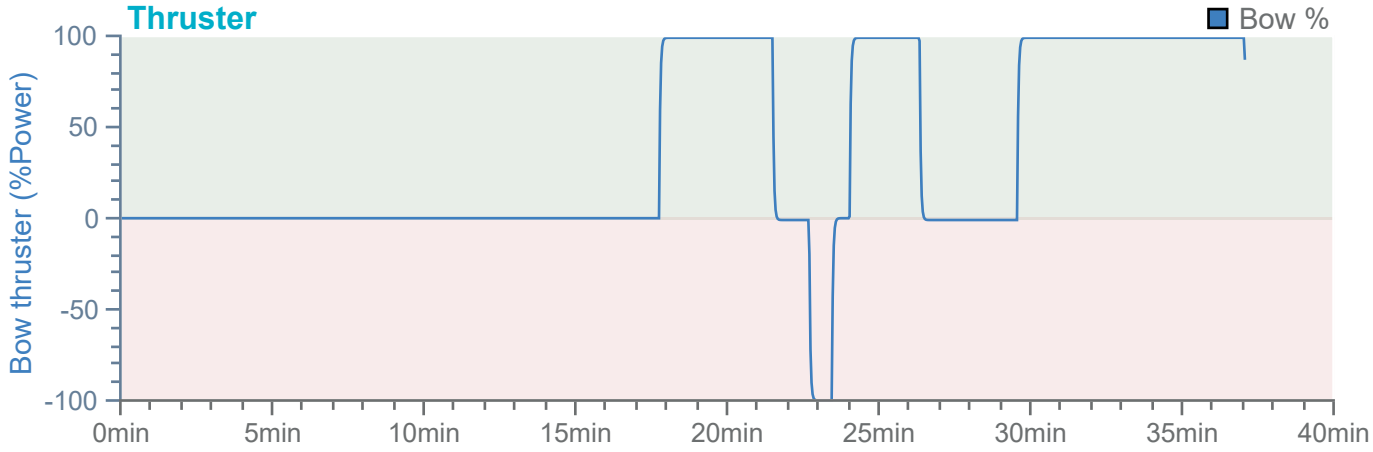

Course over ground and drift
COG
Drift Angle
COG (°)
Drift Angle (°)
360
270
180
090
000
120
60
0
-60
-120
0min
5min
10min
15min
20min
25min
30min
35min
40min


Ship speed
Ground long.
Water long.
Ground lat.
Water lat.
Longitudinal speed (knots)
Lateral speed (knots)
7.2
5.4
3.6
1.8
0.0
-1.8
1.2
0.6
0.0
-0.6
-1.2
-1.8
0min
5min
10min
15min
20min
25min
30min
35min
40min

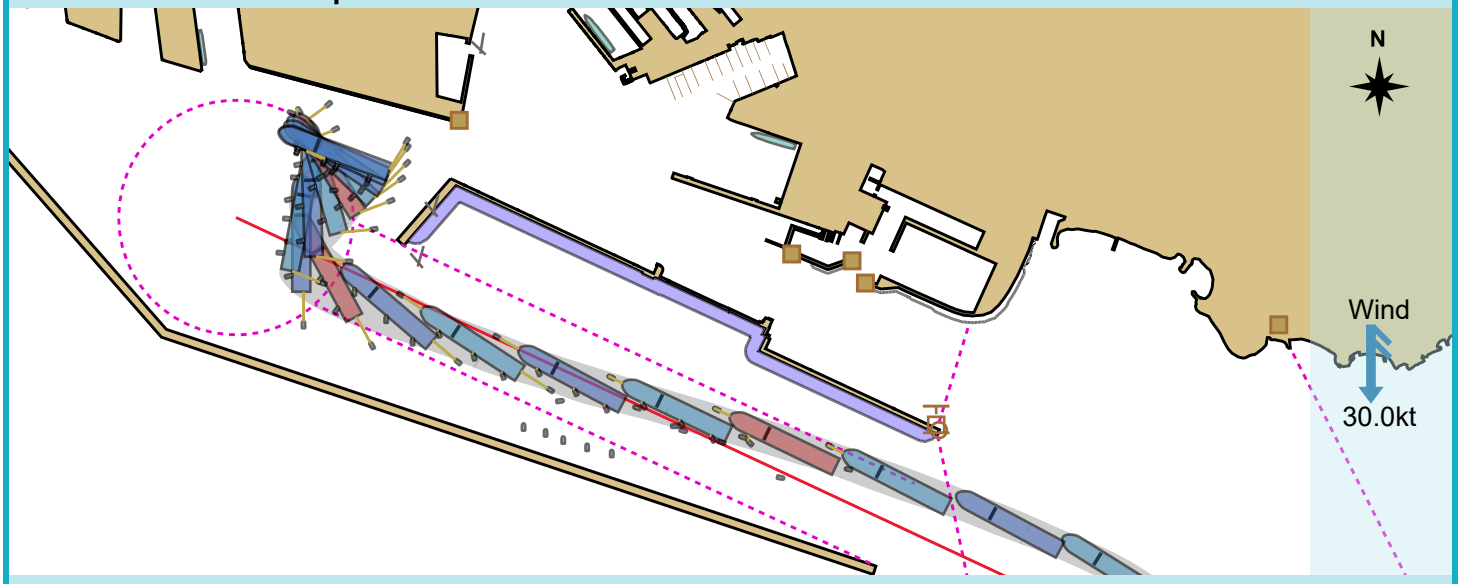

Underkeel Clearance and Speed over Ground
Bow UKC
Stern UKC
SOG
Underkeel clearance (m)
SOG (kt)
40.0
30.0
20.0
10.0
0.0
8.0
6.0
4.0
2.0
0.0
0min
5min
10min
15min
20min
25min
30min
35min
40min


Propeller RPM
RPM
Propeller RPM
50
40
30
20
10
0
-10
-20
-30
-40
-50
0min
5min
10min
15min
20min
25min
30min
35min
40min


Rudder angle
Rudder
Rudder angle (°)
40
30
20
10
0
-10
-20
-30
-40
0min
5min
10min
15min
20min
25min
30min
35min
40min

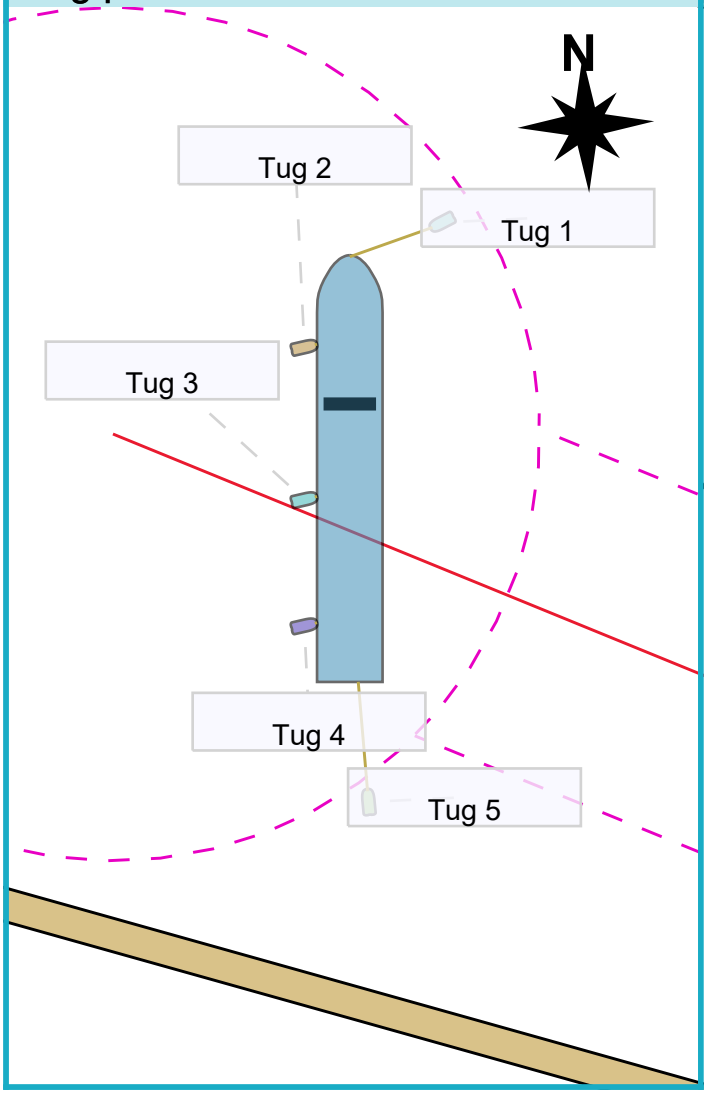

Thruster
Bow %
Bow thruster (%Power)
100
50
0
-50
-100
0min
5min
10min
15min
20min
25min
30min
35min
40min

Manoeuvre track plot

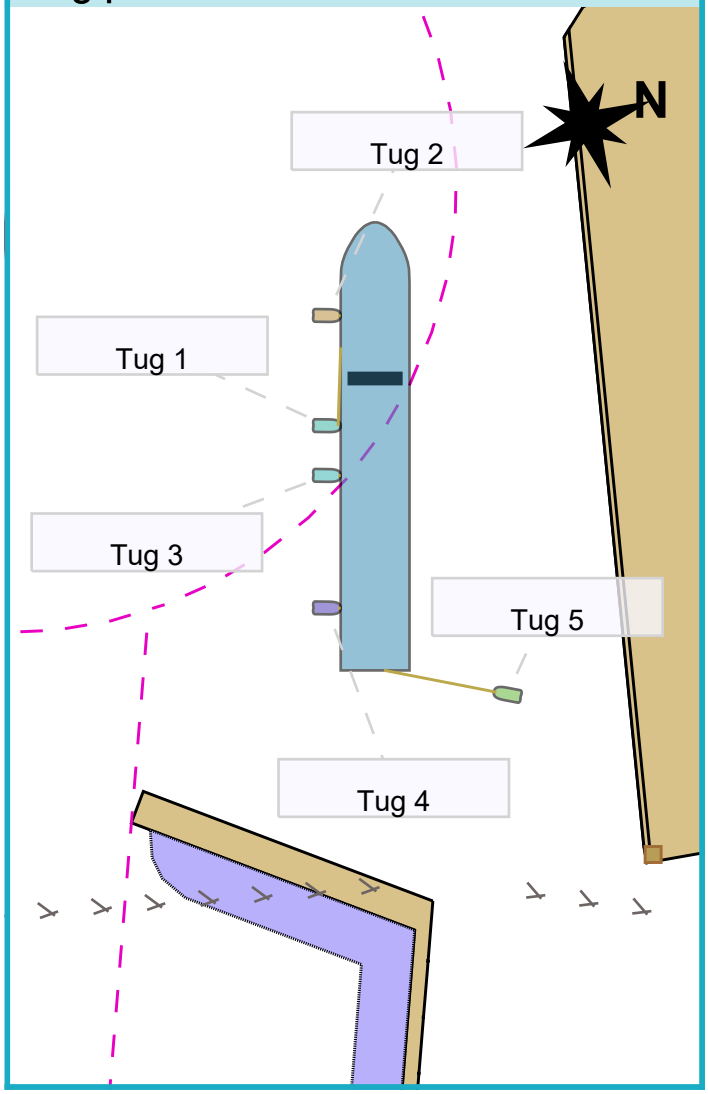


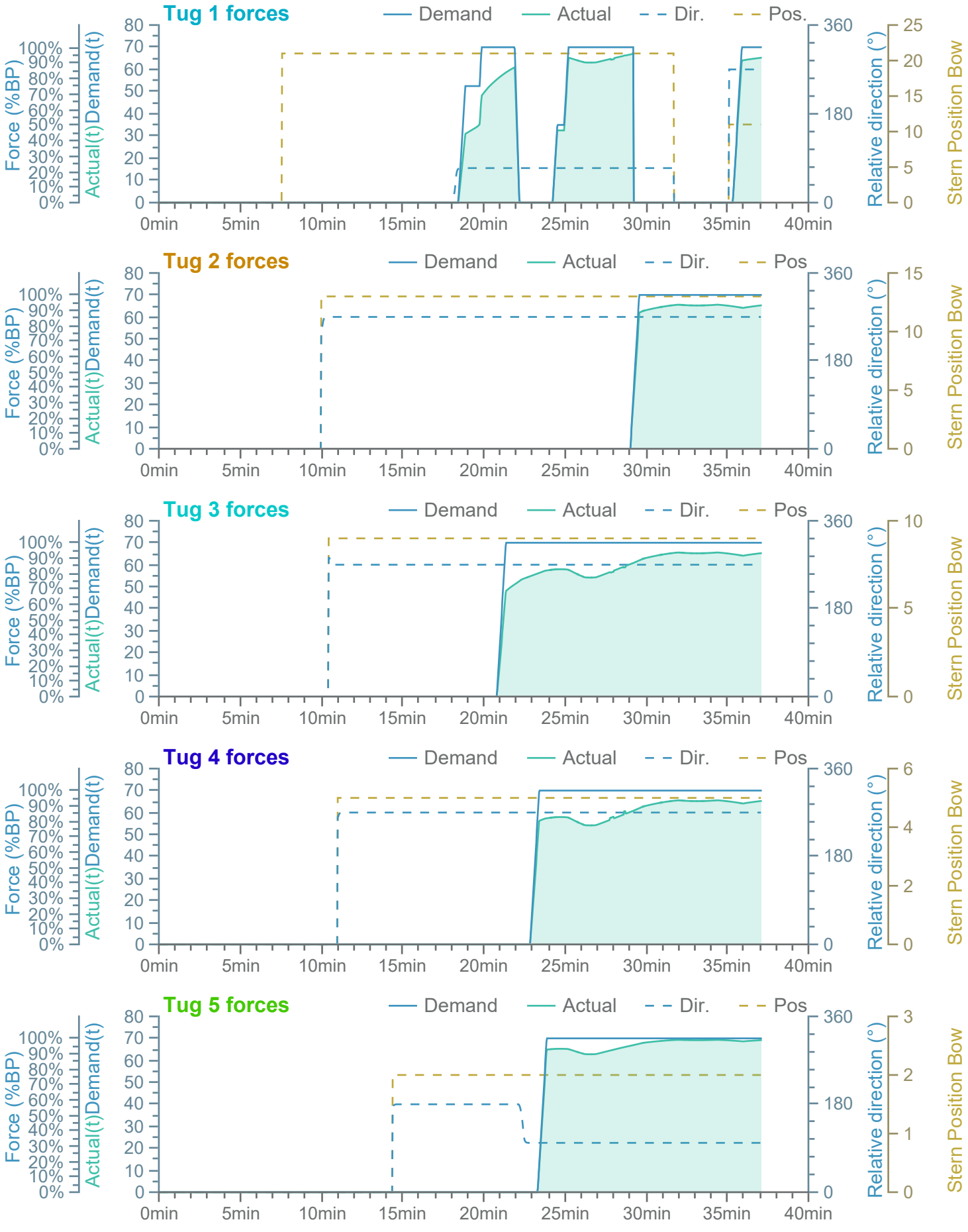
Ships plotted every 2 mins, highlight every 10 mins

Tug position: Initial



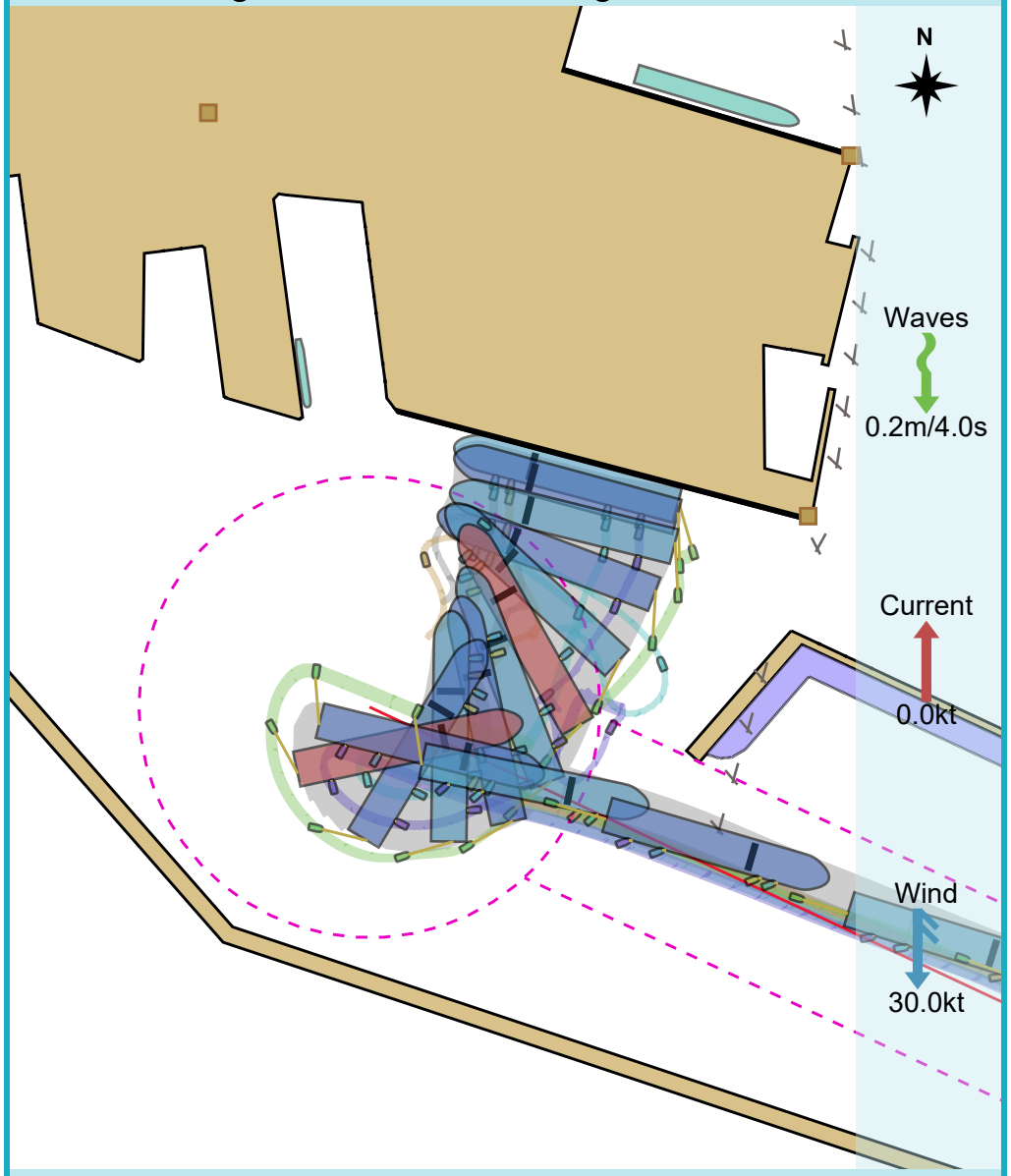
Tug position: Final




Tug 1 forces
Demand
Actual
Dir.
Pos.
Tug 2 forces
Demand
Actual
Dir.
Pos
Tug 3 forces
Demand
Actual
Dir.
Pos
Tug 4 forces
Demand
Actual
Dir.
Pos
Tug 5 forces
Demand
Actual
Dir.
Pos
Force (%BP)
Actual(t)Demand(t)
Relative direction (°)
Stern Position Bow
0min
5min
10min
15min
20min
25min
30min
35min
40min

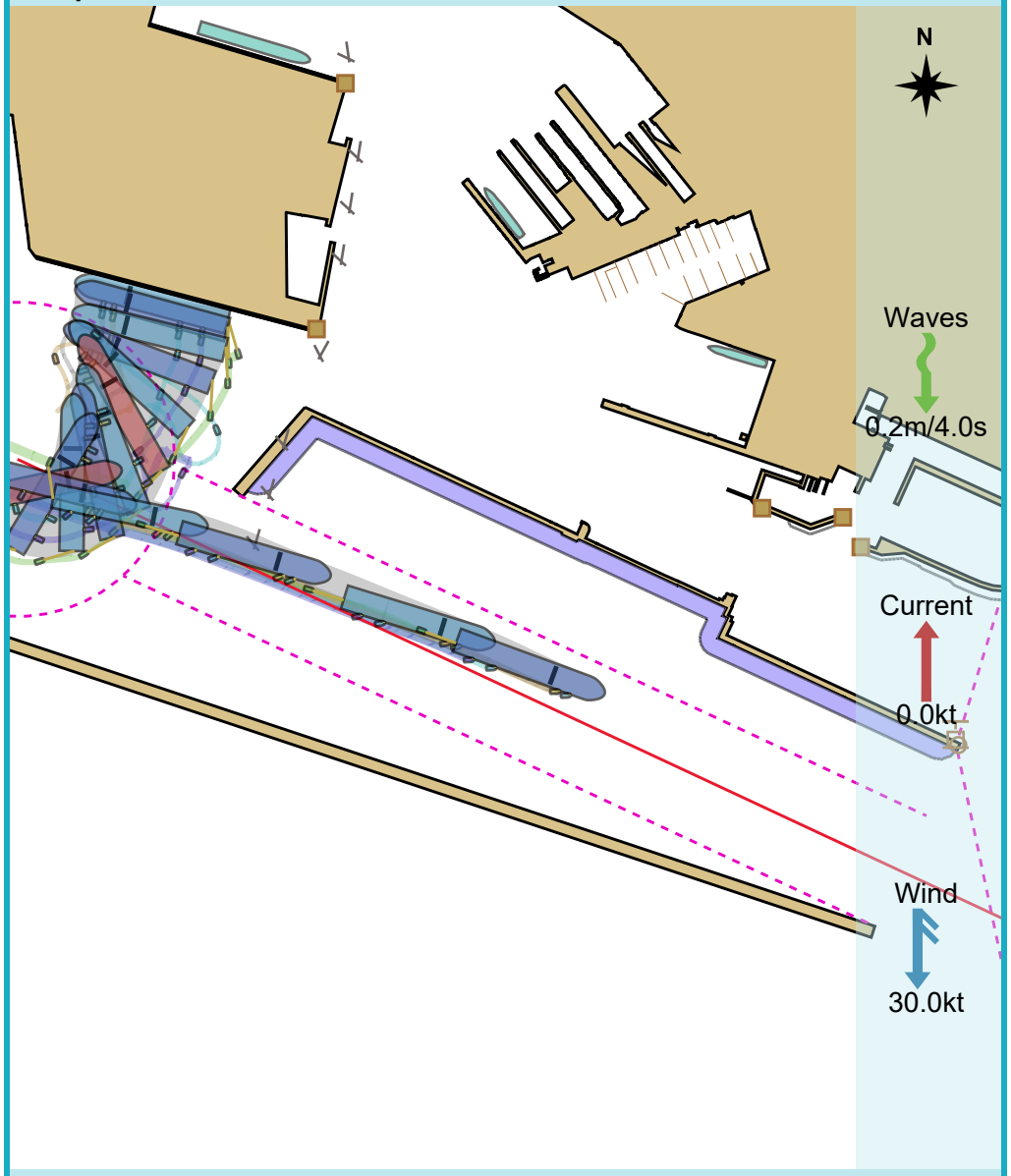
Manoeuvre track plot

Manoeuvring area and unberthing

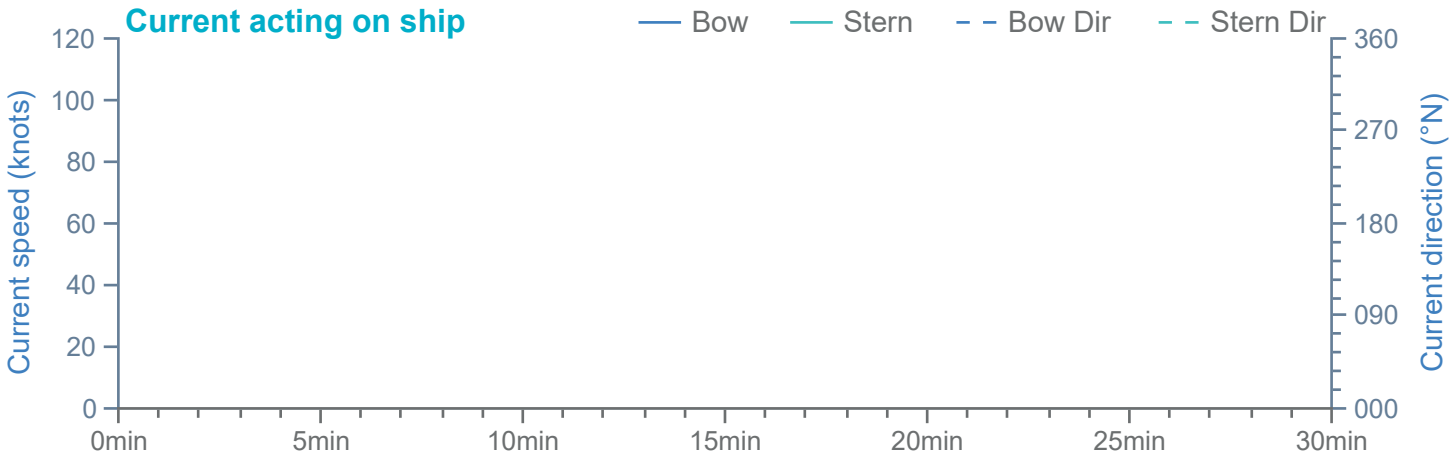


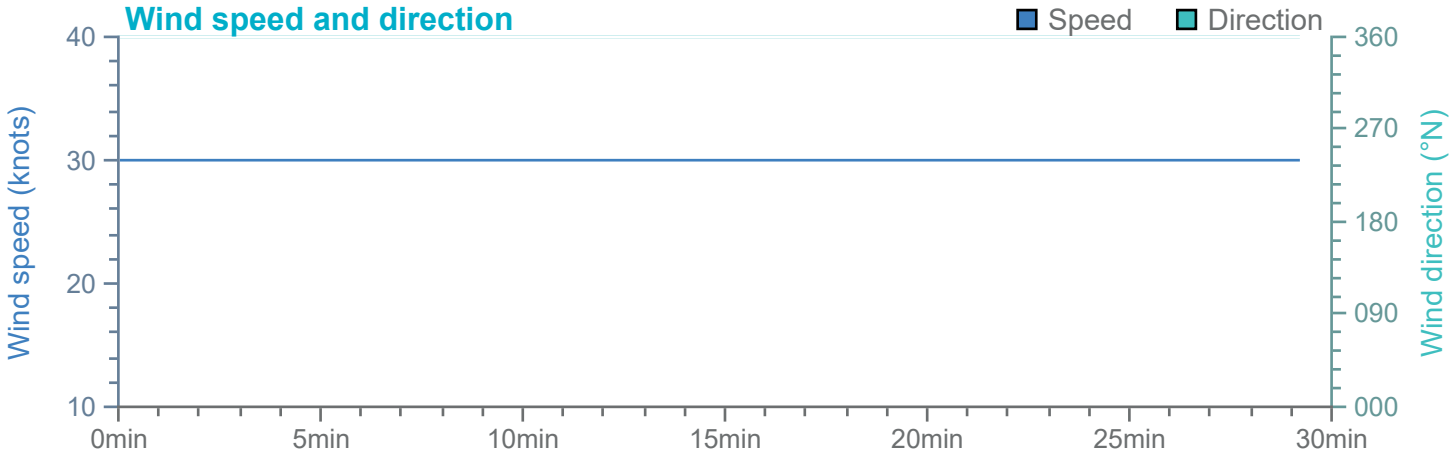
Ships plotted every 2 mins, highlight every 10 mins

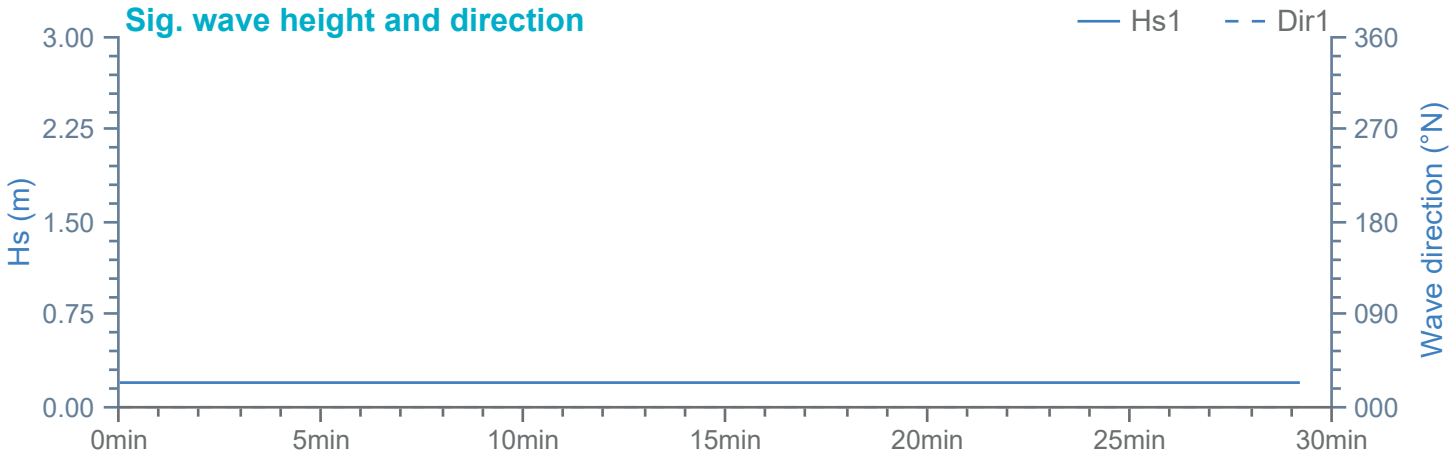
Departure Channel

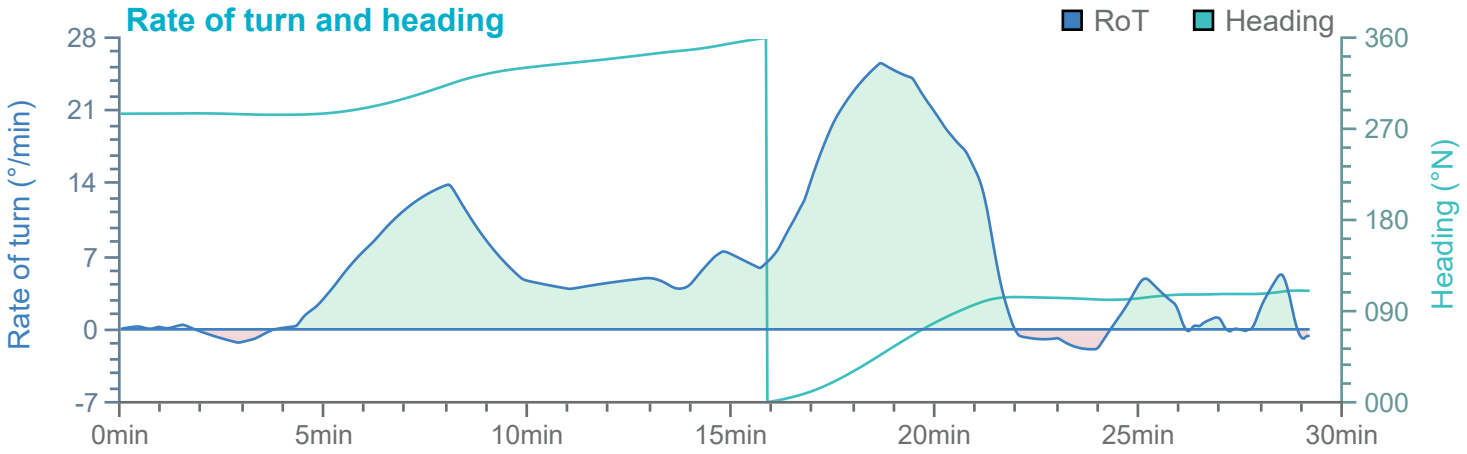


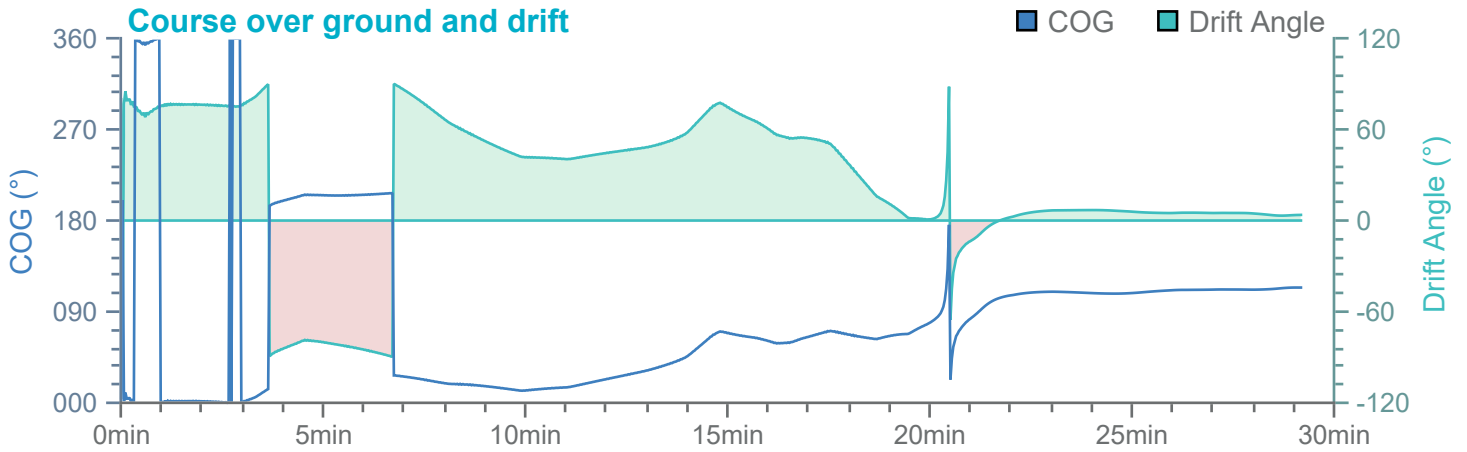
Ships plotted every 2 mins, highlight every 10 mins

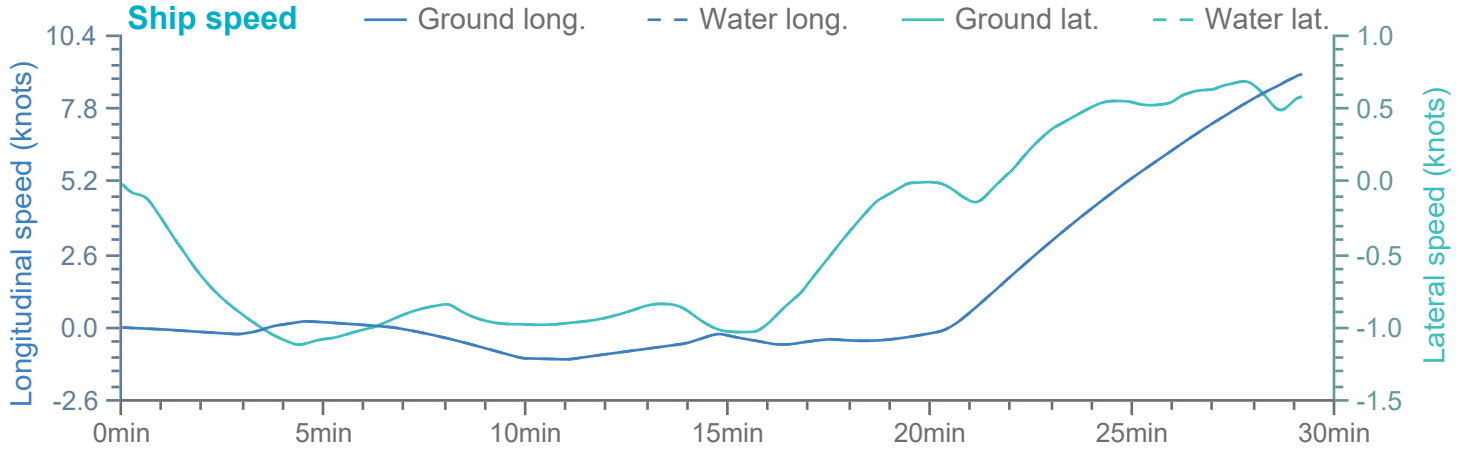

Current acting on ship
Bow
Stern
Bow Dir
Stern Dir
Current speed (knots)
120
100
80
60
40
20
0
Current direction (°N)
360
270
180
090
000
0min
5min
10min
15min
20min
25min
30min

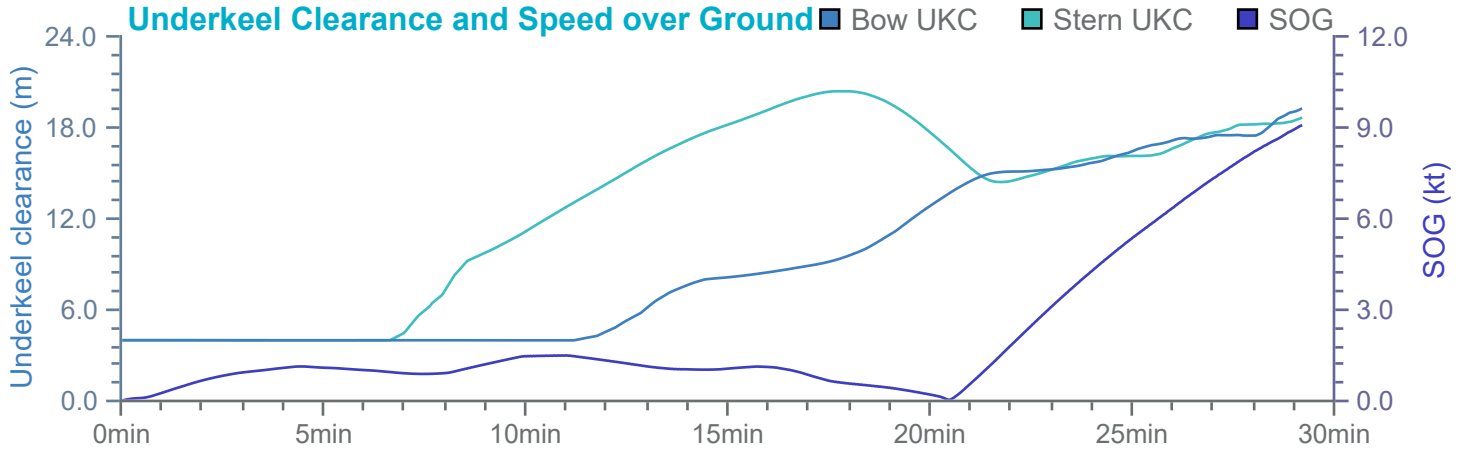

Wind speed and direction
Speed
Direction
Wind speed (knots)
40
30
20
10
Wind direction (°N)
360
270
180
090
000
0min
5min
10min
15min
20min
25min
30min

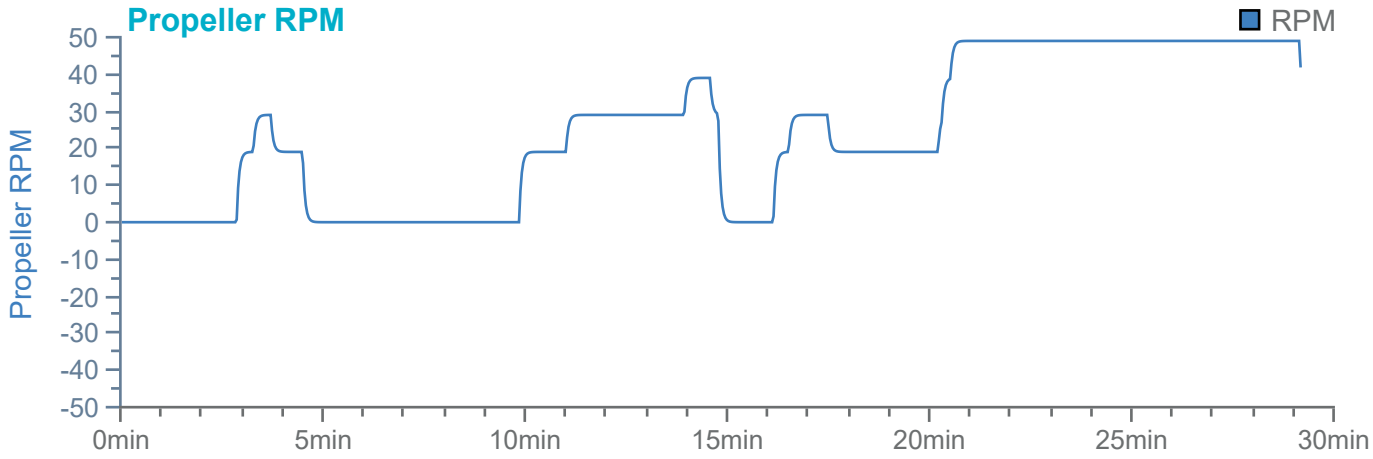

Sig. wave height and direction
Hs1
Dir1
Hs (m)
3.00
2.25
1.50
0.75
0.00
Wave direction (°N)
360
270
180
090
000
0min
5min
10min
15min
20min
25min
30min

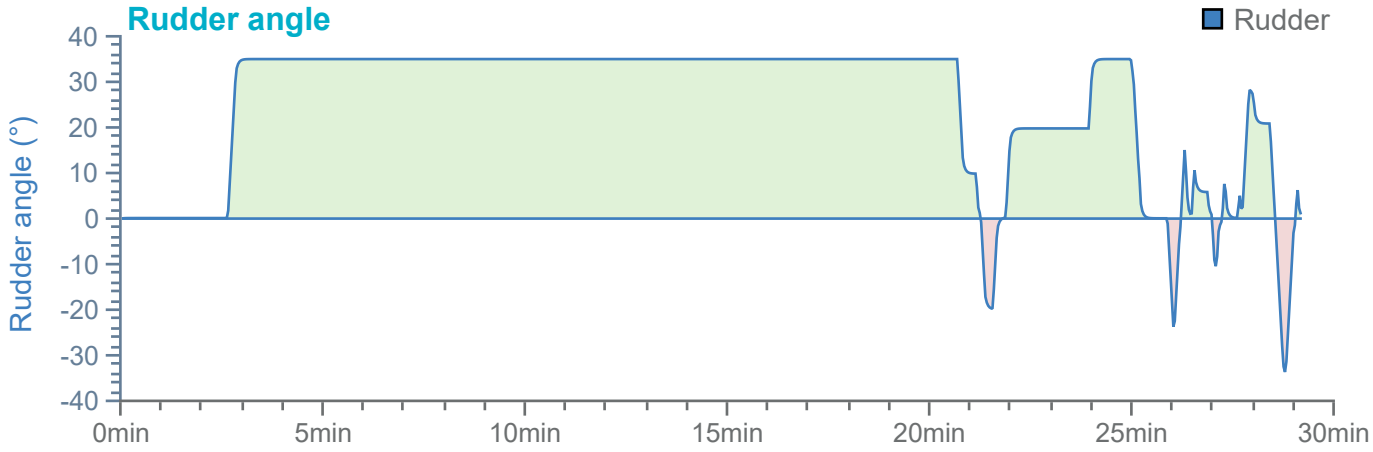

Rate of turn and heading
RoT
Heading
Rate of turn (°/min)
Heading (°N)
28
21
14
7
0
-7
360
270
180
090
000
0min
5min
10min
15min
20min
25min
30min

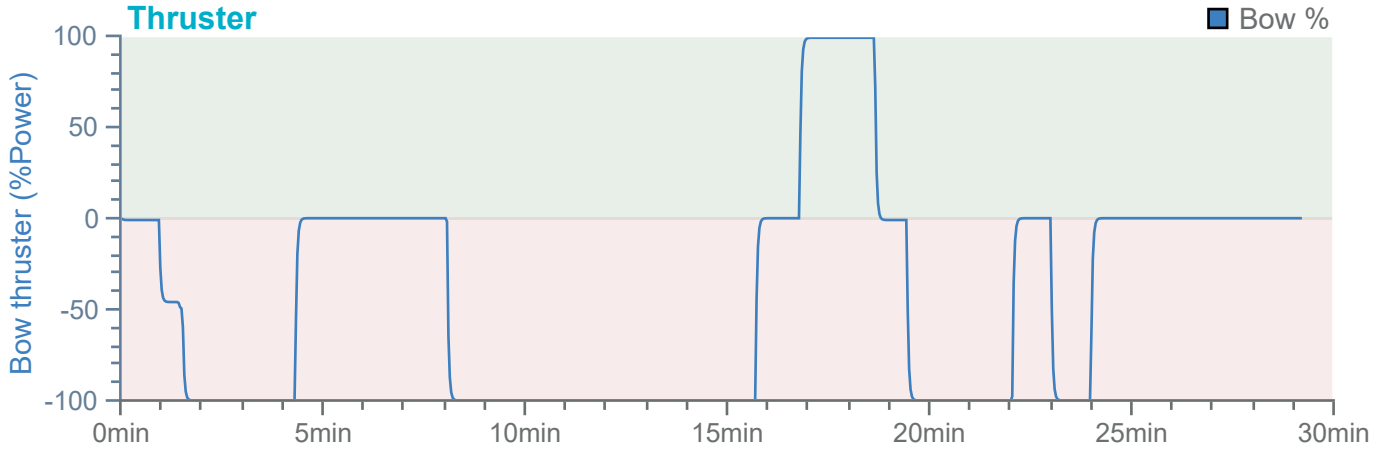

Course over ground and drift
COG
Drift Angle
COG (°)
Drift Angle (°)
360
270
180
090
000
120
60
0
-60
-120
0min
5min
10min
15min
20min
25min
30min


Ship speed
Ground long.
Water long.
Ground lat.
Water lat.
Longitudinal speed (knots)
Lateral speed (knots)
10.4
7.8
5.2
2.6
0.0
-2.6
1.0
0.5
0.0
-0.5
-1.0
-1.5
0min
5min
10min
15min
20min
25min
30min

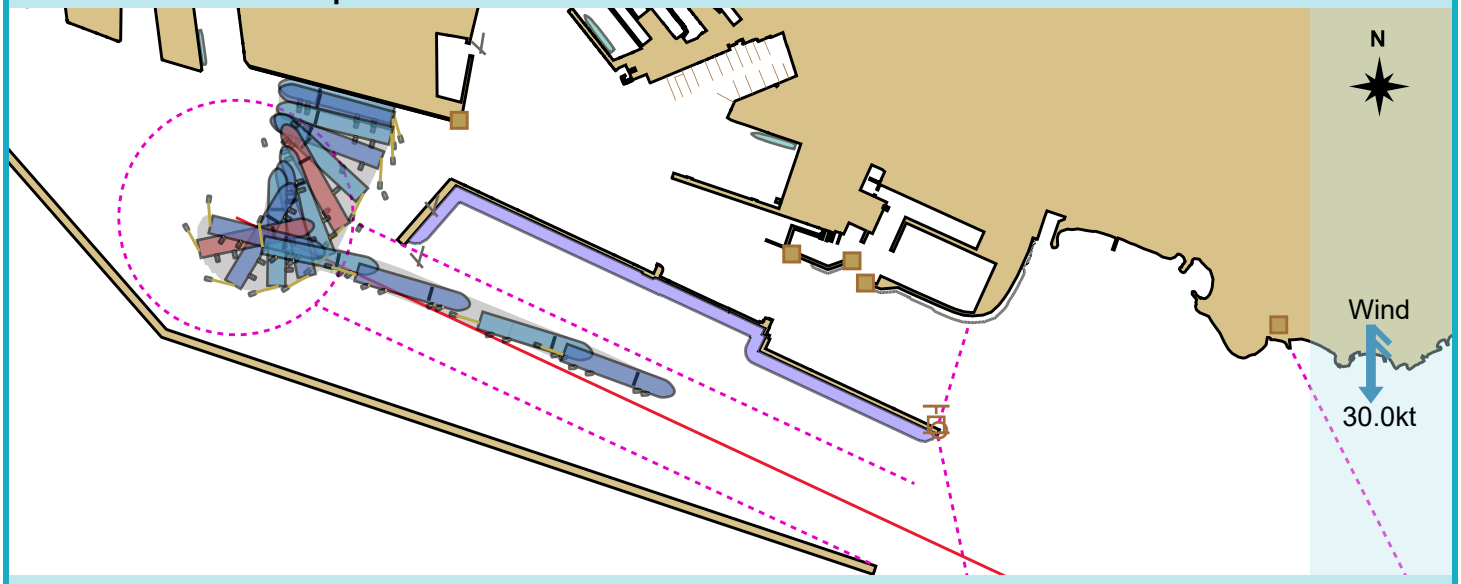

Underkeel Clearance and Speed over Ground
Bow UKC
Stern UKC
SOG
Underkeel clearance (m)
SOG (kt)
24.0
18.0
12.0
6.0
0.0
12.0
9.0
6.0
3.0
0.0
0min
5min
10min
15min
20min
25min
30min


Propeller RPM
RPM
Propeller RPM
50
40
30
20
10
0
-10
-20
-30
-40
-50
0min
5min
10min
15min
20min
25min
30min


Rudder angle
Rudder
Rudder angle (°)
40
30
20
10
0
-10
-20
-30
-40
0min
5min
10min
15min
20min
25min
30min

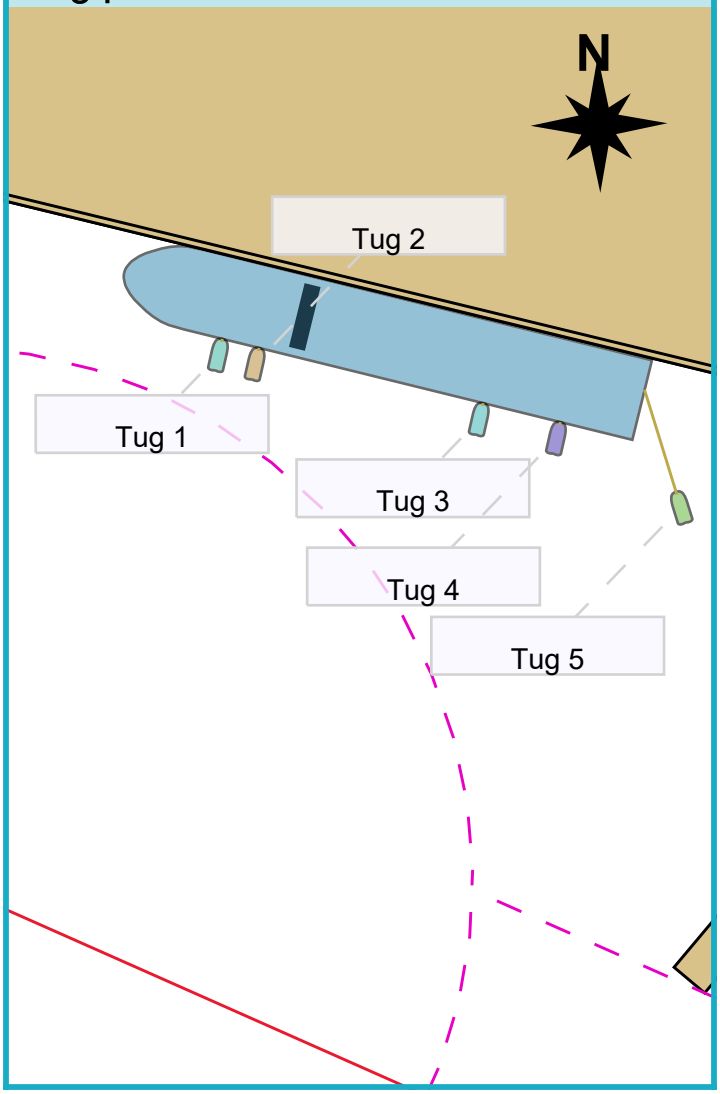

Thruster
Bow %
Bow thruster (%Power)
100
50
0
-50
-100
0min
5min
10min
15min
20min
25min
30min

Manoeuvre track plot

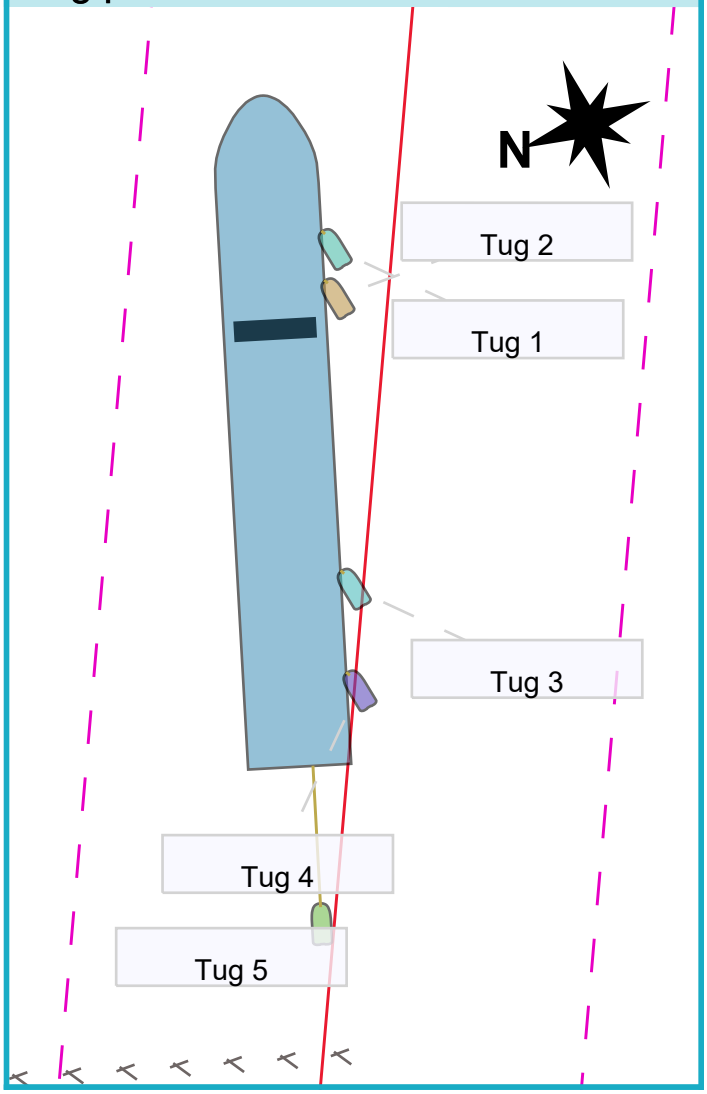


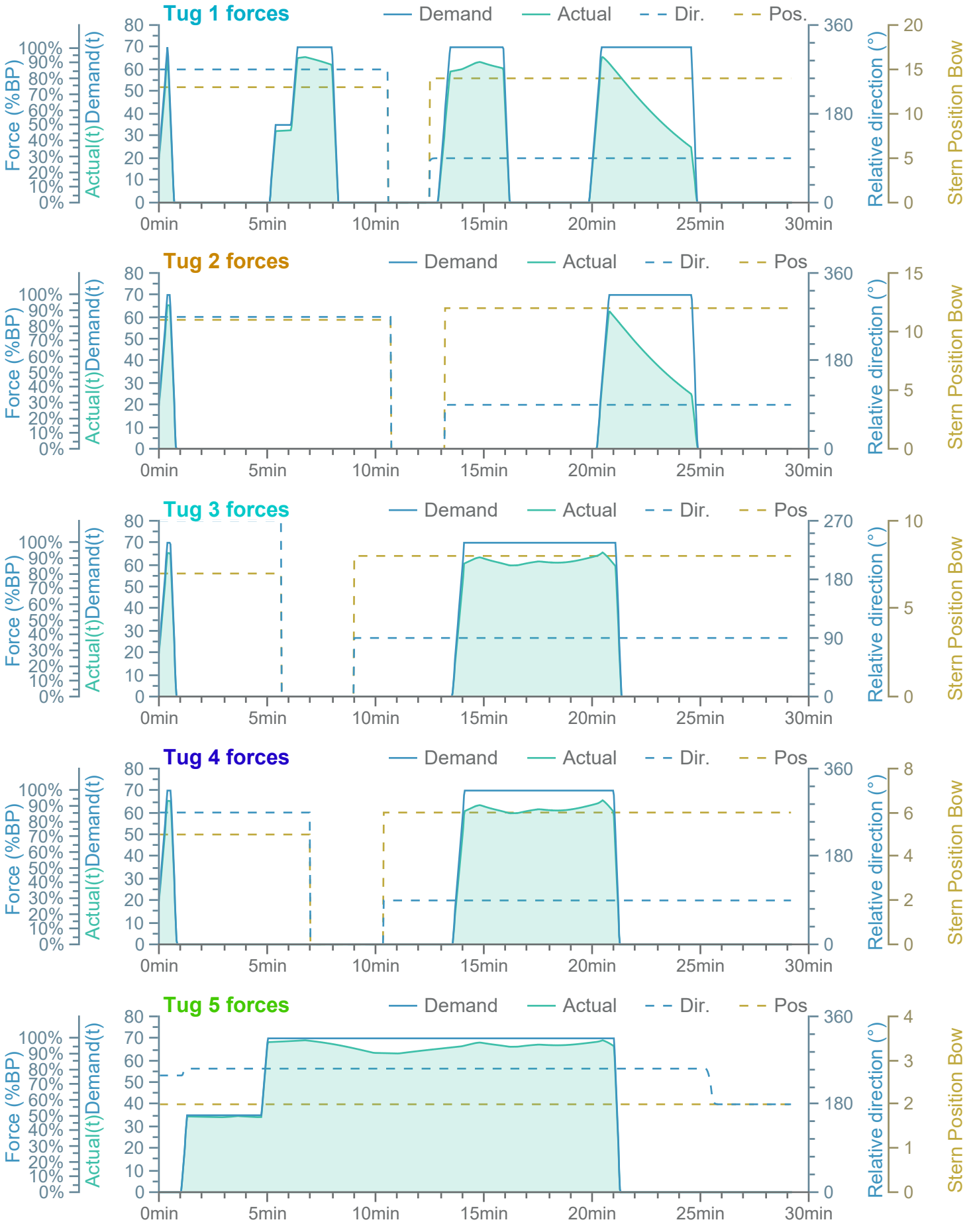
Ships plotted every 2 mins, highlight every 10 mins

Tug position: Initial

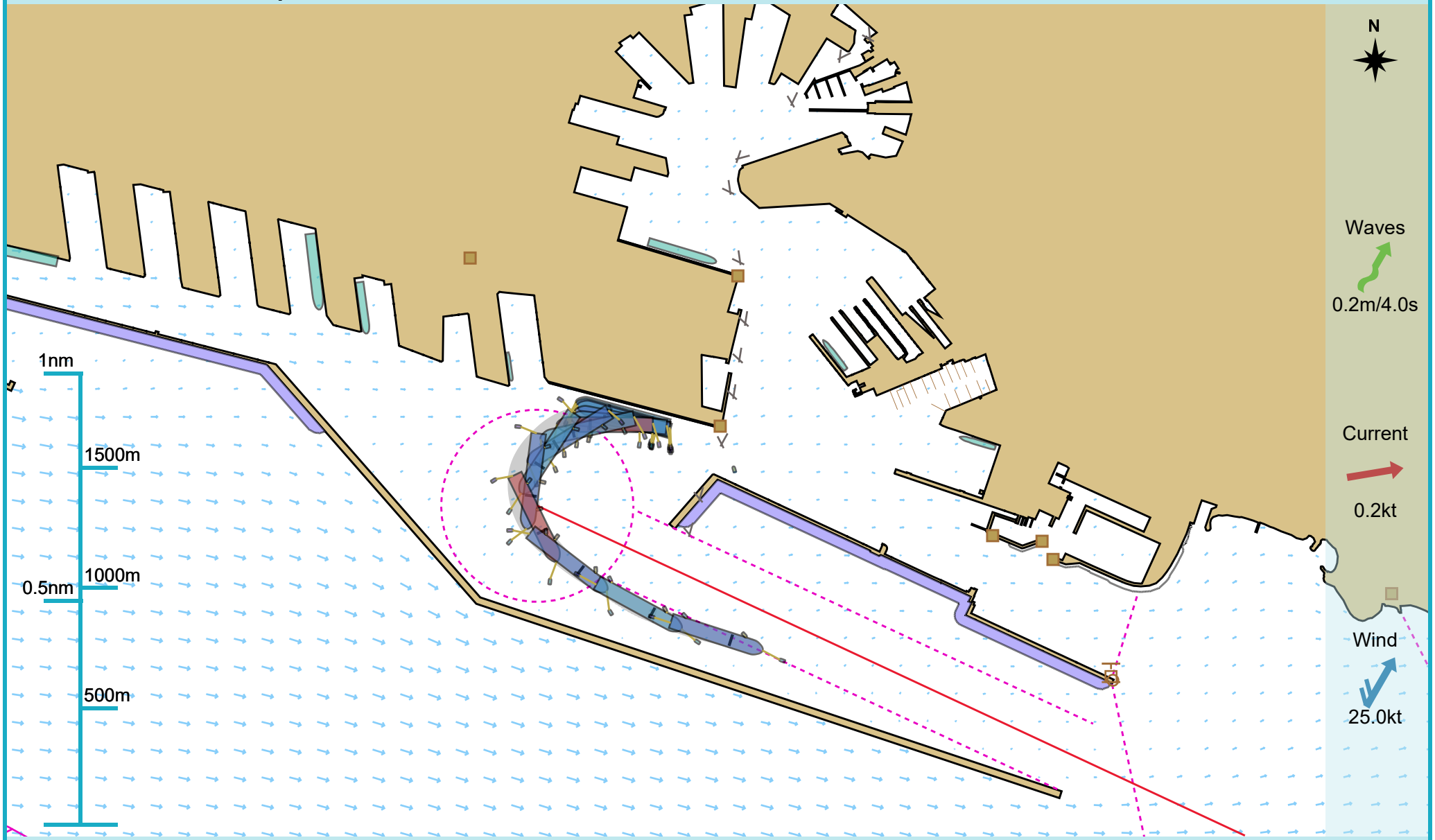


Tug position: Final

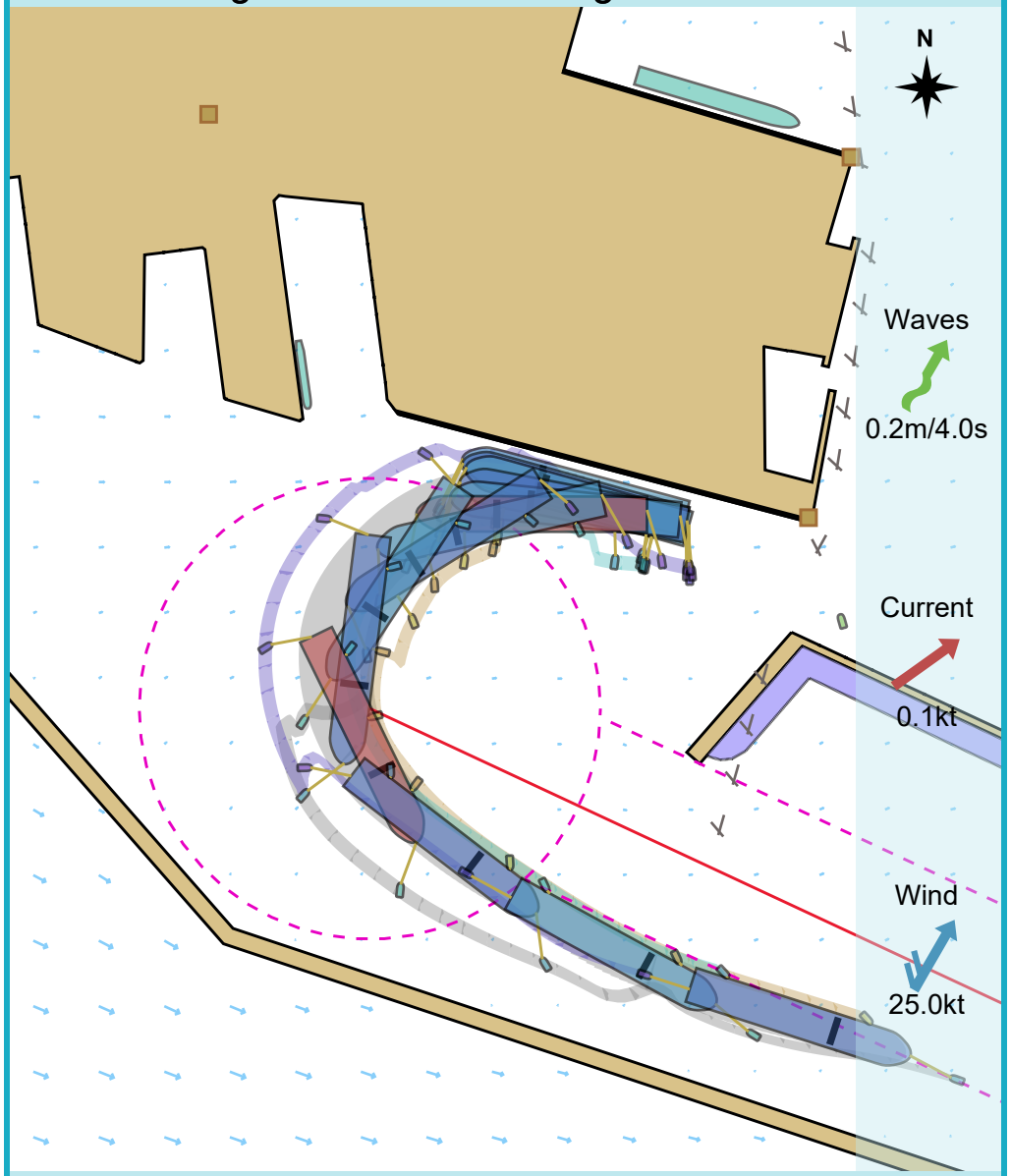



Tug 1 forces
Demand
Actual
Dir.
Pos.
Force (%BP)
Actual(t)Demand(t)
Relative direction (°)
Stern Position Bow
0min
5min
10min
15min
20min
25min
30min
Tug 2 forces
Demand
Actual
Dir.
Pos
Tug 3 forces
Demand
Actual
Dir.
Pos
Tug 4 forces
Demand
Actual
Dir.
Pos
Tug 5 forces
Demand
Actual
Dir.
Pos

Manoeuvre track plot

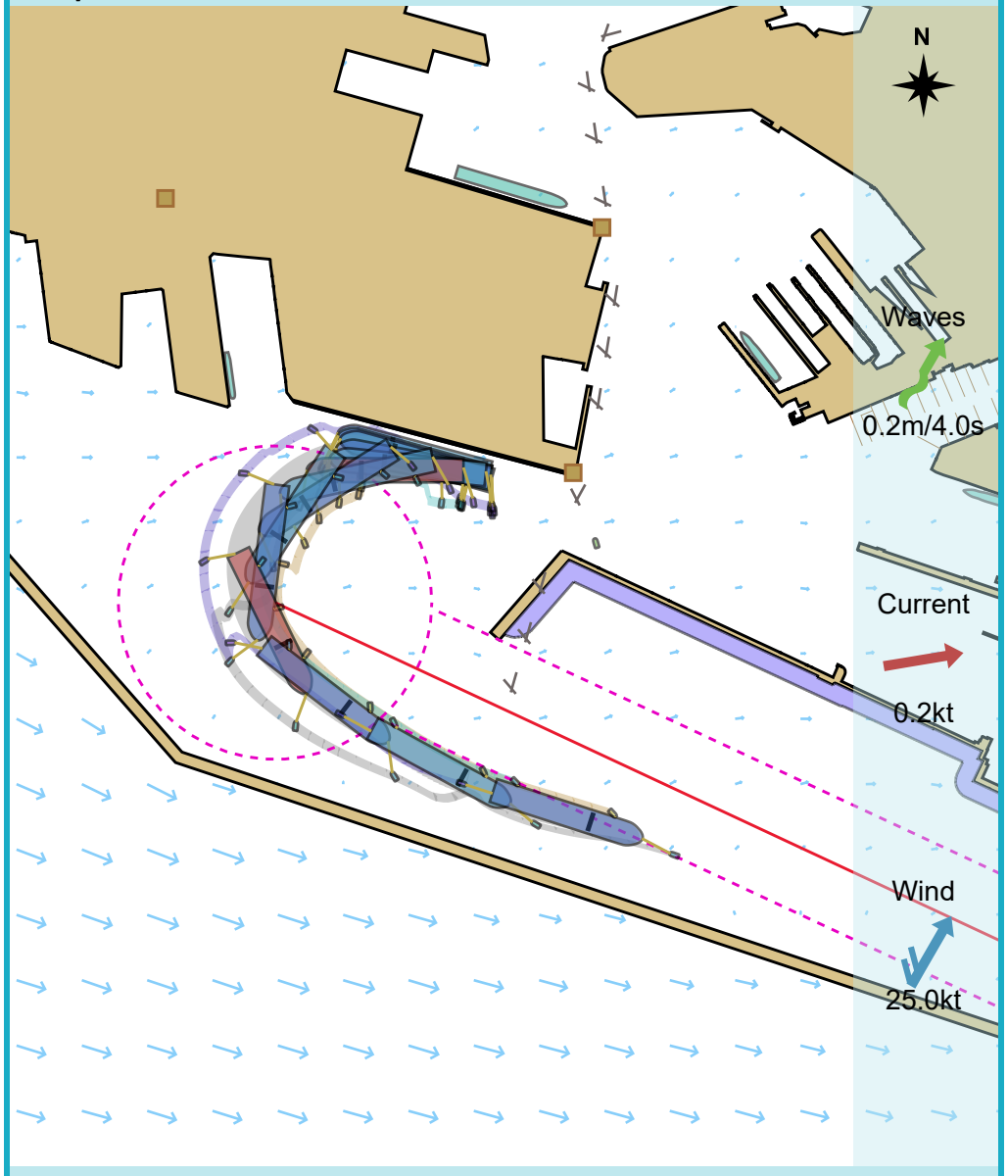


Manoeuvring area and unberthing

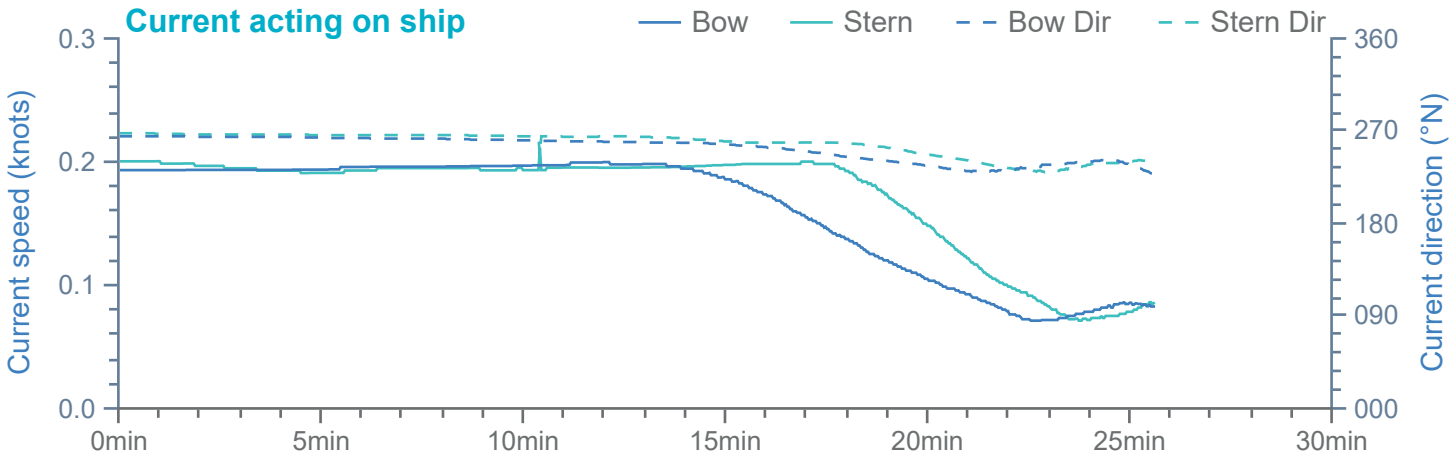


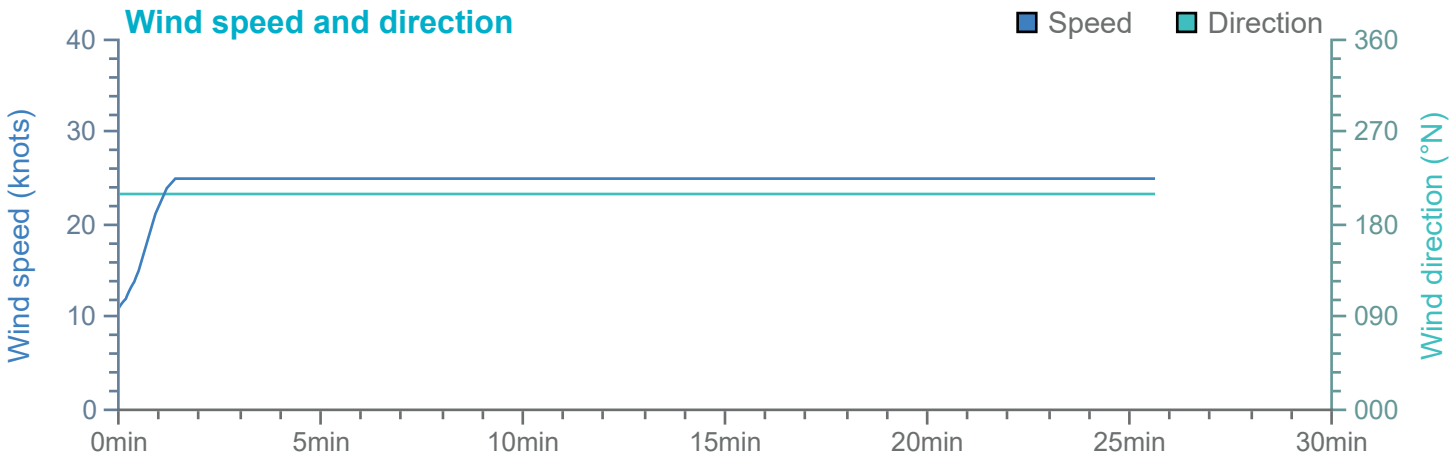
Ships plotted every 2 mins, highlight every 10 mins

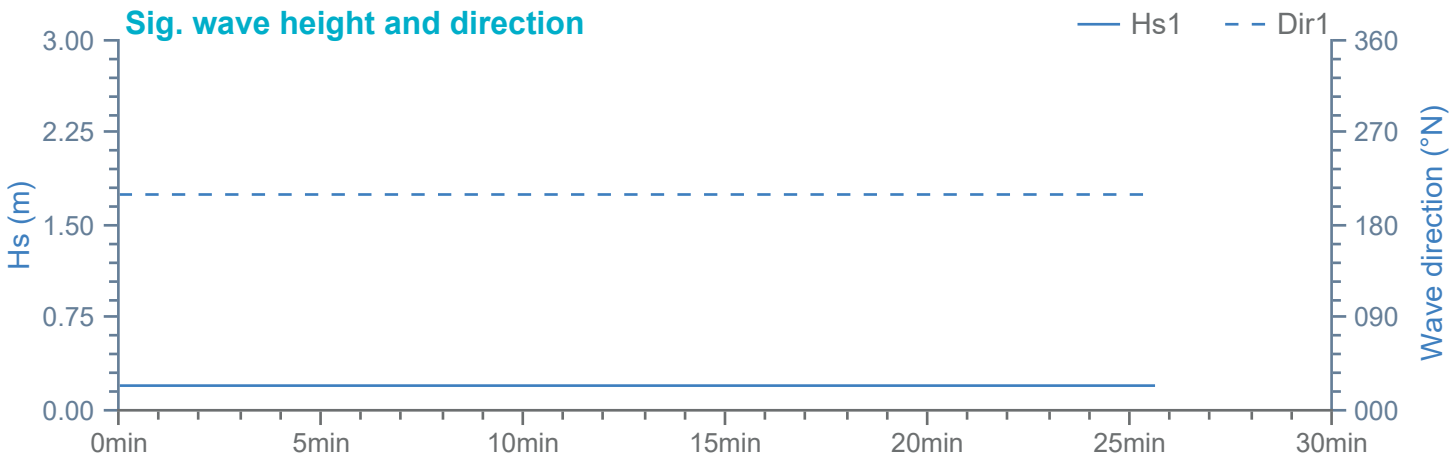
Departure Channel

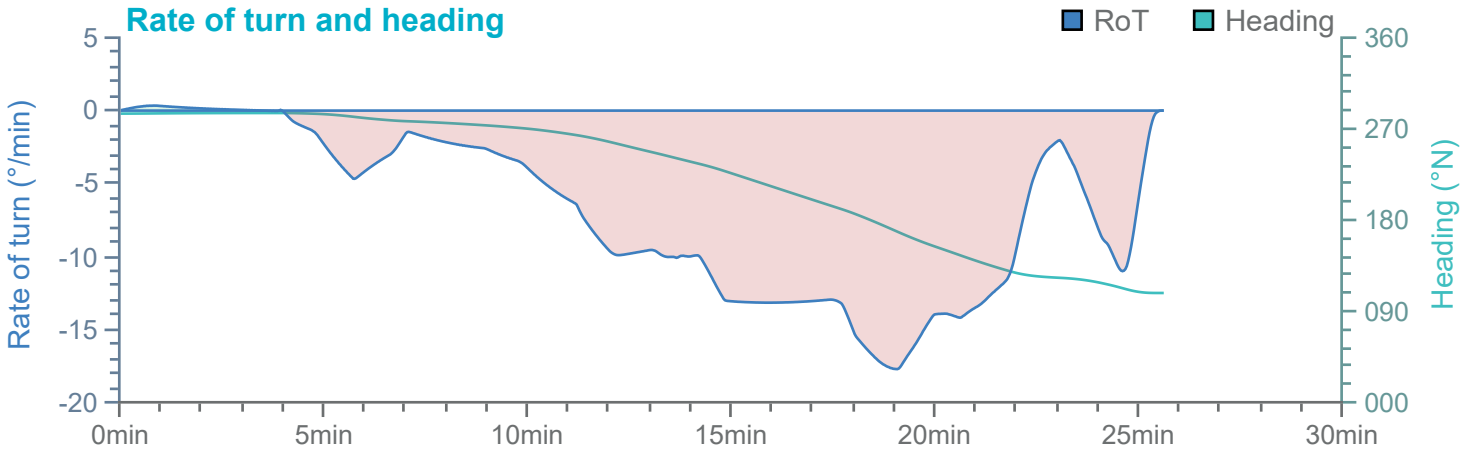


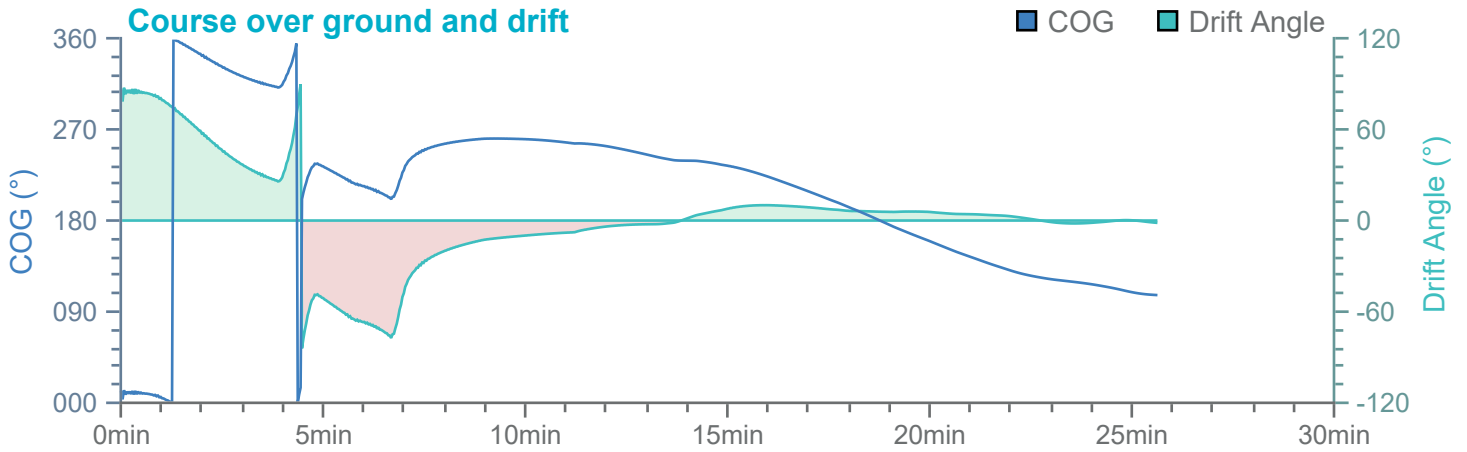
Ships plotted every 2 mins, highlight every 10 mins

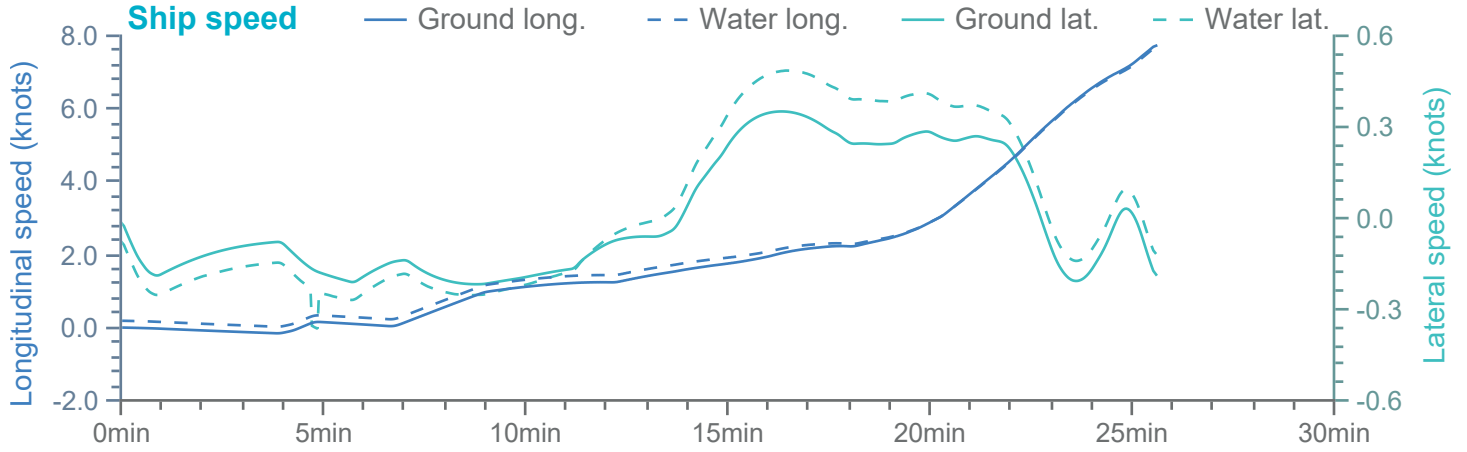

Current acting on ship
Bow
Stern
Bow Dir
Stern Dir
Current speed (knots)
Current direction (°N)
0.3
0.2
0.1
0.0
360
270
180
090
000
0min
5min
10min
15min
20min
25min
30min

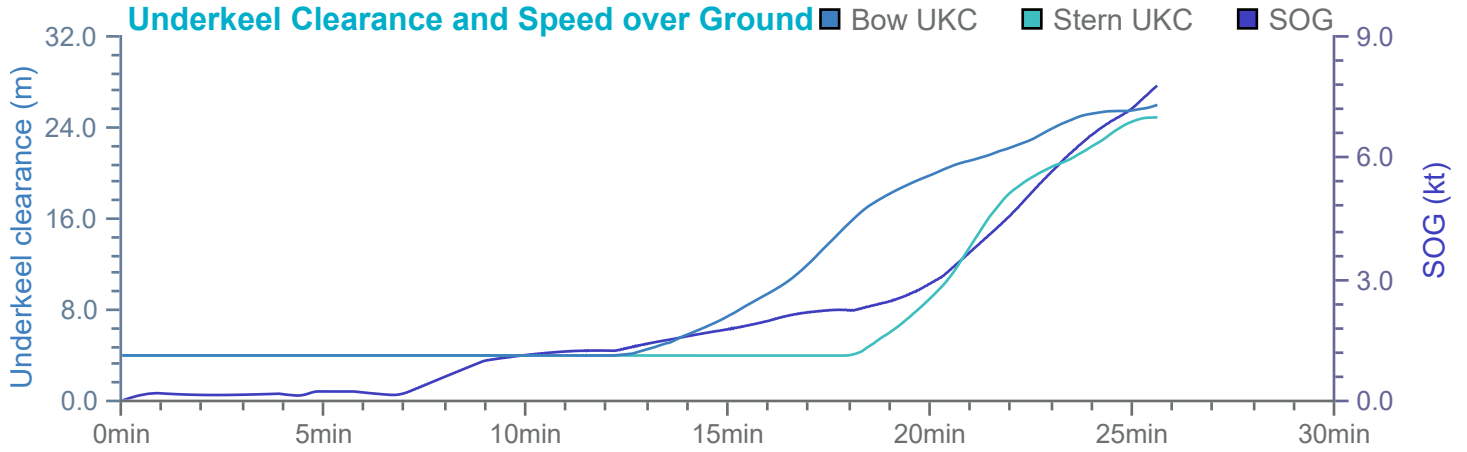

Wind speed and direction
Speed
Direction
Wind speed (knots)
Wind direction (°N)
40
30
20
10
0
360
270
180
090
000
0min
5min
10min
15min
20min
25min
30min

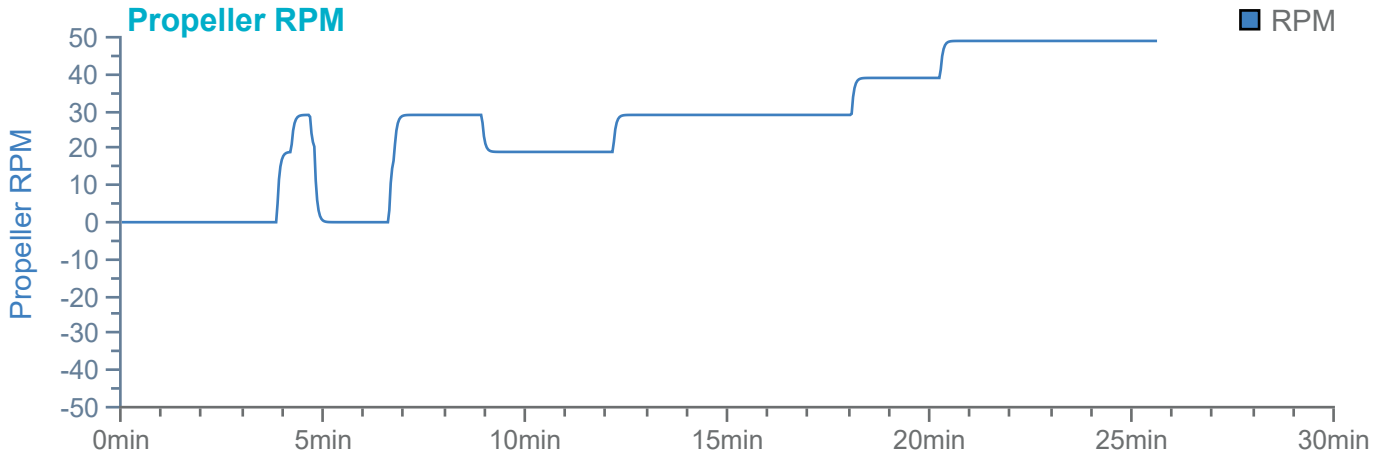

Sig. wave height and direction
Hs1
Dir1
Hs (m)
Wave direction (°N)
3.00
2.25
1.50
0.75
0.00
360
270
180
090
000
0min
5min
10min
15min
20min
25min
30min

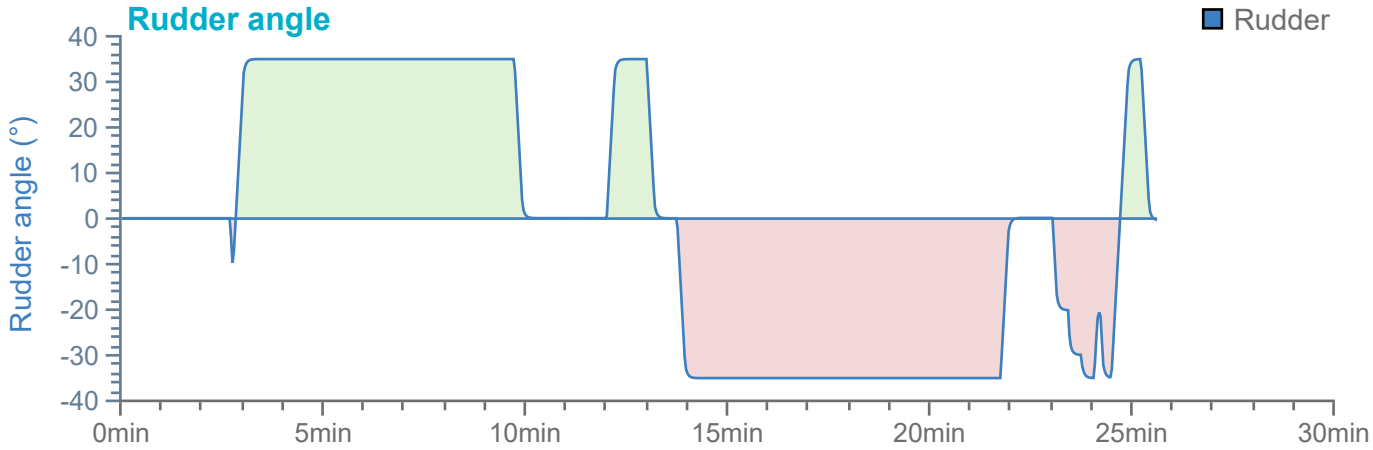

Rate of turn and heading
RoT
Heading
Rate of turn (°/min)
Heading (°N)
5
0
-5
-10
-15
-20
360
270
180
090
000
0min
5min
10min
15min
20min
25min
30min

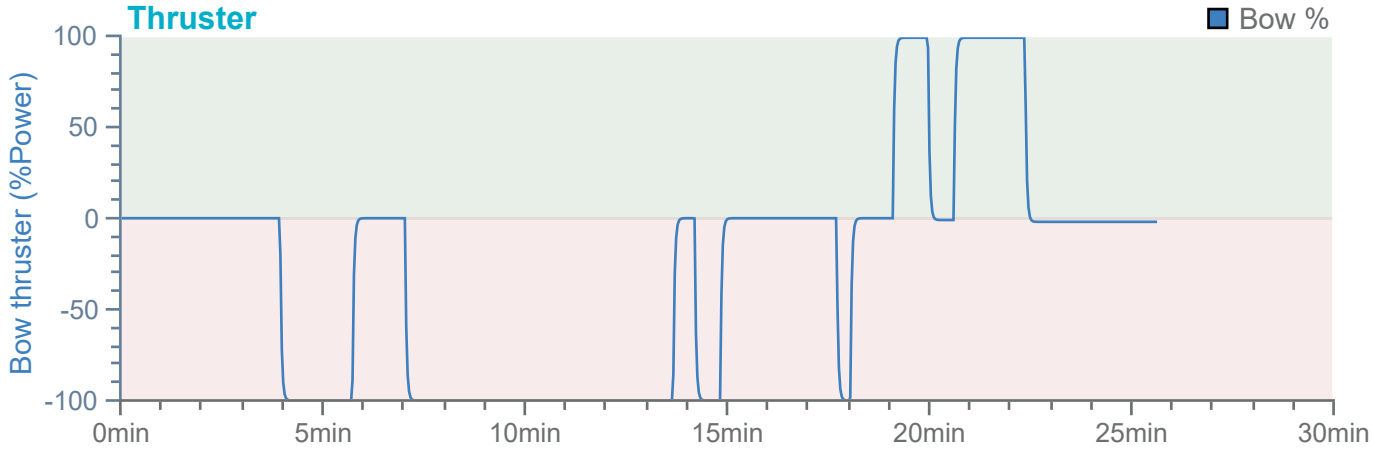

Course over ground and drift
COG
Drift Angle
COG (°)
Drift Angle (°)
360
270
180
090
000
120
60
0
-60
-120
0min
5min
10min
15min
20min
25min
30min


Ship speed
Ground long.
Water long.
Ground lat.
Water lat.
Longitudinal speed (knots)
Lateral speed (knots)
8.0
6.0
4.0
2.0
0.0
-2.0
0.6
0.3
0.0
-0.3
-0.6
0min
5min
10min
15min
20min
25min
30min

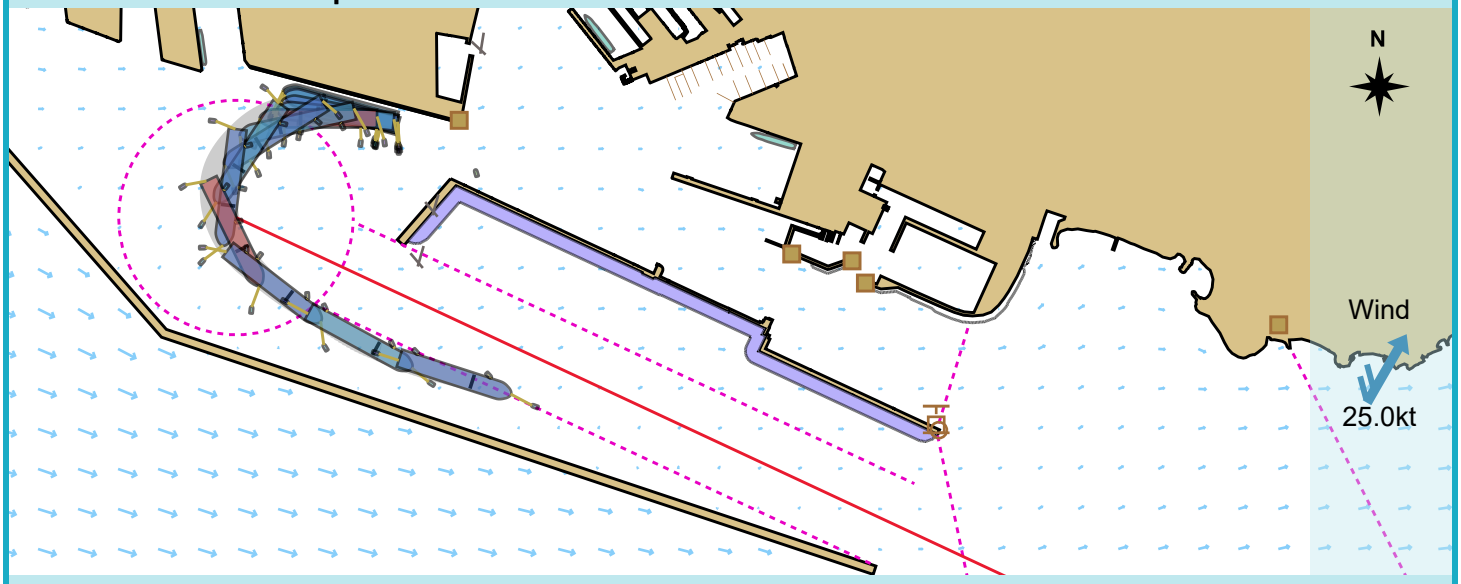

Underkeel Clearance and Speed over Ground
Bow UKC
Stern UKC
SOG
Underkeel clearance (m)
SOG (kt)
32.0
24.0
16.0
8.0
0.0
9.0
6.0
3.0
0.0
0min
5min
10min
15min
20min
25min
30min


Propeller RPM
RPM
Propeller RPM
50
40
30
20
10
0
-10
-20
-30
-40
-50
0min
5min
10min
15min
20min
25min
30min


Rudder angle
Rudder
Rudder angle (°)
40
30
20
10
0
-10
-20
-30
-40
0min
5min
10min
15min
20min
25min
30min

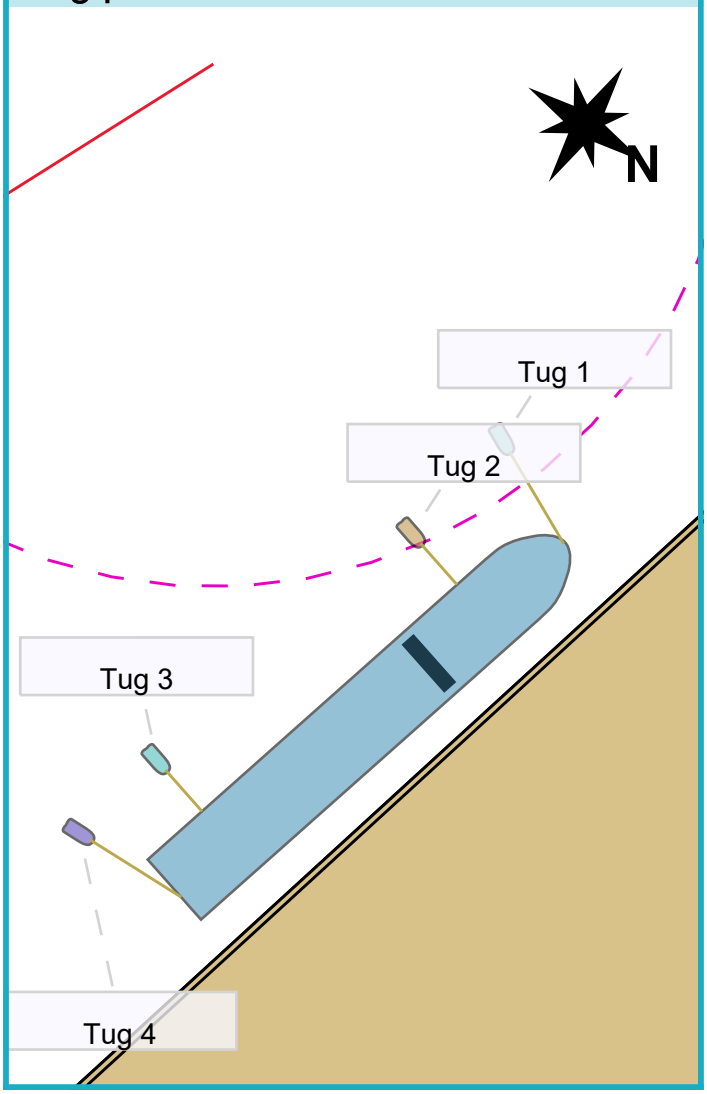

Thruster
Bow %
Bow thruster (%Power)
100
50
0
-50
-100
0min
5min
10min
15min
20min
25min
30min

Manoeuvre track plot

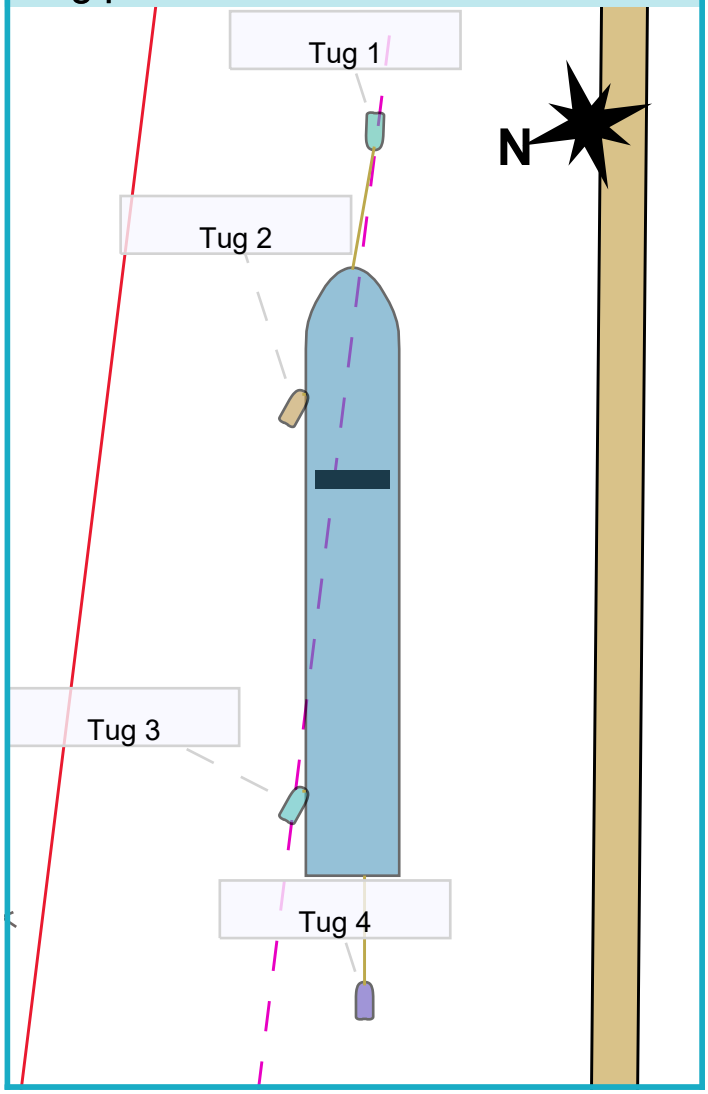


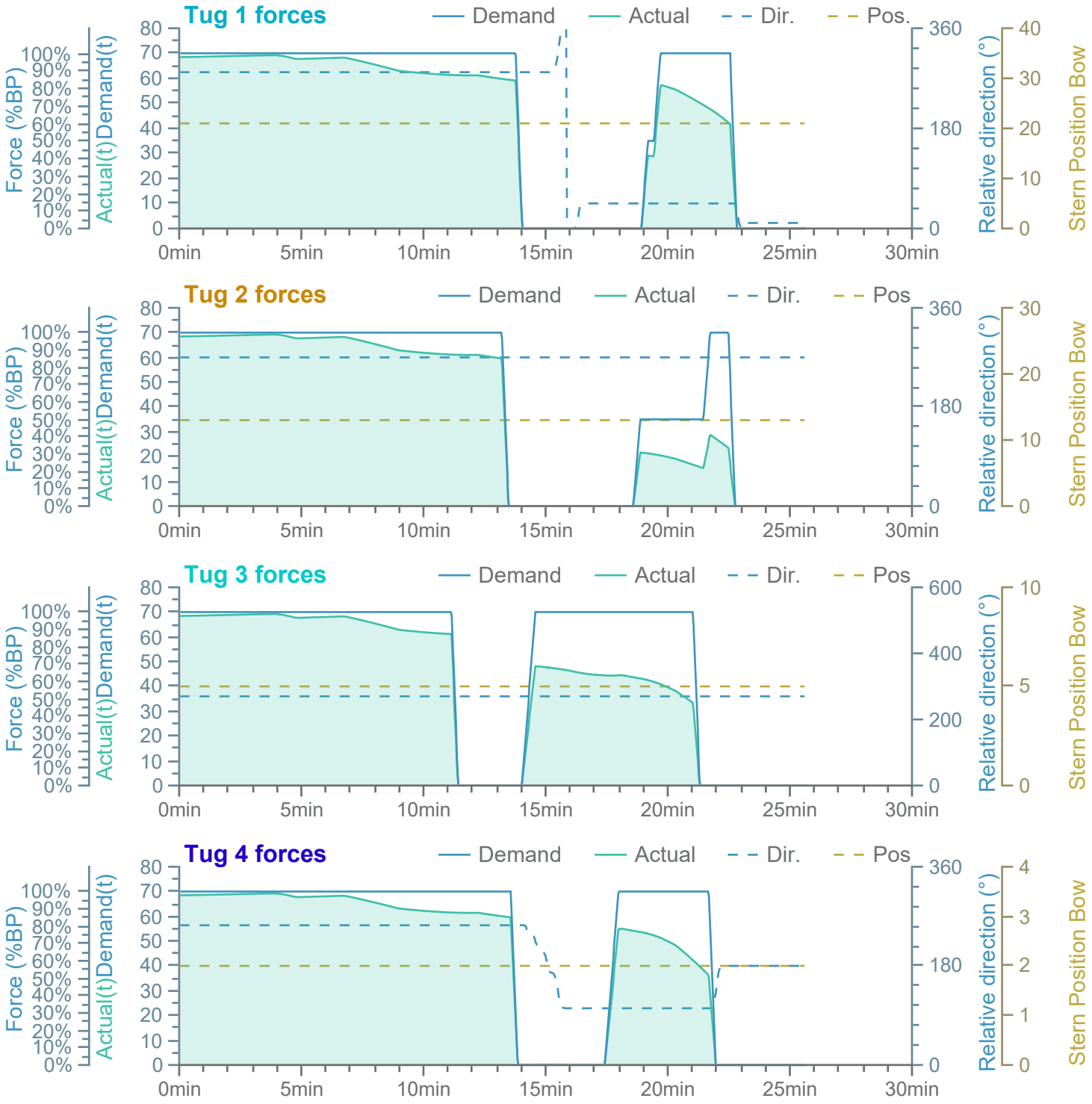
Ships plotted every 2 mins, highlight every 10 mins

Tug position: Initial

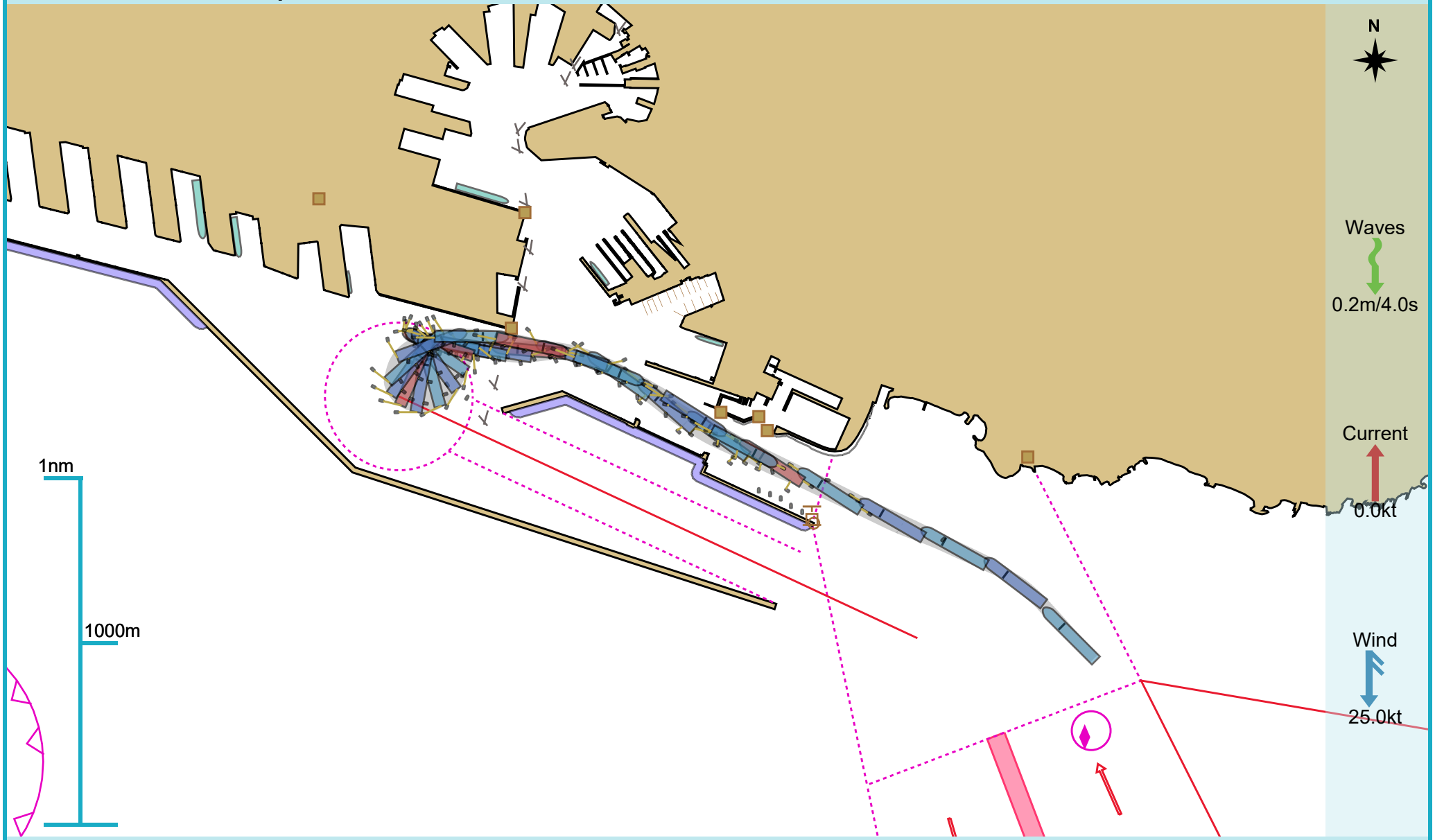


Tug position: Final

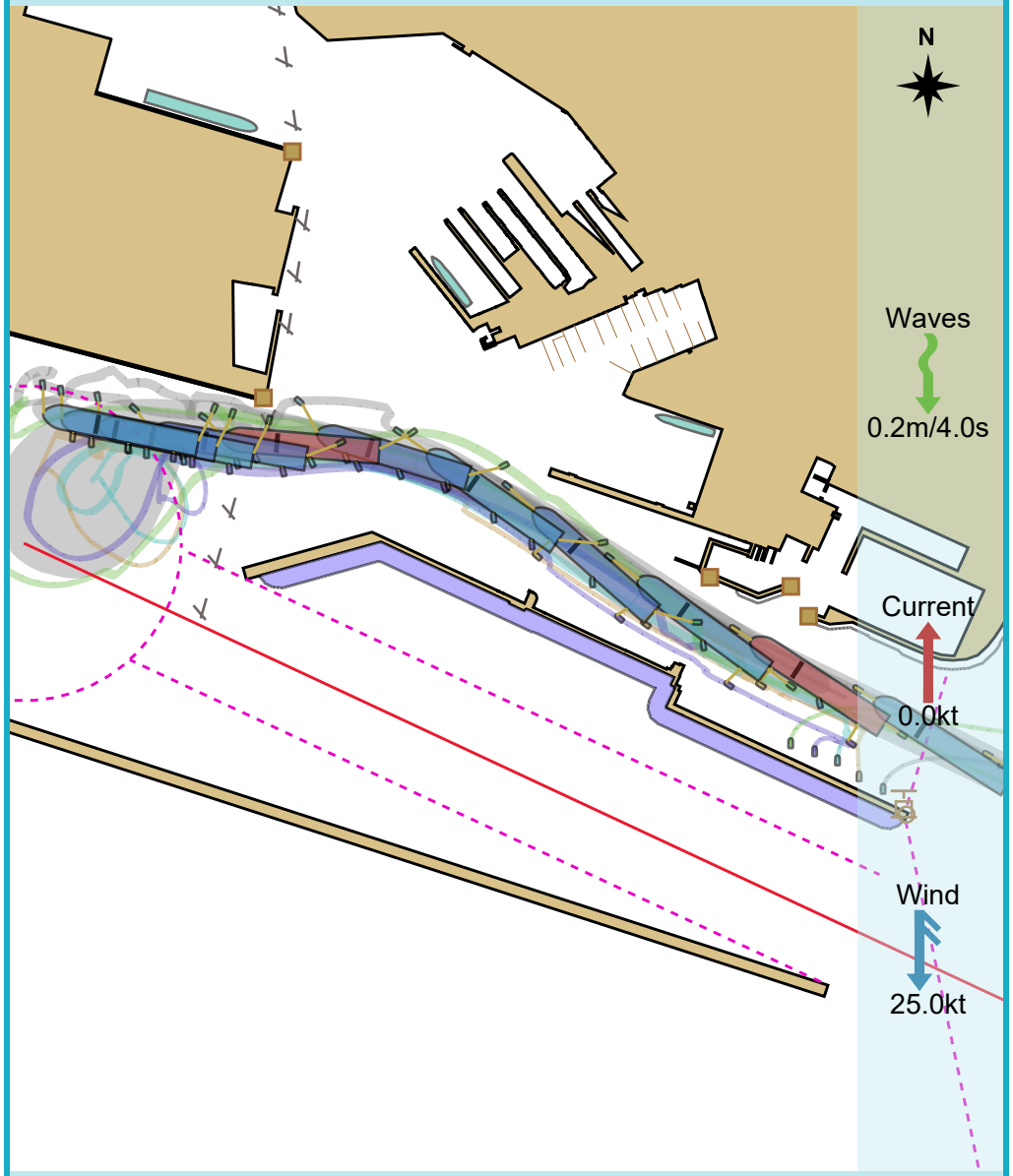



Tug 1 forces
Demand
Actual
Dir.
Pos.
Force (%BP)
Actual(t)Demand(t)
Relative direction (°)
Stern Position Bow
0min
5min
10min
15min
20min
25min
30min
Tug 2 forces
Demand
Actual
Dir.
Pos
Force (%BP)
Actual(t)Demand(t)
Relative direction (°)
Stern Position Bow
Tug 3 forces
Demand
Actual
Dir.
Pos
Force (%BP)
Actual(t)Demand(t)
Relative direction (°)
Stern Position Bow
Tug 4 forces
Demand
Actual
Dir.
Pos
Force (%BP)
Actual(t)Demand(t)
Relative direction (°)
Stern Position Bow

Manoeuvre track plot

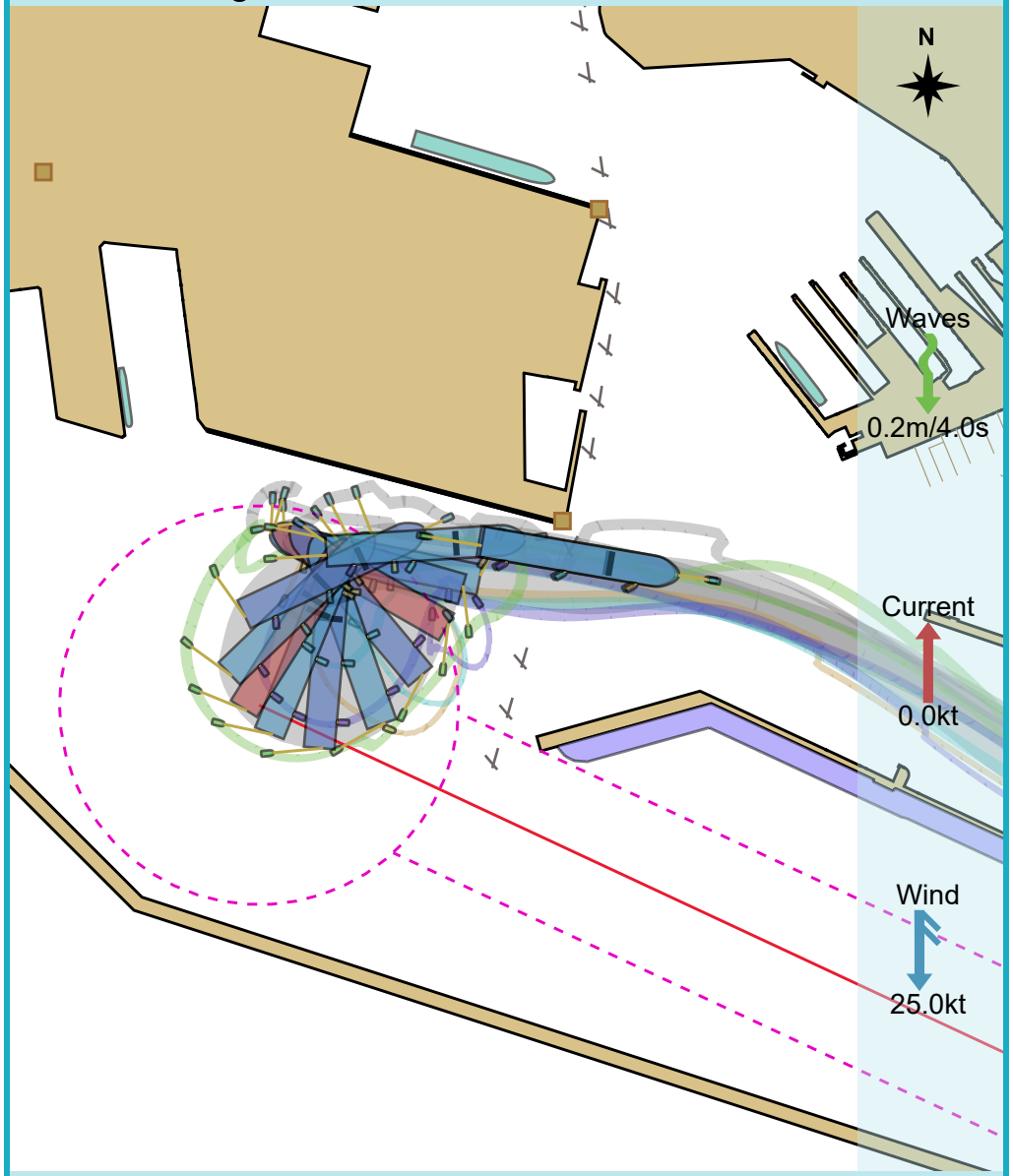


Arrival



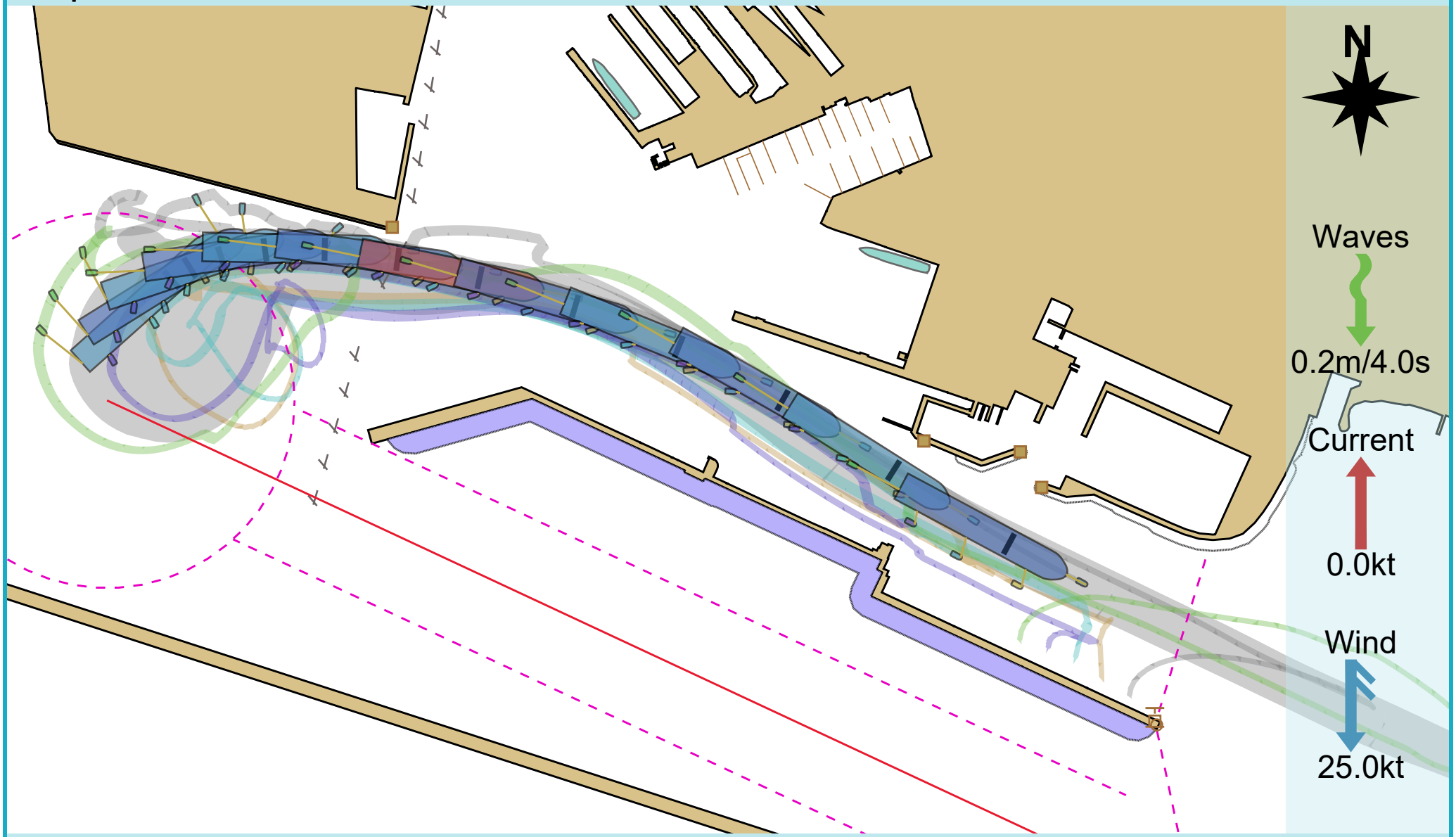
Ships plotted every 2 mins, highlight every 10 mins

Manoeuvring area

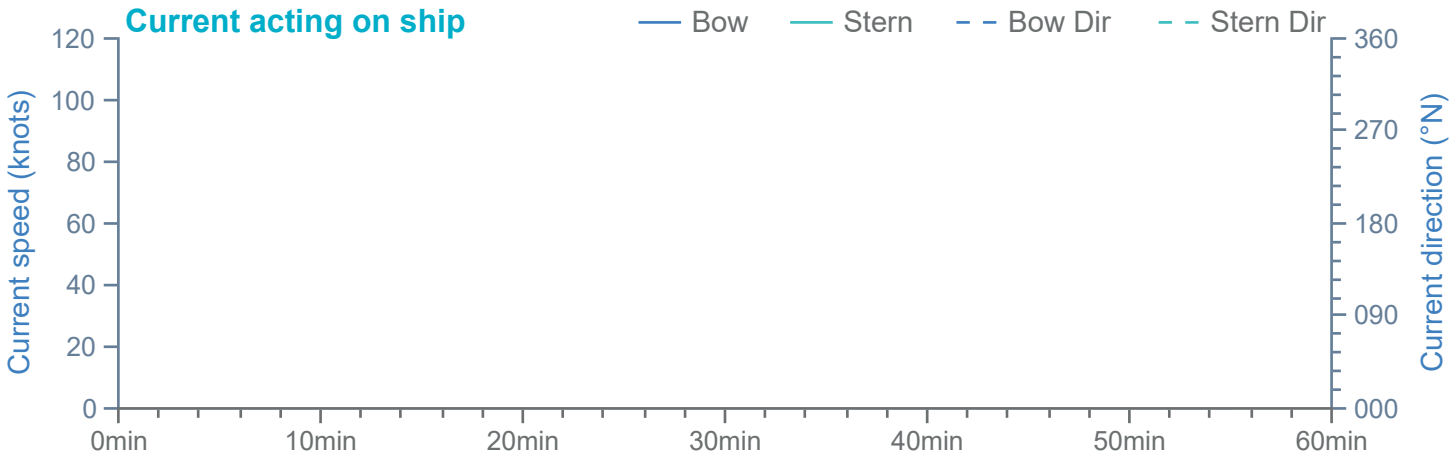


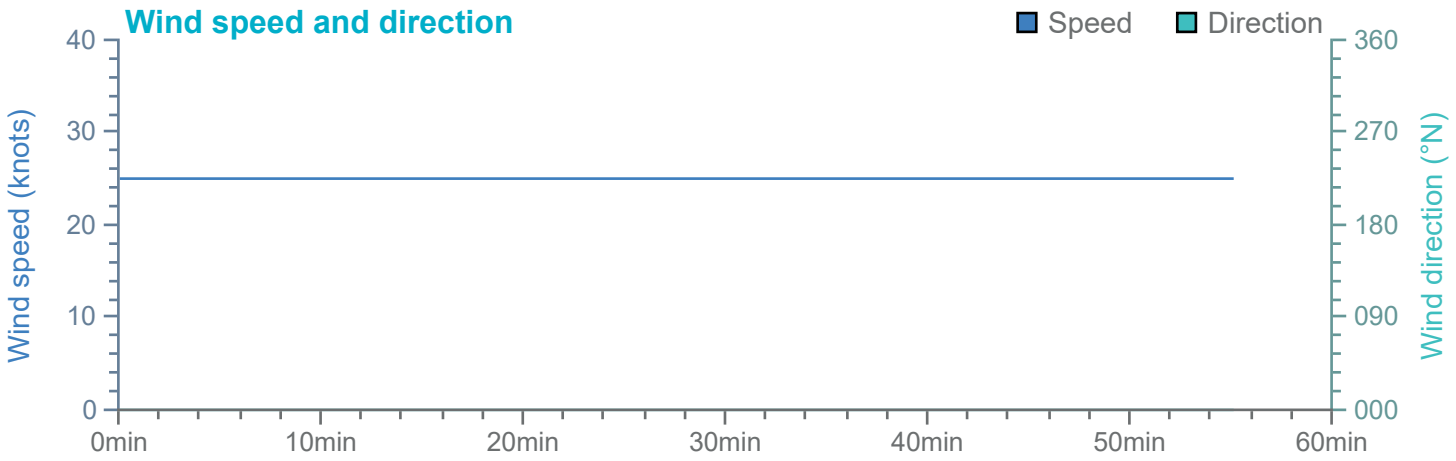
Ships plotted every 2 mins, highlight every 10 mins

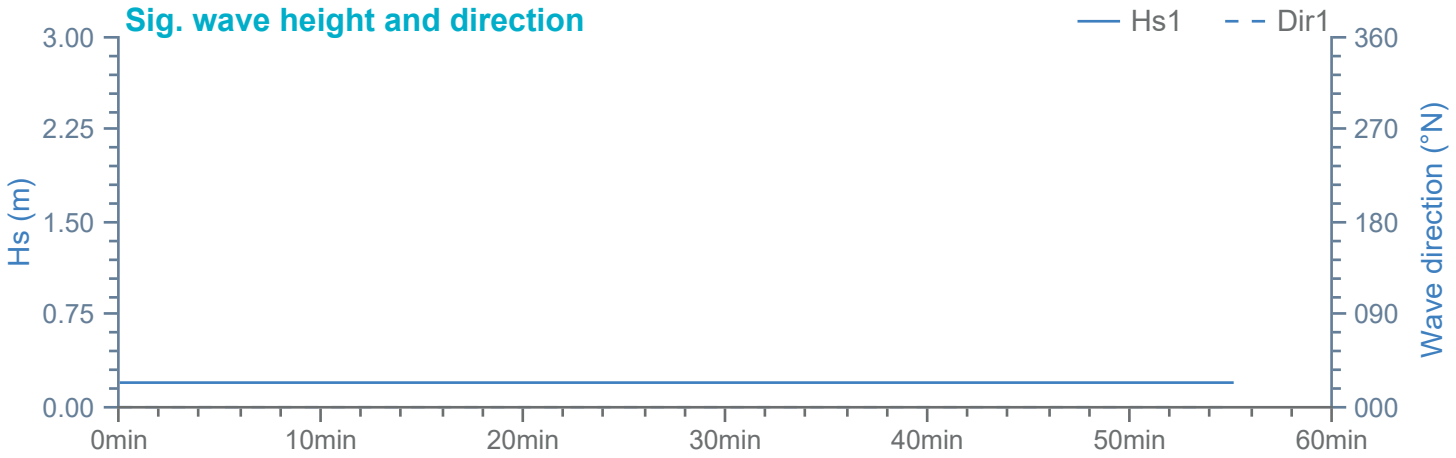
Departure

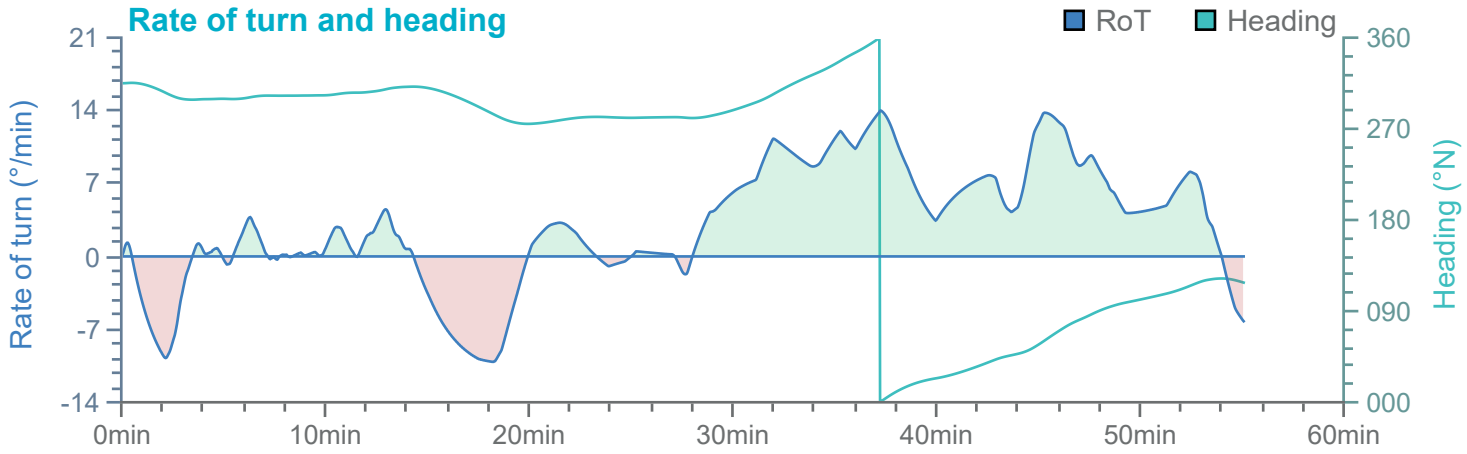


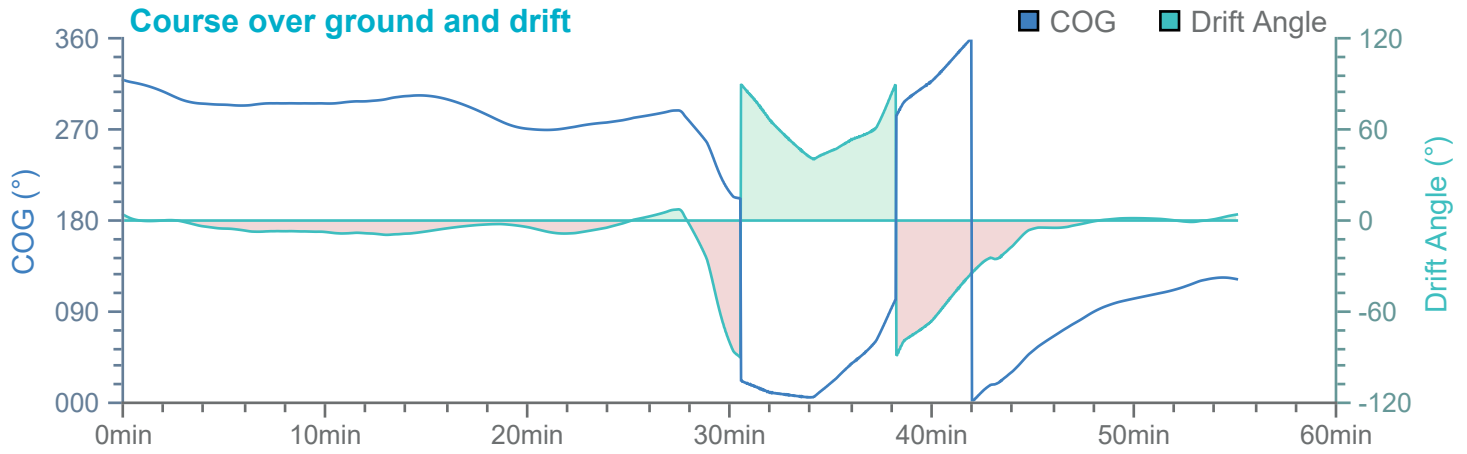
Ships plotted every 1 mins, highlight every 10 mins

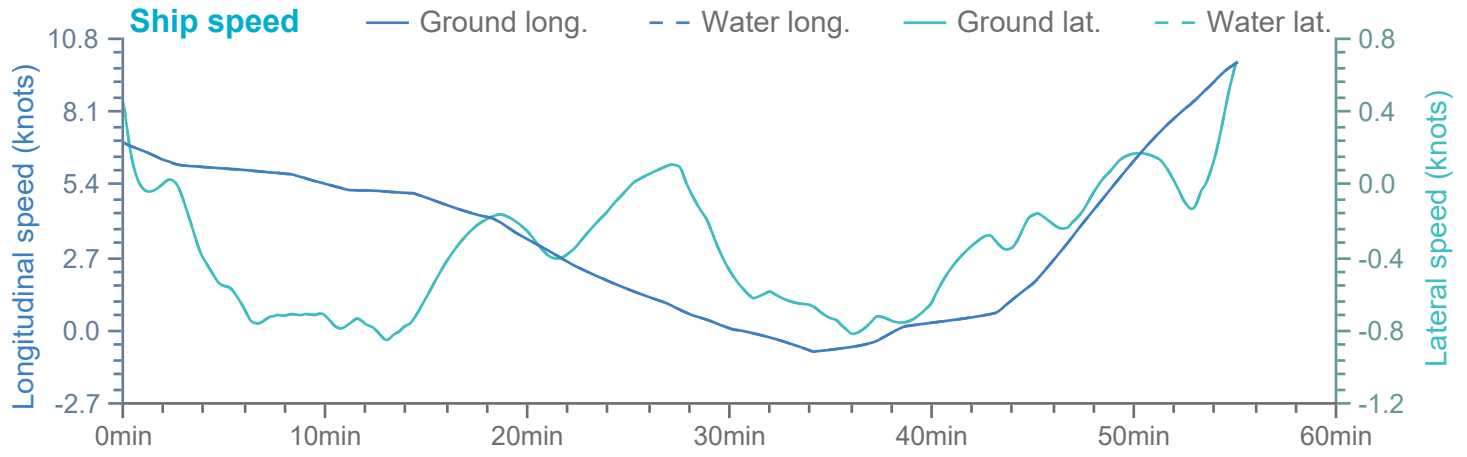

Current acting on ship
Bow
Stern
Bow Dir
Stern Dir
Current speed (knots)
120
100
80
60
40
20
0
Current direction (°N)
360
270
180
090
000
0min
10min
20min
30min
40min
50min
60min

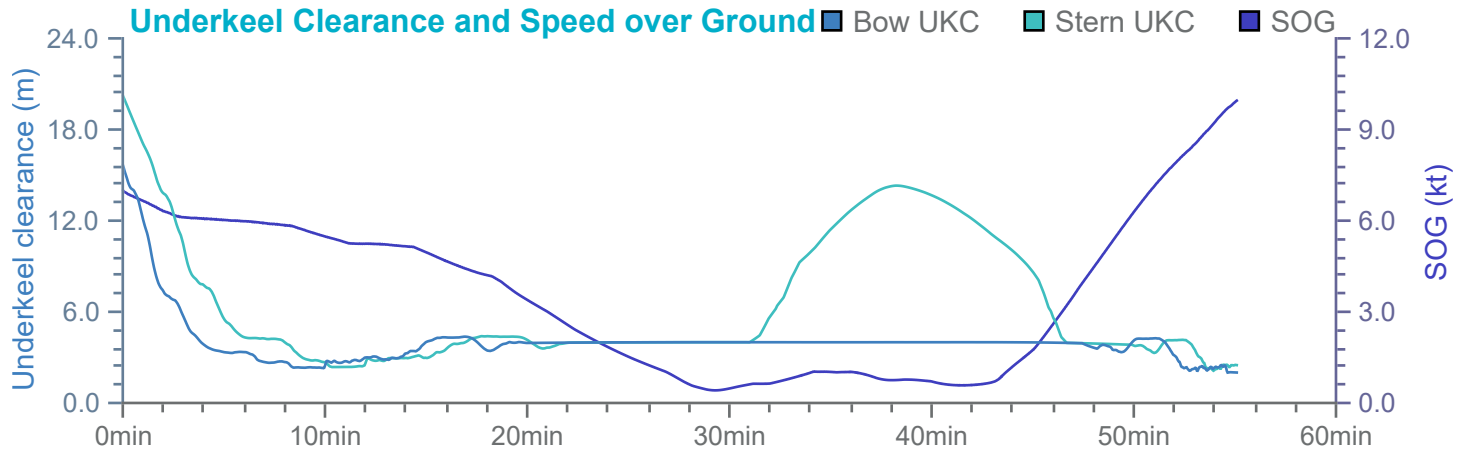

Wind speed and direction
Speed
Direction
Wind speed (knots)
40
30
20
10
0
Wind direction (°N)
360
270
180
090
000
0min
10min
20min
30min
40min
50min
60min

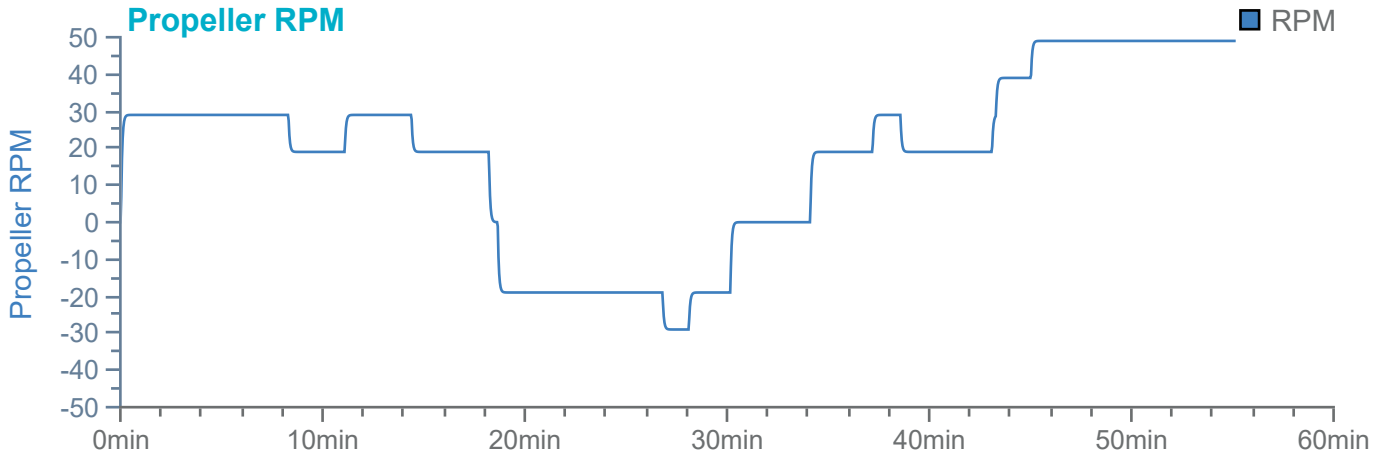

Sig. wave height and direction
Hs1
Dir1
Hs (m)
3.00
2.25
1.50
0.75
0.00
Wave direction (°N)
360
270
180
090
000
0min
10min
20min
30min
40min
50min
60min

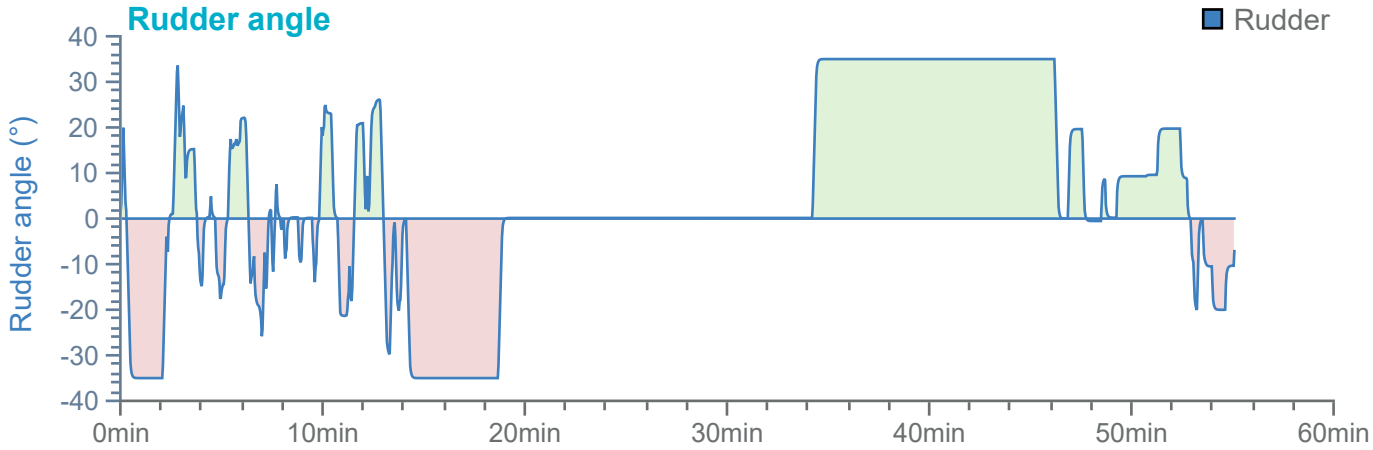

Rate of turn and heading
RoT
Heading
Rate of turn (°/min)
Heading (°N)
21
14
7
0
-7
-14
360
270
180
090
000
0min
10min
20min
30min
40min
50min
60min

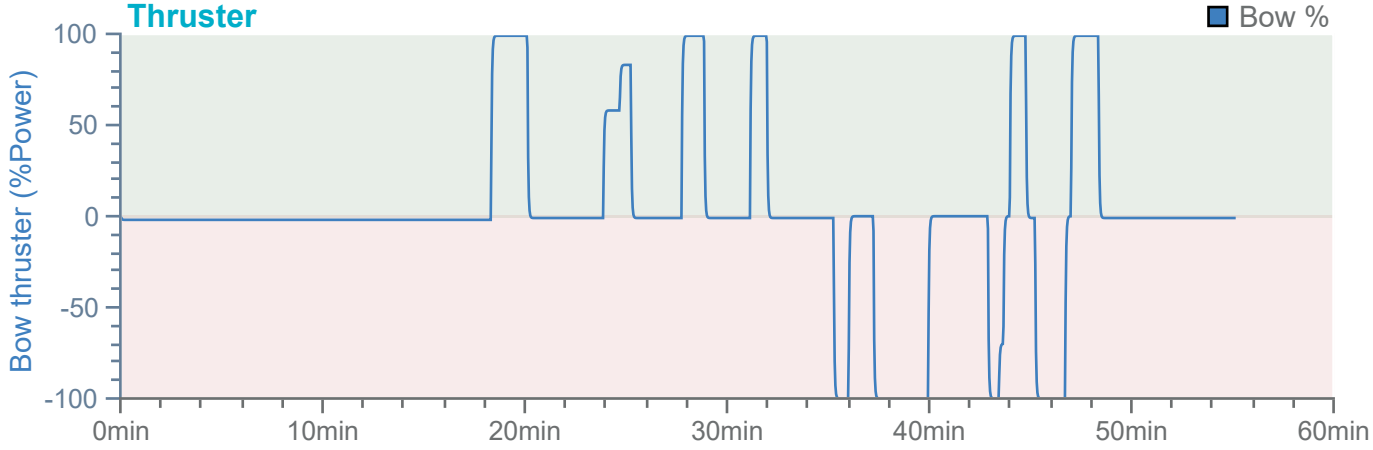

Course over ground and drift
COG
Drift Angle
COG (°)
Drift Angle (°)
360
270
180
090
000
120
60
0
-60
-120
0min
10min
20min
30min
40min
50min
60min


Ship speed
Ground long.
Water long.
Ground lat.
Water lat.
Longitudinal speed (knots)
Lateral speed (knots)
10.8
8.1
5.4
2.7
0.0
-2.7
0.8
0.4
0.0
-0.4
-0.8
-1.2
0min
10min
20min
30min
40min
50min
60min

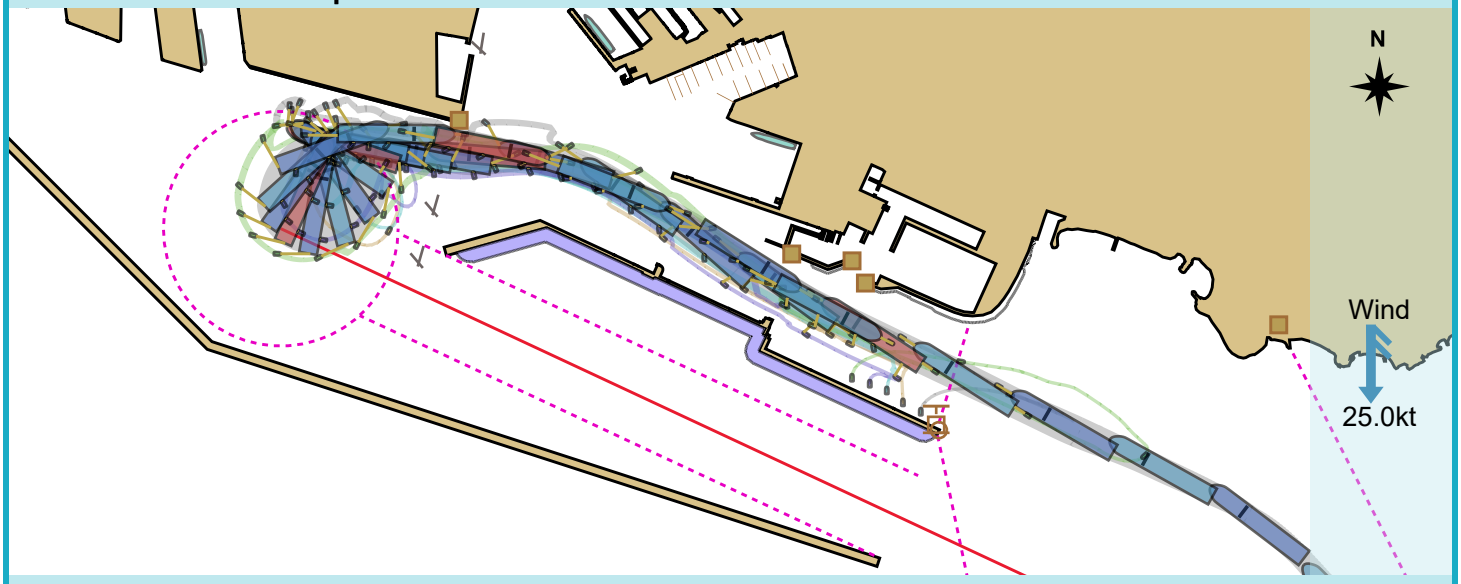

Underkeel Clearance and Speed over Ground
Bow UKC
Stern UKC
SOG
Underkeel clearance (m)
SOG (kt)
24.0
18.0
12.0
6.0
0.0
12.0
9.0
6.0
3.0
0.0
0min
10min
20min
30min
40min
50min
60min


Propeller RPM
RPM
Propeller RPM
50
40
30
20
10
0
-10
-20
-30
-40
-50
0min
10min
20min
30min
40min
50min
60min


Rudder angle
Rudder
Rudder angle (°)
40
30
20
10
0
-10
-20
-30
-40
0min
10min
20min
30min
40min
50min
60min

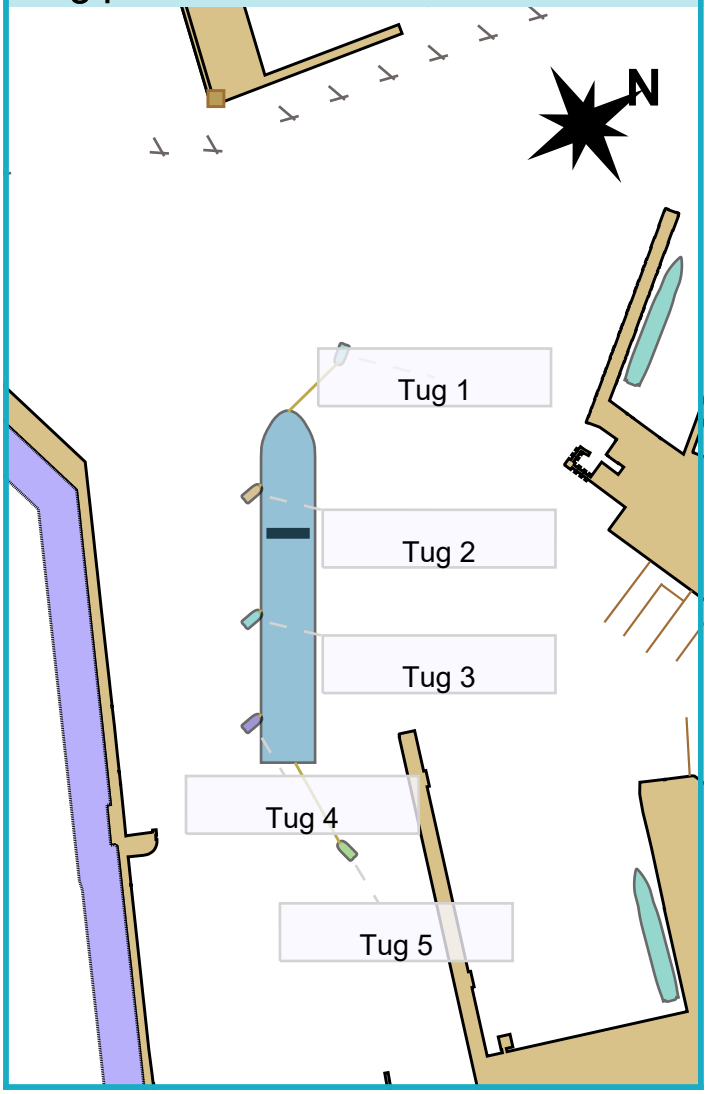

Thruster
Bow %
Bow thruster (%Power)
100
50
0
-50
-100
0min
10min
20min
30min
40min
50min
60min

Manoeuvre track plot

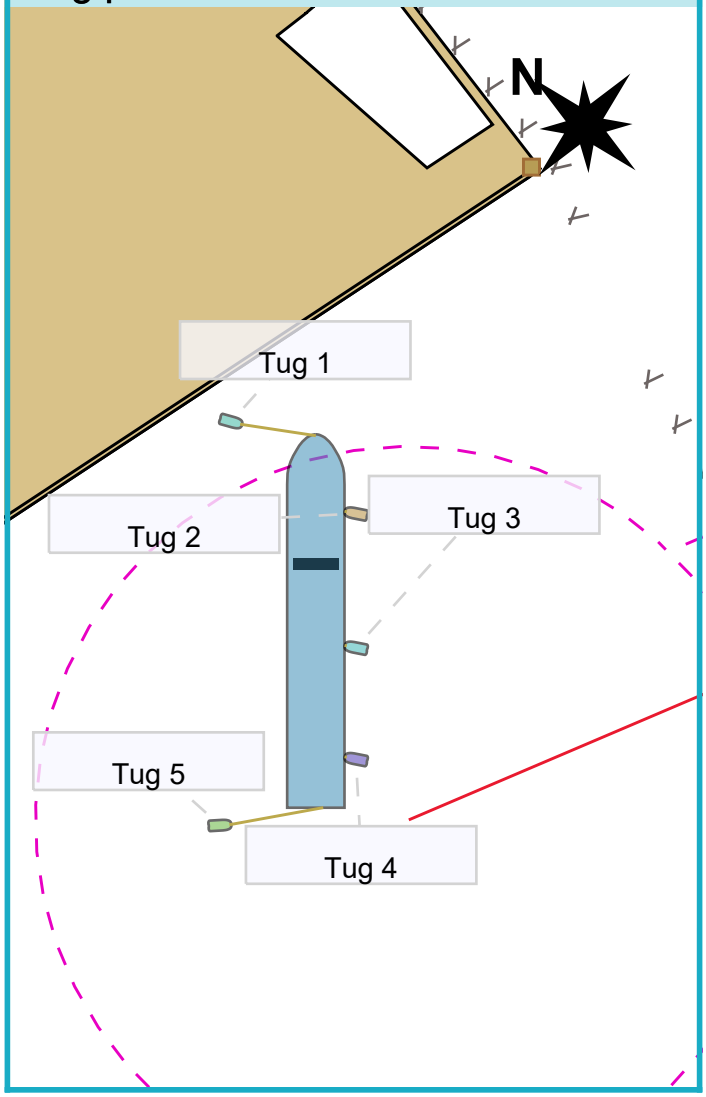


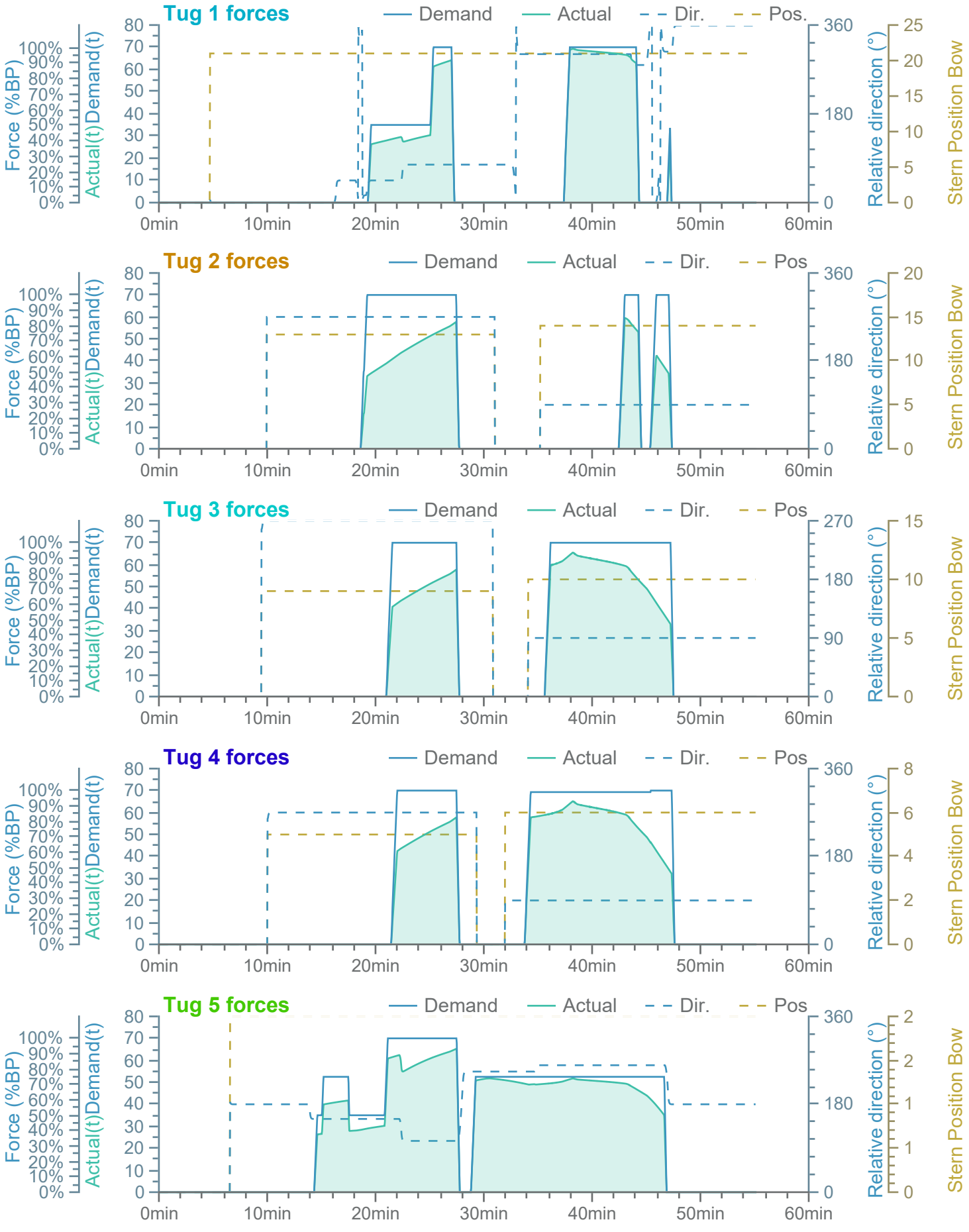
Ships plotted every 2 mins, highlight every 10 mins

Tug position: Initial

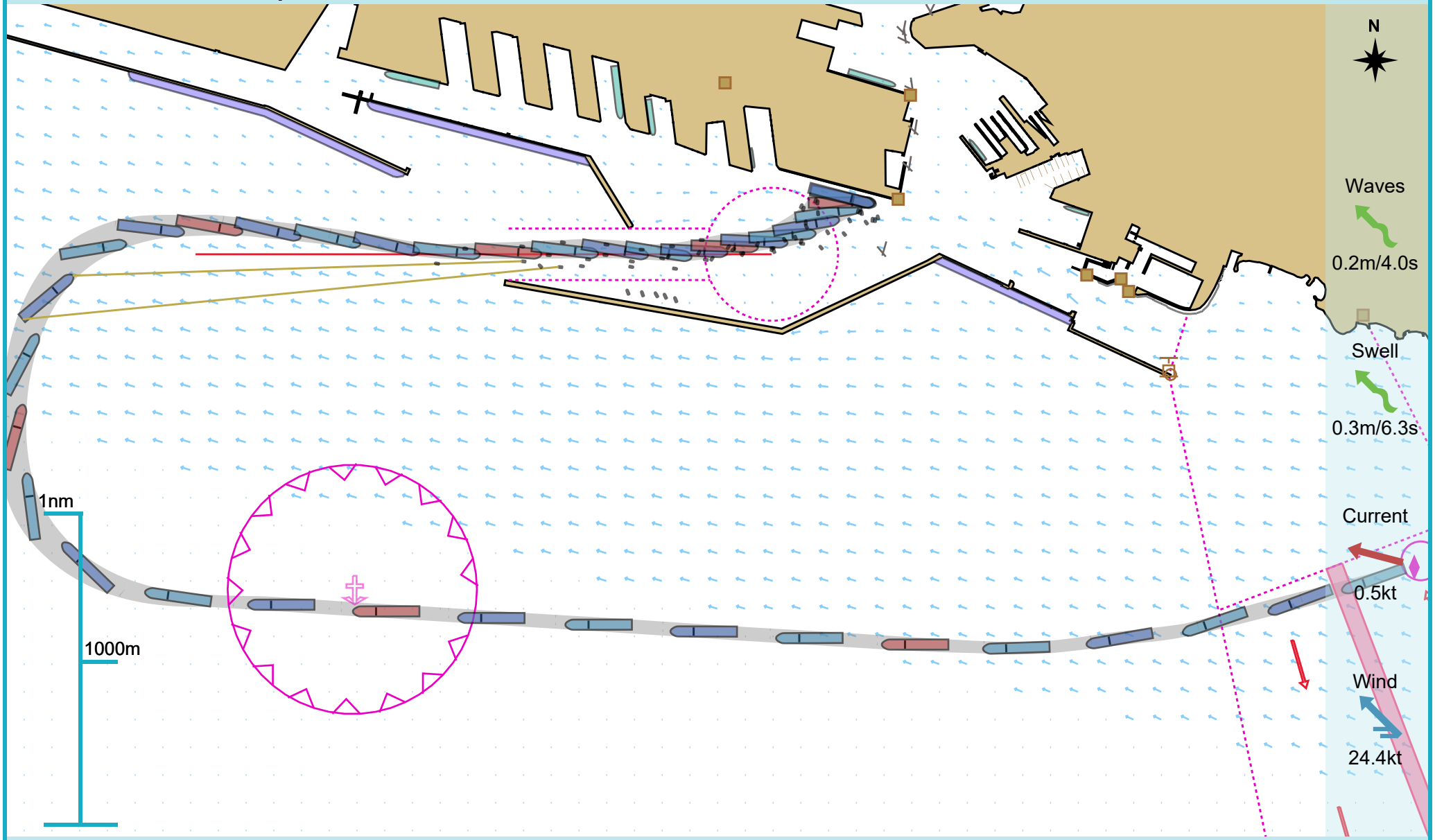


Tug position: Middle

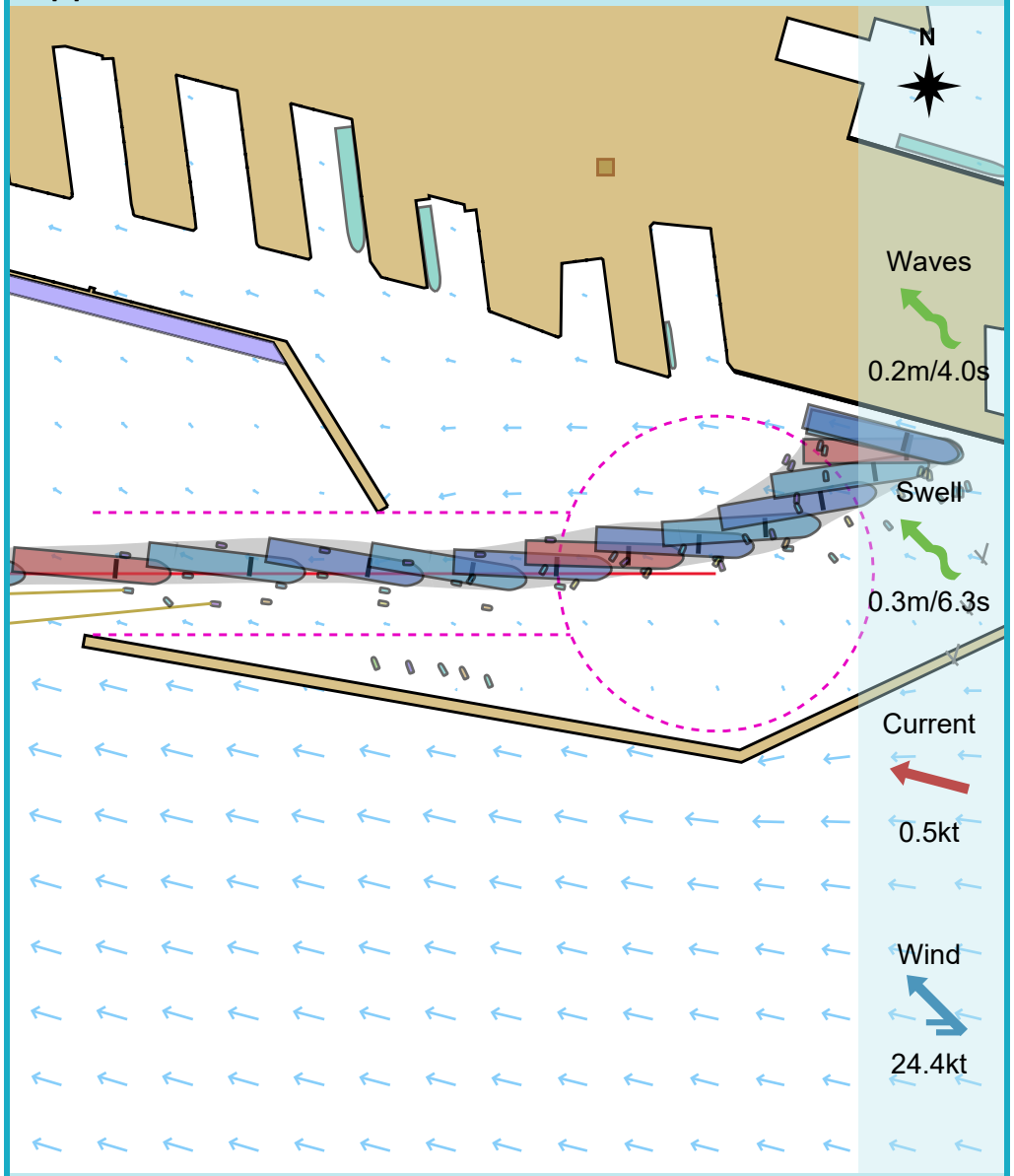



Tug 1 forces
Demand
Actual
Dir.
Pos.
Tug 2 forces
Demand
Actual
Dir.
Pos
Tug 3 forces
Demand
Actual
Dir.
Pos
Tug 4 forces
Demand
Actual
Dir.
Pos
Tug 5 forces
Demand
Actual
Dir.
Pos
Force (%BP)
Actual(t)Demand(t)
Relative direction (°)
Stern Position Bow
0min
10min
20min
30min
40min
50min
60min

Manoeuvre track plot

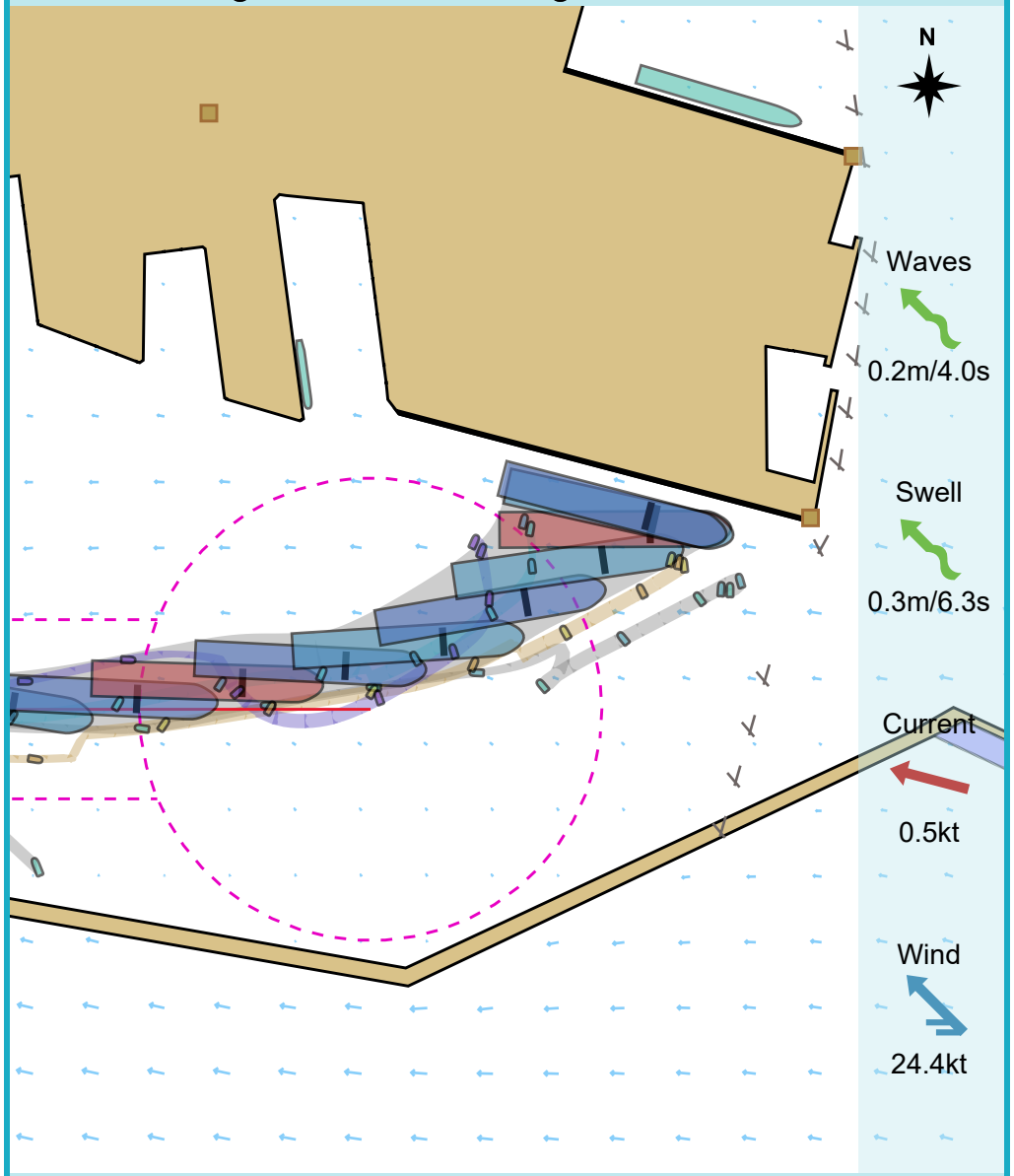


Approach Channel

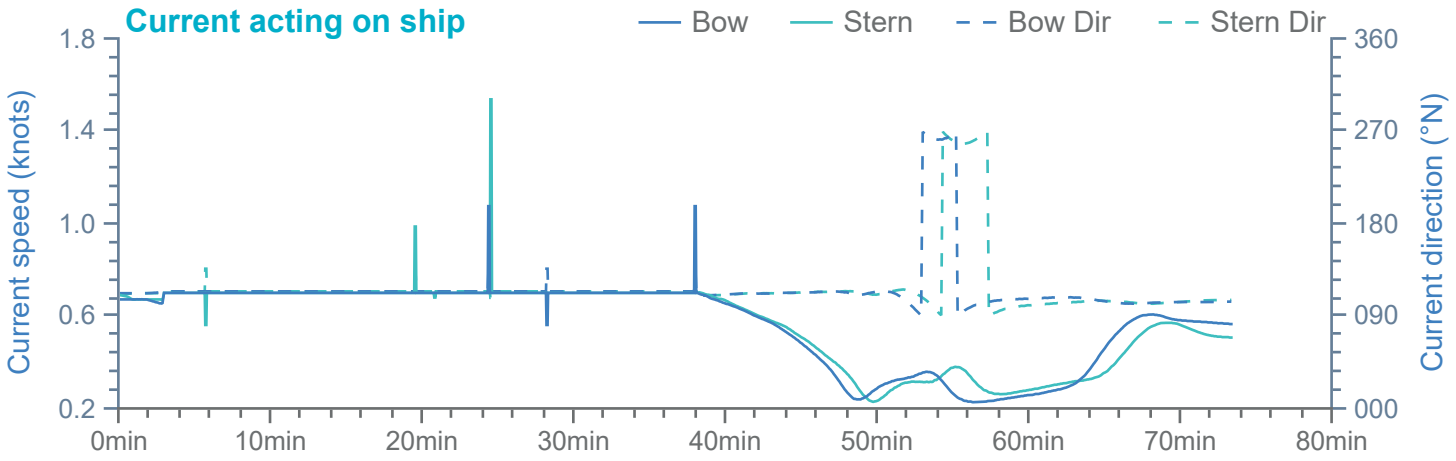


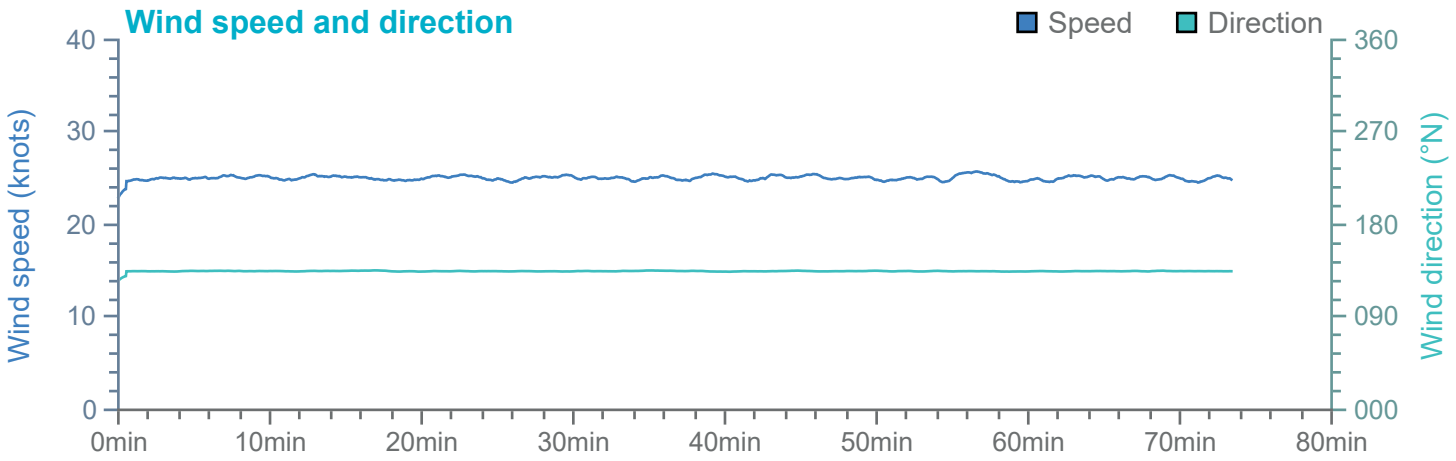
Ships plotted every 2 mins, highlight every 10 mins

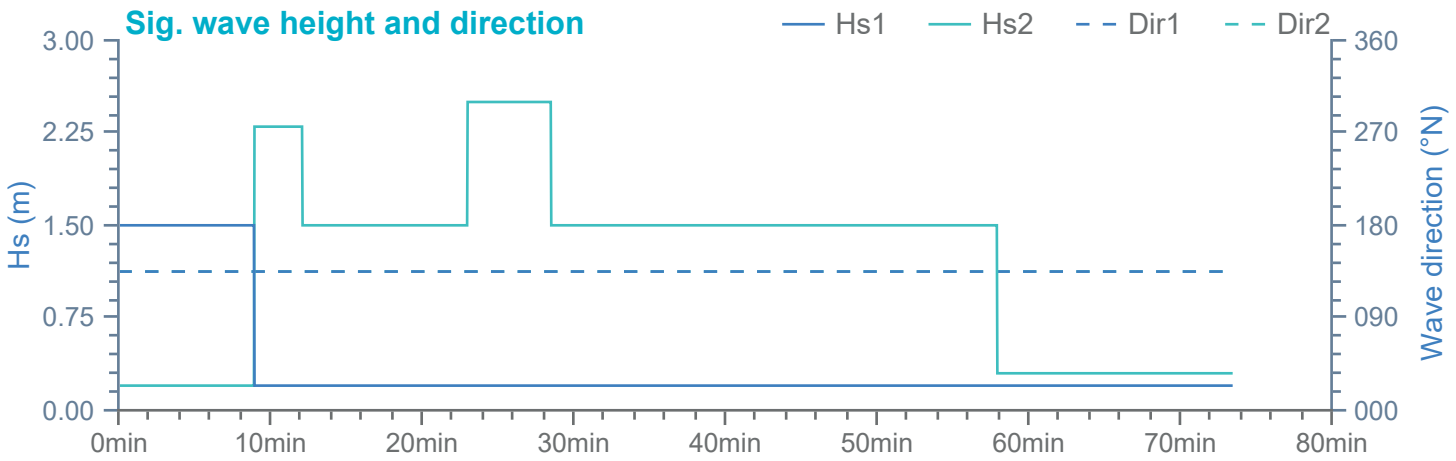
Manoeuvring area and berthing

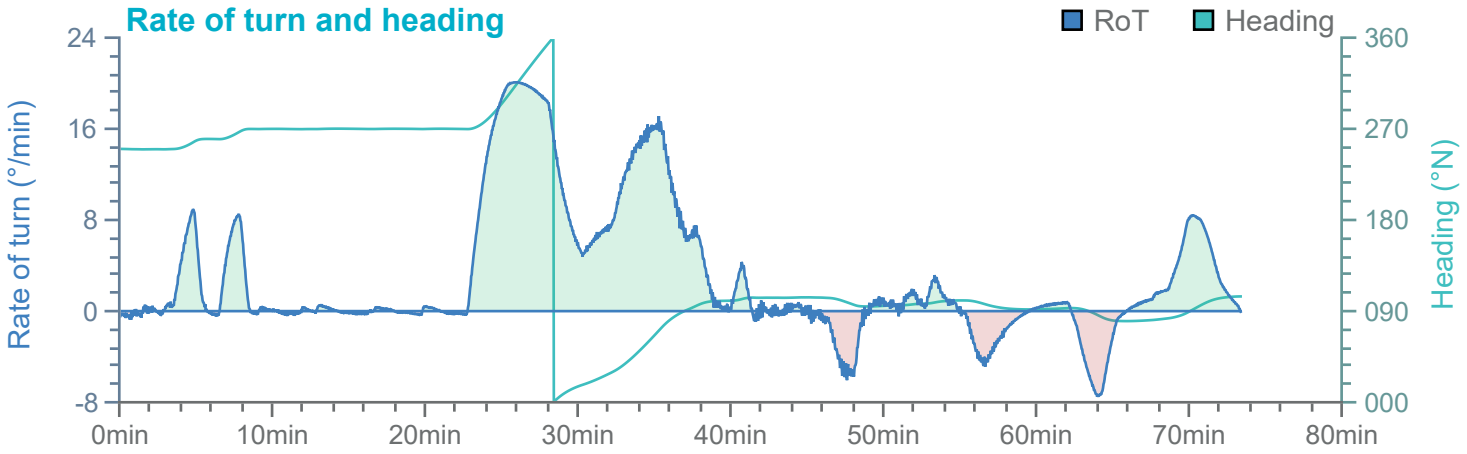


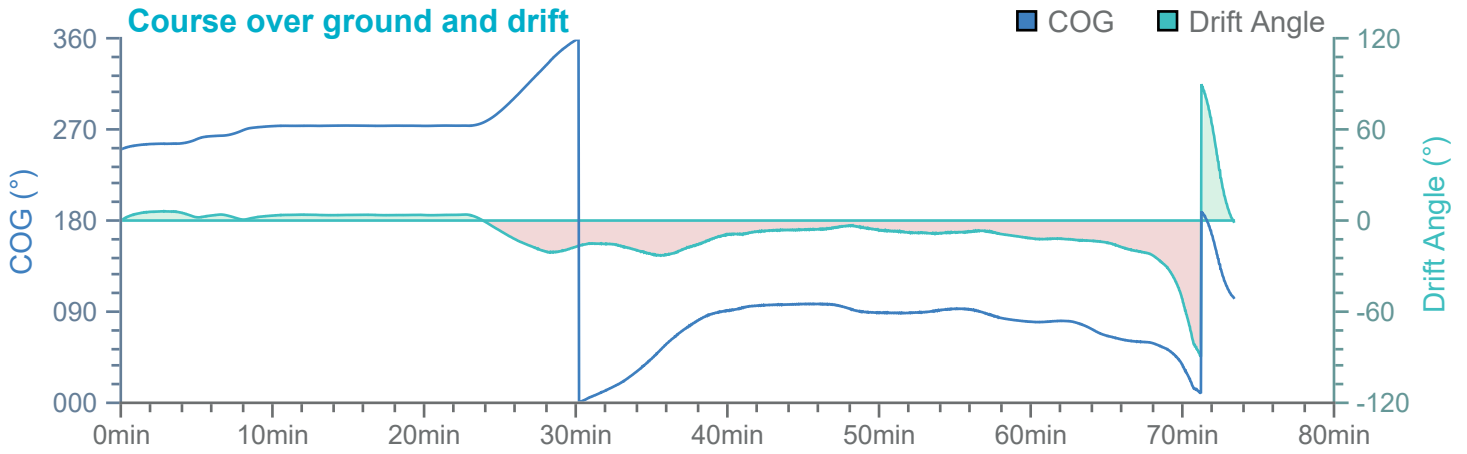
Ships plotted every 2 mins, highlight every 10 mins

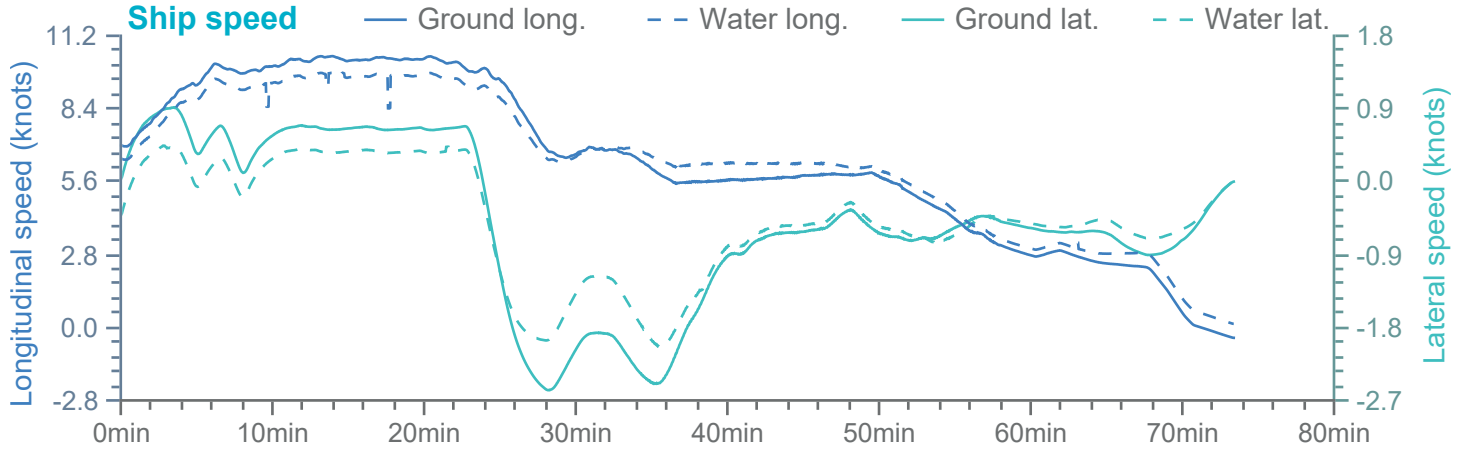

Current acting on ship
Bow
Stern
Bow Dir
Stern Dir
Current speed (knots)
Current direction (°N)
1.8
1.4
1.0
0.6
0.2
360
270
180
090
000
0min
10min
20min
30min
40min
50min
60min
70min
80min

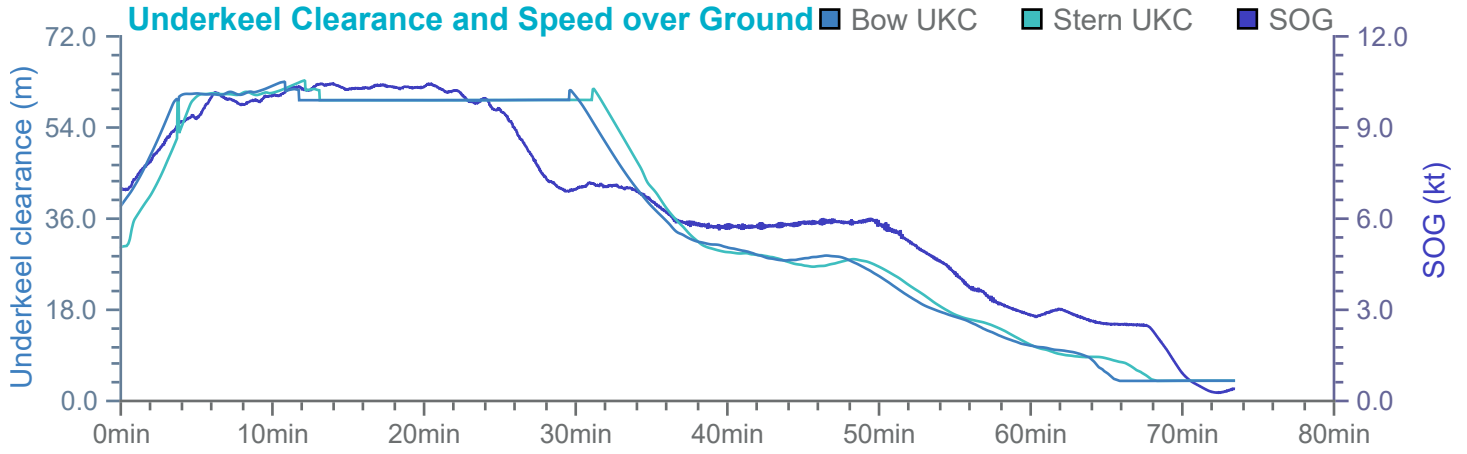

Wind speed and direction
Speed
Direction
Wind speed (knots)
Wind direction (°N)
40
30
20
10
0
360
270
180
090
000
0min
10min
20min
30min
40min
50min
60min
70min
80min

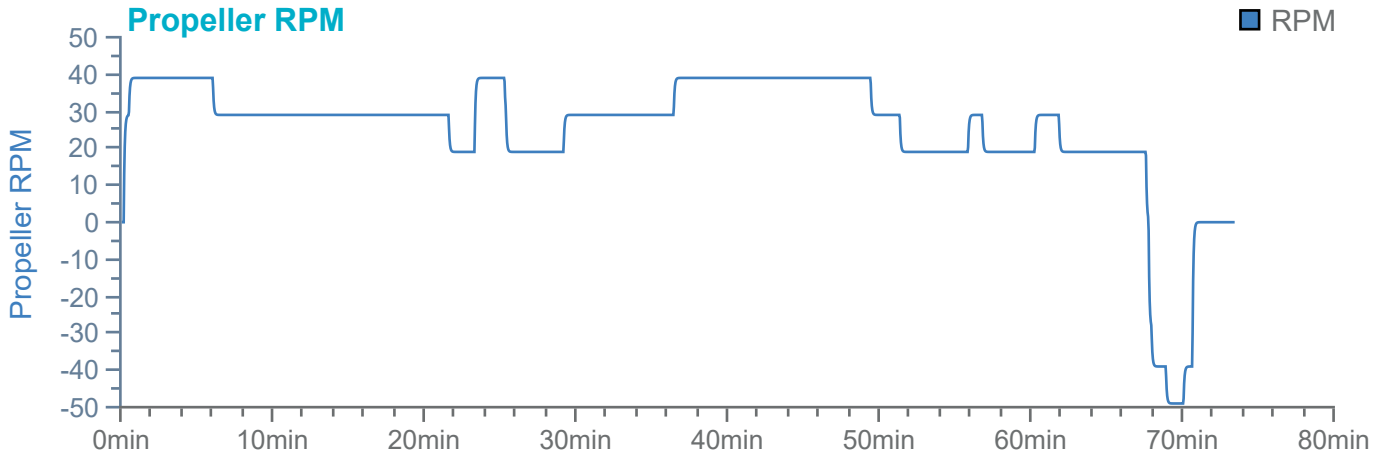

Sig. wave height and direction
Hs1
Hs2
Dir1
Dir2
Hs (m)
Wave direction (°N)
3.00
2.25
1.50
0.75
0.00
360
270
180
090
000
0min
10min
20min
30min
40min
50min
60min
70min
80min

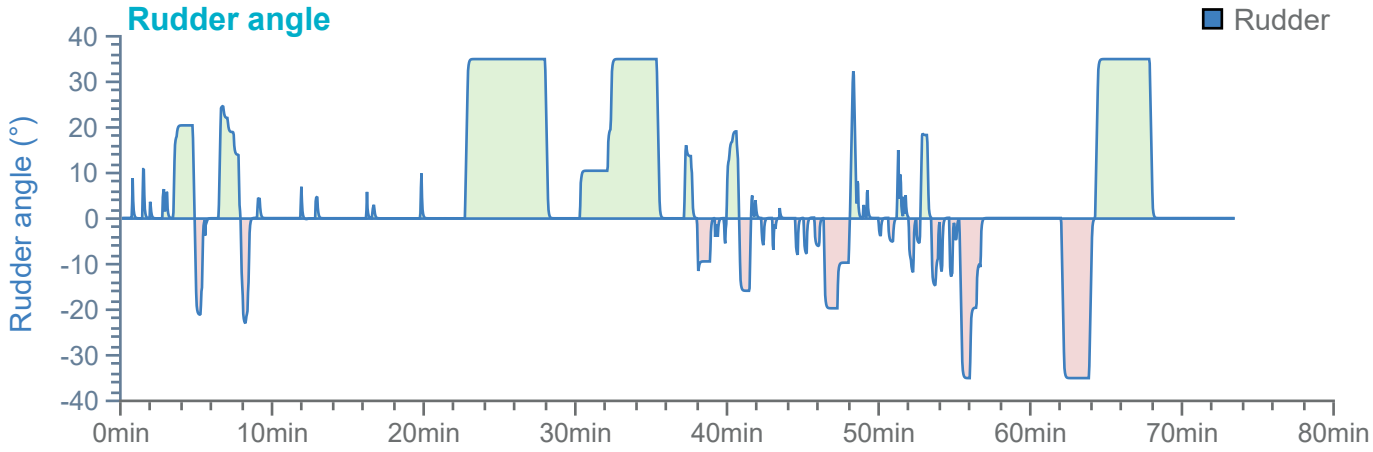

Rate of turn and heading
RoT
Heading
Rate of turn (°/min)
Heading (°N)
24
16
8
0
-8
360
270
180
090
000
0min
10min
20min
30min
40min
50min
60min
70min
80min

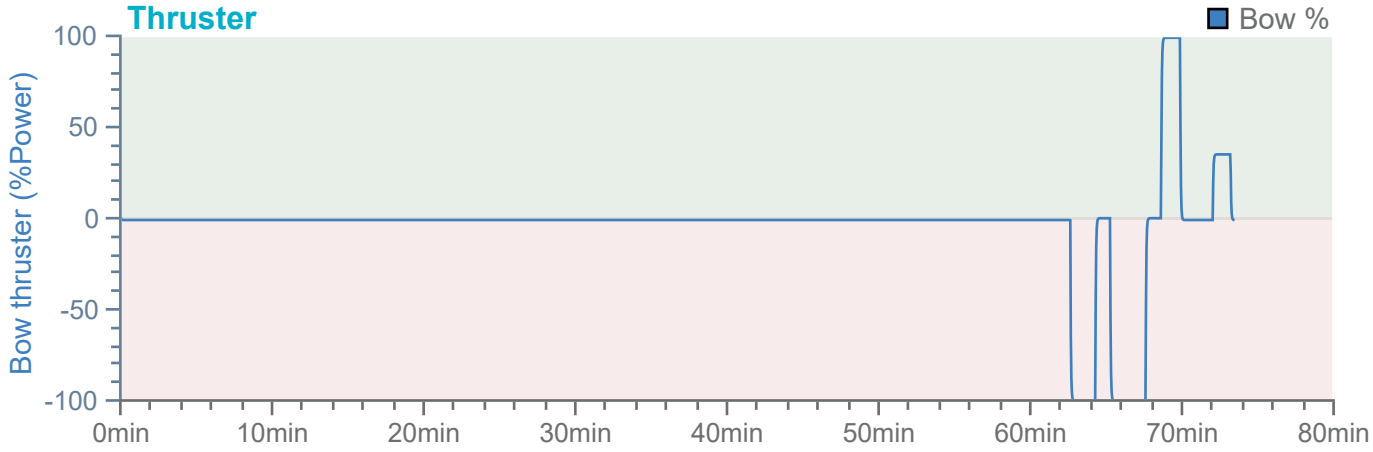

Course over ground and drift
COG
Drift Angle
COG (°)
Drift Angle (°)
360
270
180
090
000
120
60
0
-60
-120
0min
10min
20min
30min
40min
50min
60min
70min
80min


Ship speed
Ground long.
Water long.
Ground lat.
Water lat.
Longitudinal speed (knots)
Lateral speed (knots)
11.2
8.4
5.6
2.8
0.0
-2.8
1.8
0.9
0.0
-0.9
-1.8
-2.7
0min
10min
20min
30min
40min
50min
60min
70min
80min

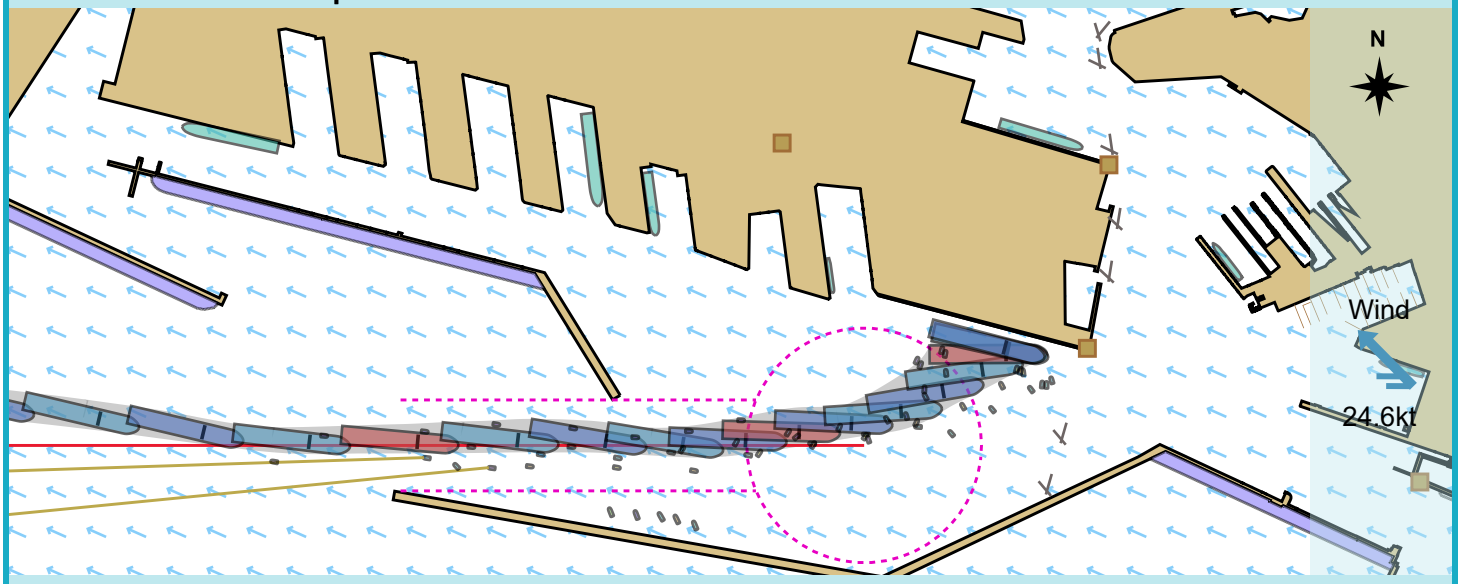

Underkeel Clearance and Speed over Ground
Bow UKC
Stern UKC
SOG
Underkeel clearance (m)
SOG (kt)
72.0
54.0
36.0
18.0
0.0
12.0
9.0
6.0
3.0
0.0
0min
10min
20min
30min
40min
50min
60min
70min
80min


Propeller RPM
RPM
Propeller RPM
50
40
30
20
10
0
-10
-20
-30
-40
-50
0min
10min
20min
30min
40min
50min
60min
70min
80min


Rudder angle
Rudder
Rudder angle (°)
40
30
20
10
0
-10
-20
-30
-40
0min
10min
20min
30min
40min
50min
60min
70min
80min

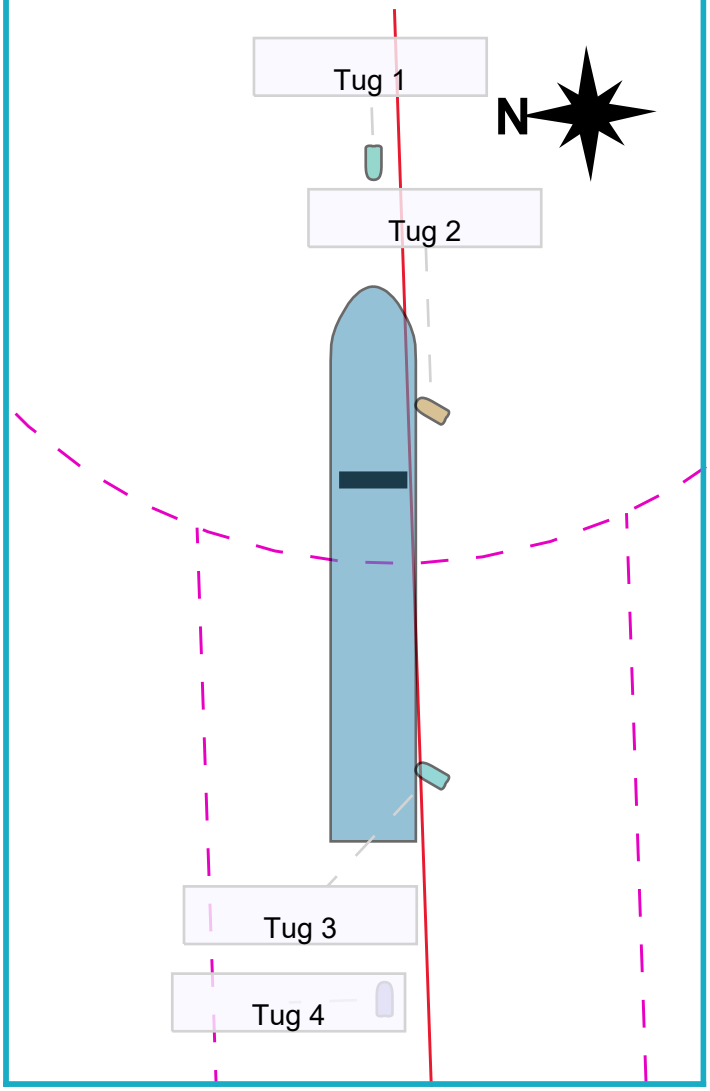

Thruster
Bow %
Bow thruster (%Power)
100
50
0
-50
-100
0min
10min
20min
30min
40min
50min
60min
70min
80min

Manoeuvre track plot

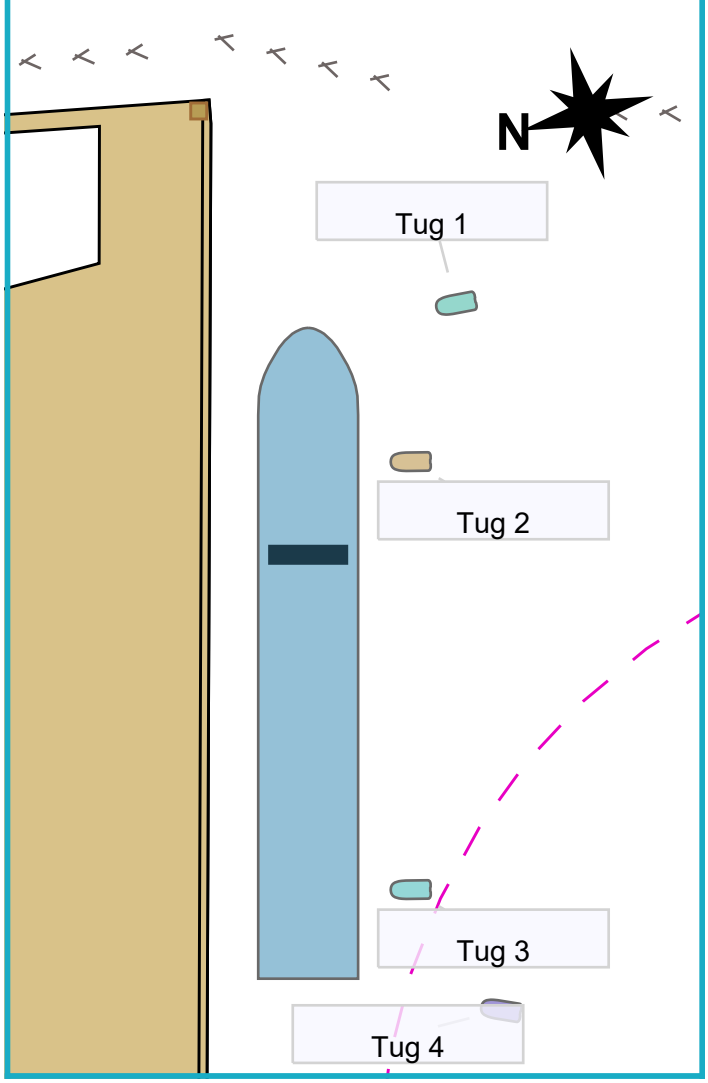


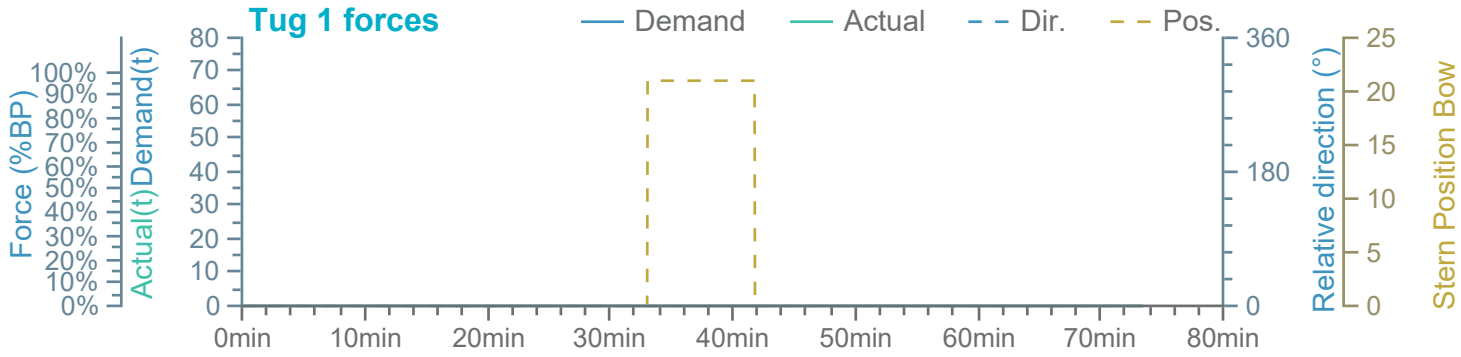
Ships plotted every 2 mins, highlight every 10 mins

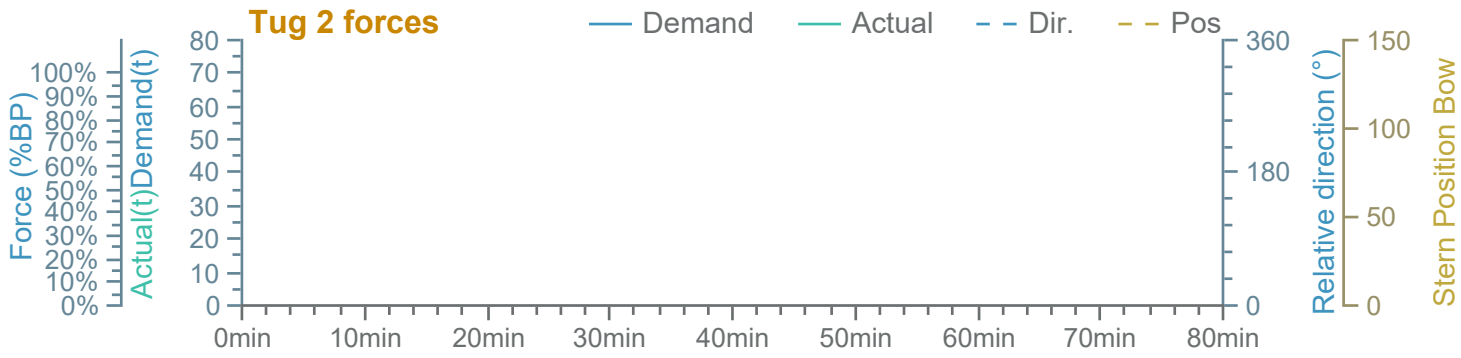
Tug position: Initial

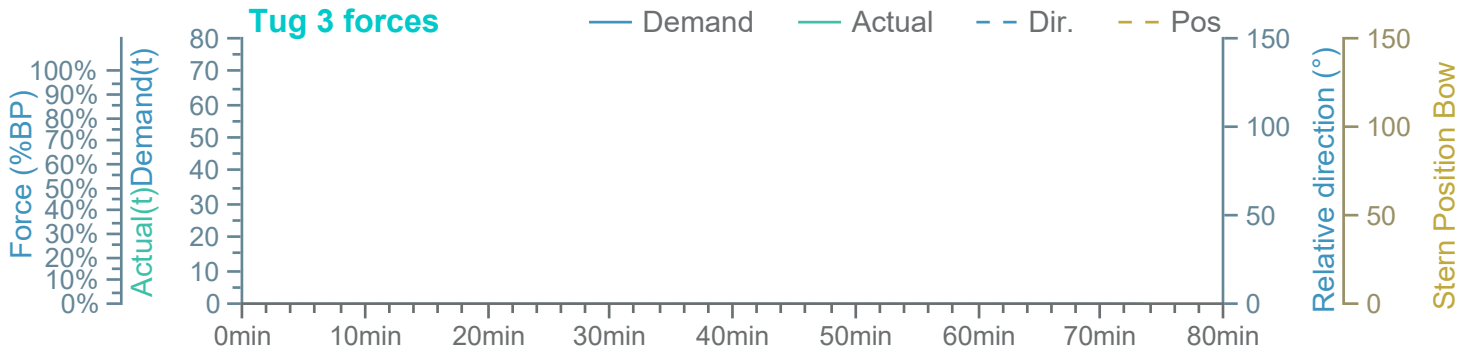


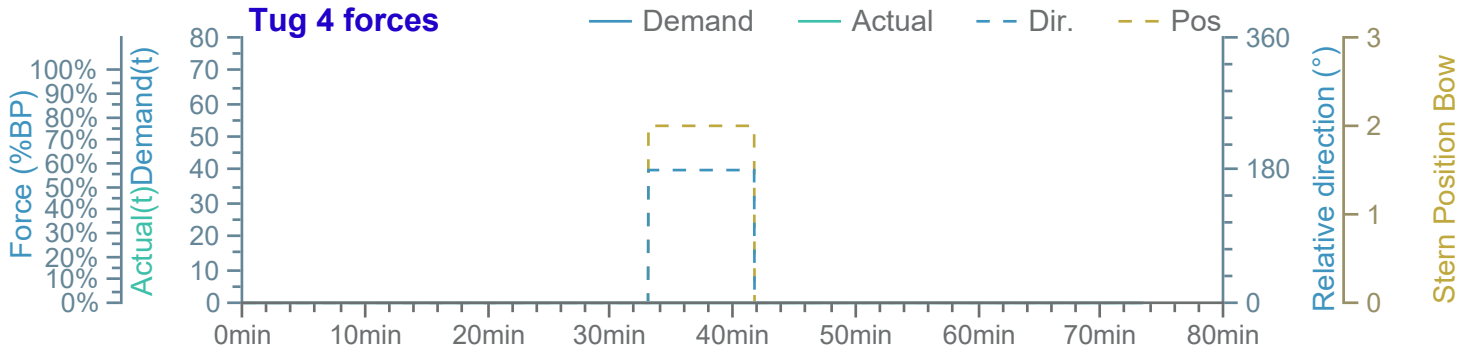
Tug position: Final



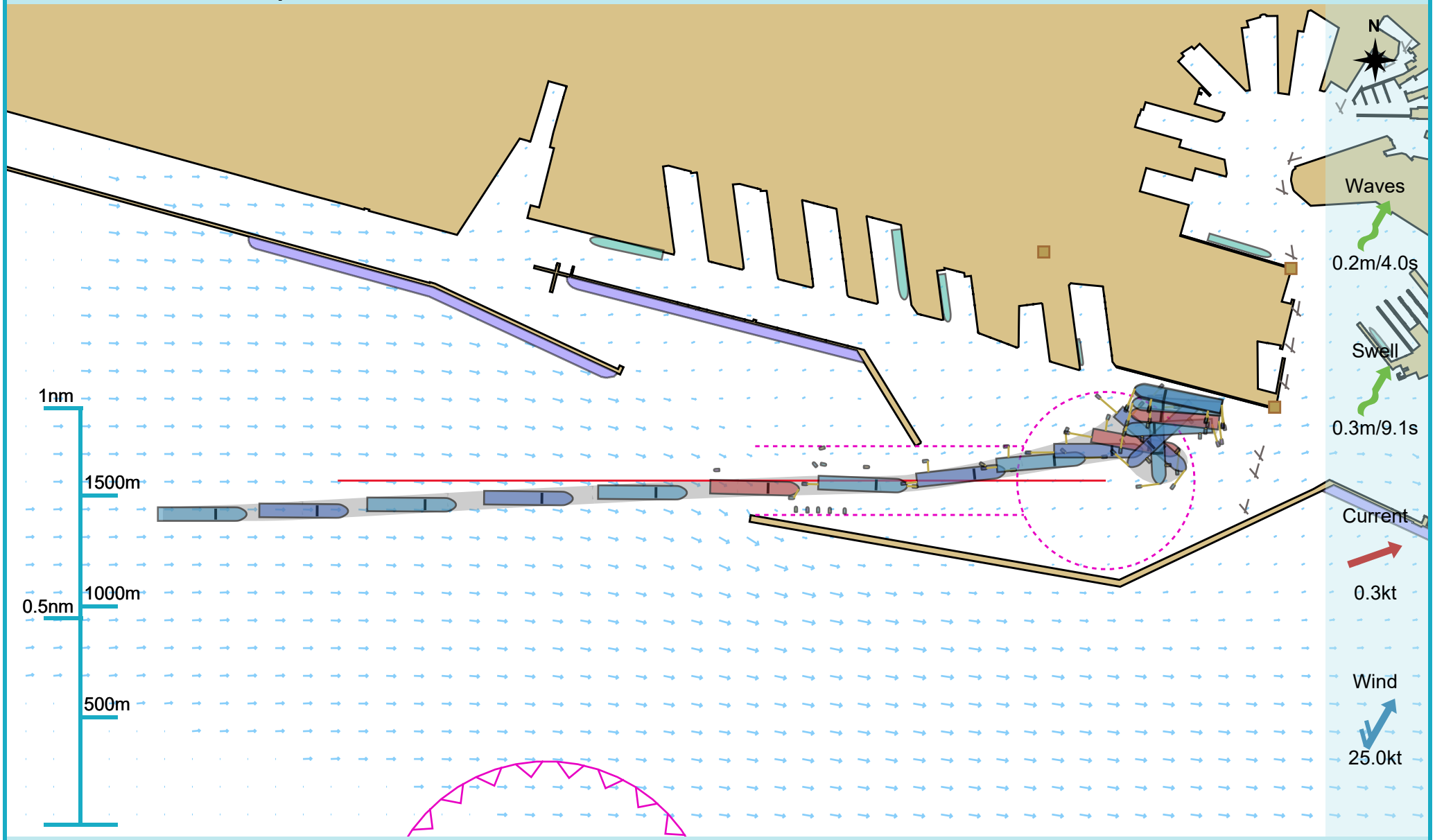

Tug 1 forces
Demand
Actual
Dir.
Pos.
Force (%BP)
Actual(t)Demand(t)
Relative direction (°)
Stern Position Bow
0min
10min
20min
30min
40min
50min
60min
70min
80min


Tug 2 forces
Demand
Actual
Dir.
Pos
Force (%BP)
Actual(t)Demand(t)
Relative direction (°)
Stern Position Bow
0min
10min
20min
30min
40min
50min
60min
70min
80min


Tug 3 forces
Demand
Actual
Dir.
Pos
Force (%BP)
Actual(t)Demand(t)
Relative direction (°)
Stern Position Bow
0min
10min
20min
30min
40min
50min
60min
70min
80min


Tug 4 forces
Demand
Actual
Dir.
Pos
Force (%BP)
Actual(t)Demand(t)
Relative direction (°)
Stern Position Bow
0min
10min
20min
30min
40min
50min
60min
70min
80min

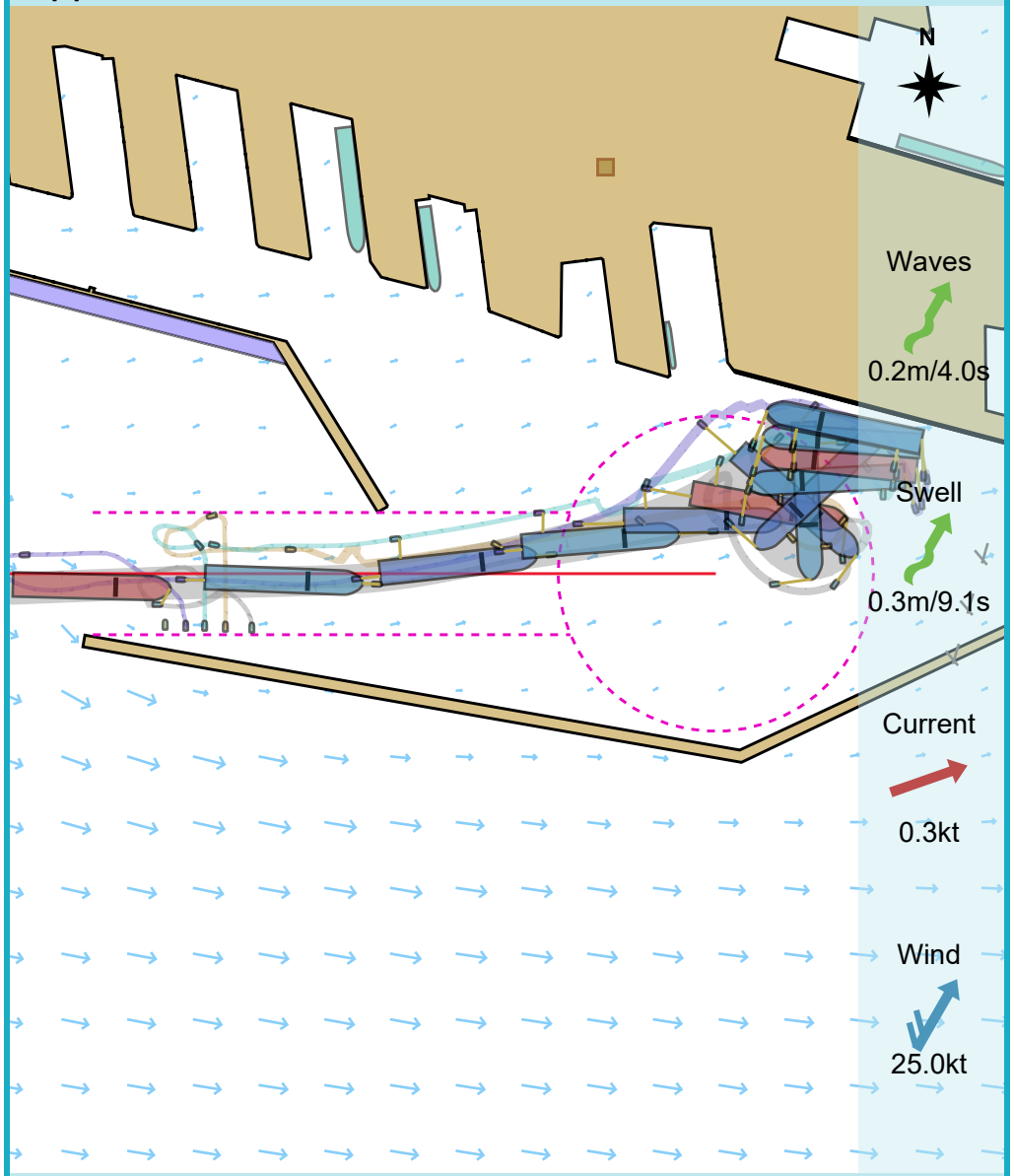
Manoeuvre track plot



0.76 kts

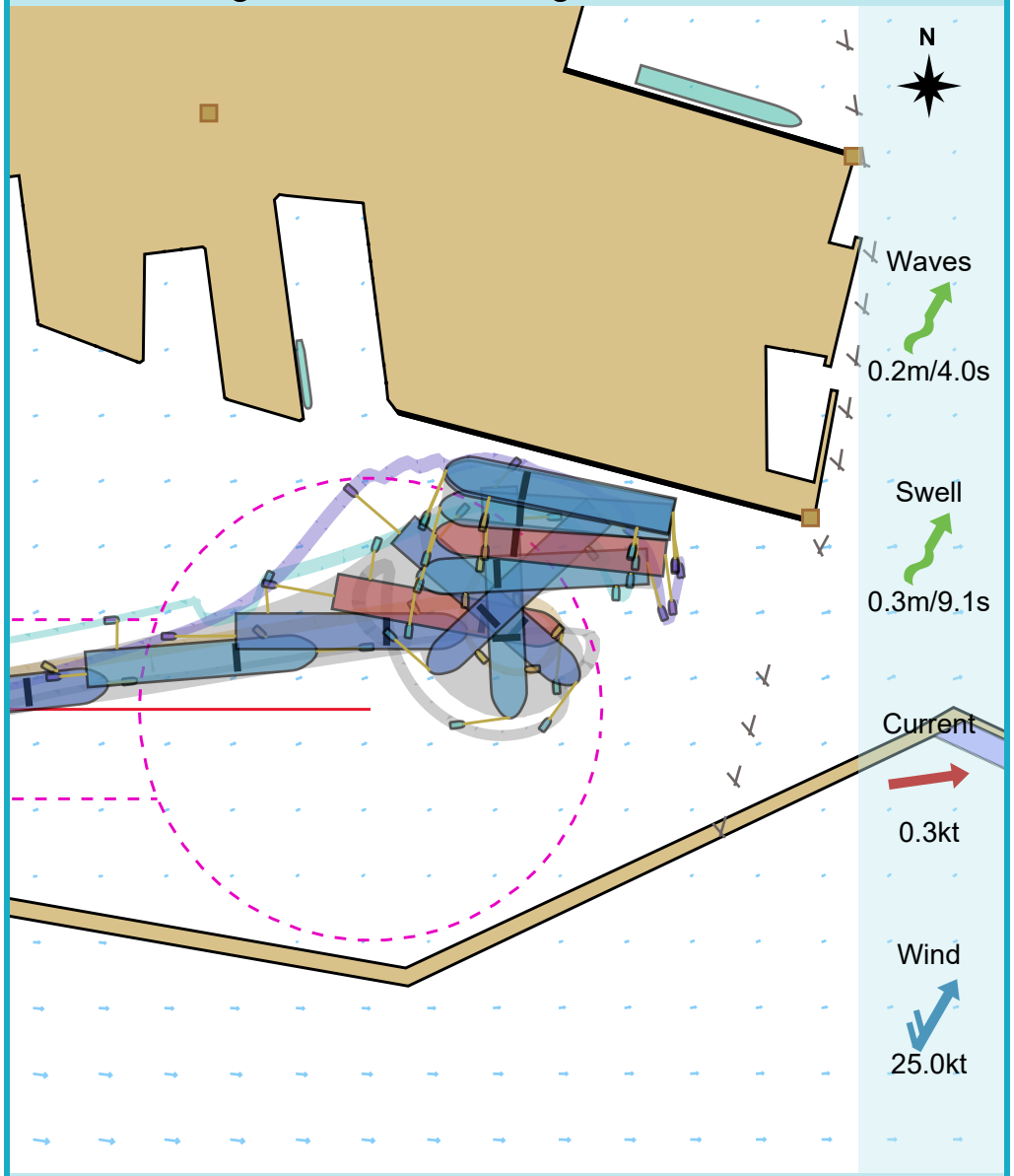
Ships plotted every 2 mins, highlight every 10 mins

Approach Channel

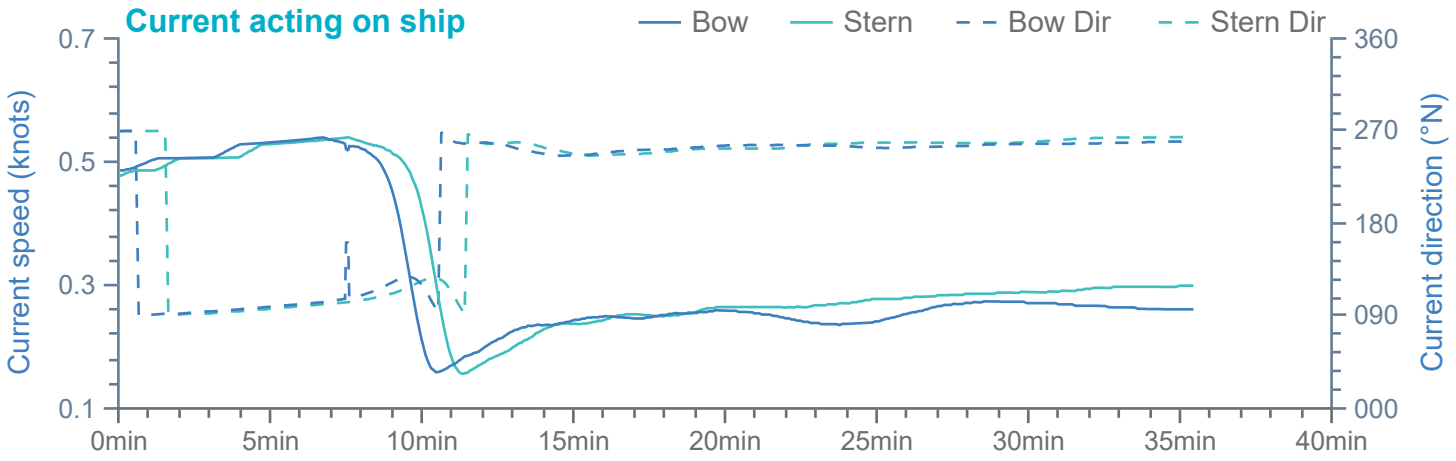


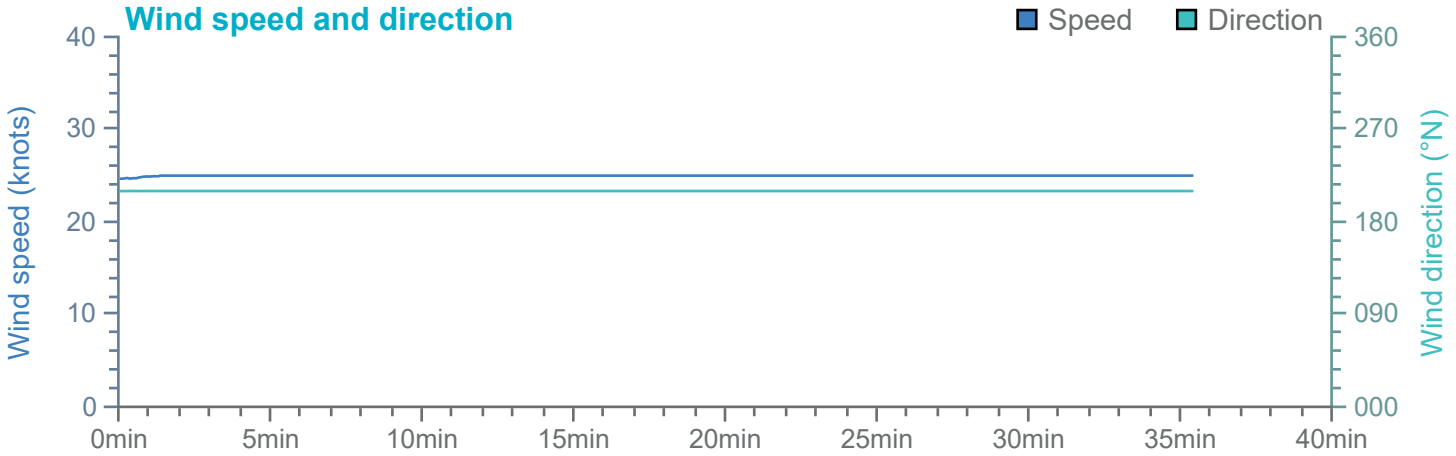
Ships plotted every 2 mins, highlight every 10 mins

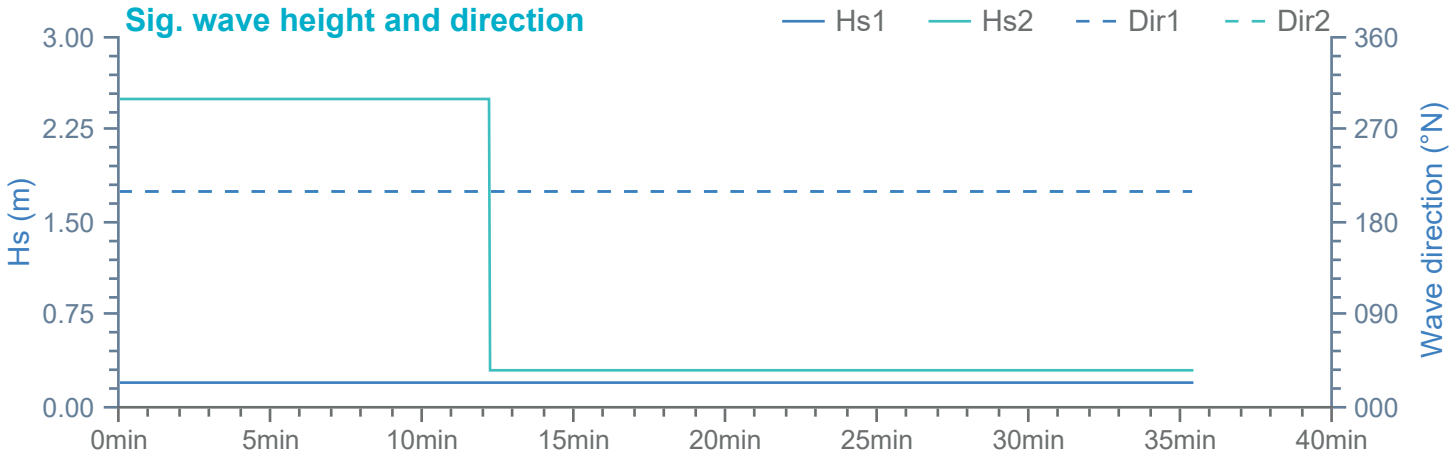
Manoeuvring area and berthing

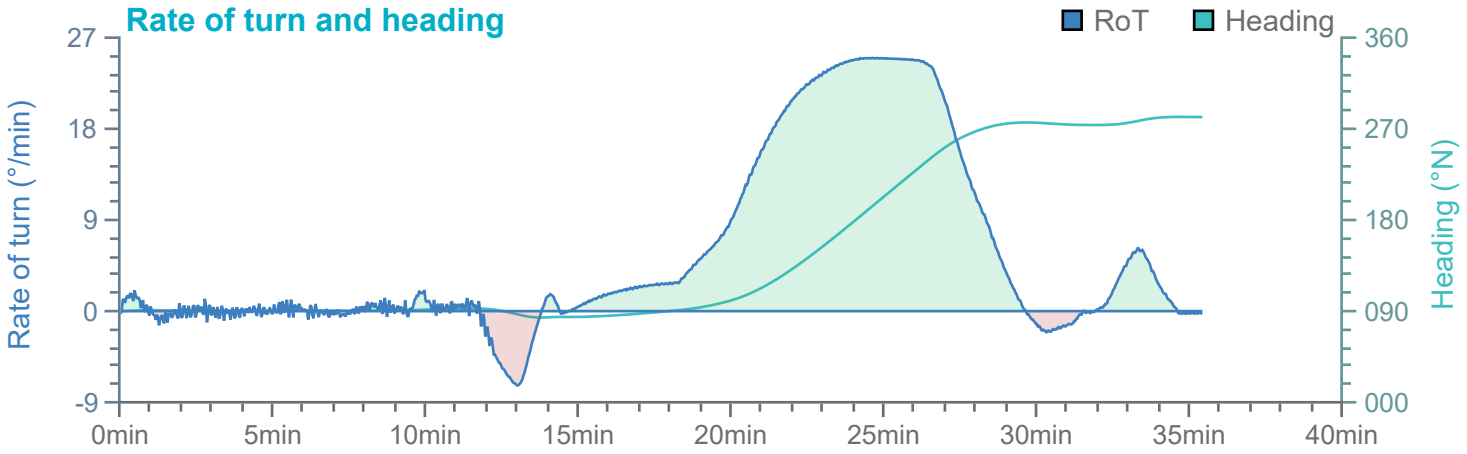


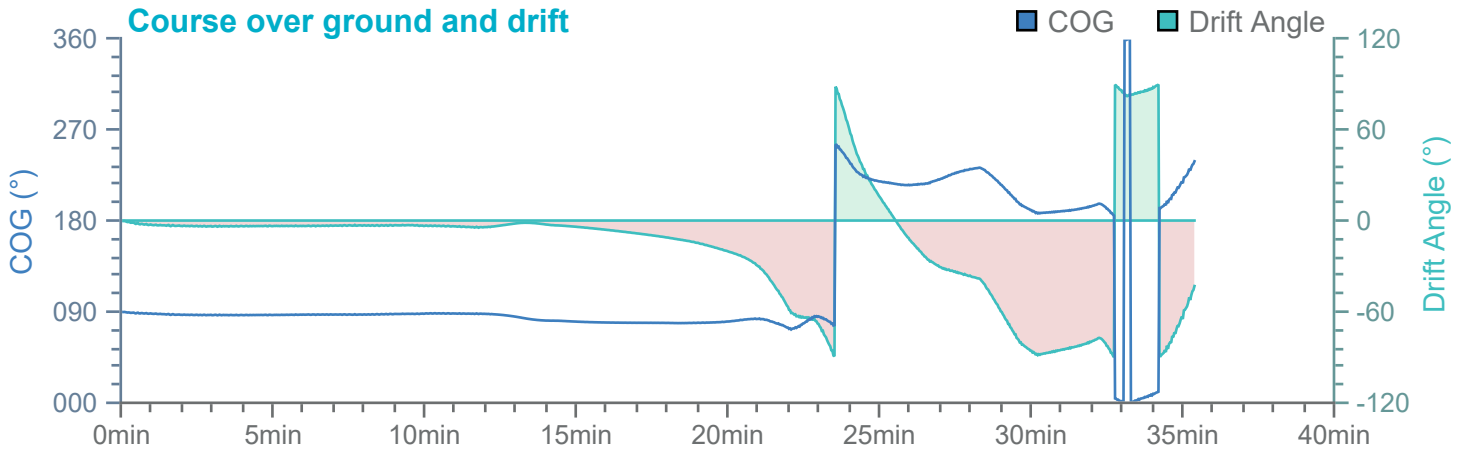
Ships plotted every 2 mins, highlight every 10 mins

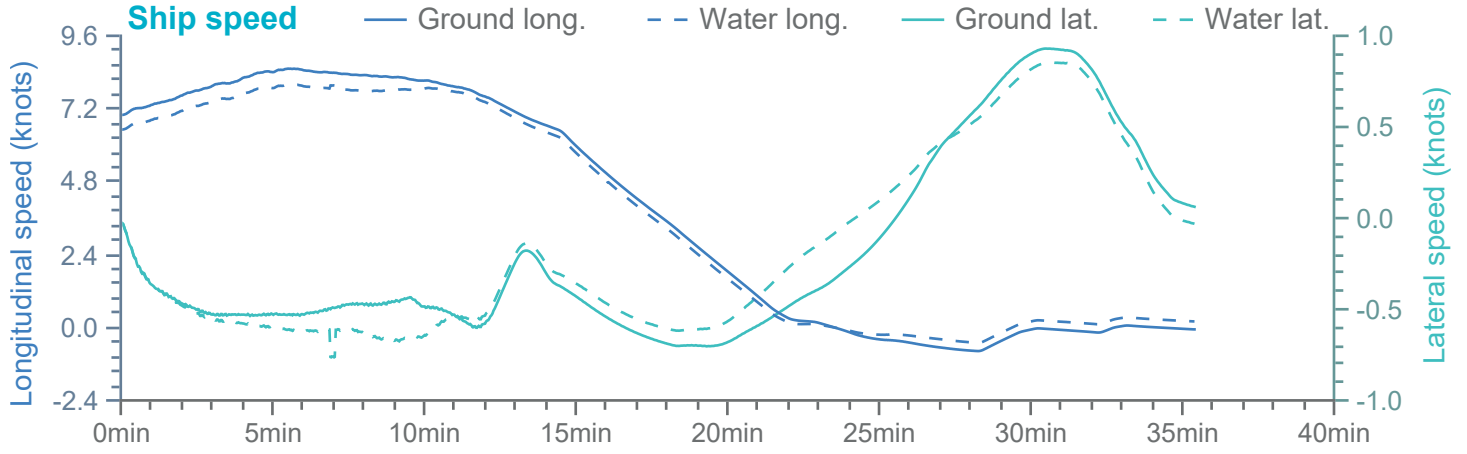

Current acting on ship
Bow
Stern
Bow Dir
Stern Dir
Current speed (knots)
0.7
0.5
0.3
0.1
Current direction (°N)
360
270
180
090
000
0min
5min
10min
15min
20min
25min
30min
35min
40min

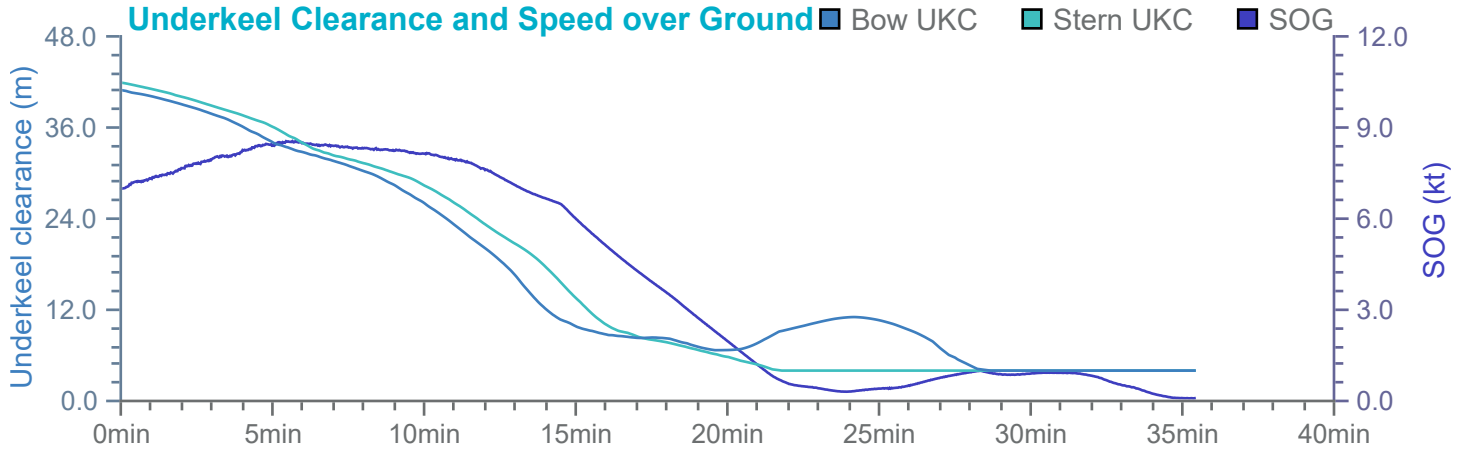

Wind speed and direction
Speed
Direction
Wind speed (knots)
40
30
20
10
0
Wind direction (°N)
360
270
180
090
000
0min
5min
10min
15min
20min
25min
30min
35min
40min

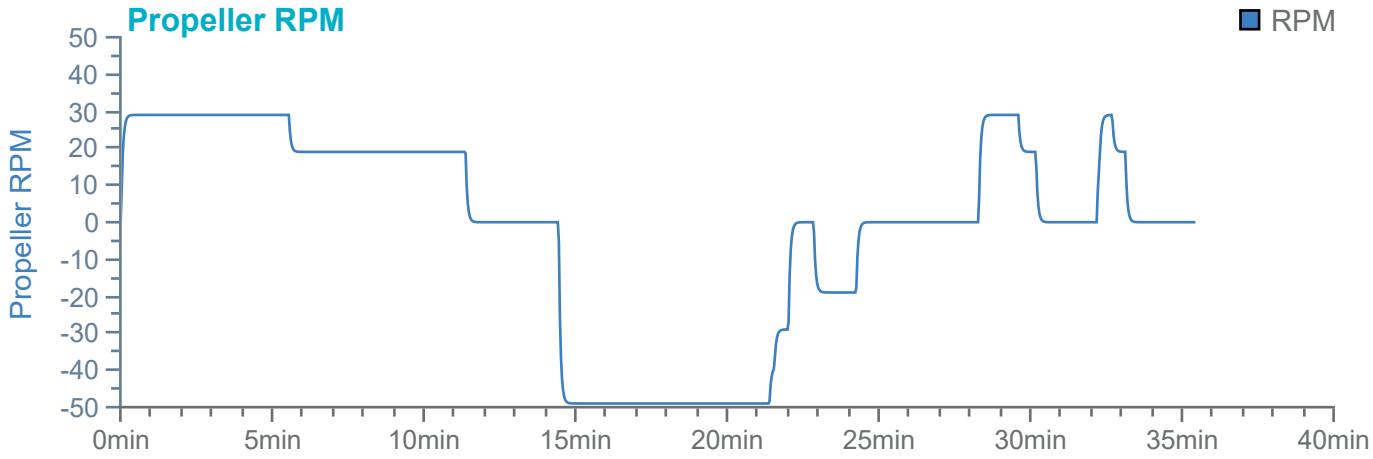

Sig. wave height and direction
Hs1
Hs2
Dir1
Dir2
Hs (m)
3.00
2.25
1.50
0.75
0.00
Wave direction (°N)
360
270
180
090
000
0min
5min
10min
15min
20min
25min
30min
35min
40min

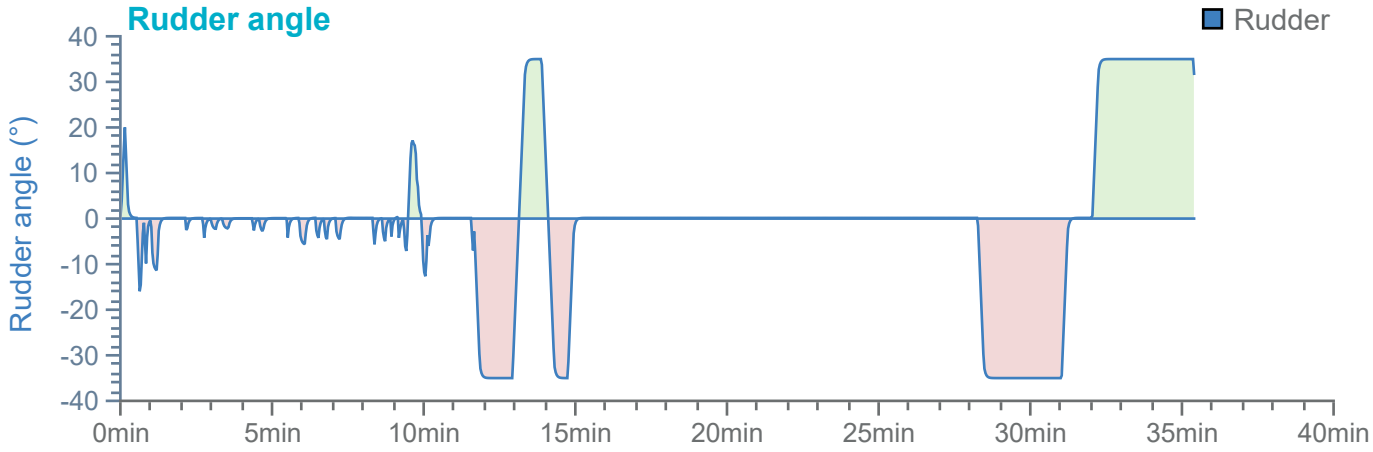

Rate of turn and heading
RoT
Heading
Rate of turn (°/min)
Heading (°N)
27
18
9
0
-9
360
270
180
090
000
0min
5min
10min
15min
20min
25min
30min
35min
40min

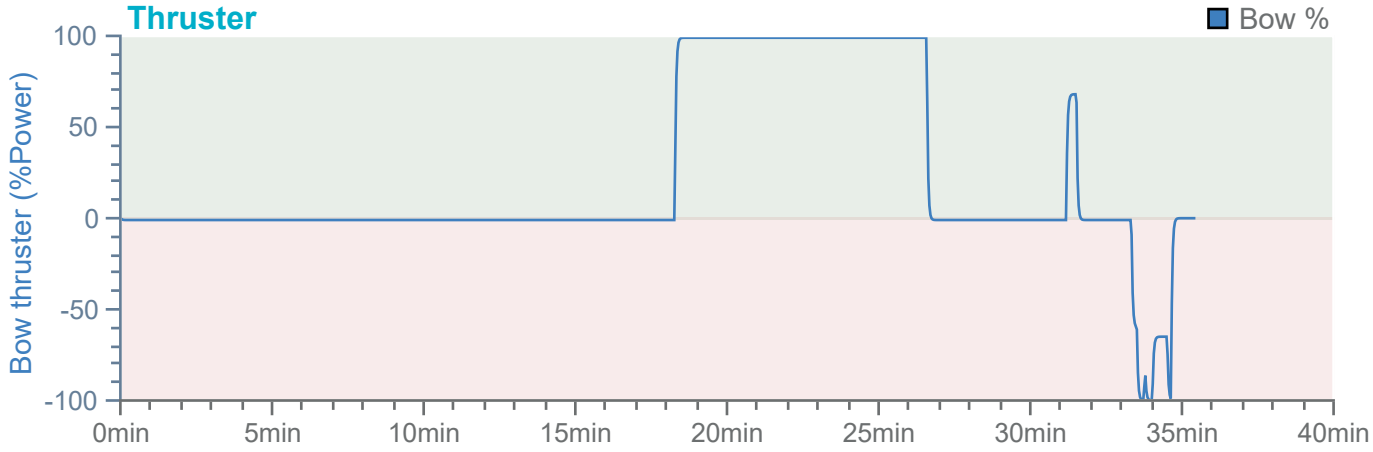

Course over ground and drift
COG
Drift Angle
COG (°)
Drift Angle (°)
360
270
180
090
000
120
60
0
-60
-120
0min
5min
10min
15min
20min
25min
30min
35min
40min


Ship speed
Ground long.
Water long.
Ground lat.
Water lat.
Longitudinal speed (knots)
Lateral speed (knots)
9.6
7.2
4.8
2.4
0.0
-2.4
1.0
0.5
0.0
-0.5
-1.0
0min
5min
10min
15min
20min
25min
30min
35min
40min

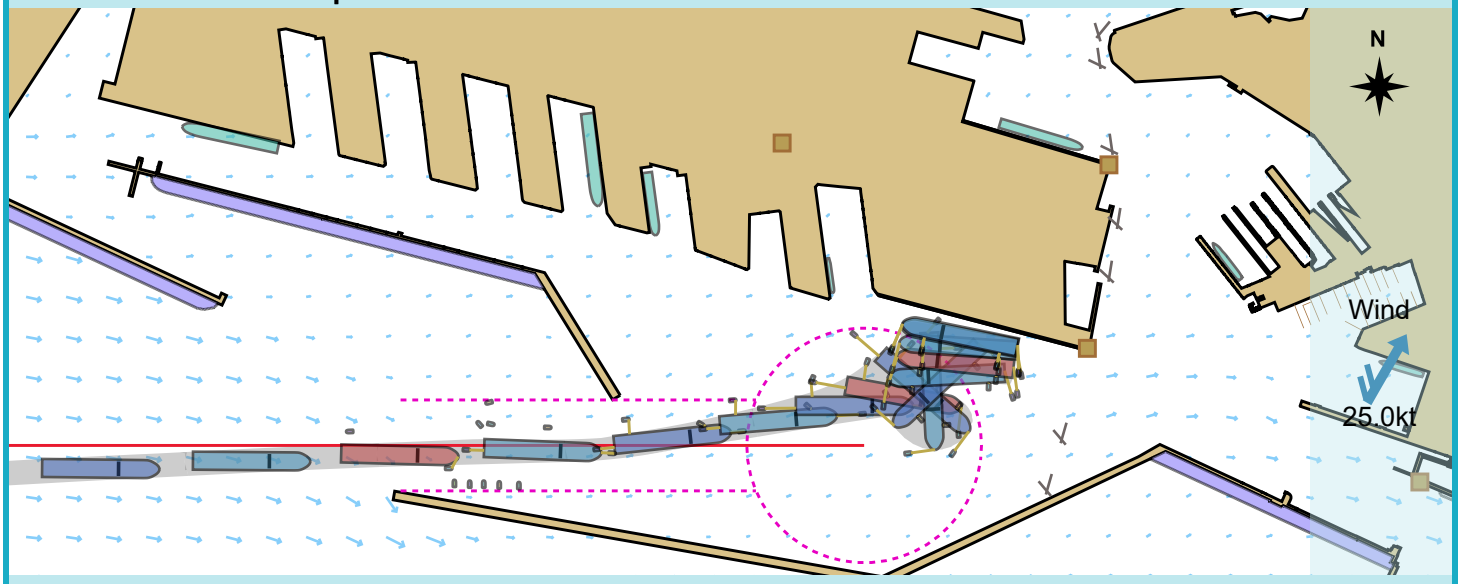

Underkeel Clearance and Speed over Ground
Bow UKC
Stern UKC
SOG
Underkeel clearance (m)
SOG (kt)
48.0
36.0
24.0
12.0
0.0
12.0
9.0
6.0
3.0
0.0
0min
5min
10min
15min
20min
25min
30min
35min
40min


Propeller RPM
RPM
Propeller RPM
50
40
30
20
10
0
-10
-20
-30
-40
-50
0min
5min
10min
15min
20min
25min
30min
35min
40min


Rudder angle
Rudder
Rudder angle (°)
40
30
20
10
0
-10
-20
-30
-40
0min
5min
10min
15min
20min
25min
30min
35min
40min

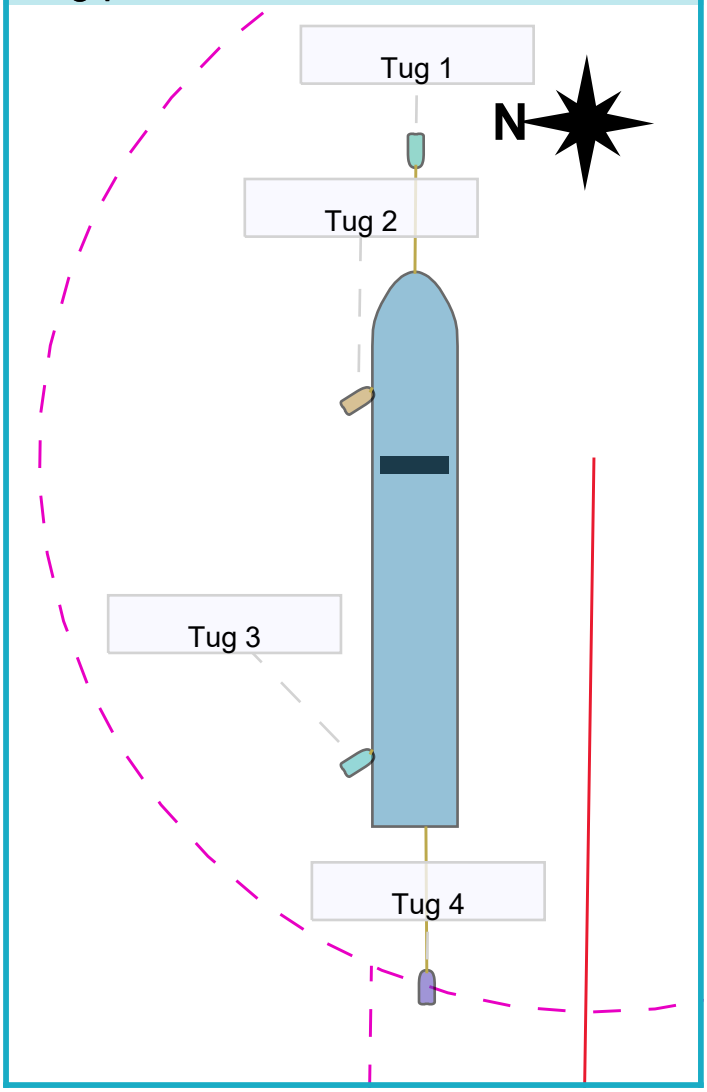

Thruster
Bow %
Bow thruster (%Power)
100
50
0
-50
-100
0min
5min
10min
15min
20min
25min
30min
35min
40min

Manoeuvre track plot

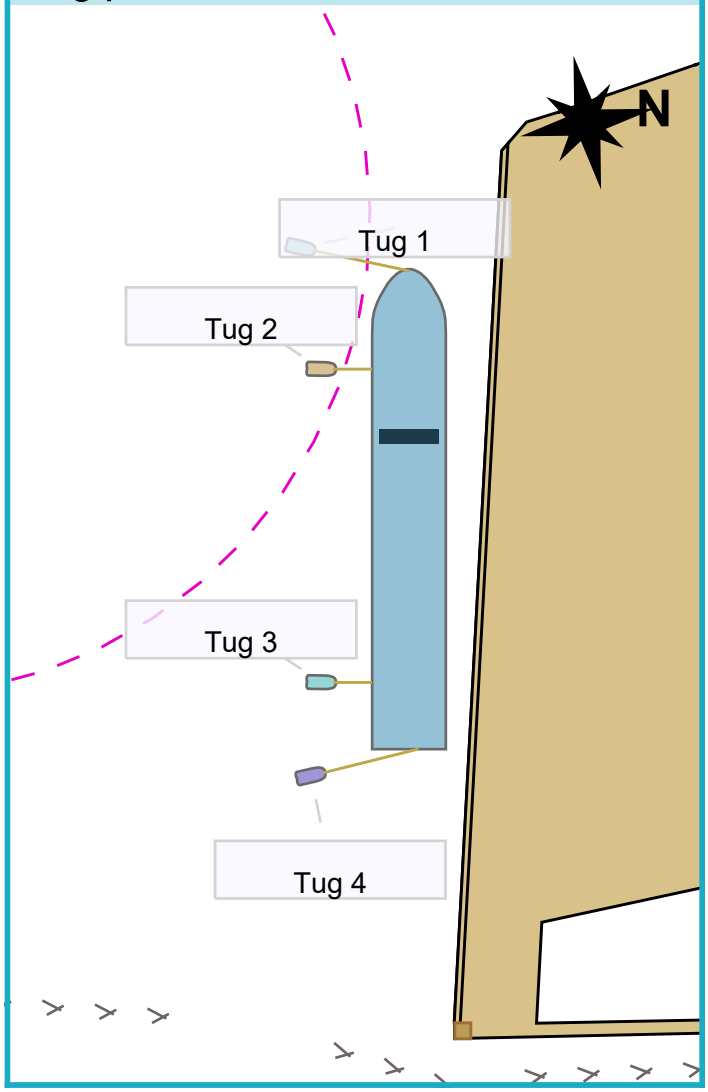


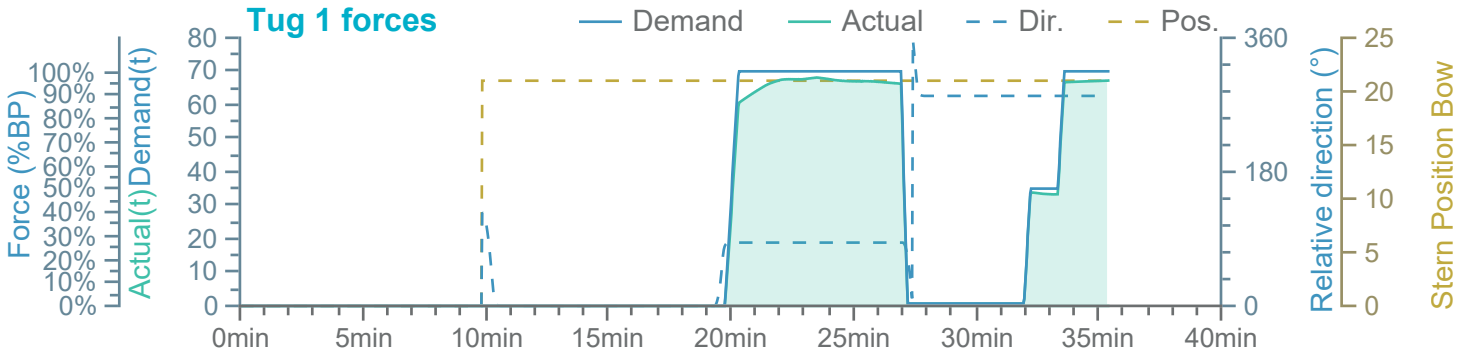
Ships plotted every 2 mins, highlight every 10 mins

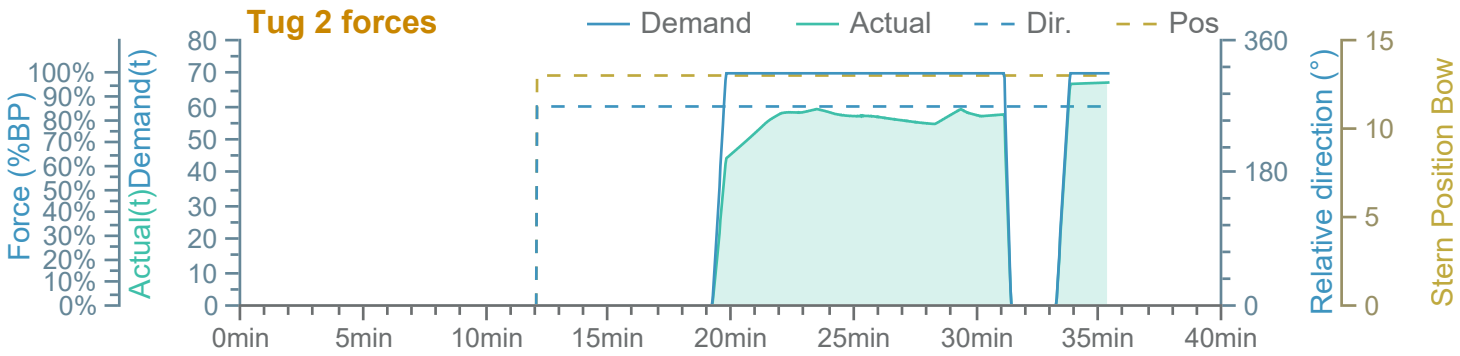
Tug position: Initial

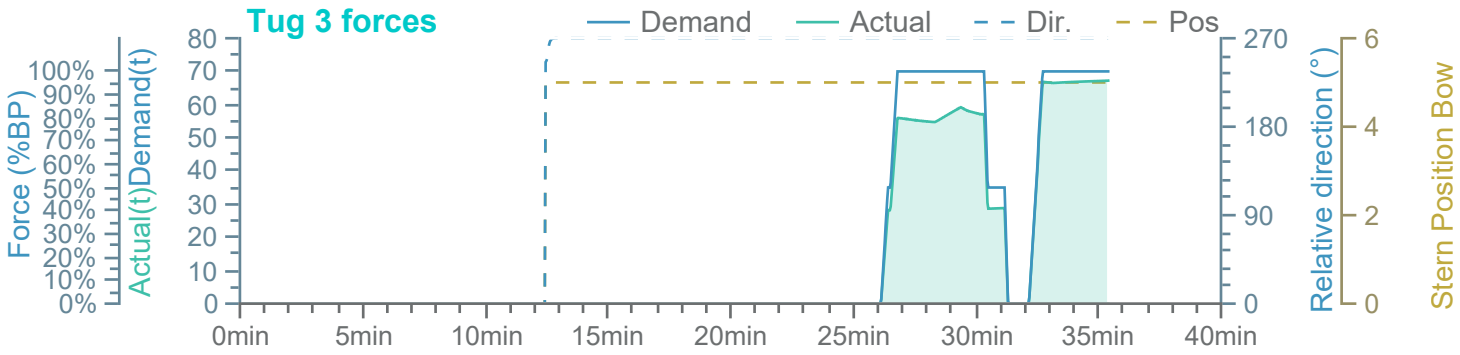


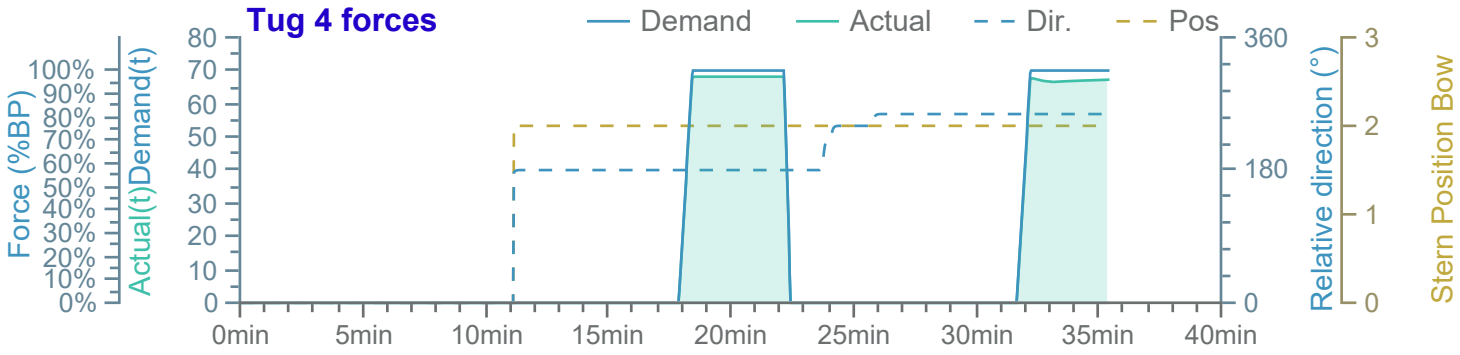
Tug position: Final



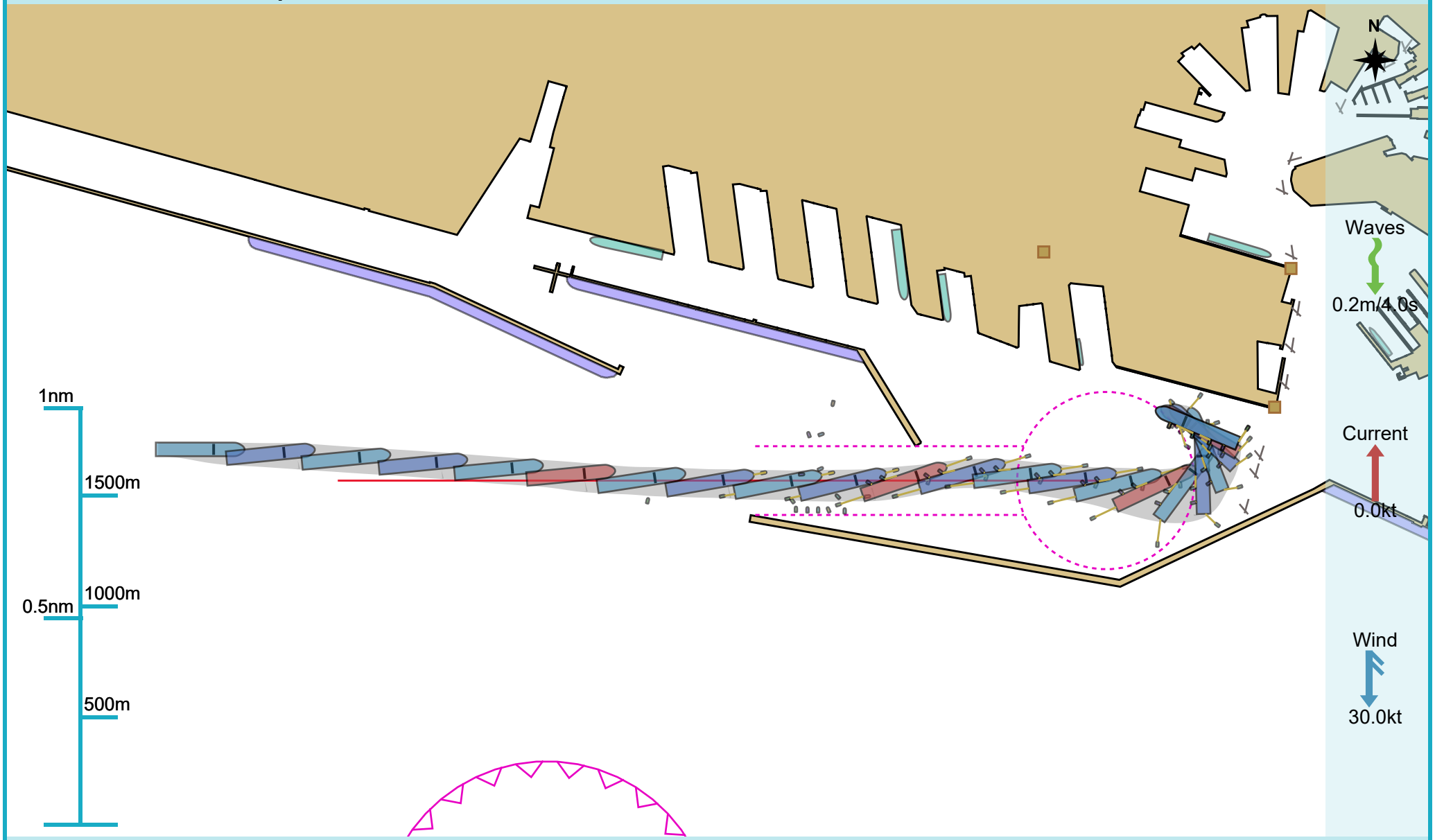

Tug 1 forces
Demand
Actual
Dir.
Pos.
Force (%BP)
Actual(t)Demand(t)
Relative direction (°)
Stern Position Bow
0min
5min
10min
15min
20min
25min
30min
35min
40min


Tug 2 forces
Demand
Actual
Dir.
Pos
Force (%BP)
Actual(t)Demand(t)
Relative direction (°)
Stern Position Bow
0min
5min
10min
15min
20min
25min
30min
35min
40min


Tug 3 forces
Demand
Actual
Dir.
Pos
Force (%BP)
Actual(t)Demand(t)
Relative direction (°)
Stern Position Bow
0min
5min
10min
15min
20min
25min
30min
35min
40min


Tug 4 forces
Demand
Actual
Dir.
Pos
Force (%BP)
Actual(t)Demand(t)
Relative direction (°)
Stern Position Bow
0min
5min
10min
15min
20min
25min
30min
35min
40min

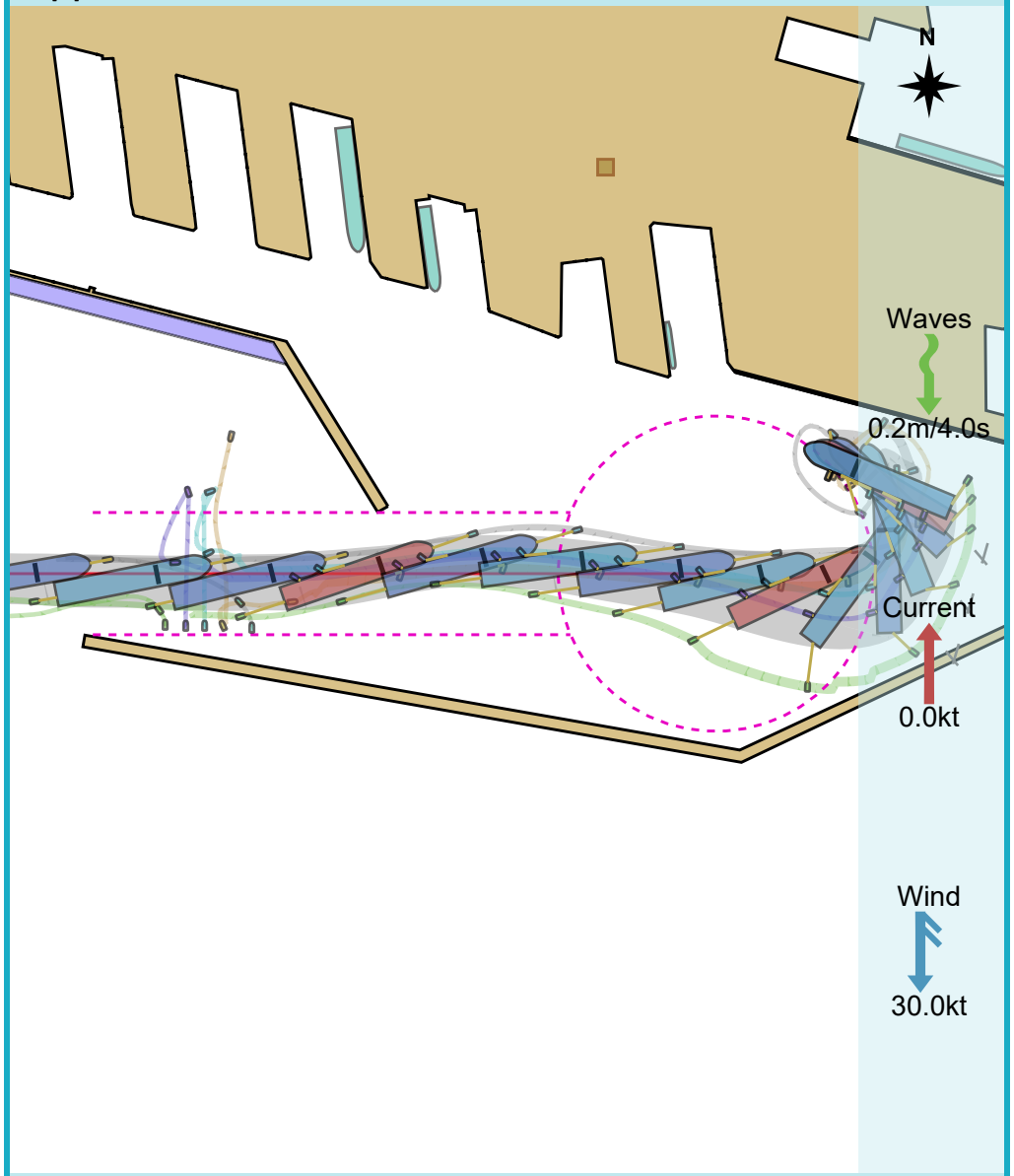
Manoeuvre track plot



0.00 kts

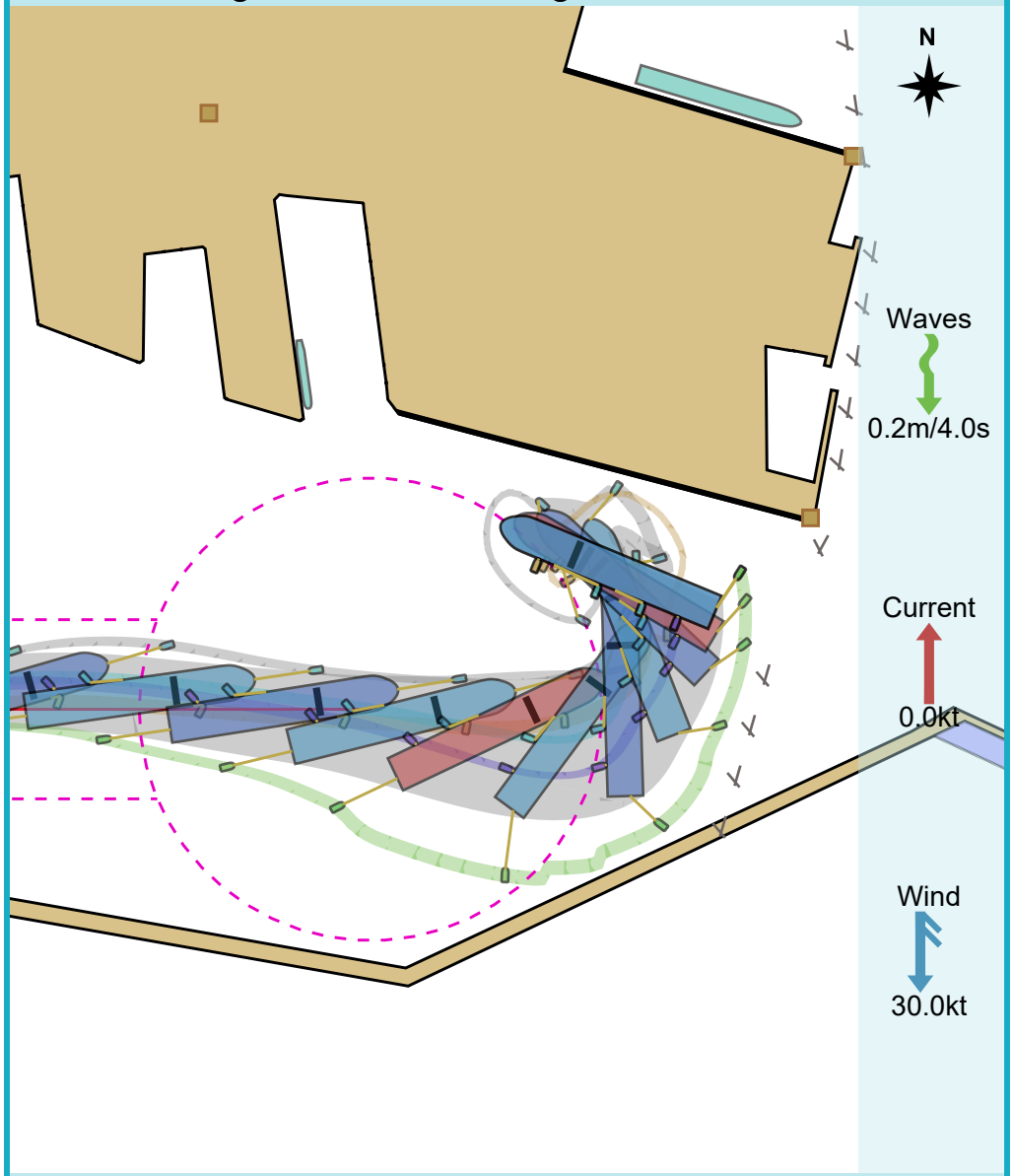
Ships plotted every 2 mins, highlight every 10 mins

Approach Channel

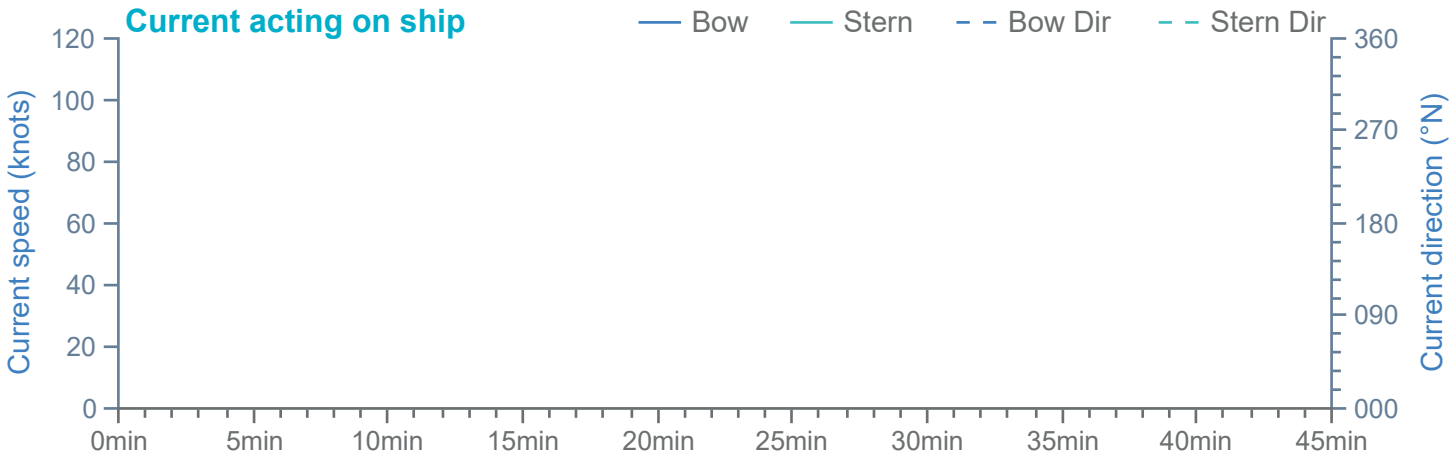


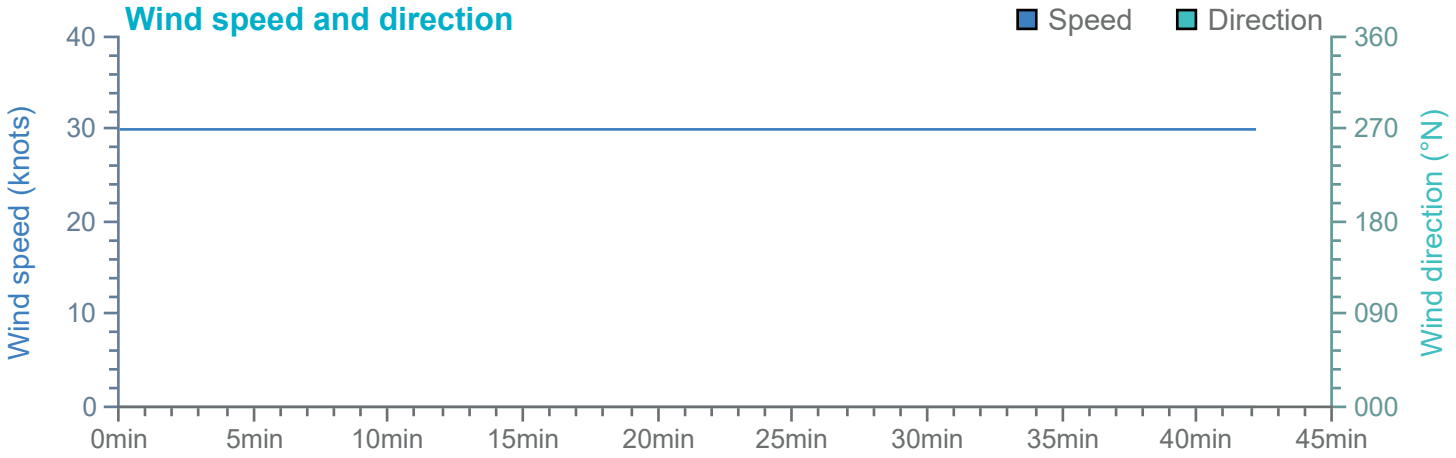
Ships plotted every 2 mins, highlight every 10 mins

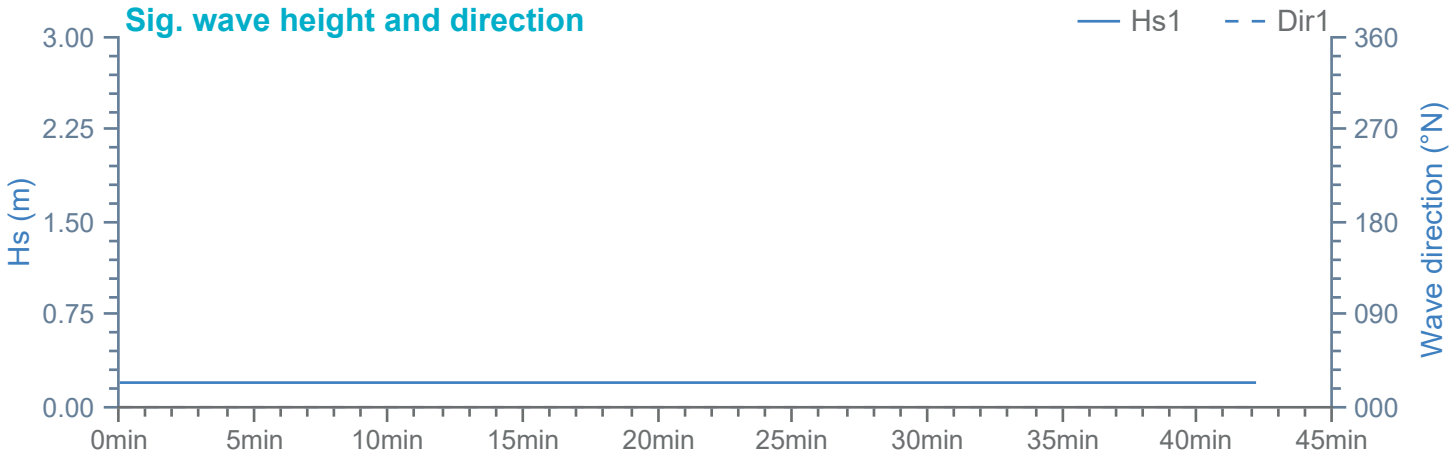
Manoeuvring area and berthing

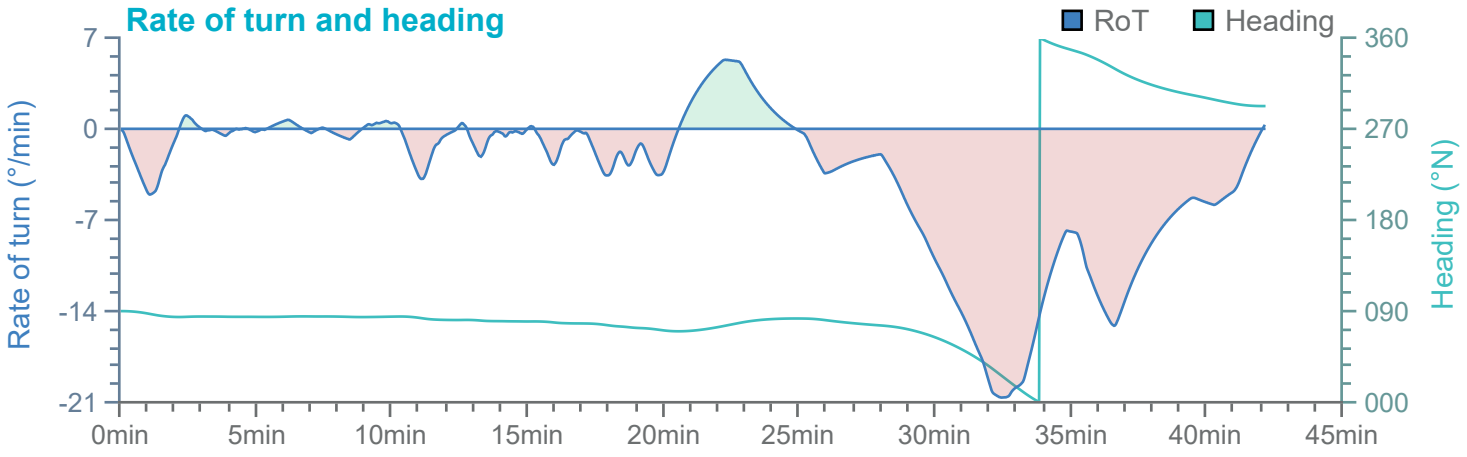


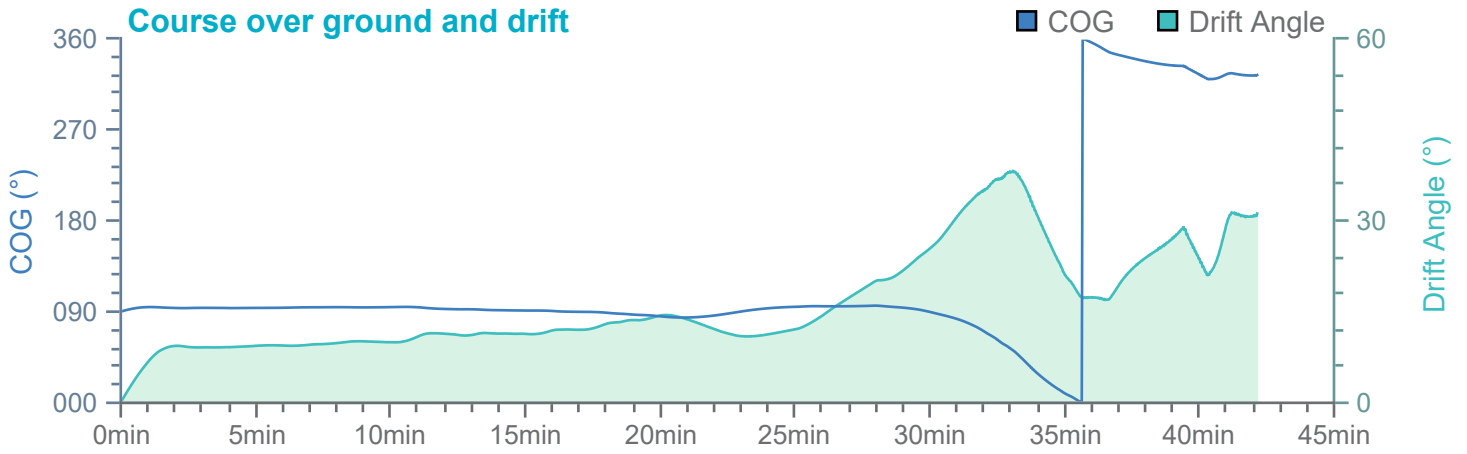
Ships plotted every 2 mins, highlight every 10 mins

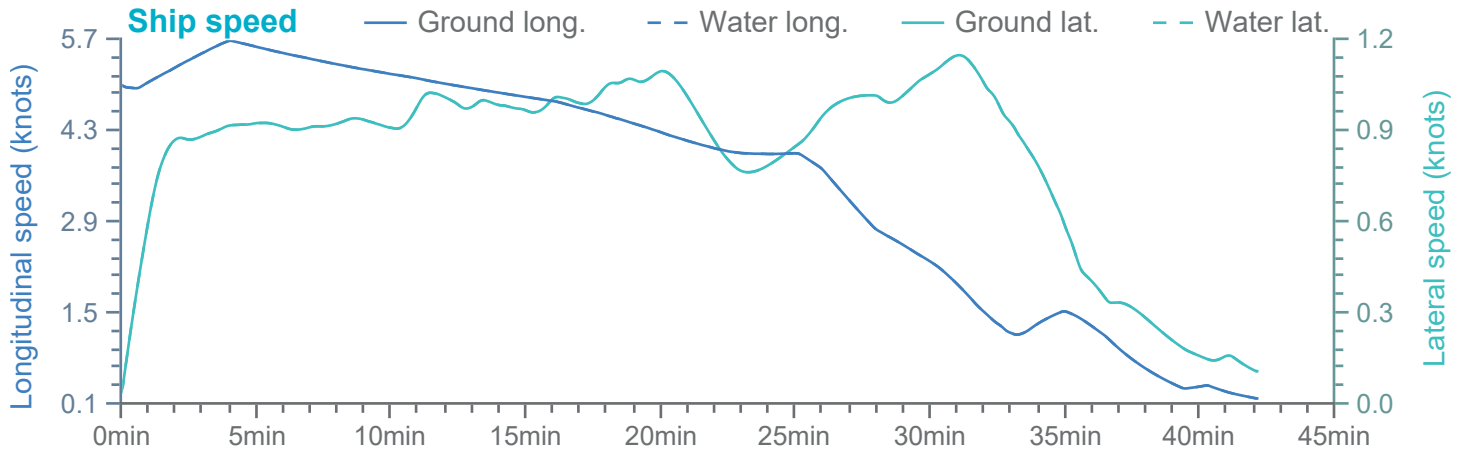

Current acting on ship
Bow
Stern
Bow Dir
Stern Dir
Current speed (knots)
Current direction (°N)
120
100
80
60
40
20
0
360
270
180
090
000
0min
5min
10min
15min
20min
25min
30min
35min
40min
45min

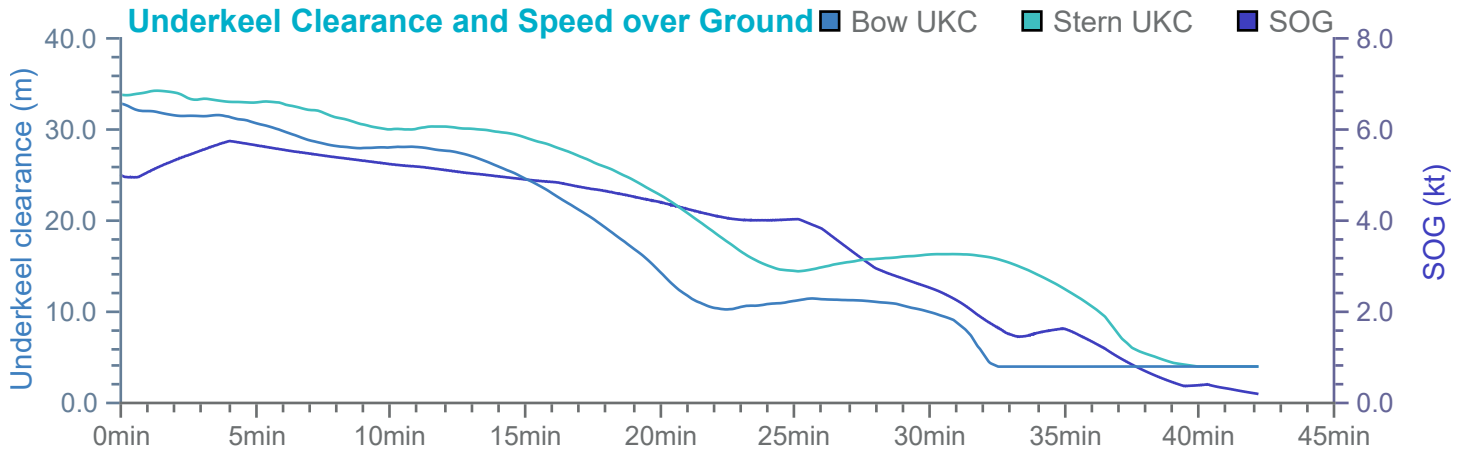

Wind speed and direction
Speed
Direction
Wind speed (knots)
Wind direction (°N)
40
30
20
10
0
360
270
180
090
000
0min
5min
10min
15min
20min
25min
30min
35min
40min
45min

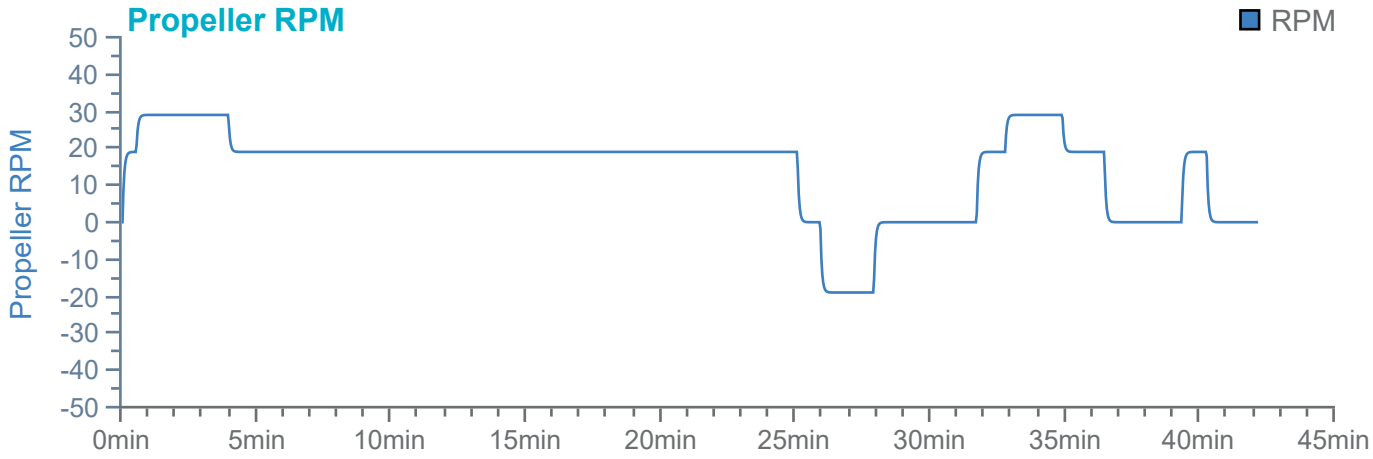

Sig. wave height and direction
Hs1
Dir1
Hs (m)
Wave direction (°N)
3.00
2.25
1.50
0.75
0.00
360
270
180
090
000
0min
5min
10min
15min
20min
25min
30min
35min
40min
45min

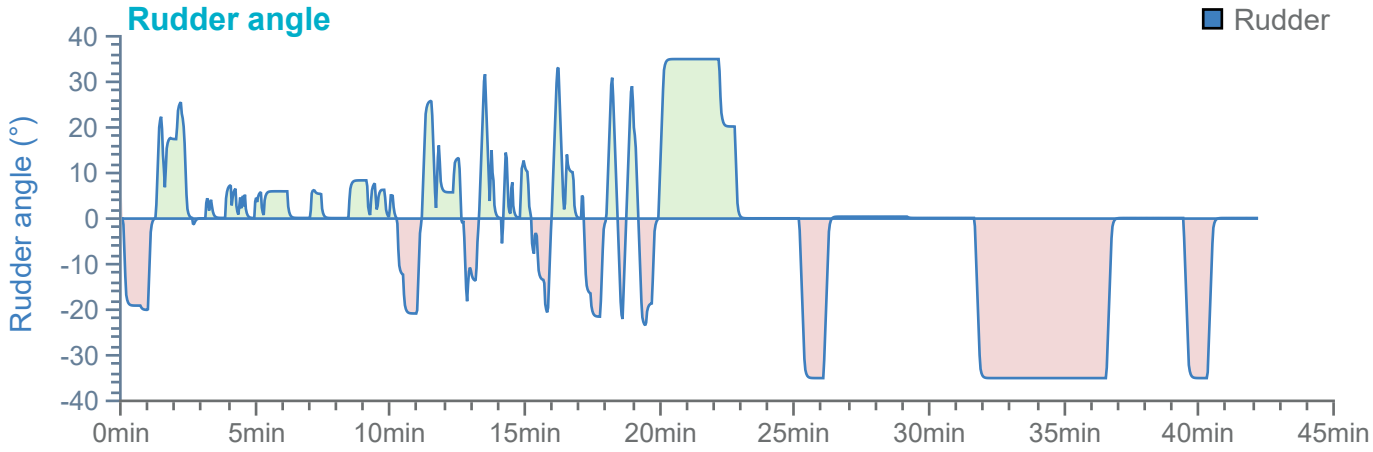

Rate of turn and heading
RoT
Heading
Rate of turn (°/min)
Heading (°N)
7
0
-7
-14
-21
360
270
180
090
000
0min
5min
10min
15min
20min
25min
30min
35min
40min
45min

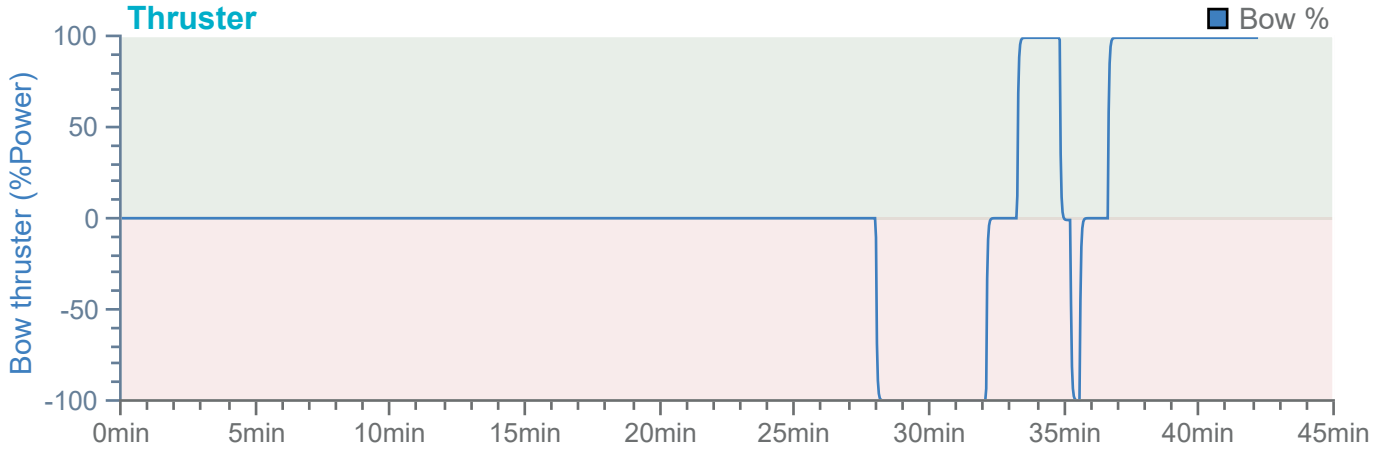

Course over ground and drift
COG
Drift Angle
COG (°)
Drift Angle (°)
360
270
180
090
000
60
30
0
0min
5min
10min
15min
20min
25min
30min
35min
40min
45min


Ship speed
Ground long.
Water long.
Ground lat.
Water lat.
Longitudinal speed (knots)
Lateral speed (knots)
5.7
4.3
2.9
1.5
0.1
1.2
0.9
0.6
0.3
0.0
0min
5min
10min
15min
20min
25min
30min
35min
40min
45min

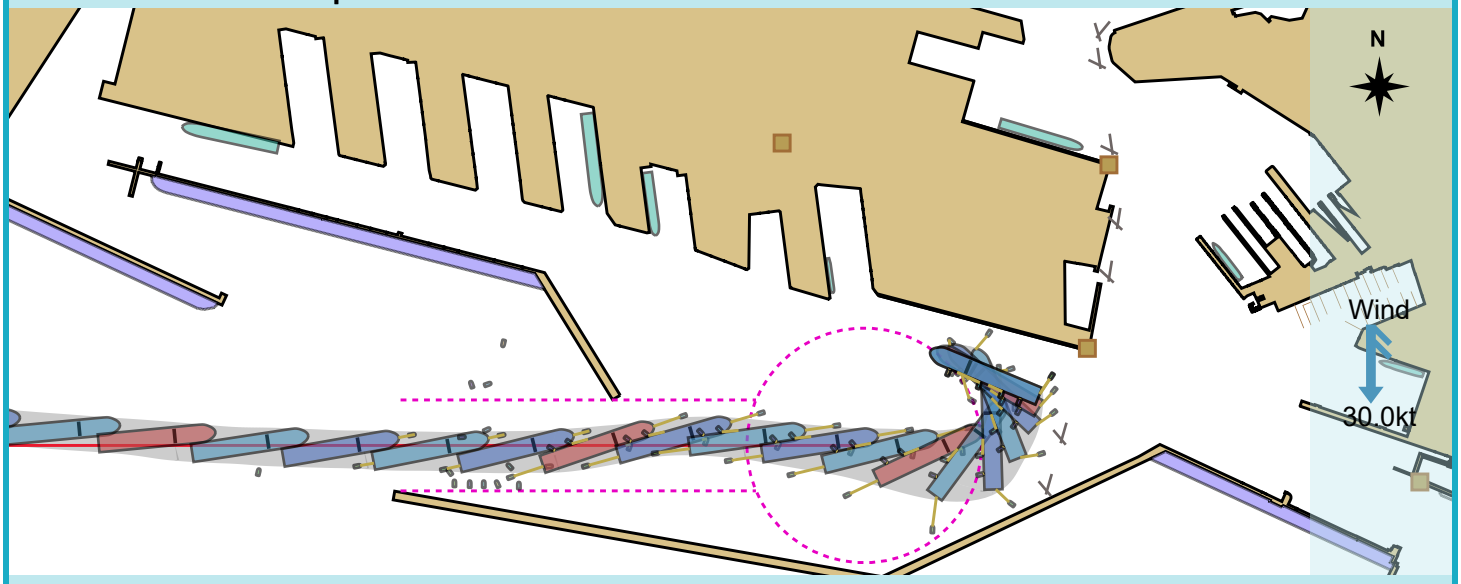

Underkeel Clearance and Speed over Ground
Bow UKC
Stern UKC
SOG
Underkeel clearance (m)
SOG (kt)
40.0
30.0
20.0
10.0
0.0
8.0
6.0
4.0
2.0
0.0
0min
5min
10min
15min
20min
25min
30min
35min
40min
45min


Propeller RPM
RPM
Propeller RPM
50
40
30
20
10
0
-10
-20
-30
-40
-50
0min
5min
10min
15min
20min
25min
30min
35min
40min
45min


Rudder angle
Rudder
Rudder angle (°)
40
30
20
10
0
-10
-20
-30
-40
0min
5min
10min
15min
20min
25min
30min
35min
40min
45min

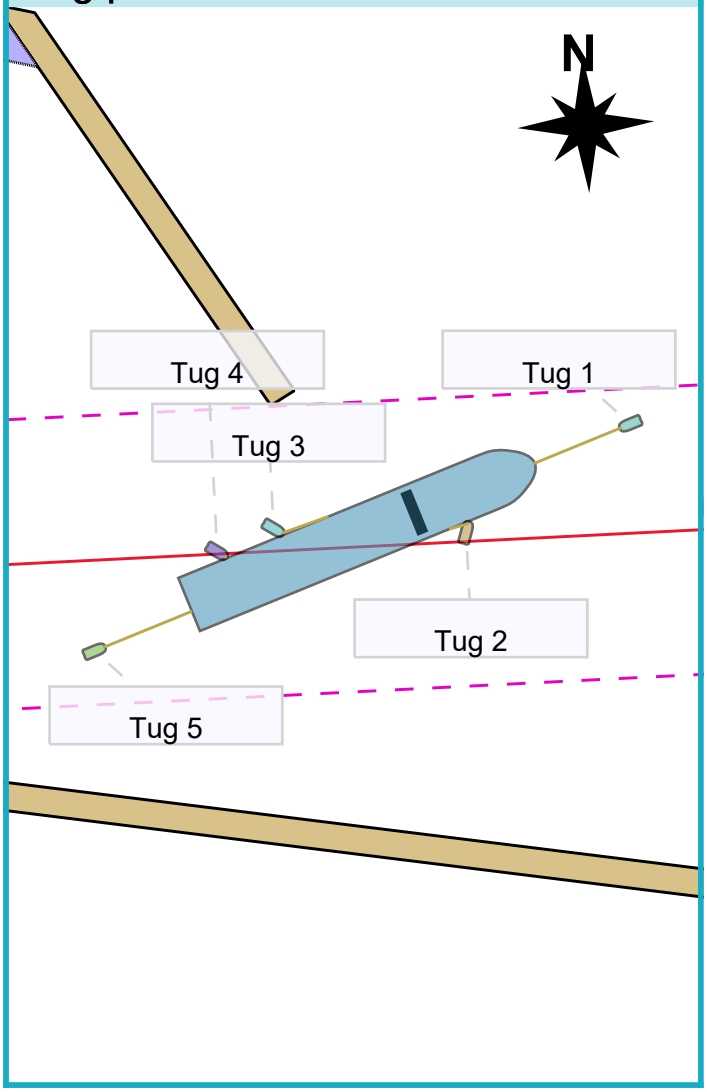

Thruster
Bow %
Bow thruster (%Power)
100
50
0
-50
-100
0min
5min
10min
15min
20min
25min
30min
35min
40min
45min

Manoeuvre track plot

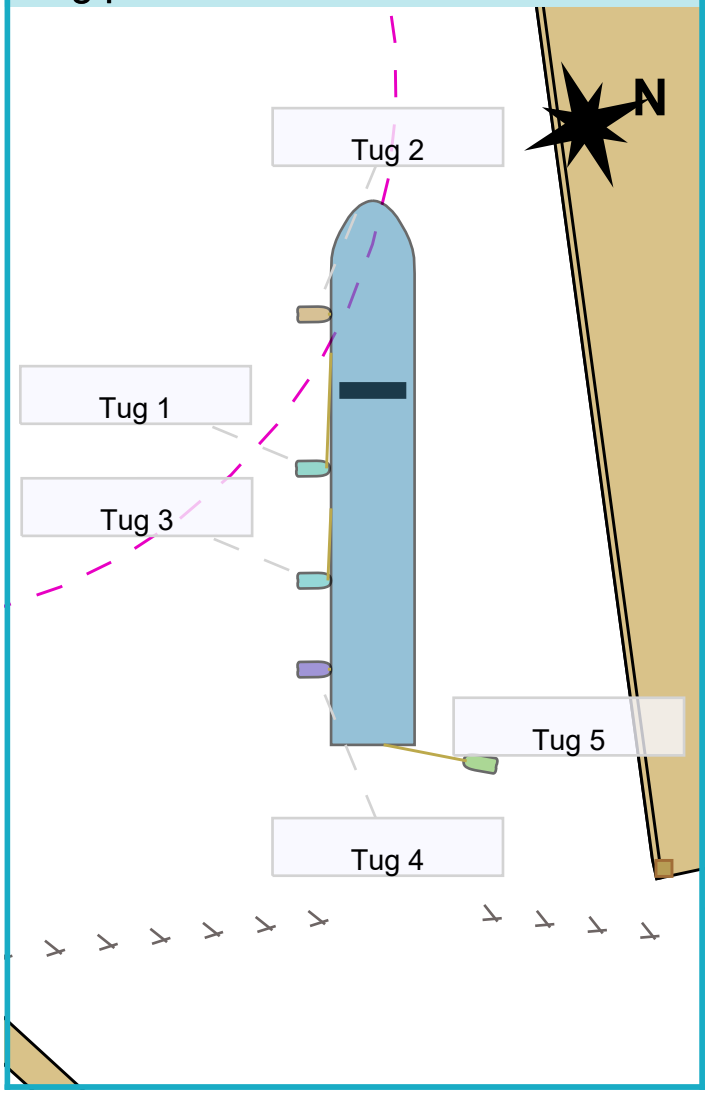


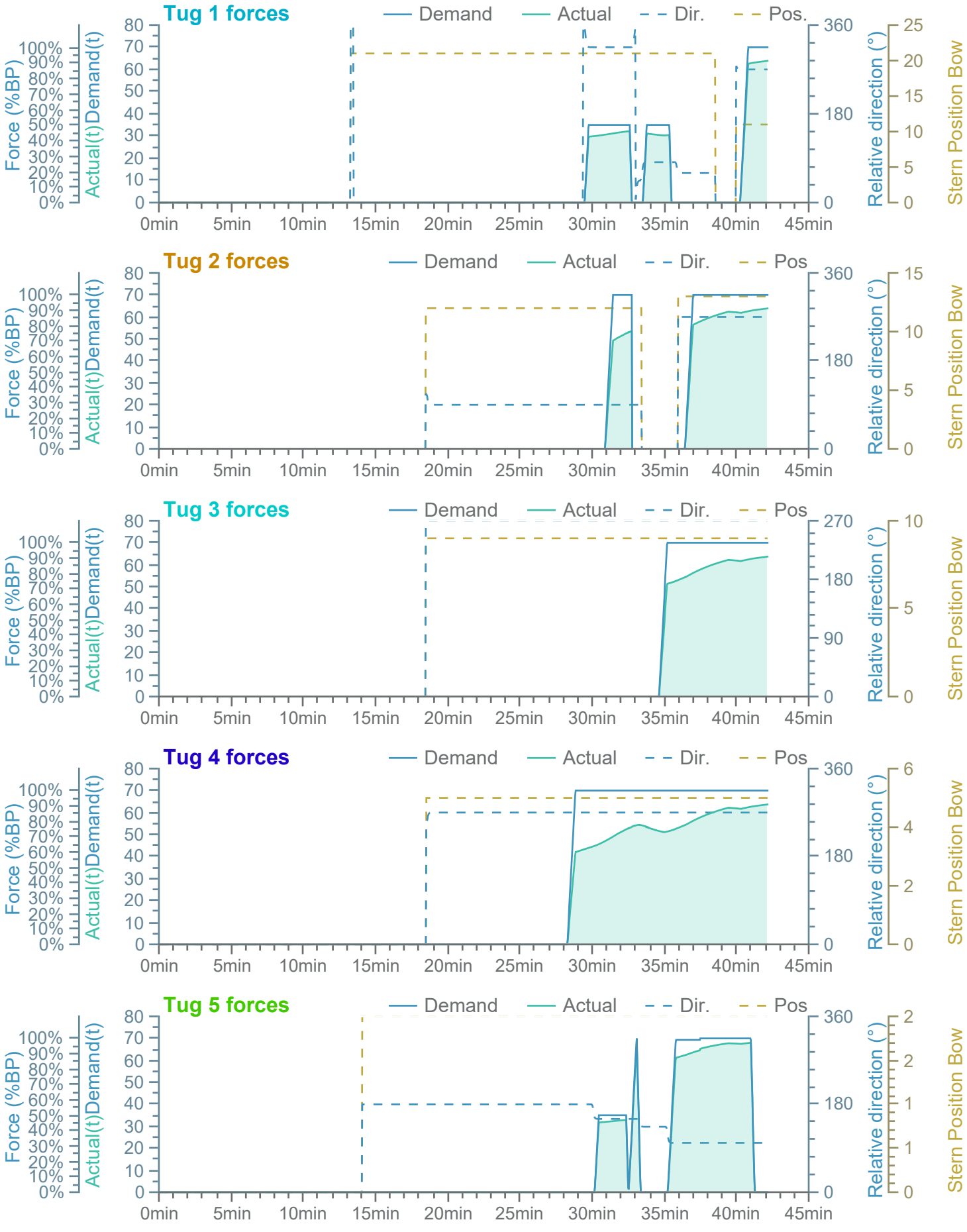
Ships plotted every 2 mins, highlight every 10 mins

Tug position: Initial

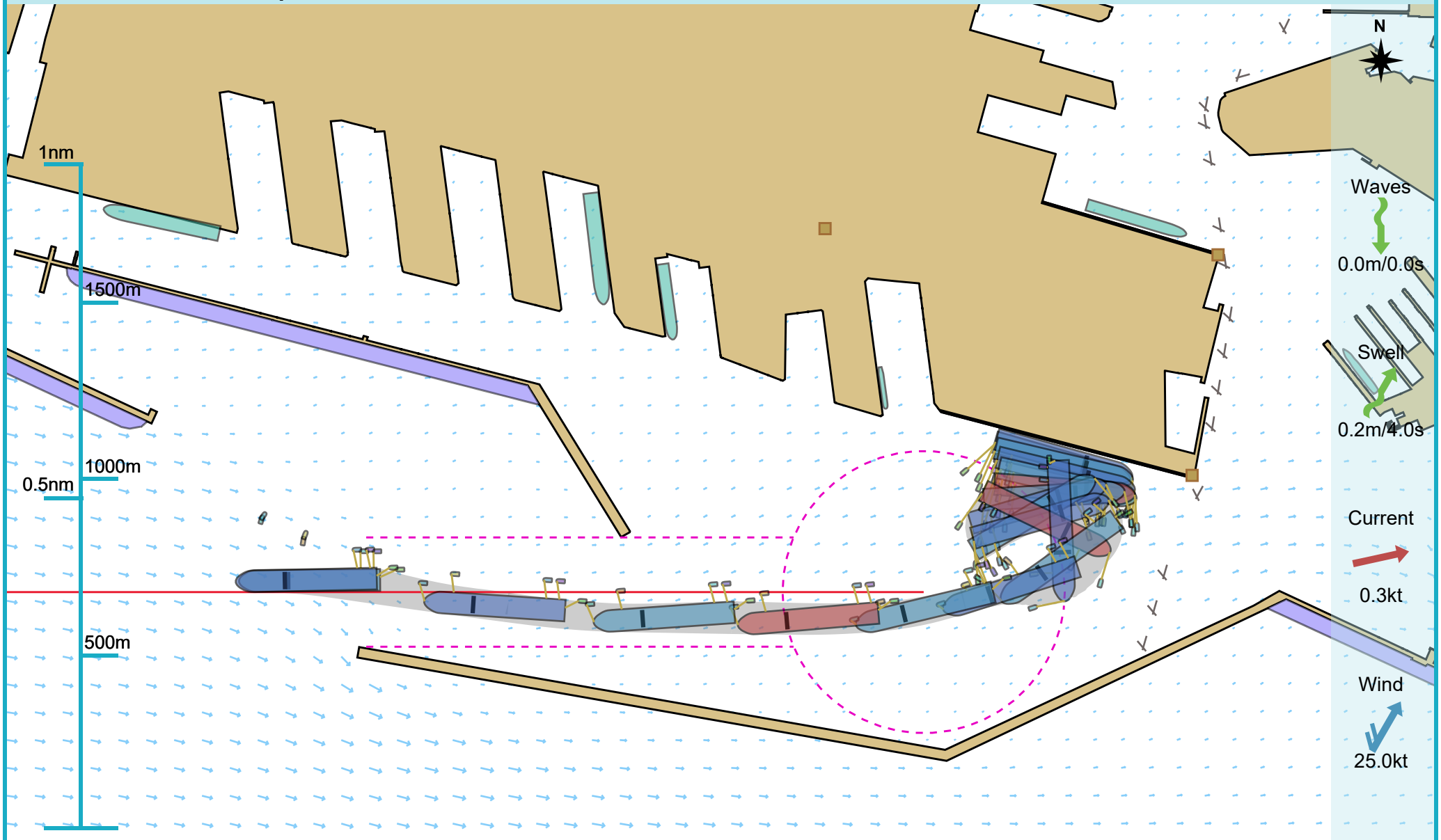


Tug position: Final




Tug 1 forces
Demand
Actual
Dir.
Pos.
Force (%BP)
Actual(t)Demand(t)
Relative direction (°)
Stern Position Bow
0min
5min
10min
15min
20min
25min
30min
35min
40min
45min
Tug 2 forces
Demand
Actual
Dir.
Pos
Tug 3 forces
Demand
Actual
Dir.
Pos
Tug 4 forces
Demand
Actual
Dir.
Pos
Tug 5 forces
Demand
Actual
Dir.
Pos

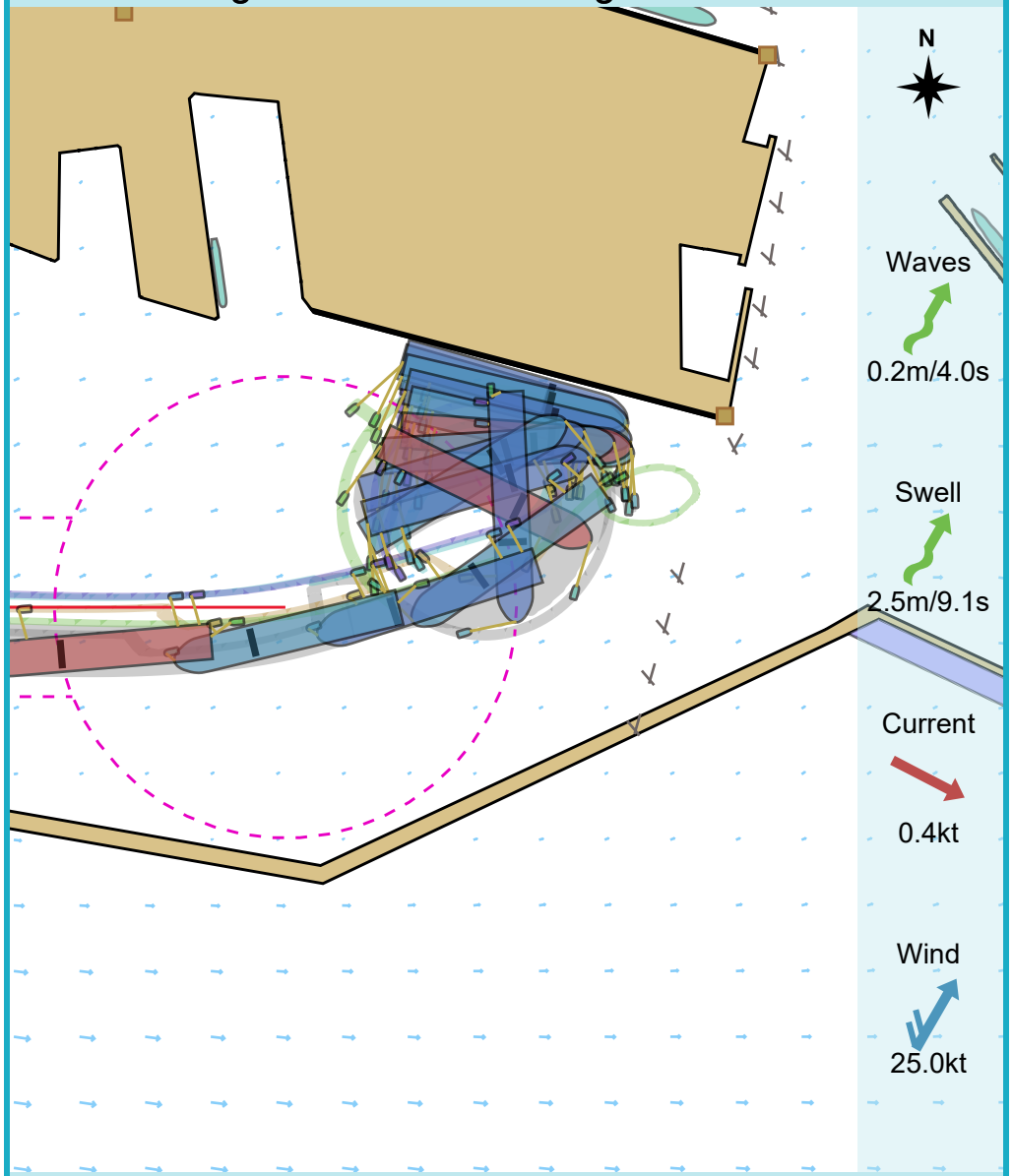
Manoeuvre track plot



0.76 kts

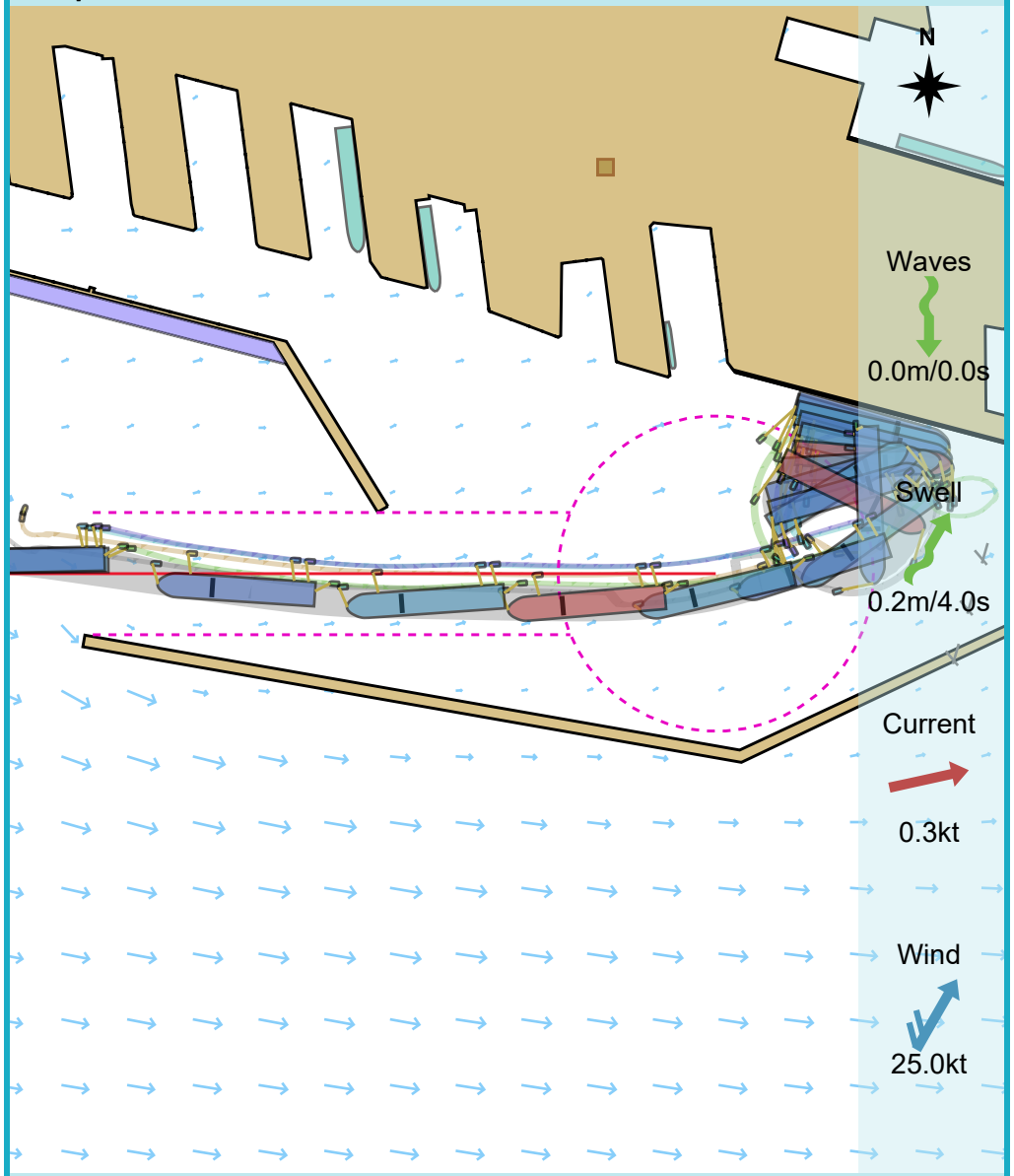
Ships plotted every 2 mins, highlight every 10 mins

Manoeuvring area and unberthing

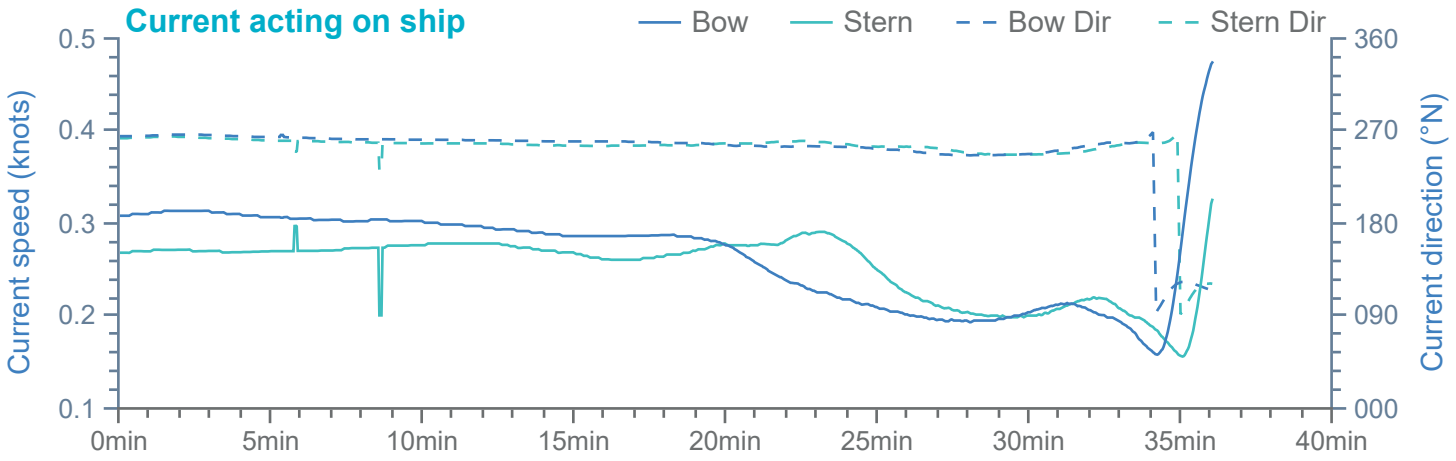


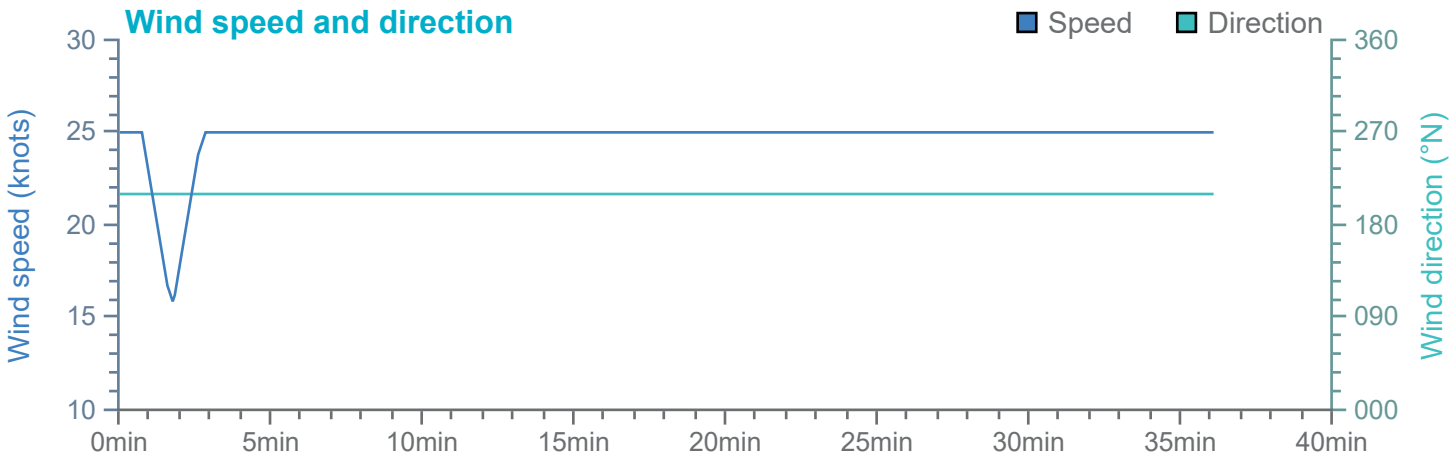
Ships plotted every 2 mins, highlight every 10 mins

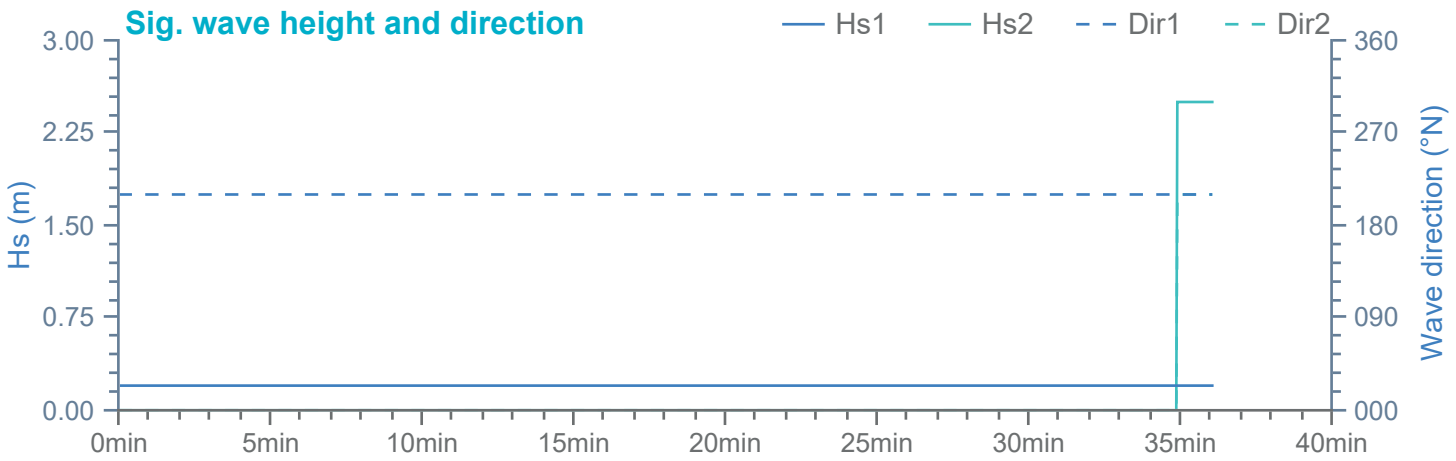
Departure Channel

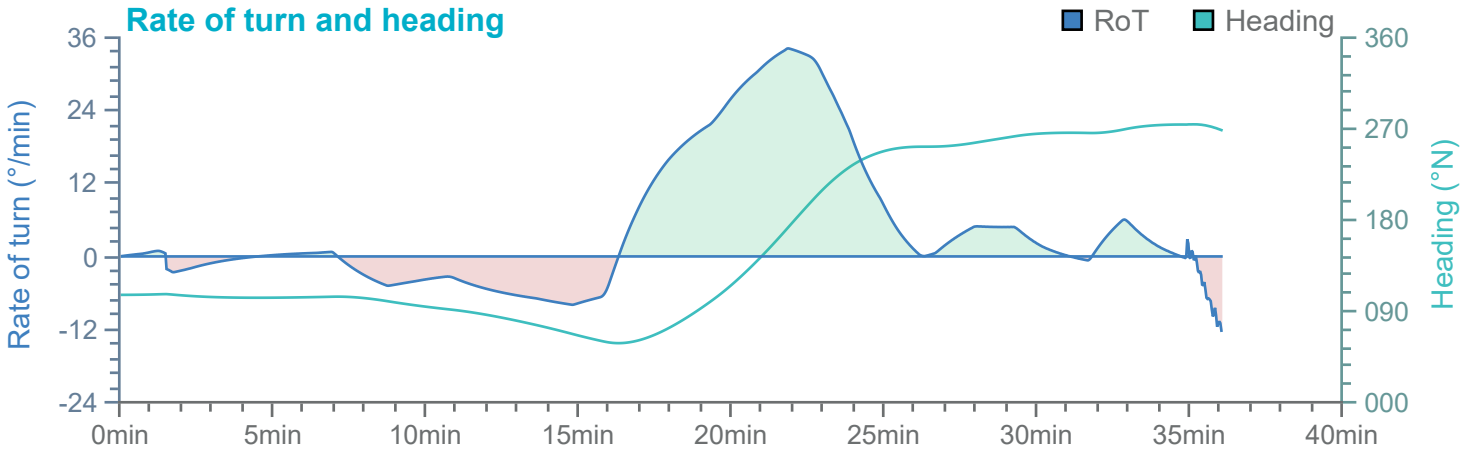


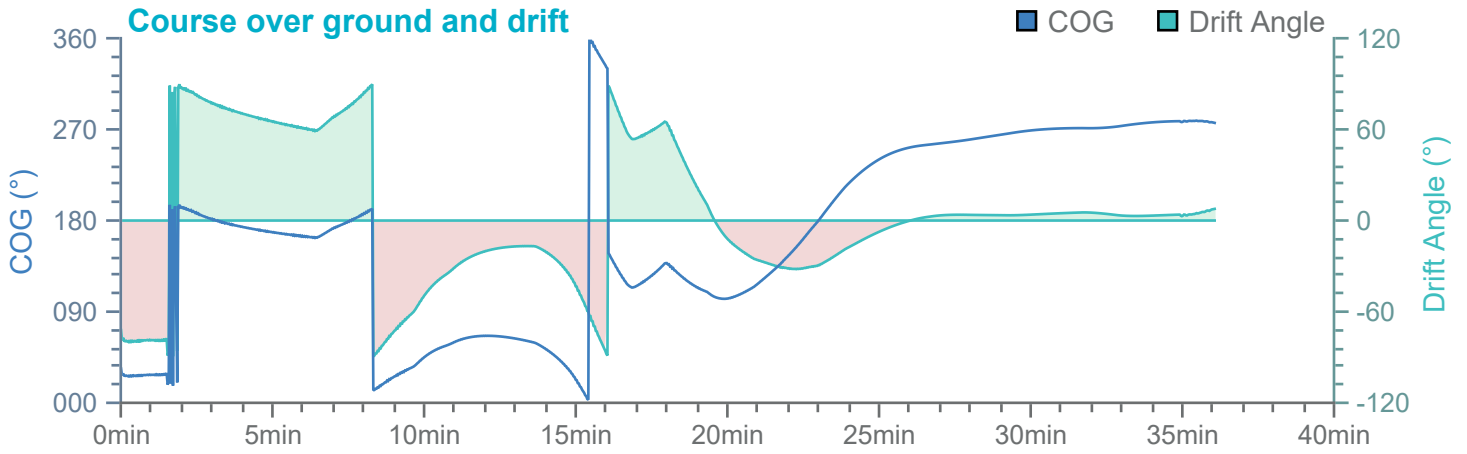
Ships plotted every 2 mins, highlight every 10 mins

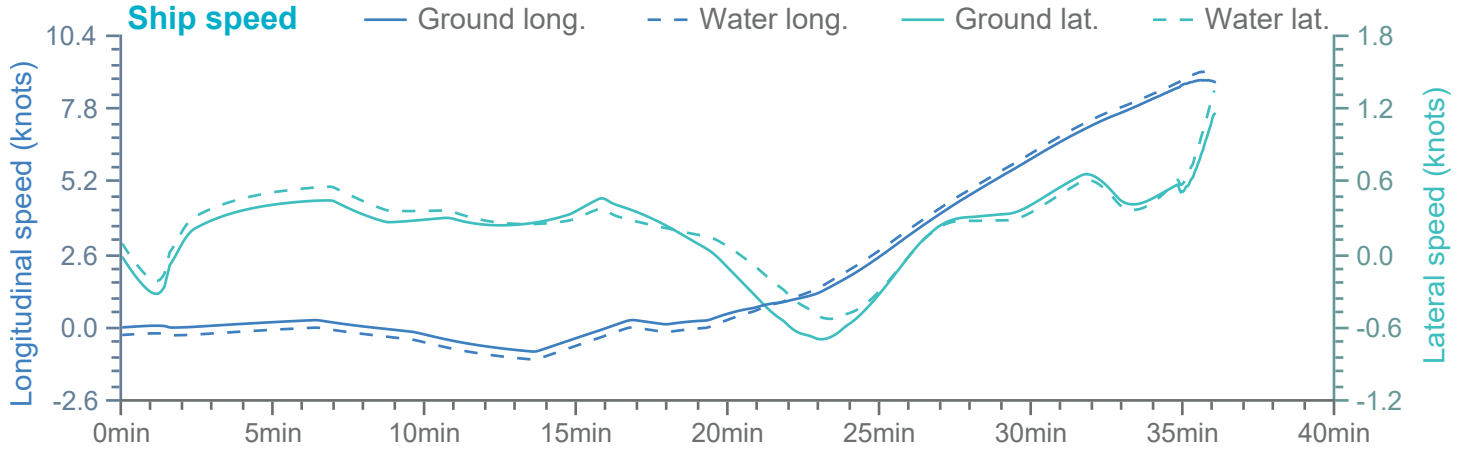

Current acting on ship
Bow
Stern
Bow Dir
Stern Dir
Current speed (knots)
0.5
0.4
0.3
0.2
0.1
Current direction (°N)
360
270
180
090
000
0min
5min
10min
15min
20min
25min
30min
35min
40min

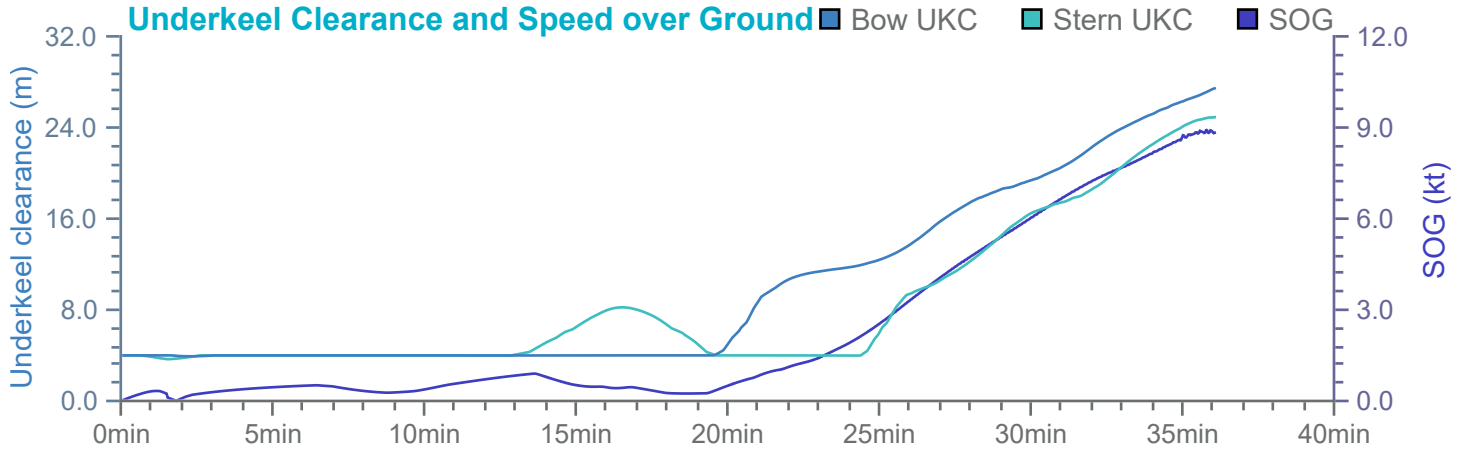

Wind speed and direction
Speed
Direction
Wind speed (knots)
30
25
20
15
10
Wind direction (°N)
360
270
180
090
000
0min
5min
10min
15min
20min
25min
30min
35min
40min

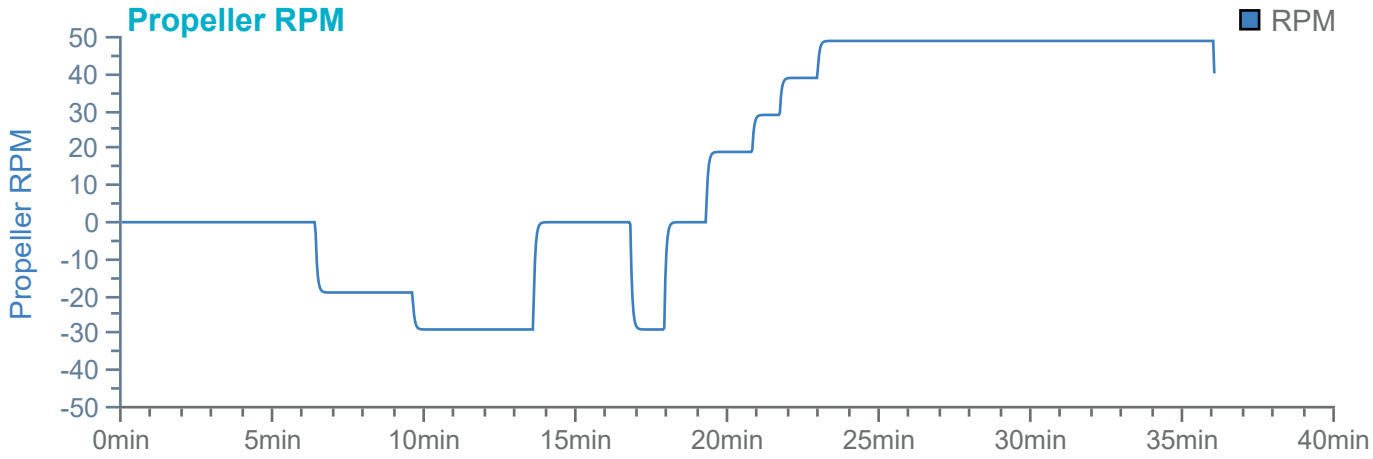

Sig. wave height and direction
Hs1
Hs2
Dir1
Dir2
Hs (m)
3.00
2.25
1.50
0.75
0.00
Wave direction (°N)
360
270
180
090
000
0min
5min
10min
15min
20min
25min
30min
35min
40min

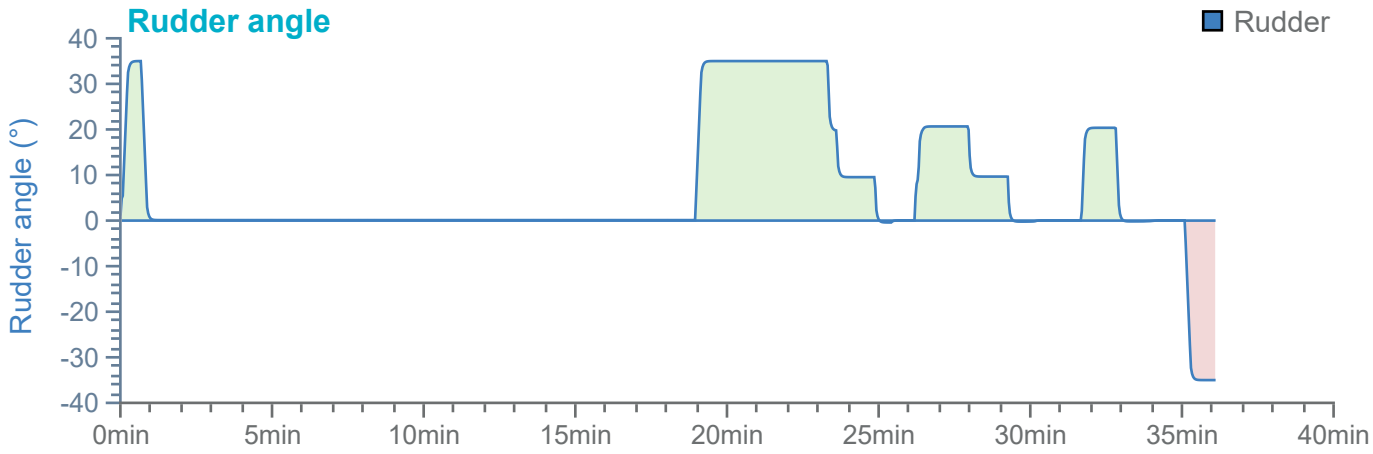

Rate of turn and heading
RoT
Heading
Rate of turn (°/min)
Heading (°N)
36
24
12
0
-12
-24
360
270
180
090
000
0min
5min
10min
15min
20min
25min
30min
35min
40min

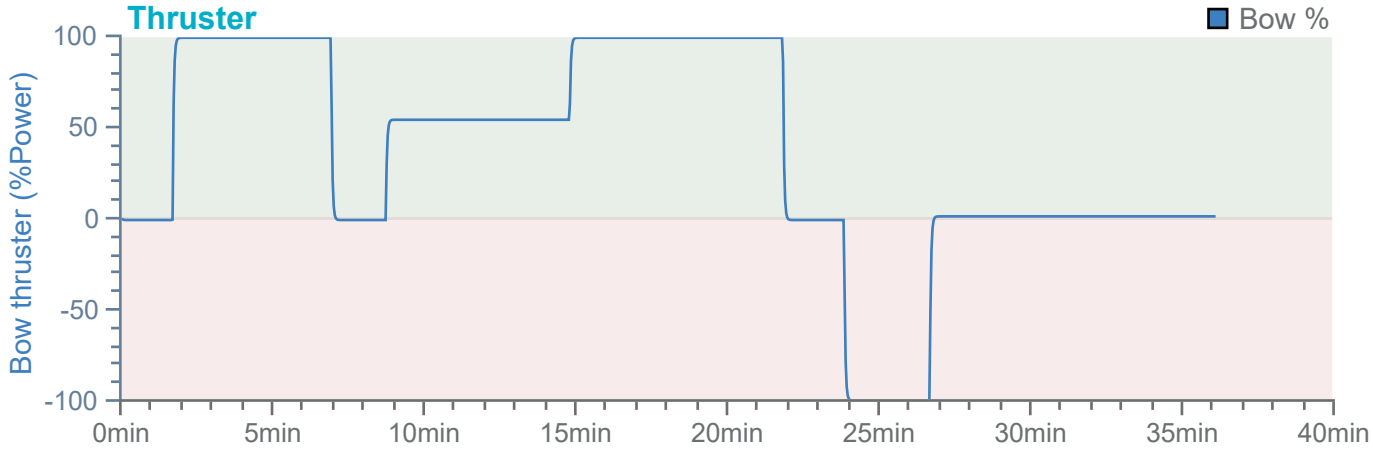

Course over ground and drift
COG
Drift Angle
COG (°)
Drift Angle (°)
360
270
180
090
000
120
60
0
-60
-120
0min
5min
10min
15min
20min
25min
30min
35min
40min


Ship speed
Ground long.
Water long.
Ground lat.
Water lat.
Longitudinal speed (knots)
Lateral speed (knots)
10.4
7.8
5.2
2.6
0.0
-2.6
1.8
1.2
0.6
0.0
-0.6
-1.2
0min
5min
10min
15min
20min
25min
30min
35min
40min

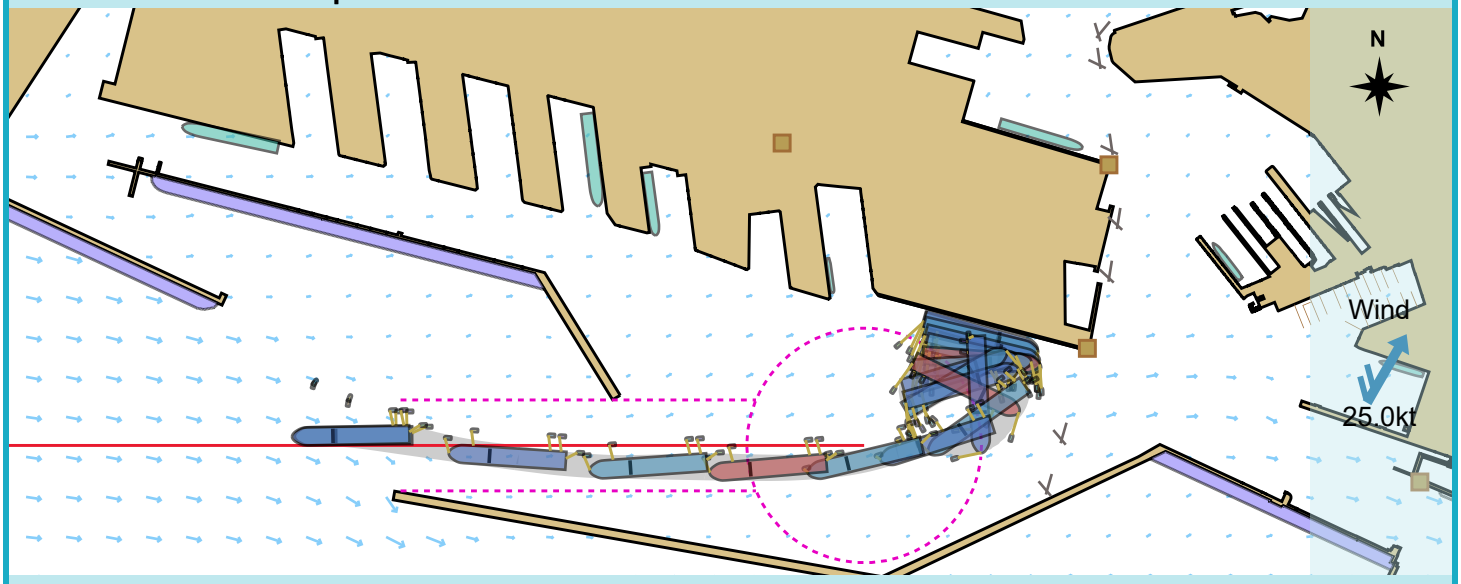

Underkeel Clearance and Speed over Ground
Bow UKC
Stern UKC
SOG
Underkeel clearance (m)
SOG (kt)
32.0
24.0
16.0
8.0
0.0
12.0
9.0
6.0
3.0
0.0
0min
5min
10min
15min
20min
25min
30min
35min
40min


Propeller RPM
RPM
Propeller RPM
50
40
30
20
10
0
-10
-20
-30
-40
-50
0min
5min
10min
15min
20min
25min
30min
35min
40min


Rudder angle
Rudder
Rudder angle (°)
40
30
20
10
0
-10
-20
-30
-40
0min
5min
10min
15min
20min
25min
30min
35min
40min

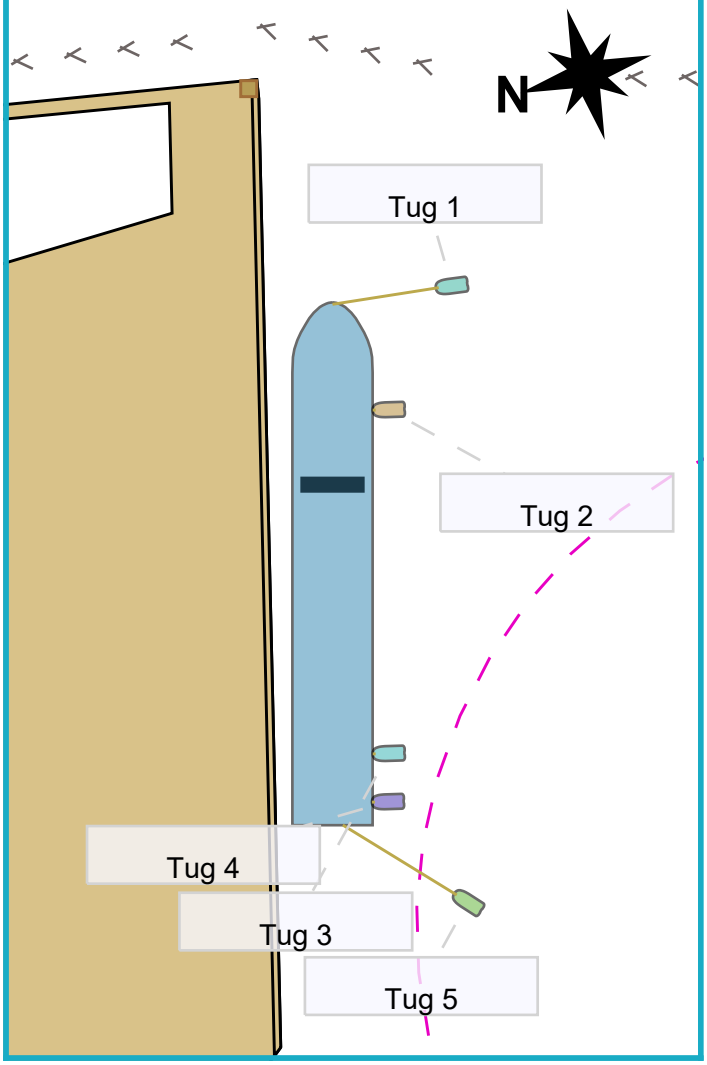

Thruster
Bow %
Bow thruster (%Power)
100
50
0
-50
-100
0min
5min
10min
15min
20min
25min
30min
35min
40min

Manoeuvre track plot

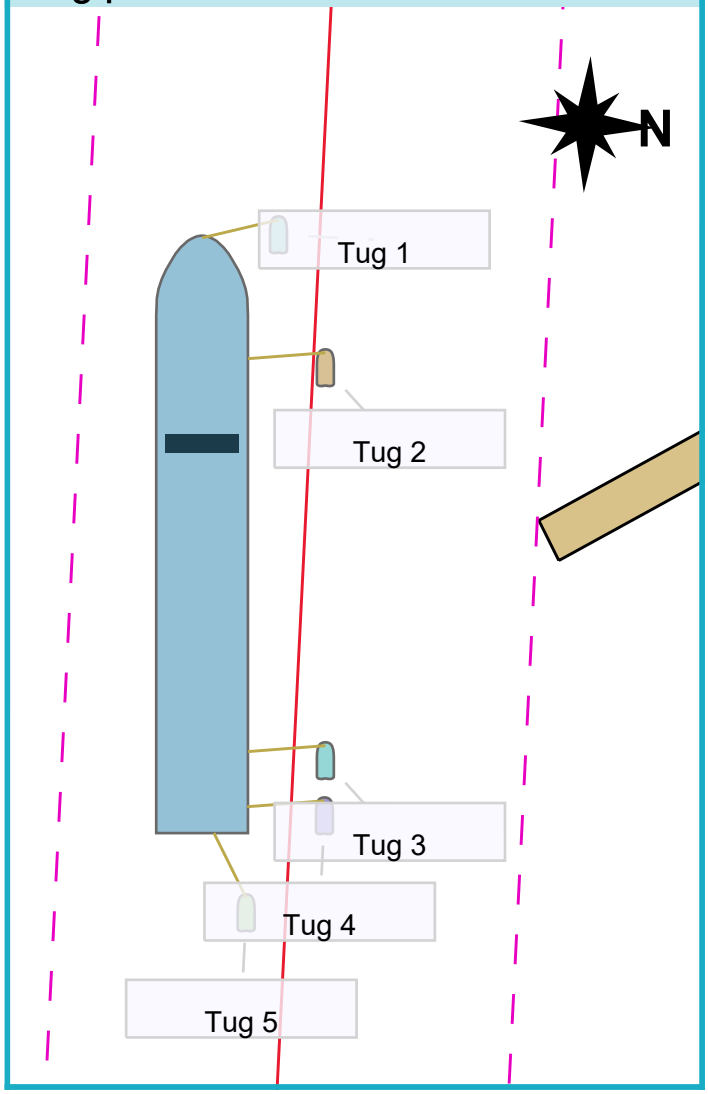


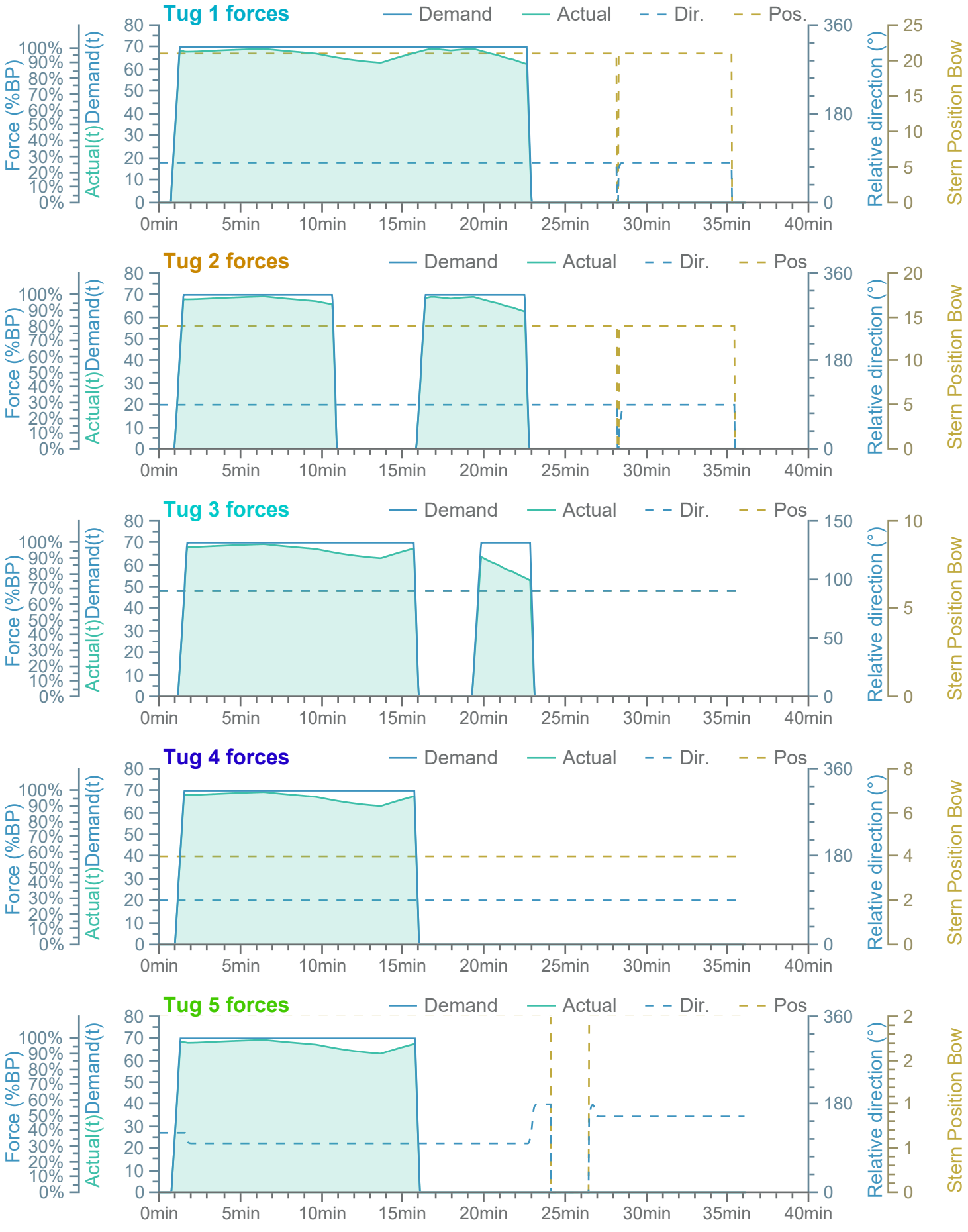
Ships plotted every 2 mins, highlight every 10 mins

Tug position: Initial

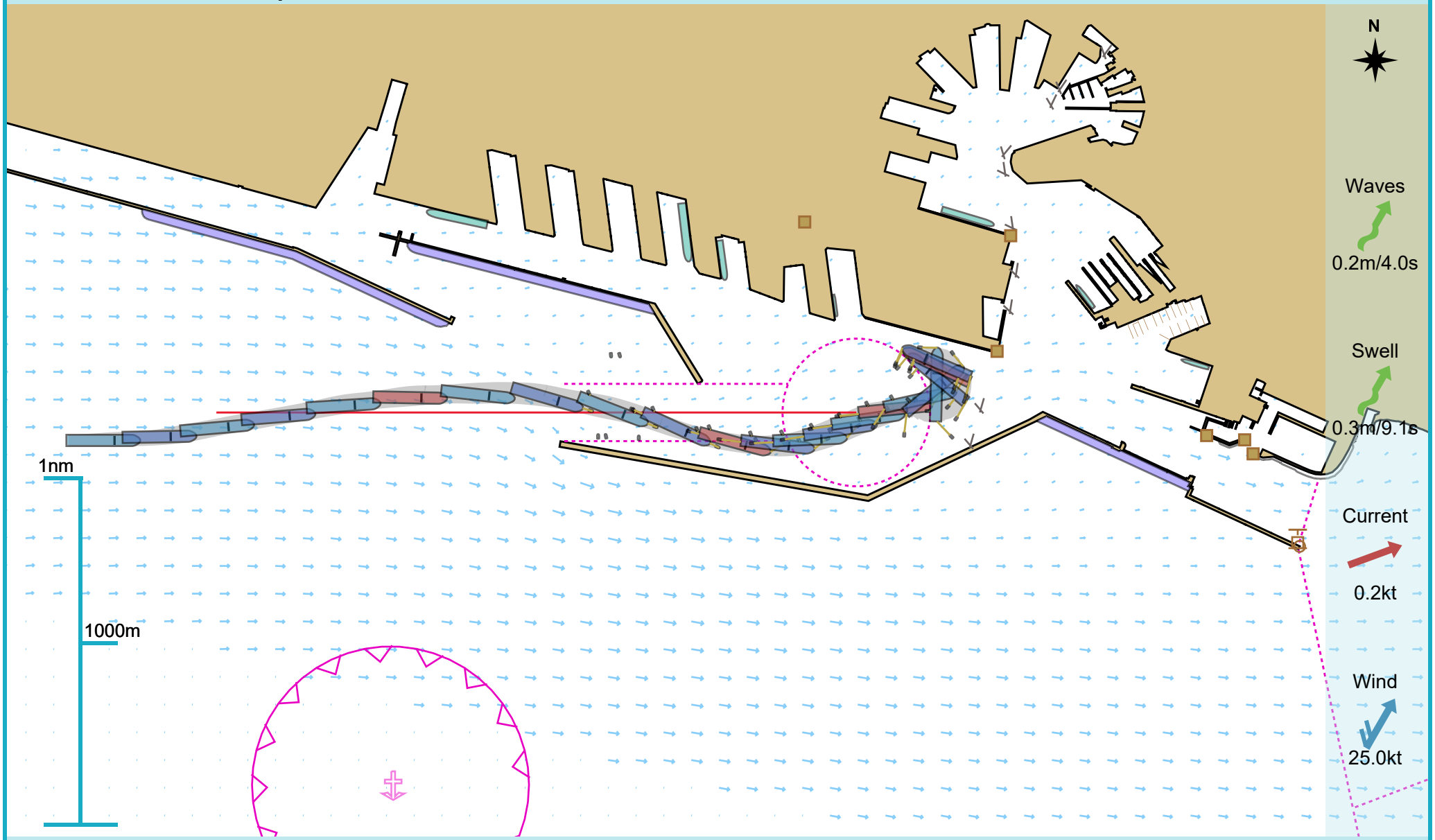


Tug position: Final

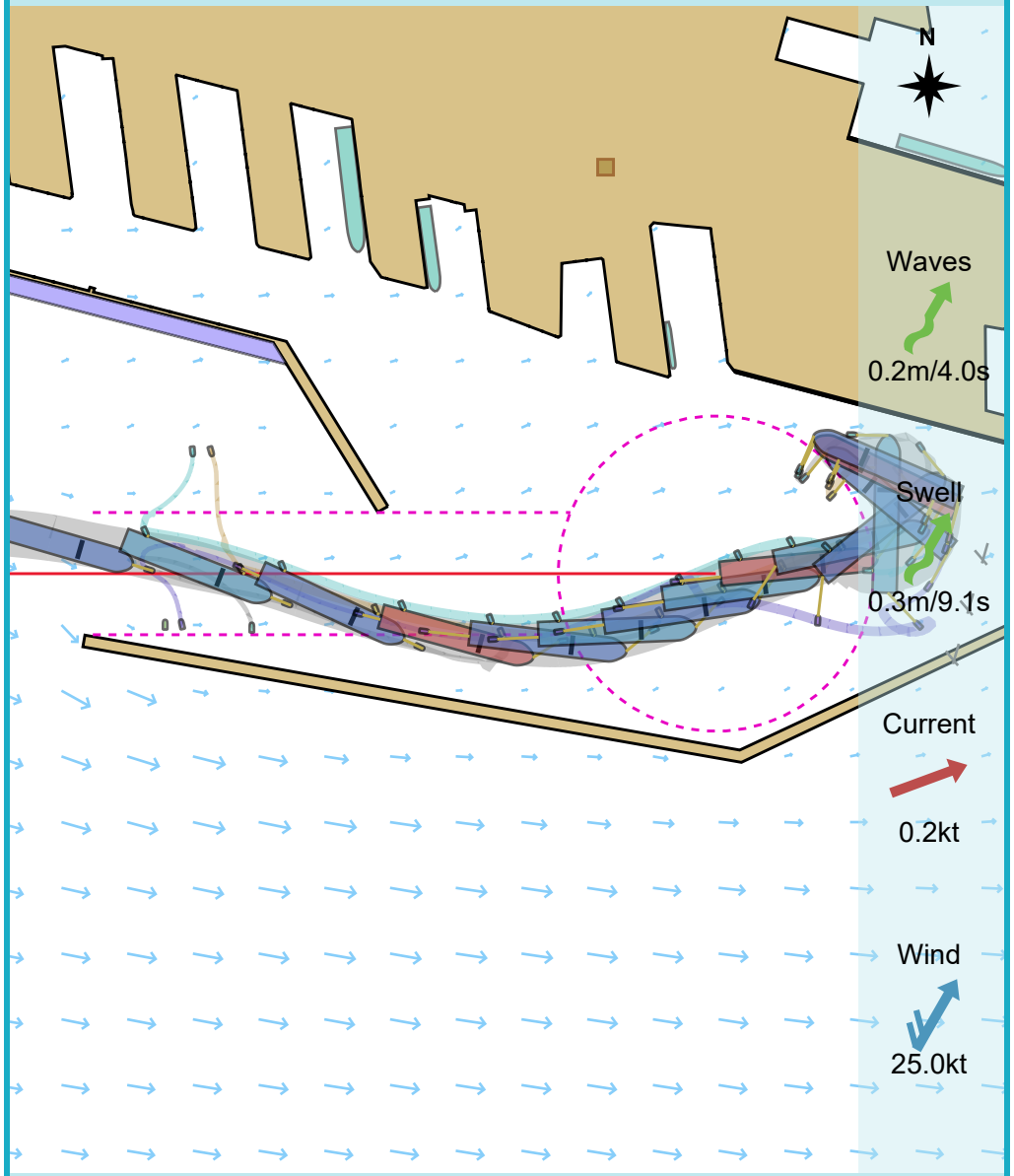



Tug 1 forces
Demand
Actual
Dir.
Pos.
Tug 2 forces
Demand
Actual
Dir.
Pos
Tug 3 forces
Demand
Actual
Dir.
Pos
Tug 4 forces
Demand
Actual
Dir.
Pos
Tug 5 forces
Demand
Actual
Dir.
Pos
Force (%BP)
Actual(t)Demand(t)
Relative direction (°)
Stern Position Bow
0min
5min
10min
15min
20min
25min
30min
35min
40min

Manoeuvre track plot

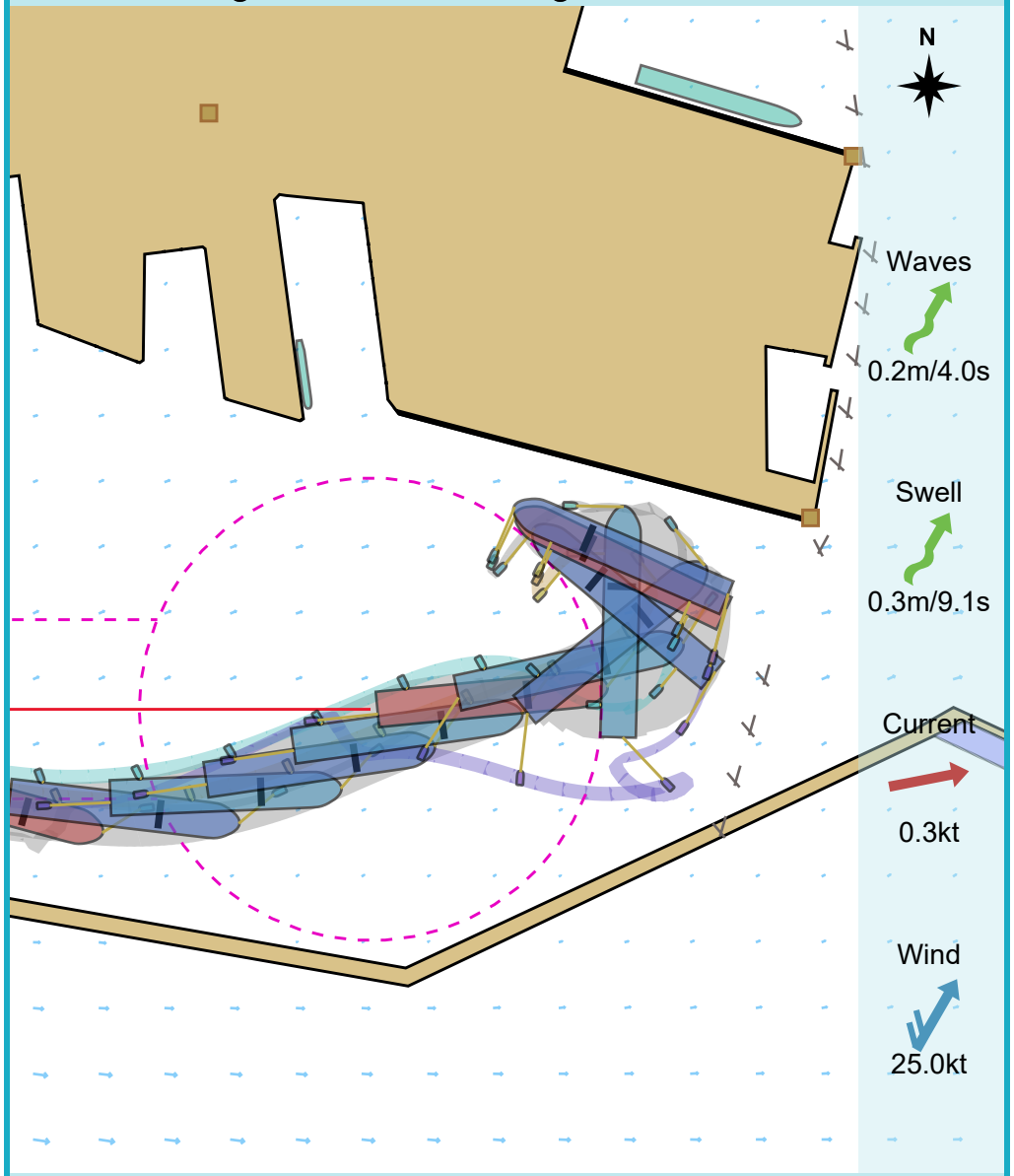


Arrival Channel

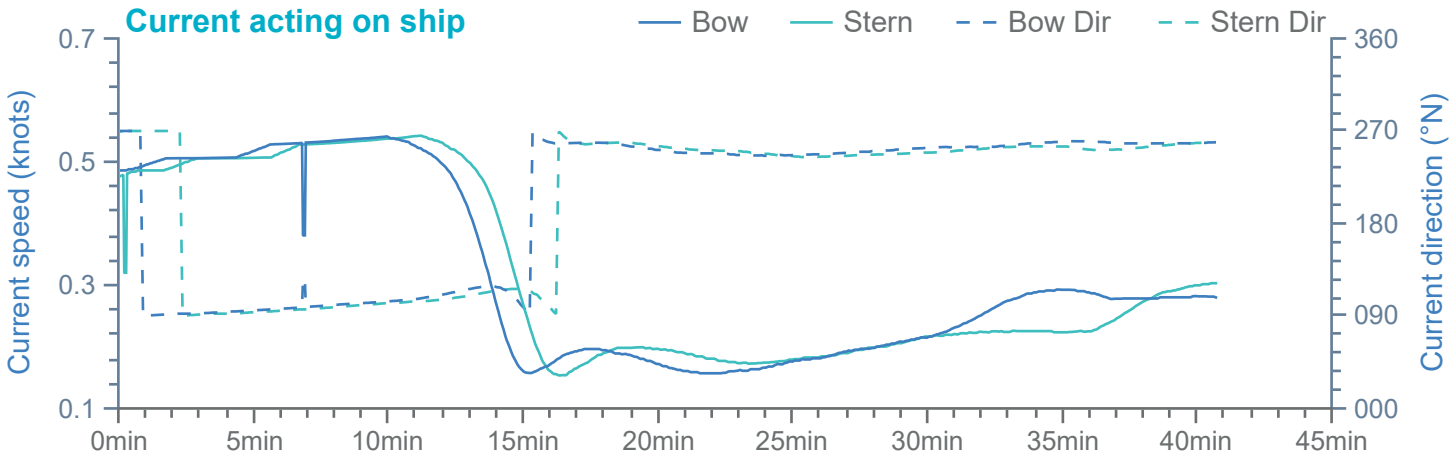


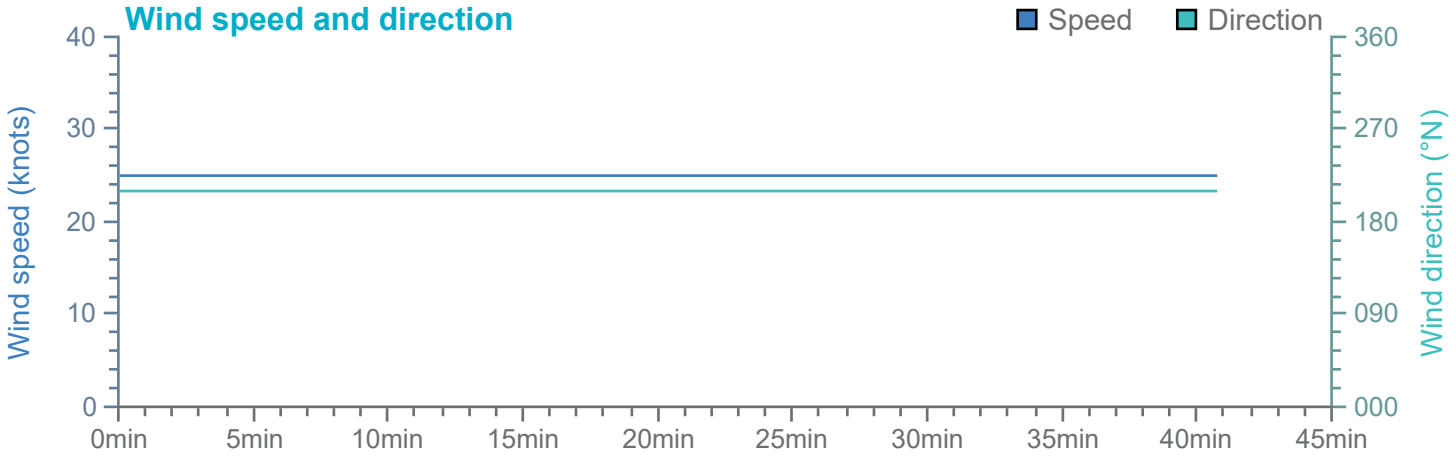
Ships plotted every 2 mins, highlight every 10 mins

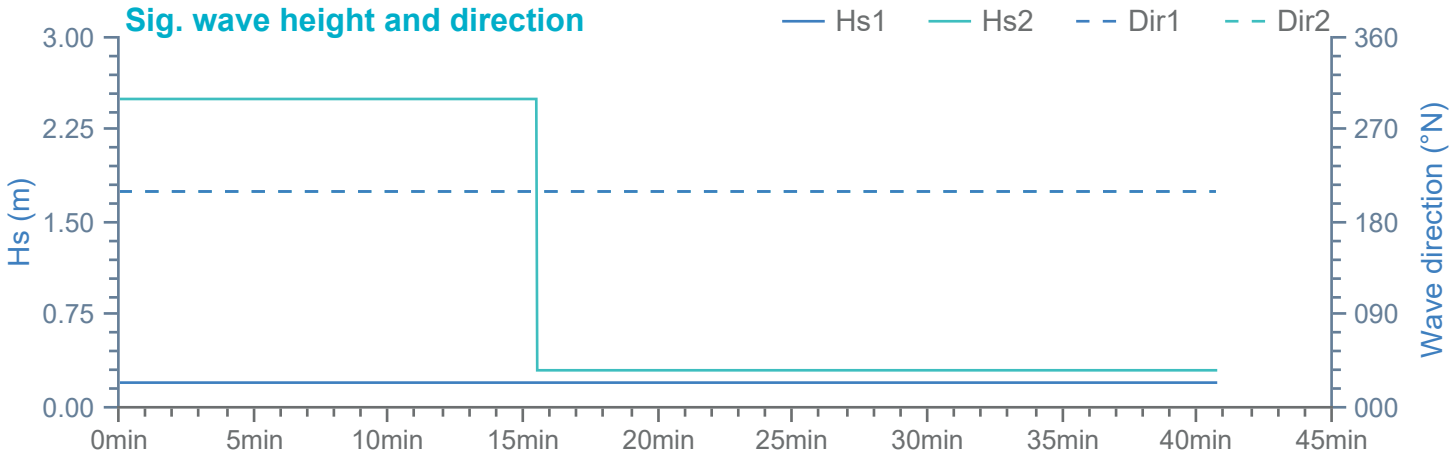
Manoeuvring area and berthing

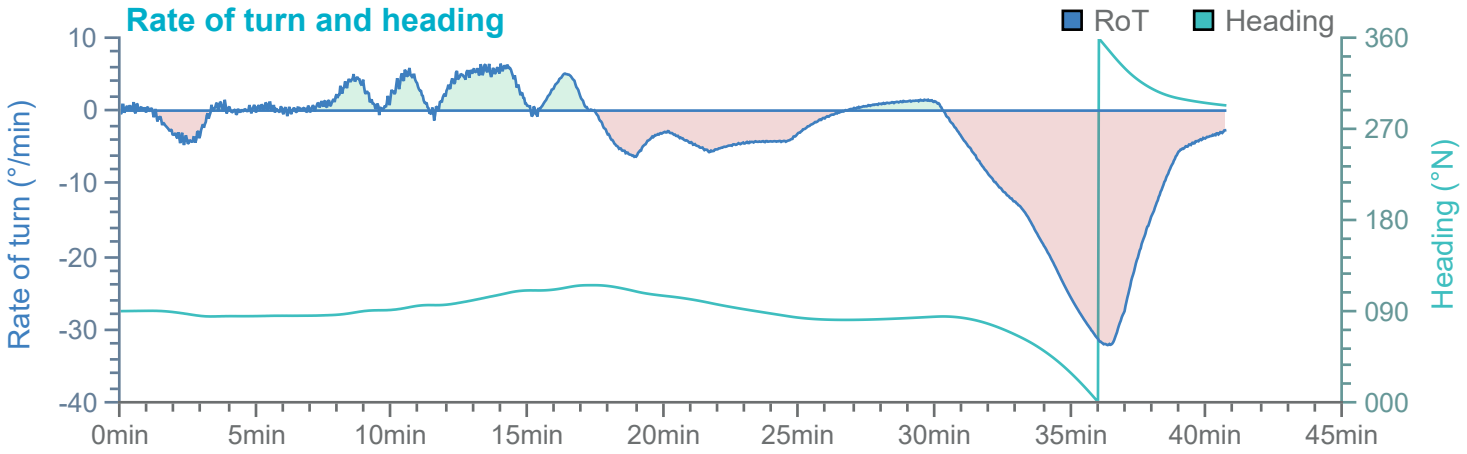


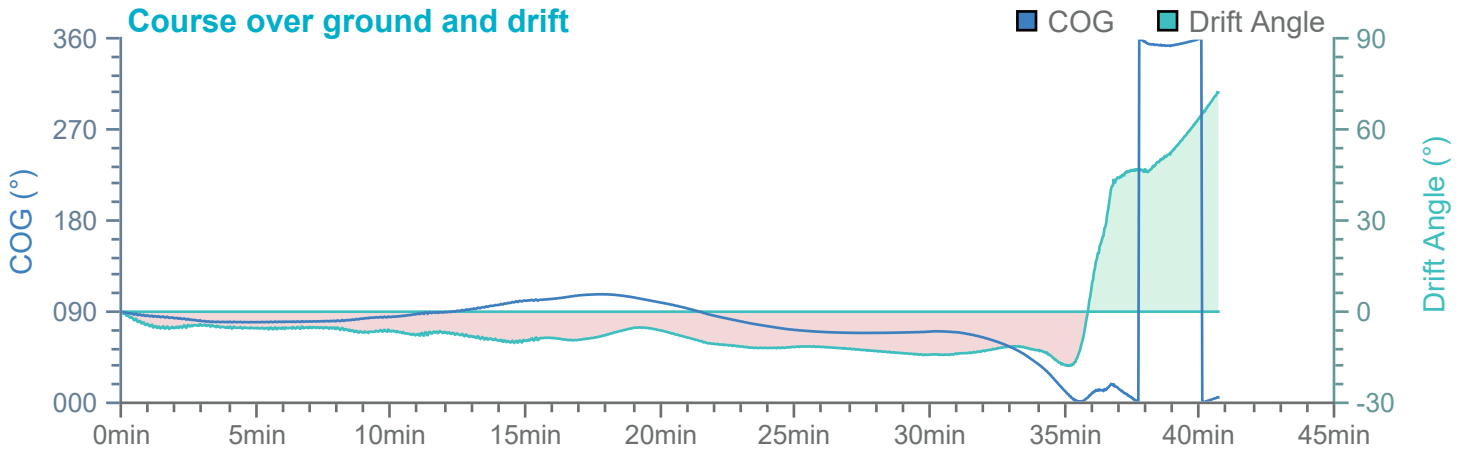
Ships plotted every 2 mins, highlight every 10 mins

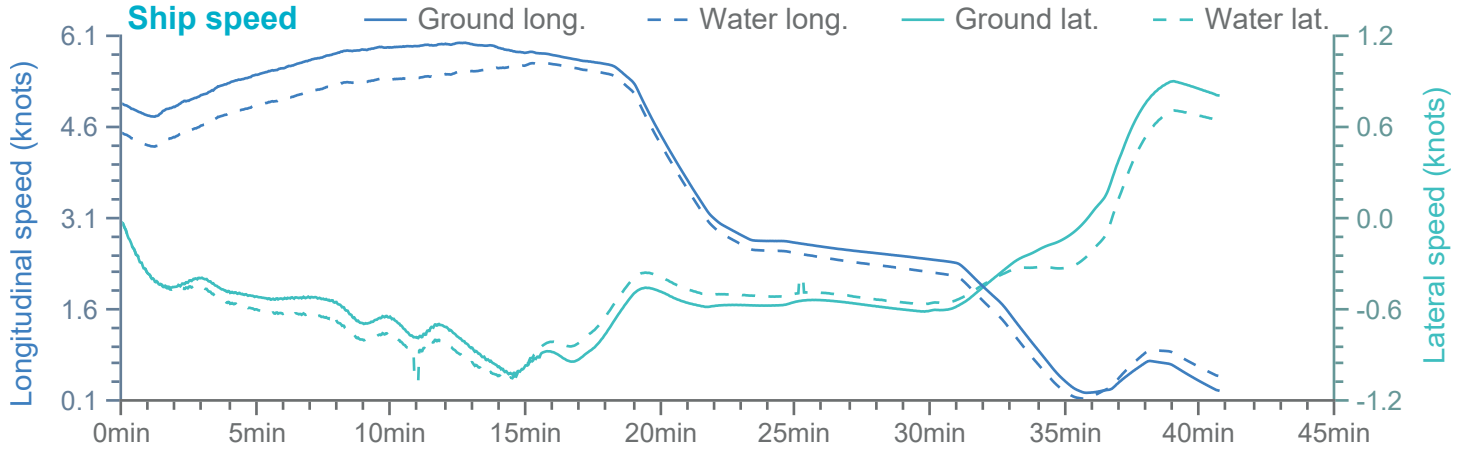

Current acting on ship
Bow
Stern
Bow Dir
Stern Dir
Current speed (knots)
Current direction (°N)
0.7
0.5
0.3
0.1
360
270
180
090
000
0min
5min
10min
15min
20min
25min
30min
35min
40min
45min

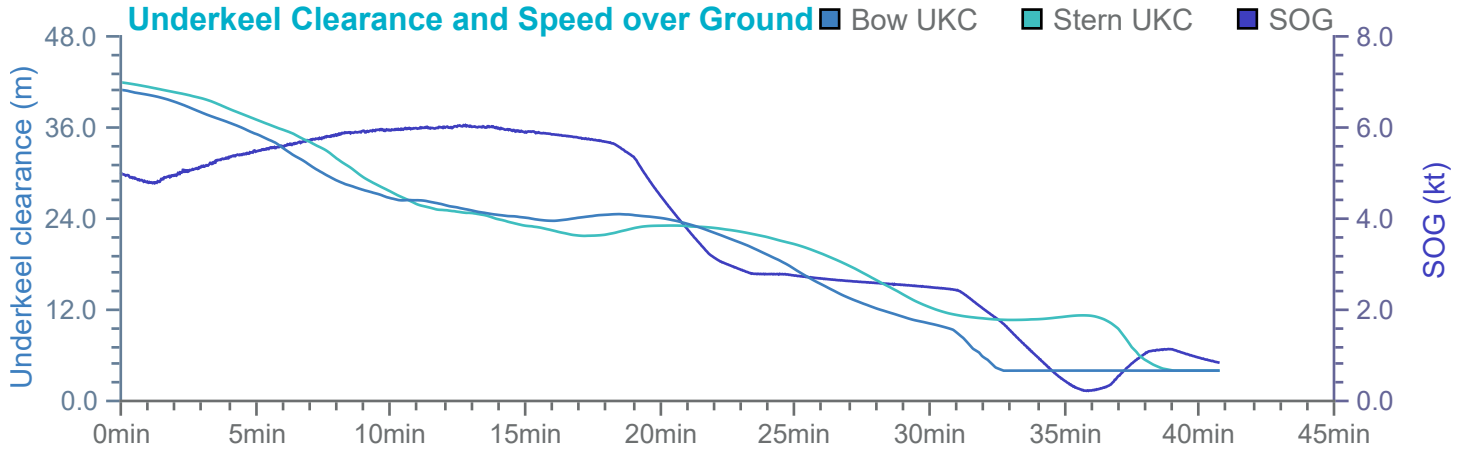

Wind speed and direction
Speed
Direction
Wind speed (knots)
Wind direction (°N)
40
30
20
10
0
360
270
180
090
000
0min
5min
10min
15min
20min
25min
30min
35min
40min
45min

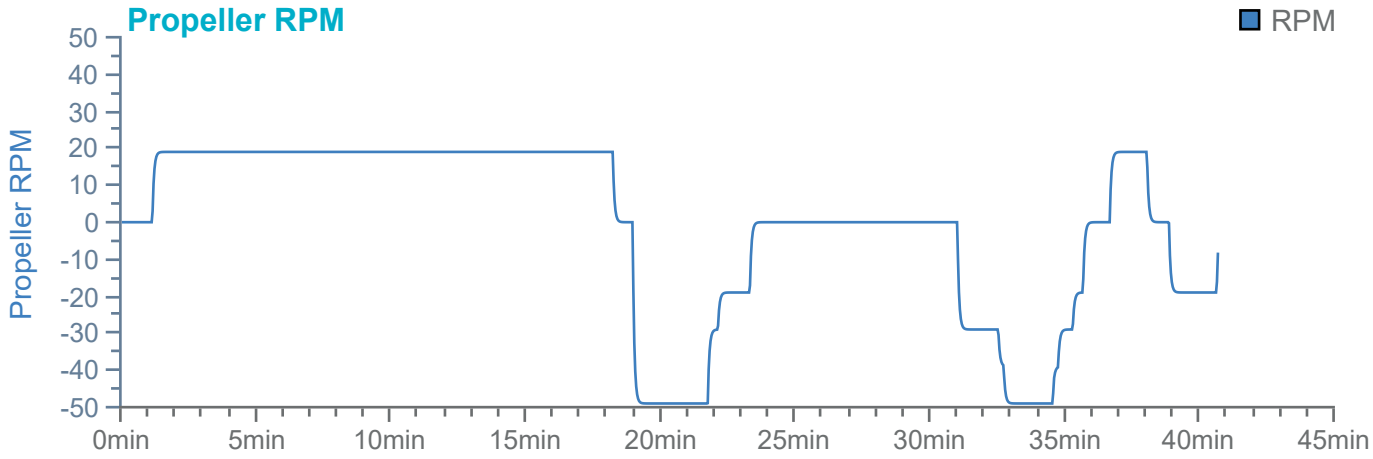

Sig. wave height and direction
Hs1
Hs2
Dir1
Dir2
Hs (m)
Wave direction (°N)
3.00
2.25
1.50
0.75
0.00
360
270
180
090
000
0min
5min
10min
15min
20min
25min
30min
35min
40min
45min

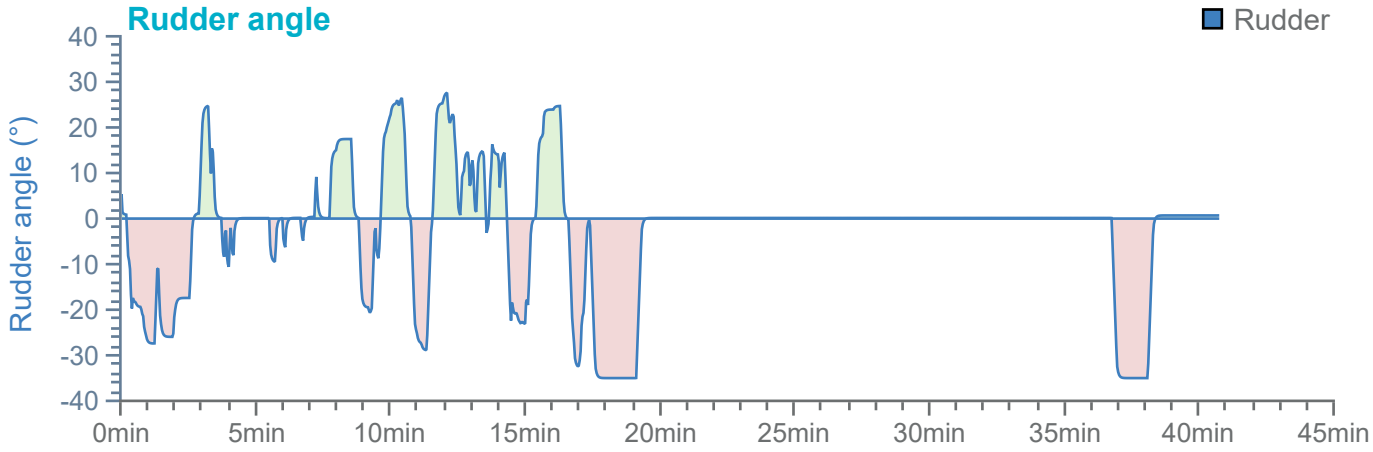

Rate of turn and heading
RoT
Heading
Rate of turn (°/min)
Heading (°N)
10
0
-10
-20
-30
-40
360
270
180
090
000
0min
5min
10min
15min
20min
25min
30min
35min
40min
45min

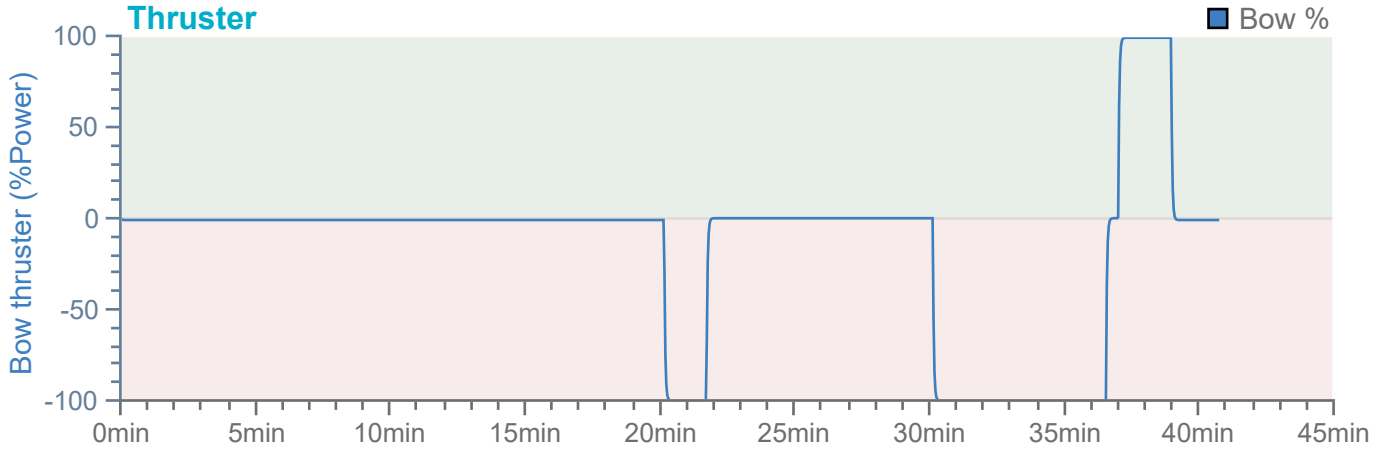

Course over ground and drift
COG
Drift Angle
COG (°)
Drift Angle (°)
360
270
180
090
000
90
60
30
0
-30
0min
5min
10min
15min
20min
25min
30min
35min
40min
45min


Ship speed
Ground long.
Water long.
Ground lat.
Water lat.
Longitudinal speed (knots)
Lateral speed (knots)
6.1
4.6
3.1
1.6
0.1
1.2
0.6
0.0
-0.6
-1.2
0min
5min
10min
15min
20min
25min
30min
35min
40min
45min

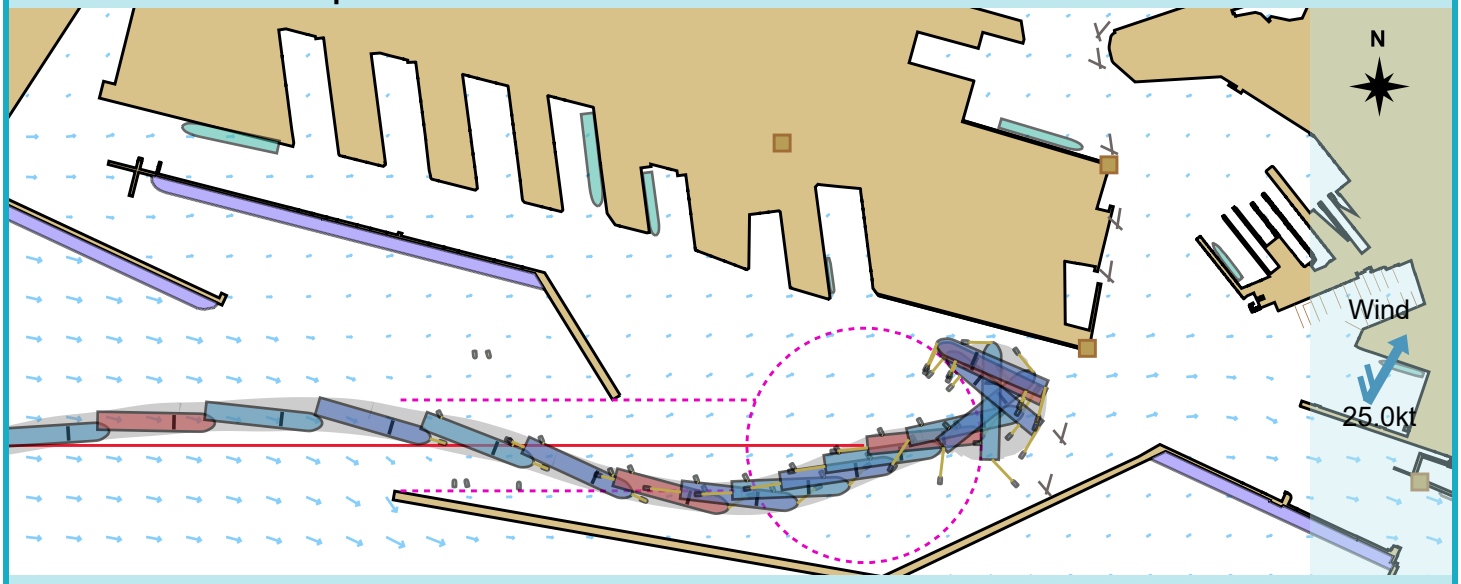

Underkeel Clearance and Speed over Ground
Bow UKC
Stern UKC
SOG
Underkeel clearance (m)
SOG (kt)
48.0
36.0
24.0
12.0
0.0
8.0
6.0
4.0
2.0
0.0
0min
5min
10min
15min
20min
25min
30min
35min
40min
45min


Propeller RPM
RPM
Propeller RPM
50
40
30
20
10
0
-10
-20
-30
-40
-50
0min
5min
10min
15min
20min
25min
30min
35min
40min
45min


Rudder angle
Rudder
Rudder angle (°)
40
30
20
10
0
-10
-20
-30
-40
0min
5min
10min
15min
20min
25min
30min
35min
40min
45min

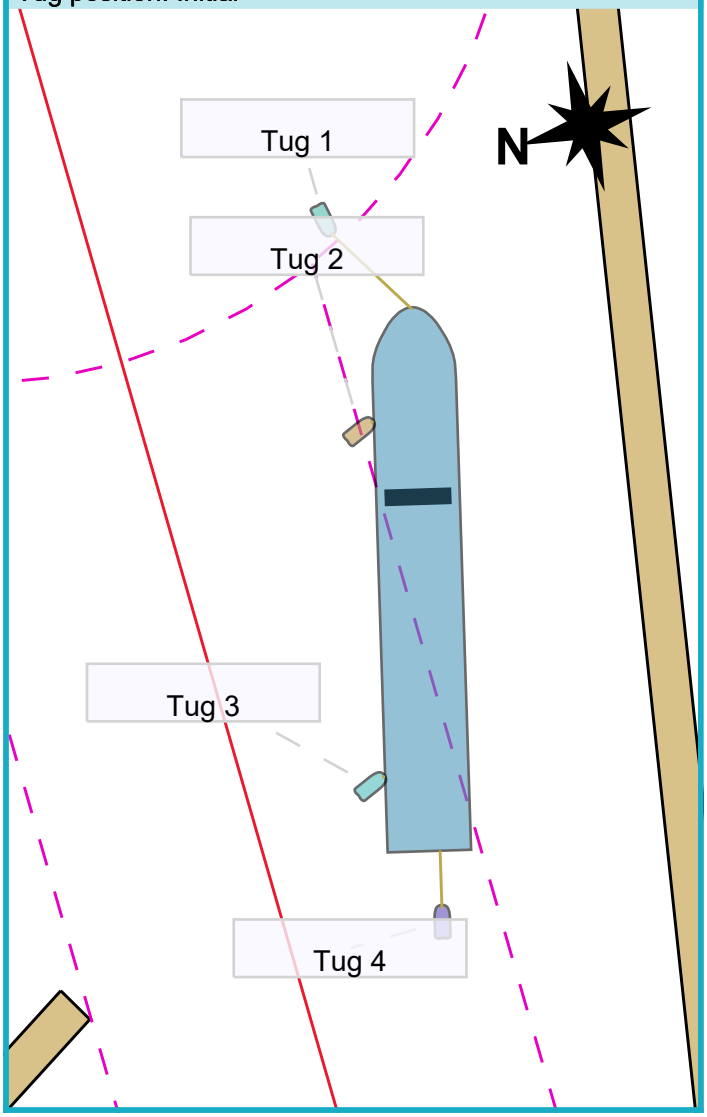

Thruster
Bow %
Bow thruster (%Power)
100
50
0
-50
-100
0min
5min
10min
15min
20min
25min
30min
35min
40min
45min

Manoeuvre track plot

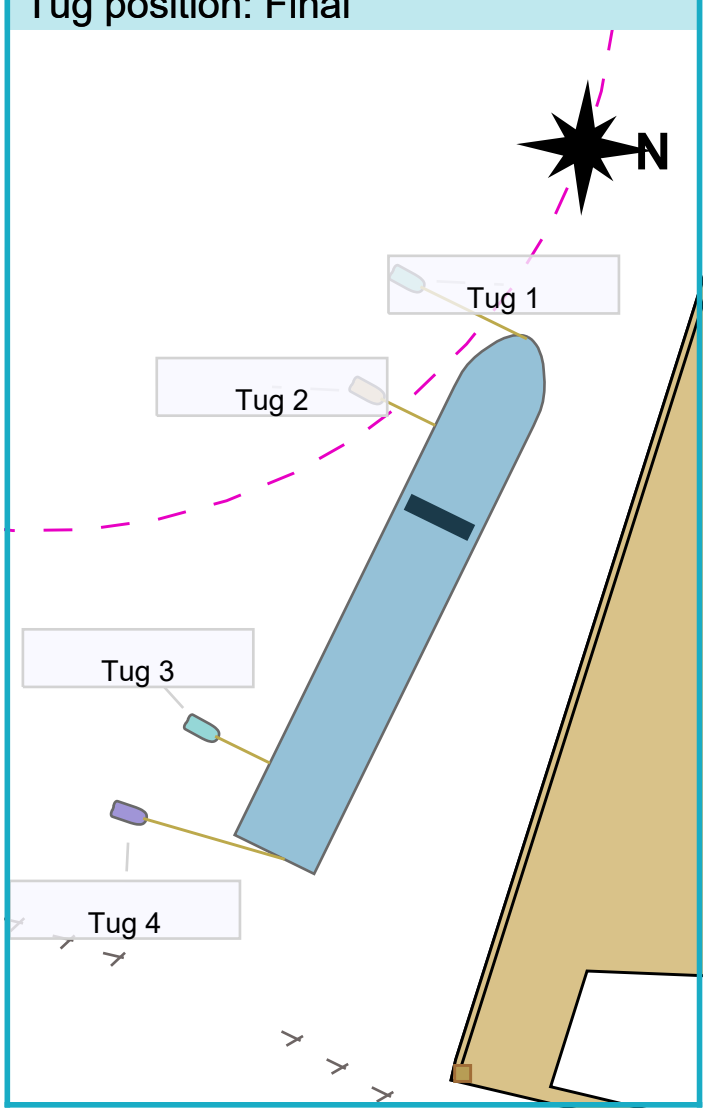


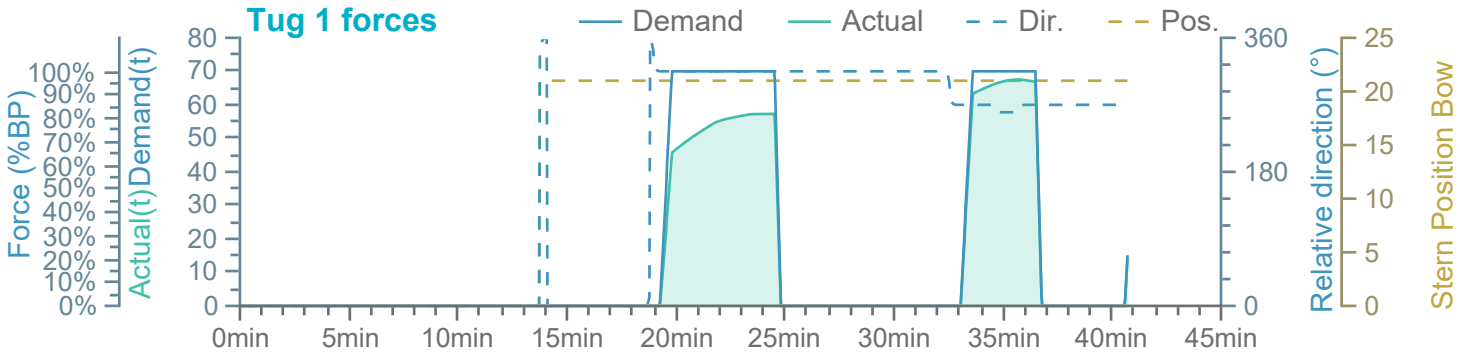
Ships plotted every 2 mins, highlight every 10 mins

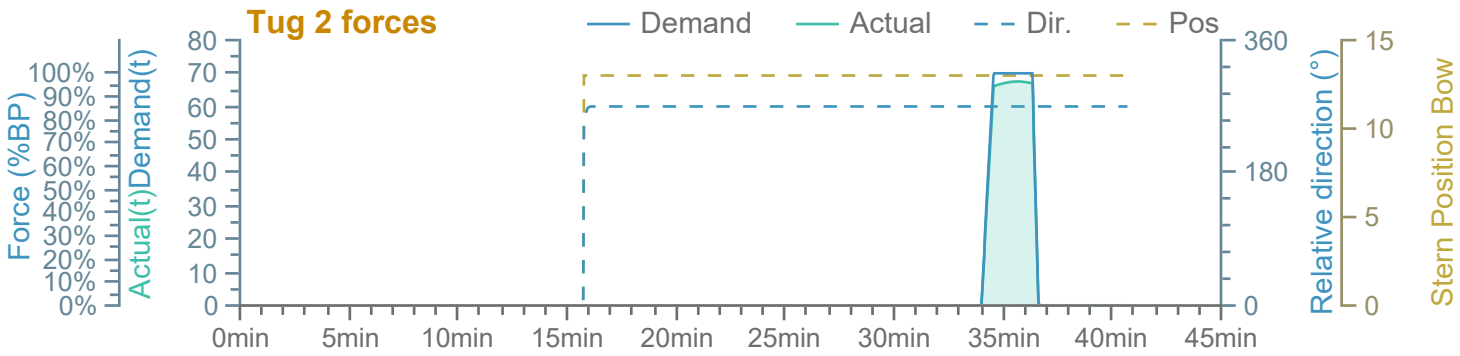
Tug position: Initial

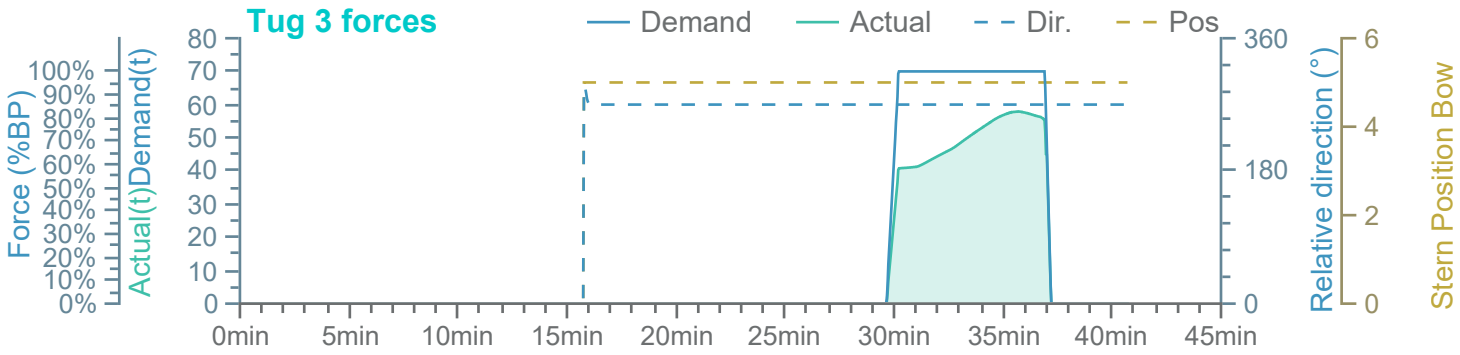


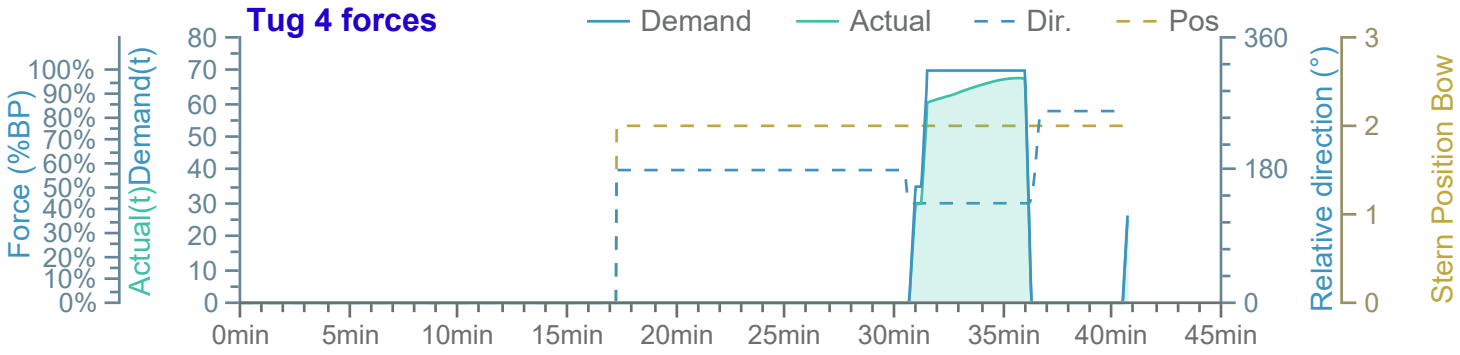
Tug position: Final



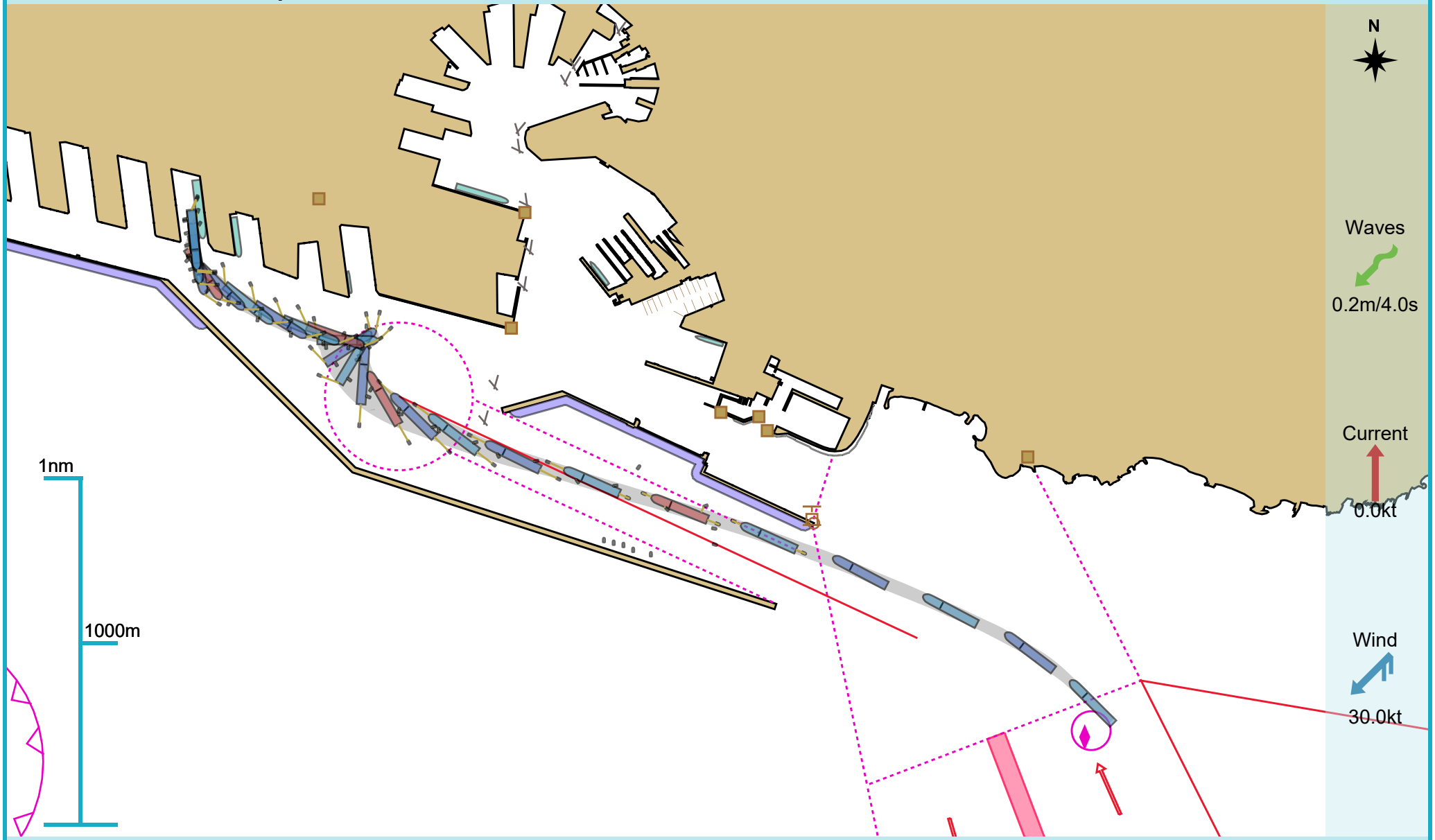

Tug 1 forces
Demand
Actual
Dir.
Pos.
Force (%BP)
Actual(t)Demand(t)
Relative direction (°)
Stern Position Bow
0min
5min
10min
15min
20min
25min
30min
35min
40min
45min


Tug 2 forces
Demand
Actual
Dir.
Pos
Force (%BP)
Actual(t)Demand(t)
Relative direction (°)
Stern Position Bow
0min
5min
10min
15min
20min
25min
30min
35min
40min
45min

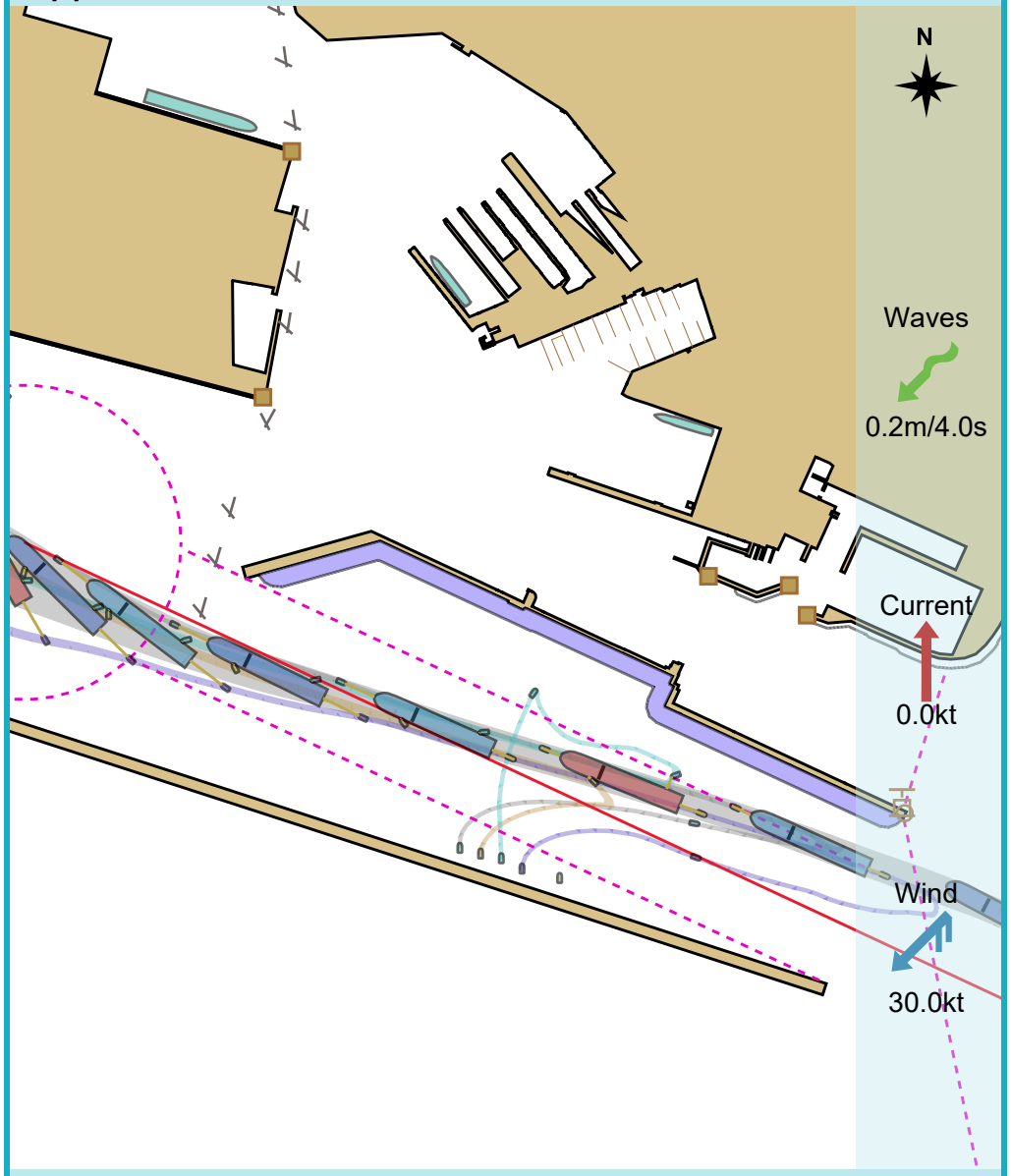

Tug 3 forces
Demand
Actual
Dir.
Pos
Force (%BP)
Actual(t)Demand(t)
Relative direction (°)
Stern Position Bow
0min
5min
10min
15min
20min
25min
30min
35min
40min
45min


Tug 4 forces
Demand
Actual
Dir.
Pos
Force (%BP)
Actual(t)Demand(t)
Relative direction (°)
Stern Position Bow
0min
5min
10min
15min
20min
25min
30min
35min
40min
45min

Manoeuvre track plot

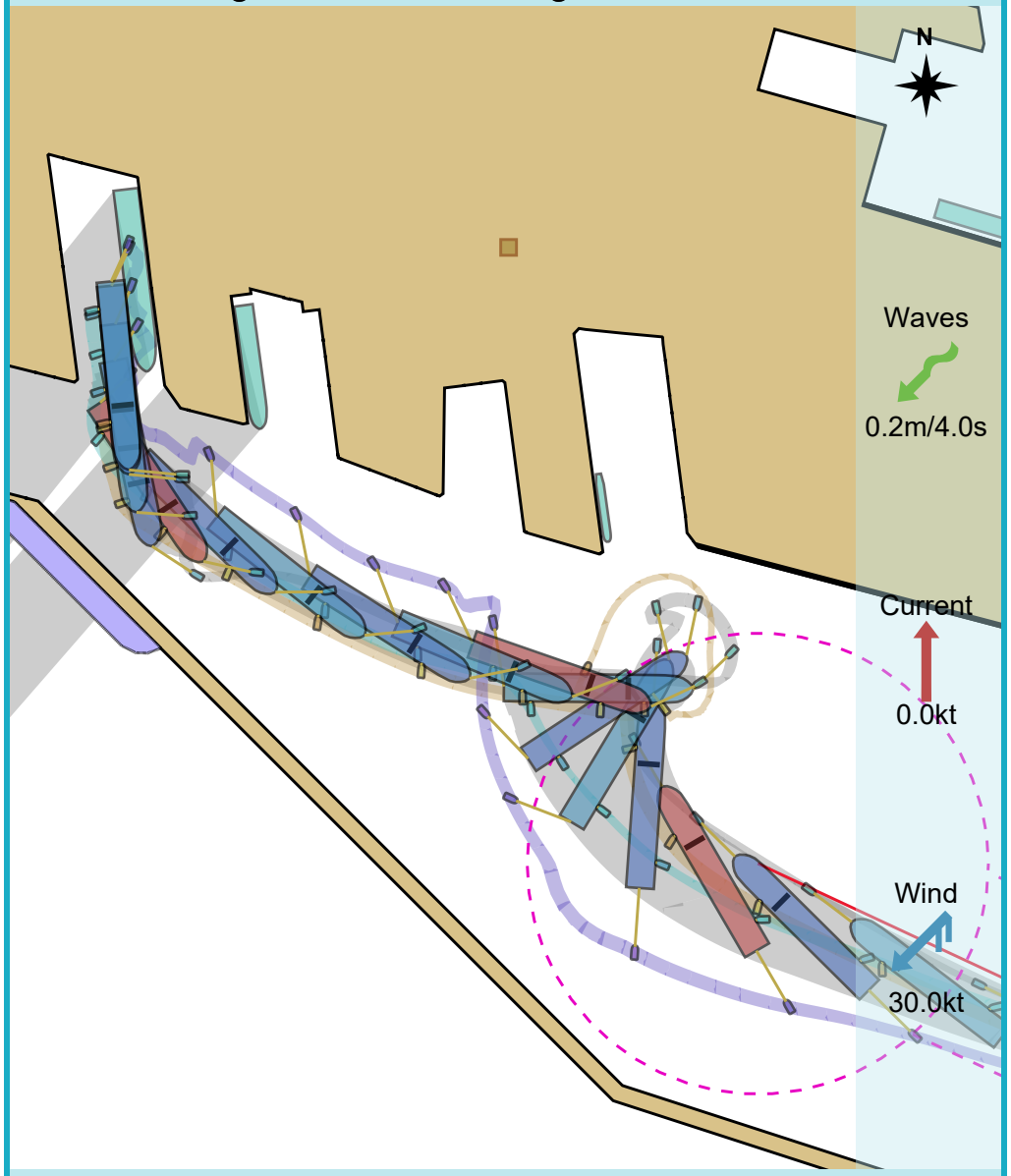


Approach Channel

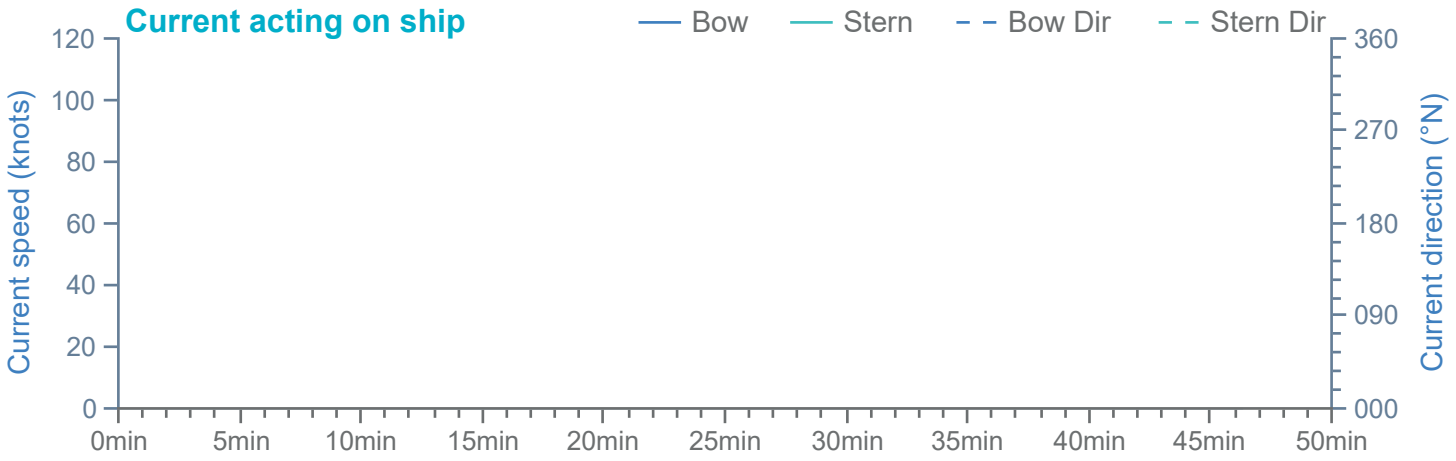


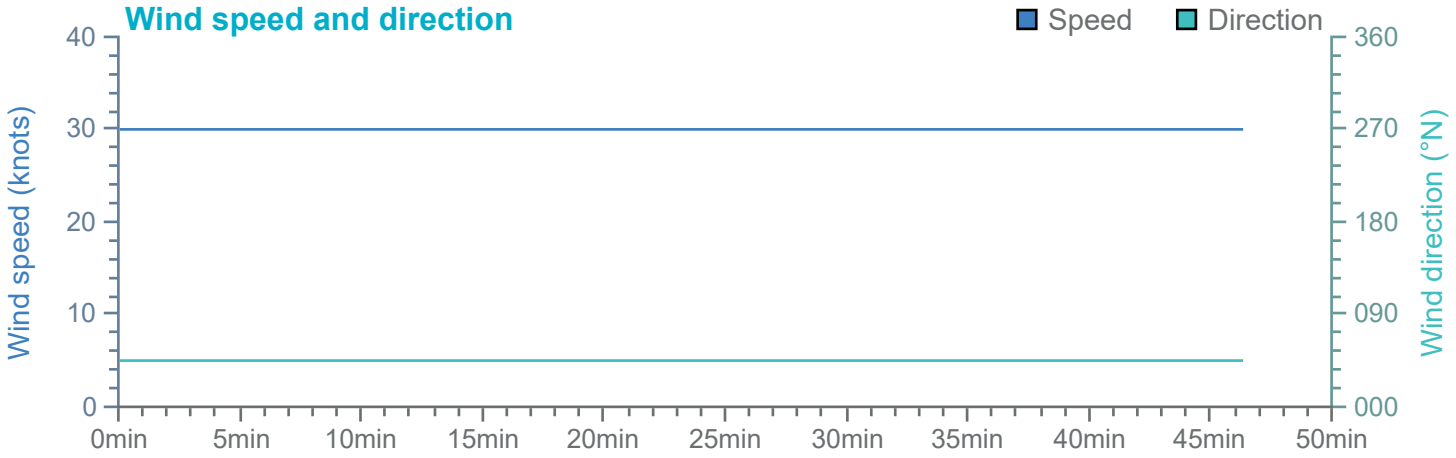
Ships plotted every 2 mins, highlight every 10 mins

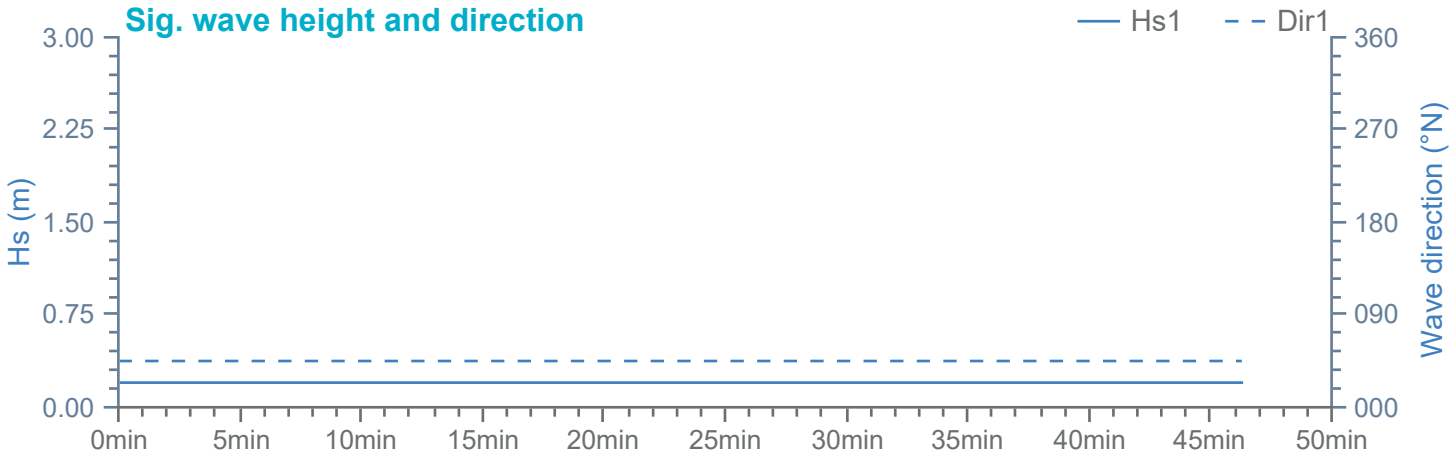
Manoeuvring area and berthing

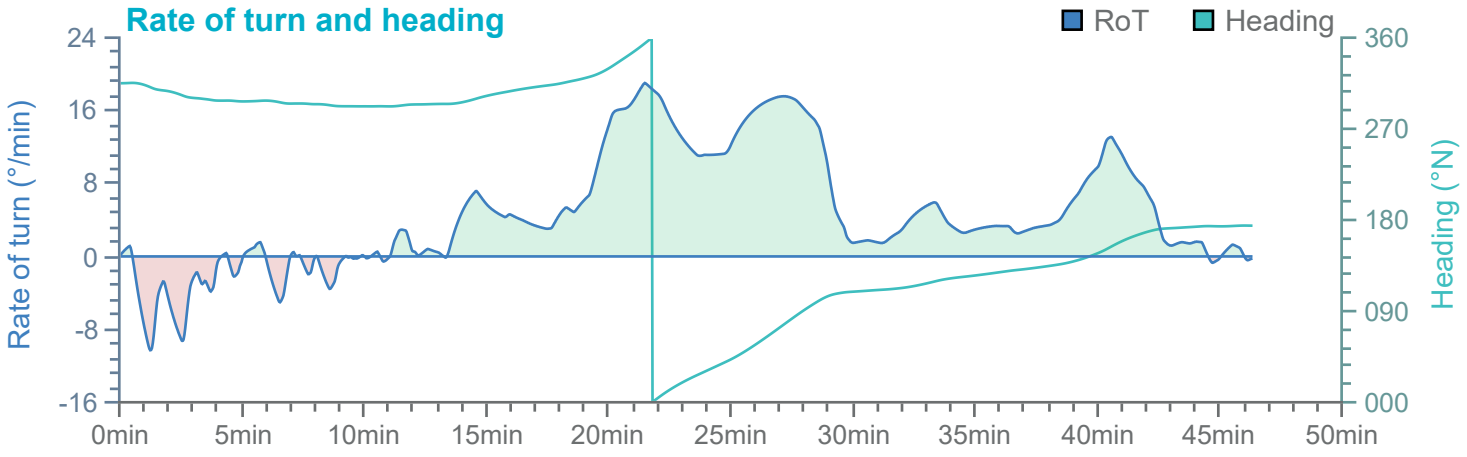


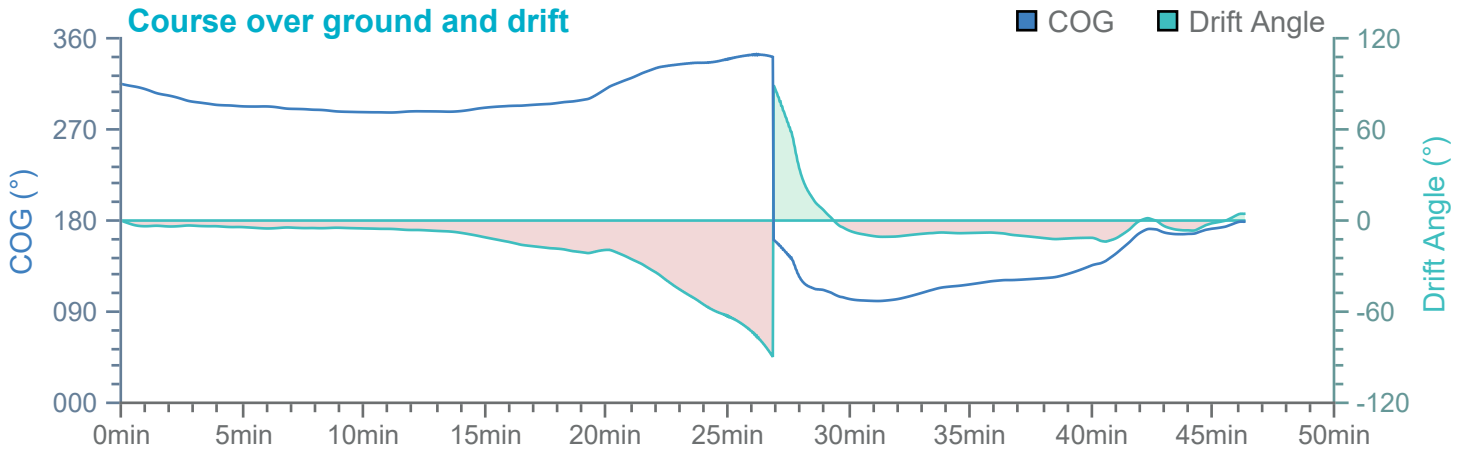
Ships plotted every 2 mins, highlight every 10 mins

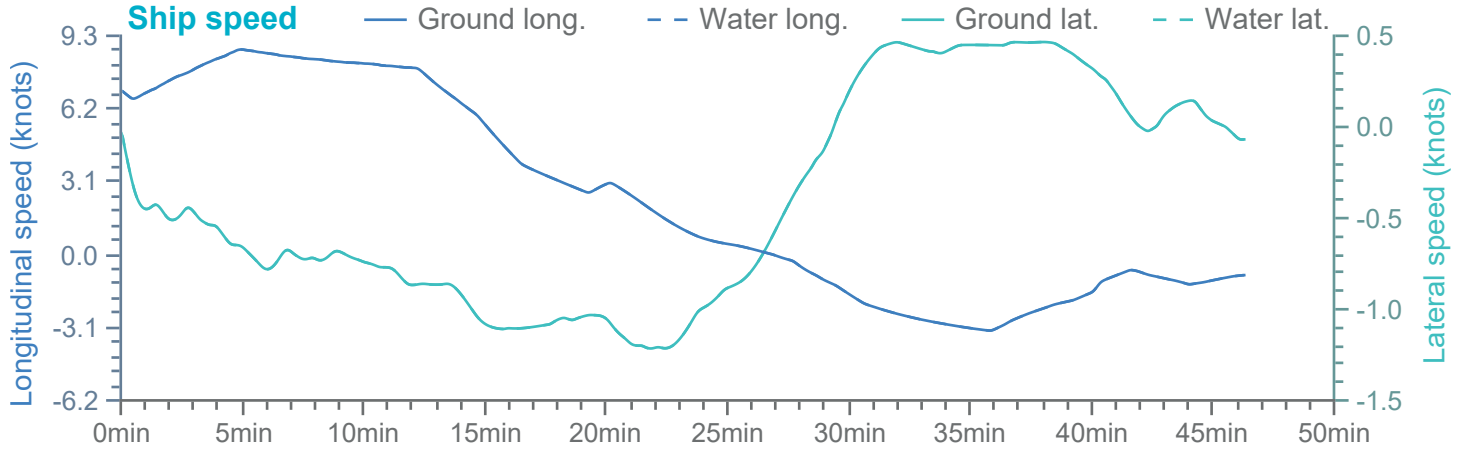

Current acting on ship
Bow
Stern
Bow Dir
Stern Dir
Current speed (knots)
Current direction (°N)
120
100
80
60
40
20
0
360
270
180
090
000
0min
5min
10min
15min
20min
25min
30min
35min
40min
45min
50min

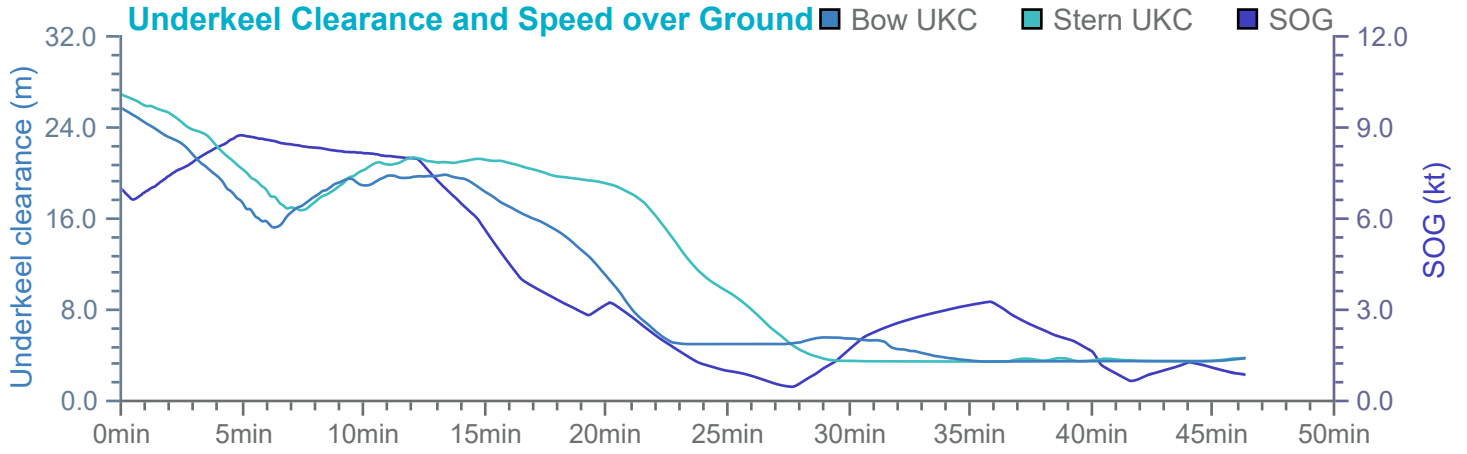

Wind speed and direction
Speed
Direction
Wind speed (knots)
Wind direction (°N)
40
30
20
10
0
360
270
180
090
000
0min
5min
10min
15min
20min
25min
30min
35min
40min
45min
50min

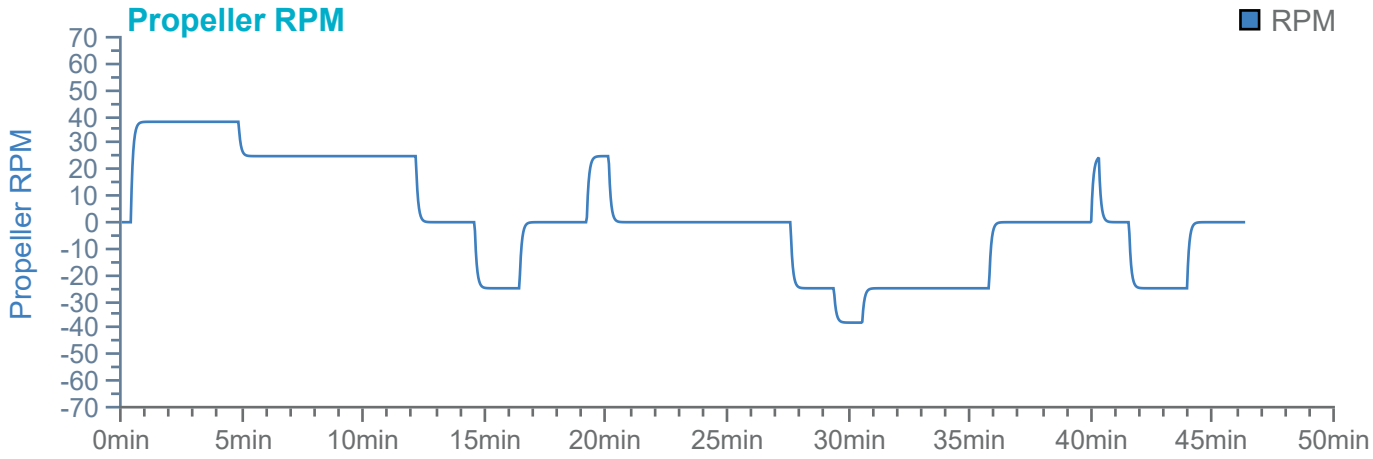

Sig. wave height and direction
Hs1
Dir1
Hs (m)
Wave direction (°N)
3.00
2.25
1.50
0.75
0.00
360
270
180
090
000
0min
5min
10min
15min
20min
25min
30min
35min
40min
45min
50min

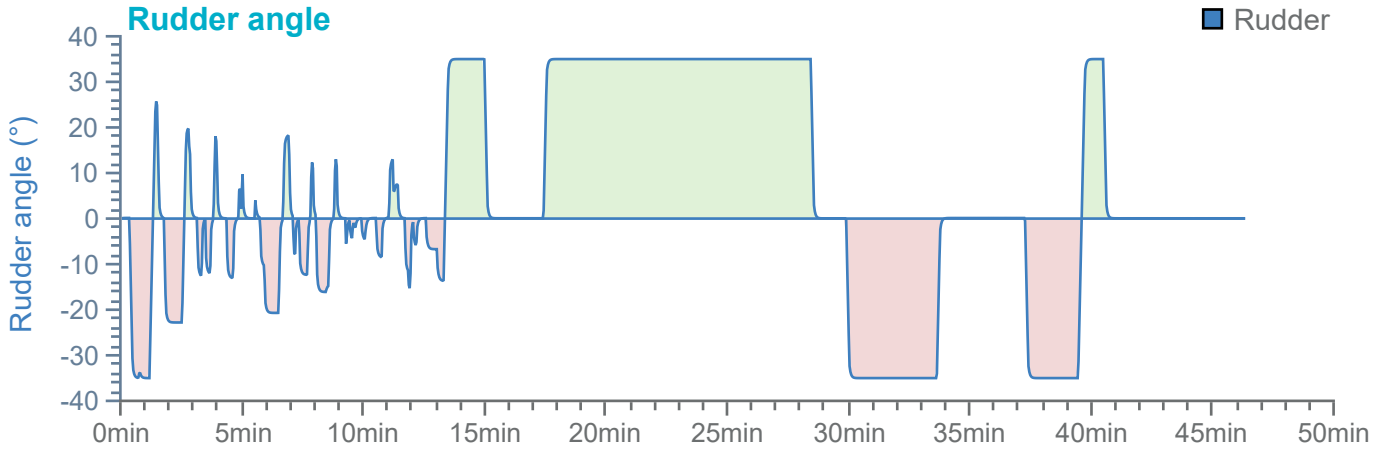

Rate of turn and heading
RoT
Heading
Rate of turn (°/min)
Heading (°N)
24
16
8
0
-8
-16
360
270
180
090
000
0min
5min
10min
15min
20min
25min
30min
35min
40min
45min
50min

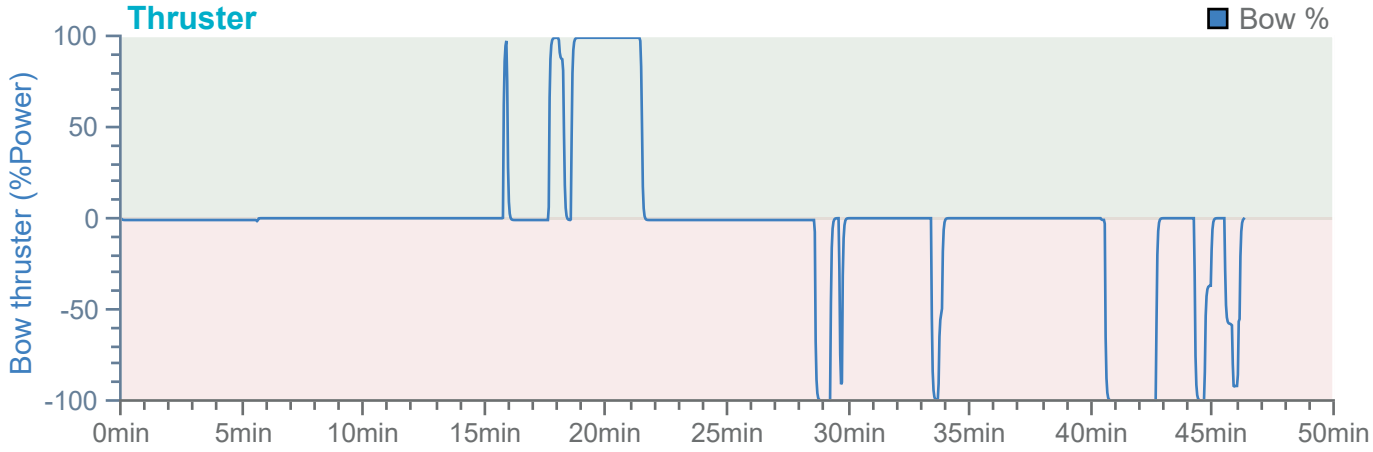

Course over ground and drift
COG
Drift Angle
COG (°)
Drift Angle (°)
360
270
180
090
000
120
60
0
-60
-120
0min
5min
10min
15min
20min
25min
30min
35min
40min
45min
50min


Ship speed
Ground long.
Water long.
Ground lat.
Water lat.
Longitudinal speed (knots)
Lateral speed (knots)
9.3
6.2
3.1
0.0
-3.1
-6.2
0.5
0.0
-0.5
-1.0
-1.5
0min
5min
10min
15min
20min
25min
30min
35min
40min
45min
50min

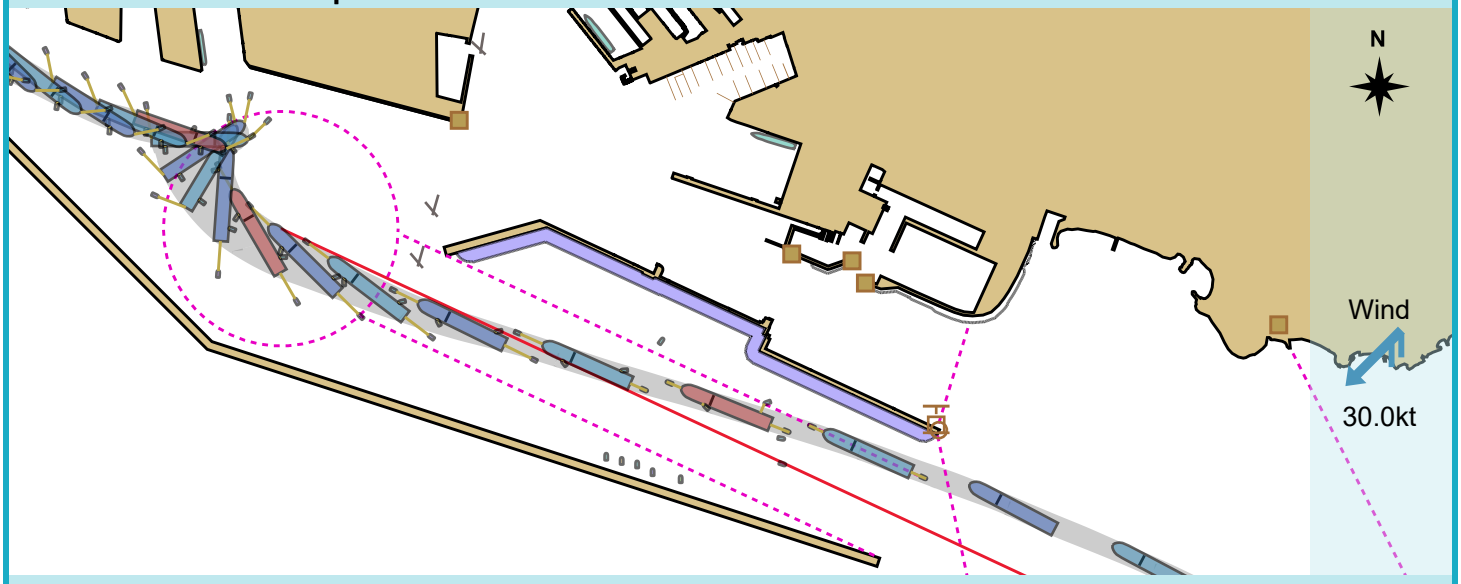

Underkeel Clearance and Speed over Ground
Bow UKC
Stern UKC
SOG
Underkeel clearance (m)
SOG (kt)
32.0
24.0
16.0
8.0
0.0
12.0
9.0
6.0
3.0
0.0
0min
5min
10min
15min
20min
25min
30min
35min
40min
45min
50min


Propeller RPM
RPM
Propeller RPM
70
60
50
40
30
20
10
0
-10
-20
-30
-40
-50
-60
-70
0min
5min
10min
15min
20min
25min
30min
35min
40min
45min
50min


Rudder angle
Rudder
Rudder angle (°)
40
30
20
10
0
-10
-20
-30
-40
0min
5min
10min
15min
20min
25min
30min
35min
40min
45min
50min

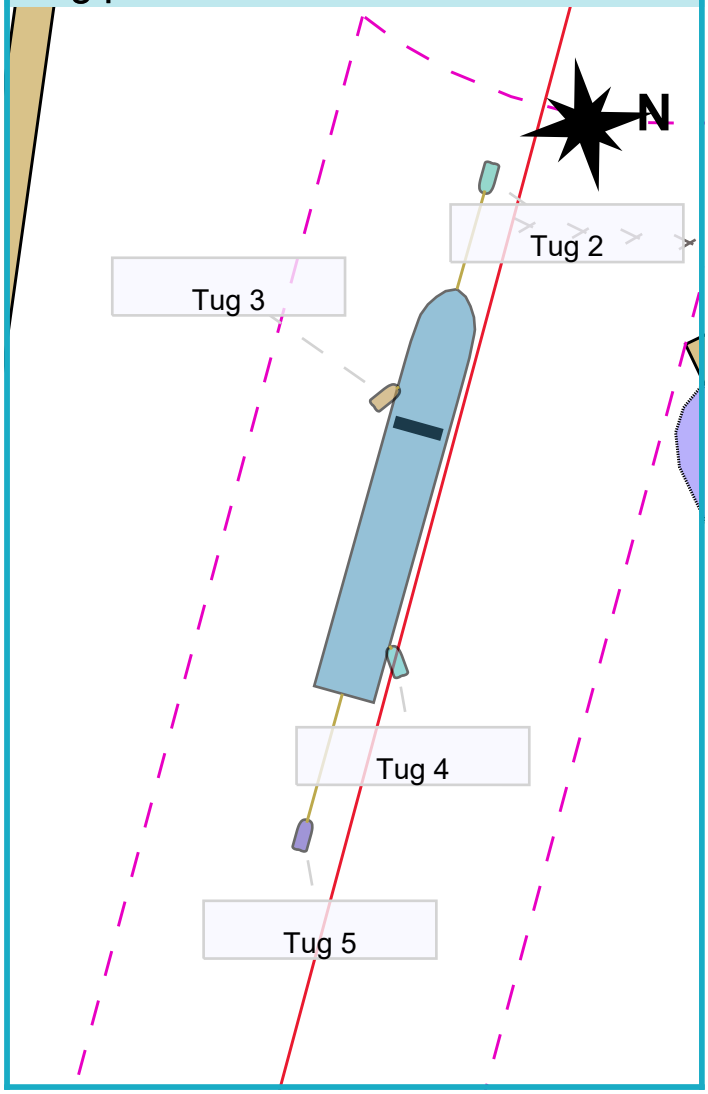

Thruster
Bow %
Bow thruster (%Power)
100
50
0
-50
-100
0min
5min
10min
15min
20min
25min
30min
35min
40min
45min
50min

Manoeuvre track plot

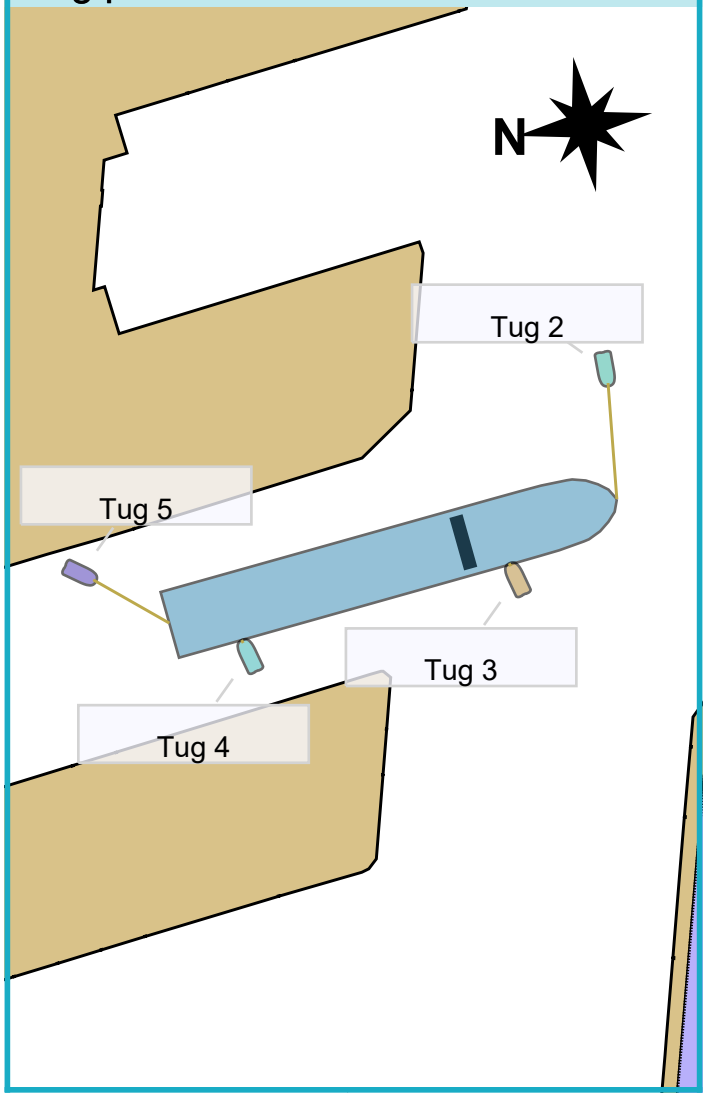


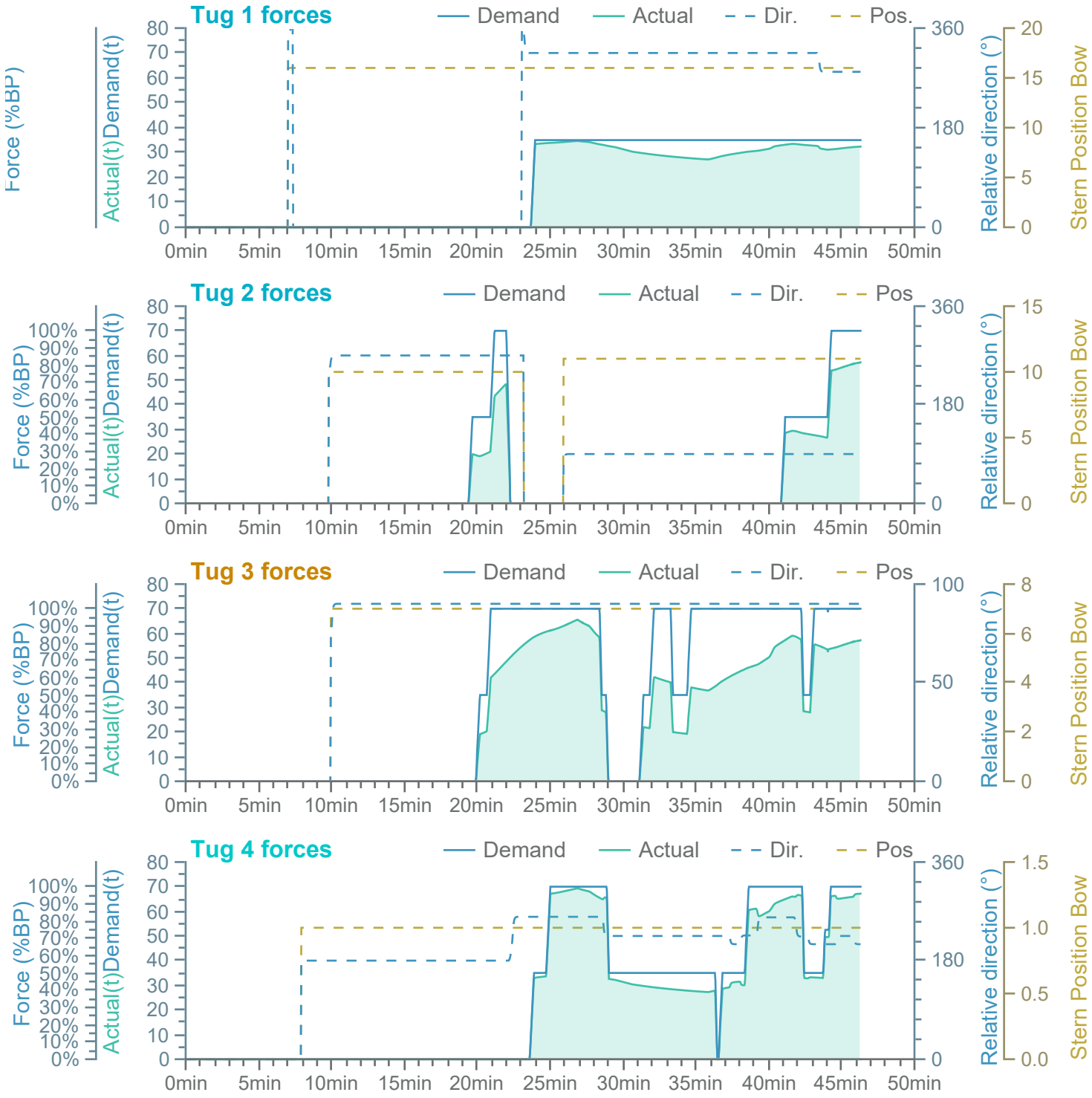
Ships plotted every 2 mins, highlight every 10 mins

Tug position: Initial

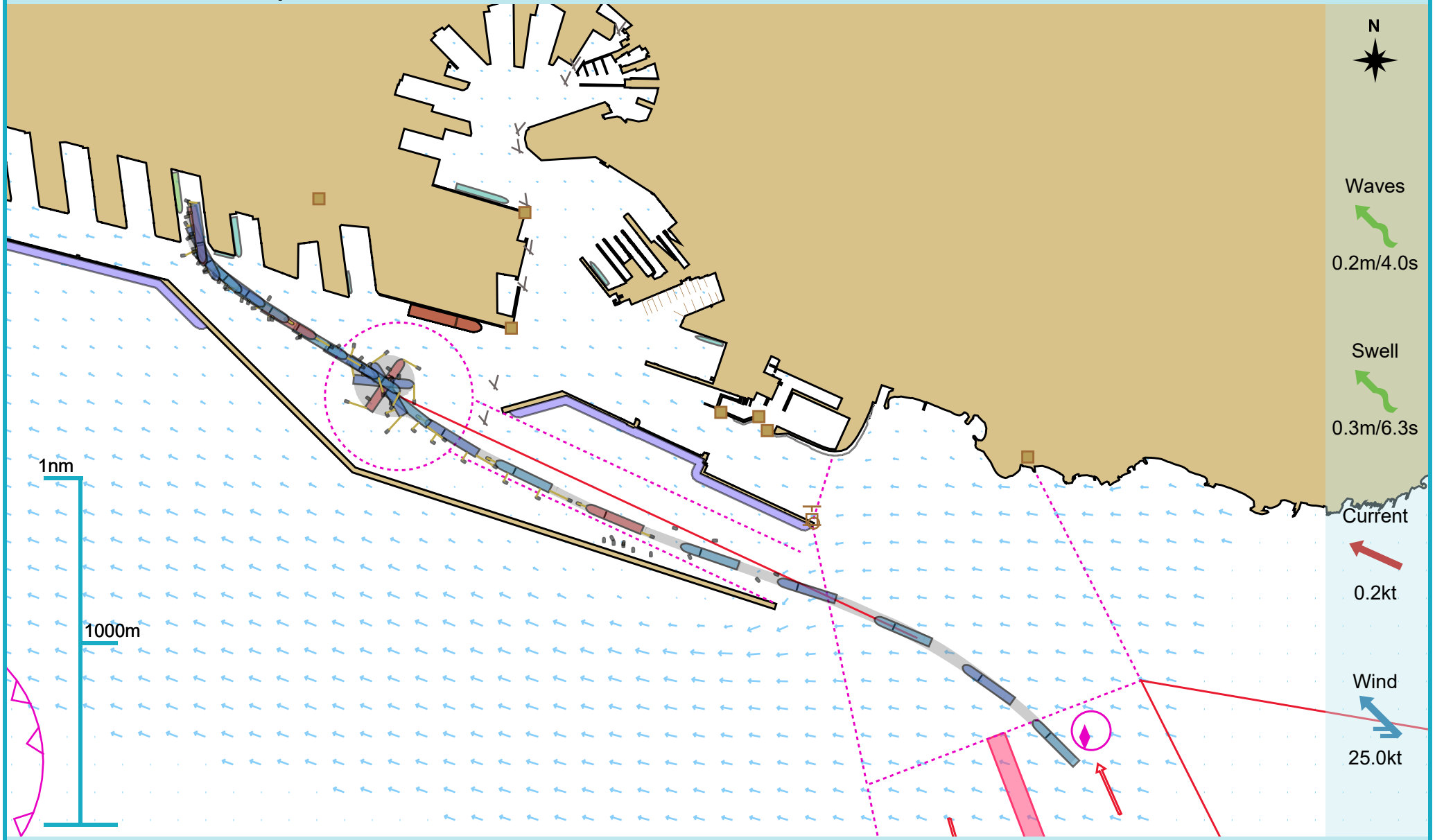


Tug position: Final

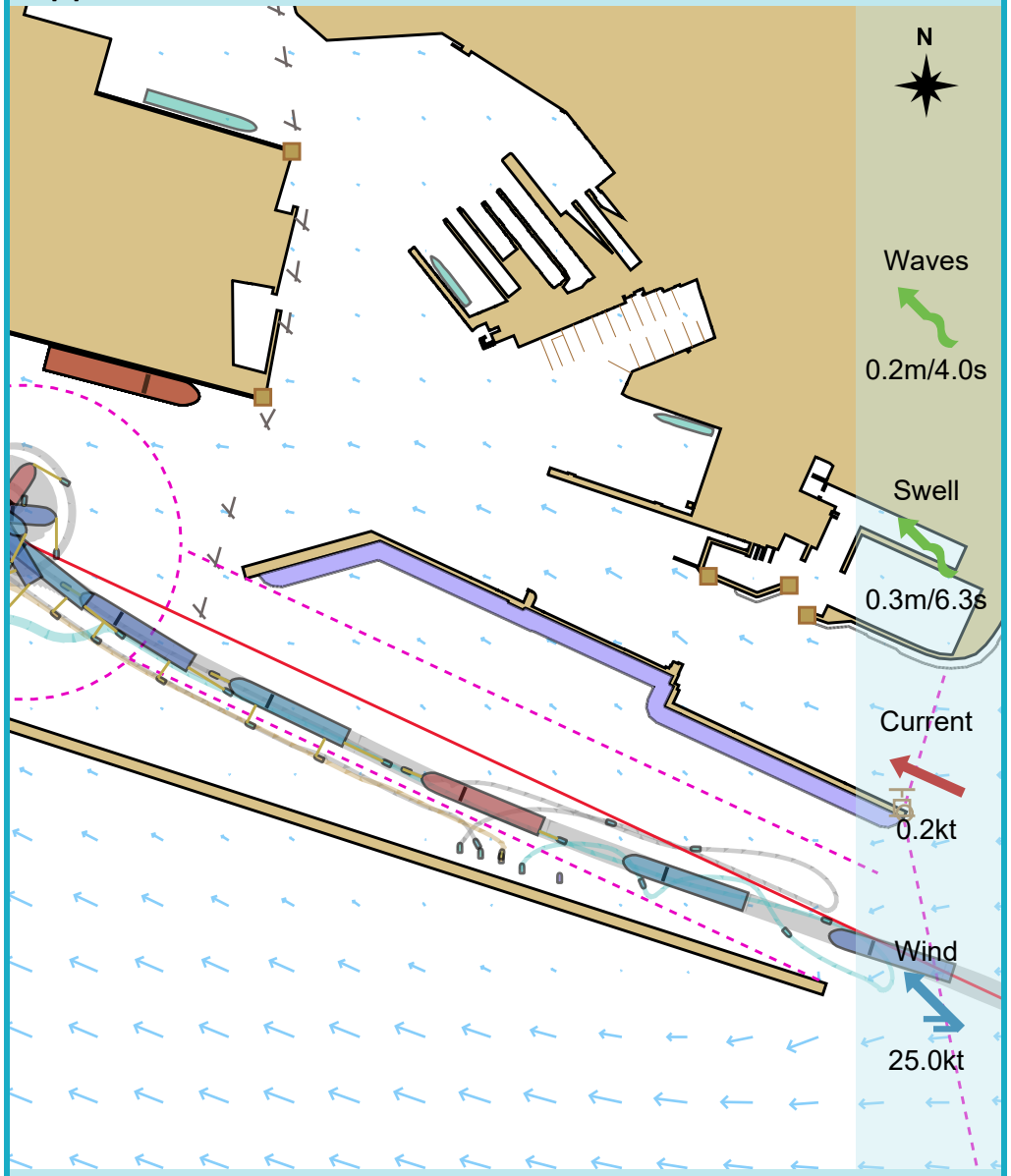



Tug 1 forces
Demand
Actual
Dir.
Pos.
Force (%BP)
Actual(t)Demand(t)
Relative direction (°)
Stern Position Bow
0min 5min 10min 15min 20min 25min 30min 35min 40min 45min 50min
Tug 2 forces
Demand
Actual
Dir.
Pos
Force (%BP)
Actual(t)Demand(t)
Relative direction (°)
Stern Position Bow
0min 5min 10min 15min 20min 25min 30min 35min 40min 45min 50min
Tug 3 forces
Demand
Actual
Dir.
Pos
Force (%BP)
Actual(t)Demand(t)
Relative direction (°)
Stern Position Bow
0min 5min 10min 15min 20min 25min 30min 35min 40min 45min 50min
Tug 4 forces
Demand
Actual
Dir.
Pos
Force (%BP)
Actual(t)Demand(t)
Relative direction (°)
Stern Position Bow
0min 5min 10min 15min 20min 25min 30min 35min 40min 45min 50min

Manoeuvre track plot

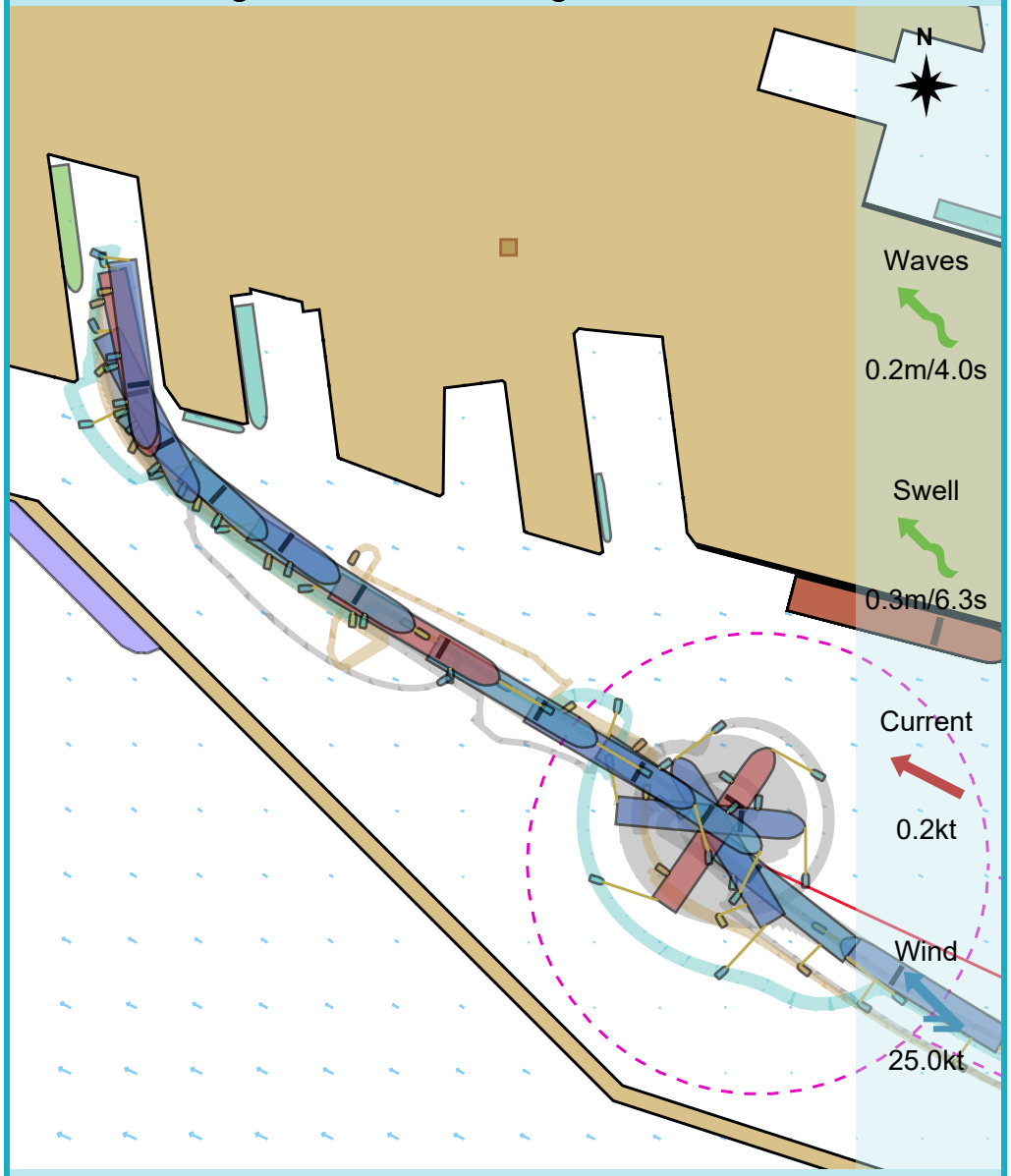


Approach Channel

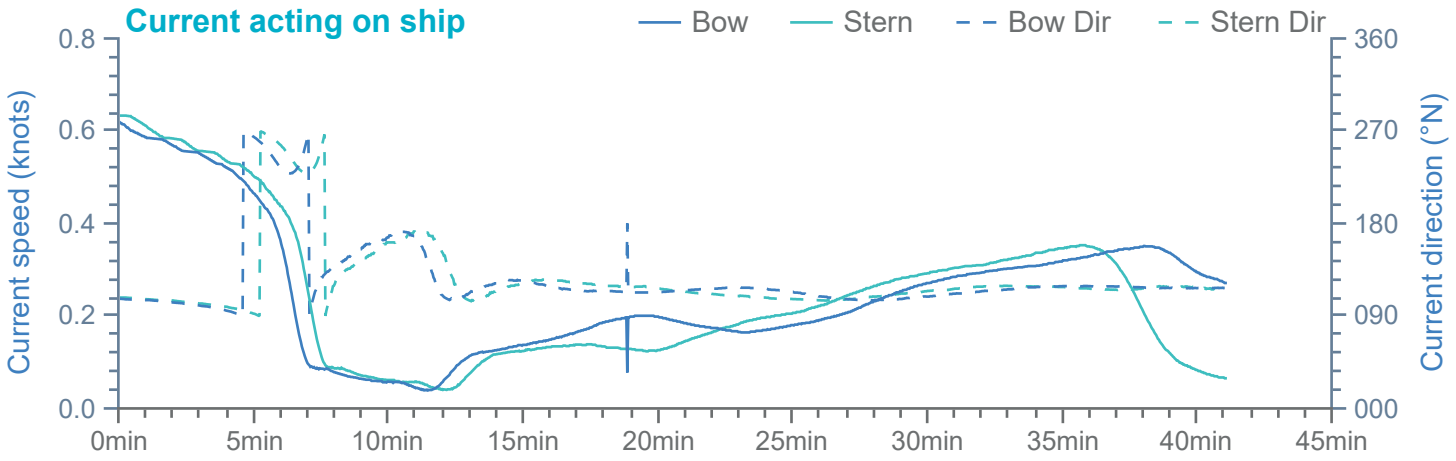


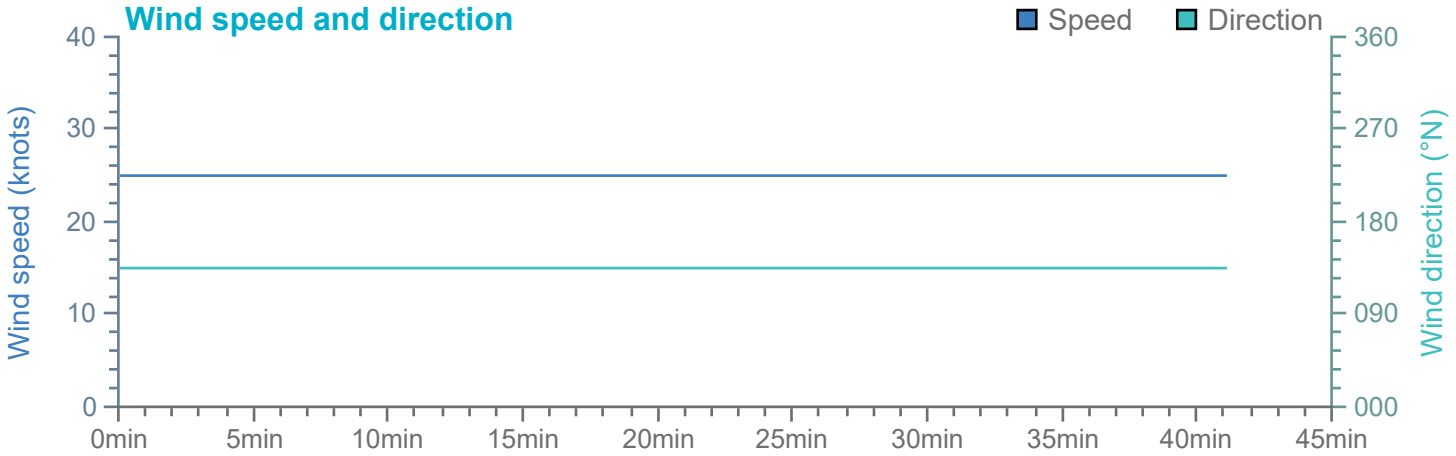
Ships plotted every 2 mins, highlight every 10 mins

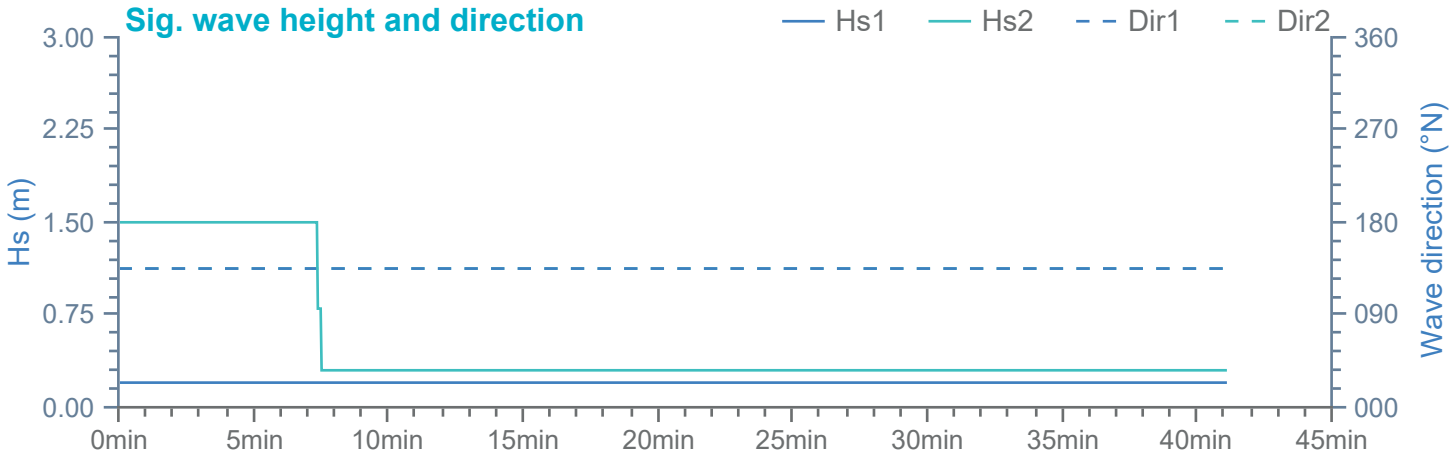
Manoeuvring area and berthing

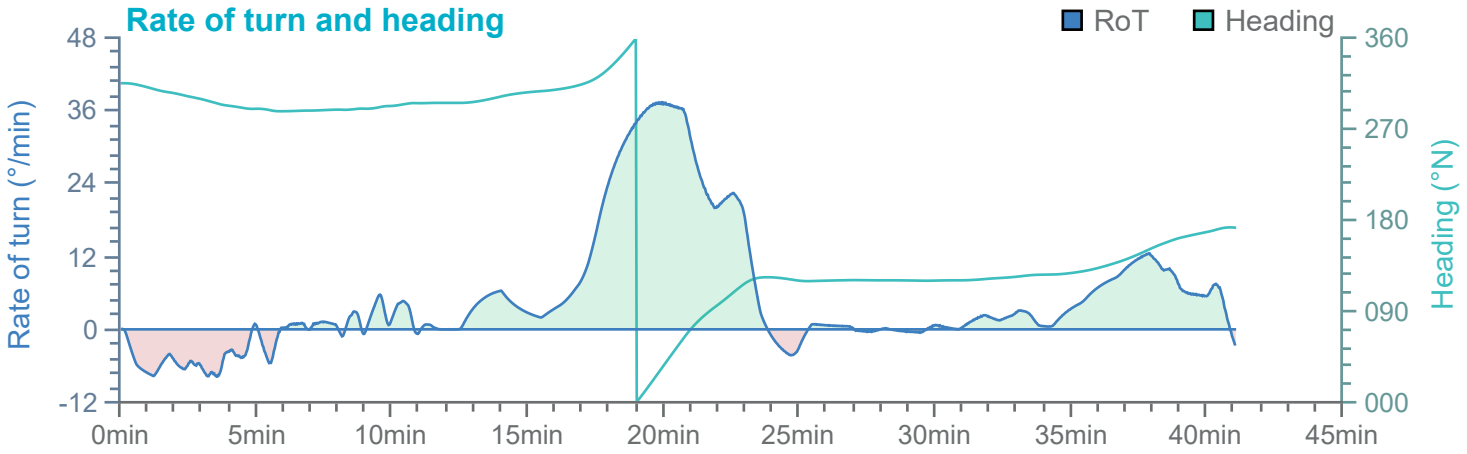


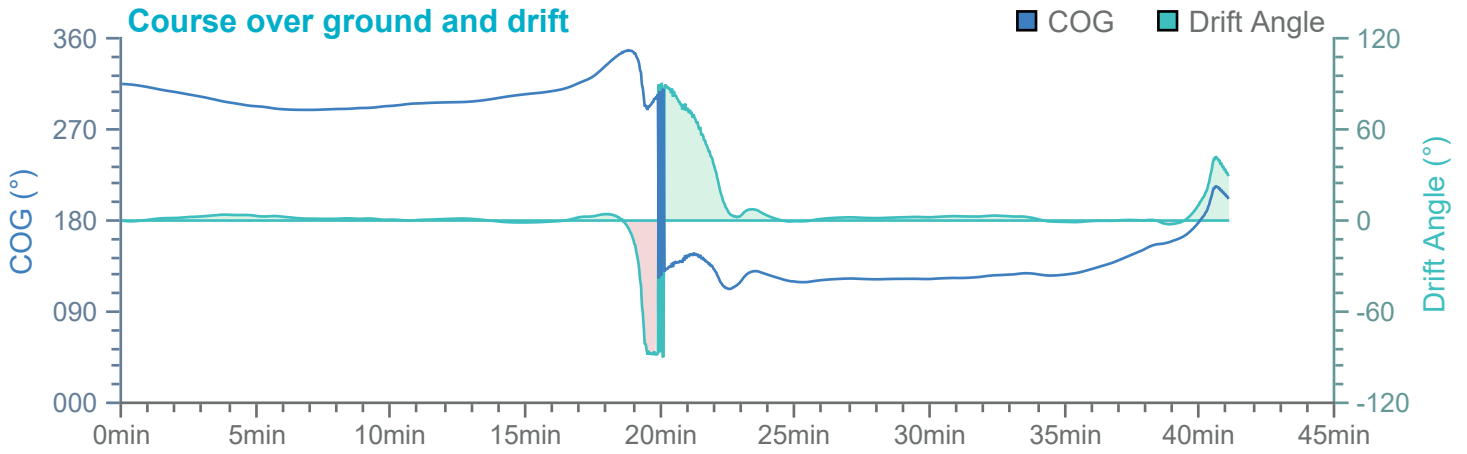
Ships plotted every 2 mins, highlight every 10 mins

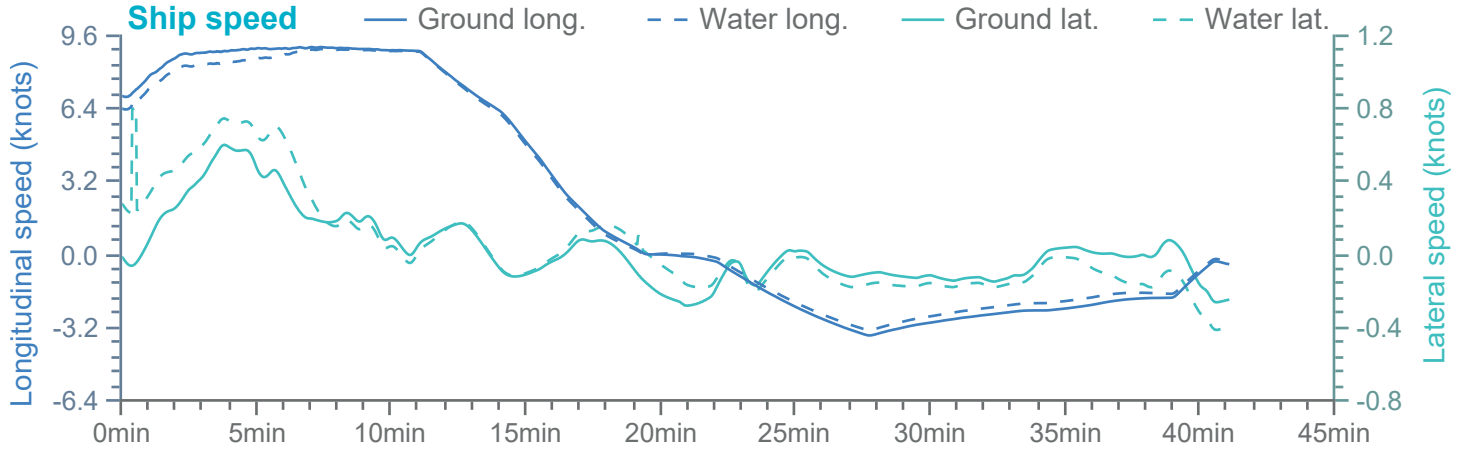

Current acting on ship
Bow
Stern
Bow Dir
Stern Dir
Current speed (knots)
Current direction (°N)
0.0
0.2
0.4
0.6
0.8
000
090
180
270
360
0min
5min
10min
15min
20min
25min
30min
35min
40min
45min

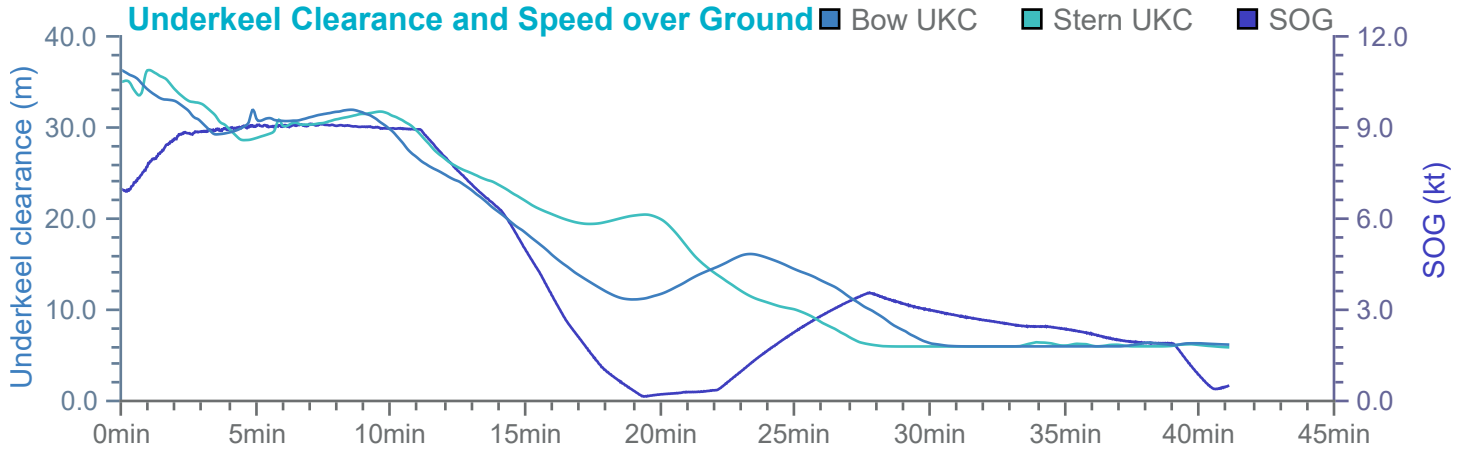

Wind speed and direction
Speed
Direction
Wind speed (knots)
Wind direction (°N)
0
10
20
30
40
000
090
180
270
360
0min
5min
10min
15min
20min
25min
30min
35min
40min
45min

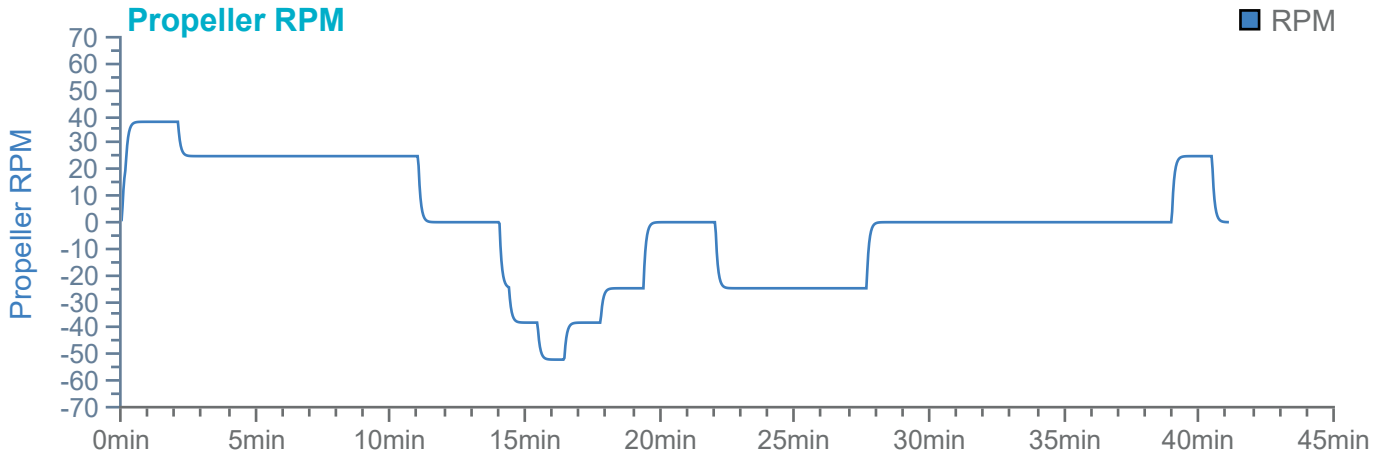

Sig. wave height and direction
Hs1
Hs2
Dir1
Dir2
Hs (m)
Wave direction (°N)
0.00
0.75
1.50
2.25
3.00
000
090
180
270
360
0min
5min
10min
15min
20min
25min
30min
35min
40min
45min

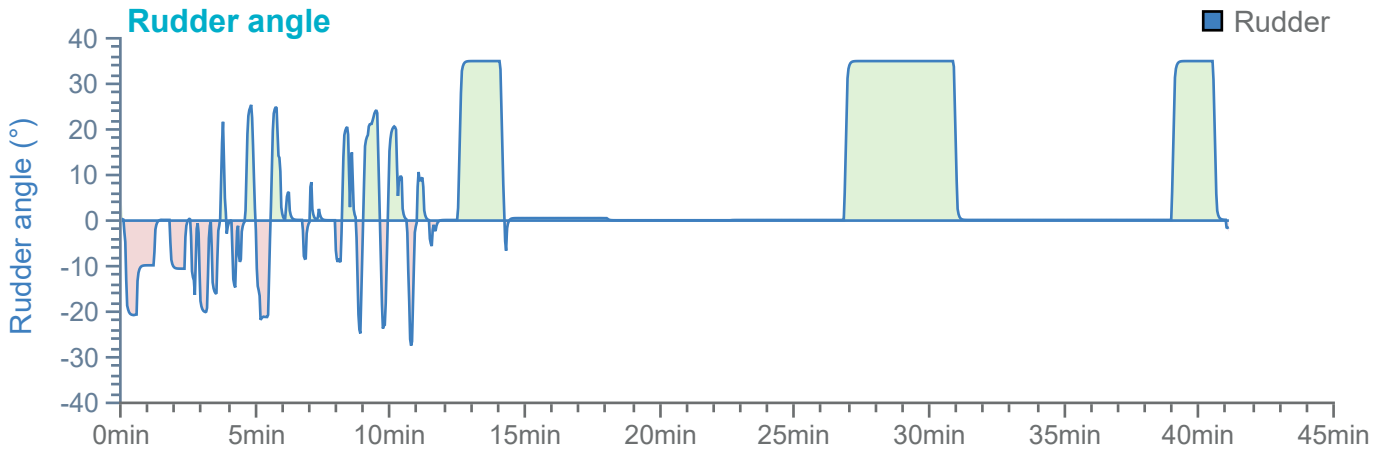

Rate of turn and heading
RoT
Heading
Rate of turn (°/min)
Heading (°N)
48
36
24
12
0
-12
360
270
180
090
000
0min
5min
10min
15min
20min
25min
30min
35min
40min
45min

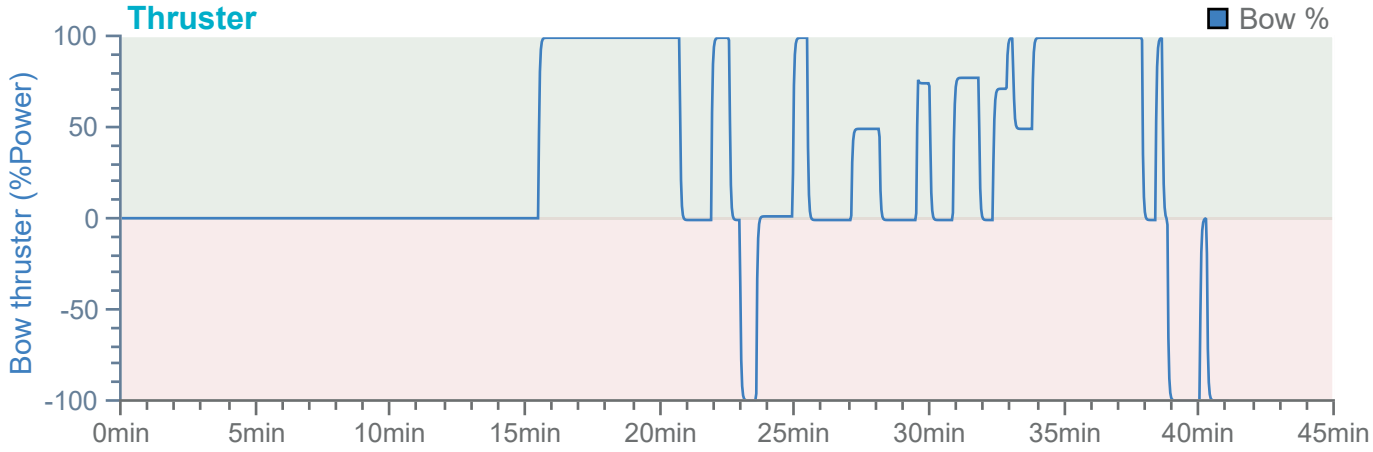

Course over ground and drift
COG
Drift Angle
COG (°)
Drift Angle (°)
360
270
180
090
000
120
60
0
-60
-120
0min
5min
10min
15min
20min
25min
30min
35min
40min
45min


Ship speed
Ground long.
Water long.
Ground lat.
Water lat.
Longitudinal speed (knots)
Lateral speed (knots)
9.6
6.4
3.2
0.0
-3.2
-6.4
1.2
0.8
0.4
0.0
-0.4
-0.8
0min
5min
10min
15min
20min
25min
30min
35min
40min
45min

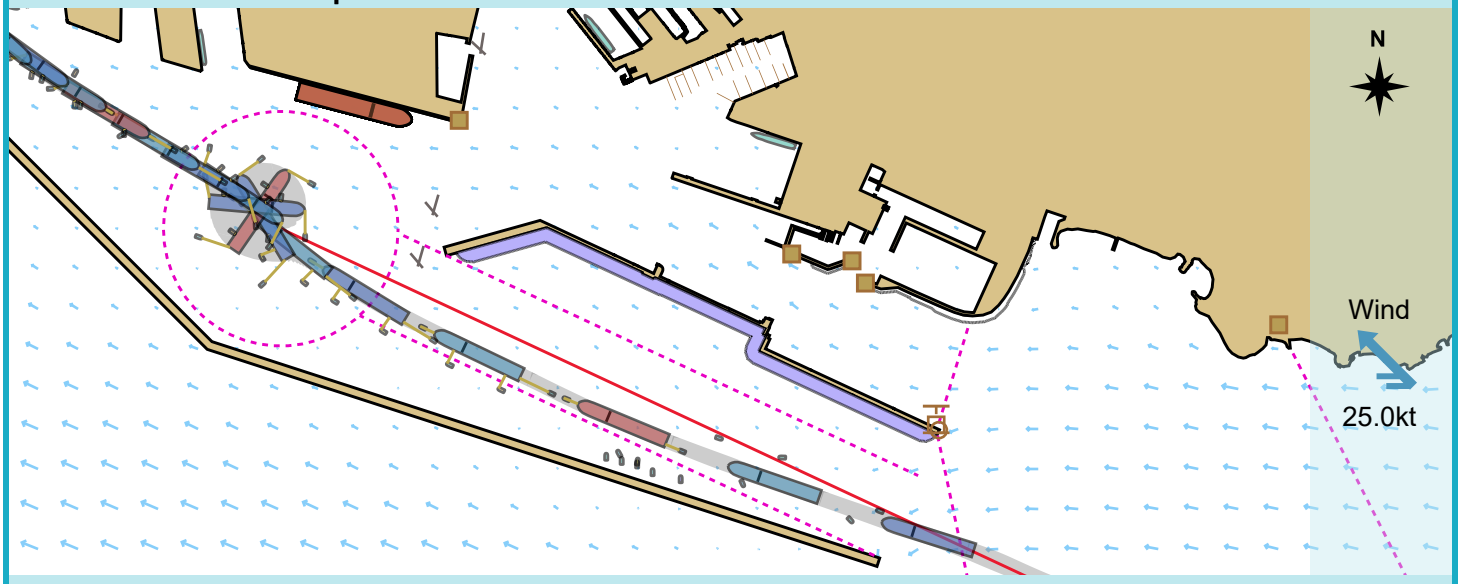

Underkeel Clearance and Speed over Ground
Bow UKC
Stern UKC
SOG
Underkeel clearance (m)
SOG (kt)
40.0
30.0
20.0
10.0
0.0
12.0
9.0
6.0
3.0
0.0
0min
5min
10min
15min
20min
25min
30min
35min
40min
45min


Propeller RPM
RPM
Propeller RPM
70
60
50
40
30
20
10
0
-10
-20
-30
-40
-50
-60
-70
0min
5min
10min
15min
20min
25min
30min
35min
40min
45min


Rudder angle
Rudder
Rudder angle (°)
40
30
20
10
0
-10
-20
-30
-40
0min
5min
10min
15min
20min
25min
30min
35min
40min
45min

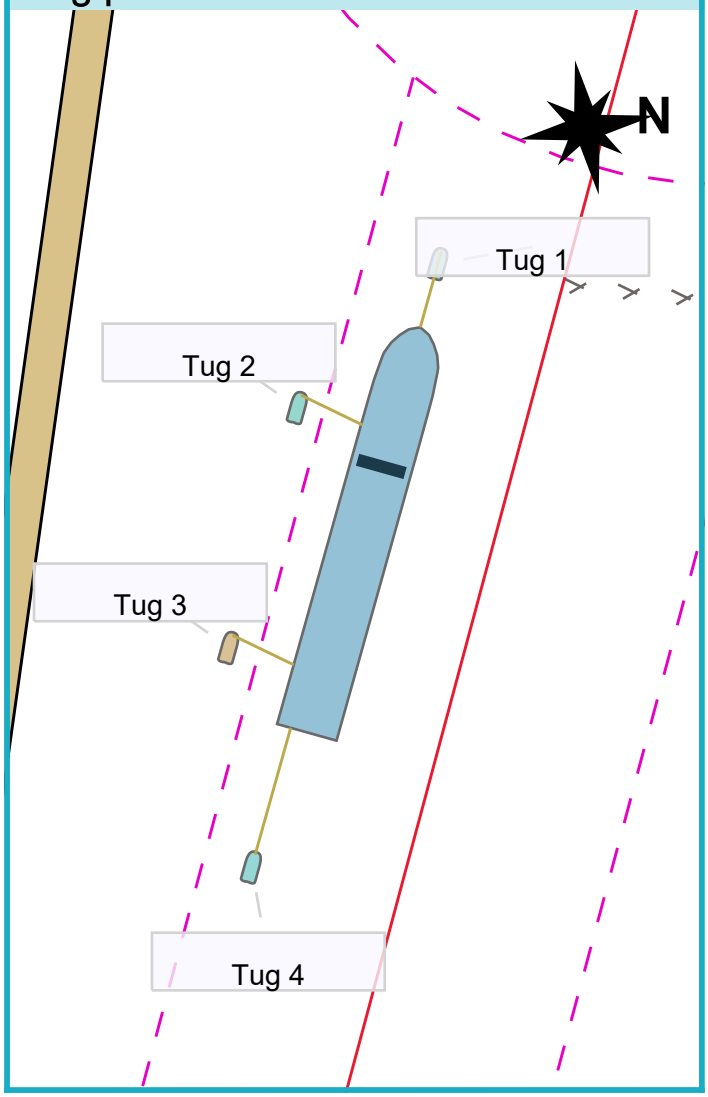

Thruster
Bow %
Bow thruster (%Power)
100
50
0
-50
-100
0min
5min
10min
15min
20min
25min
30min
35min
40min
45min

Manoeuvre track plot

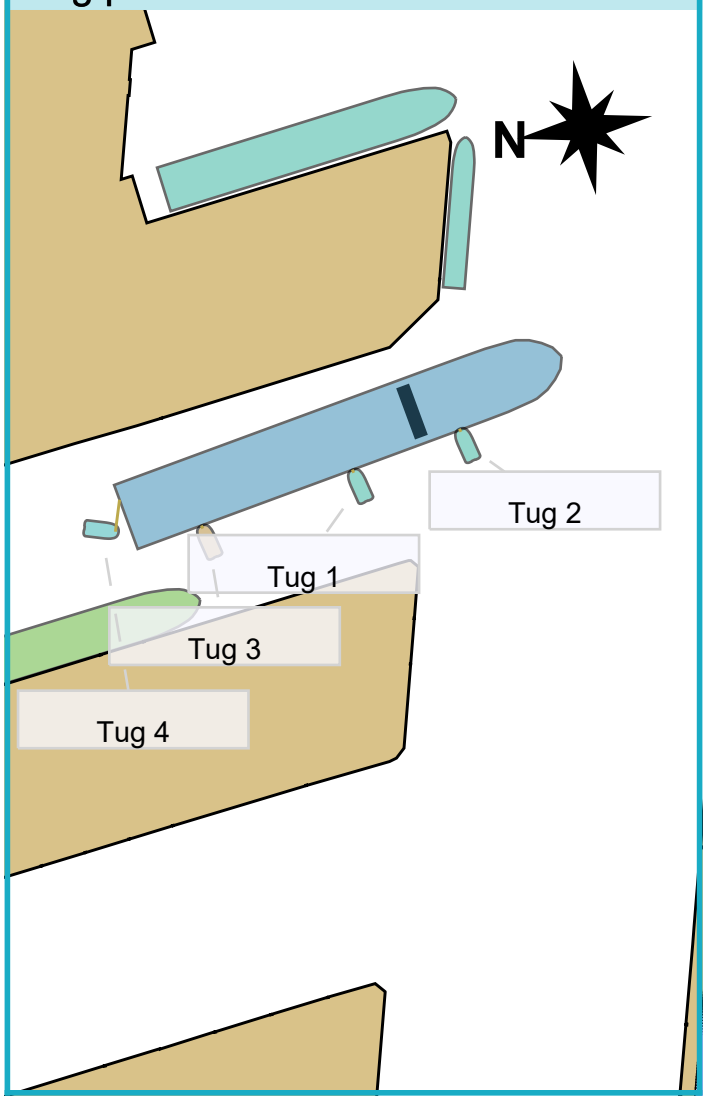


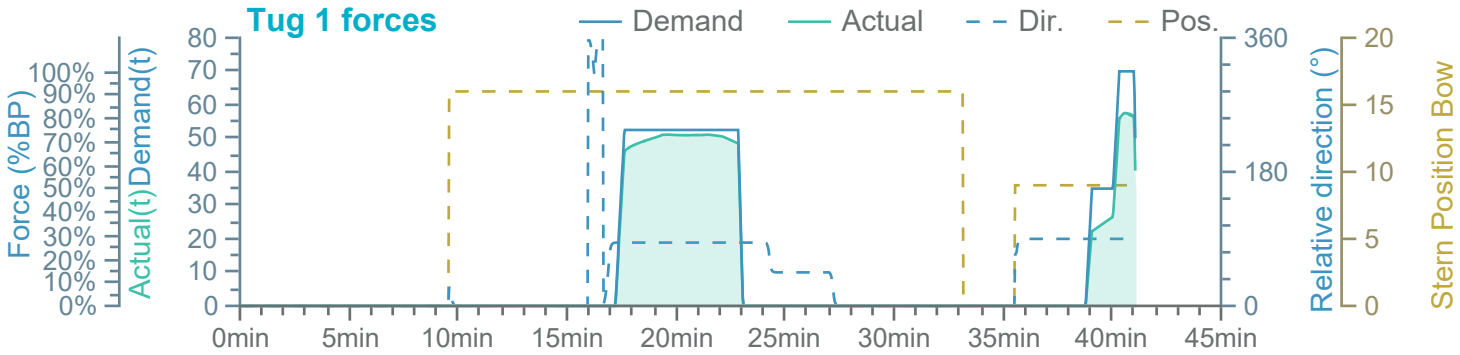
Ships plotted every 2 mins, highlight every 10 mins

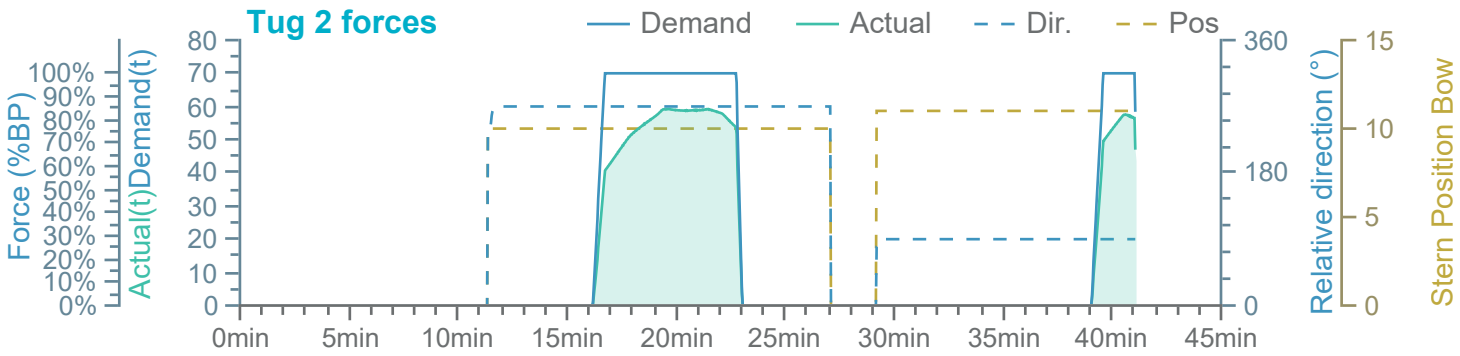
Tug position: Initial

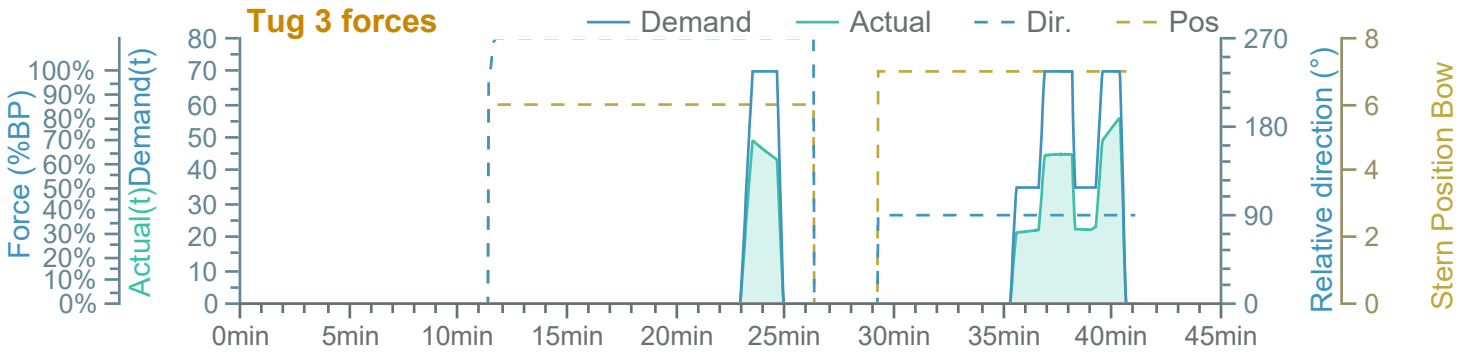


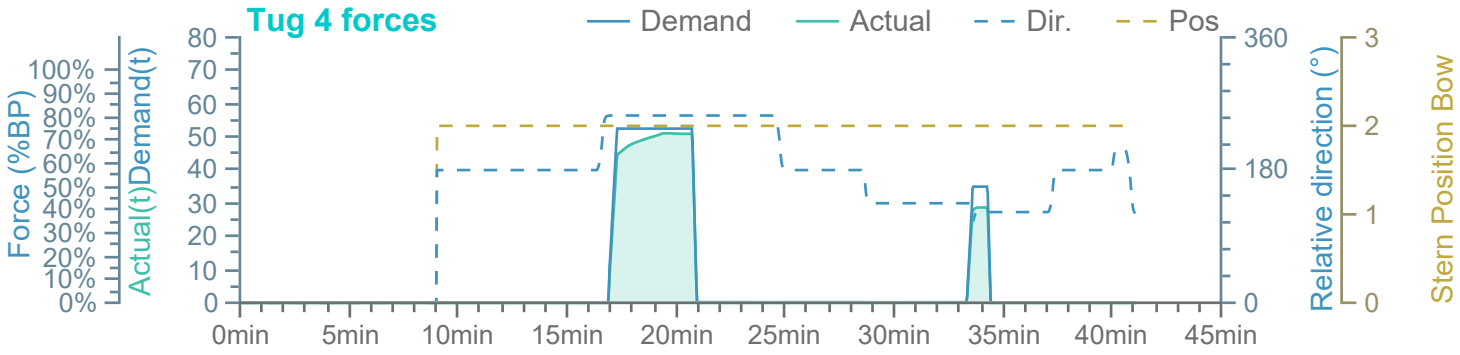
Tug position: Final



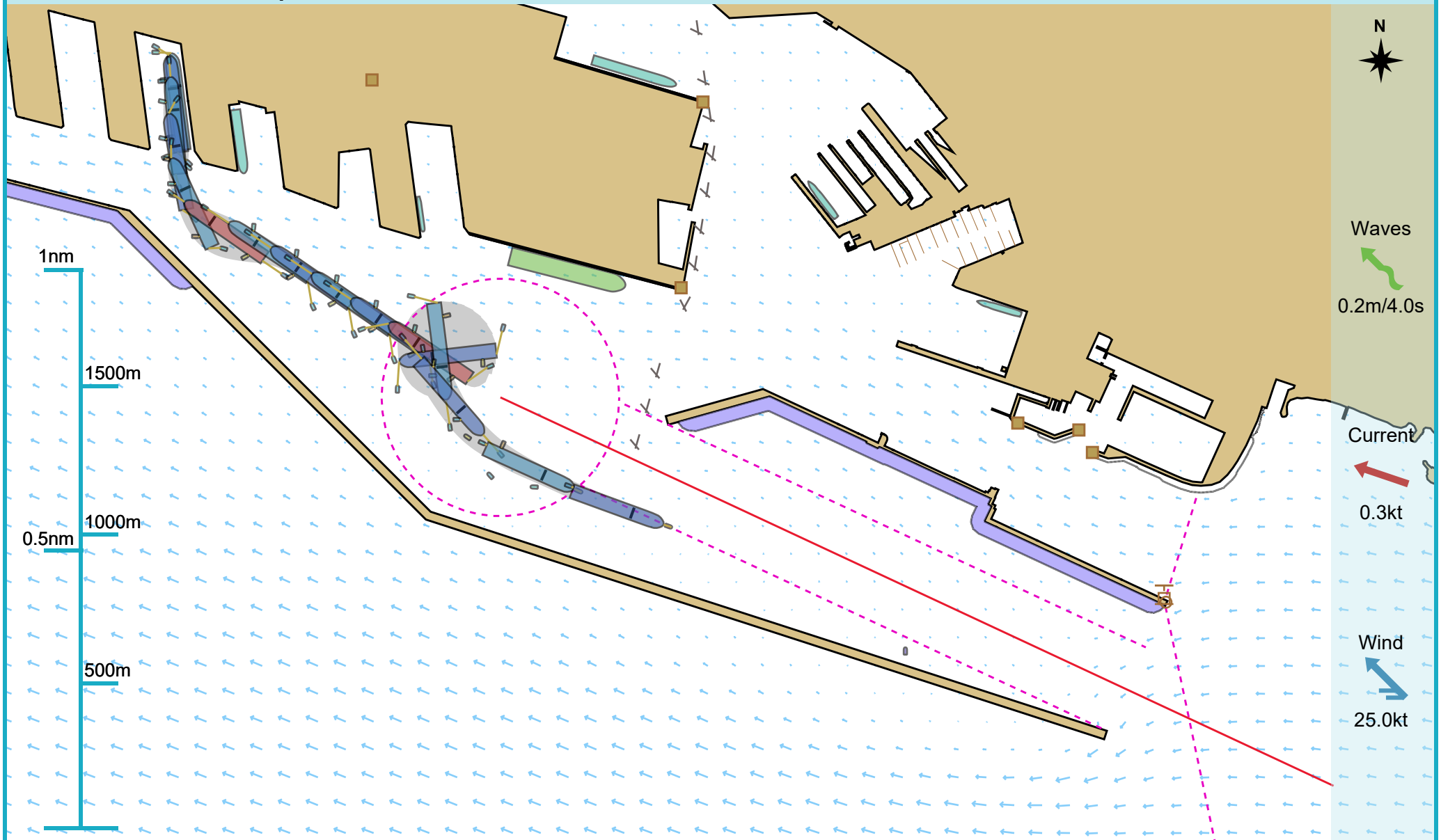

Tug 1 forces
Demand
Actual
Dir.
Pos.
Force (%BP)
Actual(t)Demand(t)
Relative direction (°)
Stern Position Bow
0min
5min
10min
15min
20min
25min
30min
35min
40min
45min


Tug 2 forces
Demand
Actual
Dir.
Pos
Force (%BP)
Actual(t)Demand(t)
Relative direction (°)
Stern Position Bow
0min
5min
10min
15min
20min
25min
30min
35min
40min
45min

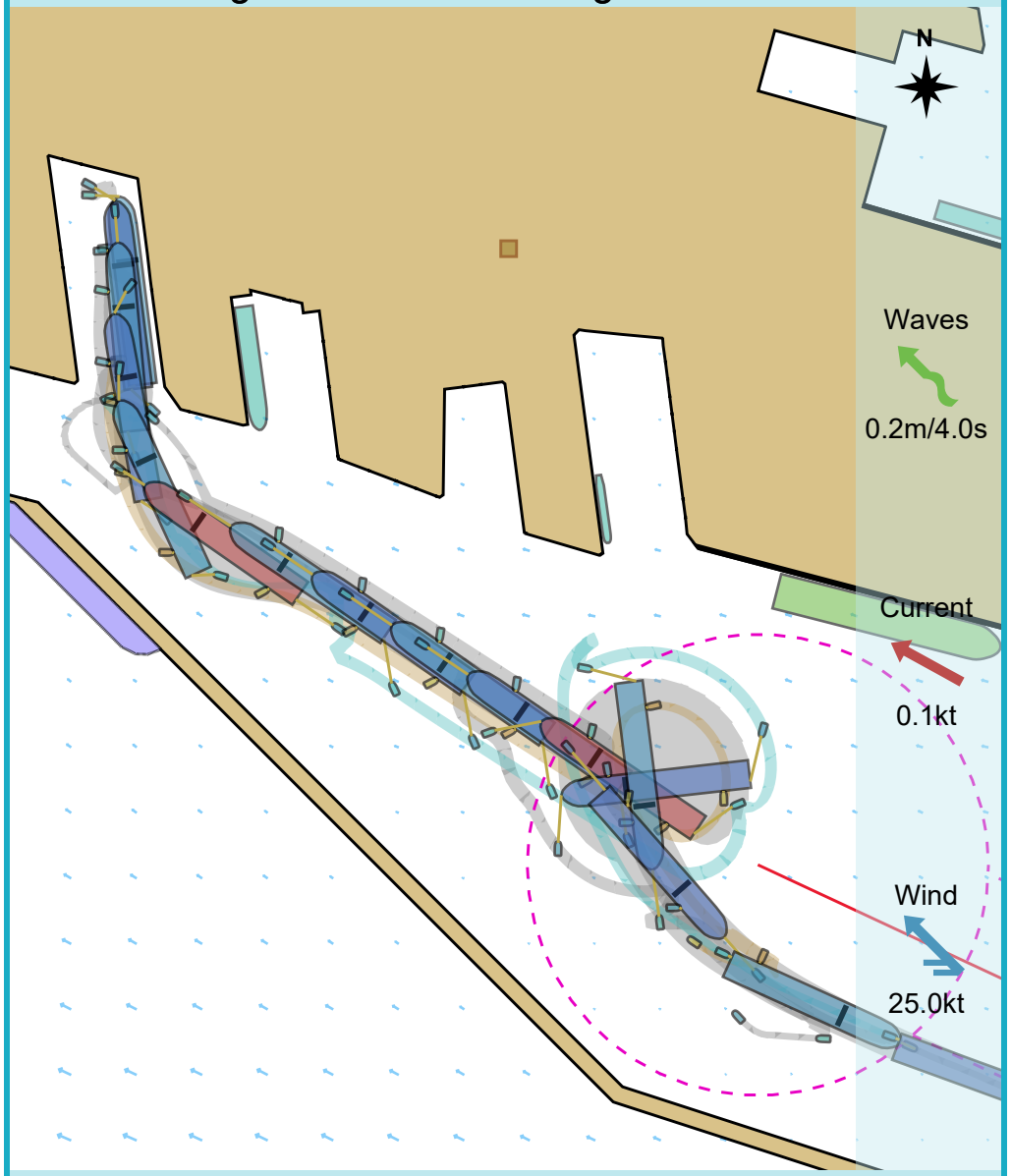

Tug 3 forces
Demand
Actual
Dir.
Pos
Force (%BP)
Actual(t)Demand(t)
Relative direction (°)
Stern Position Bow
0min
5min
10min
15min
20min
25min
30min
35min
40min
45min


Tug 4 forces
Demand
Actual
Dir.
Pos
Force (%BP)
Actual(t)Demand(t)
Relative direction (°)
Stern Position Bow
0min
5min
10min
15min
20min
25min
30min
35min
40min
45min

Manoeuvre track plot

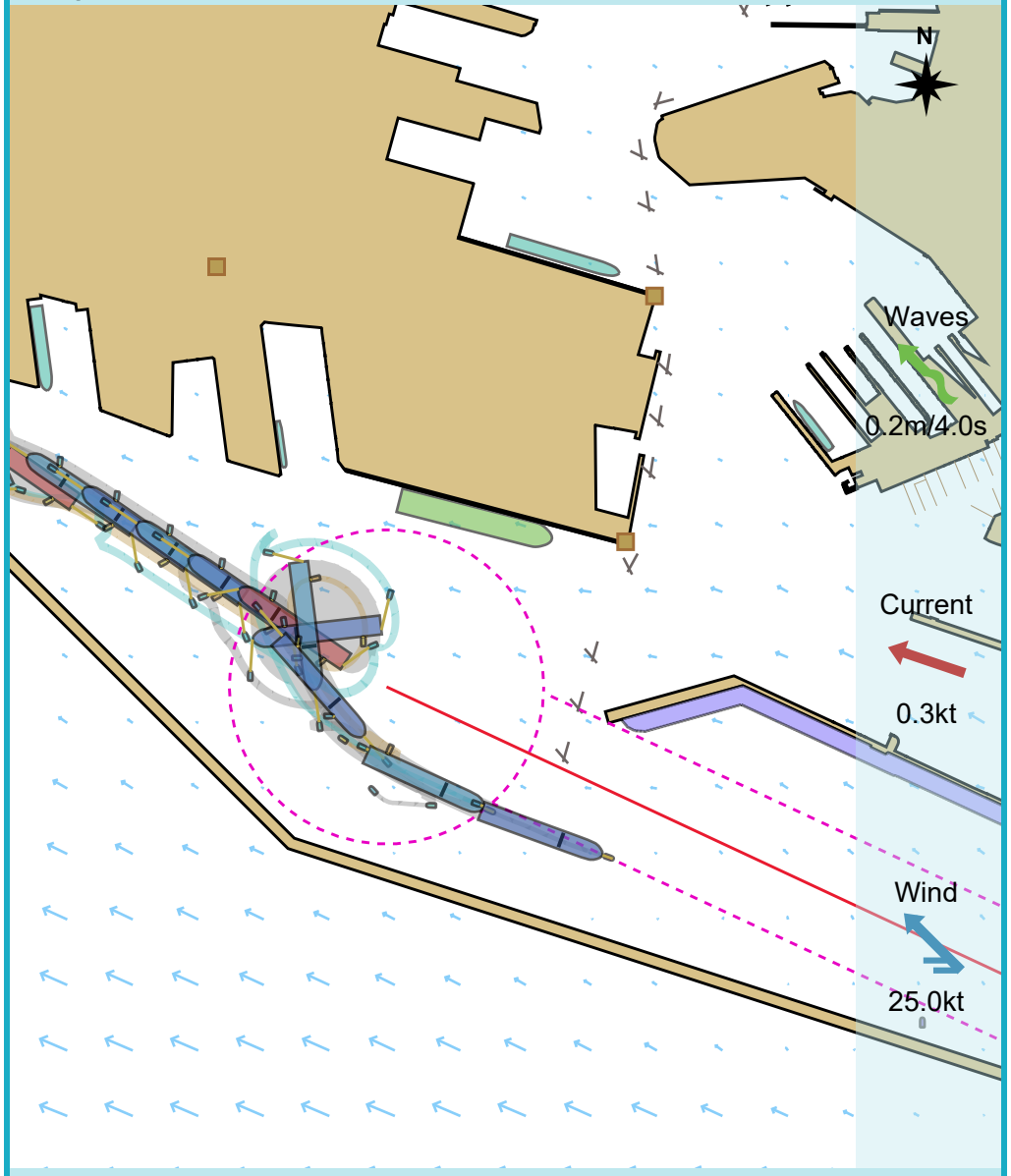


Manoeuvring area and unberthing

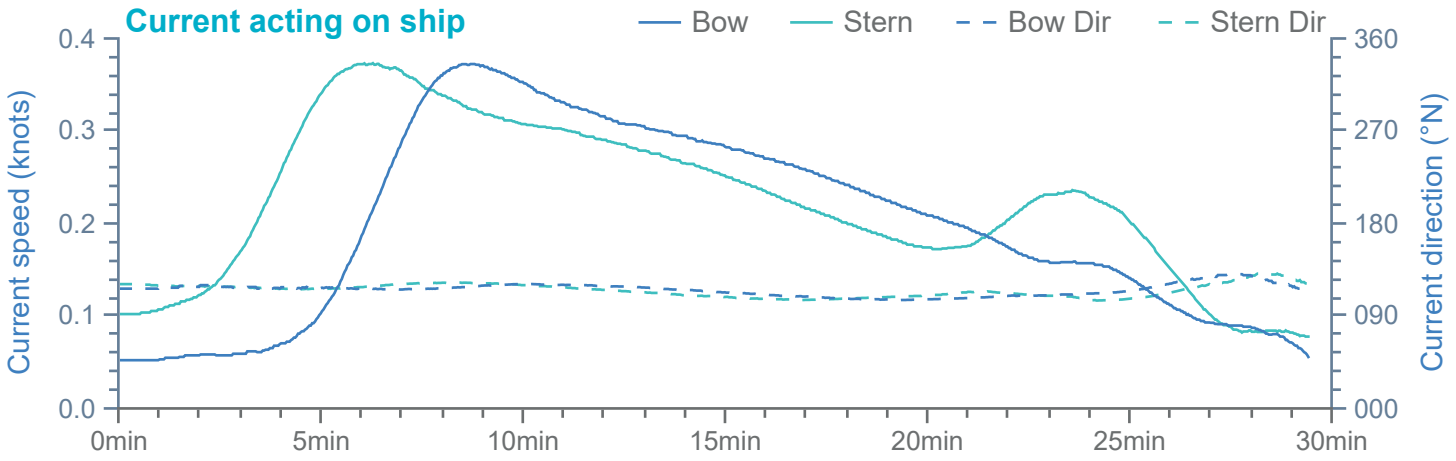


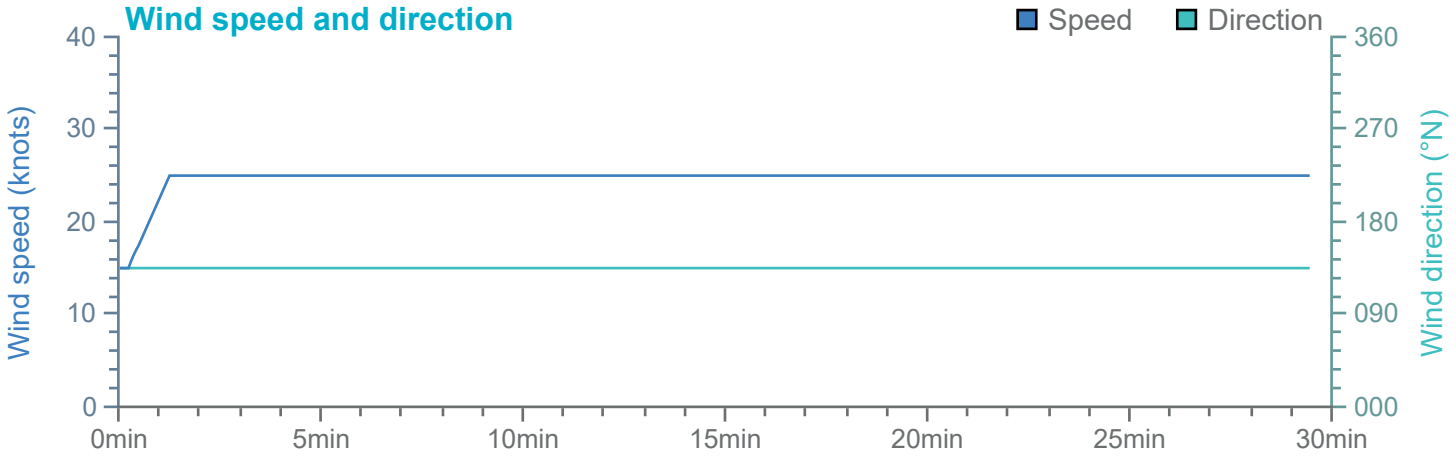
Ships plotted every 2 mins, highlight every 10 mins

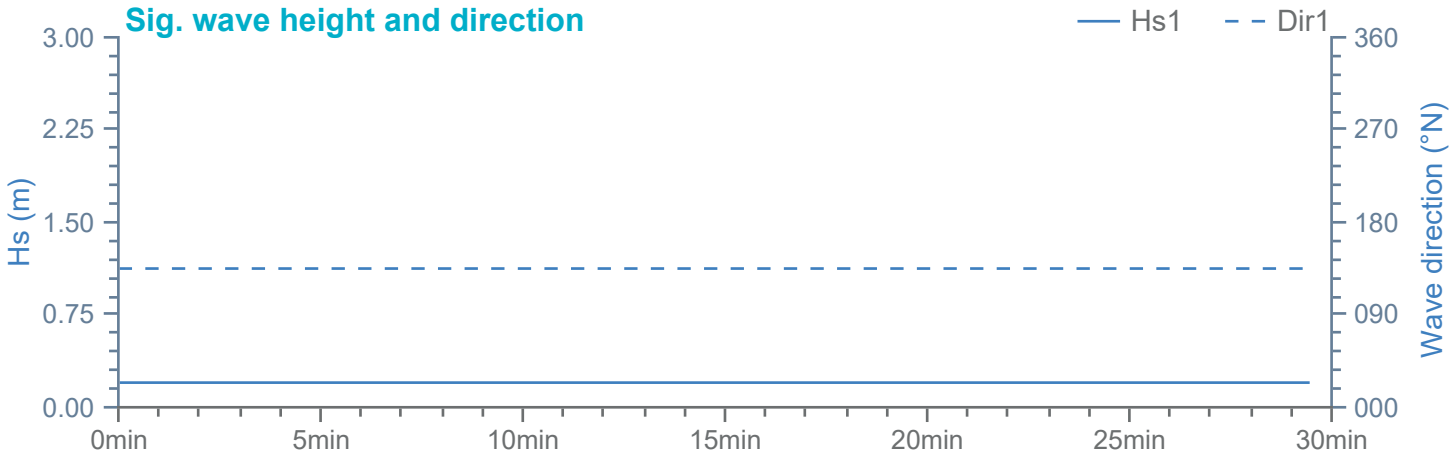
Departure Channel

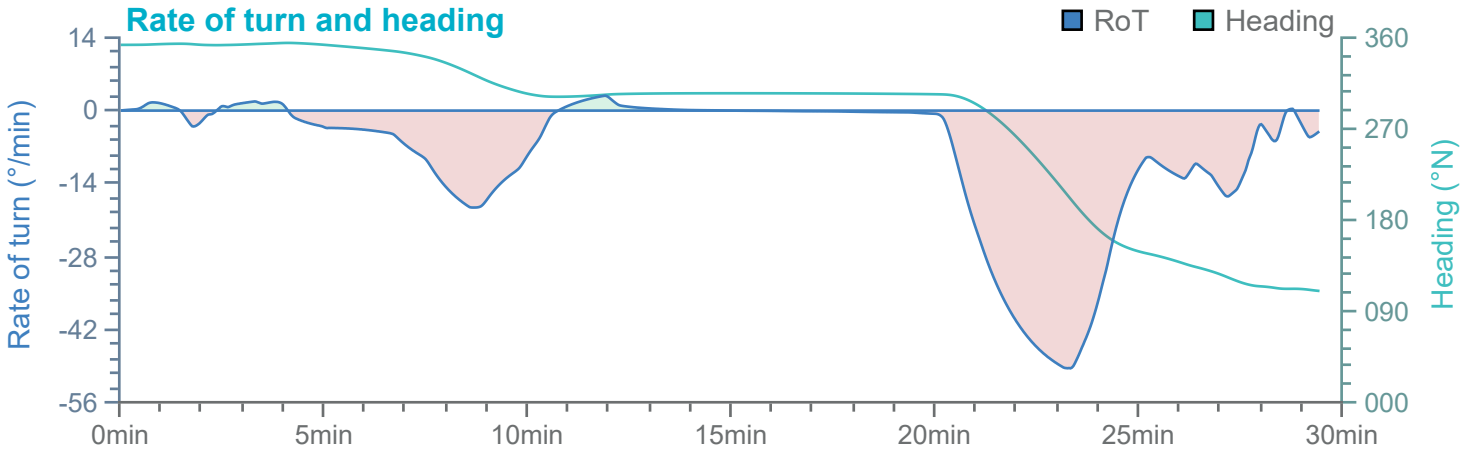


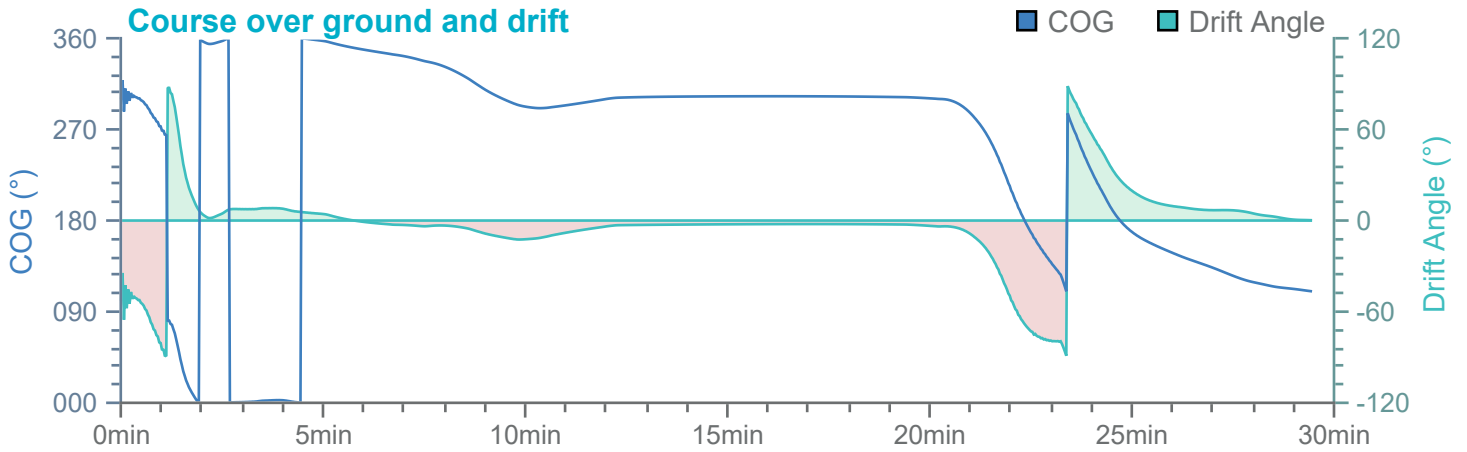
Ships plotted every 2 mins, highlight every 10 mins

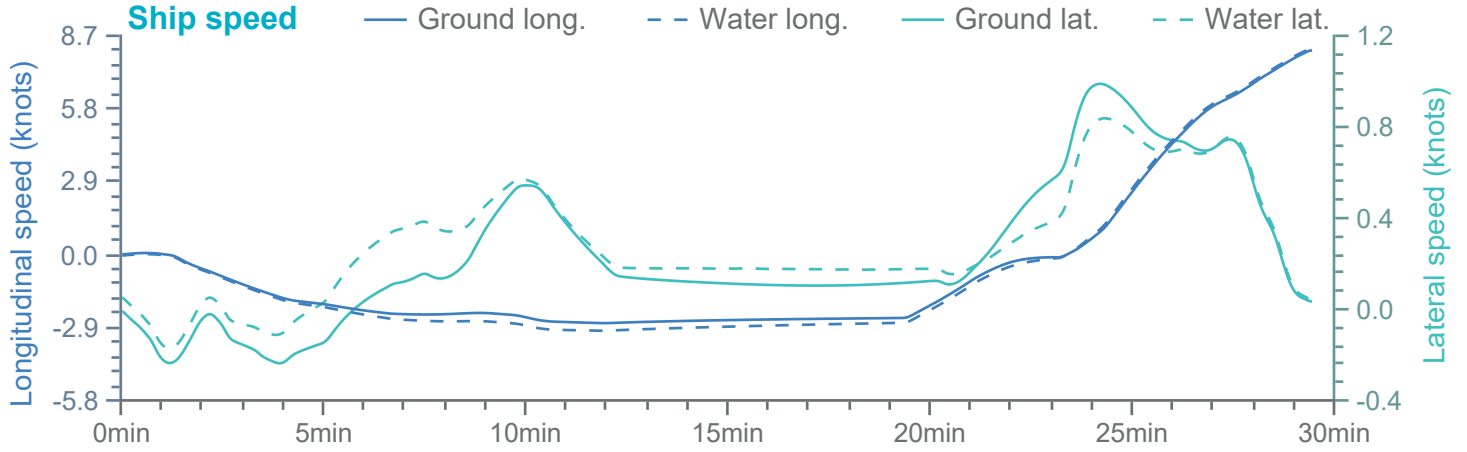

Current acting on ship
Bow
Stern
Bow Dir
Stern Dir
Current speed (knots)
Current direction (°N)
0.0
0.1
0.2
0.3
0.4
000
090
180
270
360
0min
5min
10min
15min
20min
25min
30min

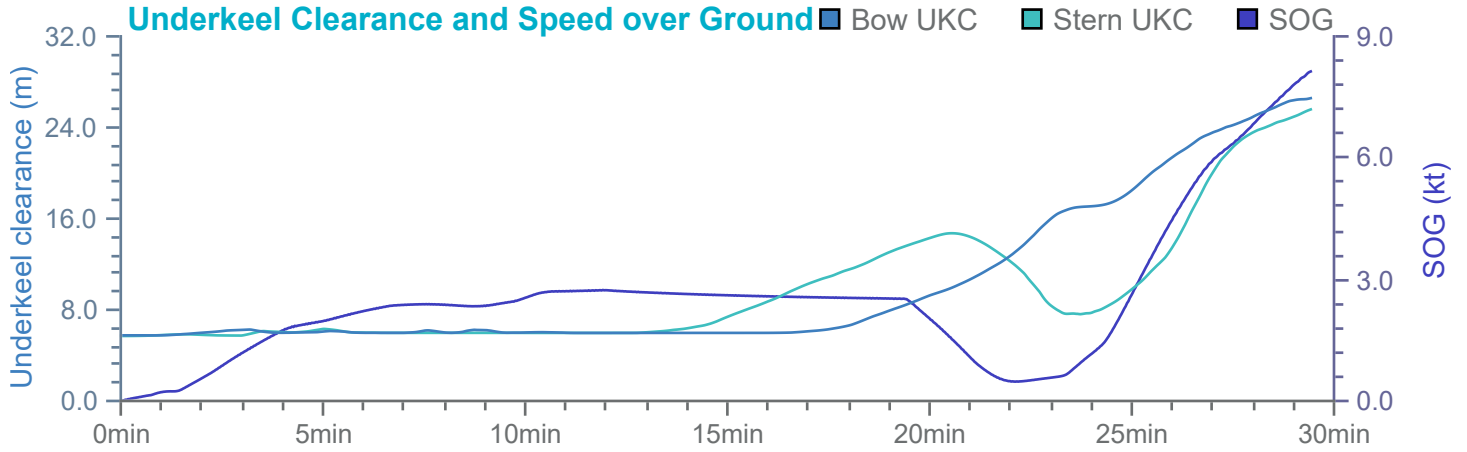

Wind speed and direction
Speed
Direction
Wind speed (knots)
Wind direction (°N)
0
10
20
30
40
000
090
180
270
360
0min
5min
10min
15min
20min
25min
30min

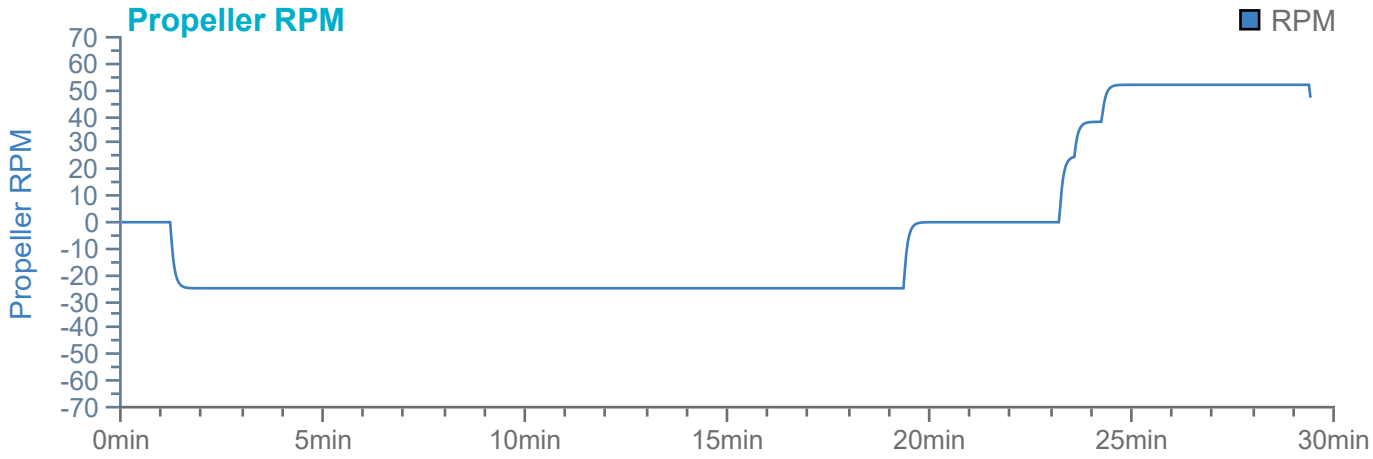

Sig. wave height and direction
Hs1
Dir1
Hs (m)
Wave direction (°N)
0.00
0.75
1.50
2.25
3.00
000
090
180
270
360
0min
5min
10min
15min
20min
25min
30min

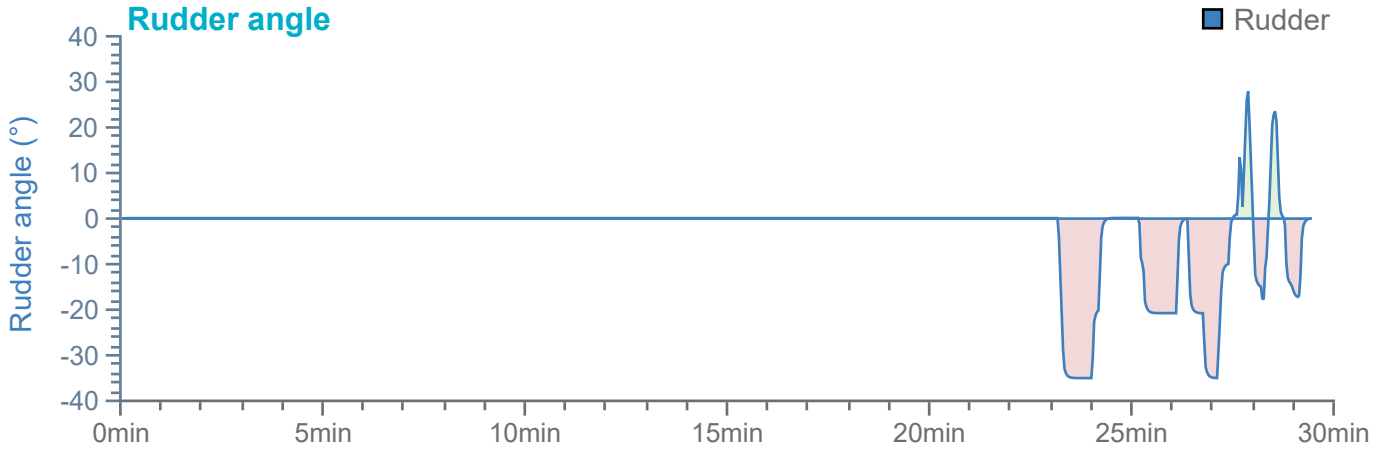

Rate of turn and heading
RoT
Heading
Rate of turn (°/min)
Heading (°N)
14
0
-14
-28
-42
-56
360
270
180
090
000
0min
5min
10min
15min
20min
25min
30min

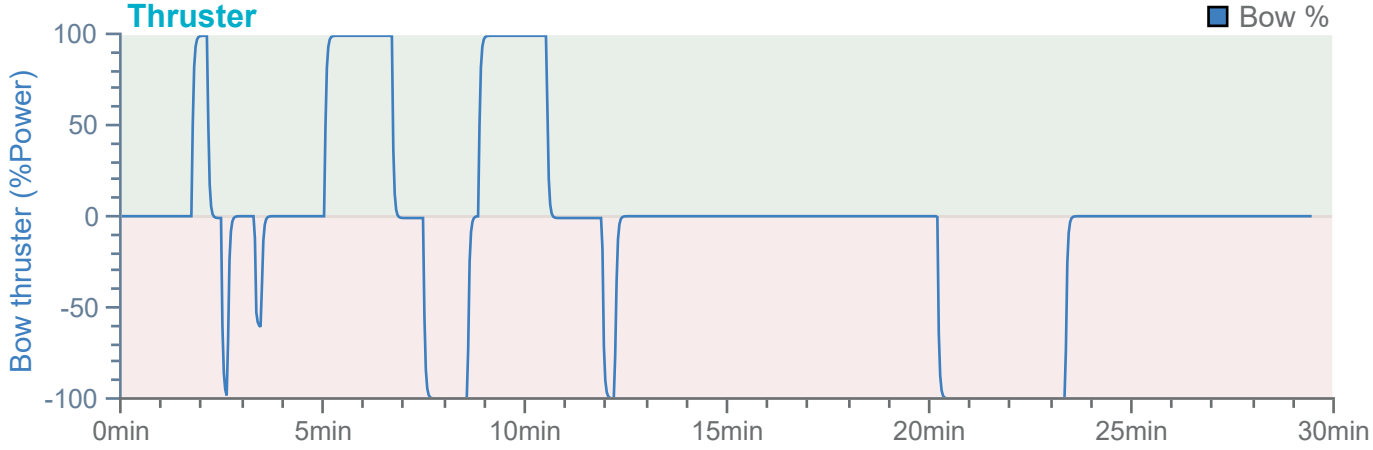

Course over ground and drift
COG
Drift Angle
COG (°)
Drift Angle (°)
360
270
180
090
000
120
60
0
-60
-120
0min
5min
10min
15min
20min
25min
30min


Ship speed
Ground long.
Water long.
Ground lat.
Water lat.
Longitudinal speed (knots)
Lateral speed (knots)
8.7
5.8
2.9
0.0
-2.9
-5.8
1.2
0.8
0.4
0.0
-0.4
0min
5min
10min
15min
20min
25min
30min

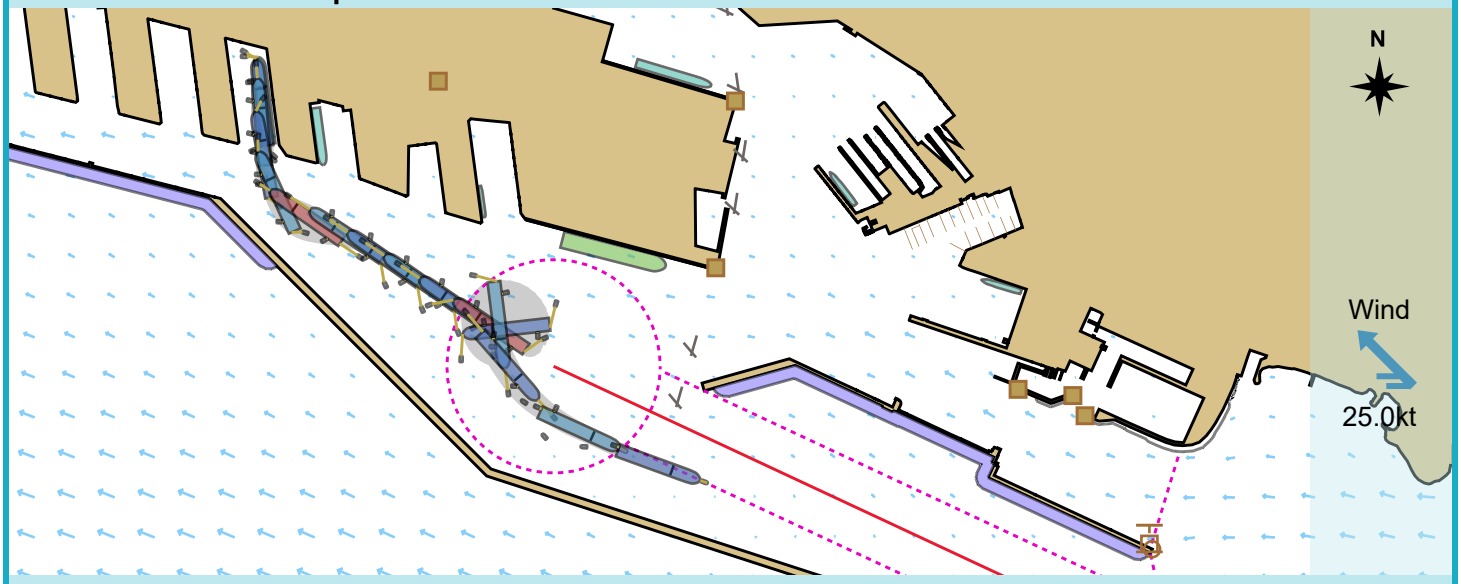

Underkeel Clearance and Speed over Ground
Bow UKC
Stern UKC
SOG
Underkeel clearance (m)
SOG (kt)
32.0
24.0
16.0
8.0
0.0
9.0
6.0
3.0
0.0
0min
5min
10min
15min
20min
25min
30min


Propeller RPM
RPM
Propeller RPM
70
60
50
40
30
20
10
0
-10
-20
-30
-40
-50
-60
-70
0min
5min
10min
15min
20min
25min
30min


Rudder angle
Rudder
Rudder angle (°)
40
30
20
10
0
-10
-20
-30
-40
0min
5min
10min
15min
20min
25min
30min

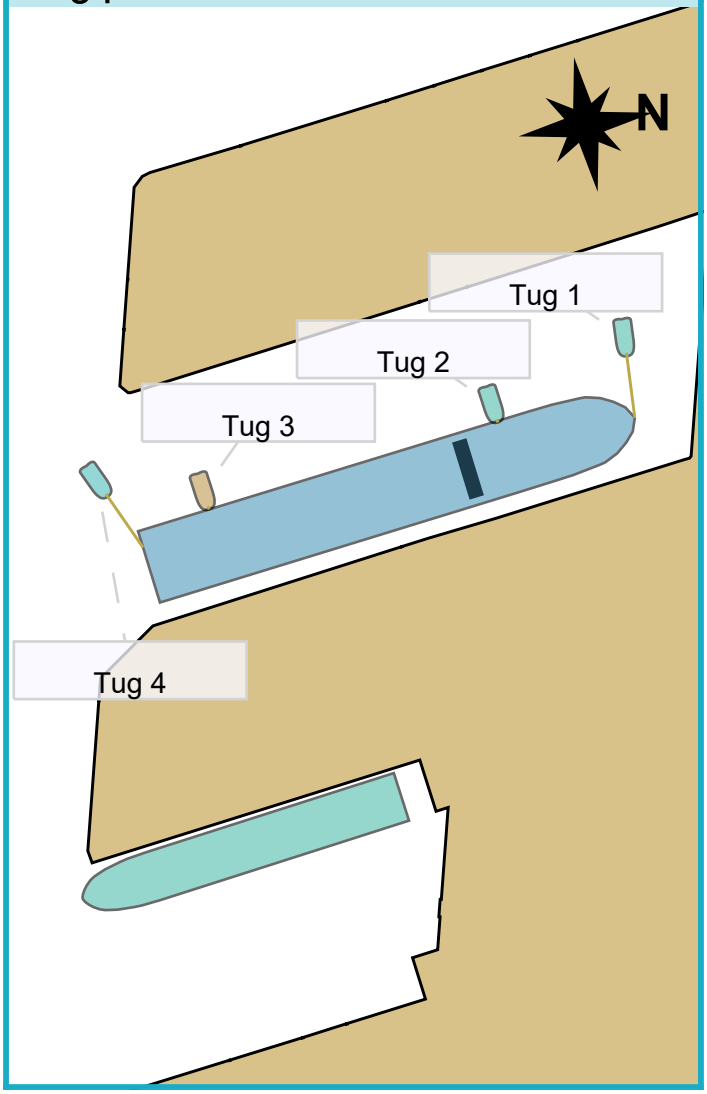

Thruster
Bow %
Bow thruster (%Power)
100
50
0
-50
-100
0min
5min
10min
15min
20min
25min
30min

Manoeuvre track plot

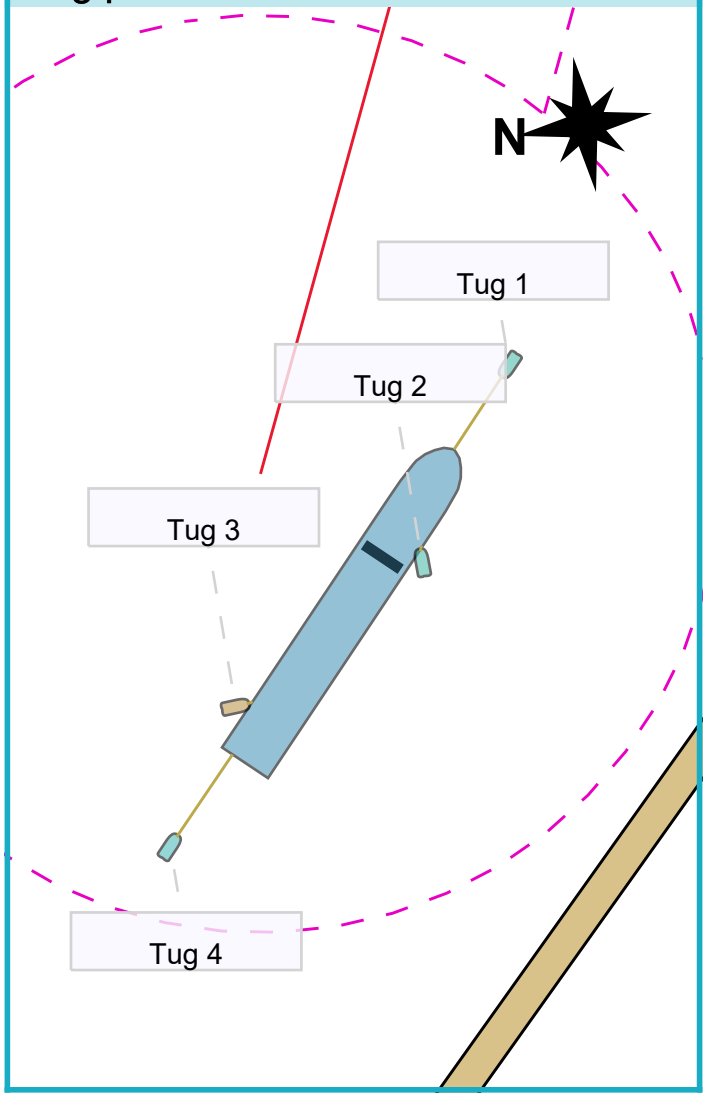


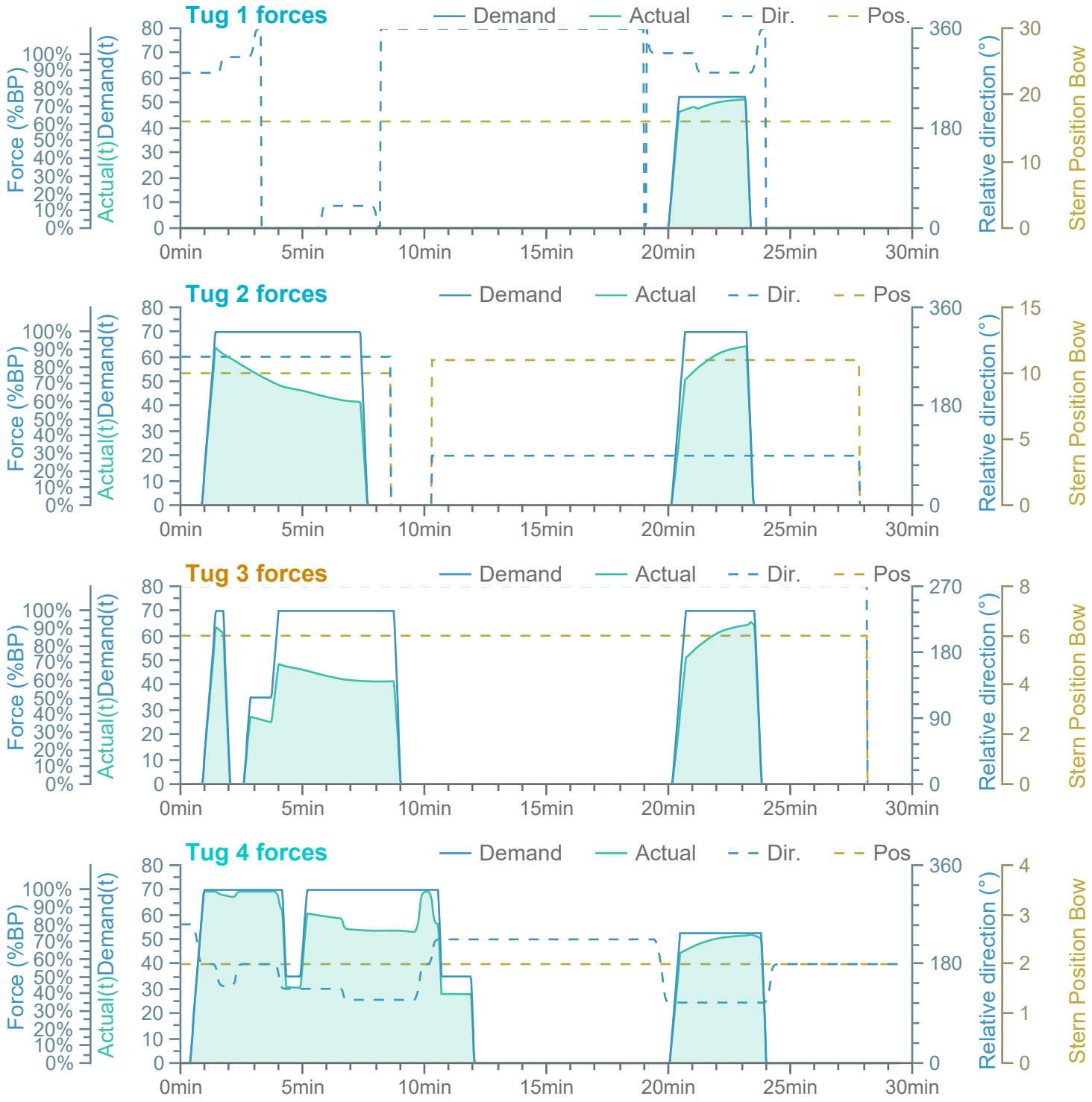
Ships plotted every 2 mins, highlight every 10 mins

Tug position: Initial

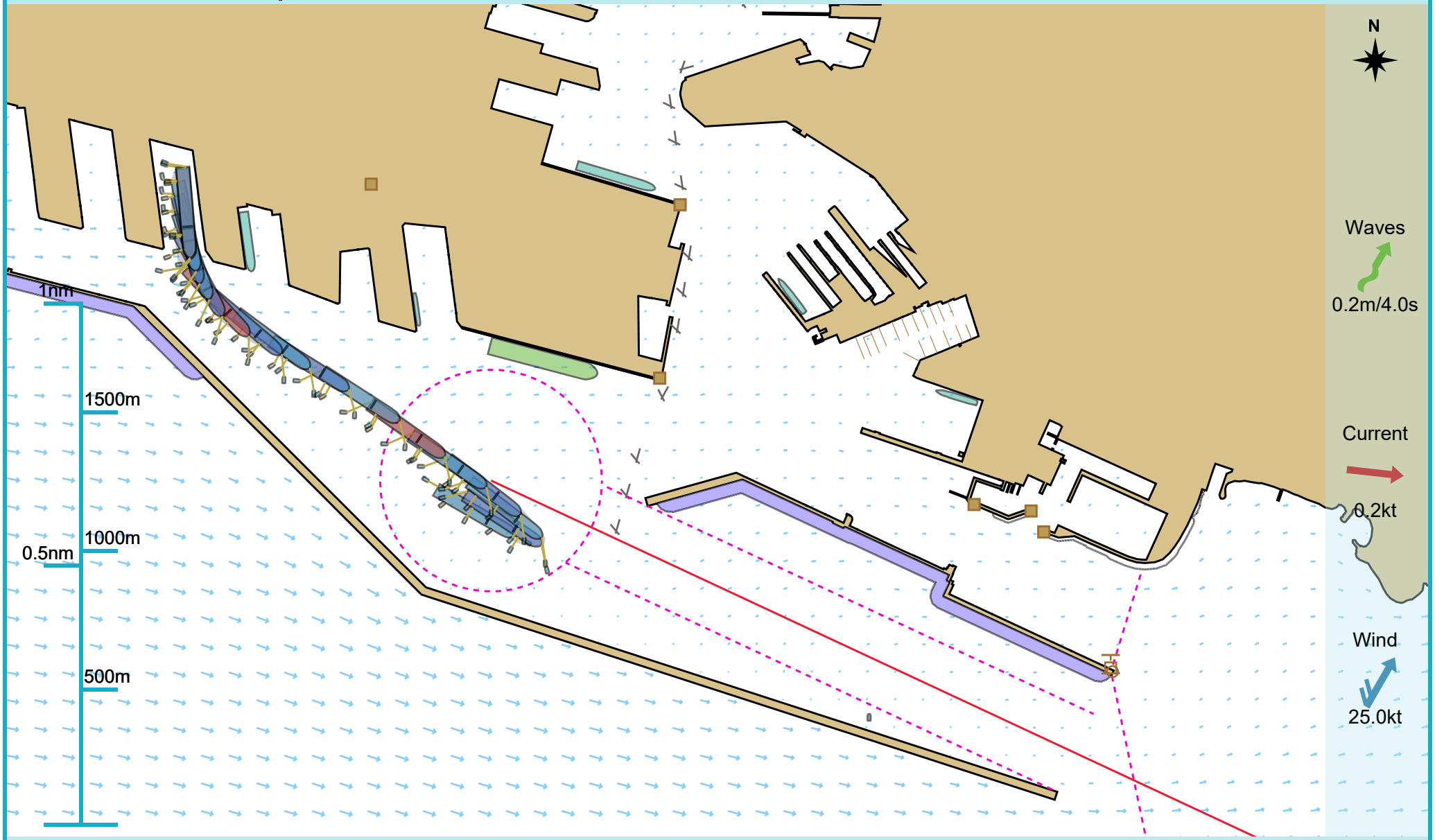


Tug position: Final

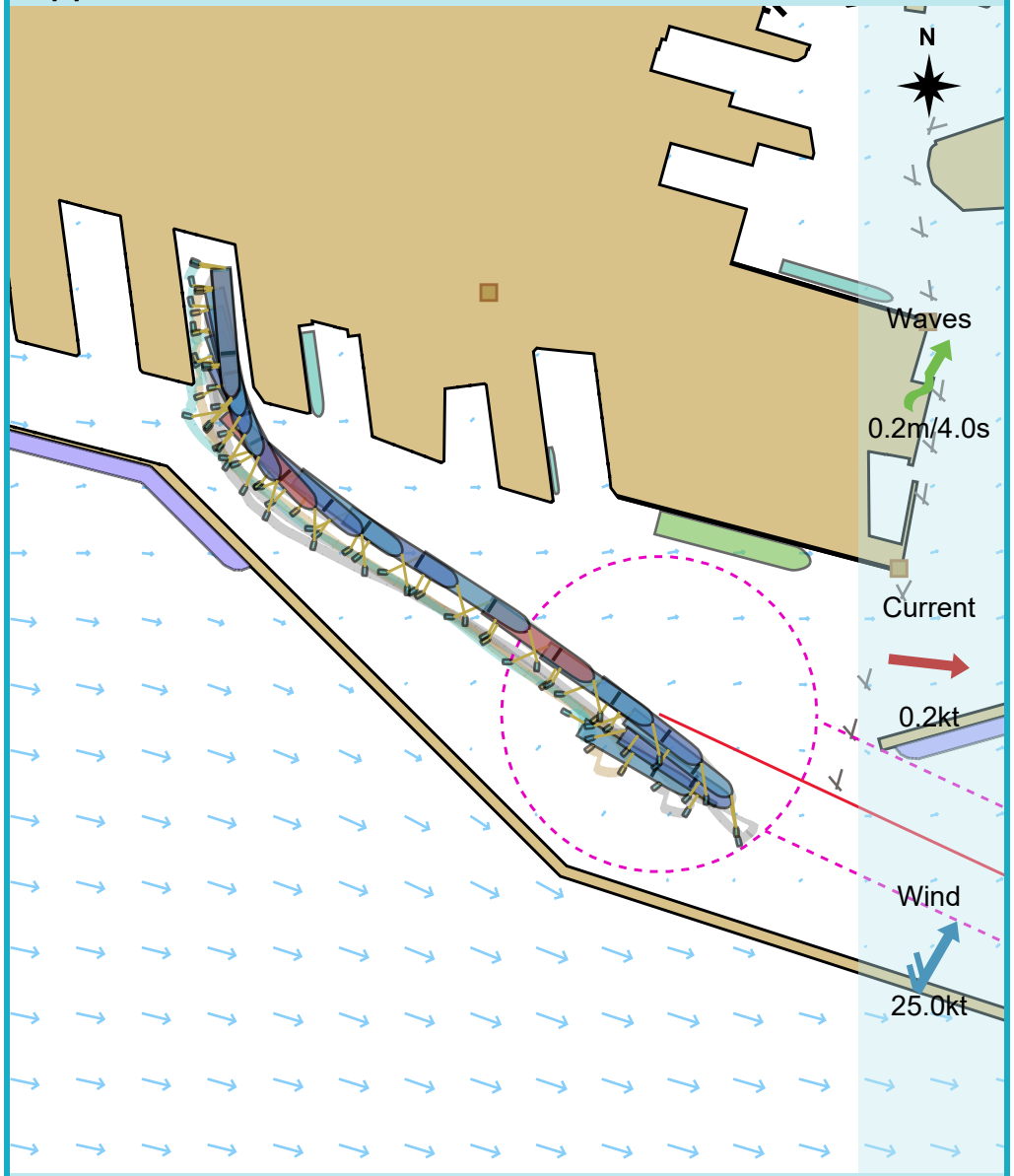



Tug 1 forces
Demand
Actual
Dir.
Pos.
Force (%BP)
Actual(t)Demand(t)
Relative direction (°)
Stern Position Bow
0min
5min
10min
15min
20min
25min
30min
Tug 2 forces
Demand
Actual
Dir.
Pos
Force (%BP)
Actual(t)Demand(t)
Relative direction (°)
Stern Position Bow
0min
5min
10min
15min
20min
25min
30min
Tug 3 forces
Demand
Actual
Dir.
Pos
Force (%BP)
Actual(t)Demand(t)
Relative direction (°)
Stern Position Bow
0min
5min
10min
15min
20min
25min
30min
Tug 4 forces
Demand
Actual
Dir.
Pos
Force (%BP)
Actual(t)Demand(t)
Relative direction (°)
Stern Position Bow
0min
5min
10min
15min
20min
25min
30min

Manoeuvre track plot

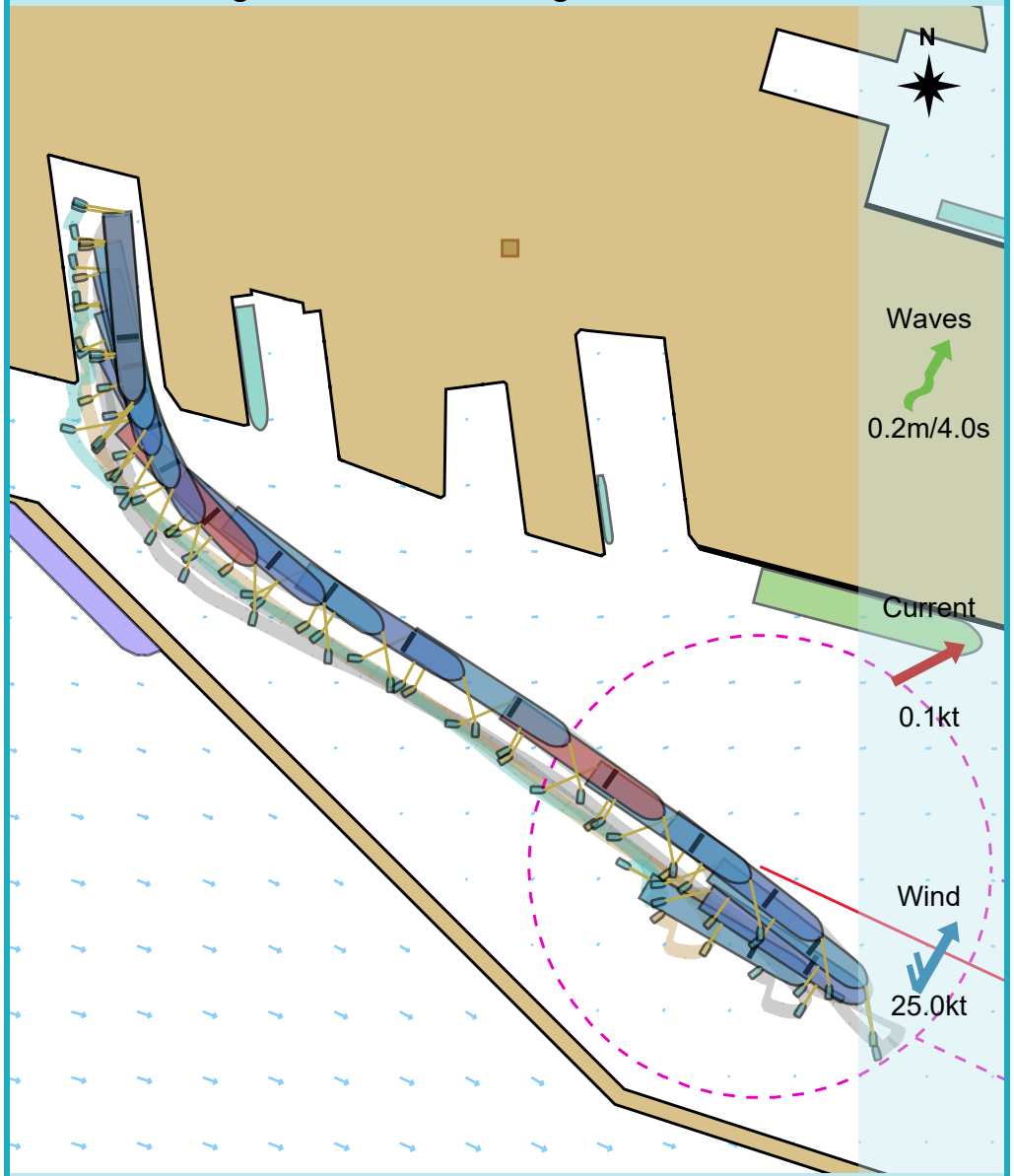


Approach Channel

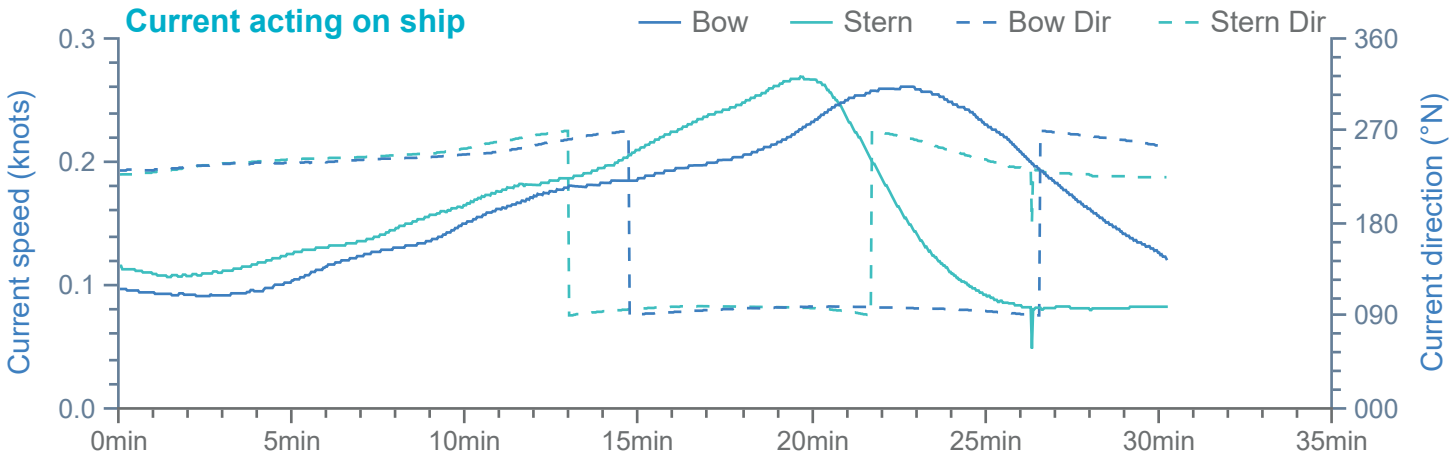


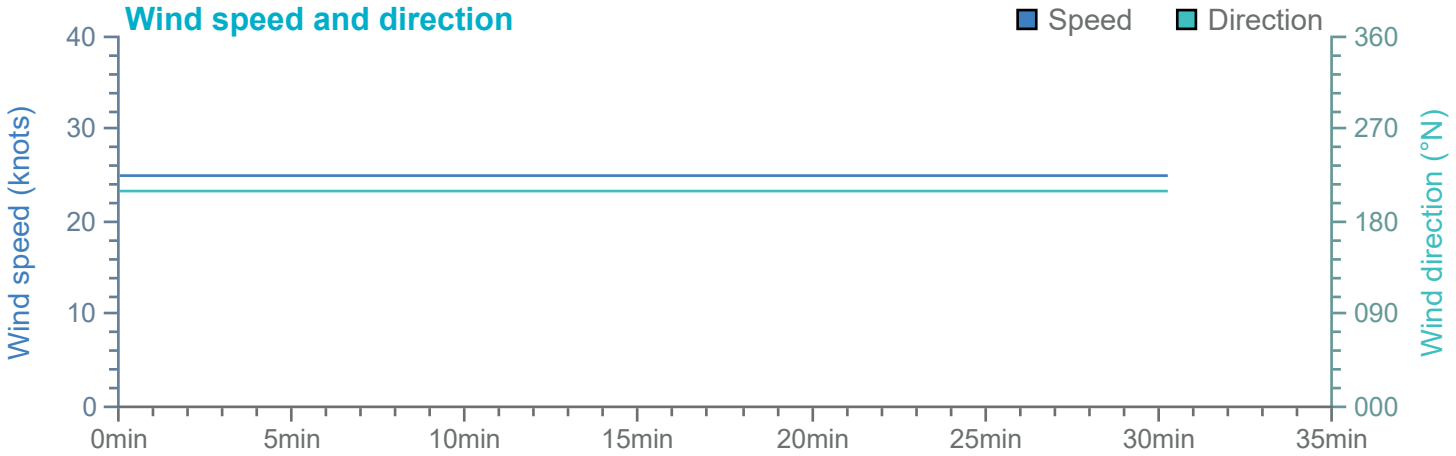
Ships plotted every 2 mins, highlight every 10 mins

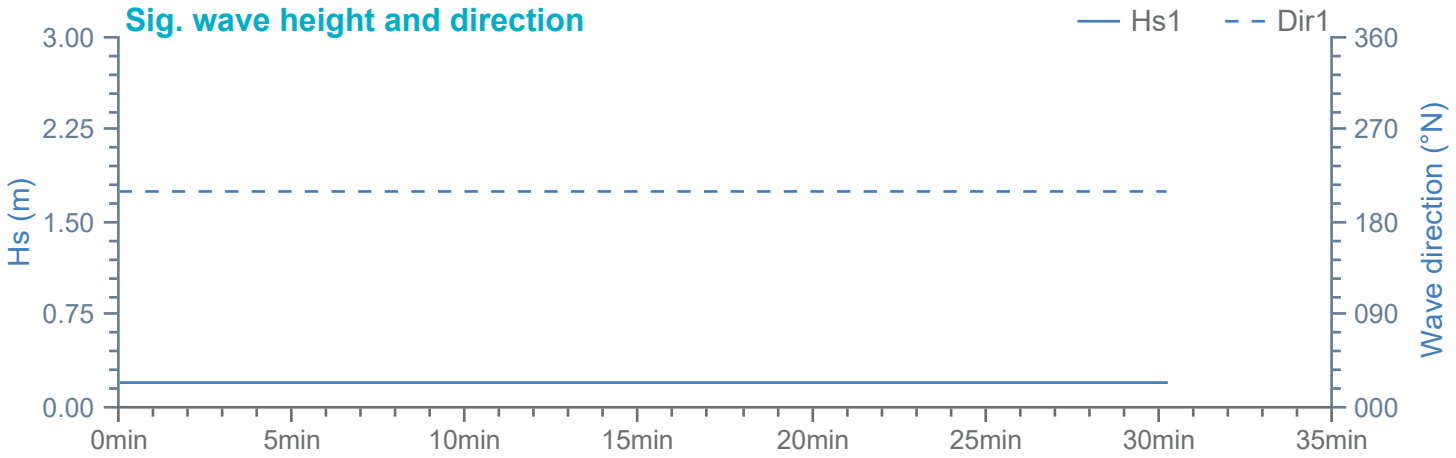
Manoeuvring area and berthing

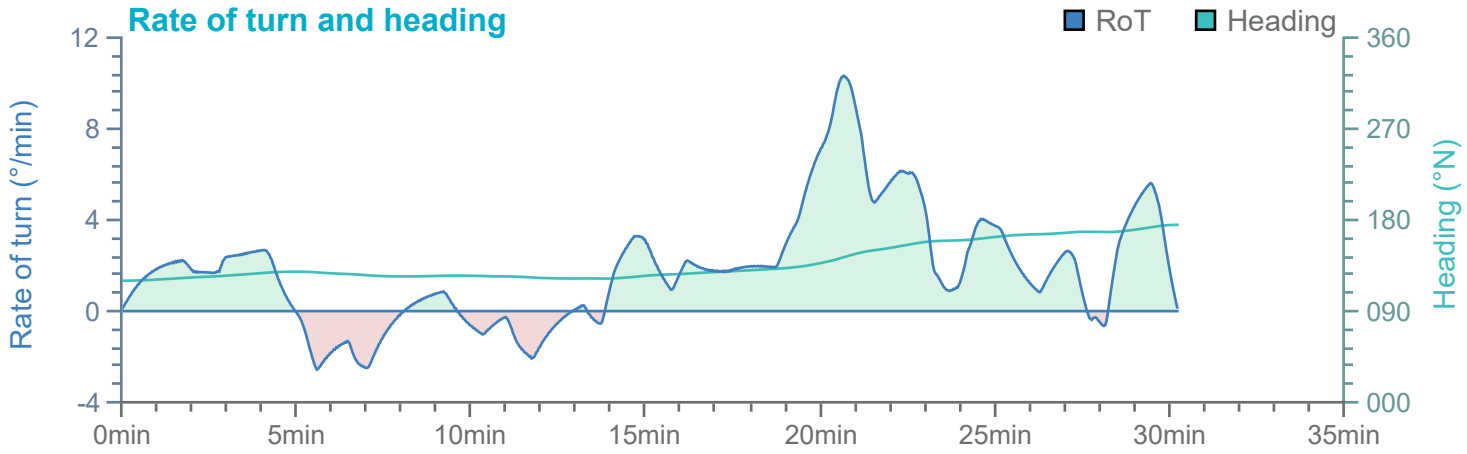


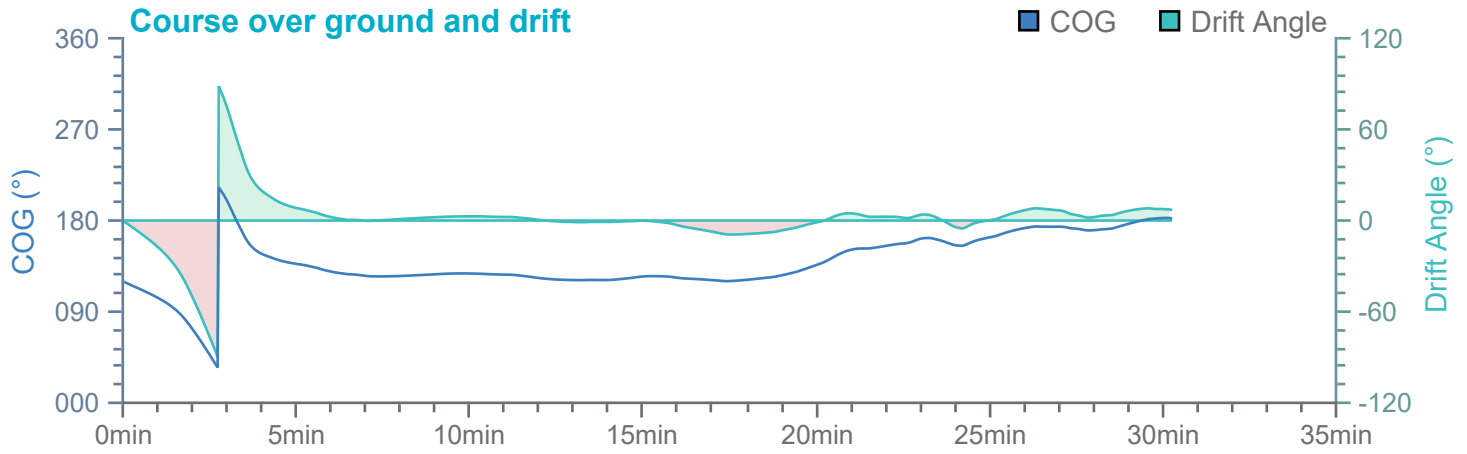
Ships plotted every 2 mins, highlight every 10 mins

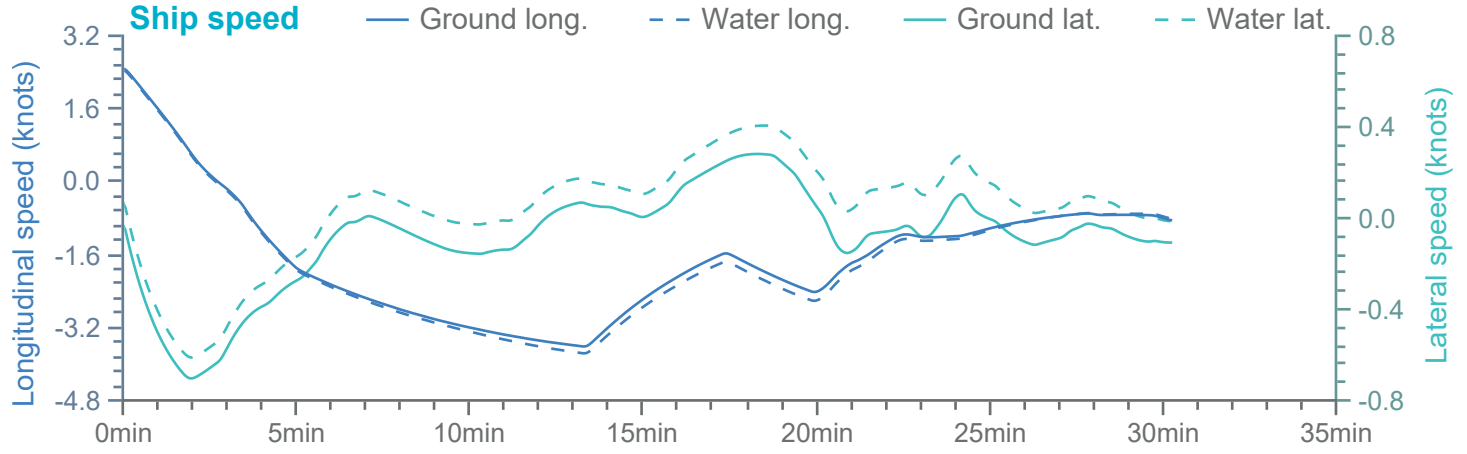

Current acting on ship
Bow
Stern
Bow Dir
Stern Dir
Current speed (knots)
Current direction (°N)
0.3
0.2
0.1
0.0
360
270
180
090
000
0min
5min
10min
15min
20min
25min
30min
35min

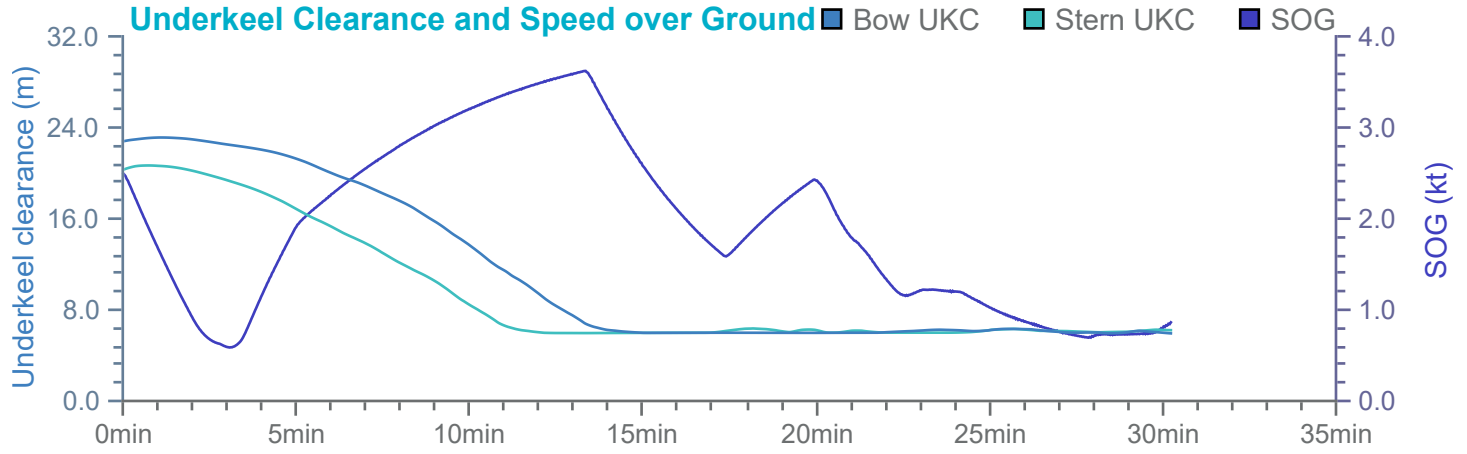

Wind speed and direction
Speed
Direction
Wind speed (knots)
Wind direction (°N)
40
30
20
10
0
360
270
180
090
000
0min
5min
10min
15min
20min
25min
30min
35min

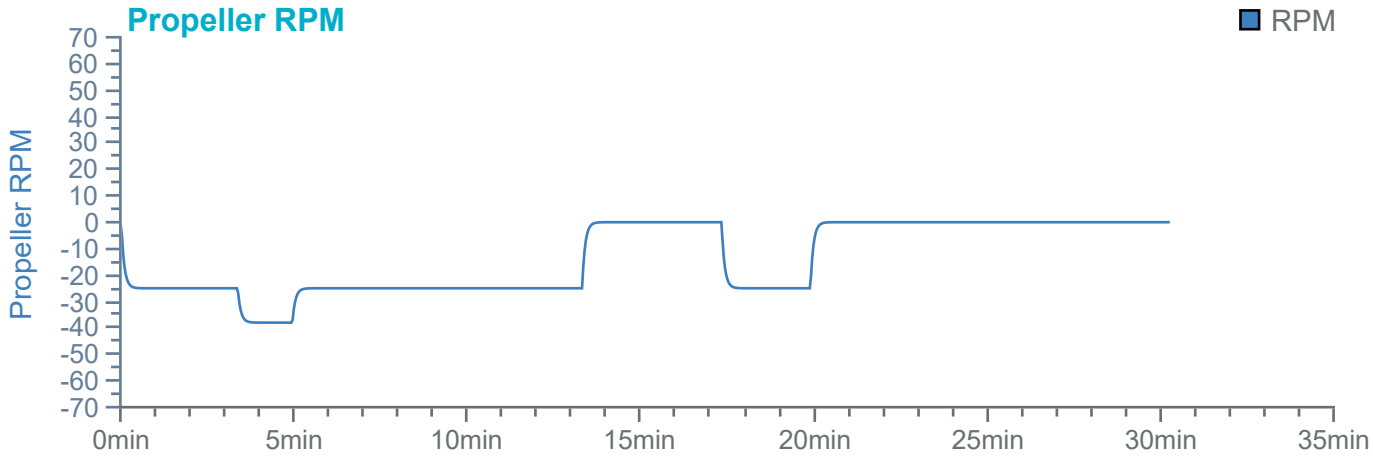

Sig. wave height and direction
Hs1
Dir1
Hs (m)
Wave direction (°N)
3.00
2.25
1.50
0.75
0.00
360
270
180
090
000
0min
5min
10min
15min
20min
25min
30min
35min

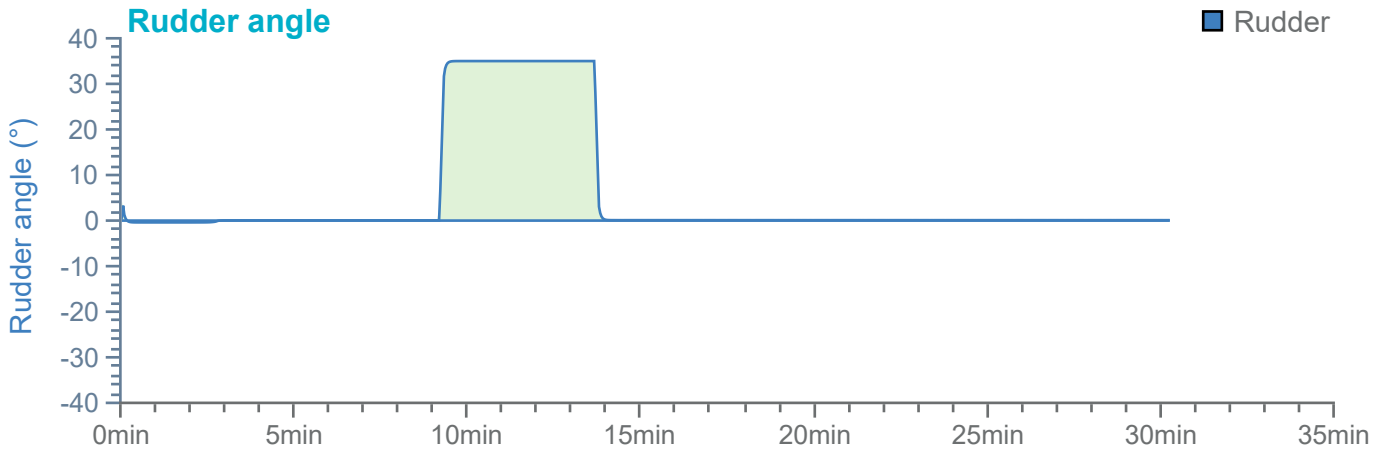

Rate of turn and heading
RoT
Heading
Rate of turn (°/min)
Heading (°N)
12
8
4
0
-4
360
270
180
090
000
0min
5min
10min
15min
20min
25min
30min
35min

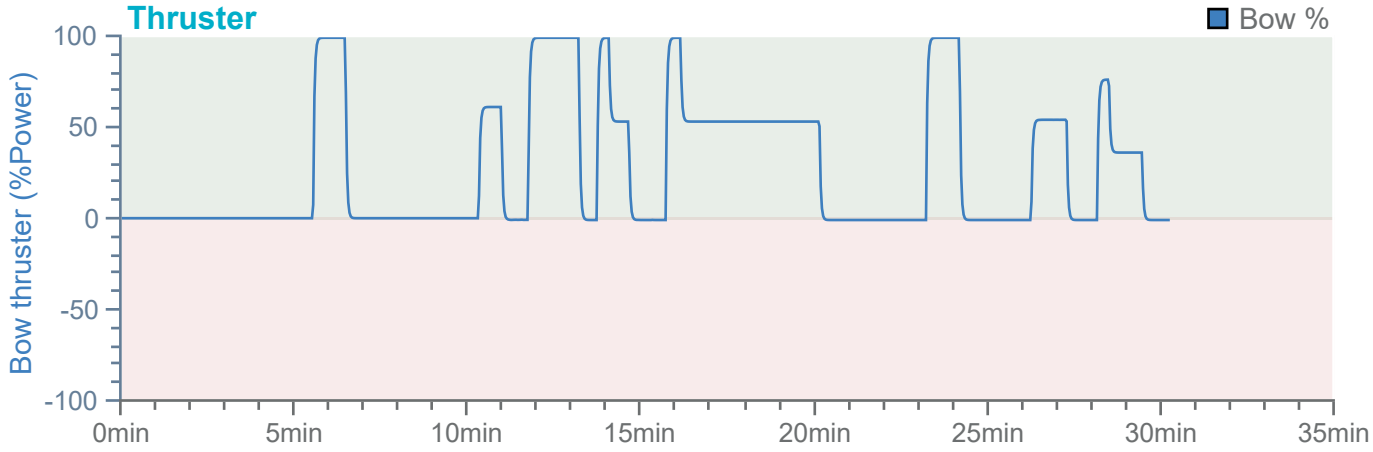

Course over ground and drift
COG
Drift Angle
COG (°)
Drift Angle (°)
360
270
180
090
000
120
60
0
-60
-120
0min
5min
10min
15min
20min
25min
30min
35min


Ship speed
Ground long.
Water long.
Ground lat.
Water lat.
Longitudinal speed (knots)
Lateral speed (knots)
3.2
1.6
0.0
-1.6
-3.2
-4.8
0.8
0.4
0.0
-0.4
-0.8
0min
5min
10min
15min
20min
25min
30min
35min

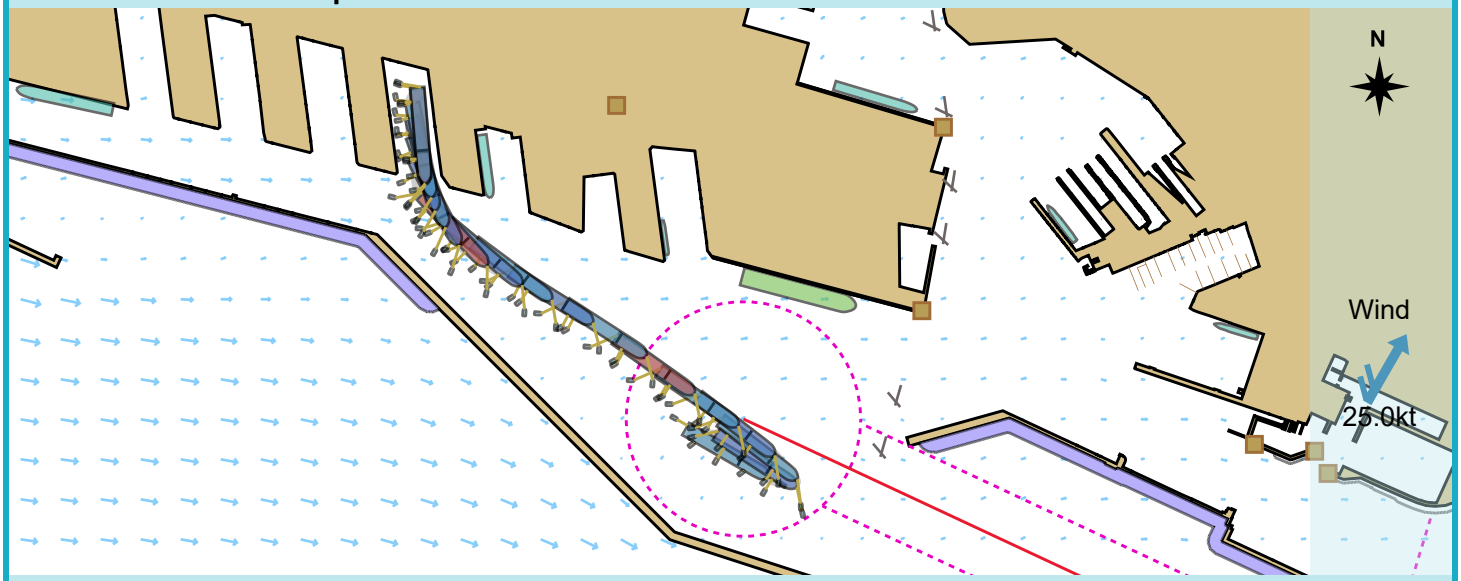

Underkeel Clearance and Speed over Ground
Bow UKC
Stern UKC
SOG
Underkeel clearance (m)
SOG (kt)
32.0
24.0
16.0
8.0
0.0
4.0
3.0
2.0
1.0
0.0
0min
5min
10min
15min
20min
25min
30min
35min


Propeller RPM
RPM
Propeller RPM
70
60
50
40
30
20
10
0
-10
-20
-30
-40
-50
-60
-70
0min
5min
10min
15min
20min
25min
30min
35min


Rudder angle
Rudder
Rudder angle (°)
40
30
20
10
0
-10
-20
-30
-40
0min
5min
10min
15min
20min
25min
30min
35min

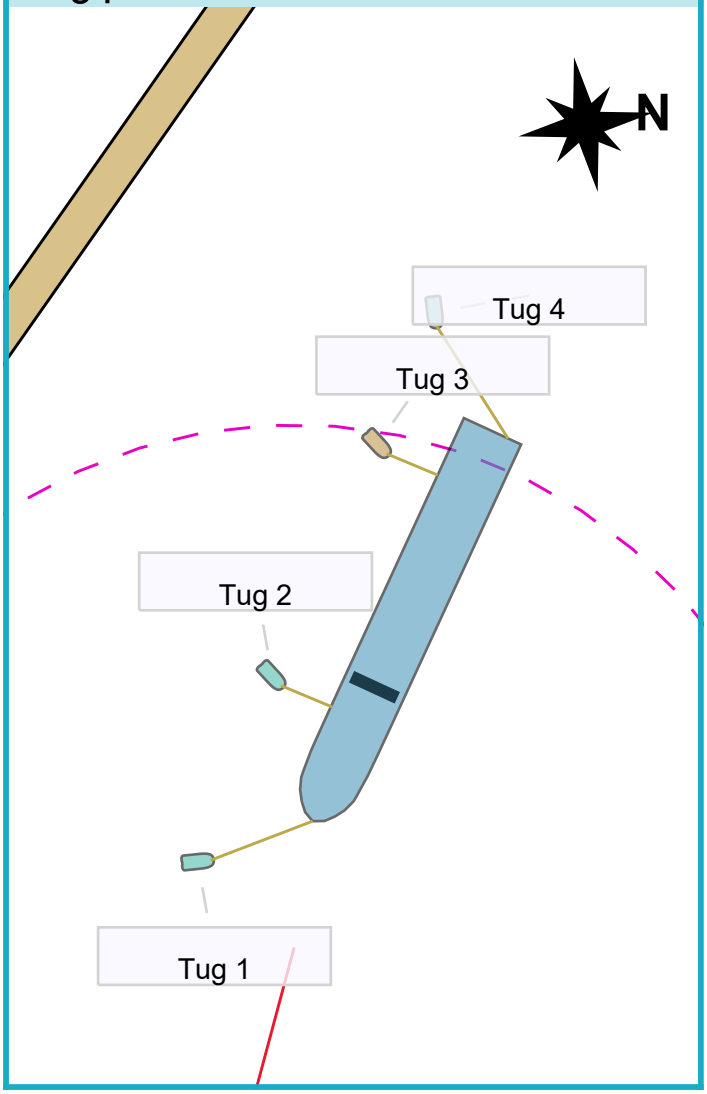

Thruster
Bow %
Bow thruster (%Power)
100
50
0
-50
-100
0min
5min
10min
15min
20min
25min
30min
35min

Manoeuvre track plot

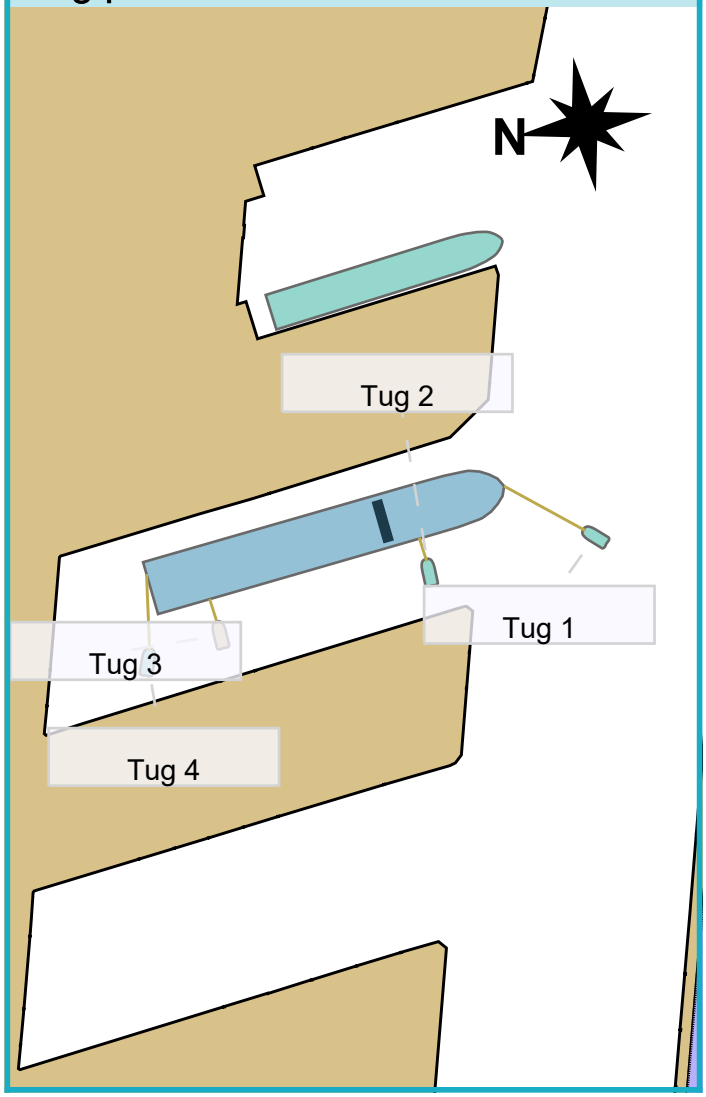


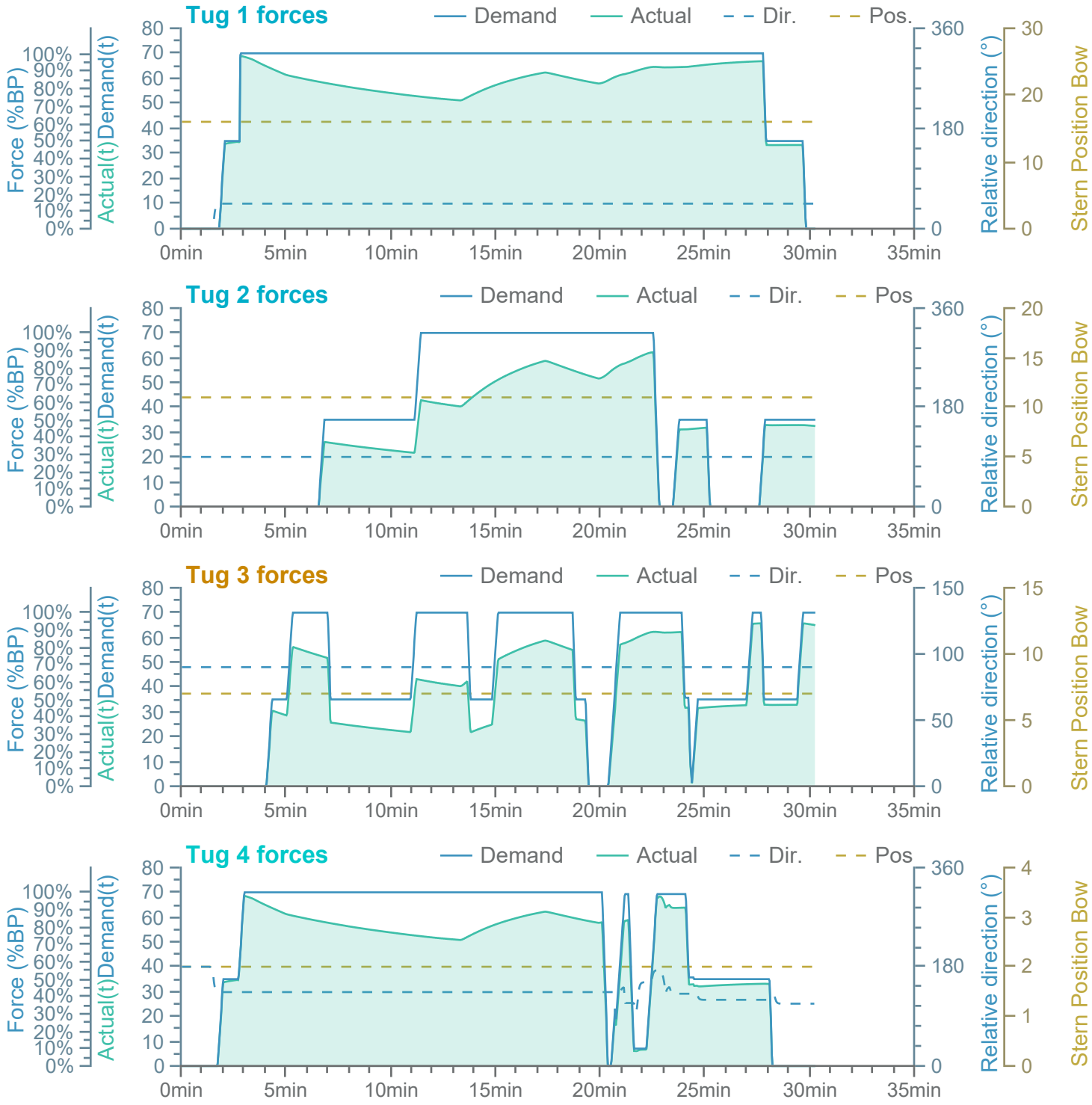
Ships plotted every 2 mins, highlight every 10 mins

Tug position: Initial

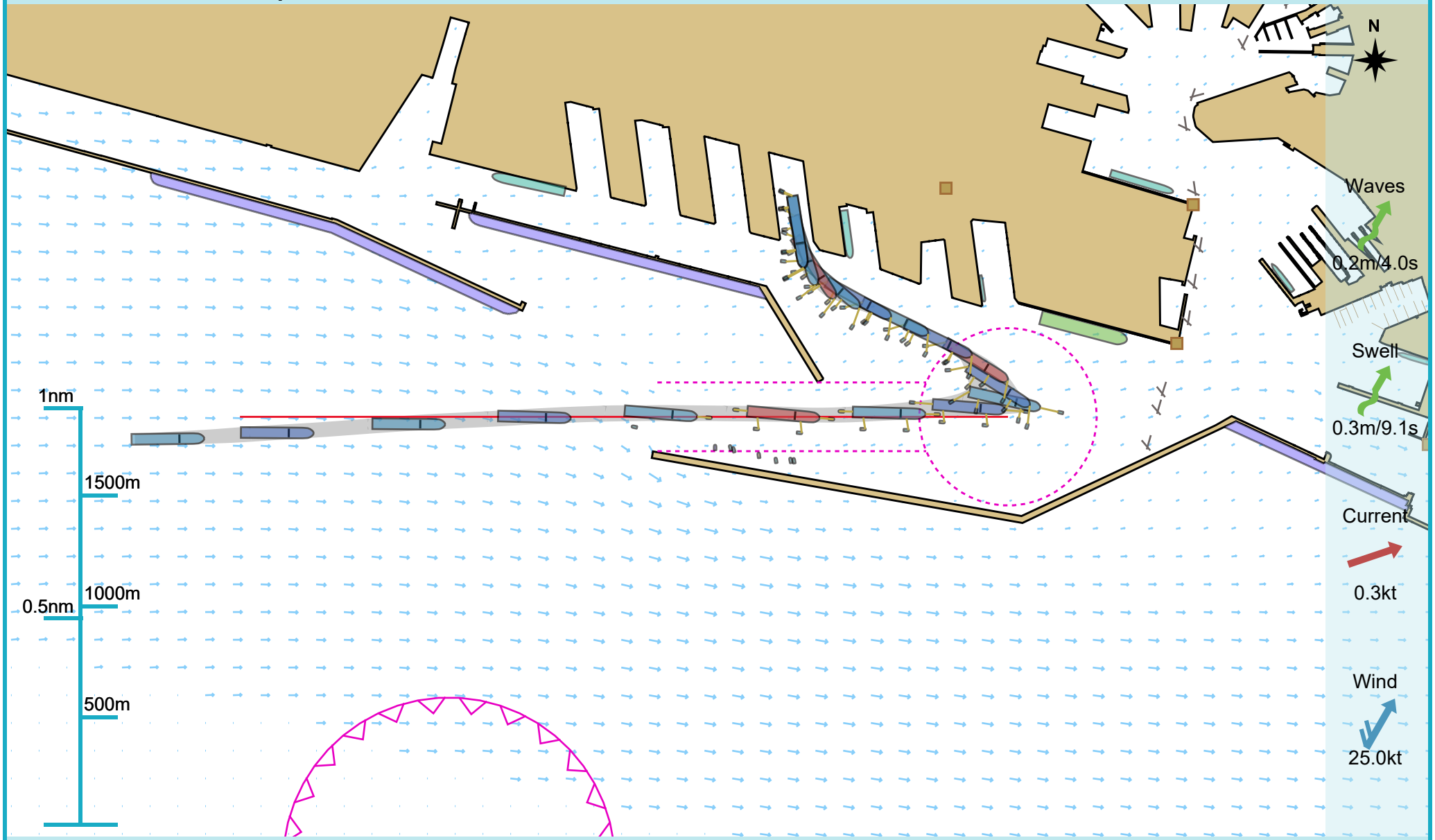


Tug position: Final




Tug 1 forces
Demand
Actual
Dir.
Pos.
Force (%BP)
Actual(t)Demand(t)
Relative direction (°)
Stern Position Bow
0min
5min
10min
15min
20min
25min
30min
35min
Tug 2 forces
Demand
Actual
Dir.
Pos
Force (%BP)
Actual(t)Demand(t)
Relative direction (°)
Stern Position Bow
Tug 3 forces
Demand
Actual
Dir.
Pos
Force (%BP)
Actual(t)Demand(t)
Relative direction (°)
Stern Position Bow
Tug 4 forces
Demand
Actual
Dir.
Pos
Force (%BP)
Actual(t)Demand(t)
Relative direction (°)
Stern Position Bow

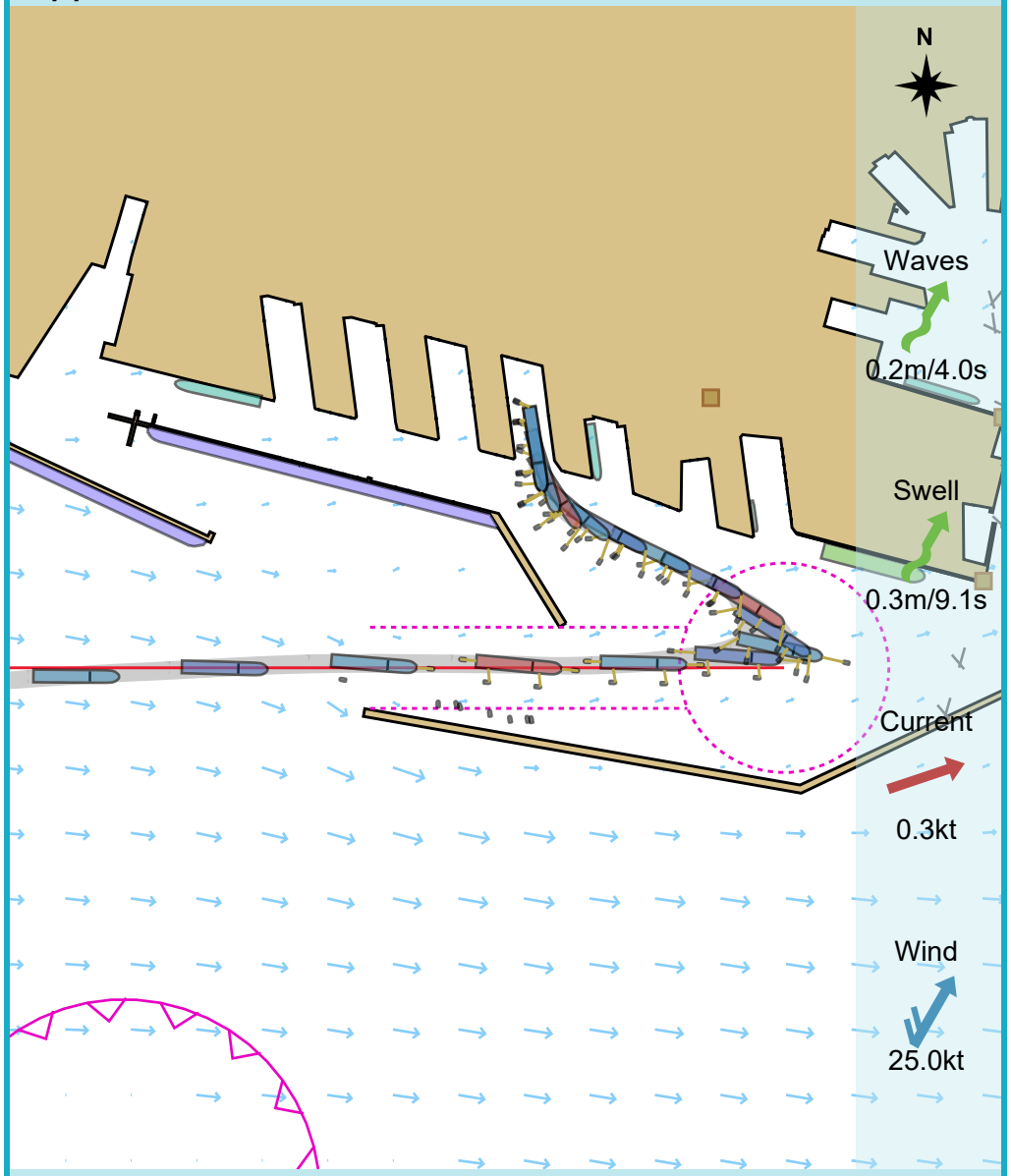
Manoeuvre track plot



0.76 kts

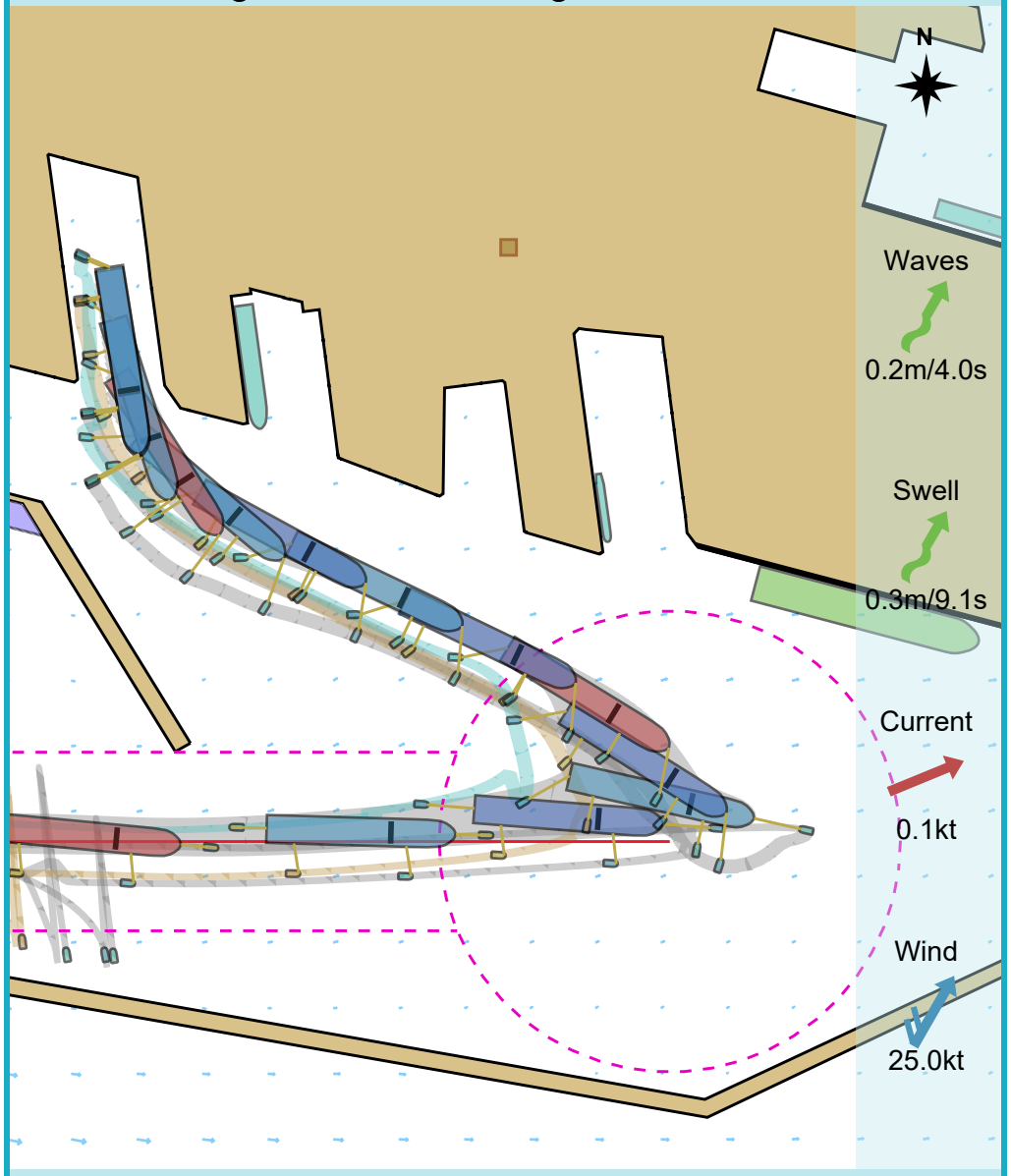
Ships plotted every 2 mins, highlight every 10 mins

Approach Channel

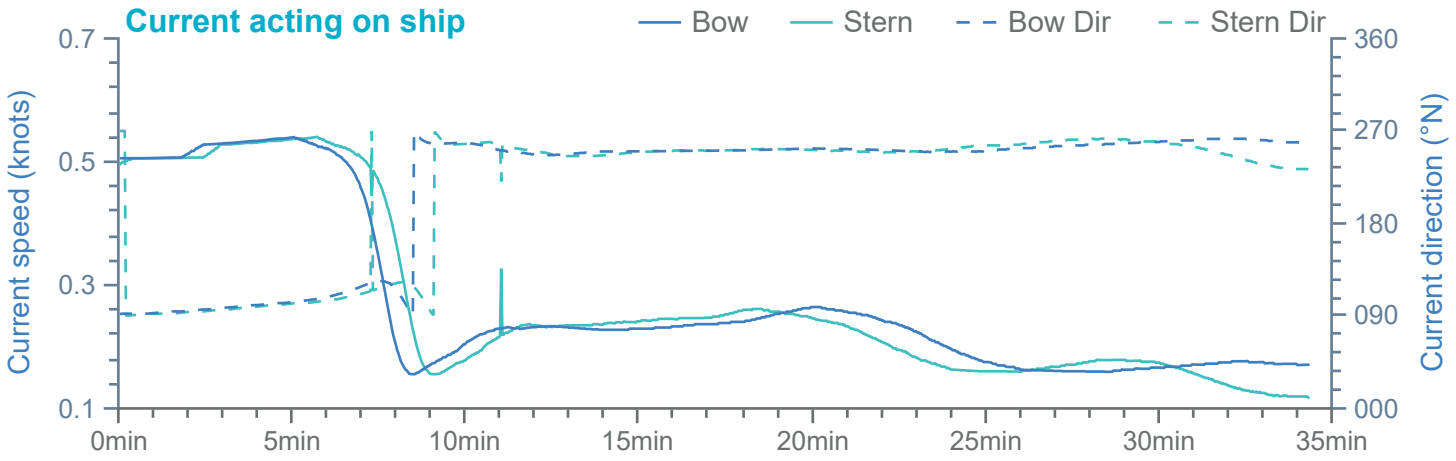


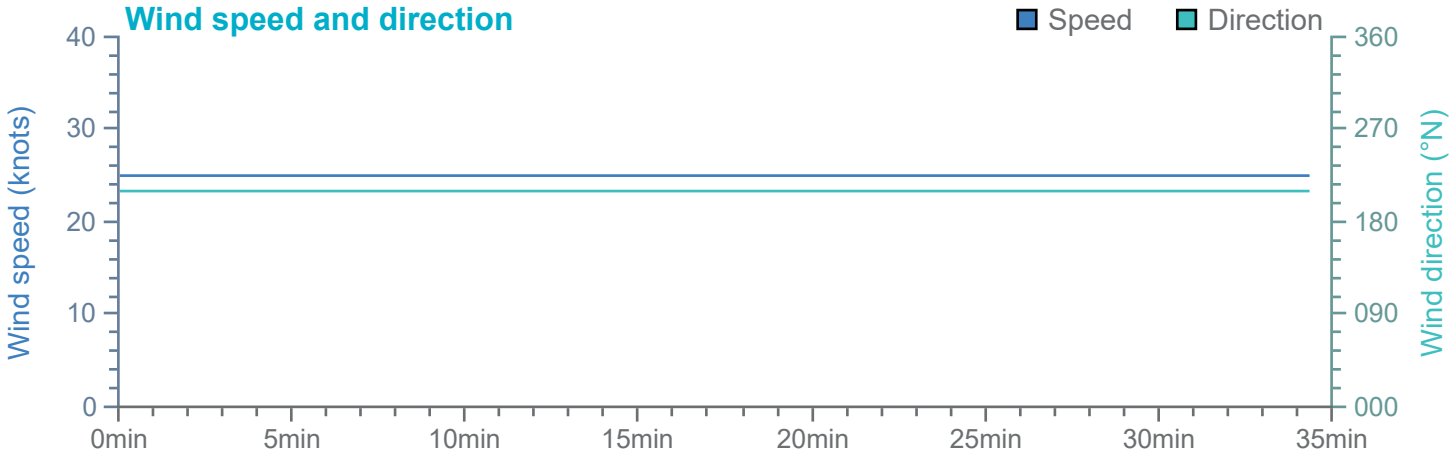
Ships plotted every 2 mins, highlight every 10 mins

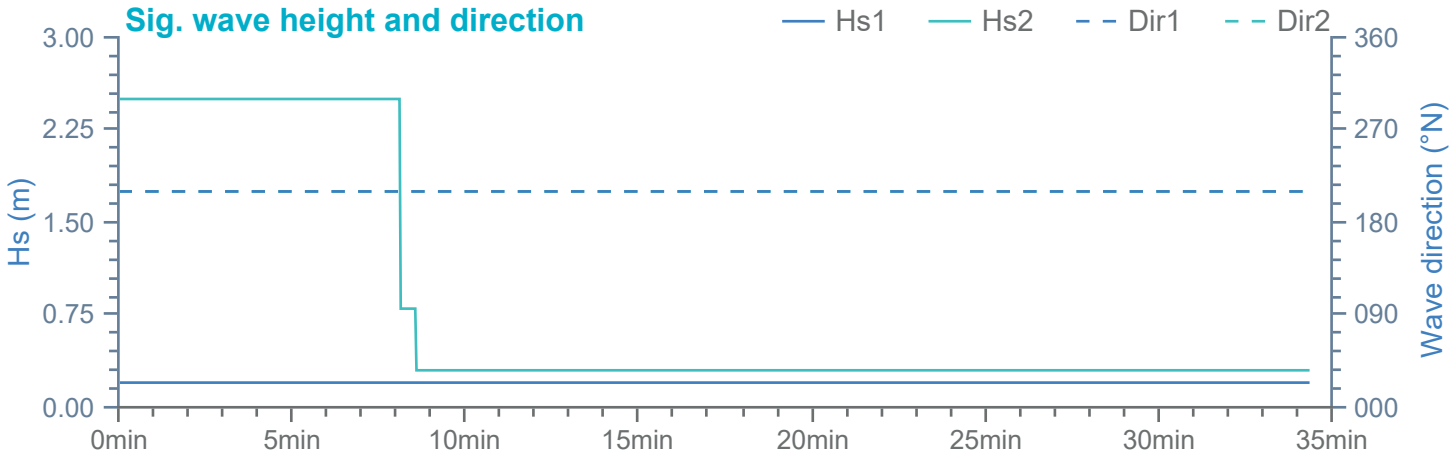
Manoeuvring area and berthing

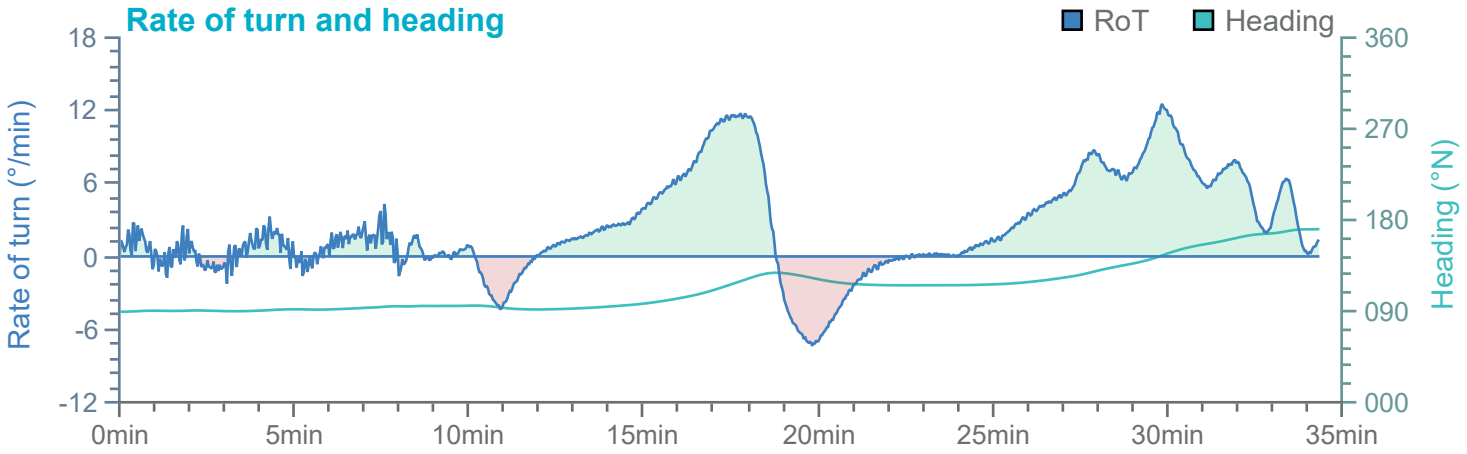


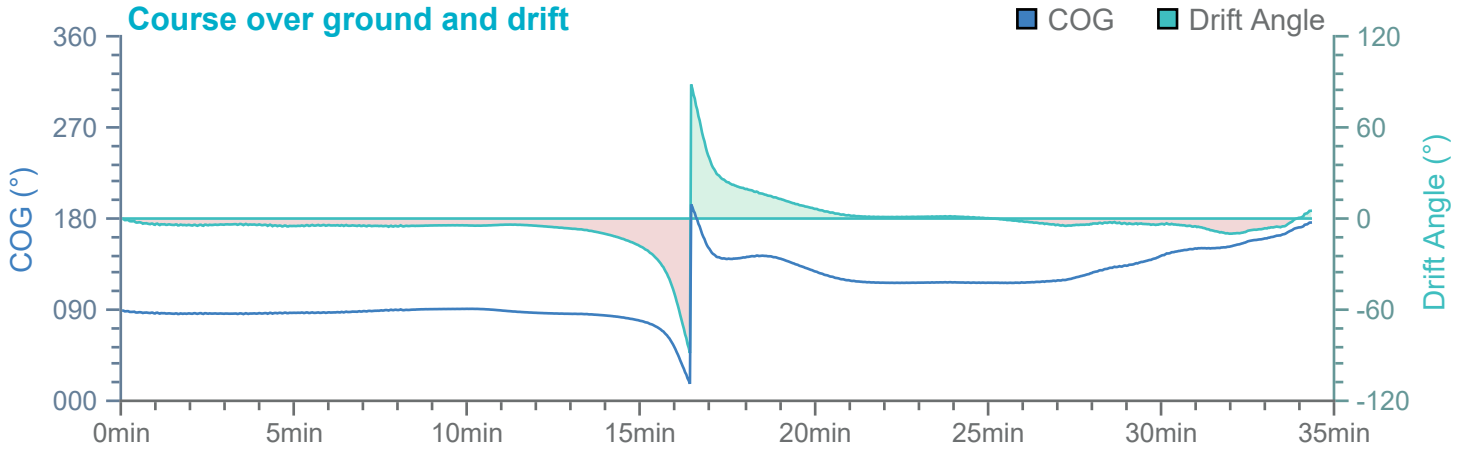
Ships plotted every 2 mins, highlight every 10 mins

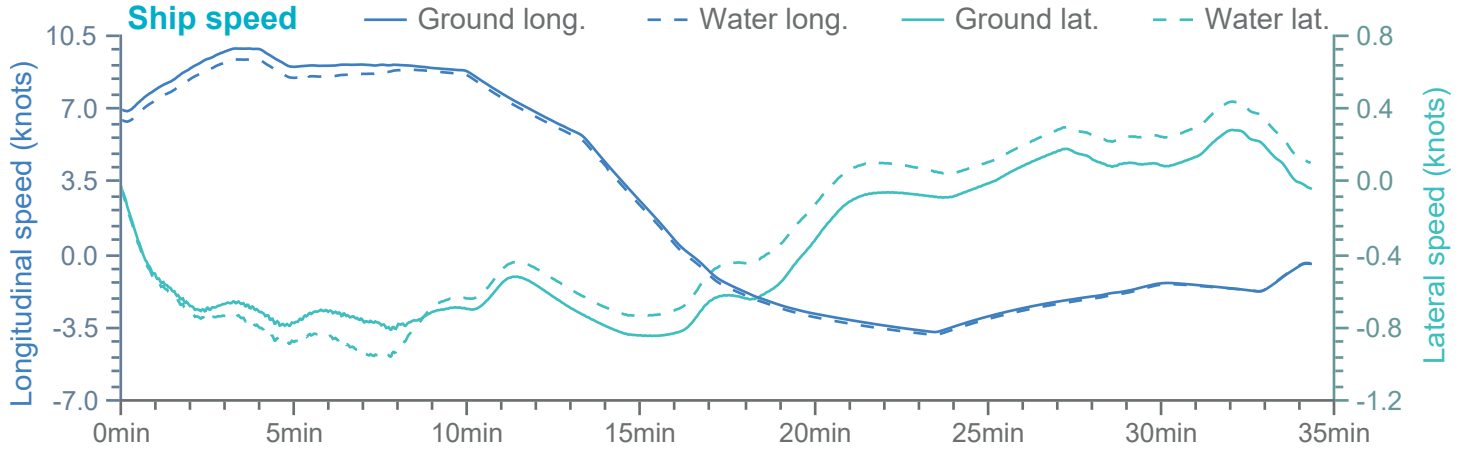

Current acting on ship
Bow
Stern
Bow Dir
Stern Dir
Current speed (knots)
Current direction (°N)
0.7
0.5
0.3
0.1
360
270
180
090
000
0min
5min
10min
15min
20min
25min
30min
35min

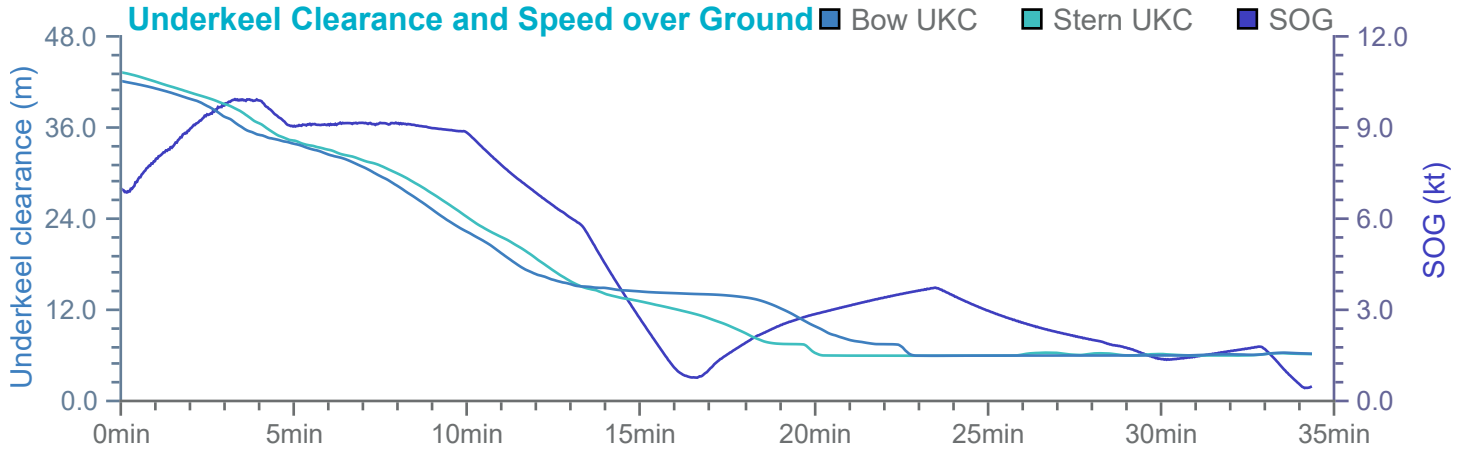

Wind speed and direction
Speed
Direction
Wind speed (knots)
Wind direction (°N)
40
30
20
10
0
360
270
180
090
000
0min
5min
10min
15min
20min
25min
30min
35min

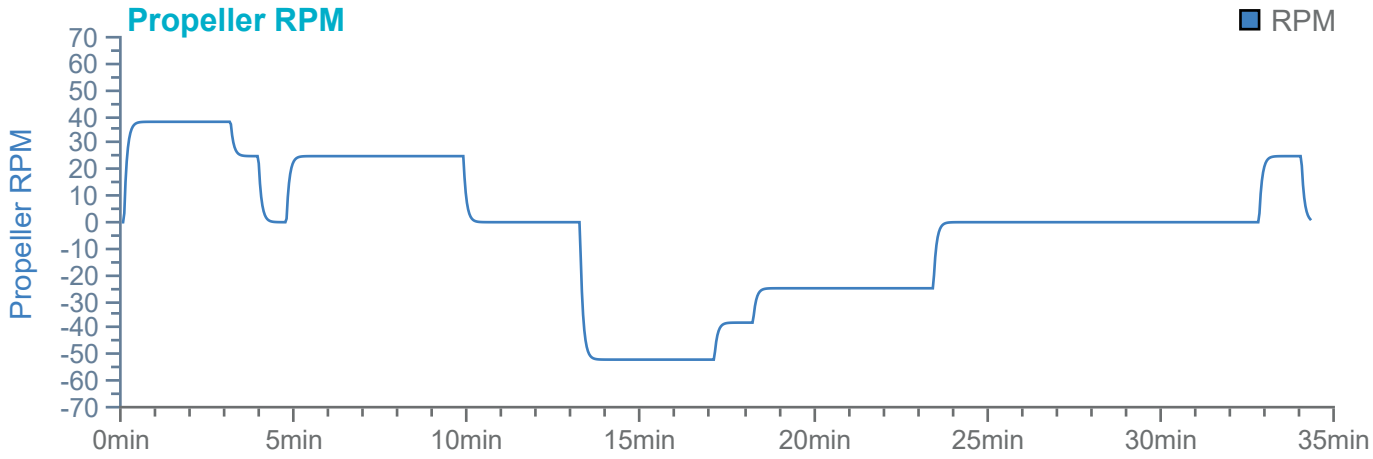

Sig. wave height and direction
Hs1
Hs2
Dir1
Dir2
Hs (m)
Wave direction (°N)
3.00
2.25
1.50
0.75
0.00
360
270
180
090
000
0min
5min
10min
15min
20min
25min
30min
35min

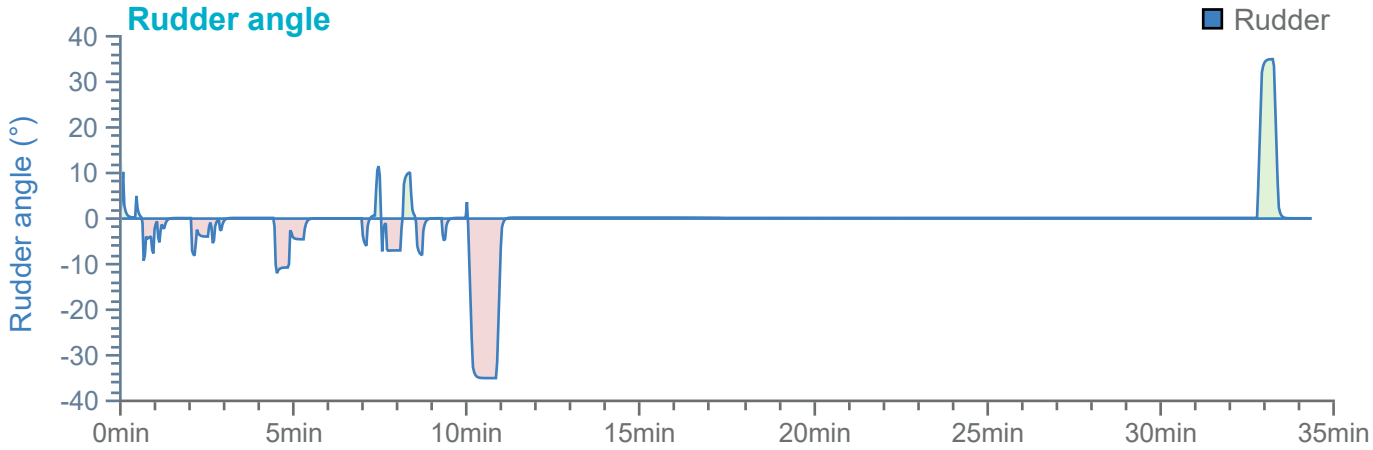

Rate of turn and heading
RoT
Heading
Rate of turn (°/min)
Heading (°N)
18
12
6
0
-6
-12
360
270
180
090
000
0min
5min
10min
15min
20min
25min
30min
35min

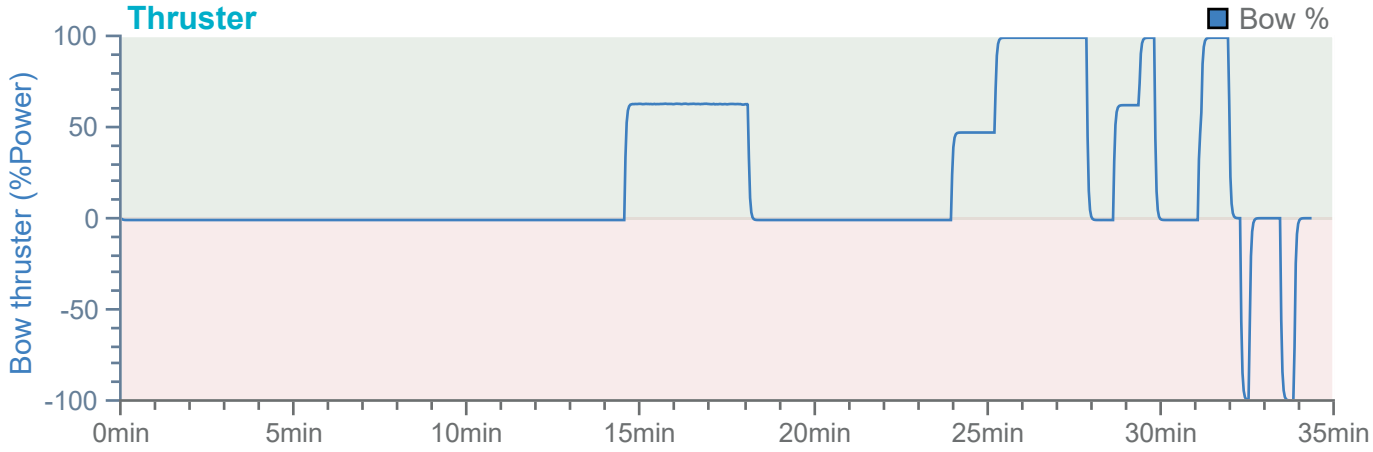

Course over ground and drift
COG
Drift Angle
COG (°)
Drift Angle (°)
360
270
180
090
000
120
60
0
-60
-120
0min
5min
10min
15min
20min
25min
30min
35min


Ship speed
Ground long.
Water long.
Ground lat.
Water lat.
Longitudinal speed (knots)
Lateral speed (knots)
10.5
7.0
3.5
0.0
-3.5
-7.0
0.8
0.4
0.0
-0.4
-0.8
-1.2
0min
5min
10min
15min
20min
25min
30min
35min

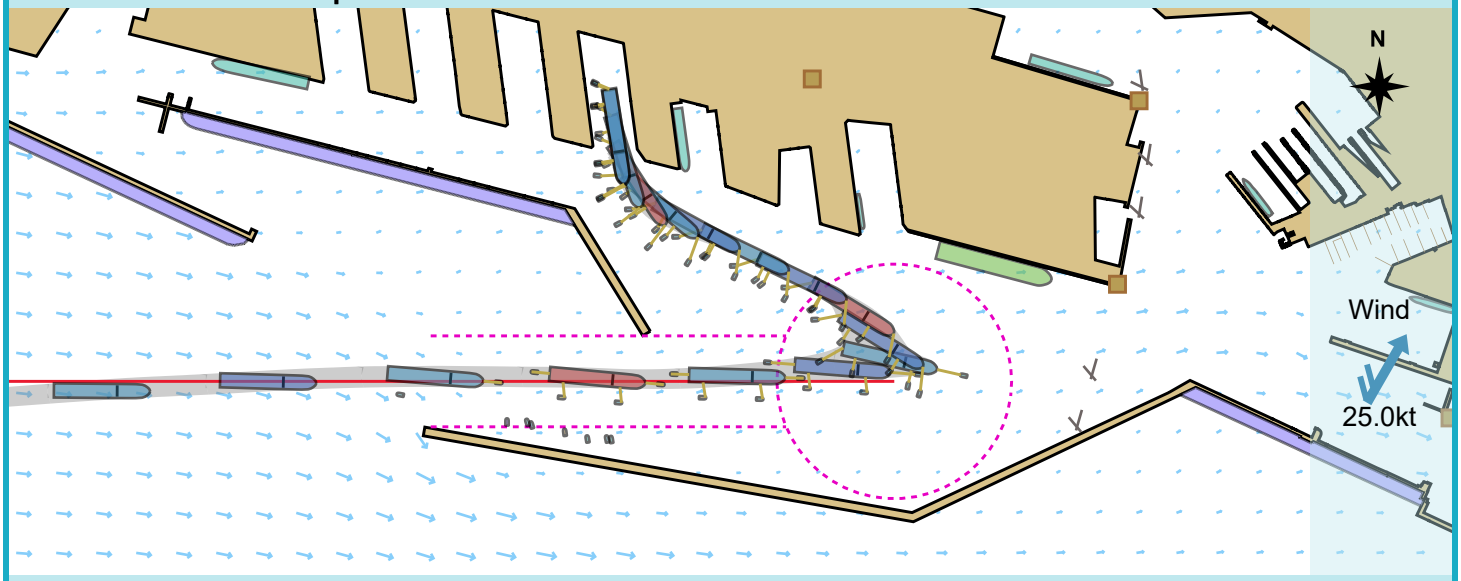

Underkeel Clearance and Speed over Ground
Bow UKC
Stern UKC
SOG
Underkeel clearance (m)
SOG (kt)
48.0
36.0
24.0
12.0
0.0
12.0
9.0
6.0
3.0
0.0
0min
5min
10min
15min
20min
25min
30min
35min


Propeller RPM
RPM
Propeller RPM
70
60
50
40
30
20
10
0
-10
-20
-30
-40
-50
-60
-70
0min
5min
10min
15min
20min
25min
30min
35min


Rudder angle
Rudder
Rudder angle (°)
40
30
20
10
0
-10
-20
-30
-40
0min
5min
10min
15min
20min
25min
30min
35min

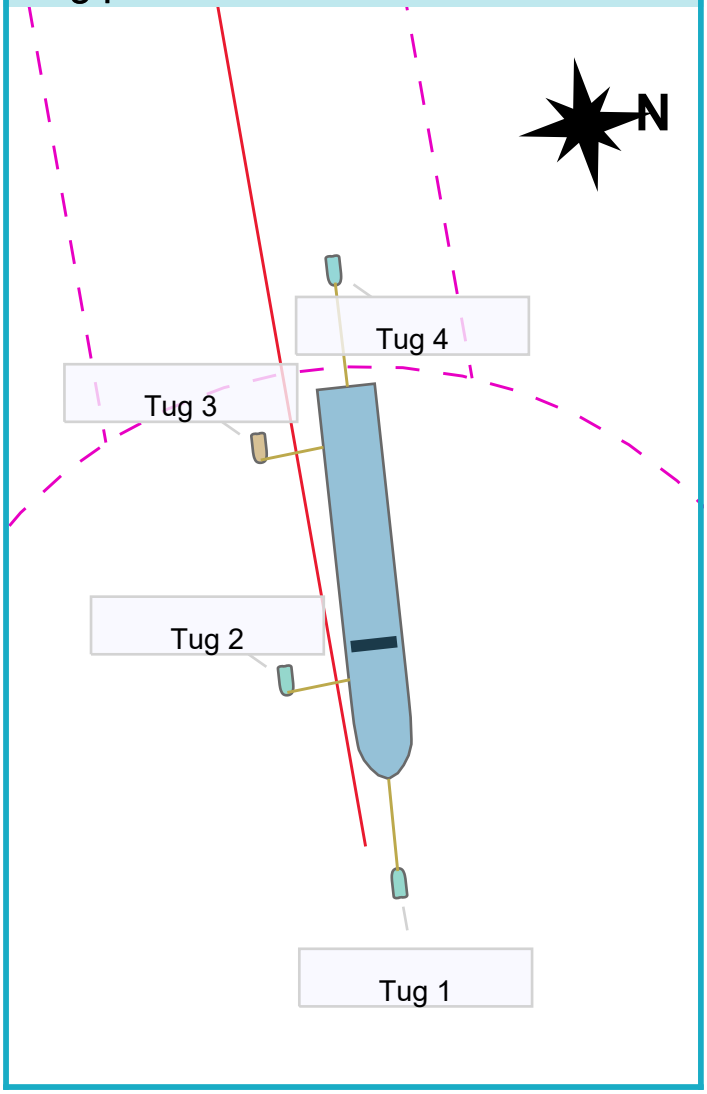

Thruster
Bow %
Bow thruster (%Power)
100
50
0
-50
-100
0min
5min
10min
15min
20min
25min
30min
35min

Manoeuvre track plot

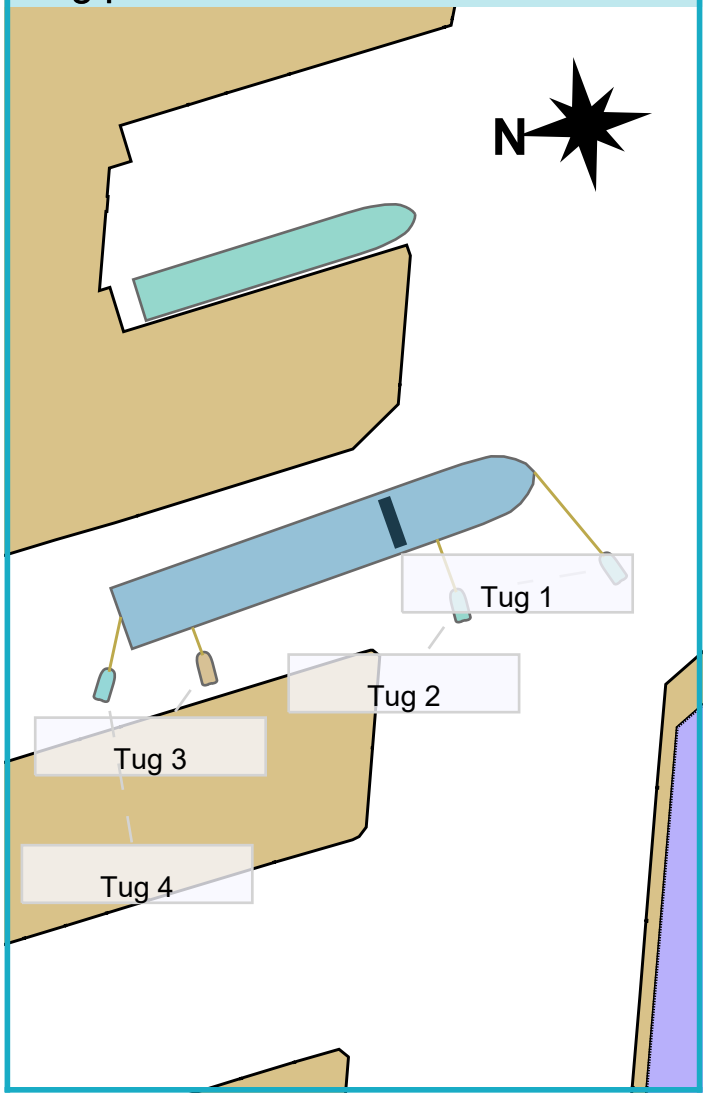


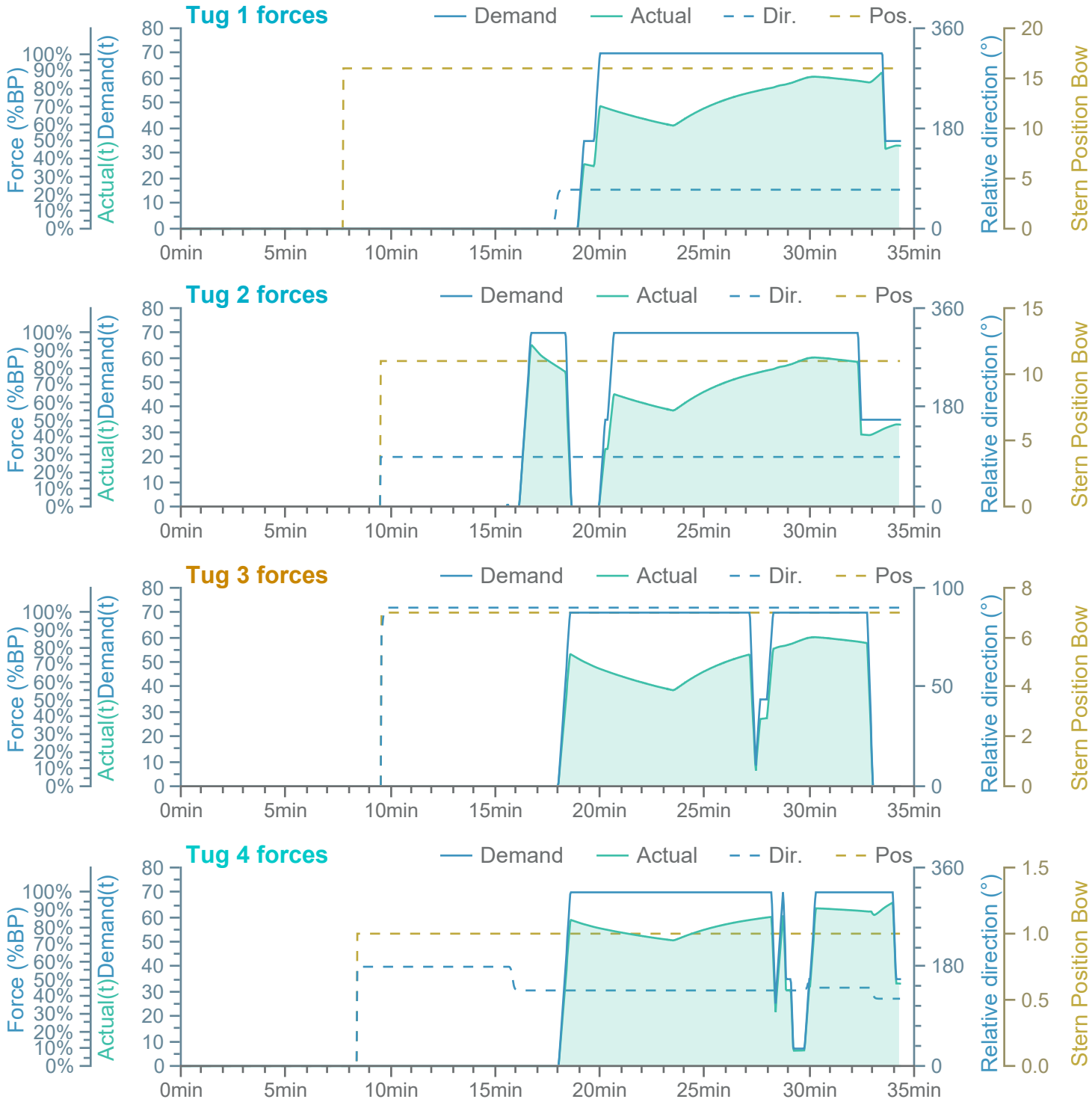
Ships plotted every 2 mins, highlight every 10 mins

Tug position: Initial

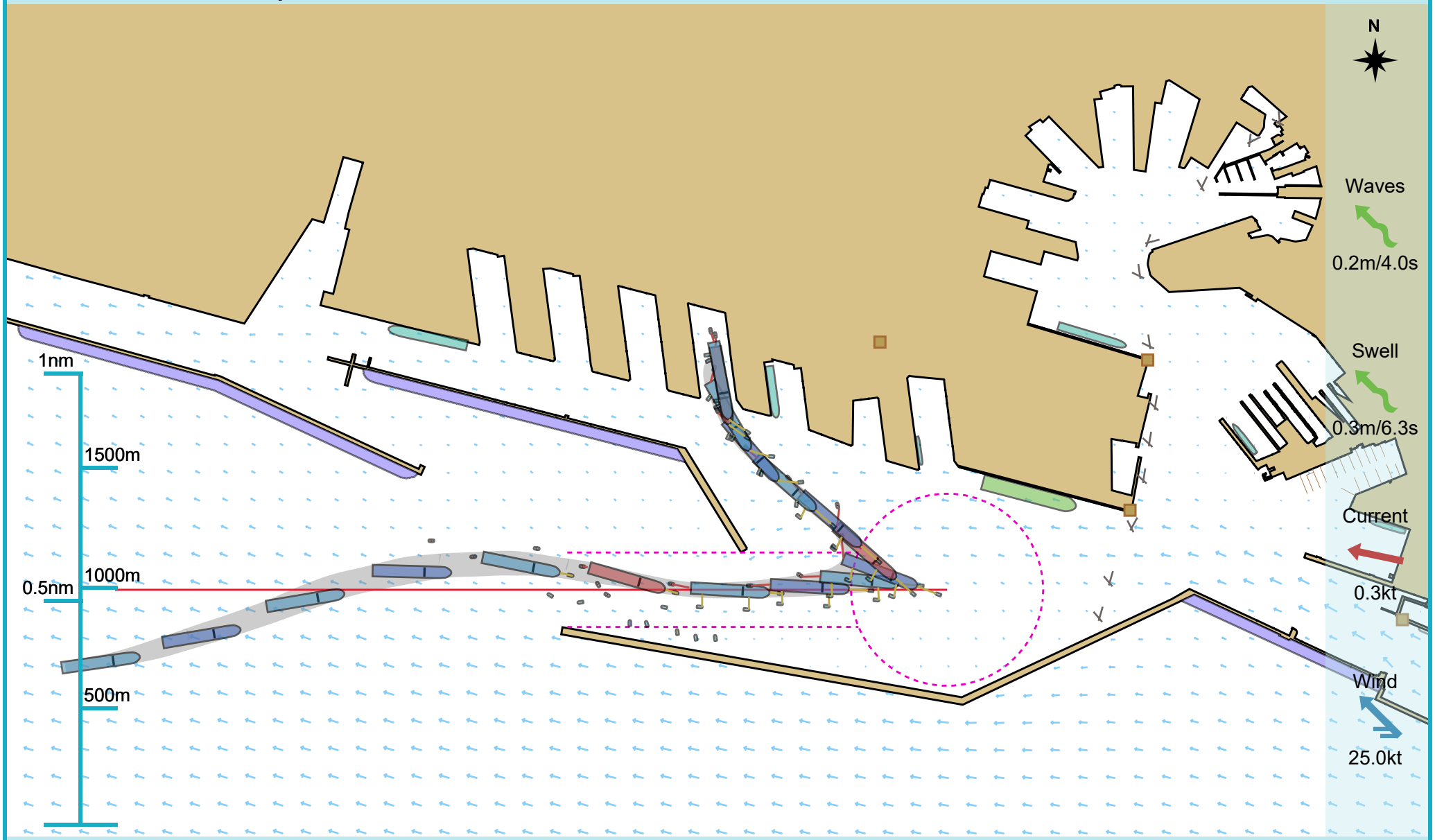


Tug position: Final




Tug 1 forces
Demand
Actual
Dir.
Pos.
Force (%BP)
Actual(t)Demand(t)
Relative direction (°)
Stern Position Bow
0min
5min
10min
15min
20min
25min
30min
35min
Tug 2 forces
Demand
Actual
Dir.
Pos
Force (%BP)
Actual(t)Demand(t)
Relative direction (°)
Stern Position Bow
Tug 3 forces
Demand
Actual
Dir.
Pos
Force (%BP)
Actual(t)Demand(t)
Relative direction (°)
Stern Position Bow
Tug 4 forces
Demand
Actual
Dir.
Pos
Force (%BP)
Actual(t)Demand(t)
Relative direction (°)
Stern Position Bow

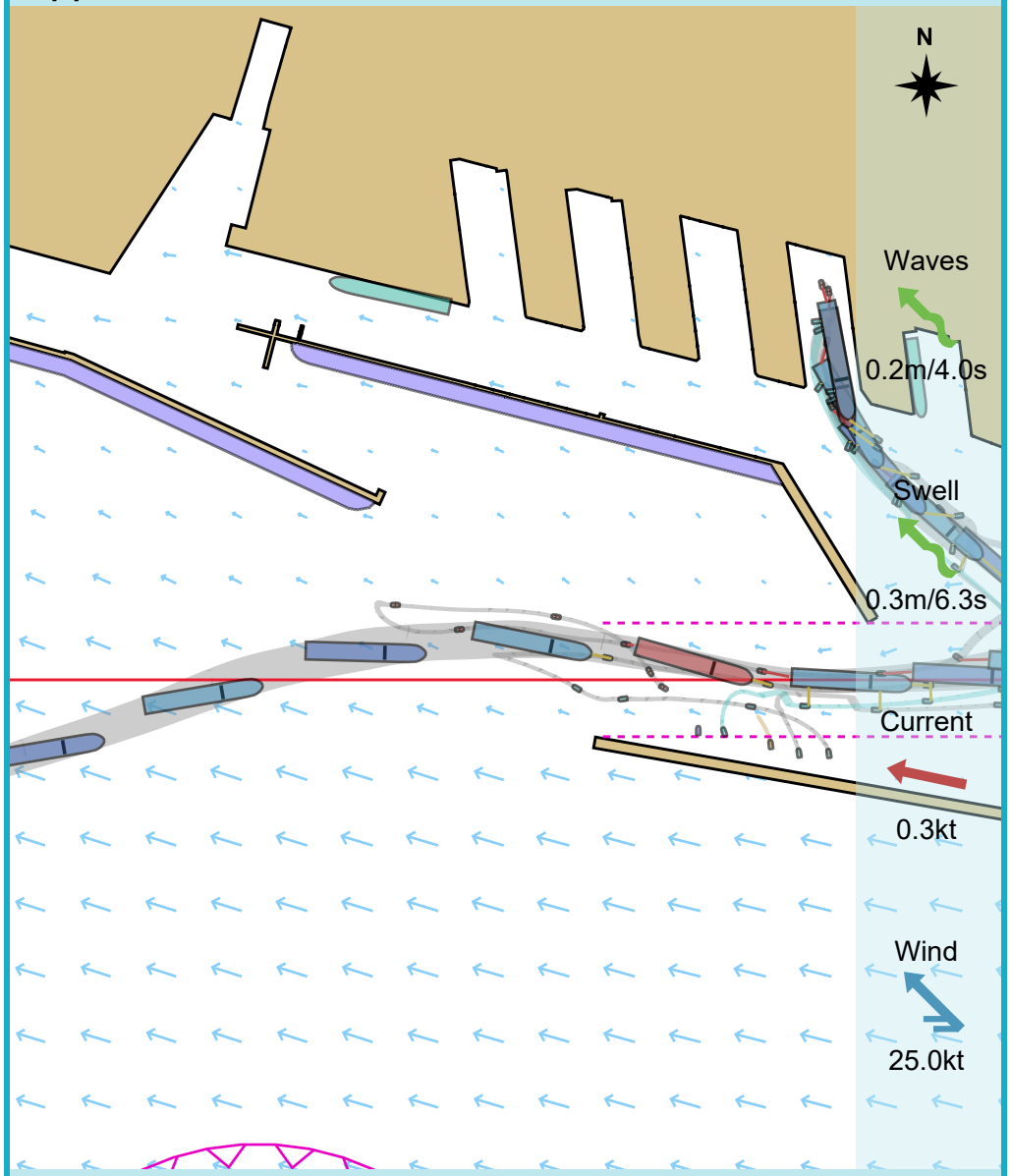
Manoeuvre track plot



1.07 kts

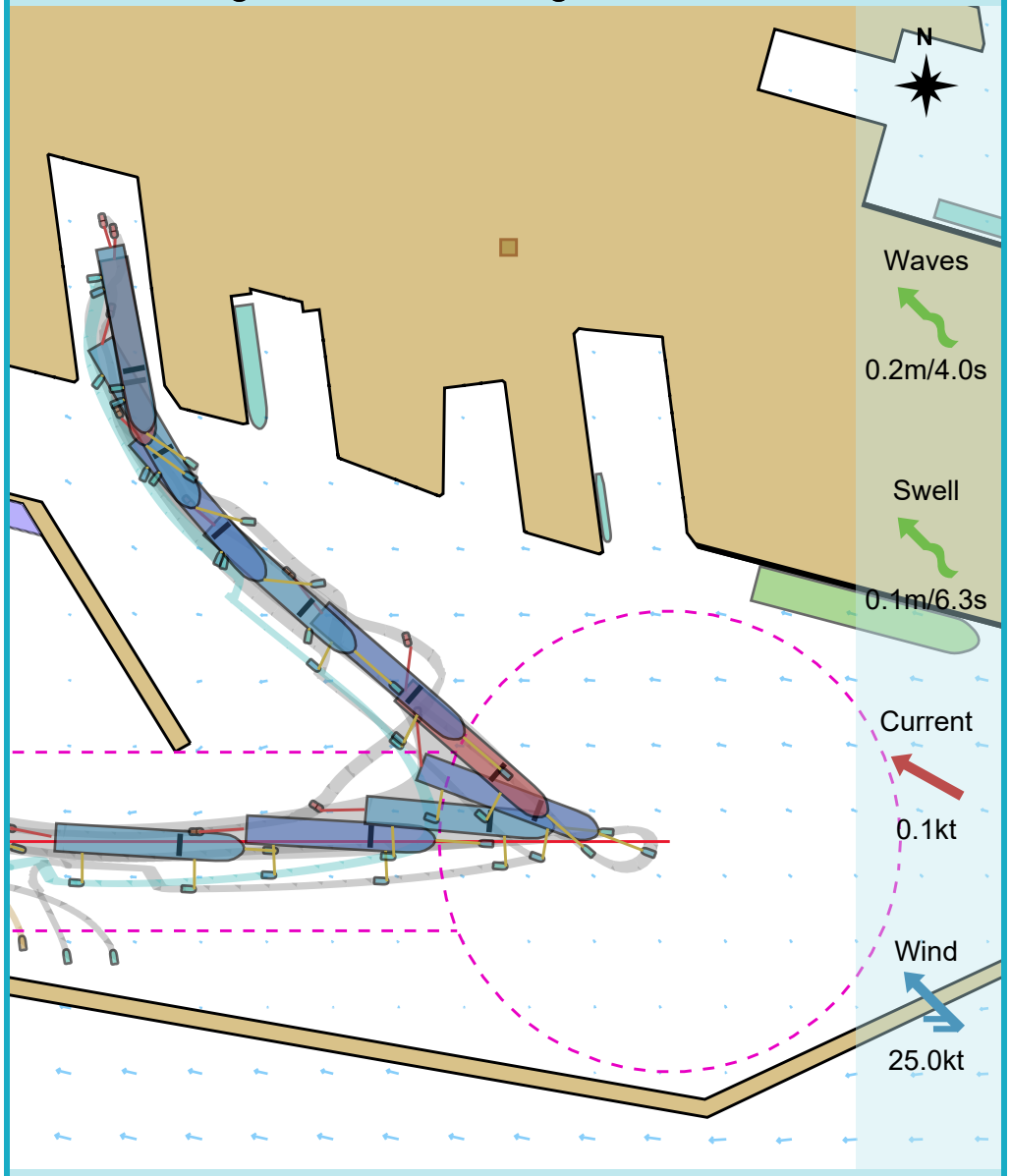
Ships plotted every 2 mins, highlight every 10 mins

Approach Channel

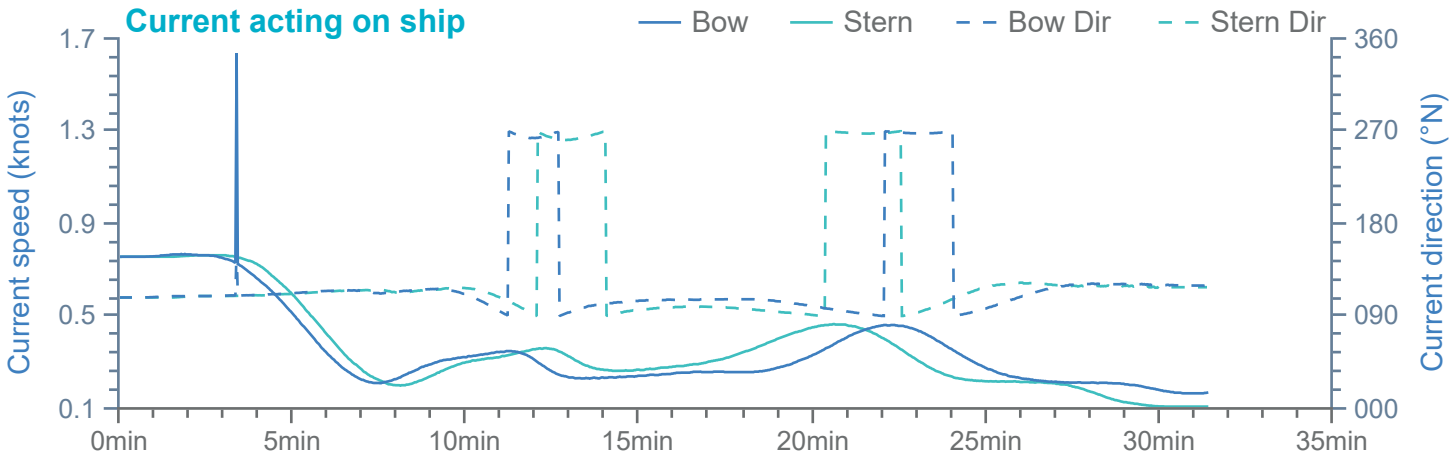


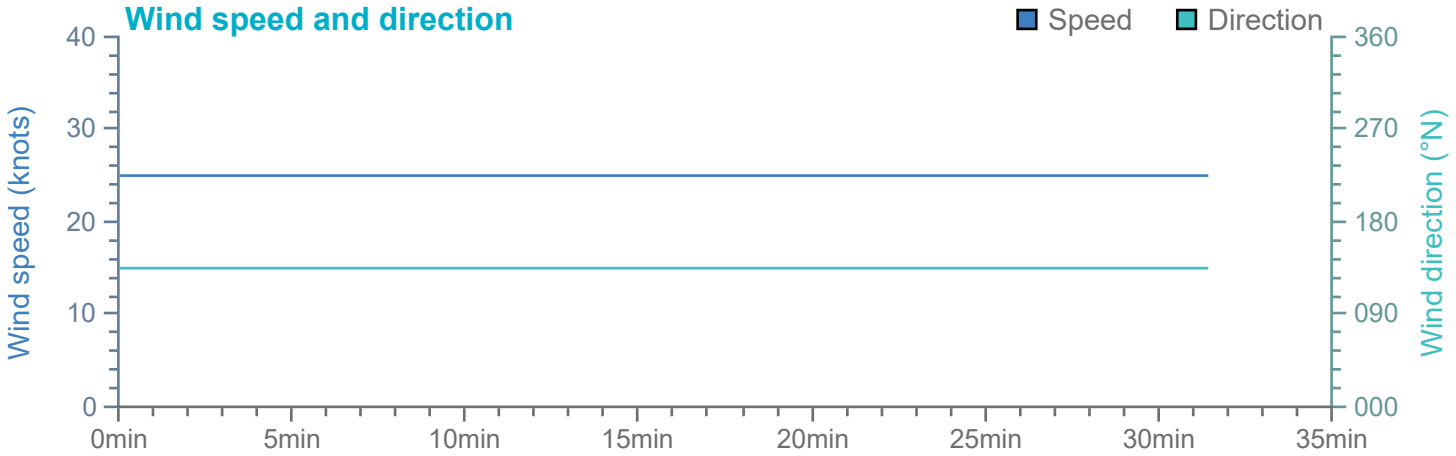
Ships plotted every 2 mins, highlight every 10 mins

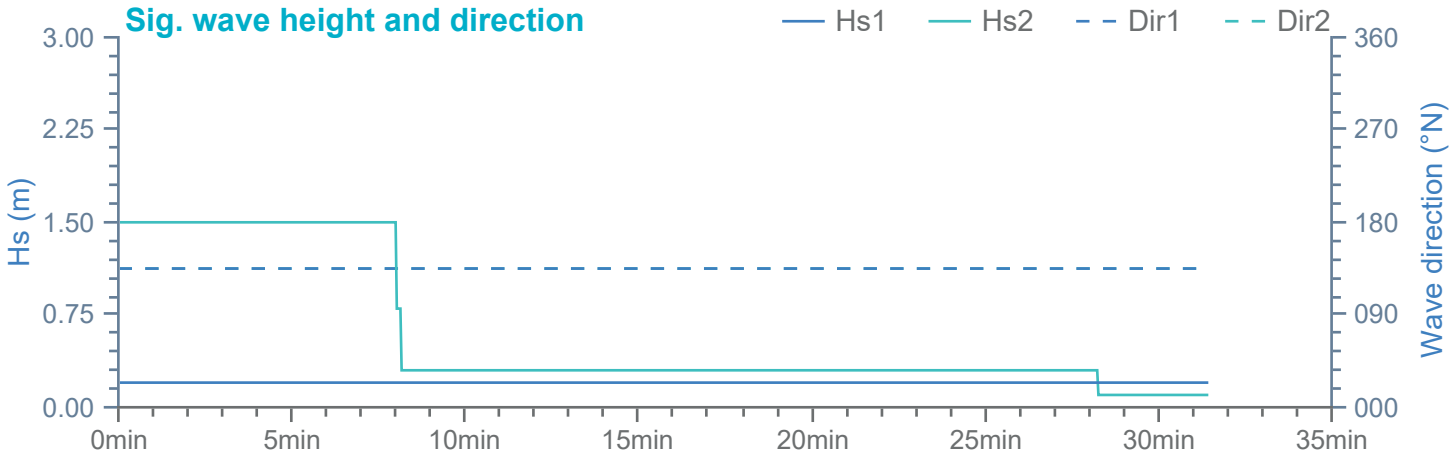
Manoeuvring area and berthing

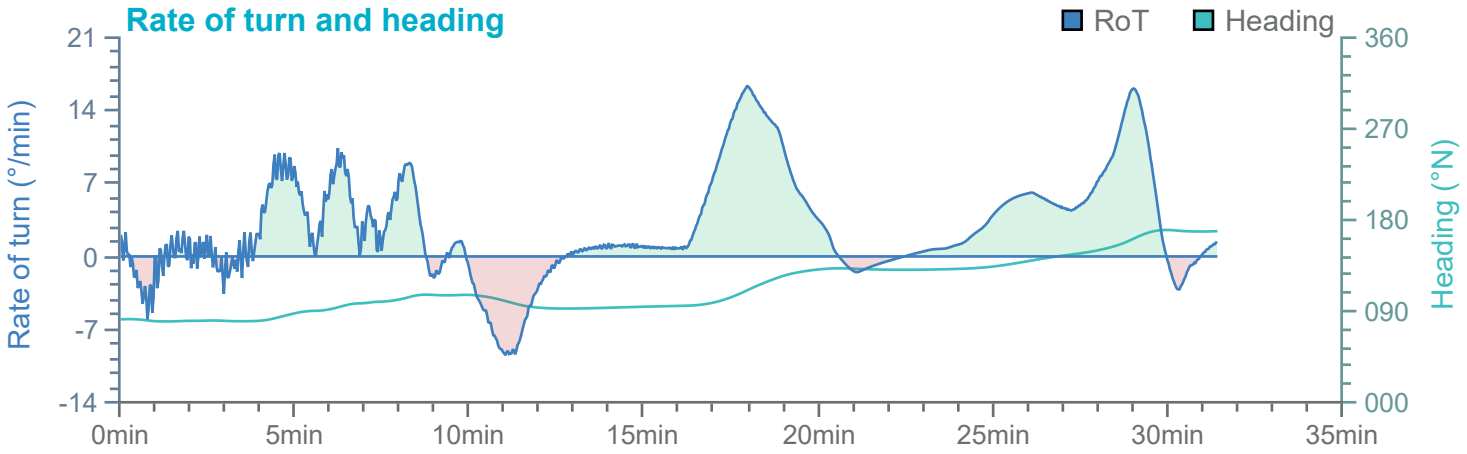


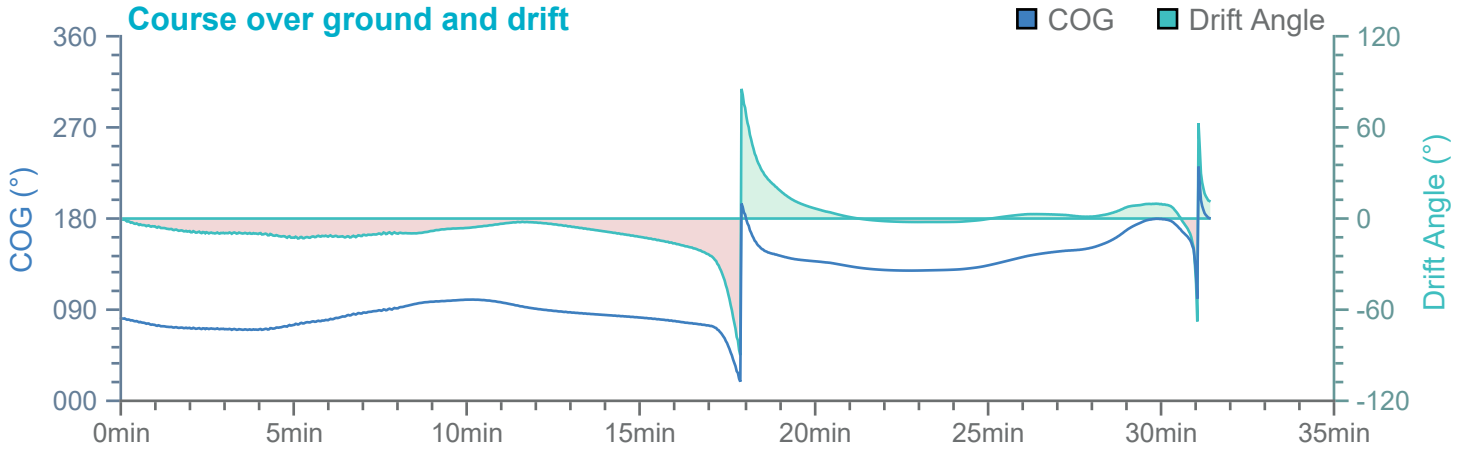
Ships plotted every 2 mins, highlight every 10 mins

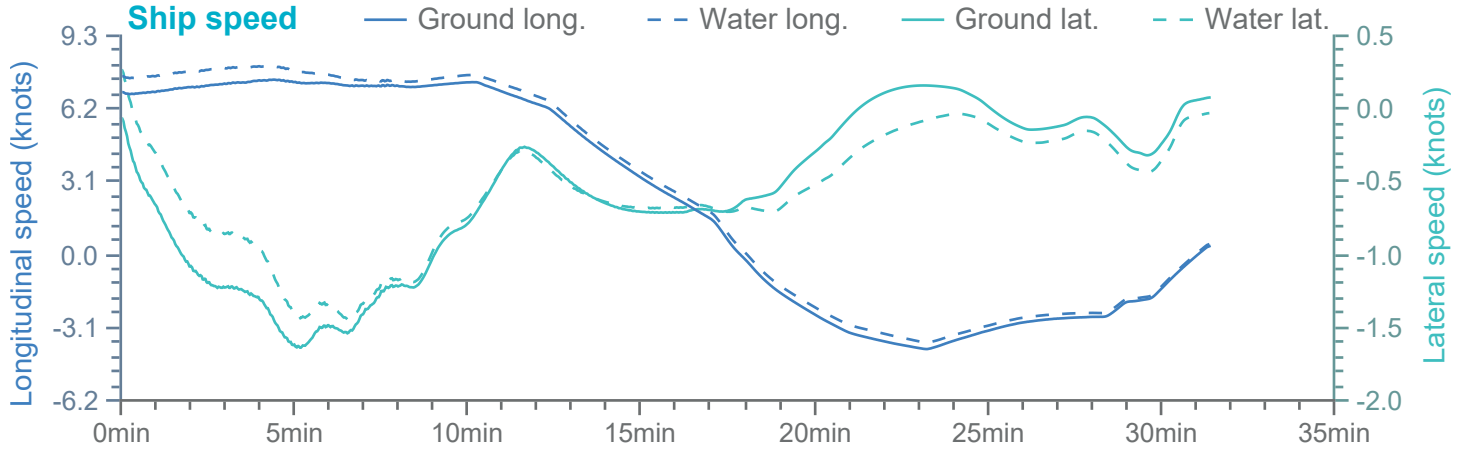

Current acting on ship
Bow
Stern
Bow Dir
Stern Dir
Current speed (knots)
Current direction (°N)
1.7
1.3
0.9
0.5
0.1
360
270
180
090
000
0min
5min
10min
15min
20min
25min
30min
35min

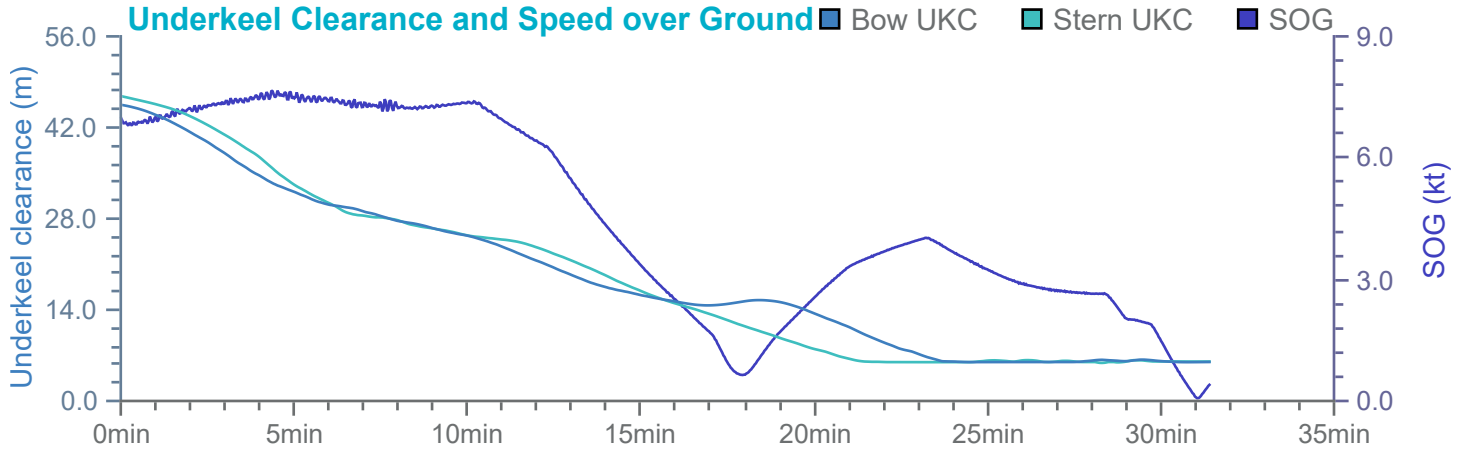

Wind speed and direction
Speed
Direction
Wind speed (knots)
Wind direction (°N)
40
30
20
10
0
360
270
180
090
000
0min
5min
10min
15min
20min
25min
30min
35min

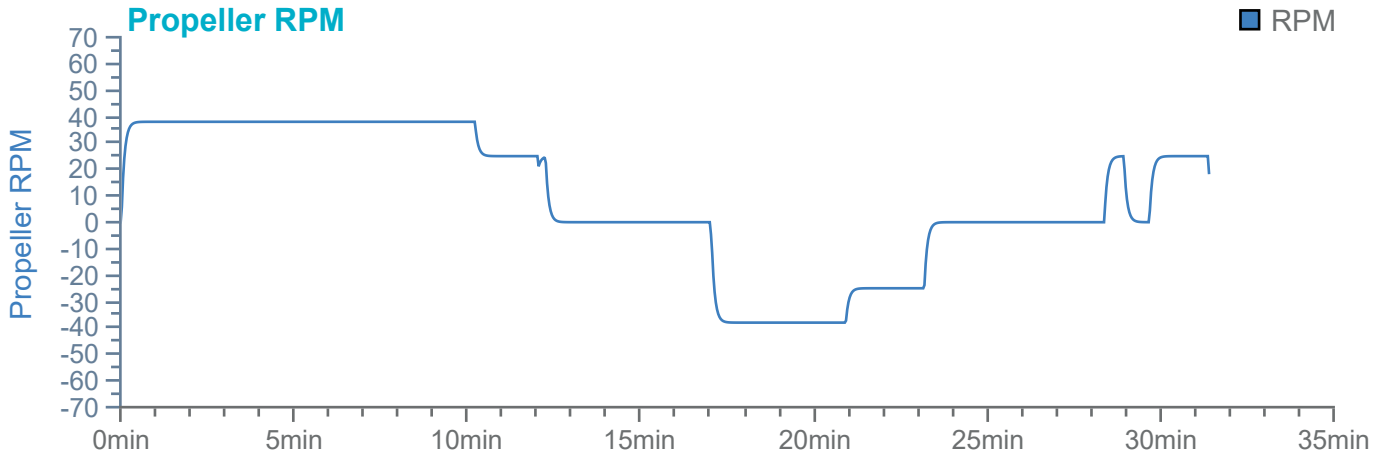

Sig. wave height and direction
Hs1
Hs2
Dir1
Dir2
Hs (m)
Wave direction (°N)
3.00
2.25
1.50
0.75
0.00
360
270
180
090
000
0min
5min
10min
15min
20min
25min
30min
35min

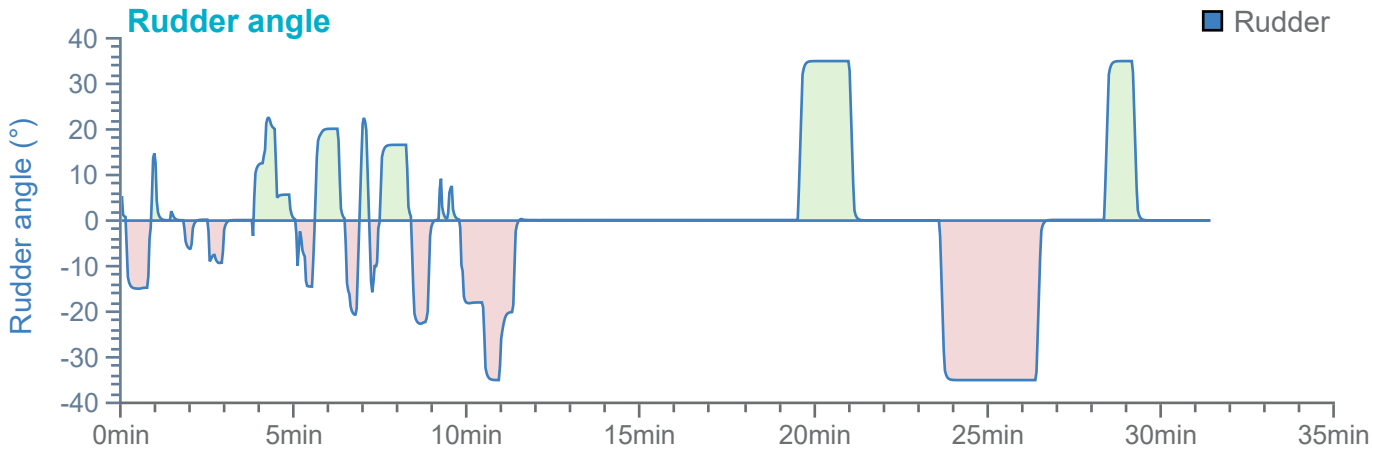

Rate of turn and heading
RoT
Heading
Rate of turn (°/min)
Heading (°N)
21
14
7
0
-7
-14
360
270
180
090
000
0min
5min
10min
15min
20min
25min
30min
35min

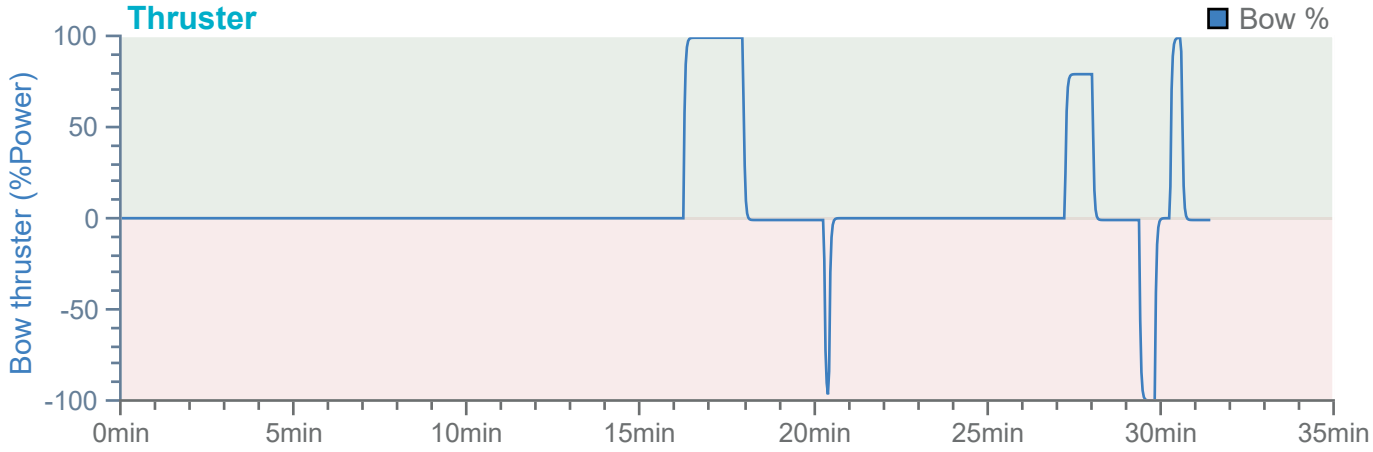

Course over ground and drift
COG
Drift Angle
COG (°)
Drift Angle (°)
360
270
180
090
000
120
60
0
-60
-120
0min
5min
10min
15min
20min
25min
30min
35min


Ship speed
Ground long.
Water long.
Ground lat.
Water lat.
Longitudinal speed (knots)
Lateral speed (knots)
9.3
6.2
3.1
0.0
-3.1
-6.2
0.5
0.0
-0.5
-1.0
-1.5
-2.0
0min
5min
10min
15min
20min
25min
30min
35min

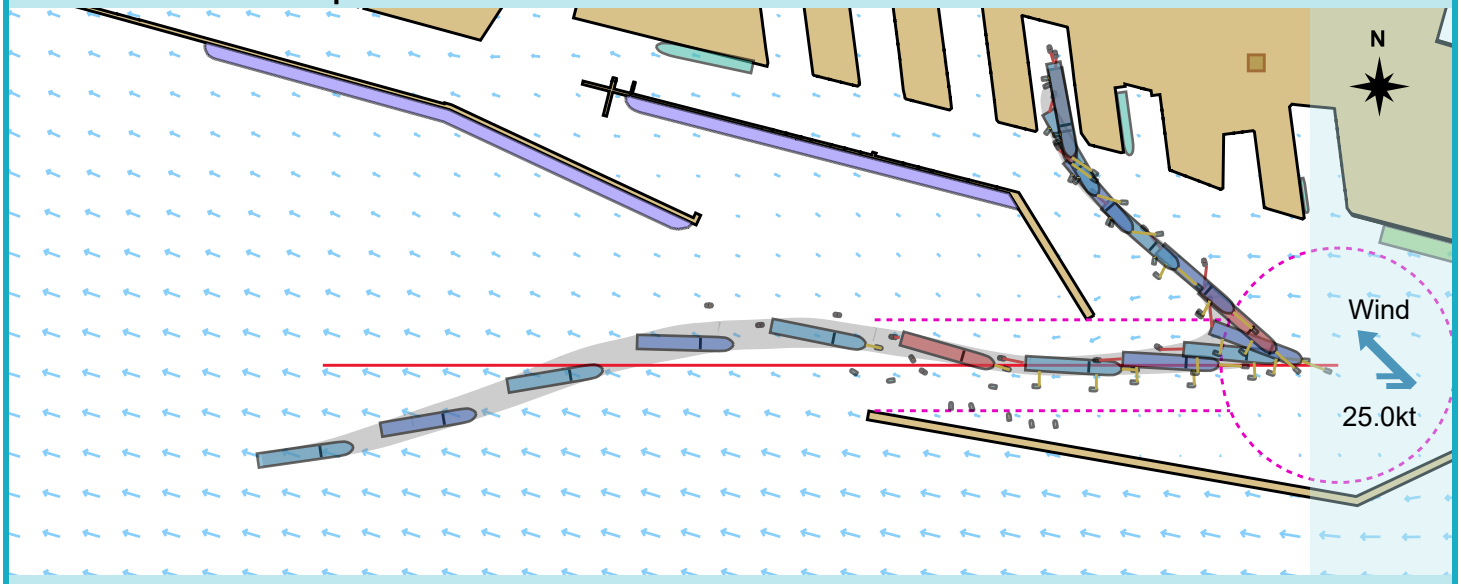

Underkeel Clearance and Speed over Ground
Bow UKC
Stern UKC
SOG
Underkeel clearance (m)
SOG (kt)
56.0
42.0
28.0
14.0
0.0
9.0
6.0
3.0
0.0
0min
5min
10min
15min
20min
25min
30min
35min


Propeller RPM
RPM
Propeller RPM
70
60
50
40
30
20
10
0
-10
-20
-30
-40
-50
-60
-70
0min
5min
10min
15min
20min
25min
30min
35min


Rudder angle
Rudder
Rudder angle (°)
40
30
20
10
0
-10
-20
-30
-40
0min
5min
10min
15min
20min
25min
30min
35min

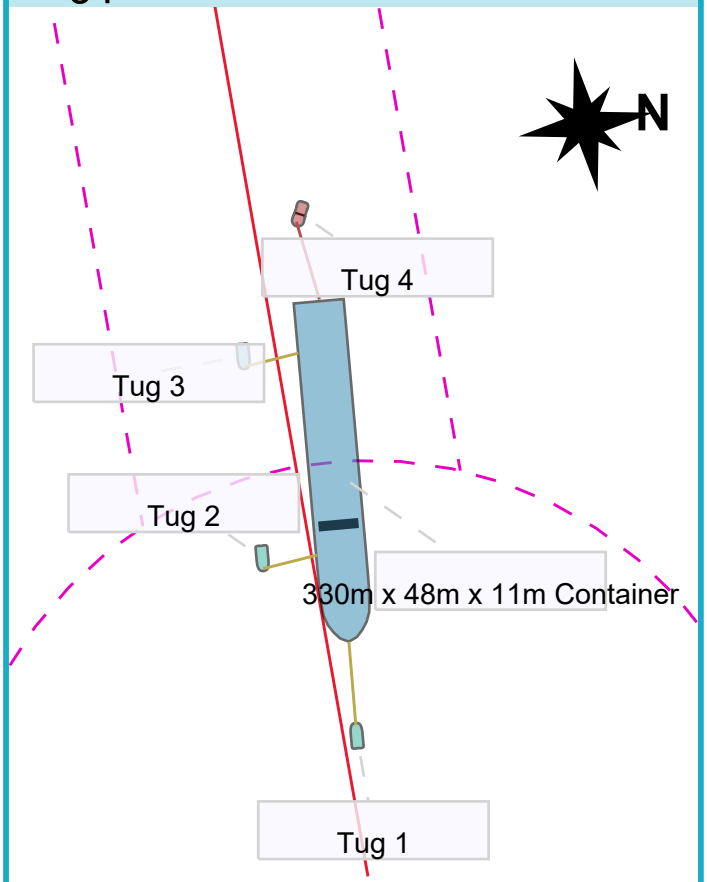

Thruster
Bow %
Bow thruster (%Power)
100
50
0
-50
-100
0min
5min
10min
15min
20min
25min
30min
35min

Manoeuvre track plot

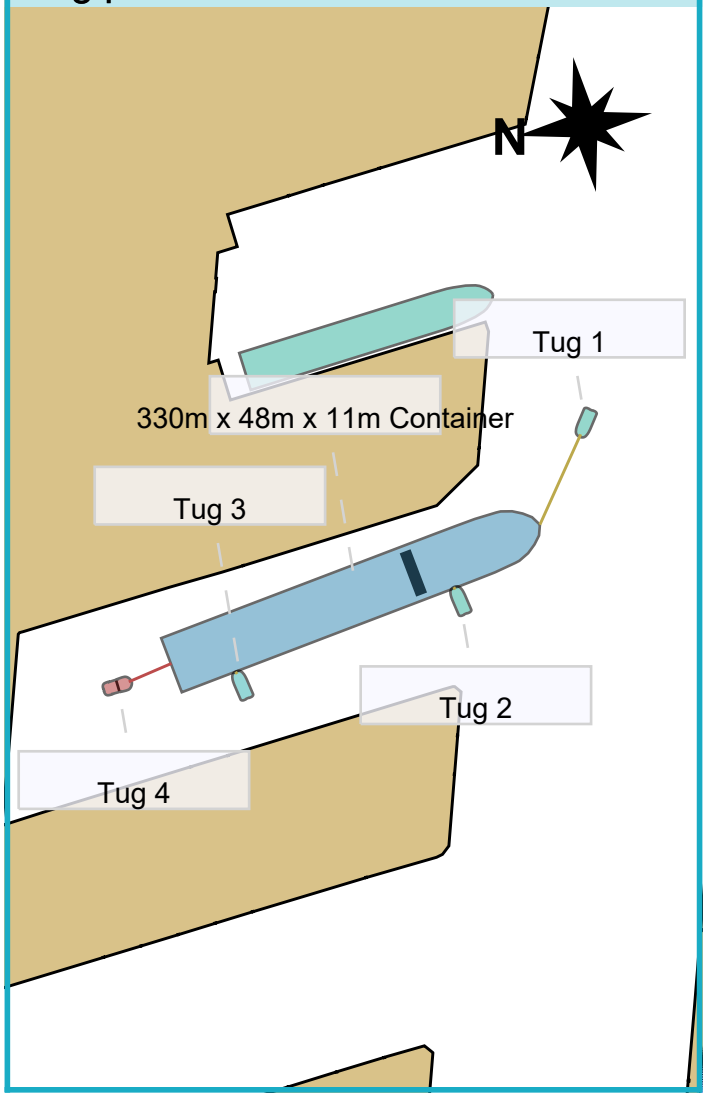


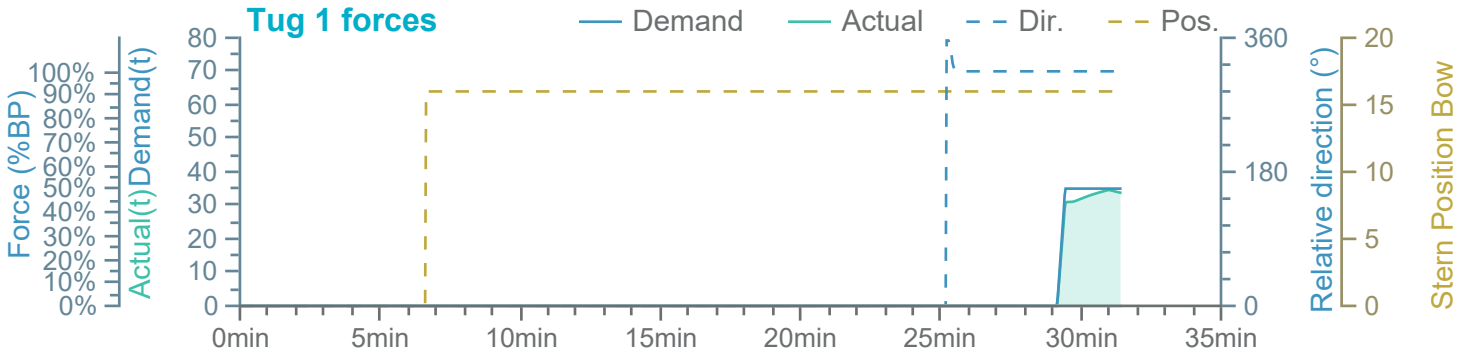
Ships plotted every 2 mins, highlight every 10 mins

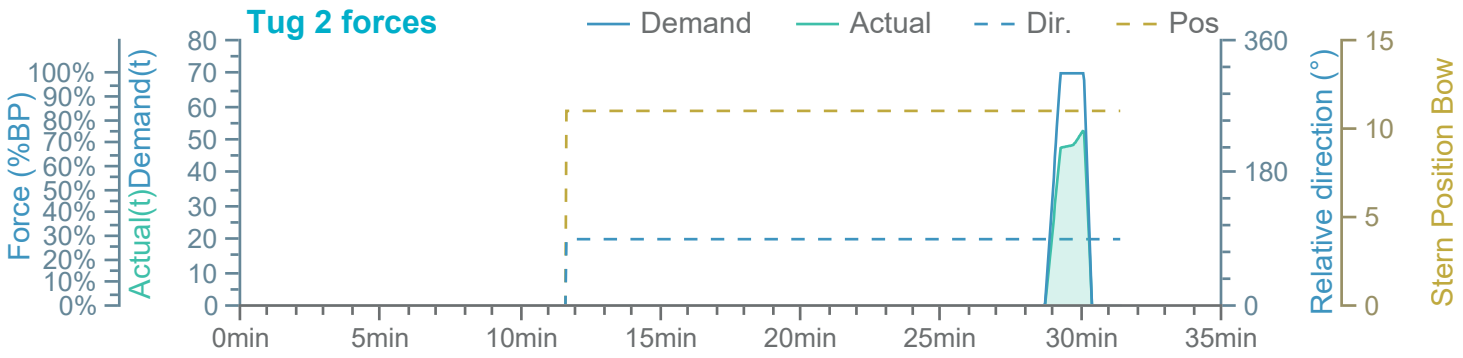
Tug position: Initial

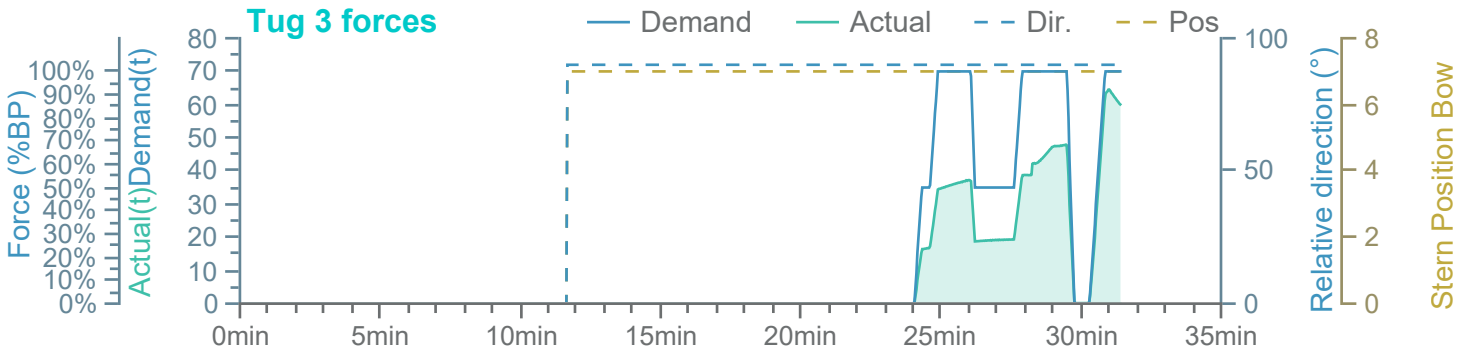


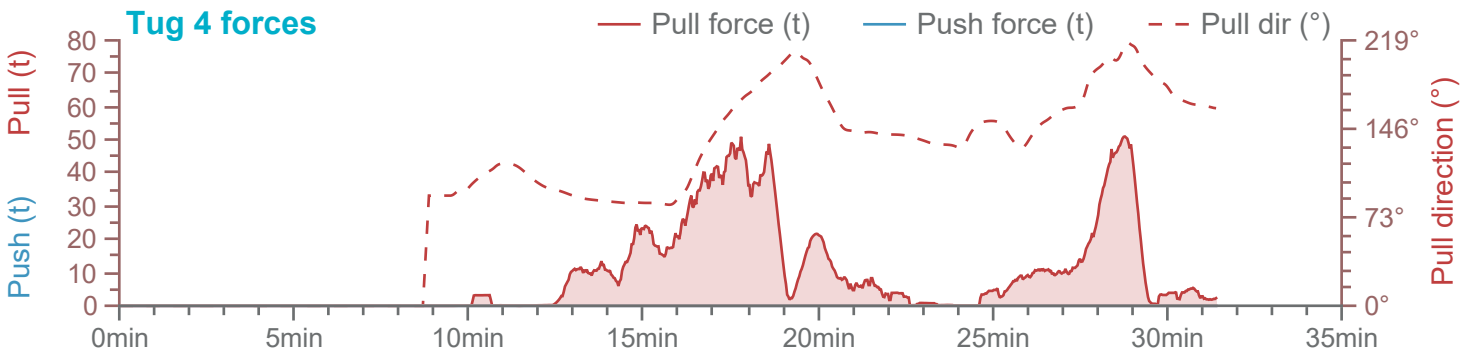
Tug position: Final



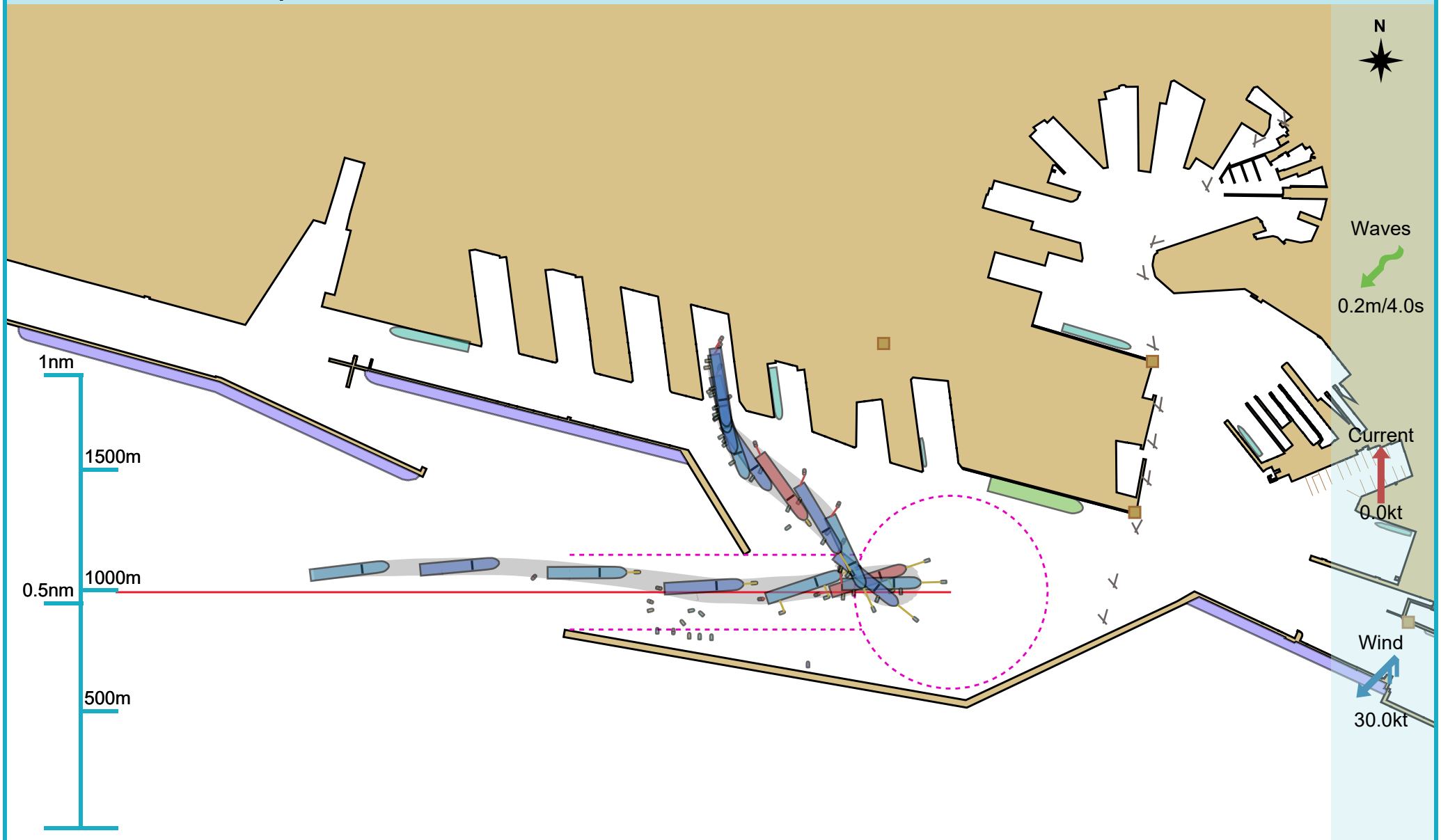

Tug 1 forces
Demand
Actual
Dir.
Pos.
Force (%BP)
Actual(t)Demand(t)
Relative direction (°)
Stern Position Bow
0min
5min
10min
15min
20min
25min
30min
35min


Tug 2 forces
Demand
Actual
Dir.
Pos
Force (%BP)
Actual(t)Demand(t)
Relative direction (°)
Stern Position Bow
0min
5min
10min
15min
20min
25min
30min
35min


Tug 3 forces
Demand
Actual
Dir.
Pos
Force (%BP)
Actual(t)Demand(t)
Relative direction (°)
Stern Position Bow
0min
5min
10min
15min
20min
25min
30min
35min


Tug 4 forces
Pull force (t)
Push force (t)
Pull dir (°)
Pull (t)
Push (t)
Pull direction (°)
0min
5min
10min
15min
20min
25min
30min
35min

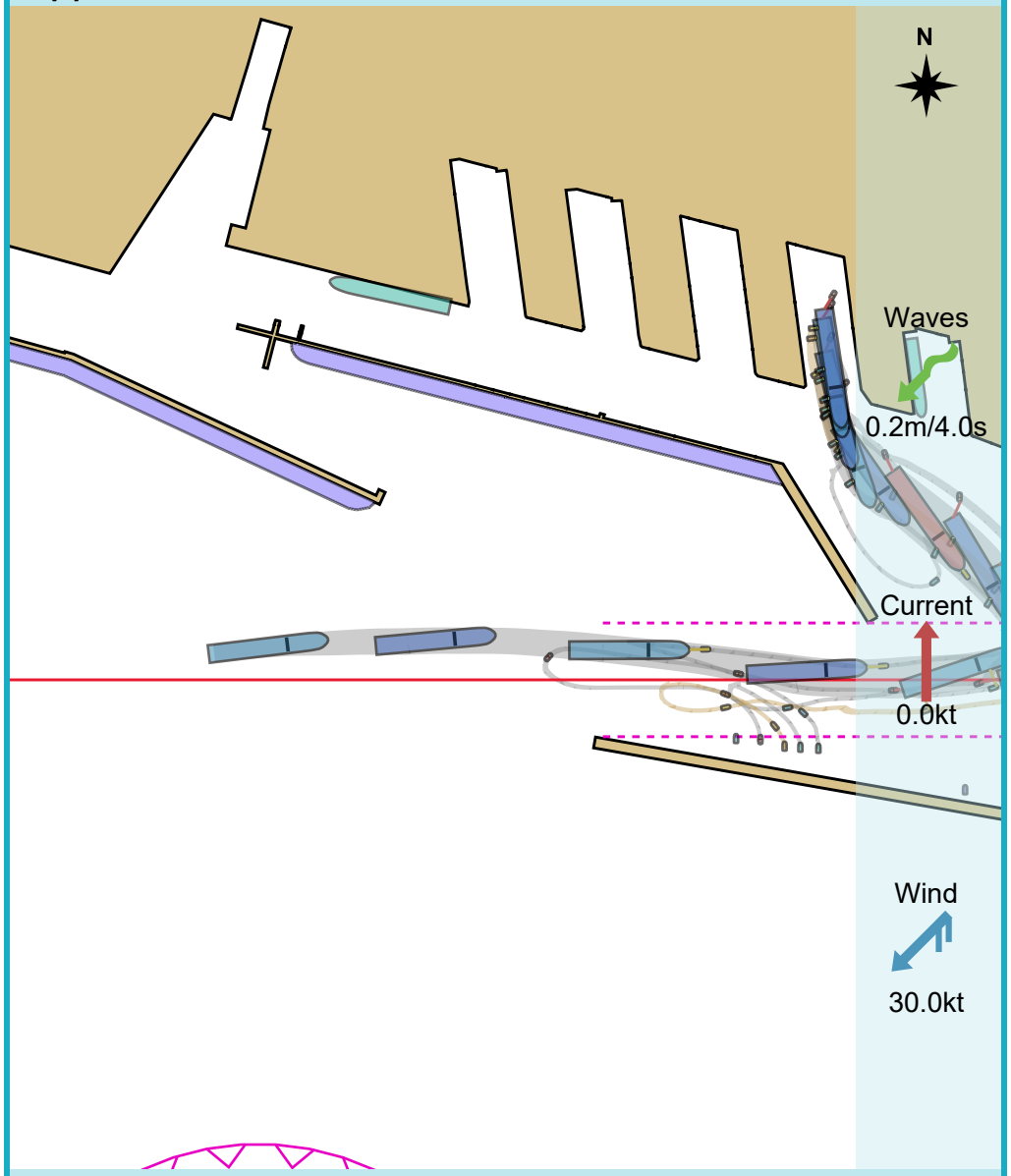
Manoeuvre track plot



0.00 kts

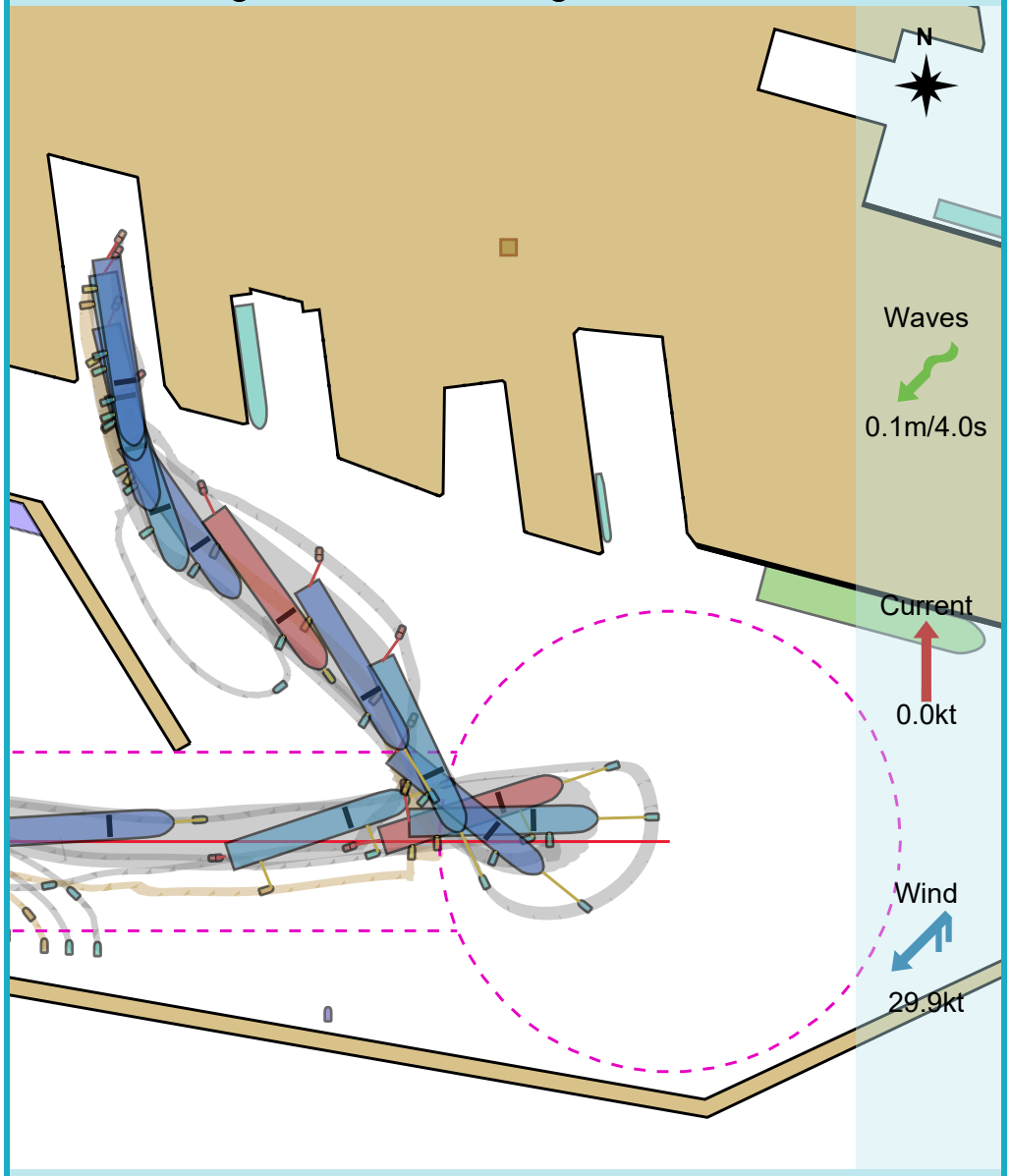
Ships plotted every 2 mins, highlight every 10 mins

Approach Channel

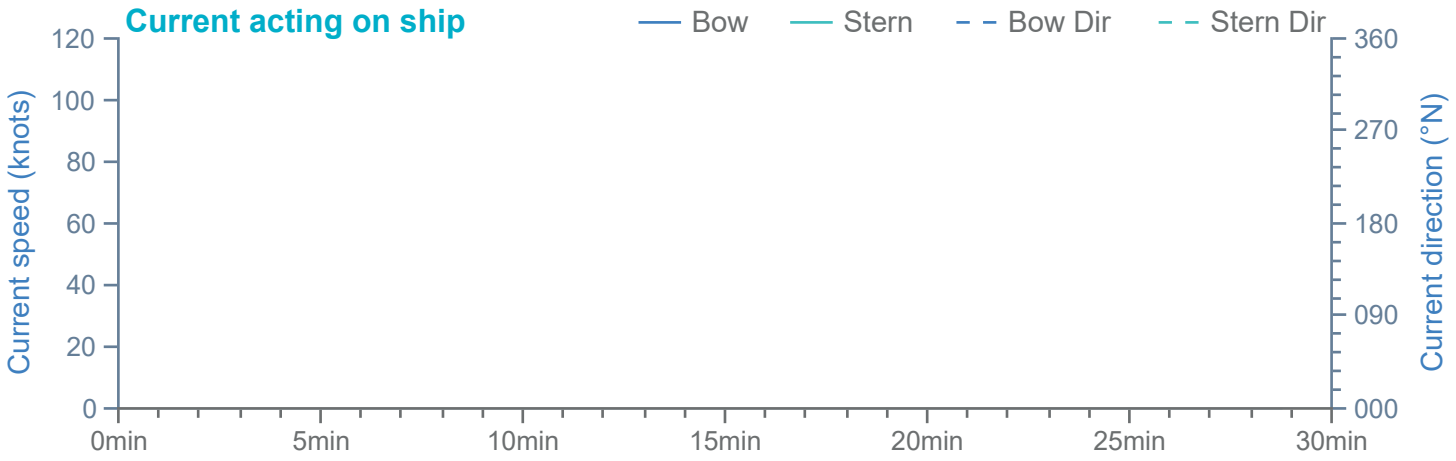


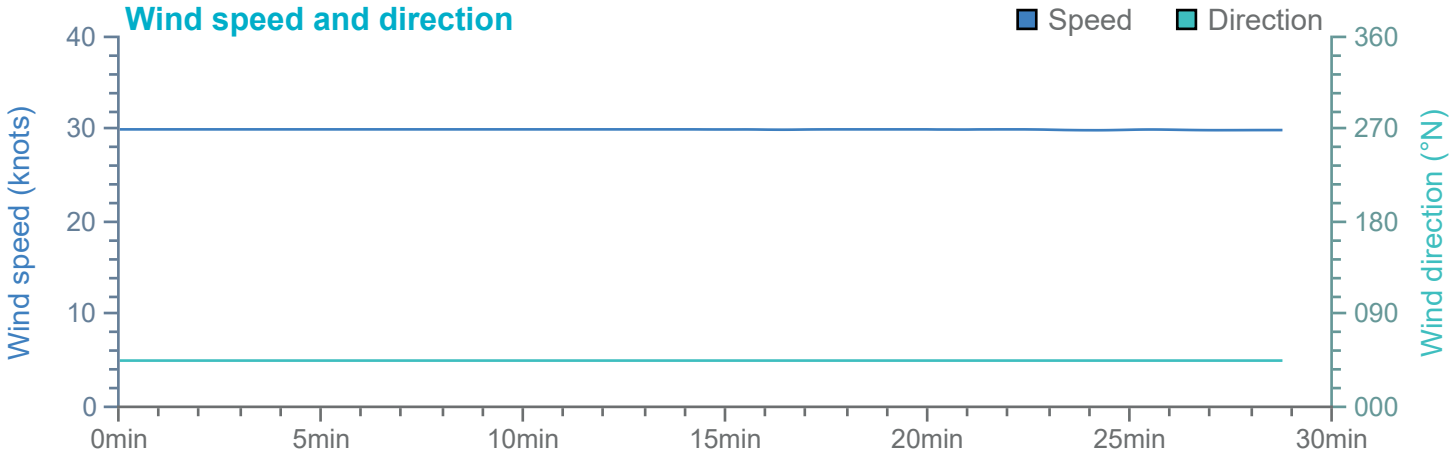
Ships plotted every 2 mins, highlight every 10 mins

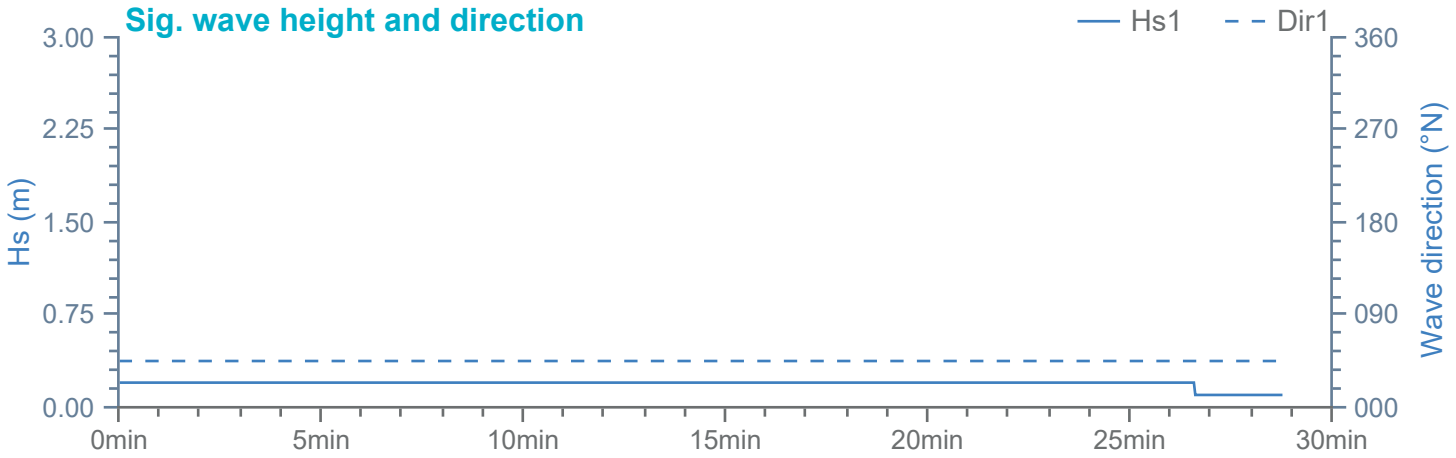
Manoeuvring area and berthing

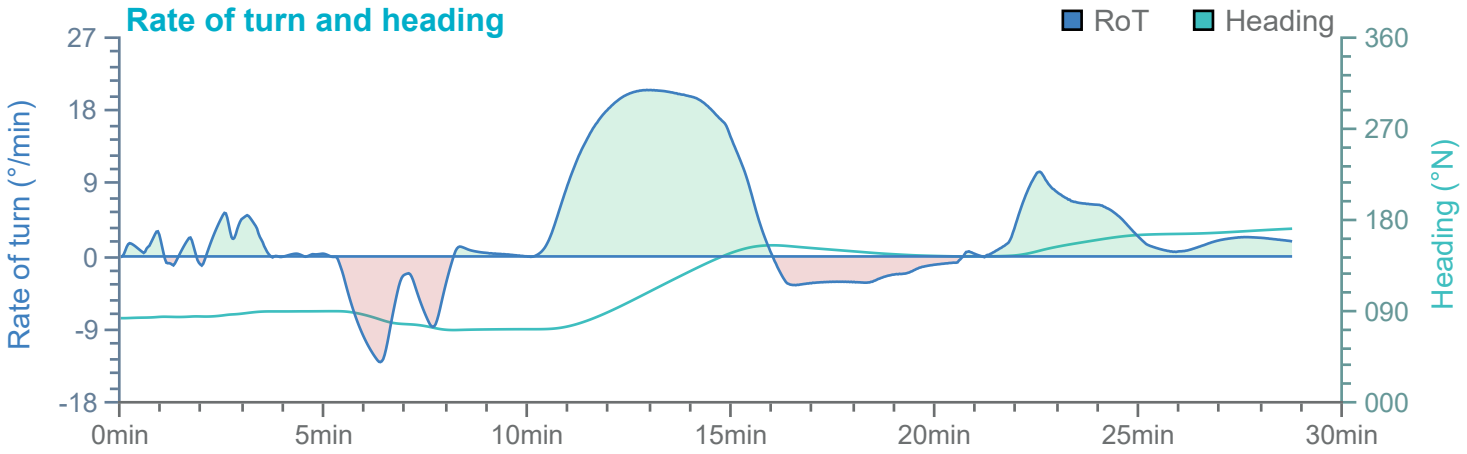


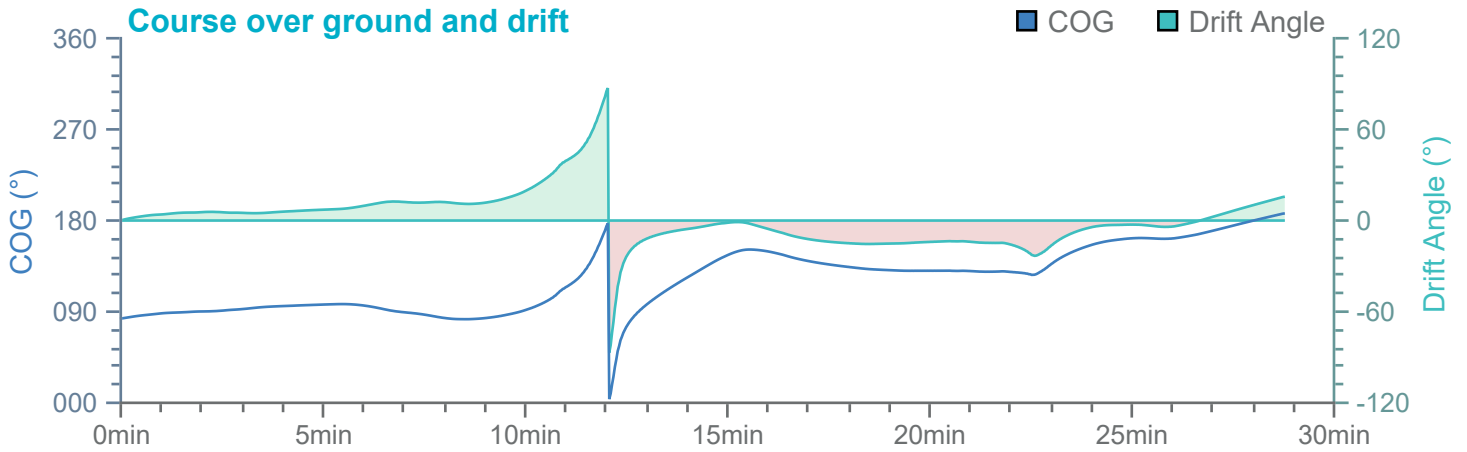
Ships plotted every 2 mins, highlight every 10 mins

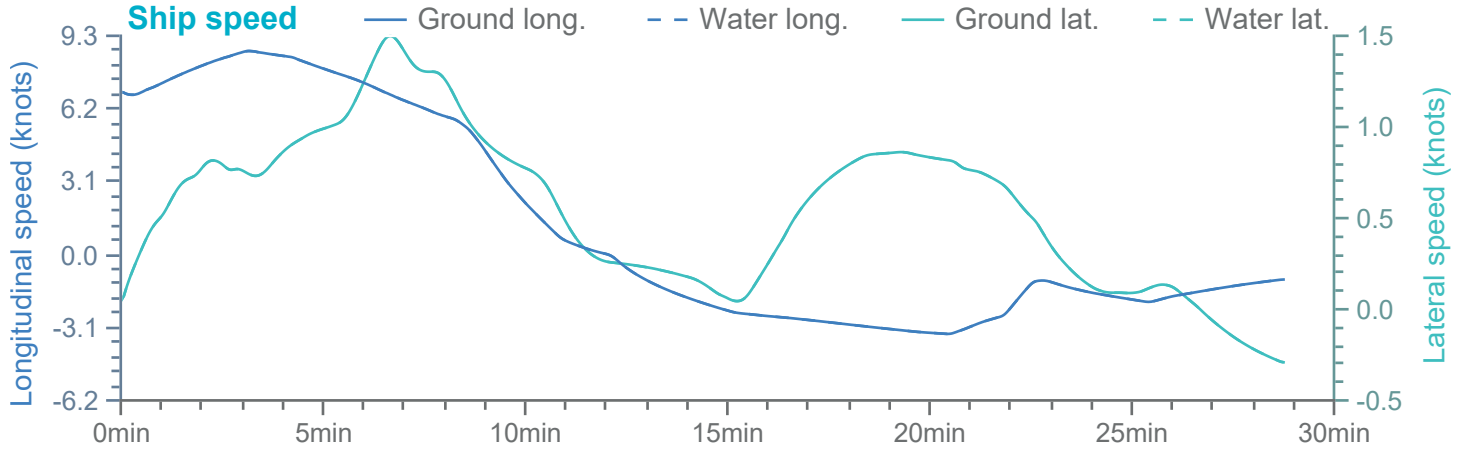

Current acting on ship
Bow
Stern
Bow Dir
Stern Dir
Current speed (knots)
Current direction (°N)
120
100
80
60
40
20
0
360
270
180
090
000
0min
5min
10min
15min
20min
25min
30min

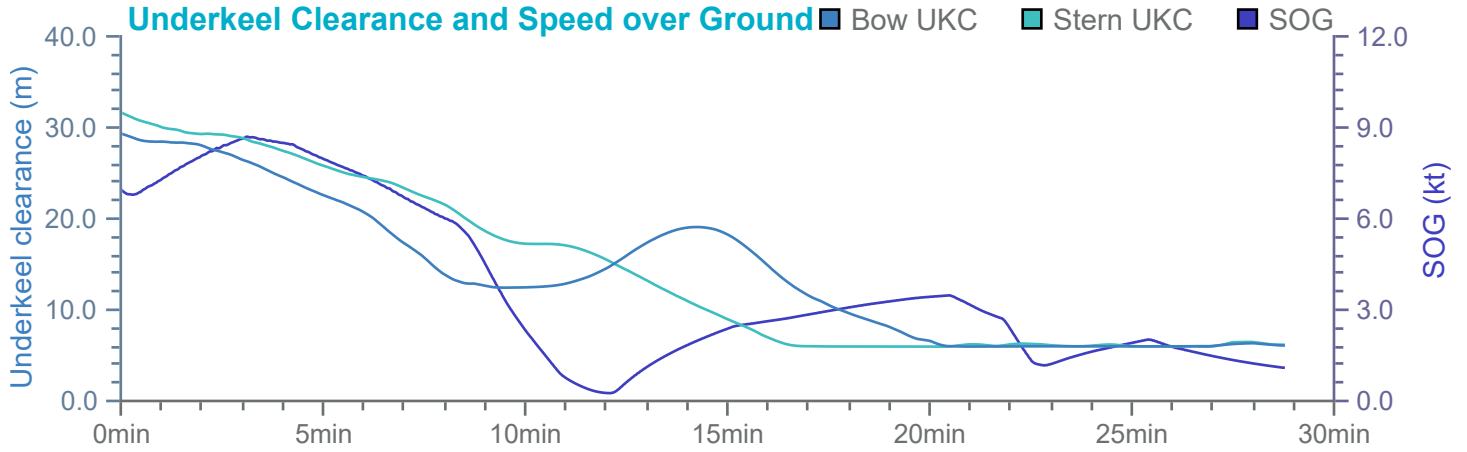

Wind speed and direction
Speed
Direction
Wind speed (knots)
Wind direction (°N)
40
30
20
10
0
360
270
180
090
000
0min
5min
10min
15min
20min
25min
30min

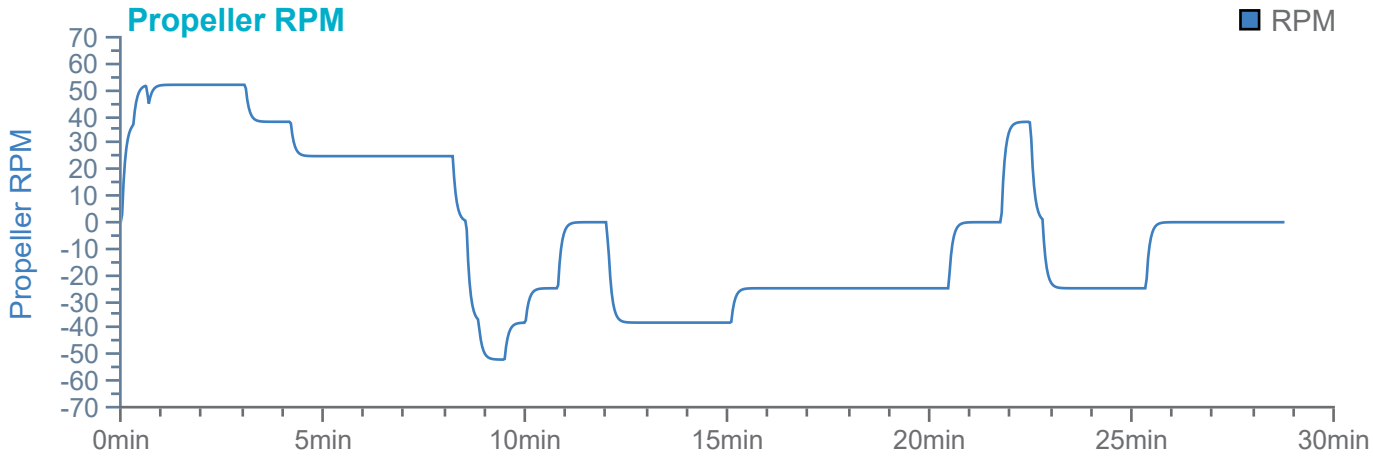

Sig. wave height and direction
Hs1
Dir1
Hs (m)
Wave direction (°N)
3.00
2.25
1.50
0.75
0.00
360
270
180
090
000
0min
5min
10min
15min
20min
25min
30min

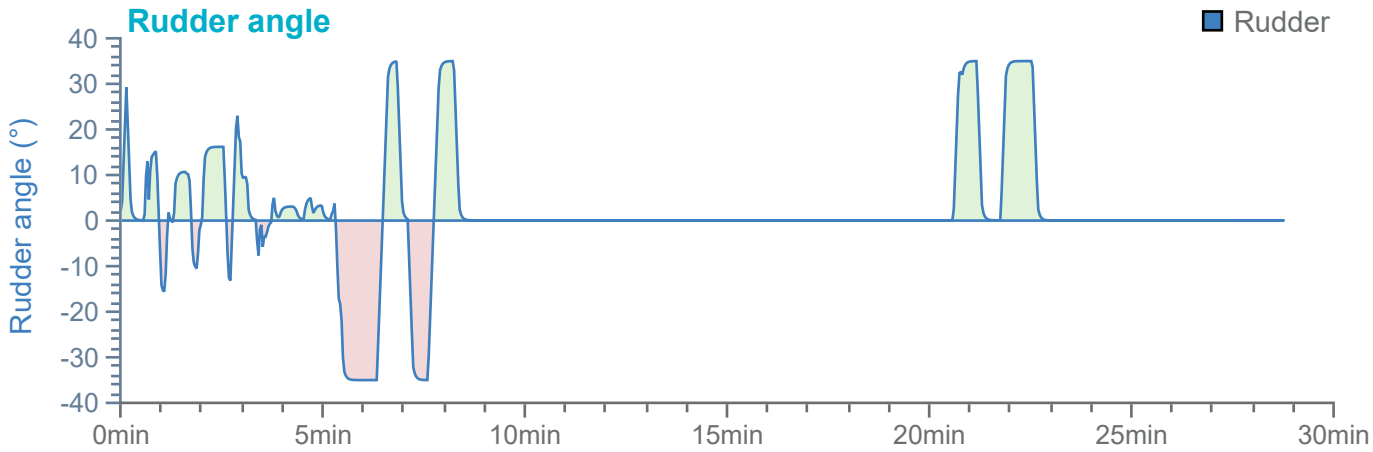

Rate of turn and heading
RoT
Heading
Rate of turn (°/min)
Heading (°N)
27
18
9
0
-9
-18
360
270
180
090
000
0min
5min
10min
15min
20min
25min
30min

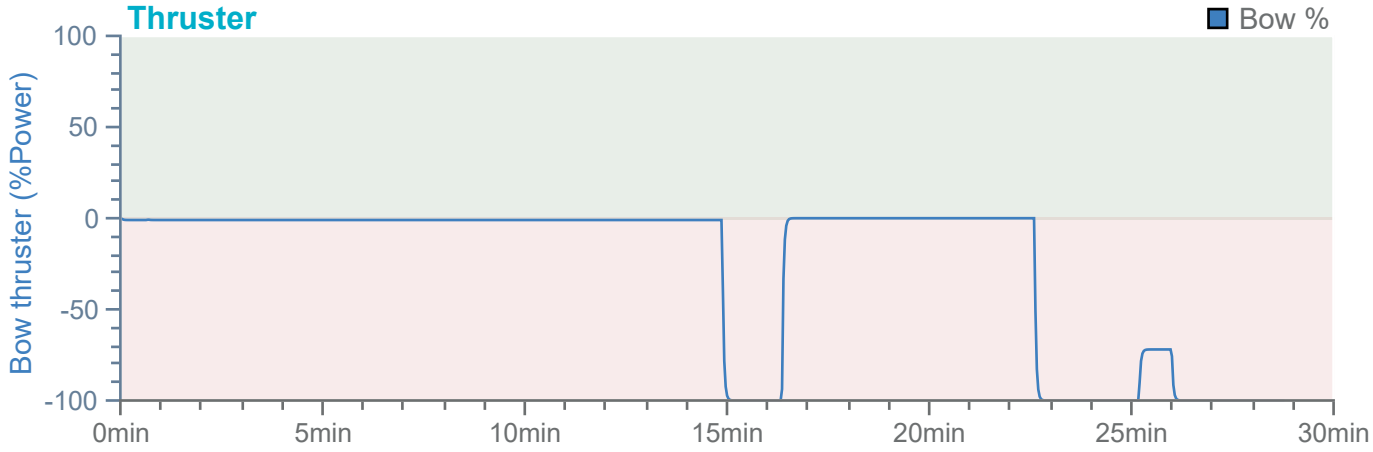

Course over ground and drift
COG
Drift Angle
COG (°)
Drift Angle (°)
360
270
180
090
000
120
60
0
-60
-120
0min
5min
10min
15min
20min
25min
30min


Ship speed
Ground long.
Water long.
Ground lat.
Water lat.
Longitudinal speed (knots)
Lateral speed (knots)
9.3
6.2
3.1
0.0
-3.1
-6.2
1.5
1.0
0.5
0.0
-0.5
0min
5min
10min
15min
20min
25min
30min

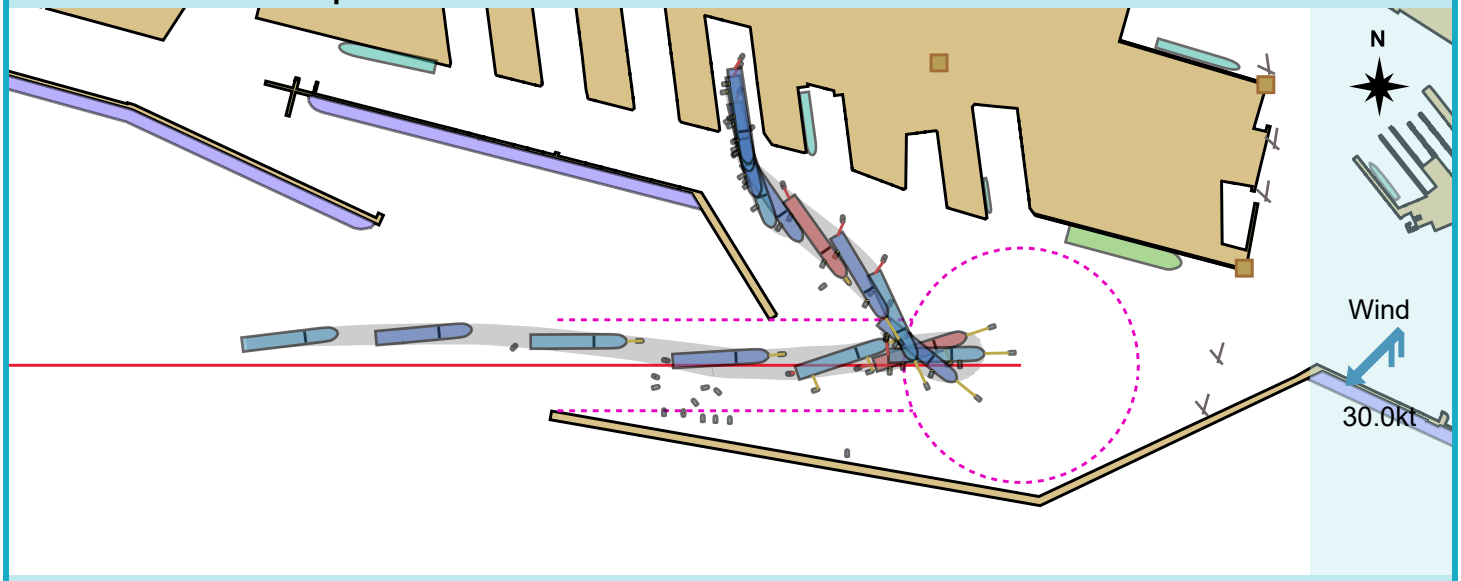

Underkeel Clearance and Speed over Ground
Bow UKC
Stern UKC
SOG
Underkeel clearance (m)
SOG (kt)
40.0
30.0
20.0
10.0
0.0
12.0
9.0
6.0
3.0
0.0
0min
5min
10min
15min
20min
25min
30min


Propeller RPM
RPM
Propeller RPM
70
60
50
40
30
20
10
0
-10
-20
-30
-40
-50
-60
-70
0min
5min
10min
15min
20min
25min
30min


Rudder angle
Rudder
Rudder angle (°)
40
30
20
10
0
-10
-20
-30
-40
0min
5min
10min
15min
20min
25min
30min

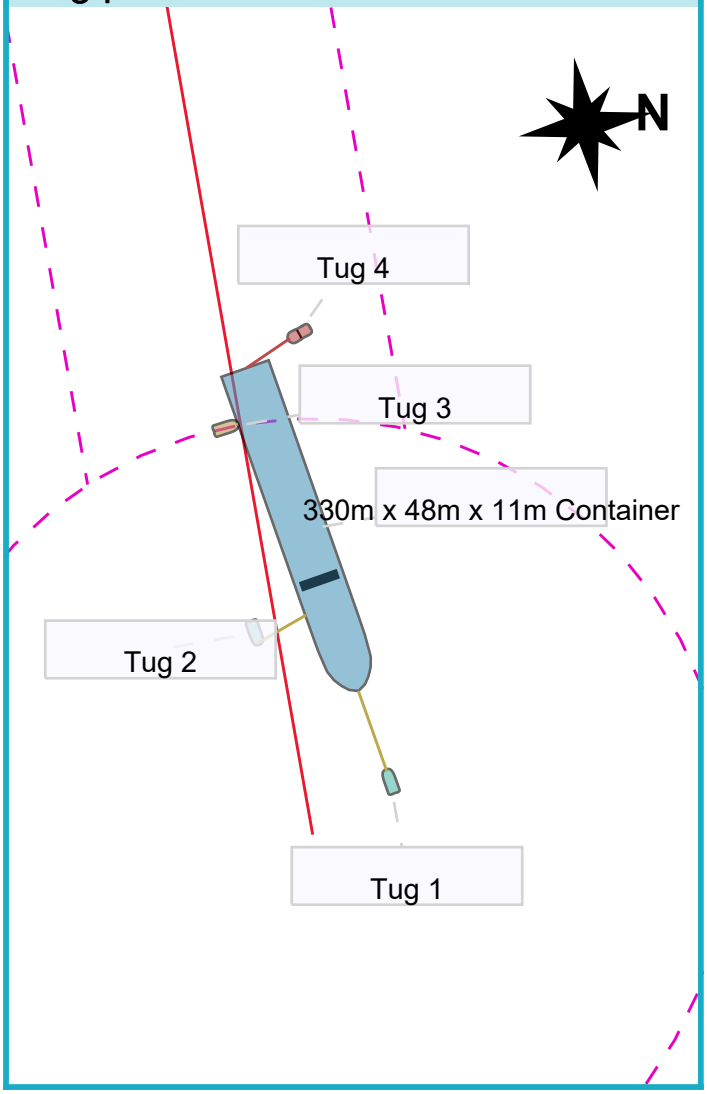

Thruster
Bow %
Bow thruster (%Power)
100
50
0
-50
-100
0min
5min
10min
15min
20min
25min
30min

Manoeuvre track plot

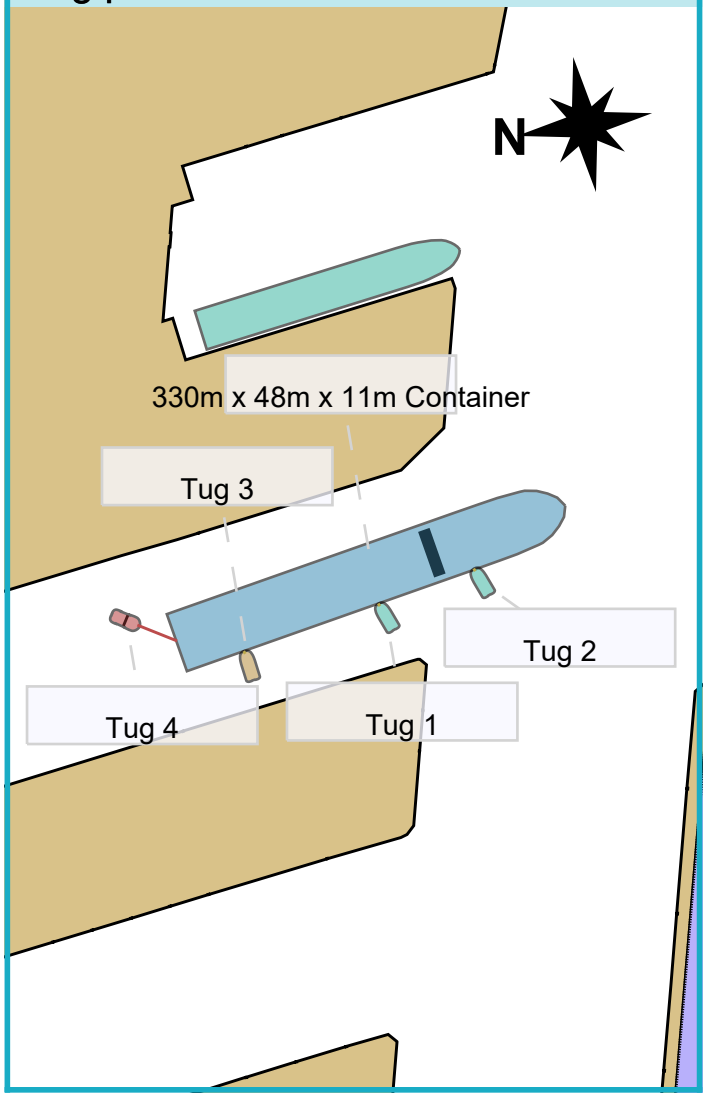


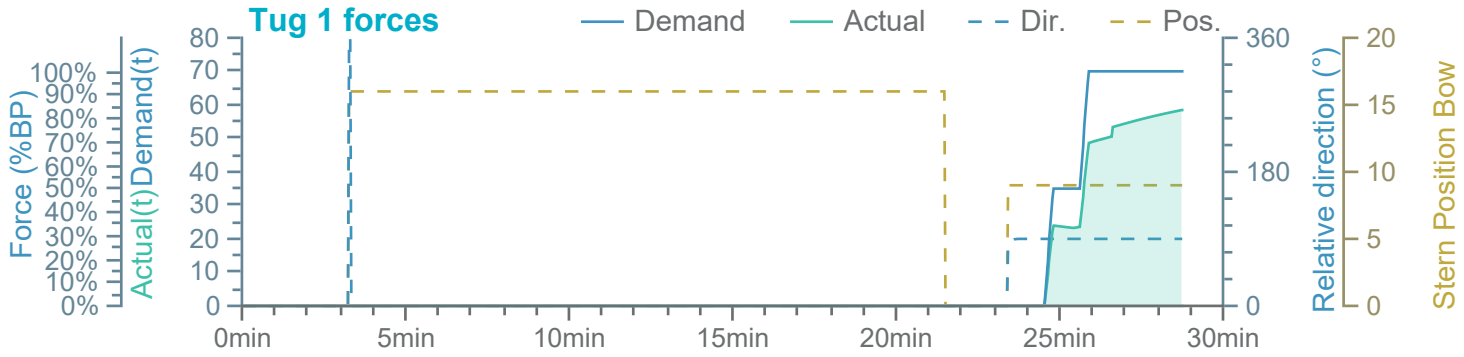
Ships plotted every 2 mins, highlight every 10 mins

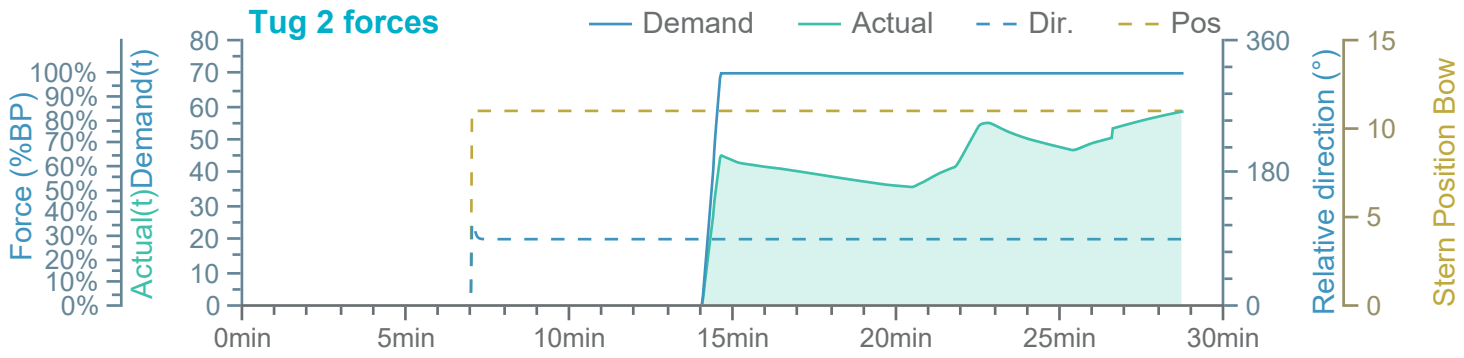
Tug position: Initial

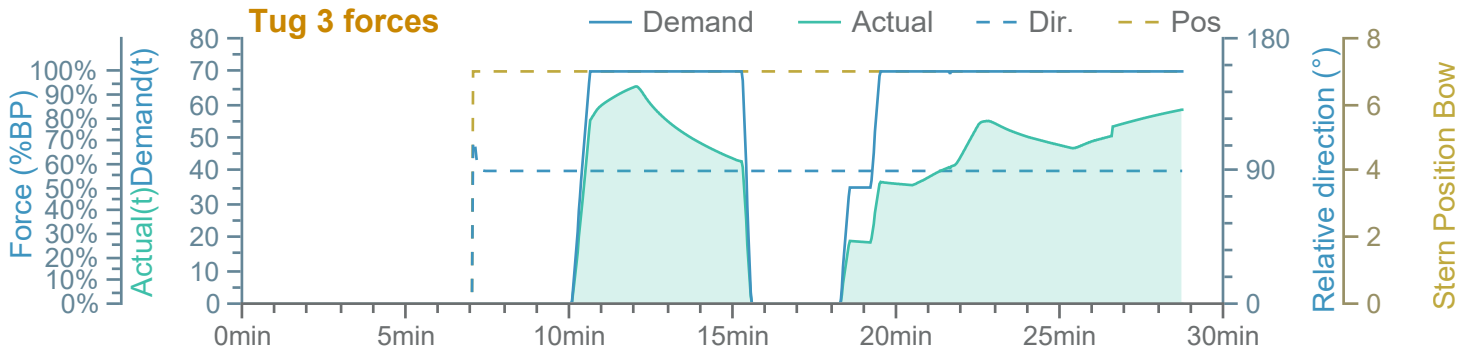


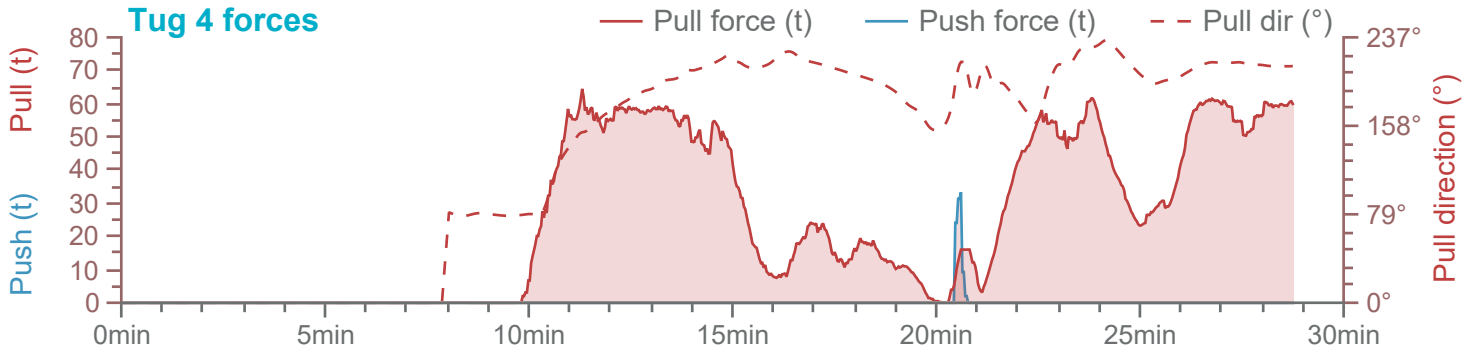
Tug position: Final



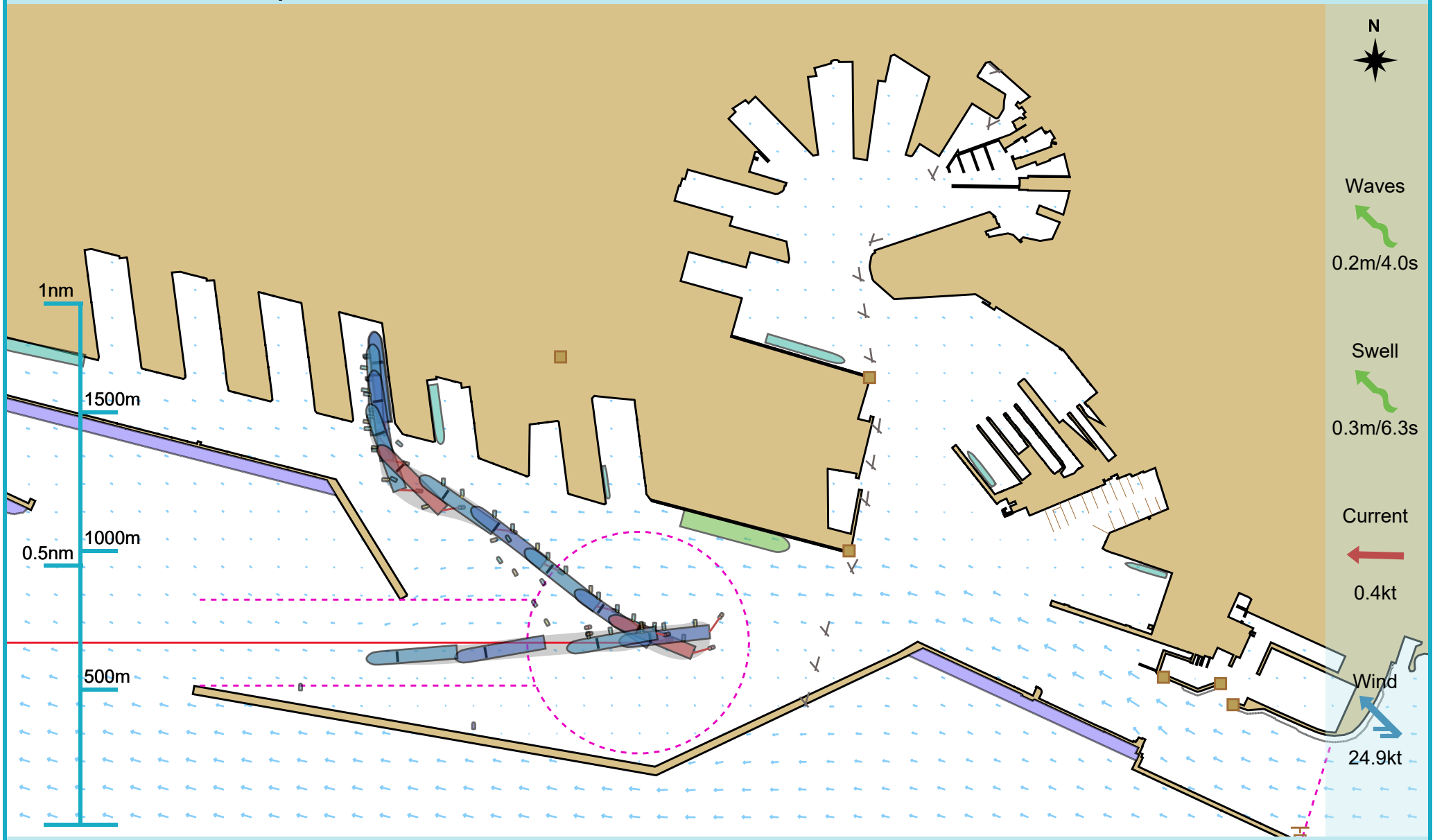

Tug 1 forces
Demand
Actual
Dir.
Pos.
Force (%BP)
Actual(t)Demand(t)
Relative direction (°)
Stern Position Bow
0min
5min
10min
15min
20min
25min
30min


Tug 2 forces
Demand
Actual
Dir.
Pos
Force (%BP)
Actual(t)Demand(t)
Relative direction (°)
Stern Position Bow
0min
5min
10min
15min
20min
25min
30min


Tug 3 forces
Demand
Actual
Dir.
Pos
Force (%BP)
Actual(t)Demand(t)
Relative direction (°)
Stern Position Bow
0min
5min
10min
15min
20min
25min
30min


Tug 4 forces
Pull force (t)
Push force (t)
Pull dir (°)
Pull (t)
Push (t)
Pull direction (°)
0min
5min
10min
15min
20min
25min
30min

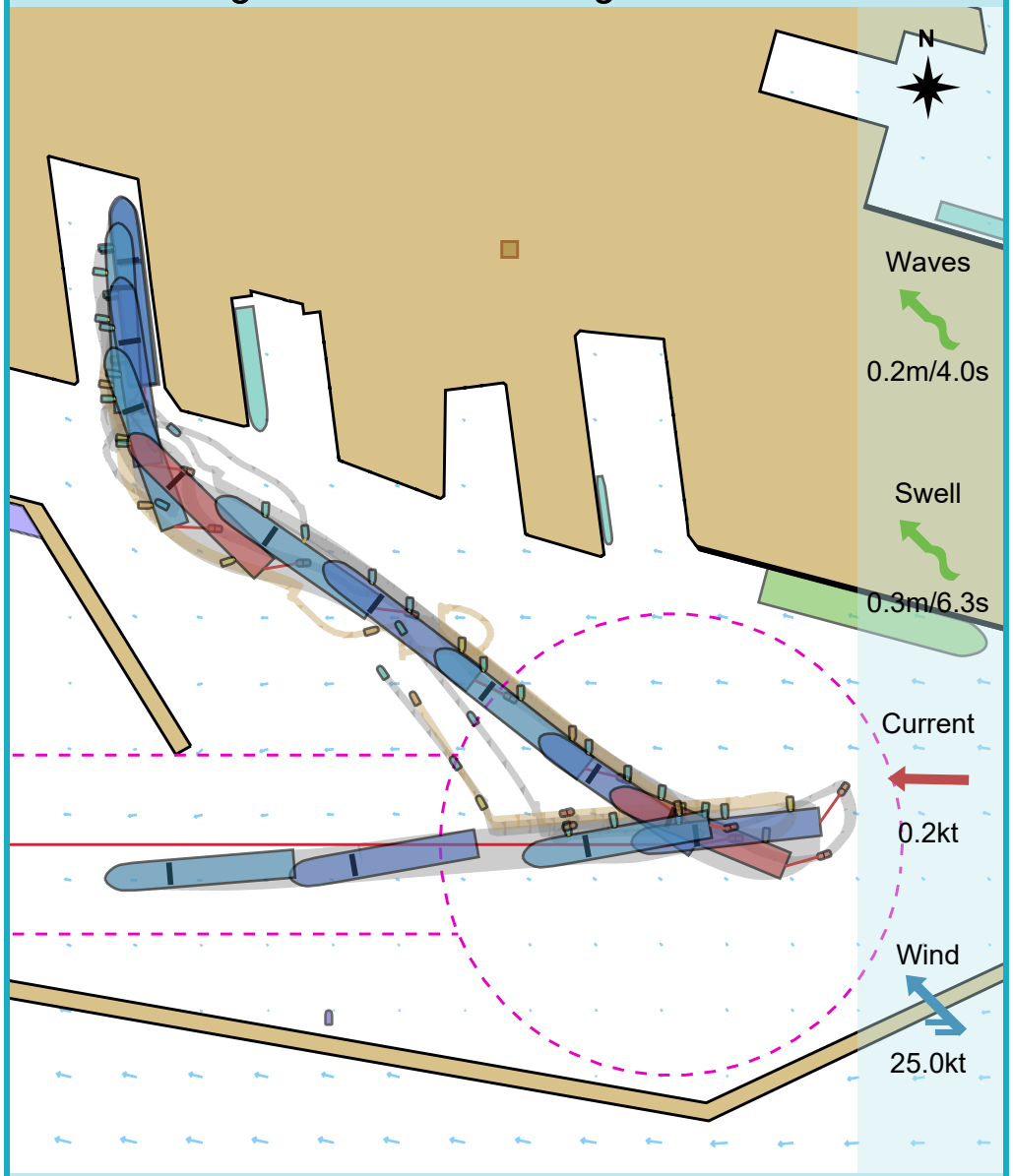
Manoeuvre track plot



1.11 kts

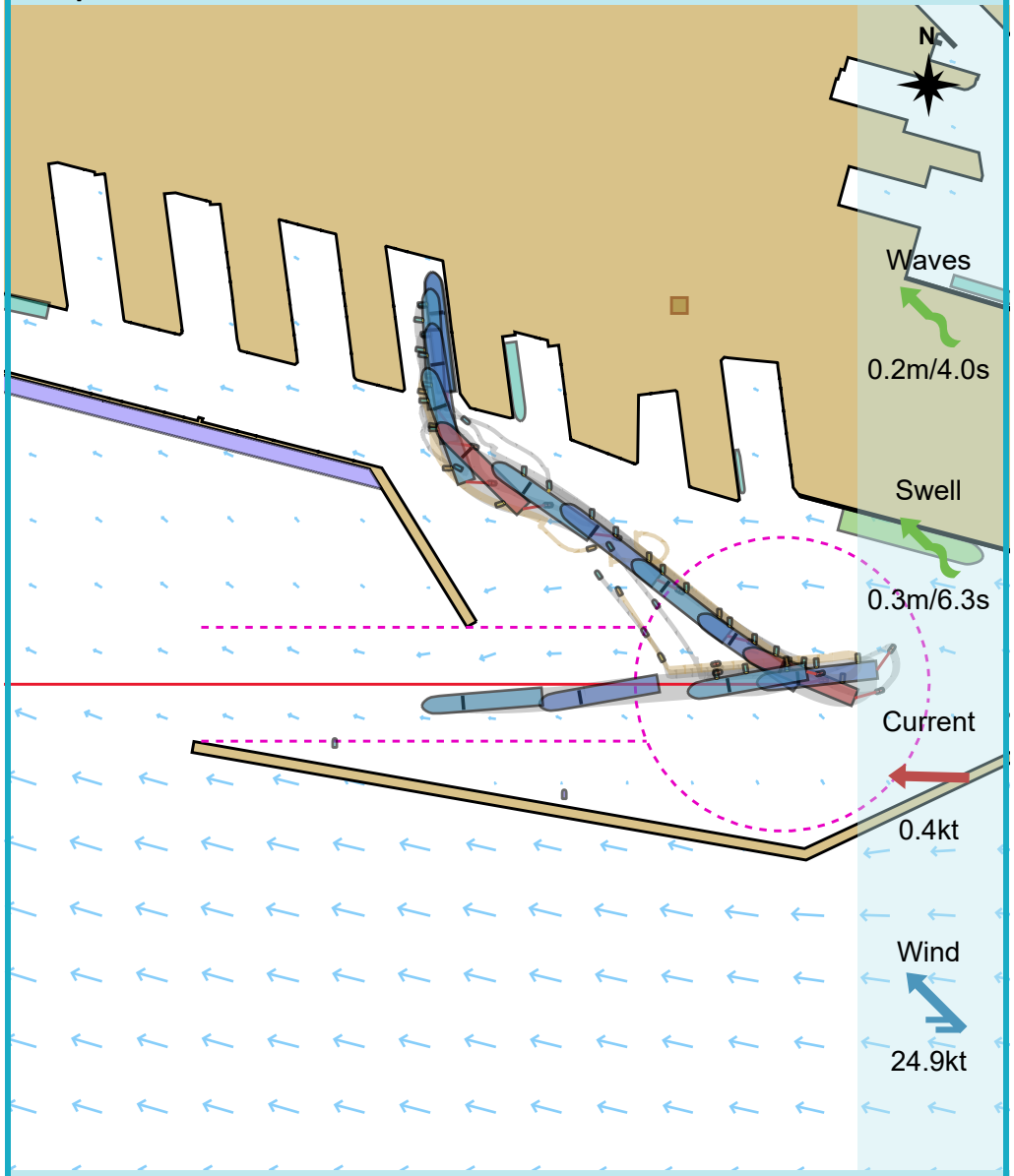
Ships plotted every 2 mins, highlight every 10 mins

Manoeuvring area and unberthing

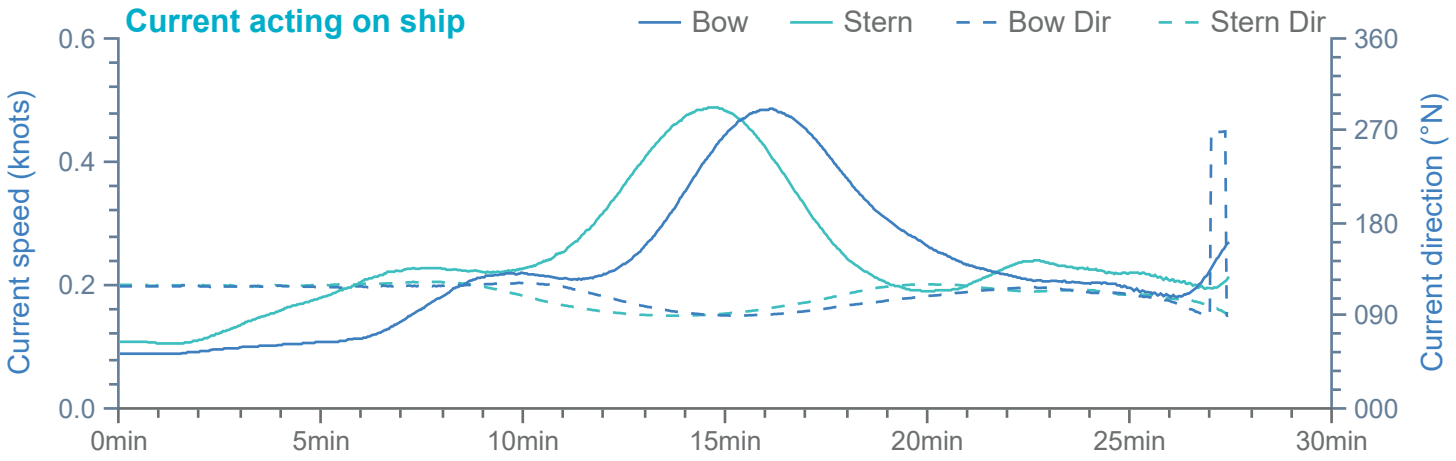


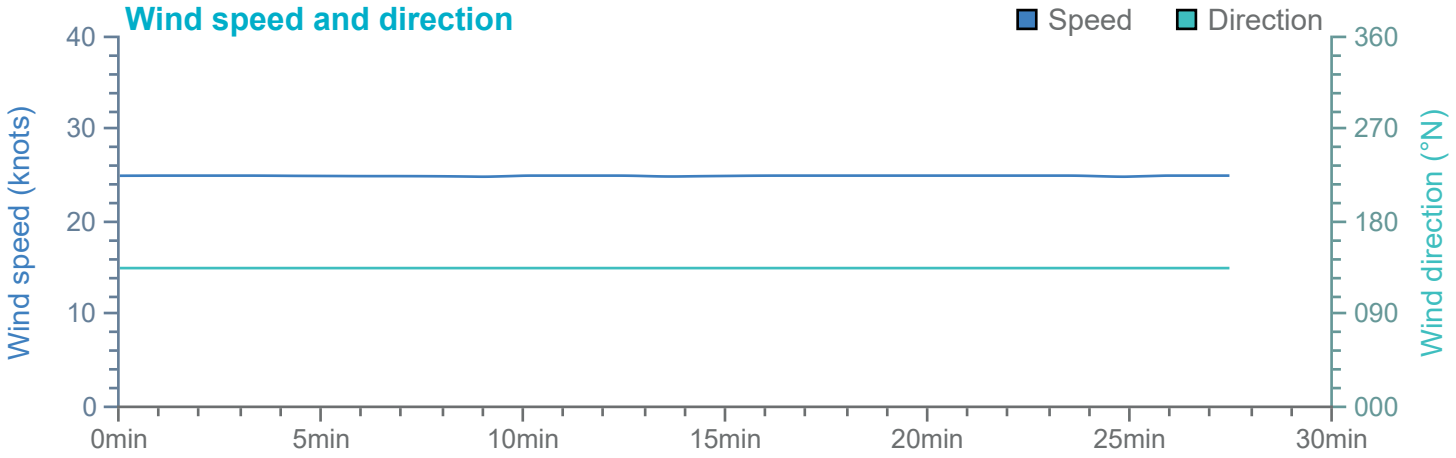
Ships plotted every 2 mins, highlight every 10 mins

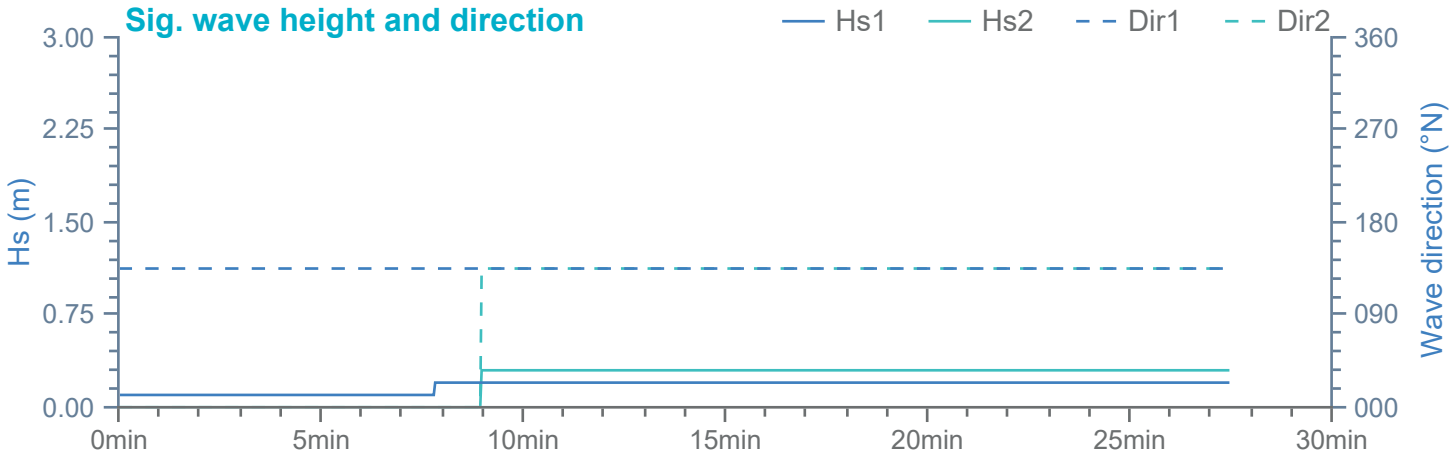
Departure Channel

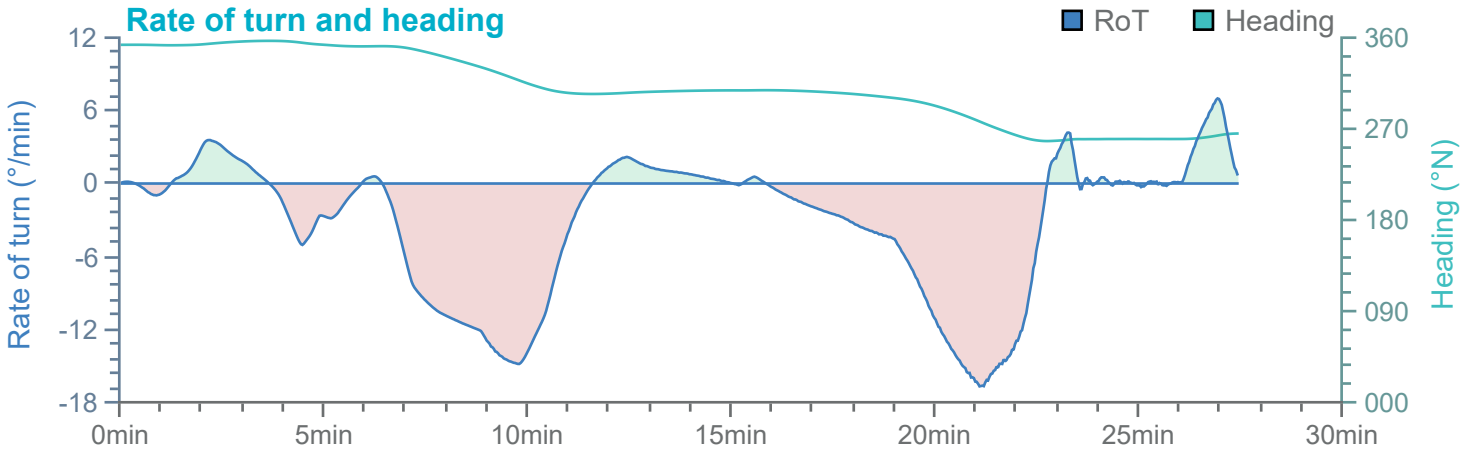


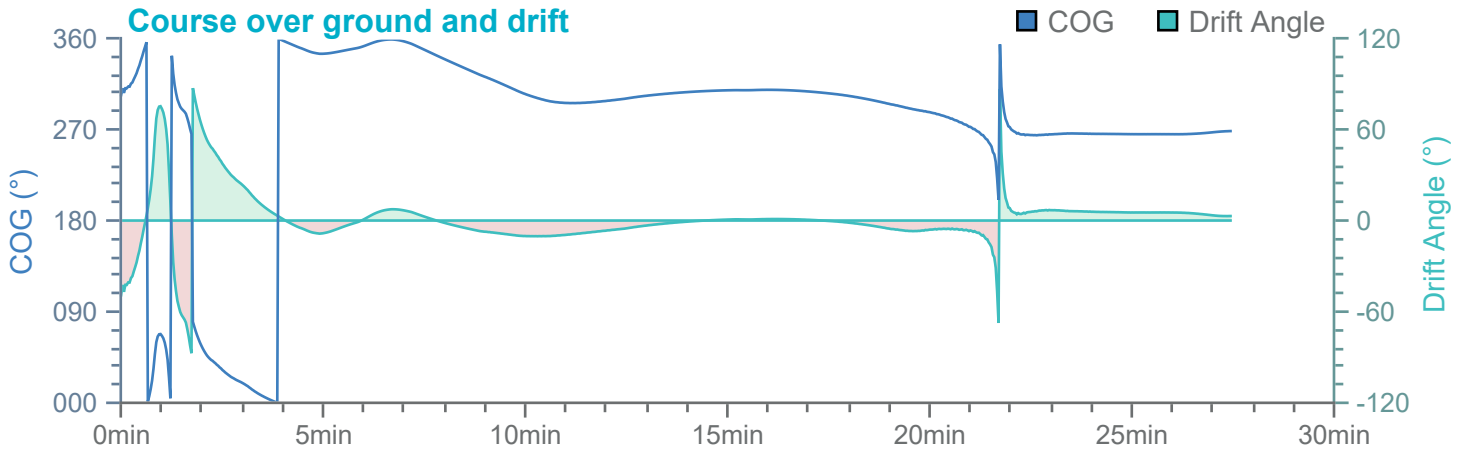
Ships plotted every 2 mins, highlight every 10 mins

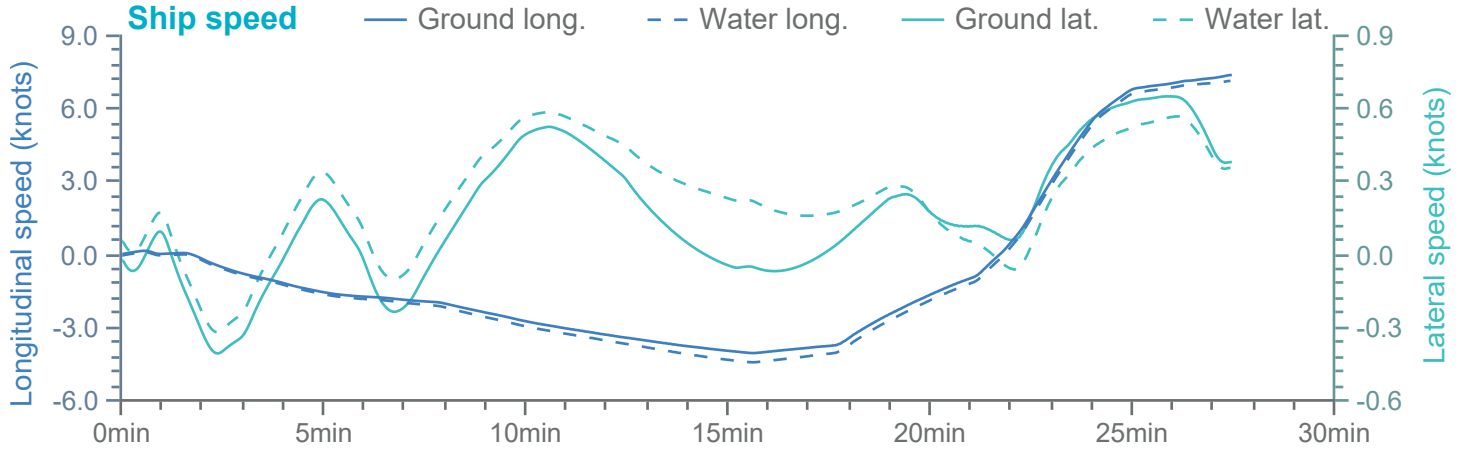

Current acting on ship
Bow
Stern
Bow Dir
Stern Dir
Current speed (knots)
Current direction (°N)
0.6
0.4
0.2
0.0
360
270
180
090
000
0min
5min
10min
15min
20min
25min
30min

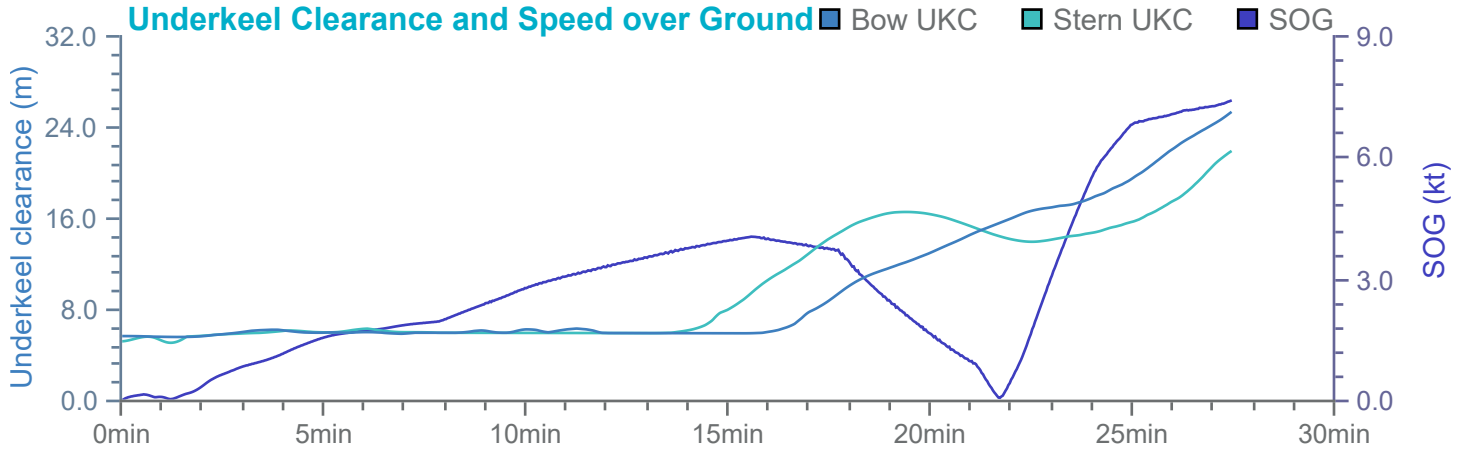

Wind speed and direction
Speed
Direction
Wind speed (knots)
Wind direction (°N)
40
30
20
10
0
360
270
180
090
000
0min
5min
10min
15min
20min
25min
30min

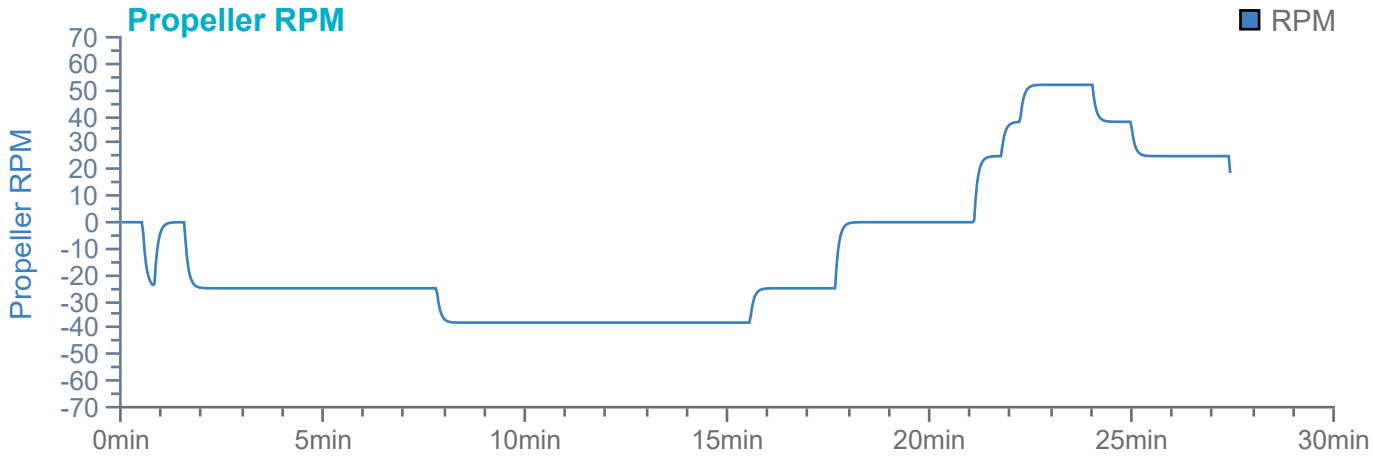

Sig. wave height and direction
Hs1
Hs2
Dir1
Dir2
Hs (m)
Wave direction (°N)
3.00
2.25
1.50
0.75
0.00
360
270
180
090
000
0min
5min
10min
15min
20min
25min
30min

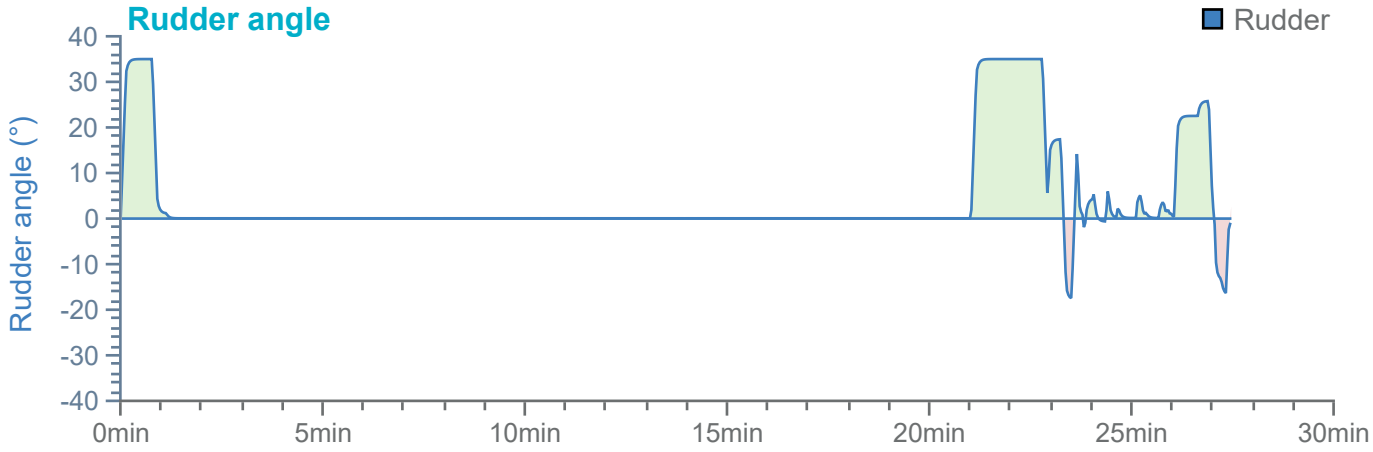

Rate of turn and heading
RoT
Heading
Rate of turn (°/min)
Heading (°N)
12
6
0
-6
-12
-18
360
270
180
090
000
0min
5min
10min
15min
20min
25min
30min

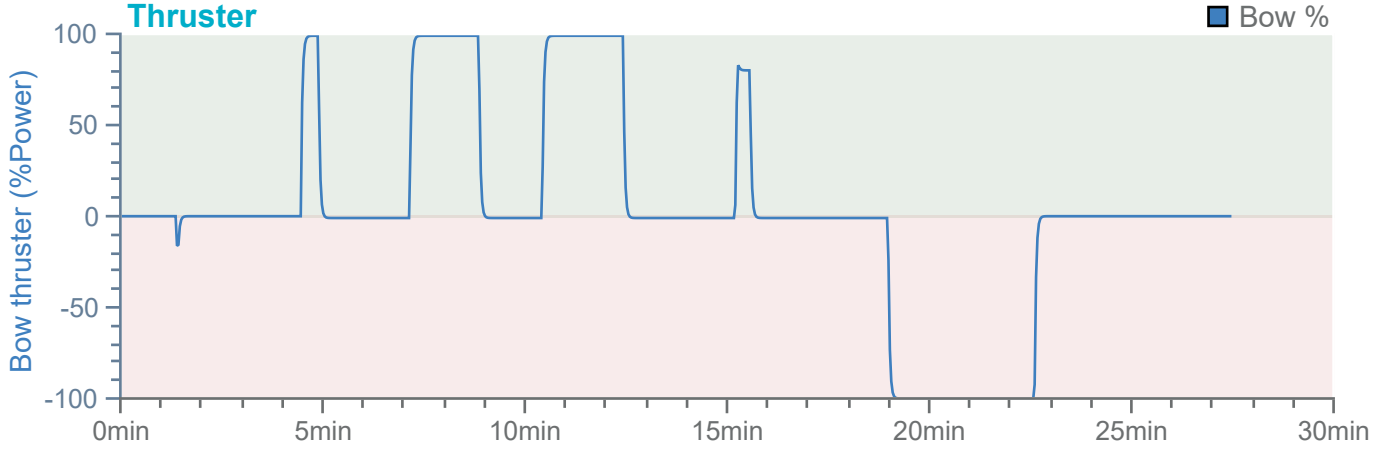

Course over ground and drift
COG
Drift Angle
COG (°)
Drift Angle (°)
360
270
180
090
000
120
60
0
-60
-120
0min
5min
10min
15min
20min
25min
30min


Ship speed
Ground long.
Water long.
Ground lat.
Water lat.
Longitudinal speed (knots)
Lateral speed (knots)
9.0
6.0
3.0
0.0
-3.0
-6.0
0.9
0.6
0.3
0.0
-0.3
-0.6
0min
5min
10min
15min
20min
25min
30min

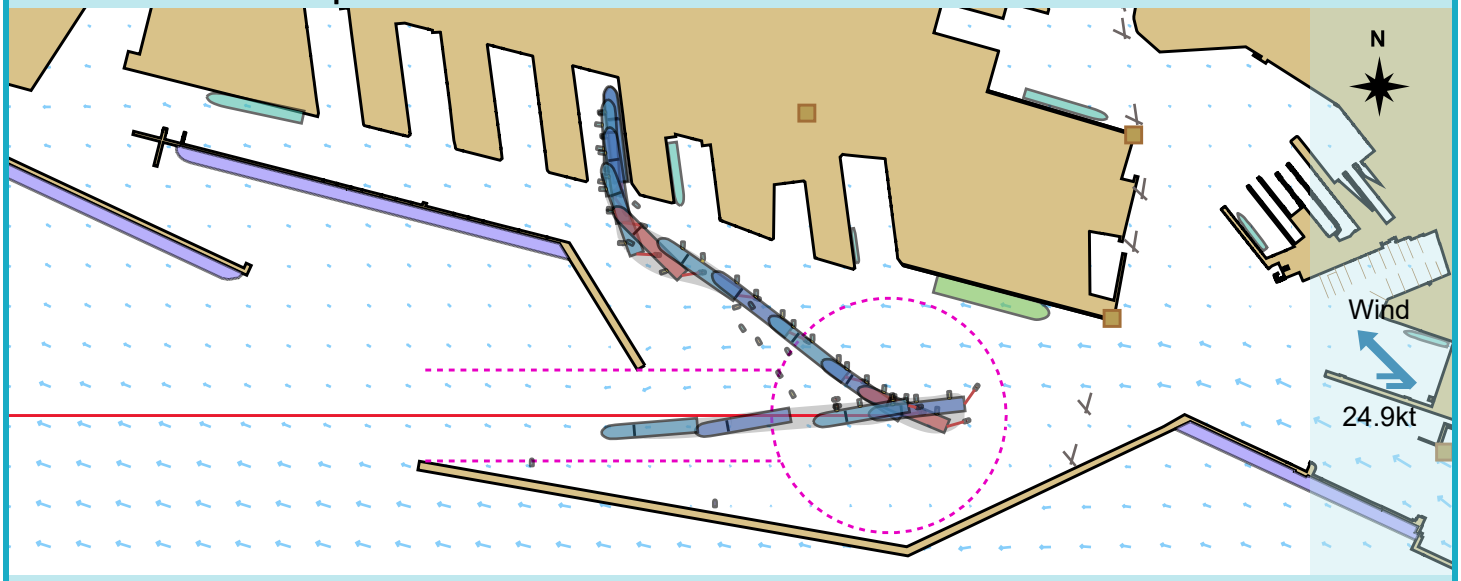

Underkeel Clearance and Speed over Ground
Bow UKC
Stern UKC
SOG
Underkeel clearance (m)
SOG (kt)
32.0
24.0
16.0
8.0
0.0
9.0
6.0
3.0
0.0
0min
5min
10min
15min
20min
25min
30min


Propeller RPM
RPM
Propeller RPM
70
60
50
40
30
20
10
0
-10
-20
-30
-40
-50
-60
-70
0min
5min
10min
15min
20min
25min
30min


Rudder angle
Rudder
Rudder angle (°)
40
30
20
10
0
-10
-20
-30
-40
0min
5min
10min
15min
20min
25min
30min

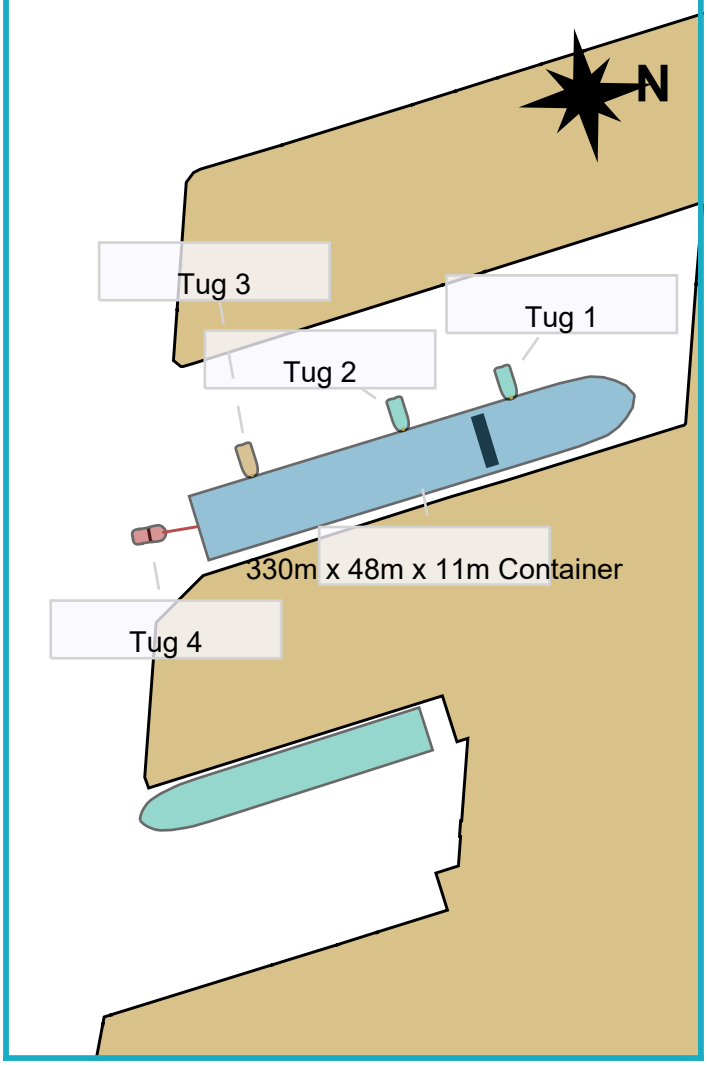

Thruster
Bow %
Bow thruster (%Power)
100
50
0
-50
-100
0min
5min
10min
15min
20min
25min
30min

Manoeuvre track plot

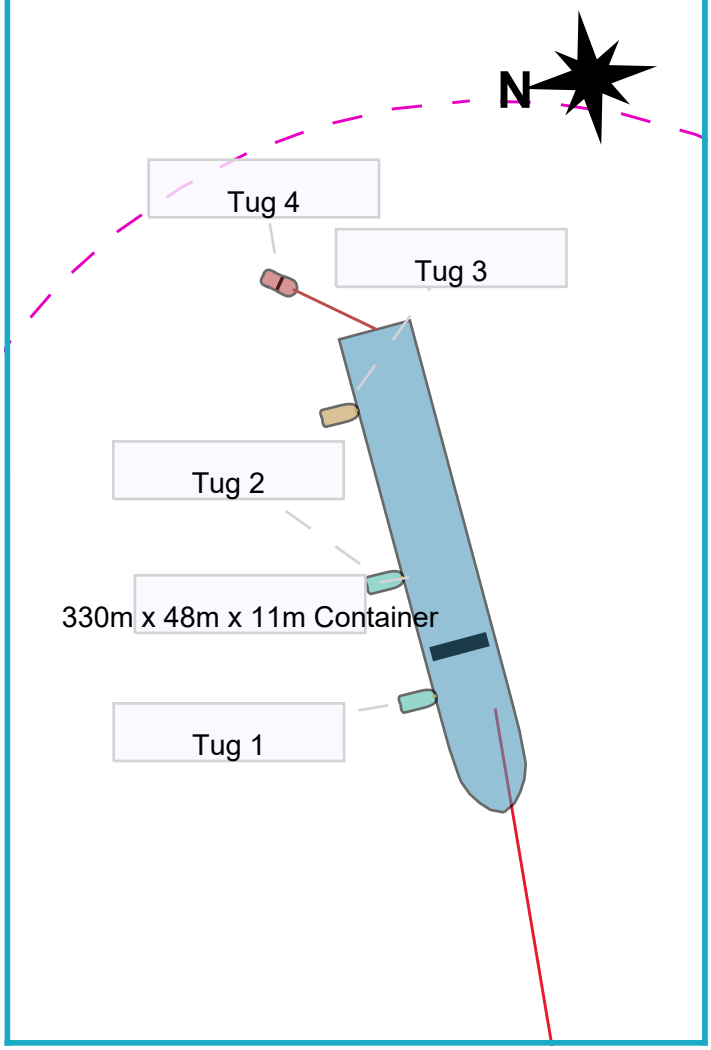


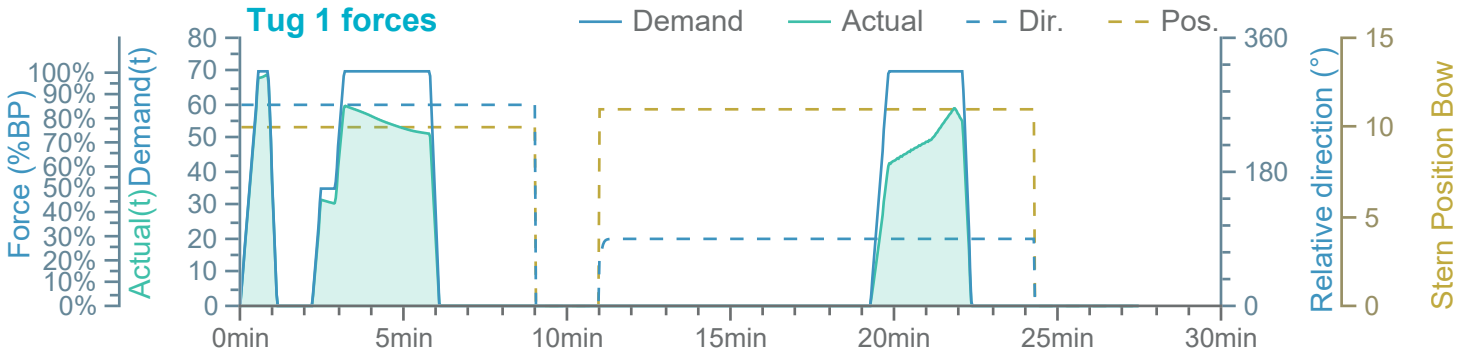
Ships plotted every 2 mins, highlight every 10 mins

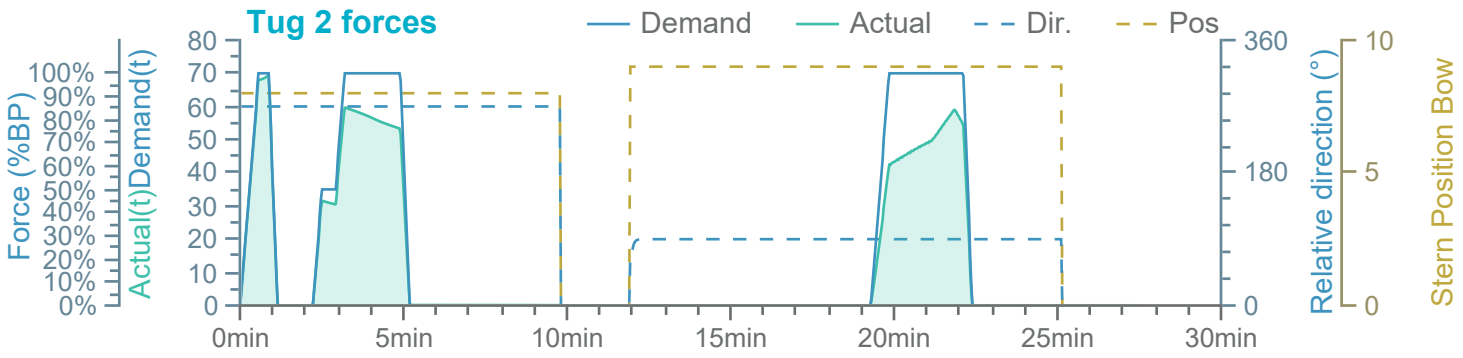
Tug position: Initial

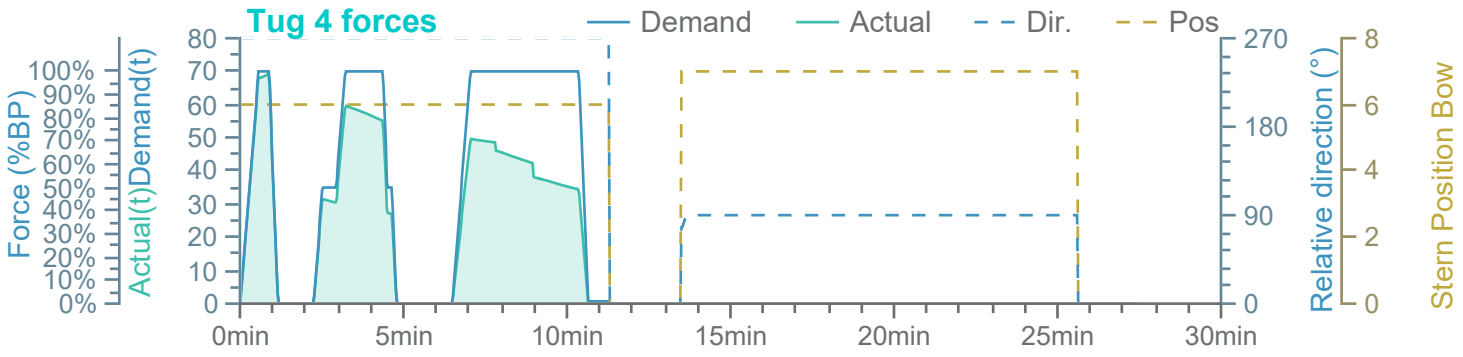


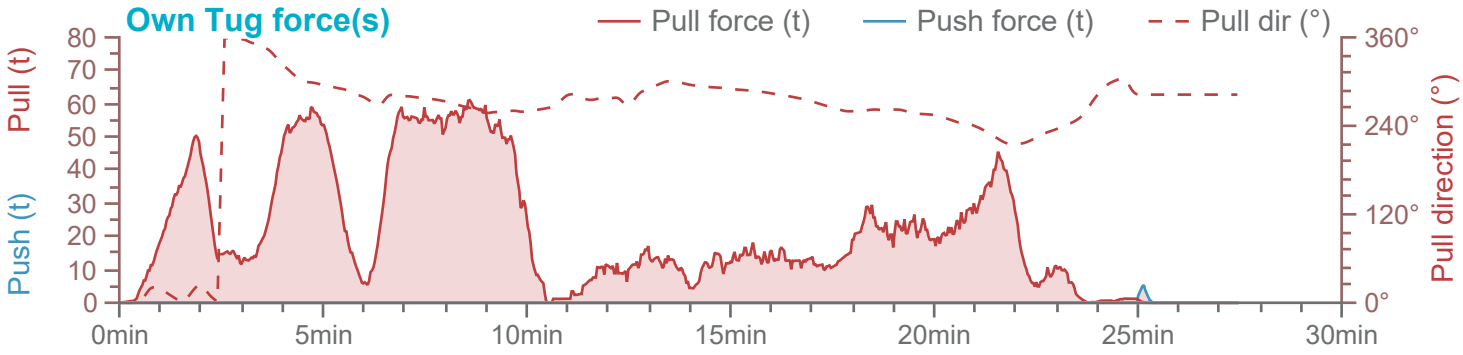
Tug position: Final



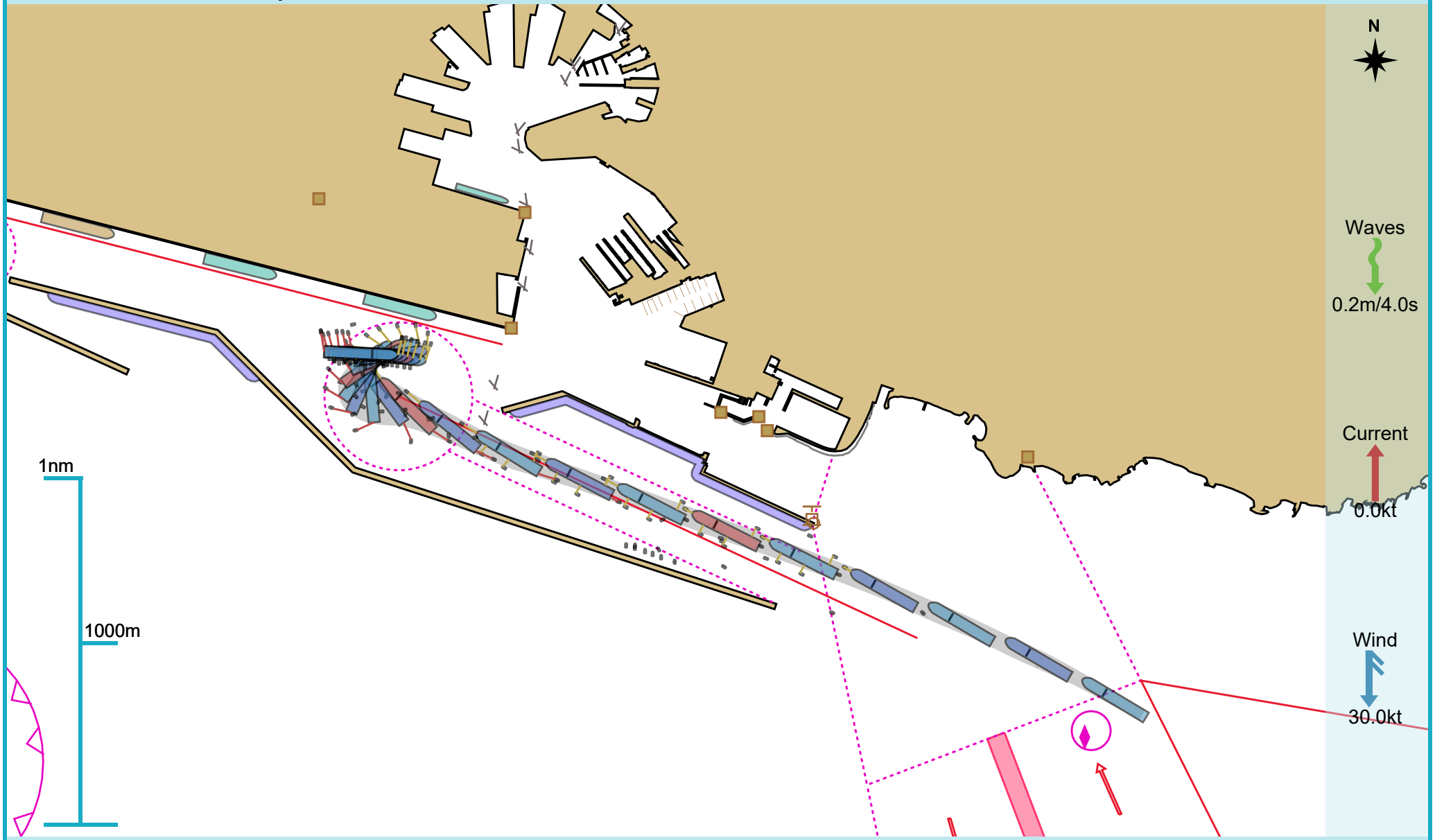

Tug 1 forces
Demand
Actual
Dir.
Pos.
Force (%BP)
Actual(t)Demand(t)
Relative direction (°)
Stern Position Bow
0min
5min
10min
15min
20min
25min
30min


Tug 2 forces
Demand
Actual
Dir.
Pos
Force (%BP)
Actual(t)Demand(t)
Relative direction (°)
Stern Position Bow
0min
5min
10min
15min
20min
25min
30min

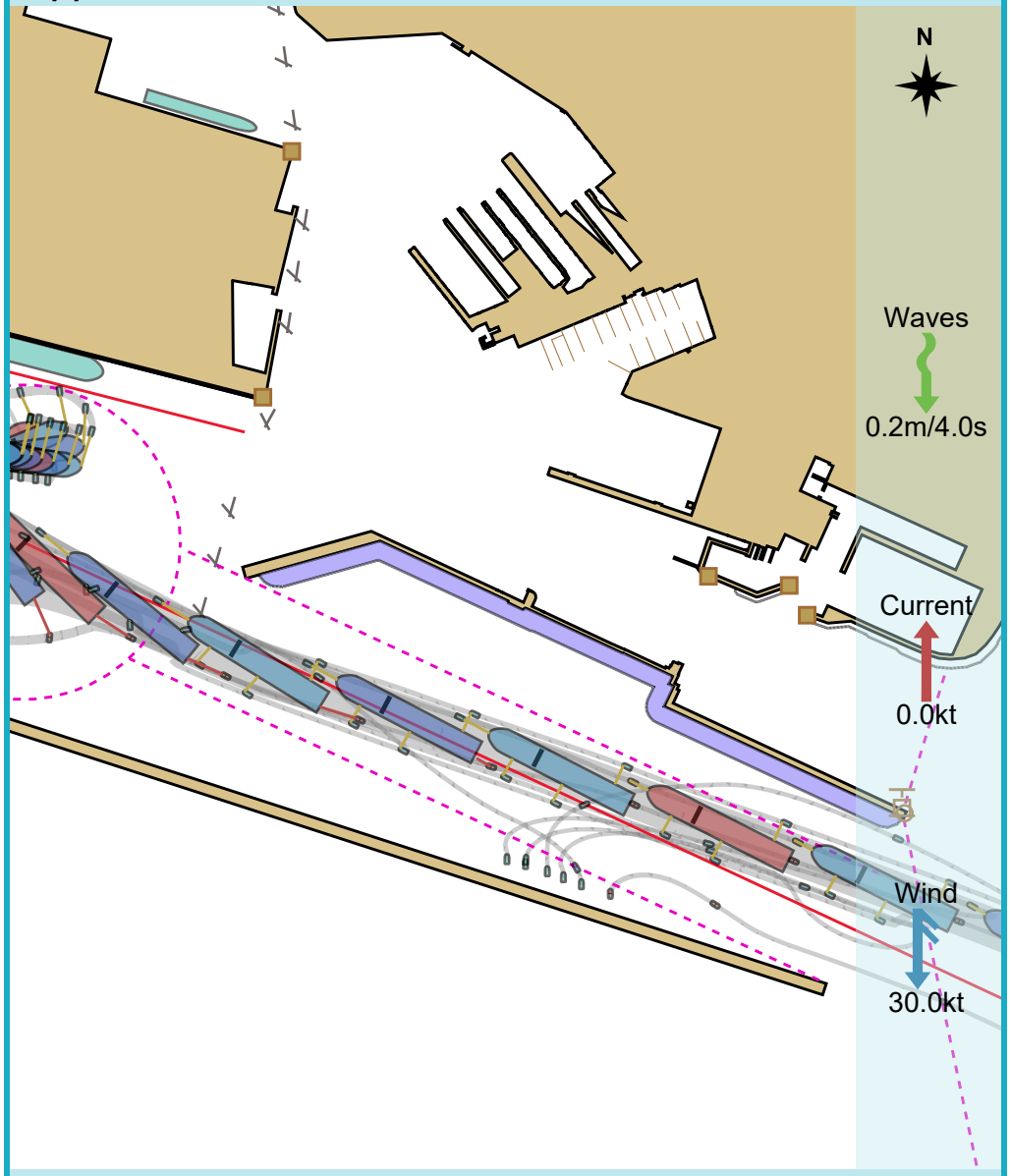

Tug 4 forces
Demand
Actual
Dir.
Pos
Force (%BP)
Actual(t)Demand(t)
Relative direction (°)
Stern Position Bow
0min
5min
10min
15min
20min
25min
30min


Own Tug force(s)
Pull force (t)
Push force (t)
Pull dir (°)
Pull (t)
Push (t)
Pull direction (°)
0min
5min
10min
15min
20min
25min
30min

Manoeuvre track plot

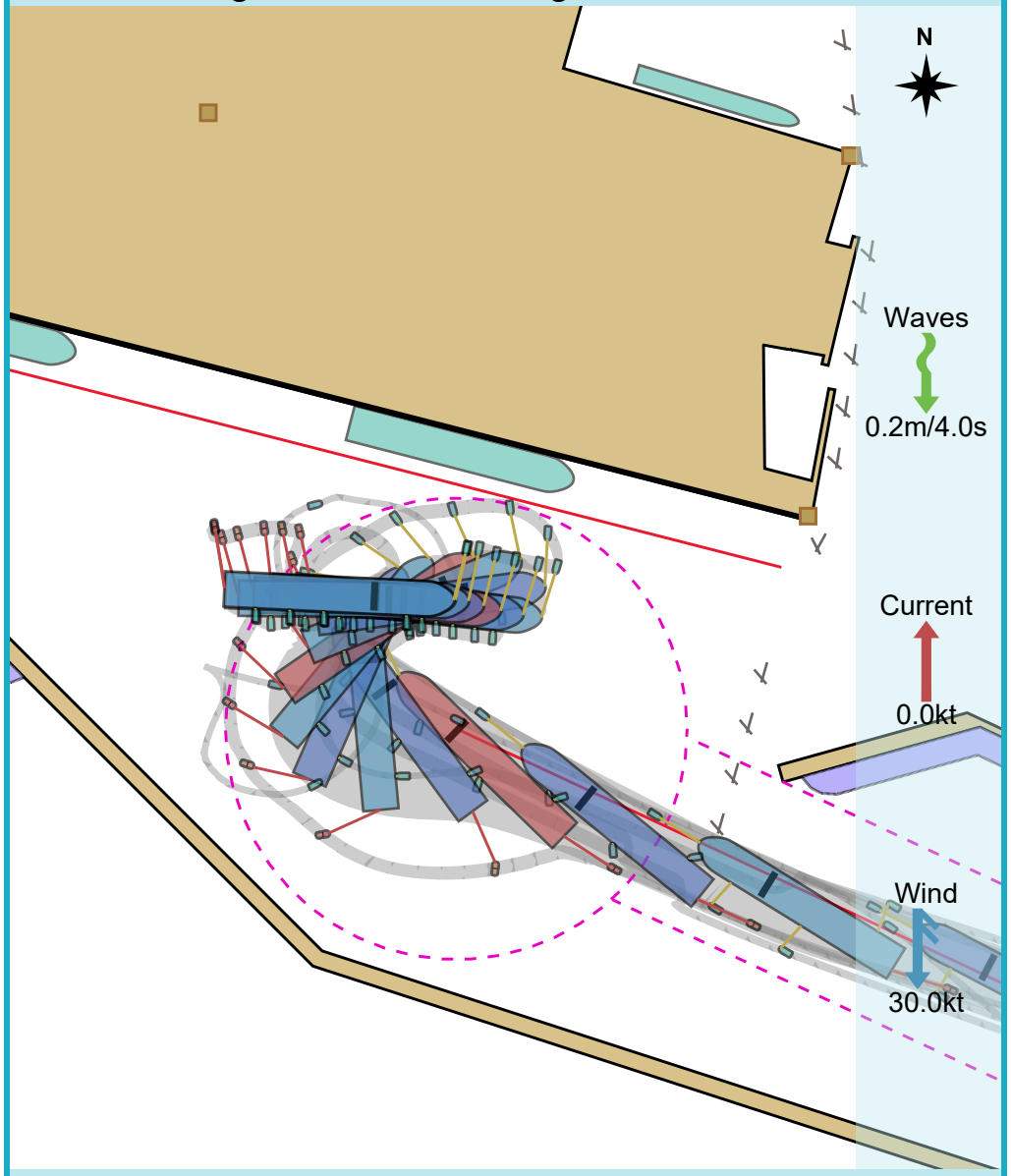


Approach Channel

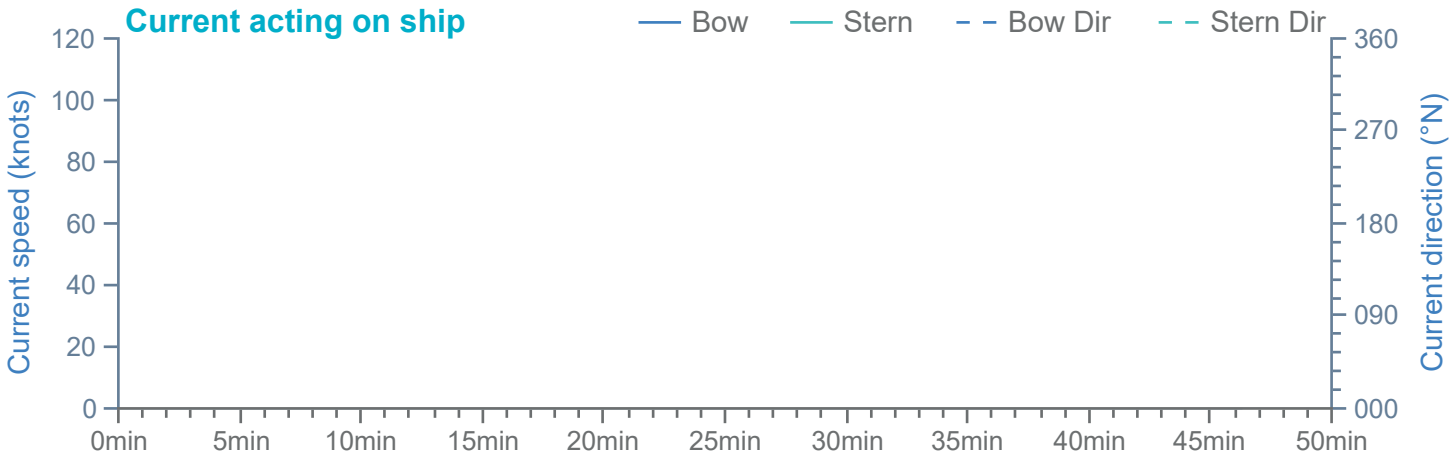


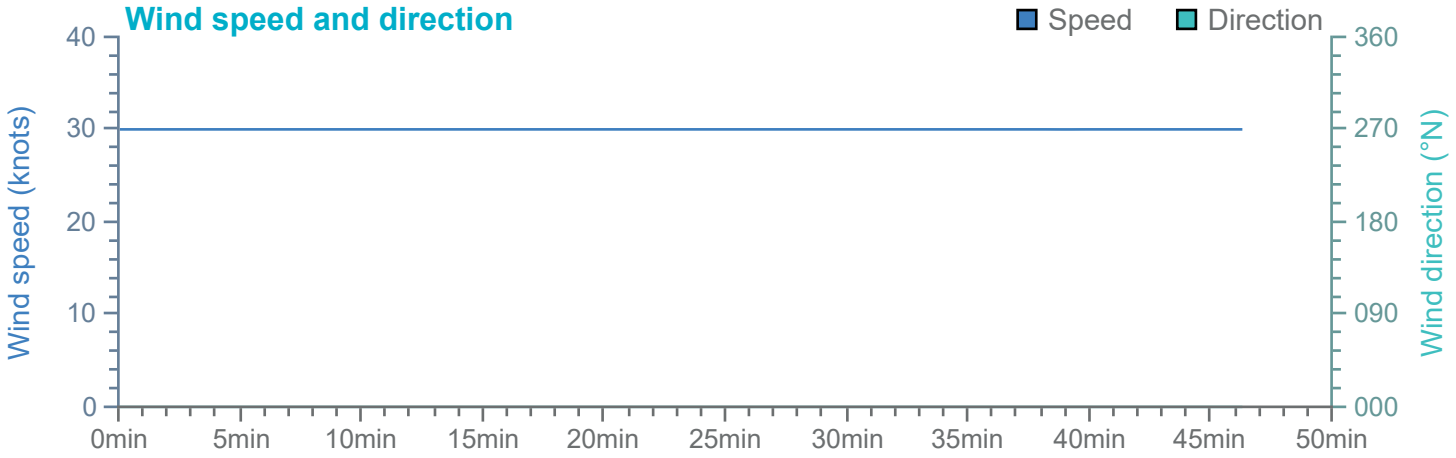
Ships plotted every 2 mins, highlight every 10 mins

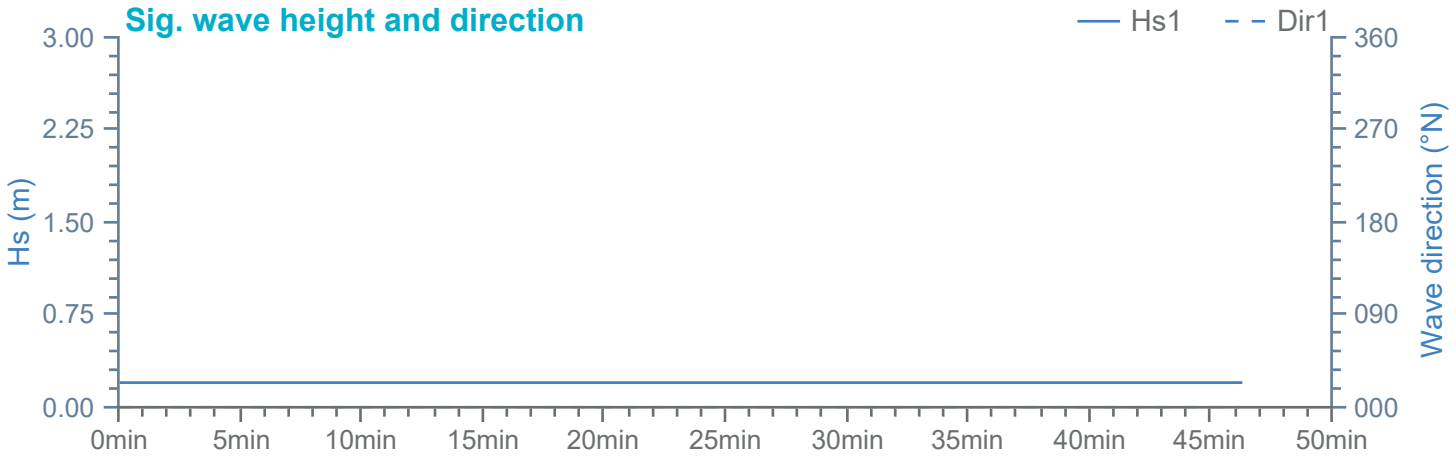
Manoeuvring area and berthing

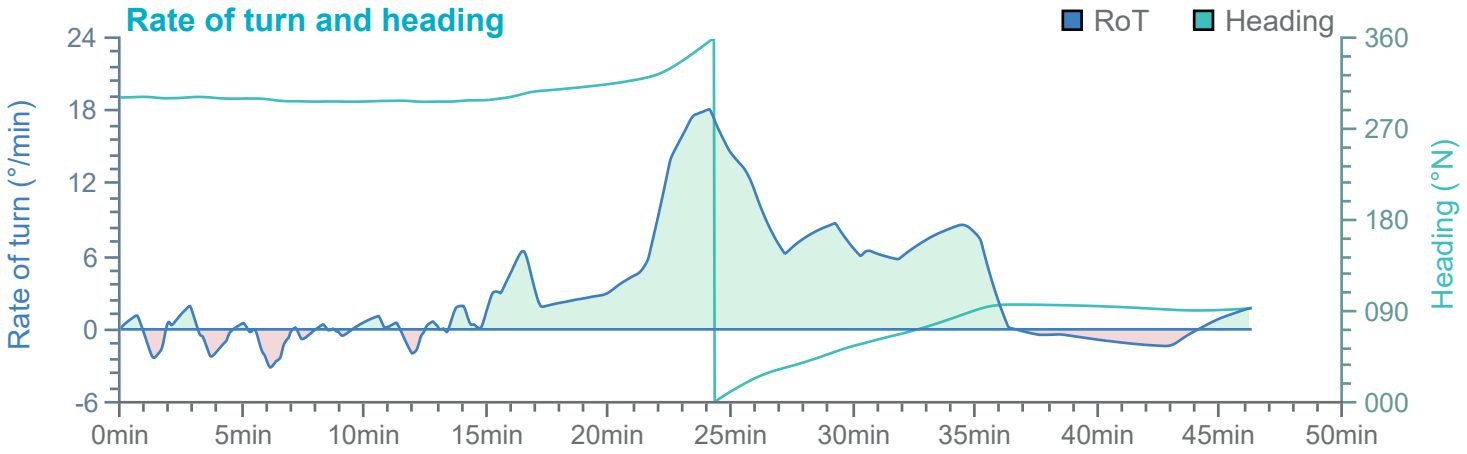


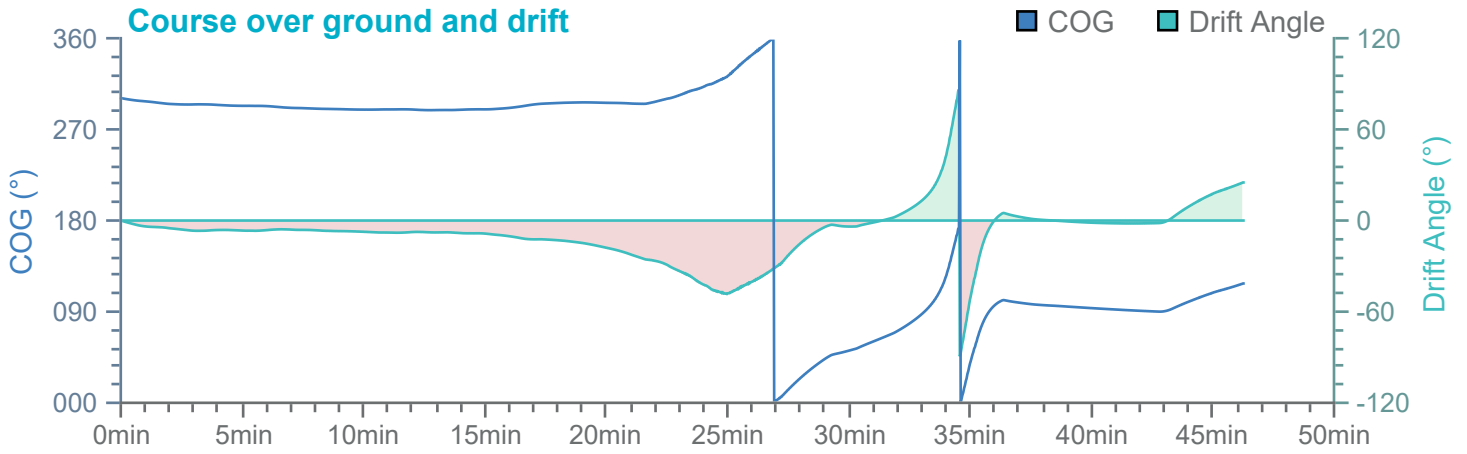
Ships plotted every 2 mins, highlight every 10 mins

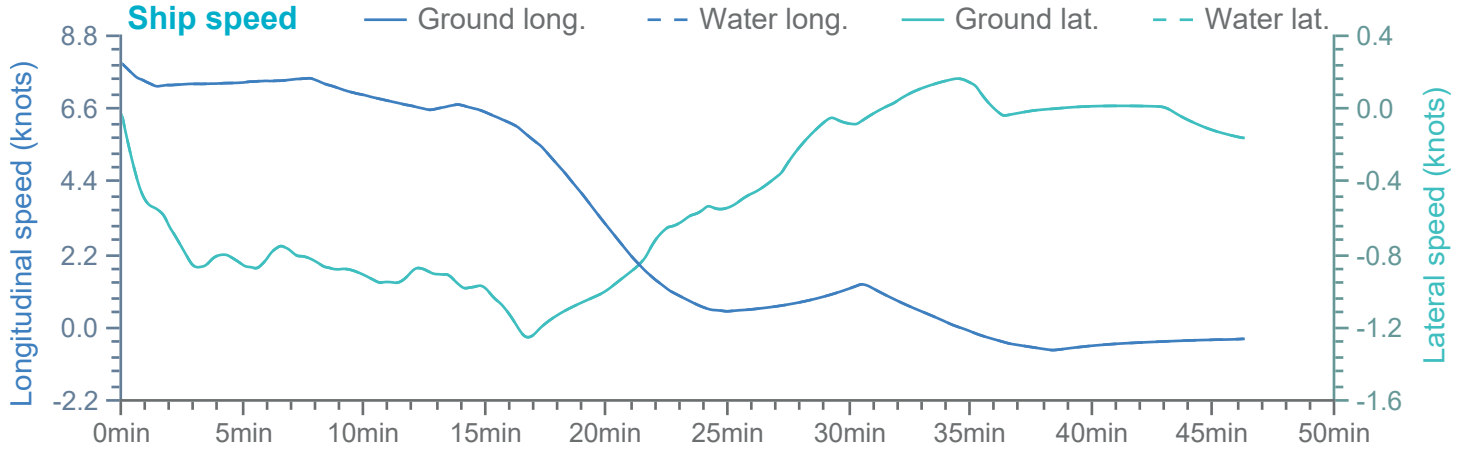

Current acting on ship
Bow
Stern
Bow Dir
Stern Dir
Current speed (knots)
Current direction (°N)
120
100
80
60
40
20
0
360
270
180
090
000
0min
5min
10min
15min
20min
25min
30min
35min
40min
45min
50min

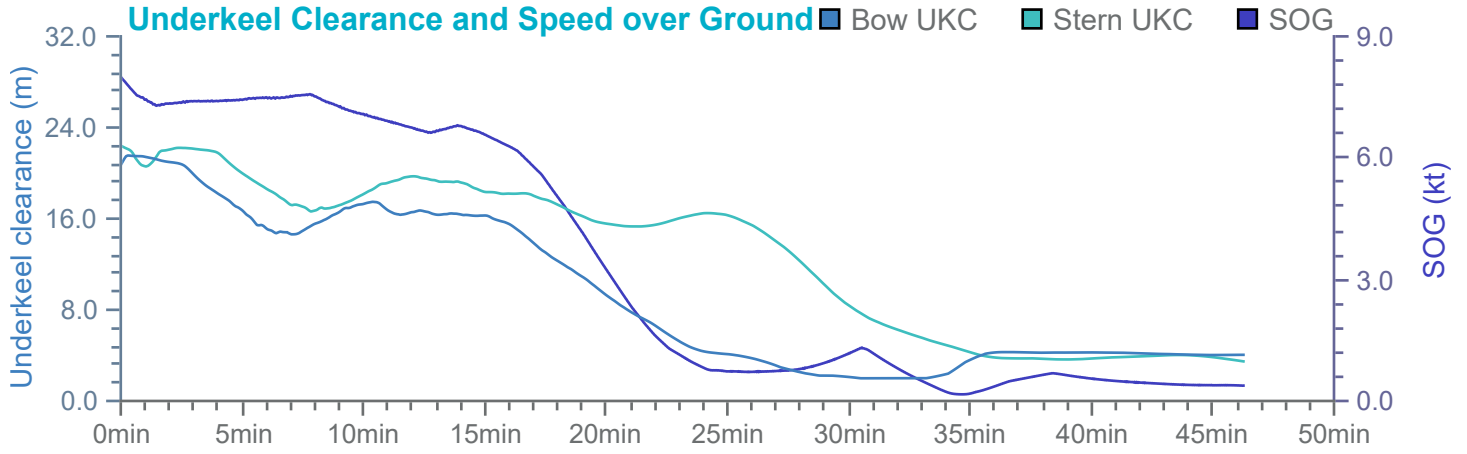

Wind speed and direction
Speed
Direction
Wind speed (knots)
Wind direction (°N)
40
30
20
10
0
360
270
180
090
000
0min
5min
10min
15min
20min
25min
30min
35min
40min
45min
50min

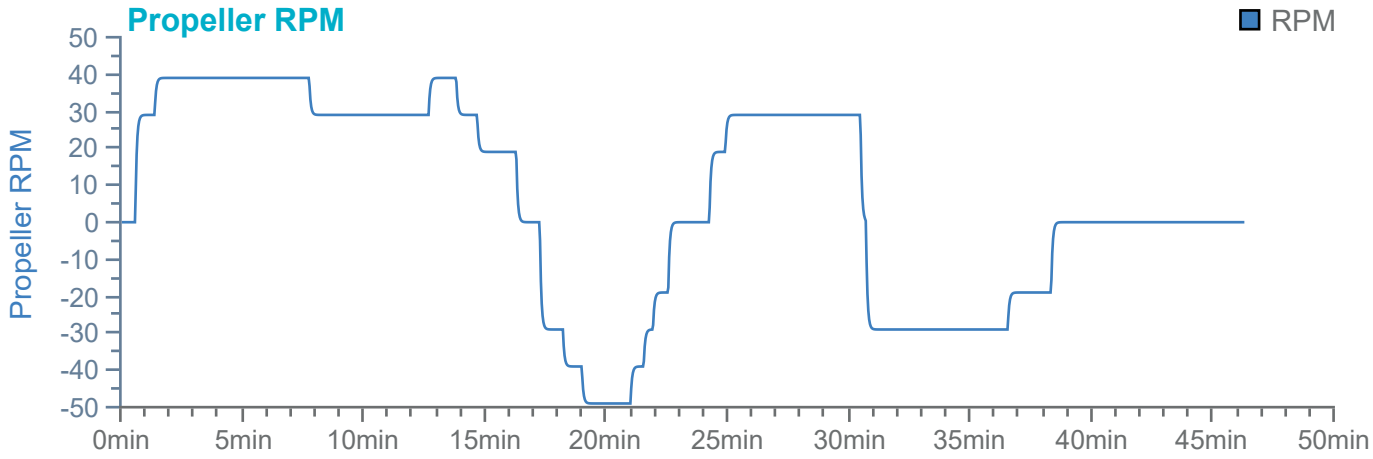

Sig. wave height and direction
Hs1
Dir1
Hs (m)
Wave direction (°N)
3.00
2.25
1.50
0.75
0.00
360
270
180
090
000
0min
5min
10min
15min
20min
25min
30min
35min
40min
45min
50min

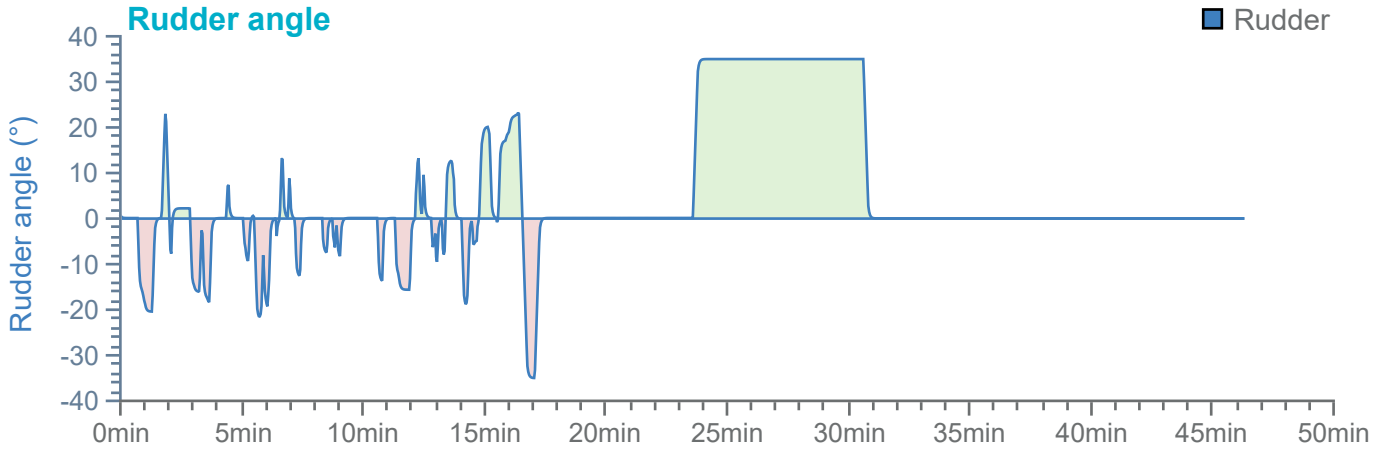

Rate of turn and heading
RoT
Heading
Rate of turn (°/min)
Heading (°N)
24
18
12
6
0
-6
360
270
180
090
000
0min
5min
10min
15min
20min
25min
30min
35min
40min
45min
50min

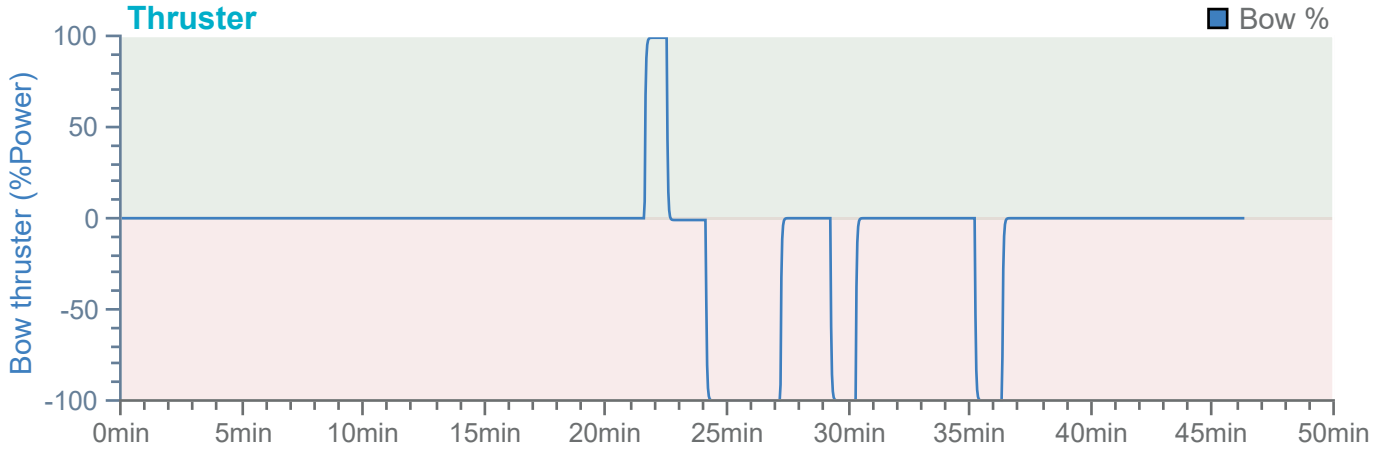

Course over ground and drift
COG
Drift Angle
COG (°)
Drift Angle (°)
360
270
180
090
000
120
60
0
-60
-120
0min
5min
10min
15min
20min
25min
30min
35min
40min
45min
50min


Ship speed
Ground long.
Water long.
Ground lat.
Water lat.
Longitudinal speed (knots)
Lateral speed (knots)
8.8
6.6
4.4
2.2
0.0
-2.2
0.4
0.0
-0.4
-0.8
-1.2
-1.6
0min
5min
10min
15min
20min
25min
30min
35min
40min
45min
50min

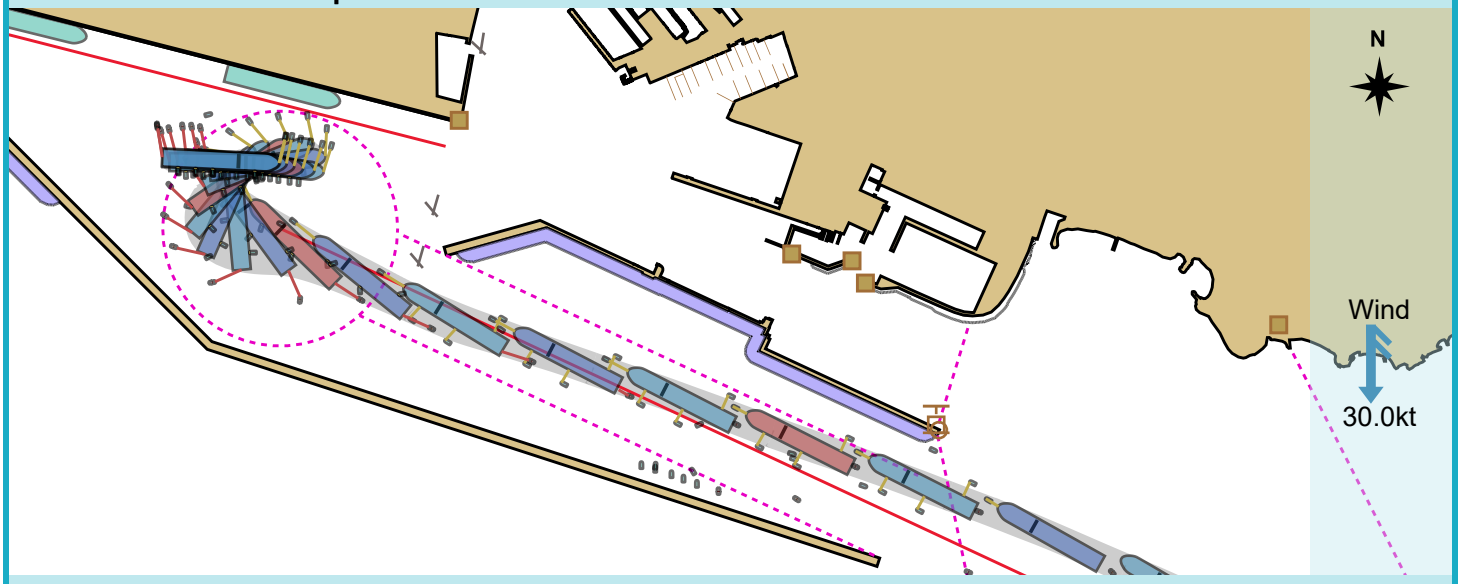

Underkeel Clearance and Speed over Ground
Bow UKC
Stern UKC
SOG
Underkeel clearance (m)
SOG (kt)
32.0
24.0
16.0
8.0
0.0
9.0
6.0
3.0
0.0
0min
5min
10min
15min
20min
25min
30min
35min
40min
45min
50min


Propeller RPM
RPM
Propeller RPM
50
40
30
20
10
0
-10
-20
-30
-40
-50
0min
5min
10min
15min
20min
25min
30min
35min
40min
45min
50min


Rudder angle
Rudder
Rudder angle (°)
40
30
20
10
0
-10
-20
-30
-40
0min
5min
10min
15min
20min
25min
30min
35min
40min
45min
50min

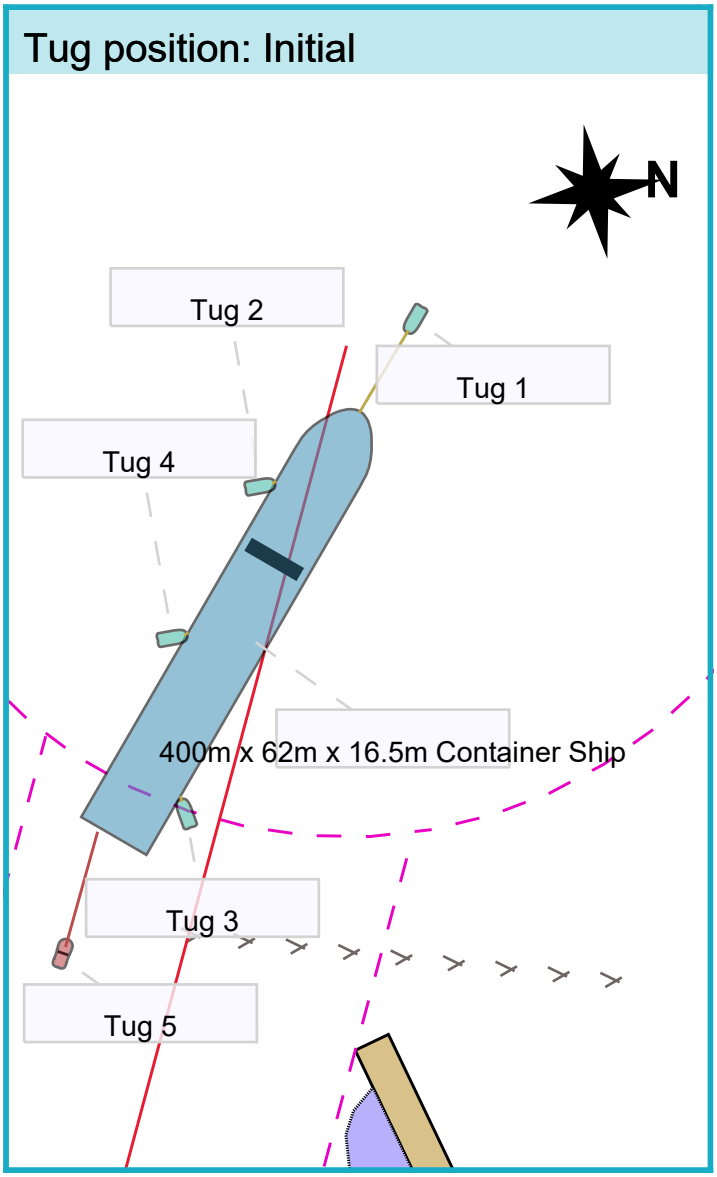

Thruster
Bow %
Bow thruster (%Power)
100
50
0
-50
-100
0min
5min
10min
15min
20min
25min
30min
35min
40min
45min
50min

Manoeuvre track plot

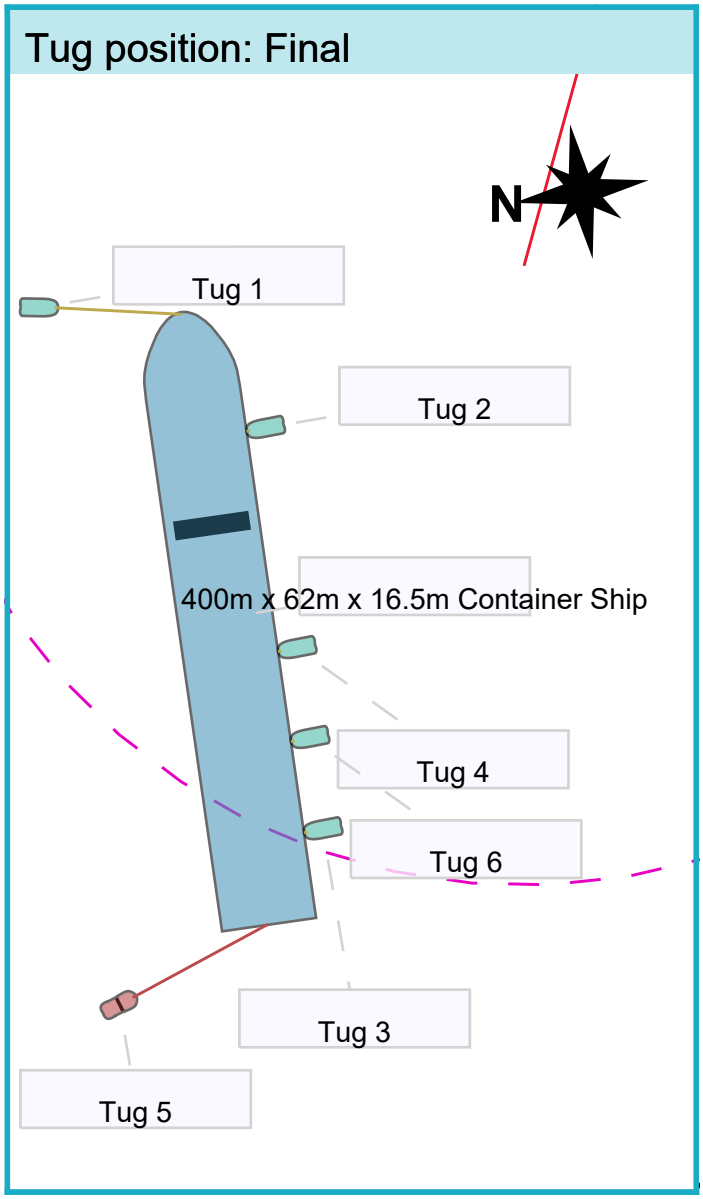


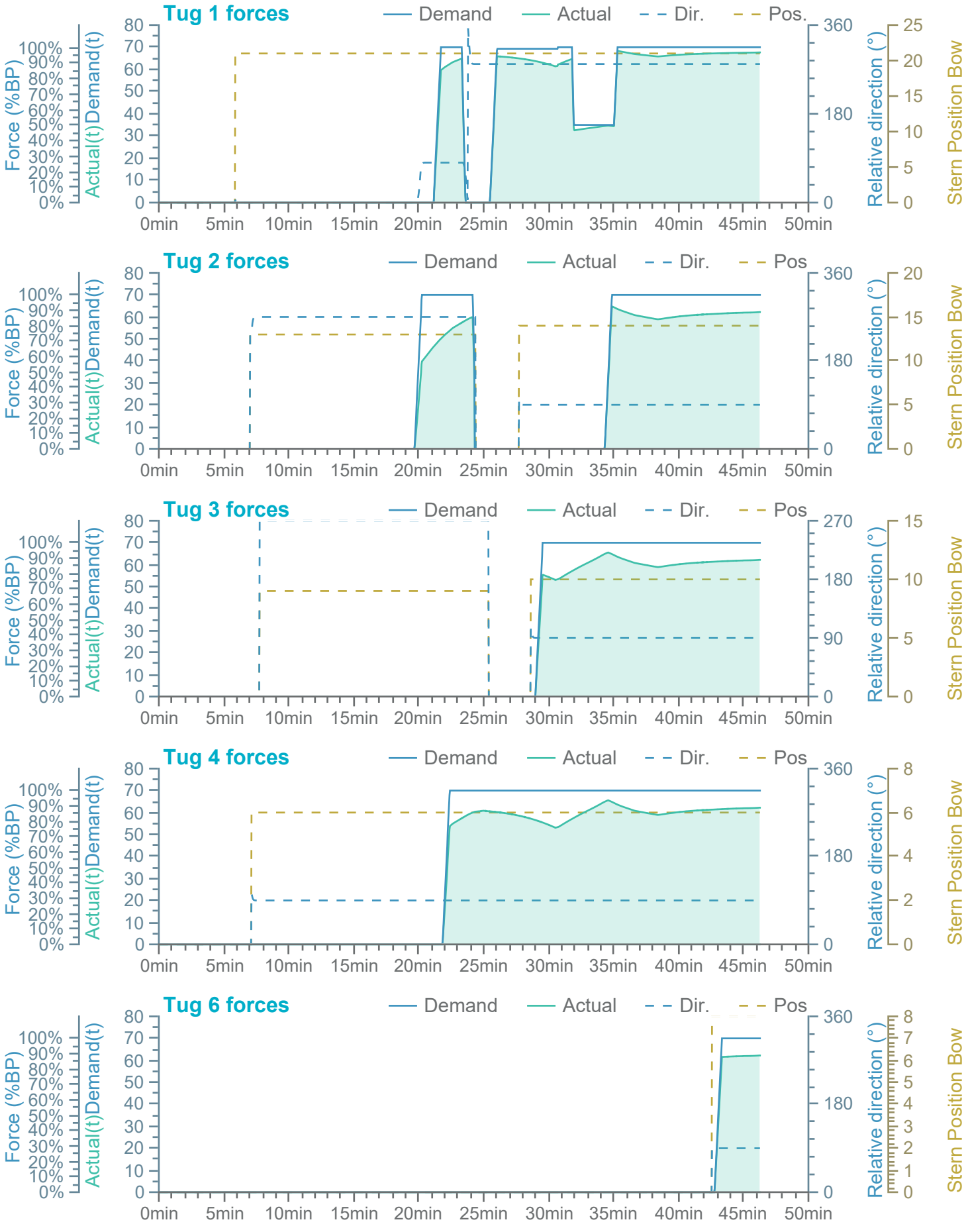
Ships plotted every 2 mins, highlight every 10 mins

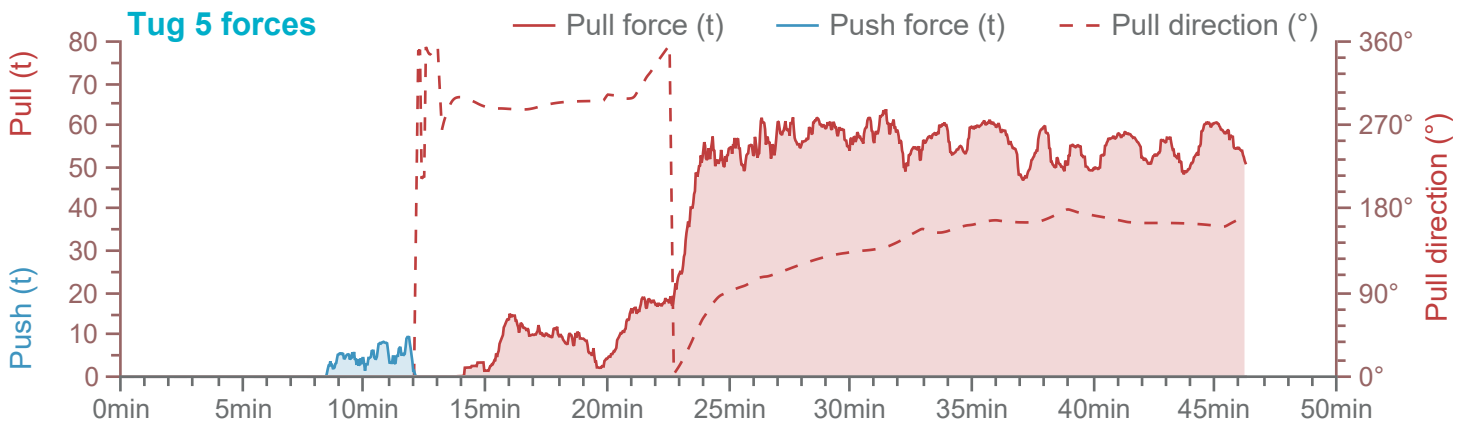
Tug position: Initial



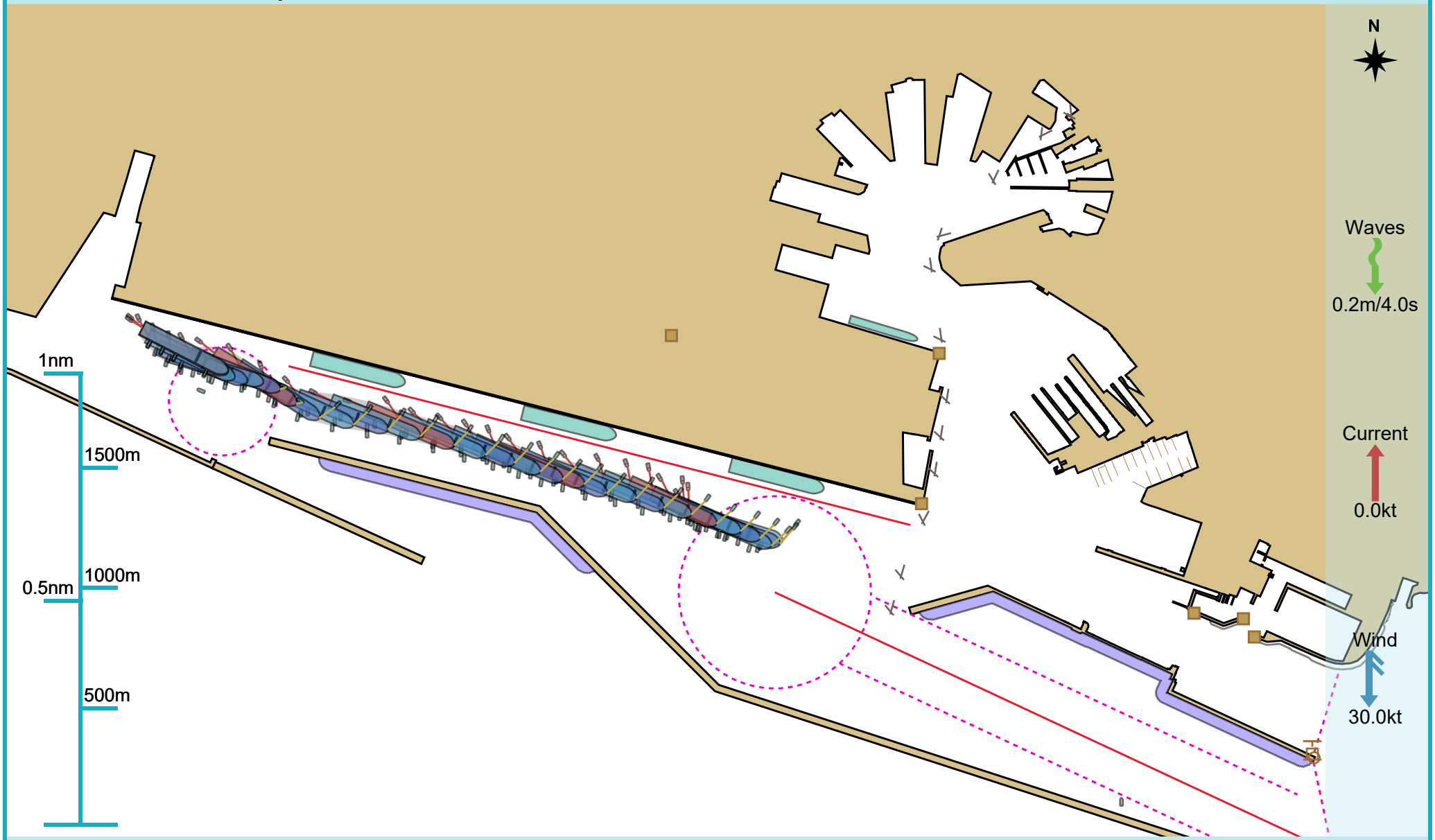
Tug position: Final




Tug 1 forces
Demand
Actual
Dir.
Pos.
Force (%BP)
Actual(t)Demand(t)
Relative direction (°)
Stern Position Bow
0min 5min 10min 15min 20min 25min 30min 35min 40min 45min 50min
Tug 2 forces
Demand
Actual
Dir.
Pos
Force (%BP)
Actual(t)Demand(t)
Relative direction (°)
Stern Position Bow
0min 5min 10min 15min 20min 25min 30min 35min 40min 45min 50min
Tug 3 forces
Demand
Actual
Dir.
Pos
Force (%BP)
Actual(t)Demand(t)
Relative direction (°)
Stern Position Bow
0min 5min 10min 15min 20min 25min 30min 35min 40min 45min 50min
Tug 4 forces
Demand
Actual
Dir.
Pos
Force (%BP)
Actual(t)Demand(t)
Relative direction (°)
Stern Position Bow
0min 5min 10min 15min 20min 25min 30min 35min 40min 45min 50min
Tug 6 forces
Demand
Actual
Dir.
Pos
Force (%BP)
Actual(t)Demand(t)
Relative direction (°)
Stern Position Bow
0min 5min 10min 15min 20min 25min 30min 35min 40min 45min 50min


Tug 5 forces
Pull force (t)
Push force (t)
Pull direction (°)
Pull (t)
Push (t)
Pull direction (°)
80
70
60
50
40
30
20
10
0
360°
270°
180°
90°
0°
0min
5min
10min
15min
20min
25min
30min
35min
40min
45min
50min

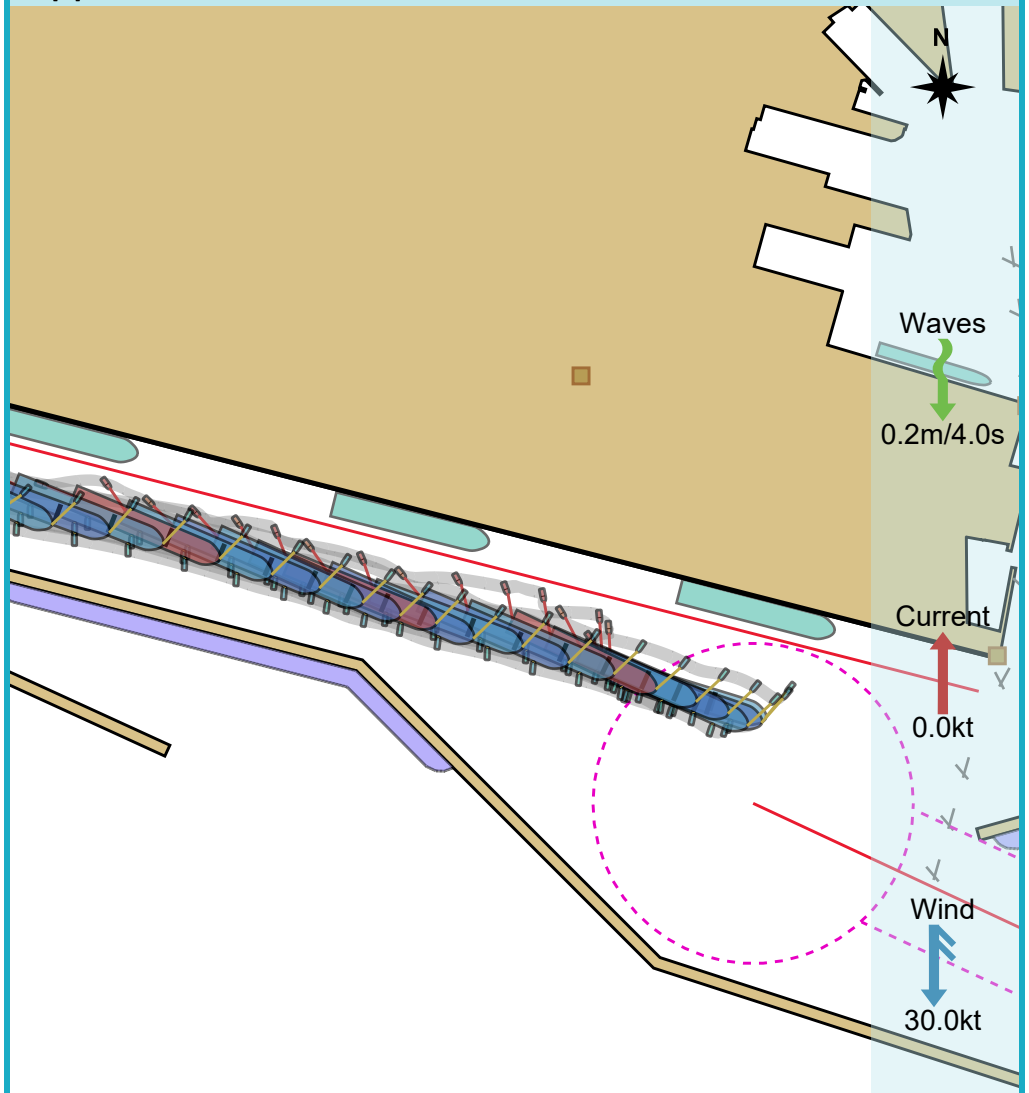
Manoeuvre track plot



0.00 kts

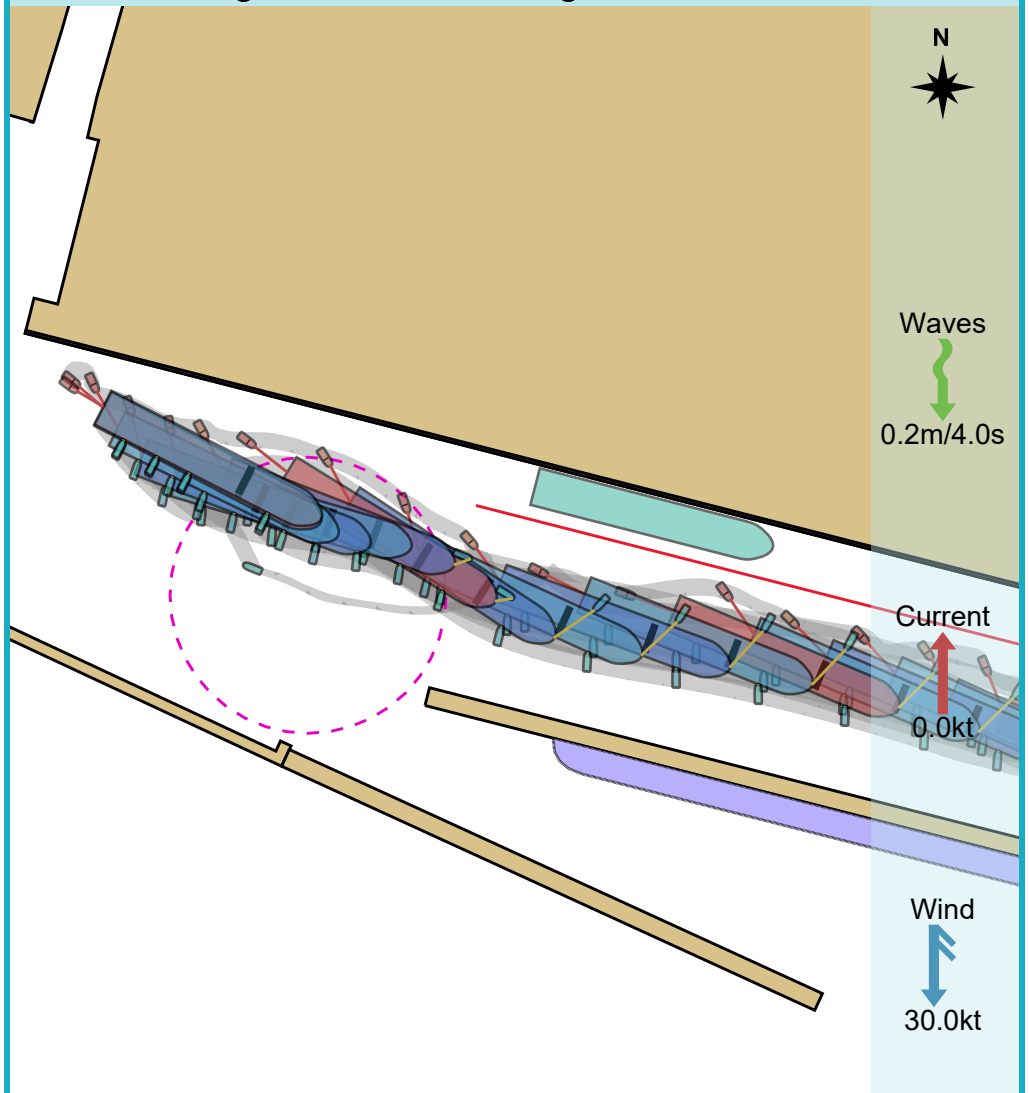
Ships plotted every 2 mins, highlight every 10 mins

Approach Channel

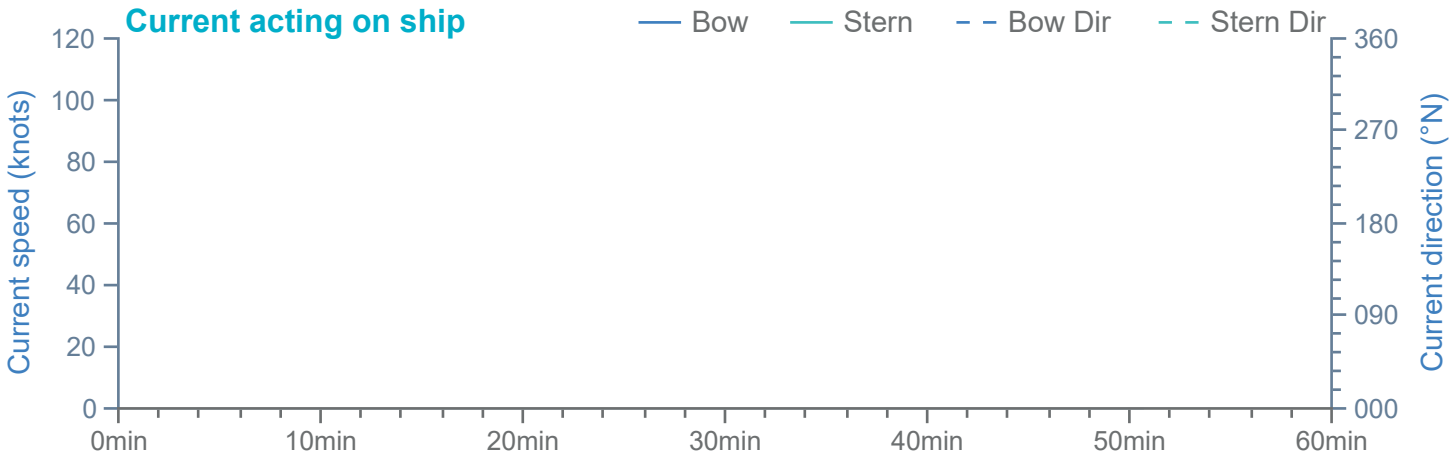


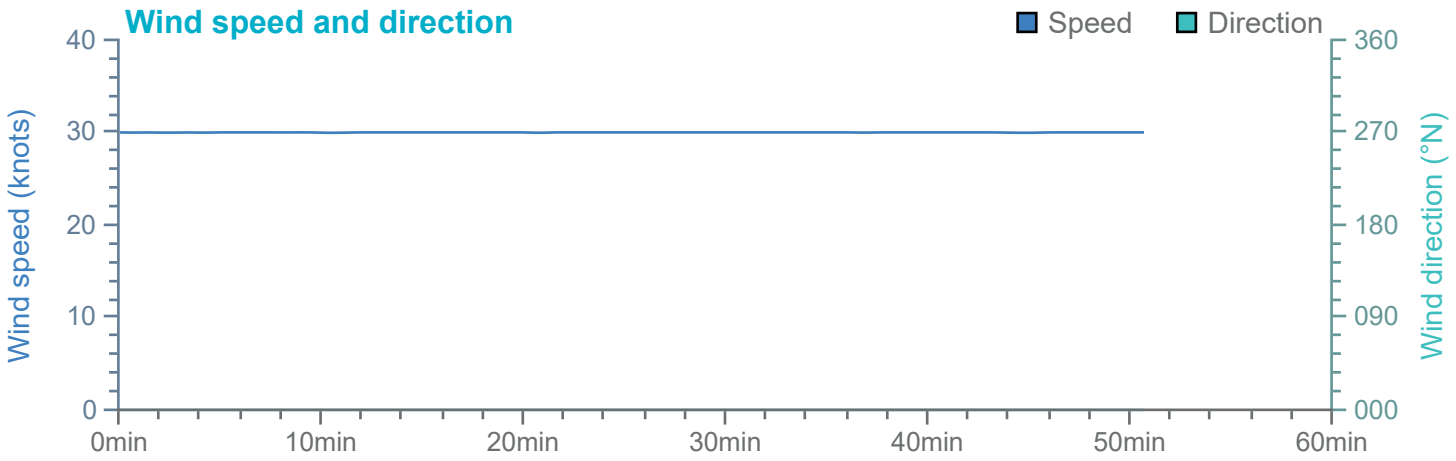
Ships plotted every 2 mins, highlight every 10 mins

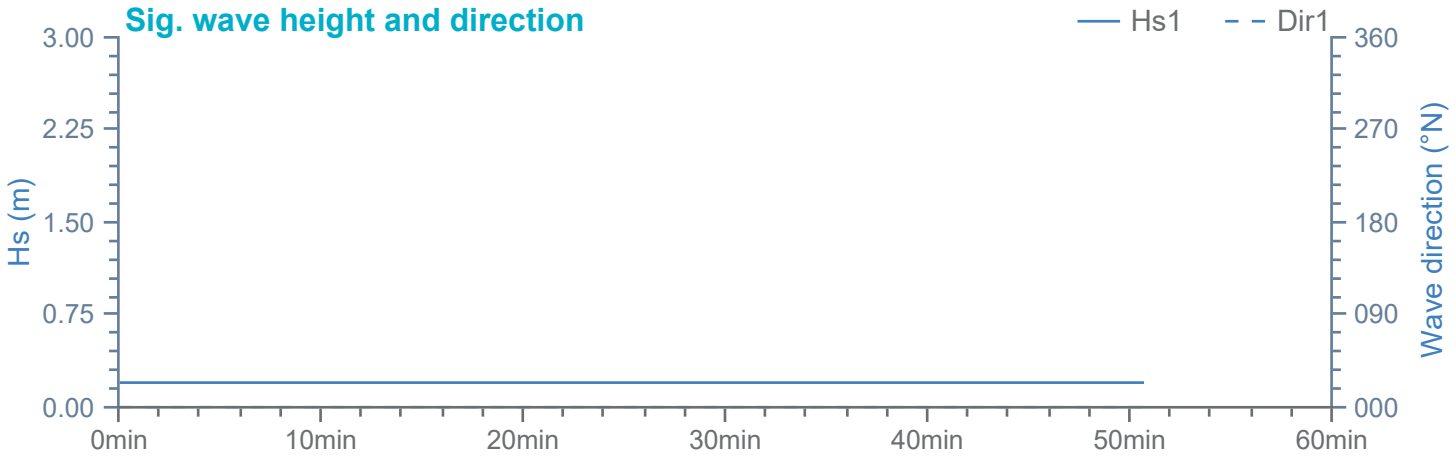
Manoeuvring area and berthing

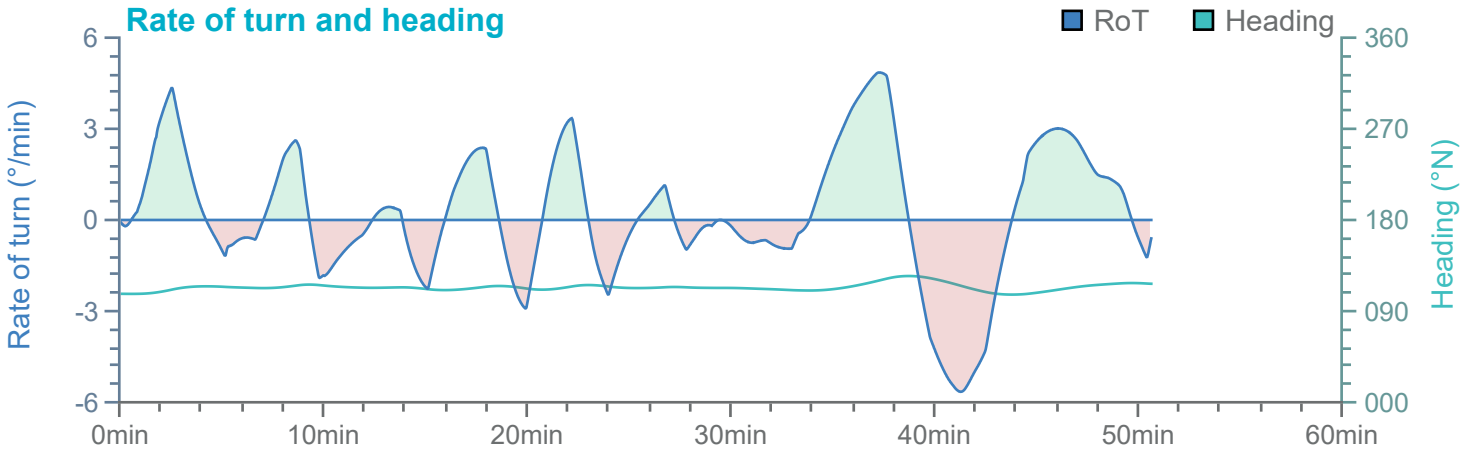


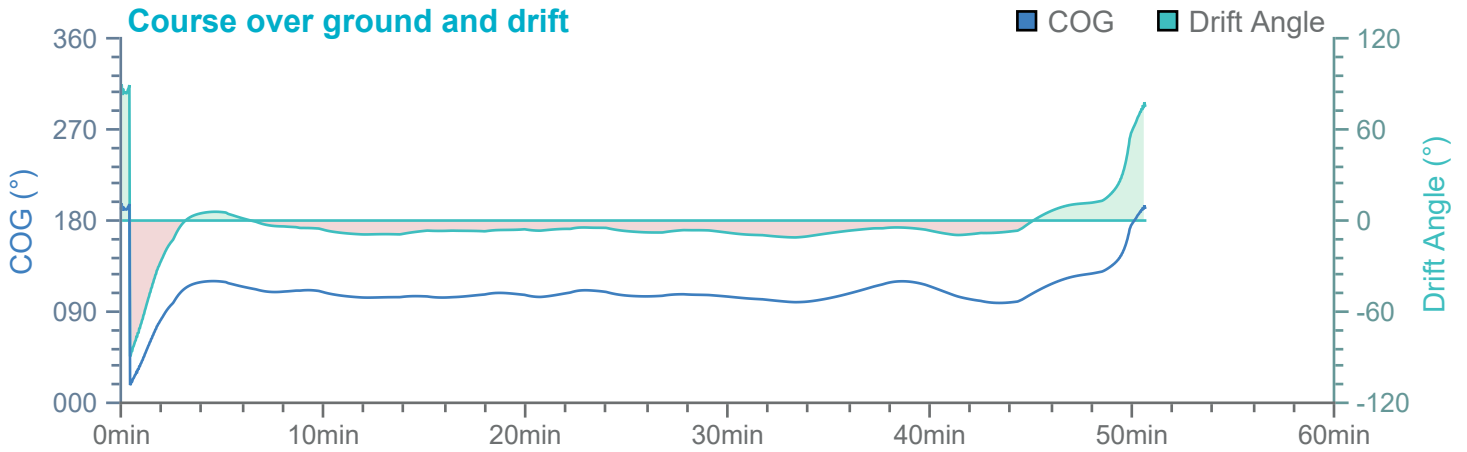
Ships plotted every 2 mins, highlight every 10 mins

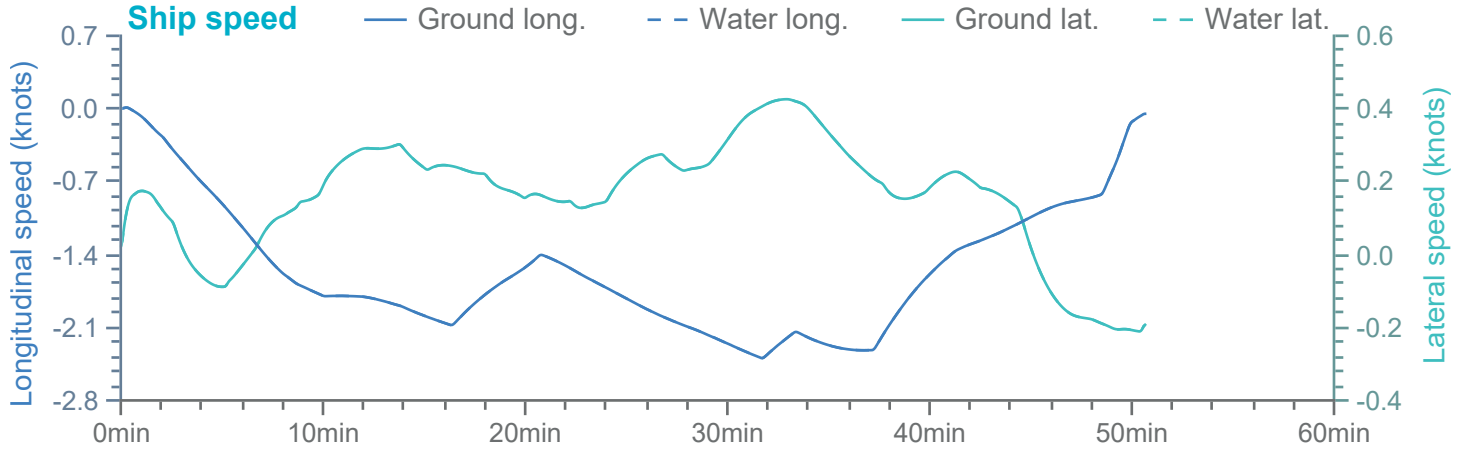

Current acting on ship
Bow
Stern
Bow Dir
Stern Dir
Current speed (knots)
120
100
80
60
40
20
0
Current direction (°N)
360
270
180
090
000
0min
10min
20min
30min
40min
50min
60min

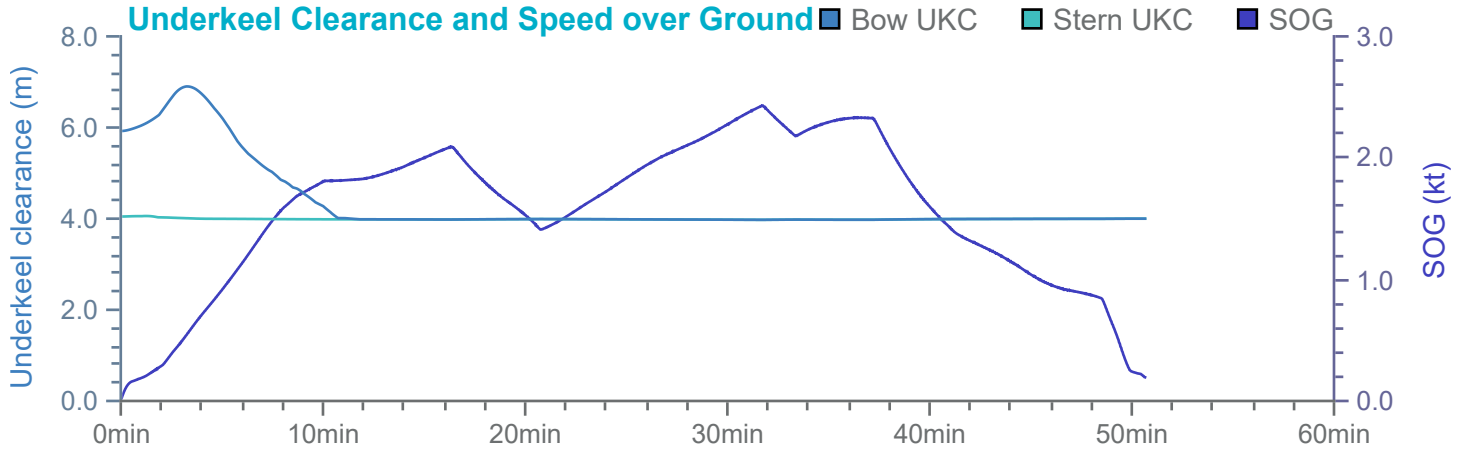

Wind speed and direction
Speed
Direction
Wind speed (knots)
40
30
20
10
0
Wind direction (°N)
360
270
180
090
000
0min
10min
20min
30min
40min
50min
60min

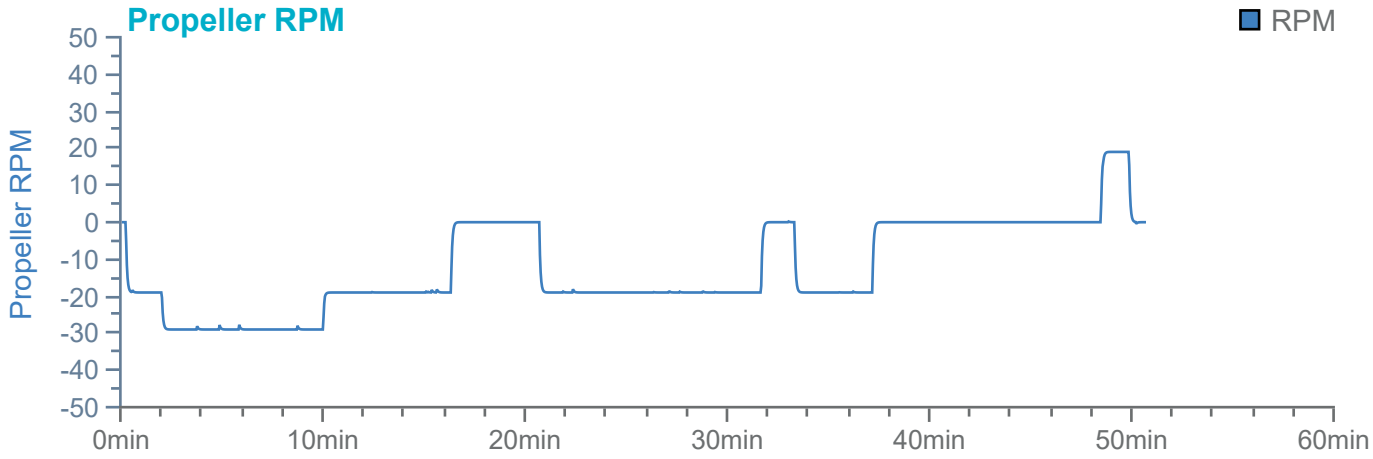

Sig. wave height and direction
Hs1
Dir1
Hs (m)
3.00
2.25
1.50
0.75
0.00
Wave direction (°N)
360
270
180
090
000
0min
10min
20min
30min
40min
50min
60min

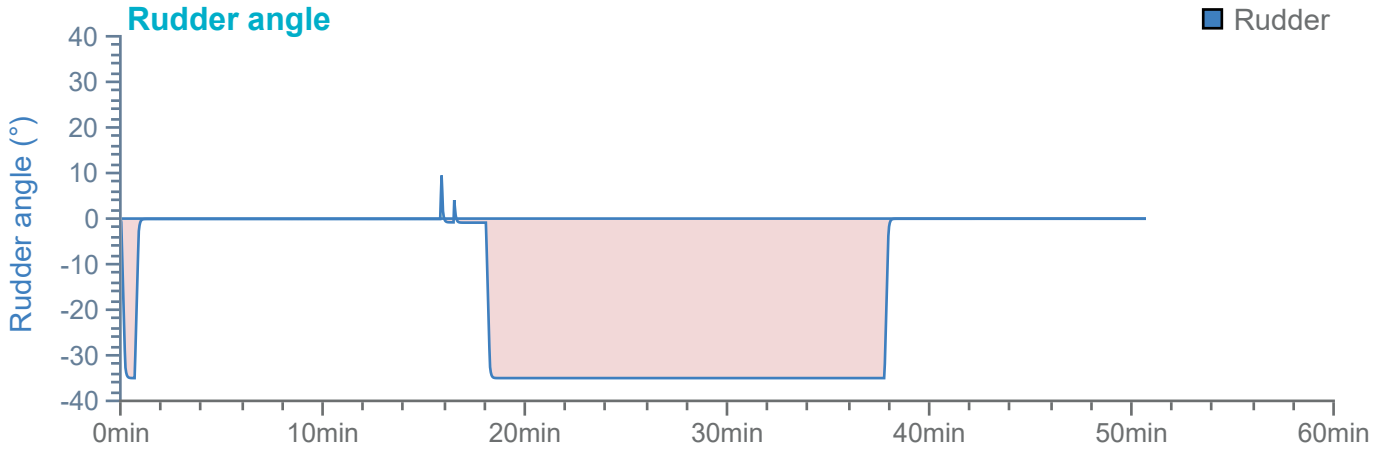

Rate of turn and heading
RoT
Heading
Rate of turn (°/min)
Heading (°N)
6
3
0
-3
-6
360
270
180
090
000
0min
10min
20min
30min
40min
50min
60min

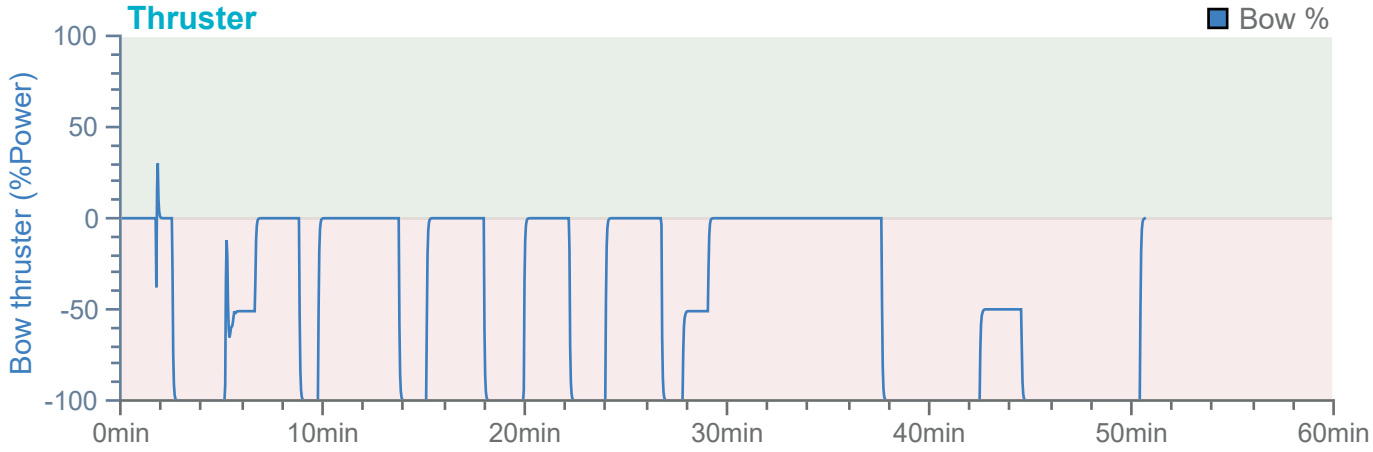

Course over ground and drift
COG
Drift Angle
COG (°)
Drift Angle (°)
360
270
180
090
000
120
60
0
-60
-120
0min
10min
20min
30min
40min
50min
60min


Ship speed
Ground long.
Water long.
Ground lat.
Water lat.
Longitudinal speed (knots)
Lateral speed (knots)
0.7
0.0
-0.7
-1.4
-2.1
-2.8
0.6
0.4
0.2
0.0
-0.2
-0.4
0min
10min
20min
30min
40min
50min
60min

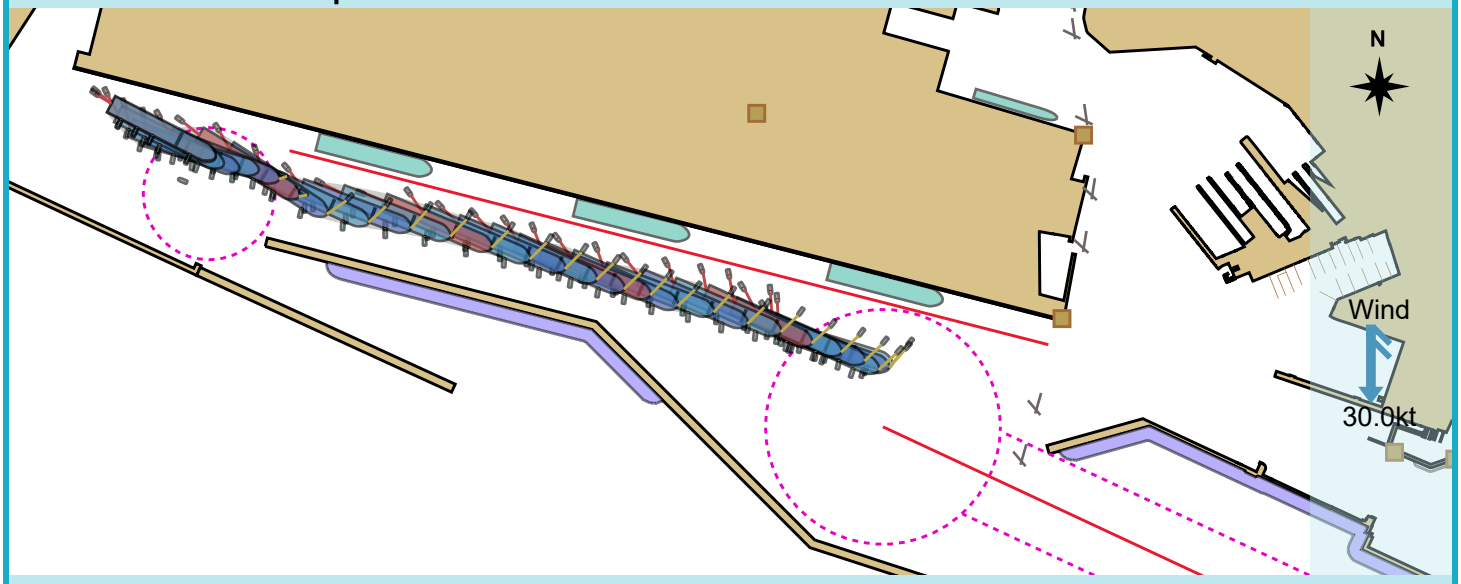

Underkeel Clearance and Speed over Ground
Bow UKC
Stern UKC
SOG
Underkeel clearance (m)
SOG (kt)
8.0
6.0
4.0
2.0
0.0
3.0
2.0
1.0
0.0
0min
10min
20min
30min
40min
50min
60min


Propeller RPM
RPM
Propeller RPM
50
40
30
20
10
0
-10
-20
-30
-40
-50
0min
10min
20min
30min
40min
50min
60min


Rudder angle
Rudder
Rudder angle (°)
40
30
20
10
0
-10
-20
-30
-40
0min
10min
20min
30min
40min
50min
60min

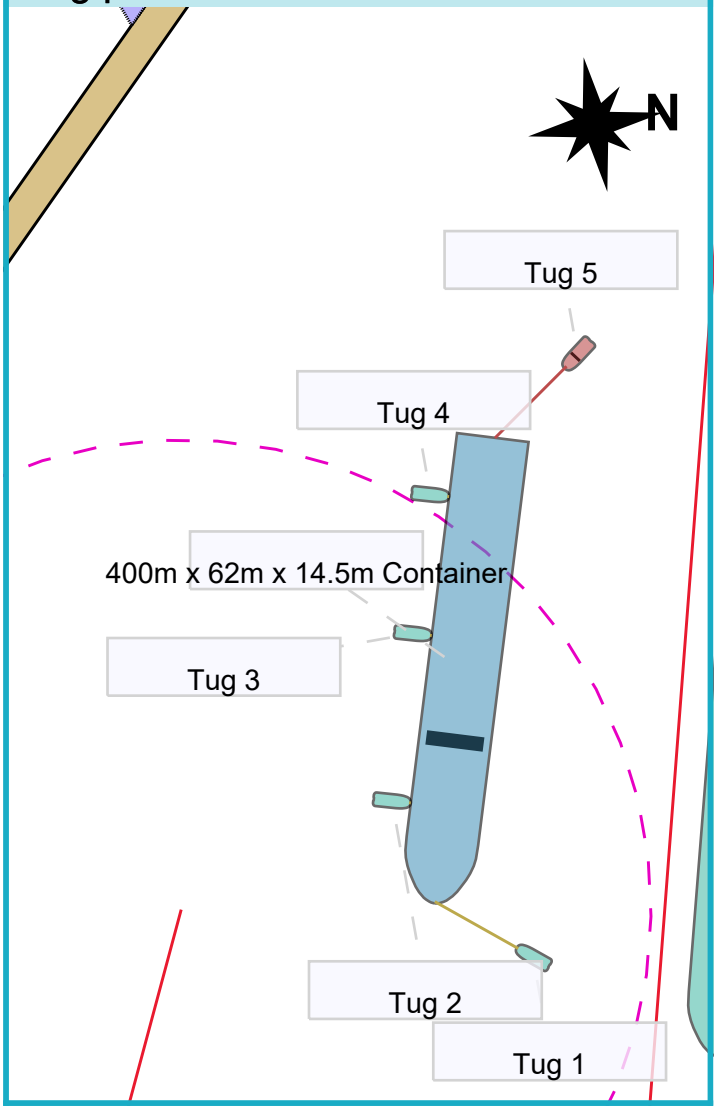

Thruster
Bow %
Bow thruster (%Power)
100
50
0
-50
-100
0min
10min
20min
30min
40min
50min
60min

Manoeuvre track plot

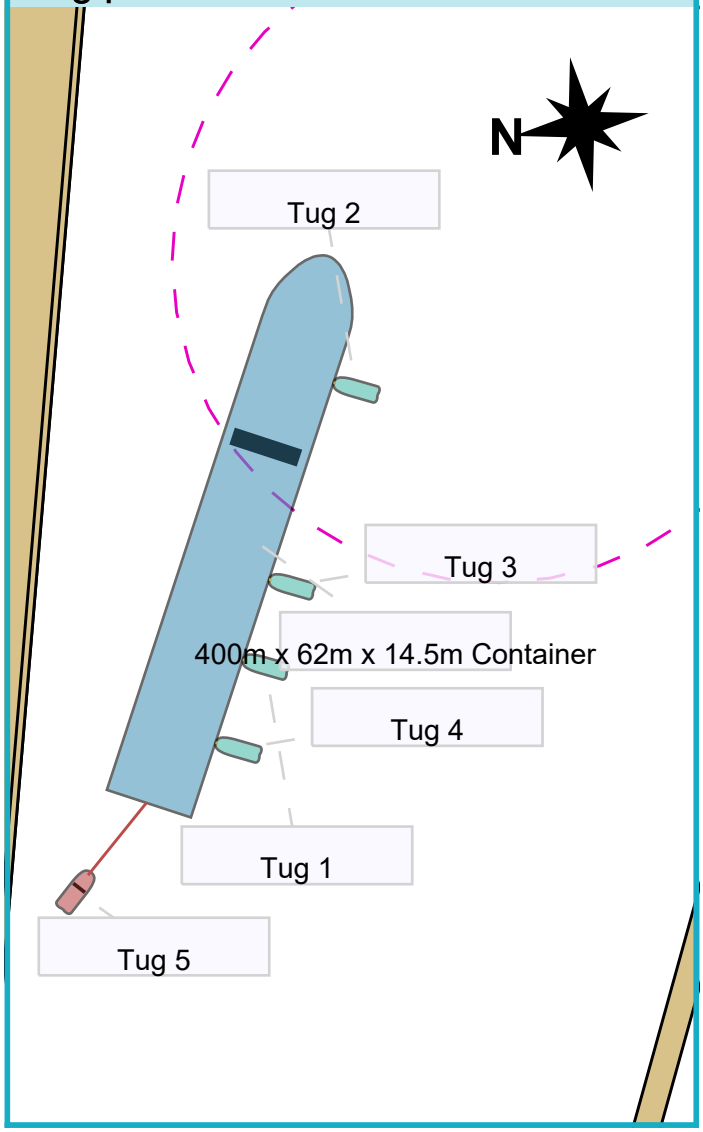


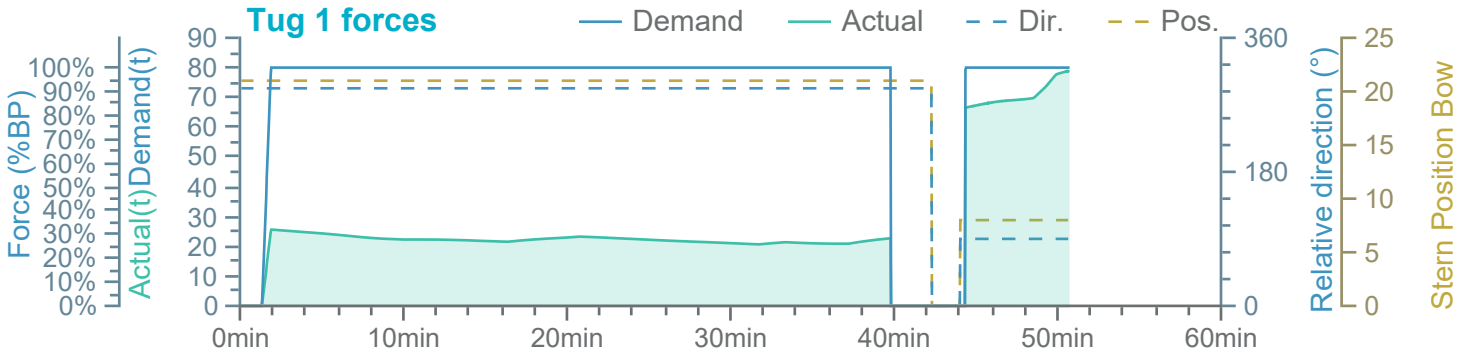
Ships plotted every 2 mins, highlight every 10 mins

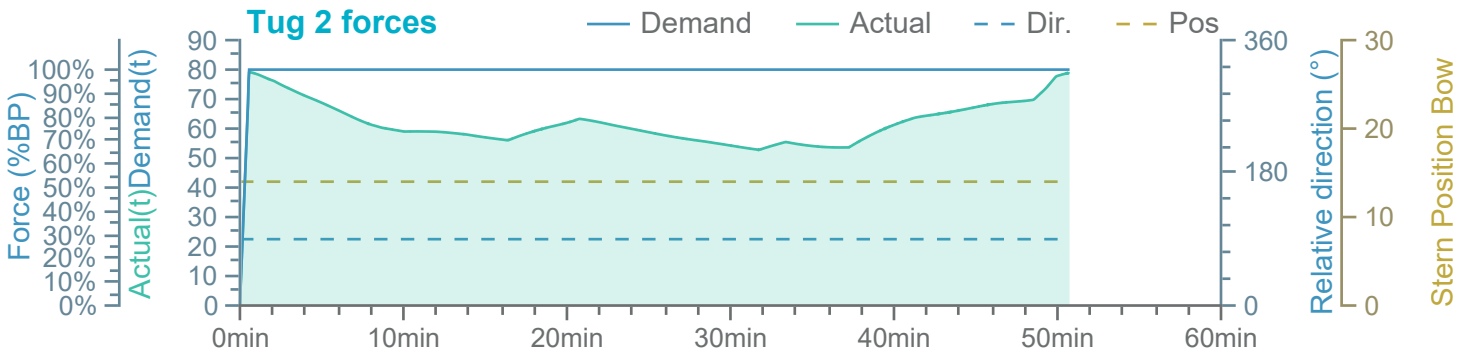
Tug position: Initial

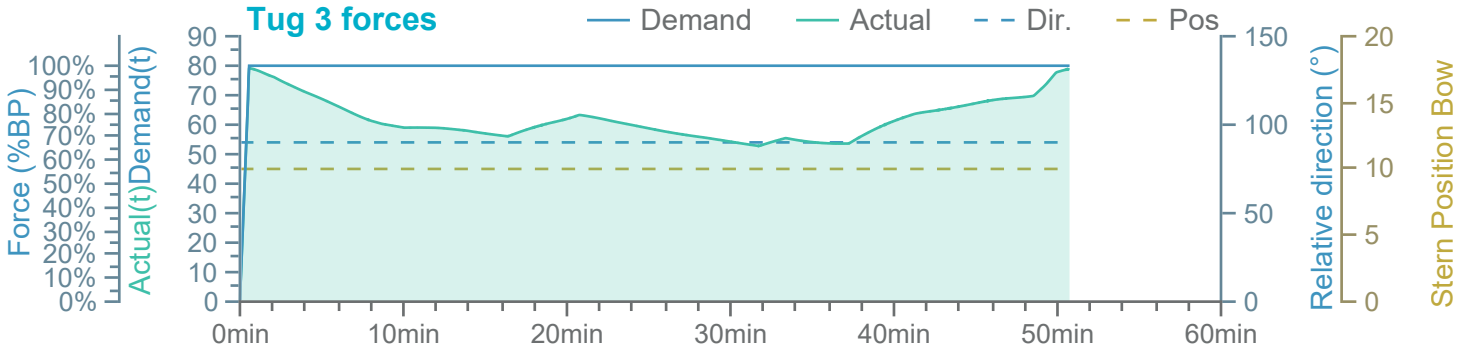


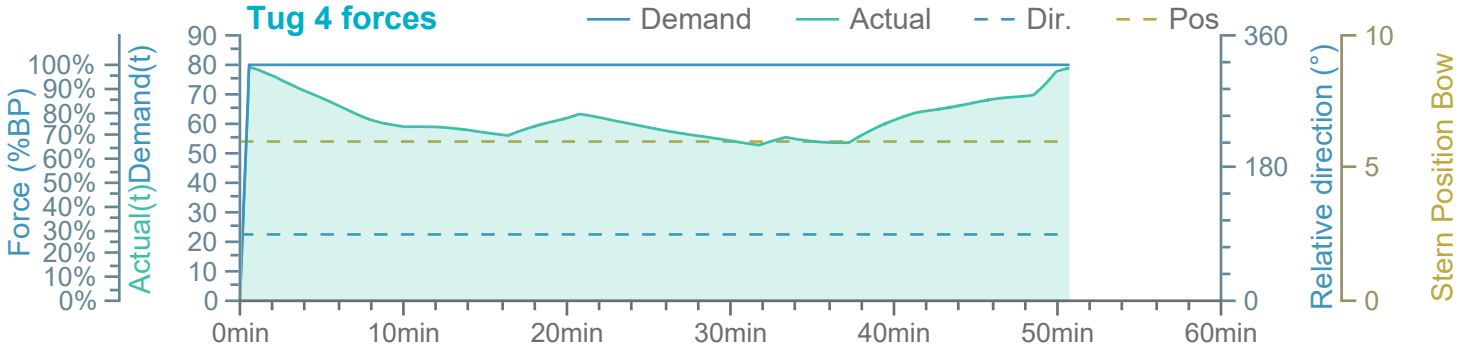
Tug position: Final

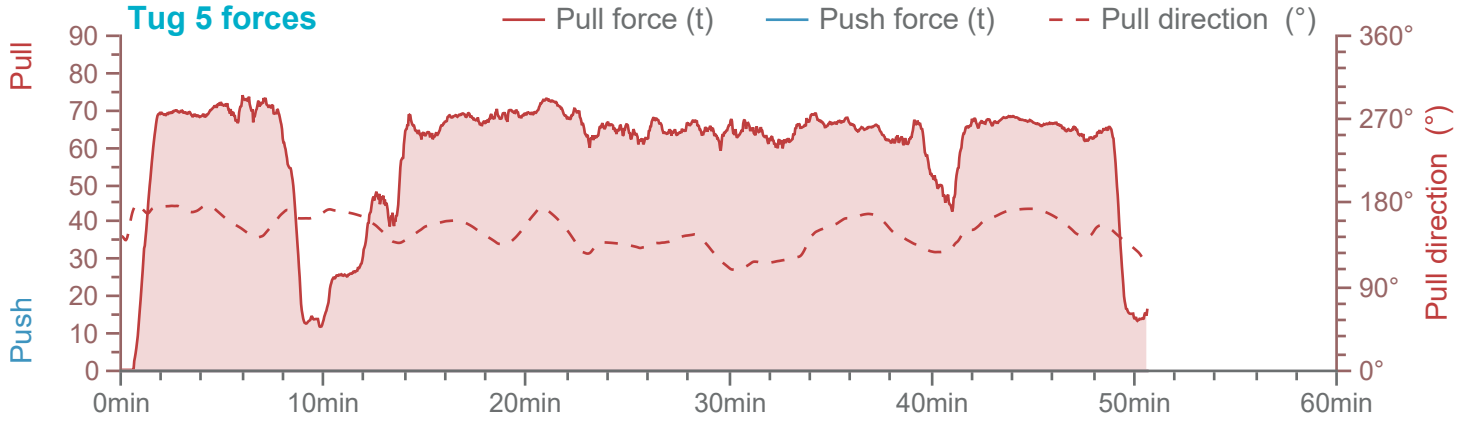



Tug 1 forces
Demand
Actual
Dir.
Pos.
Force (%BP)
Actual(t)Demand(t)
Relative direction (°)
Stern Position Bow
0min
10min
20min
30min
40min
50min
60min

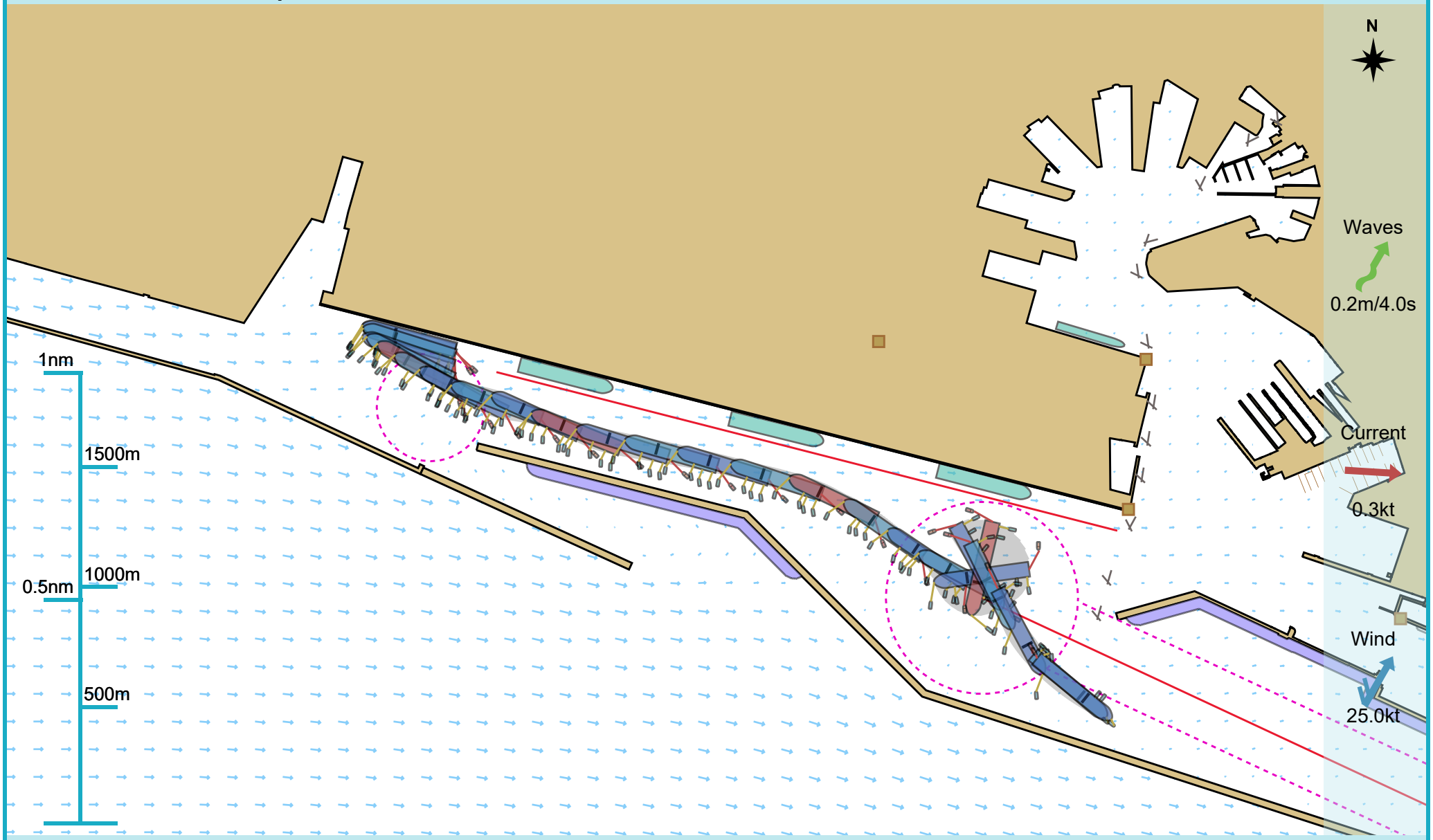

Tug 2 forces
Demand
Actual
Dir.
Pos
Force (%BP)
Actual(t)Demand(t)
Relative direction (°)
Stern Position Bow
0min
10min
20min
30min
40min
50min
60min


Tug 3 forces
Demand
Actual
Dir.
Pos
Force (%BP)
Actual(t)Demand(t)
Relative direction (°)
Stern Position Bow
0min
10min
20min
30min
40min
50min
60min


Tug 4 forces
Demand
Actual
Dir.
Pos
Force (%BP)
Actual(t)Demand(t)
Relative direction (°)
Stern Position Bow
0min
10min
20min
30min
40min
50min
60min


Tug 5 forces
Pull force (t)
Push force (t)
Pull direction (°)
Pull
Push
Pull direction (°)
0min
10min
20min
30min
40min
50min
60min

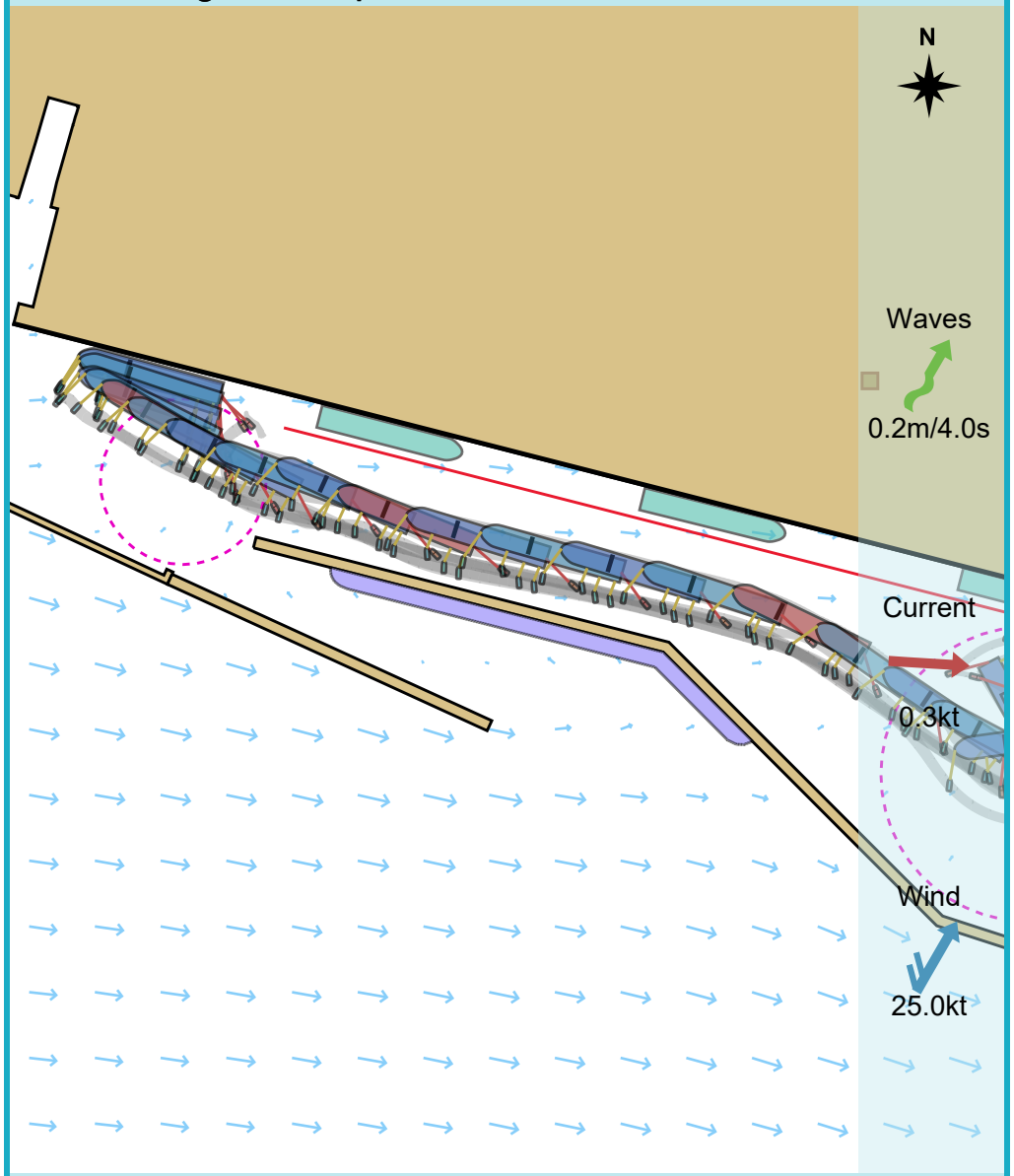
Manoeuvre track plot



0.74 kts

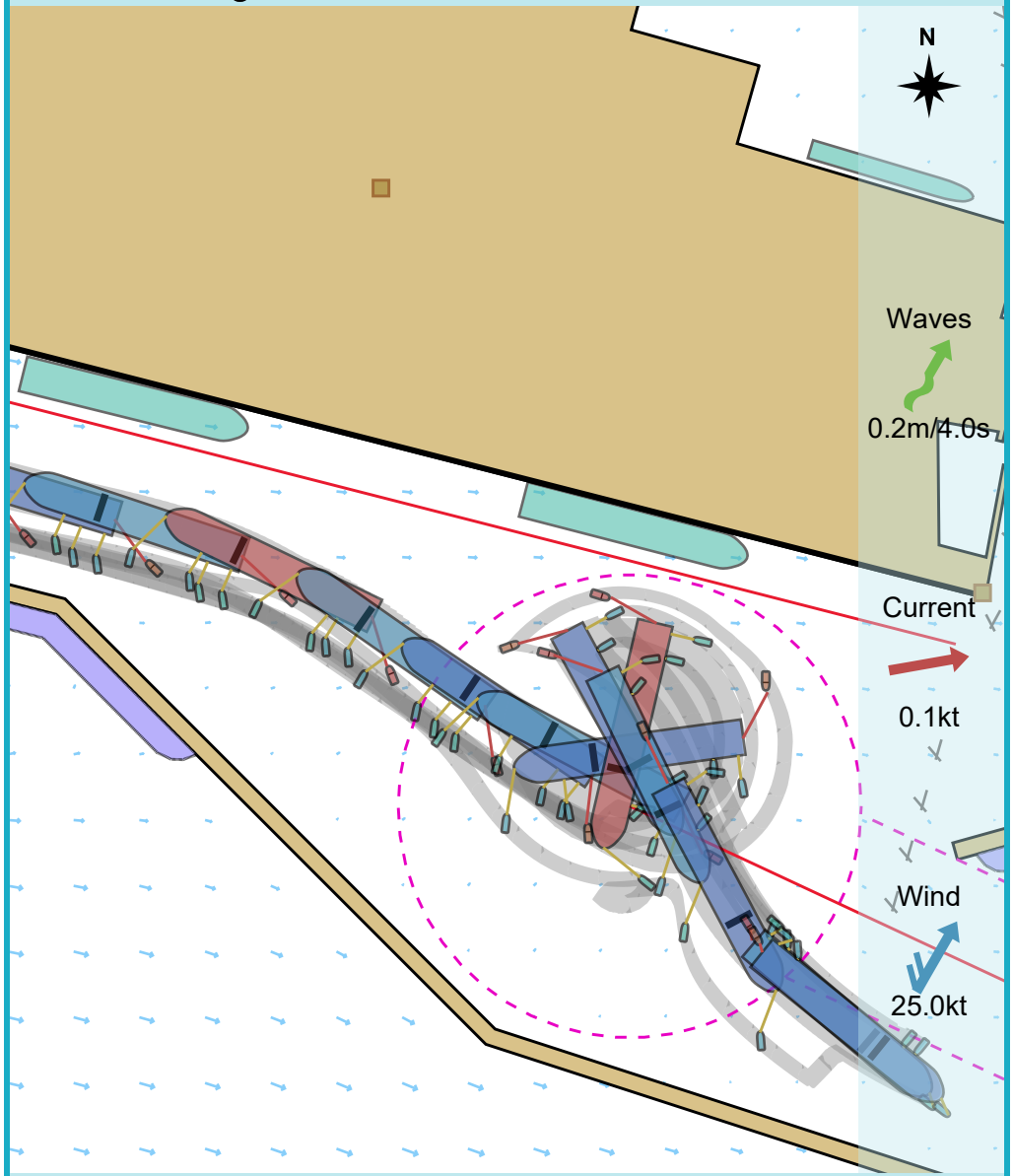
Ships plotted every 2 mins, highlight every 10 mins

Unberthing and Departure Channel

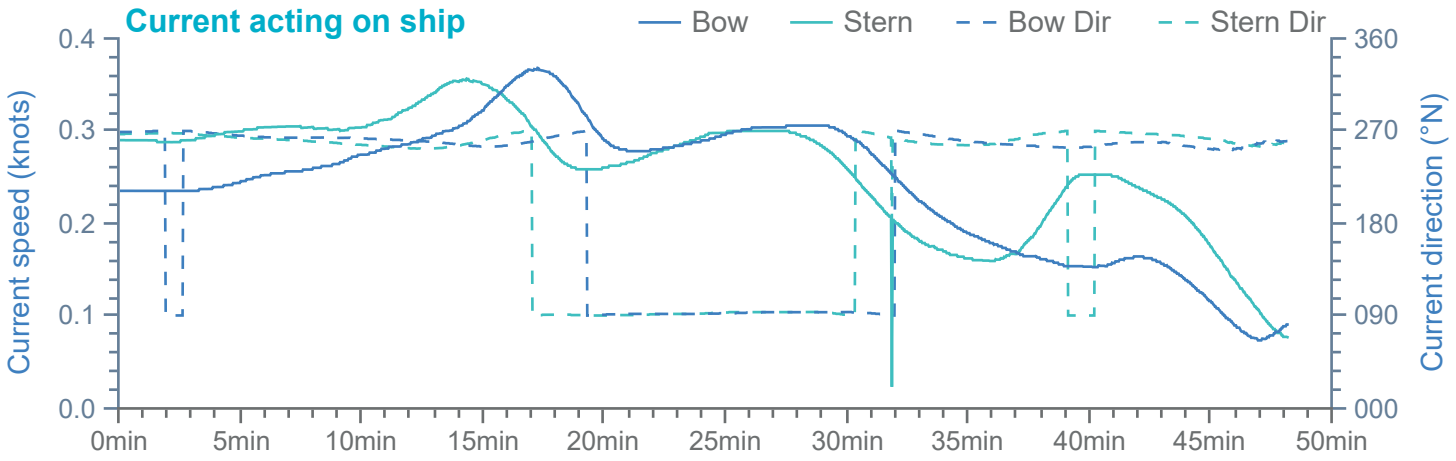


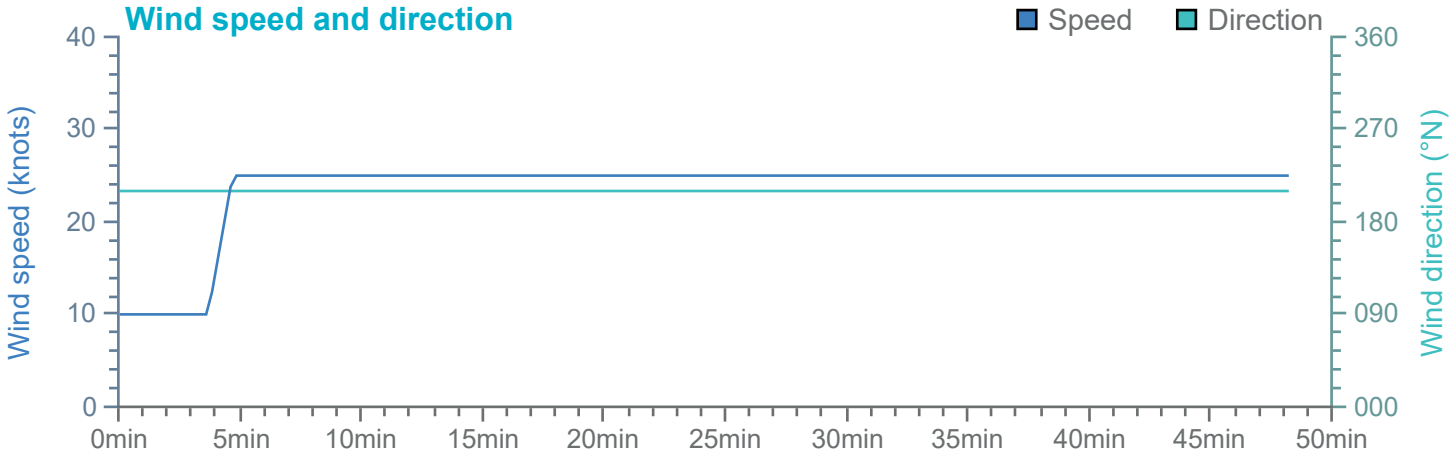
Ships plotted every 2 mins, highlight every 10 mins

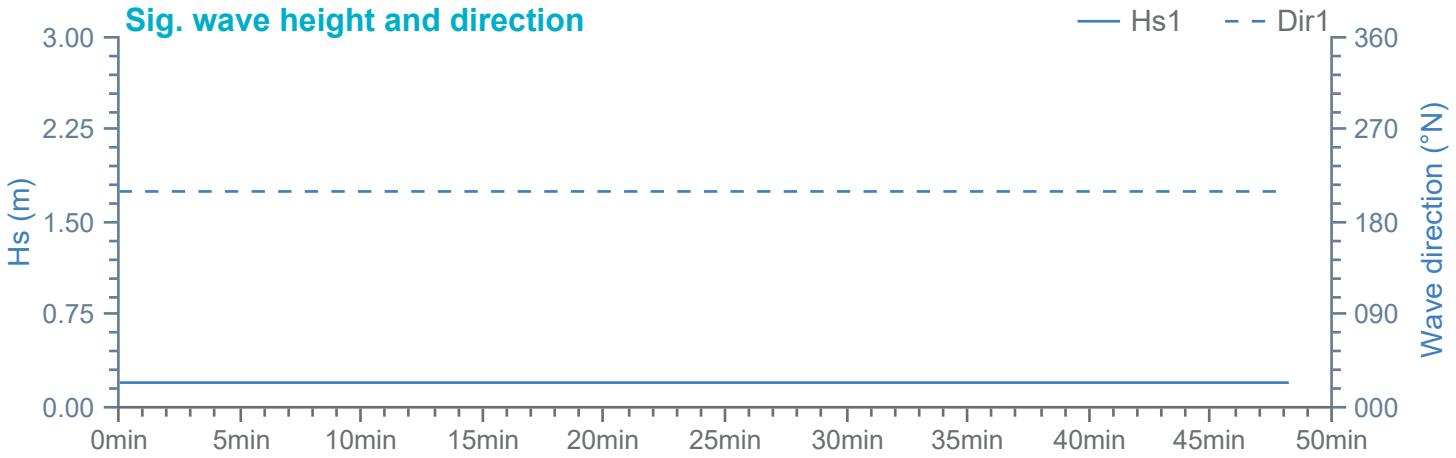
Manoeuvring area

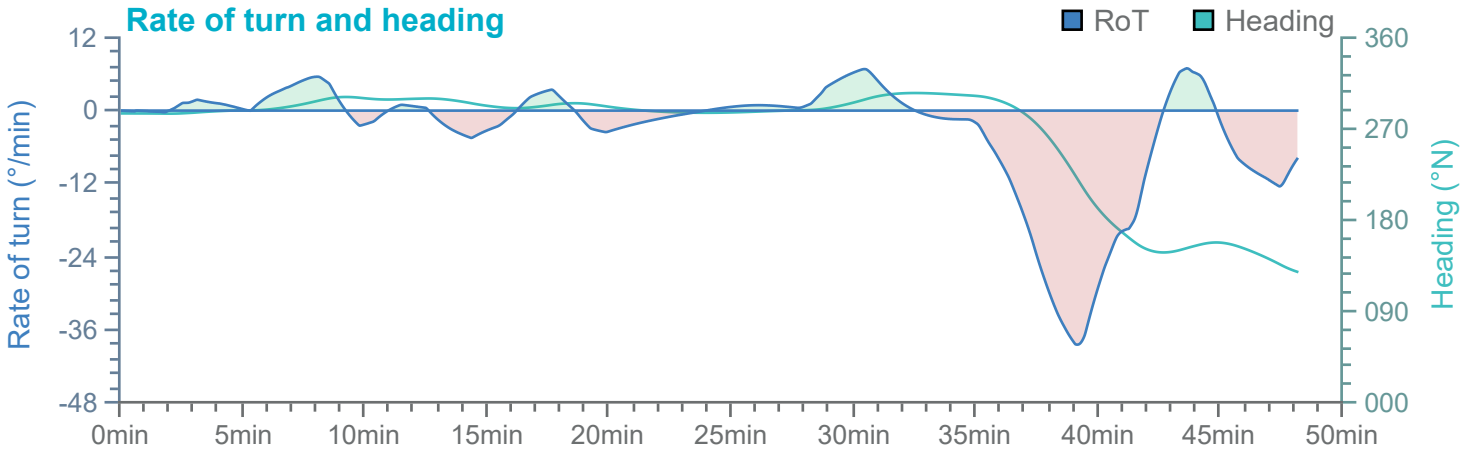


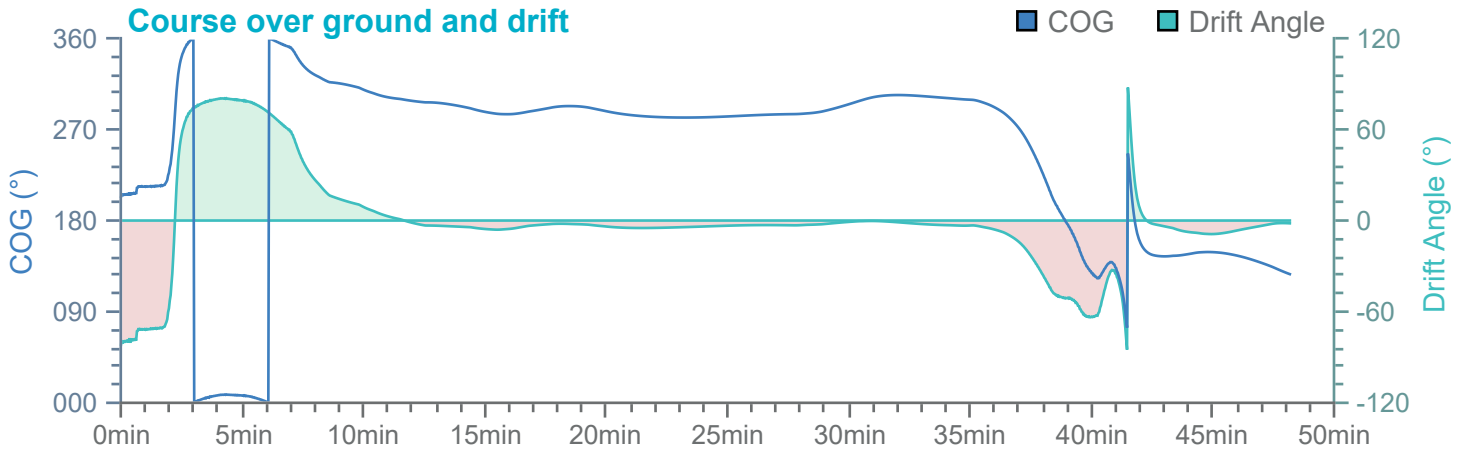
Ships plotted every 2 mins, highlight every 10 mins

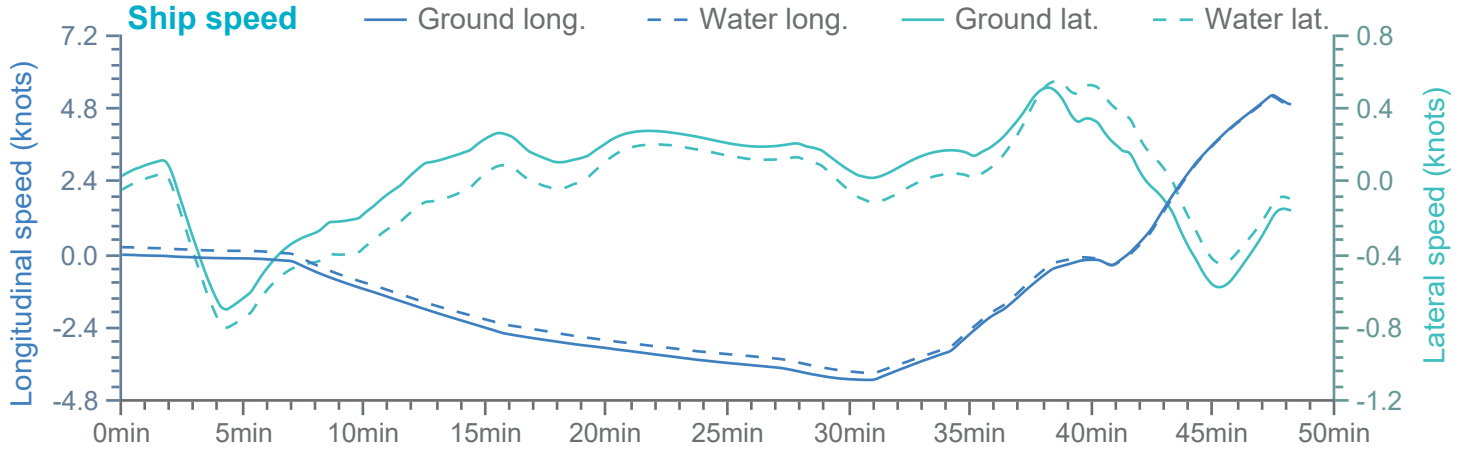

Current acting on ship
Bow
Stern
Bow Dir
Stern Dir
Current speed (knots)
Current direction (°N)
0.0
0.1
0.2
0.3
0.4
000
090
180
270
360
0min
5min
10min
15min
20min
25min
30min
35min
40min
45min
50min

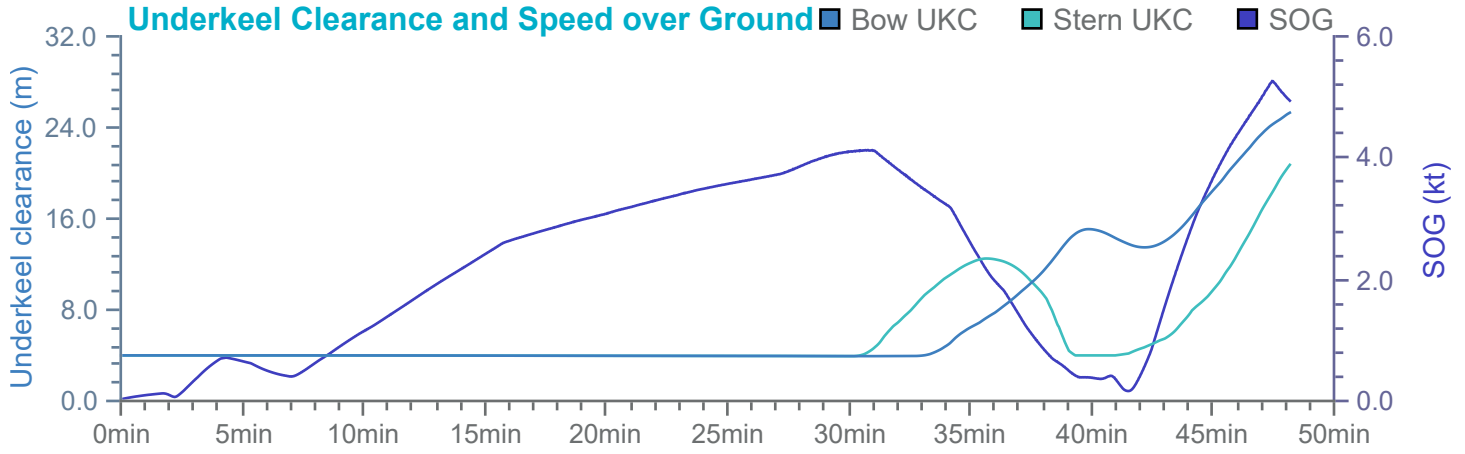

Wind speed and direction
Speed
Direction
Wind speed (knots)
Wind direction (°N)
0
10
20
30
40
000
090
180
270
360
0min
5min
10min
15min
20min
25min
30min
35min
40min
45min
50min

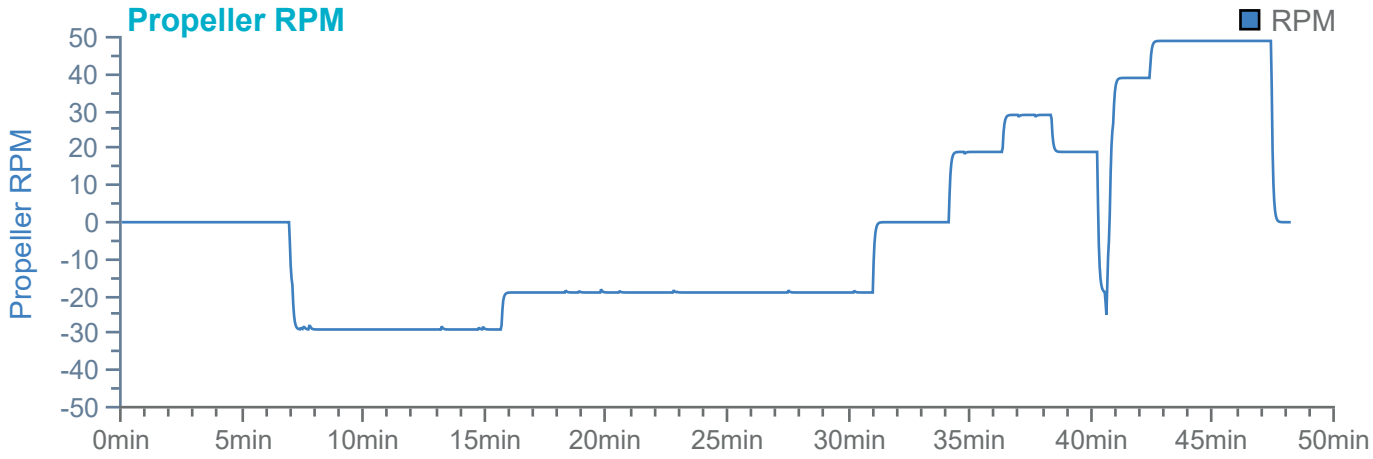

Sig. wave height and direction
Hs1
Dir1
Hs (m)
Wave direction (°N)
0.00
0.75
1.50
2.25
3.00
000
090
180
270
360
0min
5min
10min
15min
20min
25min
30min
35min
40min
45min
50min

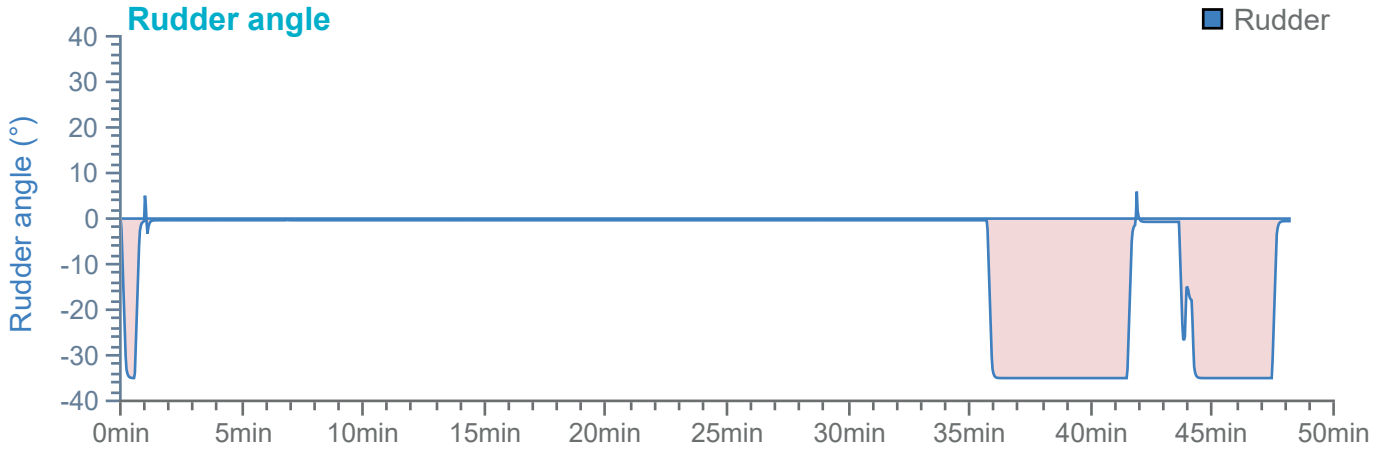

Rate of turn and heading
RoT
Heading
Rate of turn (°/min)
Heading (°N)
12
0
-12
-24
-36
-48
360
270
180
090
000
0min
5min
10min
15min
20min
25min
30min
35min
40min
45min
50min

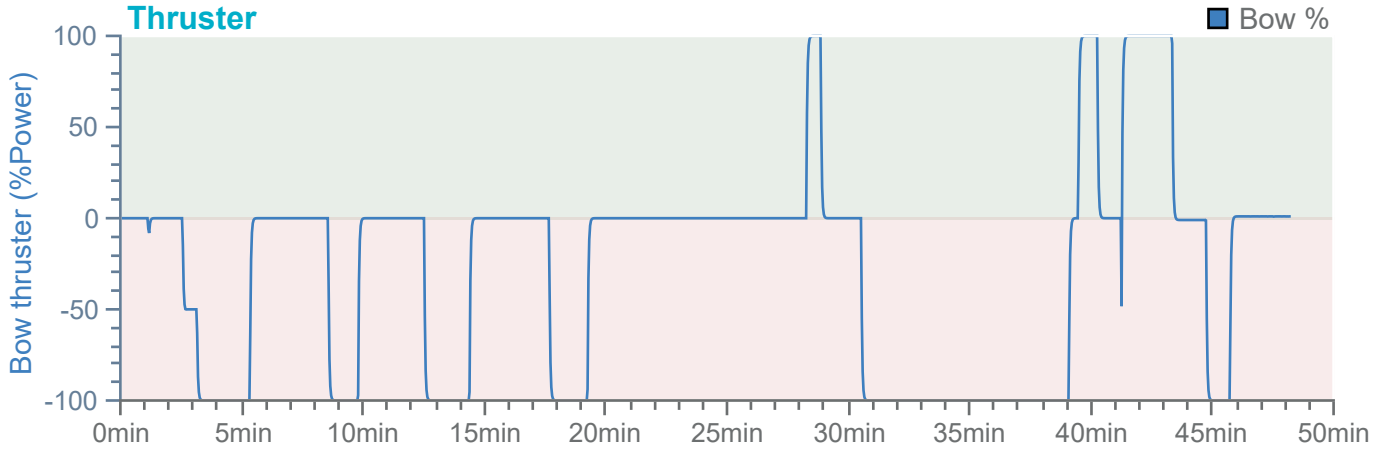

Course over ground and drift
COG
Drift Angle
COG (°)
Drift Angle (°)
360
270
180
090
000
120
60
0
-60
-120
0min
5min
10min
15min
20min
25min
30min
35min
40min
45min
50min


Ship speed
Ground long.
Water long.
Ground lat.
Water lat.
Longitudinal speed (knots)
Lateral speed (knots)
7.2
4.8
2.4
0.0
-2.4
-4.8
0.8
0.4
0.0
-0.4
-0.8
-1.2
0min
5min
10min
15min
20min
25min
30min
35min
40min
45min
50min

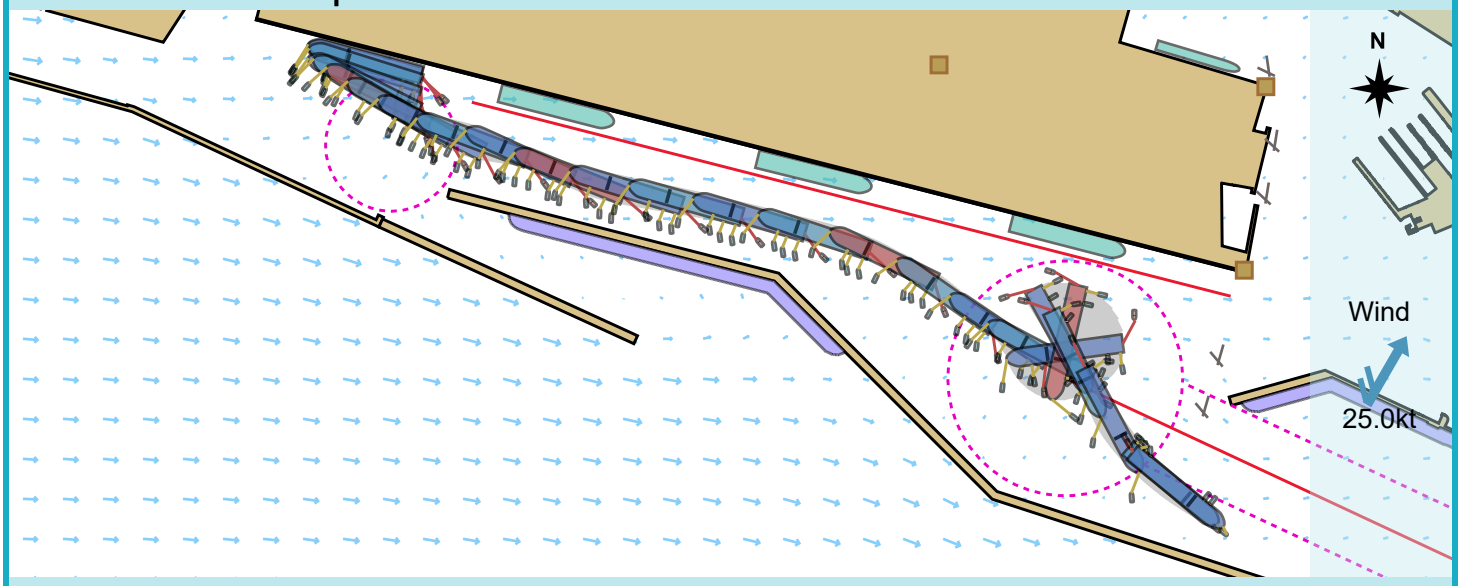

Underkeel Clearance and Speed over Ground
Bow UKC
Stern UKC
SOG
Underkeel clearance (m)
SOG (kt)
32.0
24.0
16.0
8.0
0.0
6.0
4.0
2.0
0.0
0min
5min
10min
15min
20min
25min
30min
35min
40min
45min
50min


Propeller RPM
RPM
Propeller RPM
50
40
30
20
10
0
-10
-20
-30
-40
-50
0min
5min
10min
15min
20min
25min
30min
35min
40min
45min
50min


Rudder angle
Rudder
Rudder angle (°)
40
30
20
10
0
-10
-20
-30
-40
0min
5min
10min
15min
20min
25min
30min
35min
40min
45min
50min

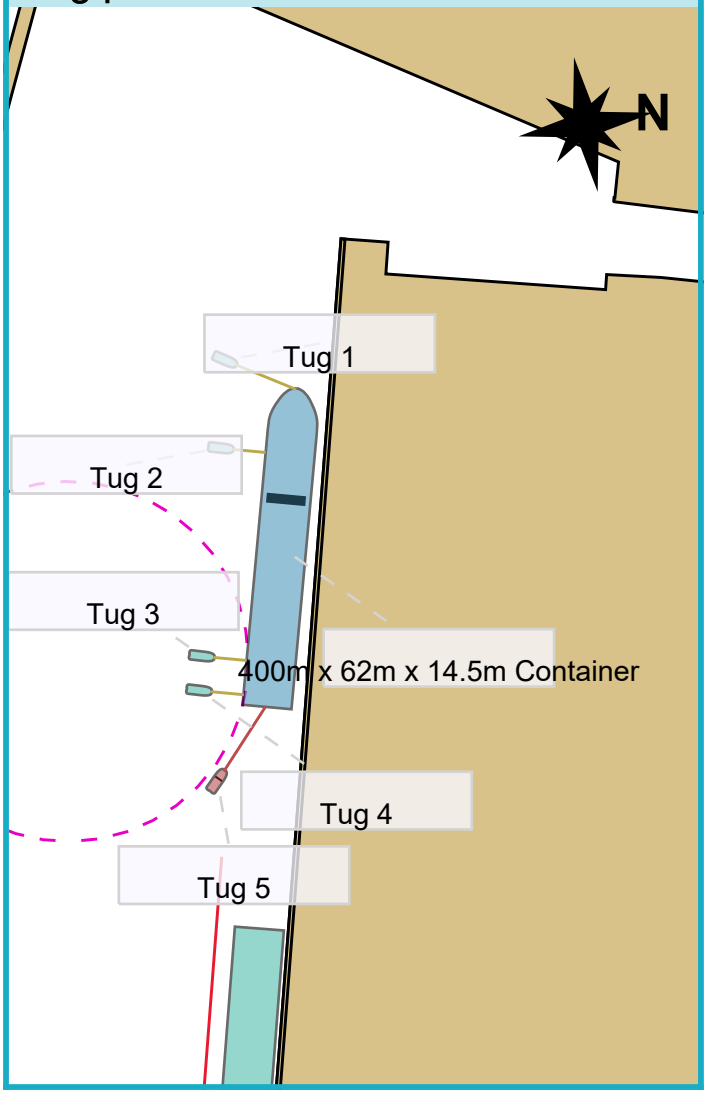

Thruster
Bow %
Bow thruster (%Power)
100
50
0
-50
-100
0min
5min
10min
15min
20min
25min
30min
35min
40min
45min
50min

Manoeuvre track plot

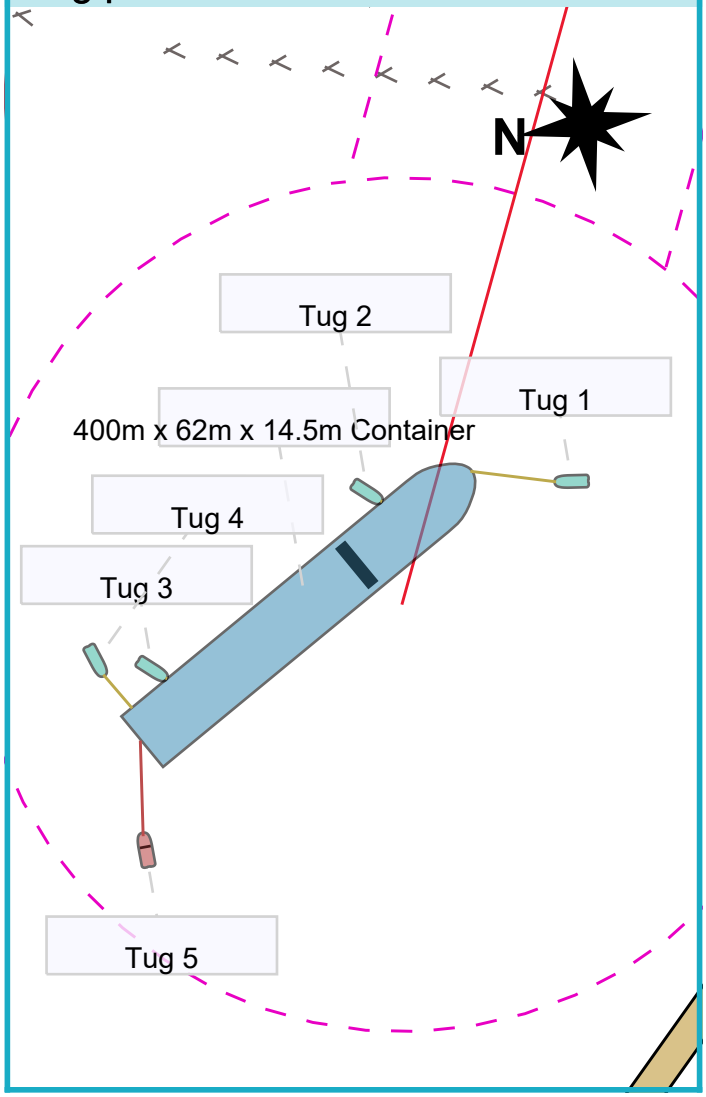


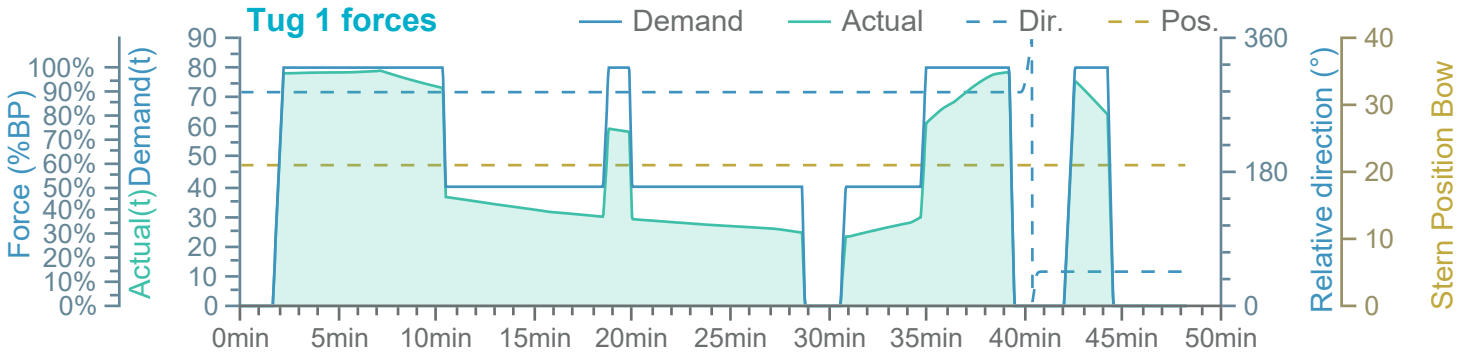
Ships plotted every 2 mins, highlight every 10 mins

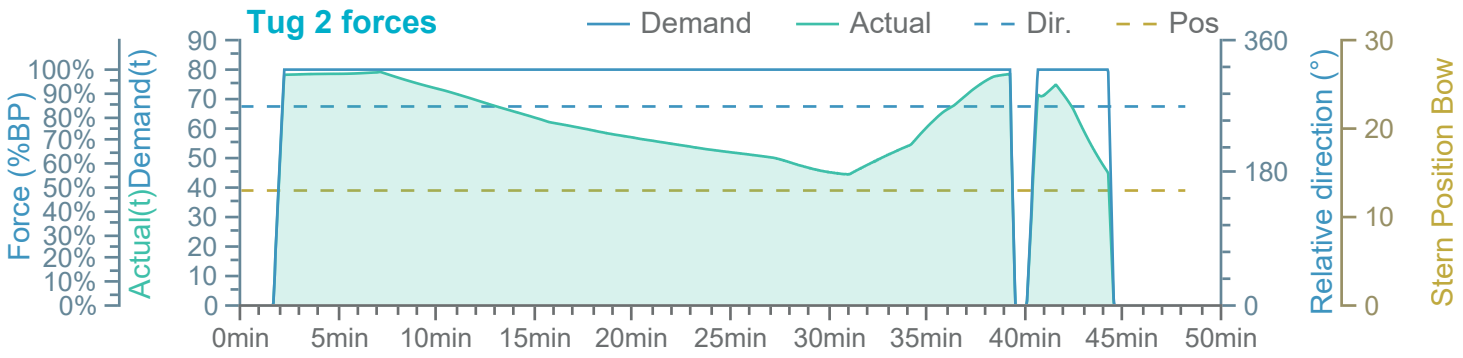
Tug position: Initial

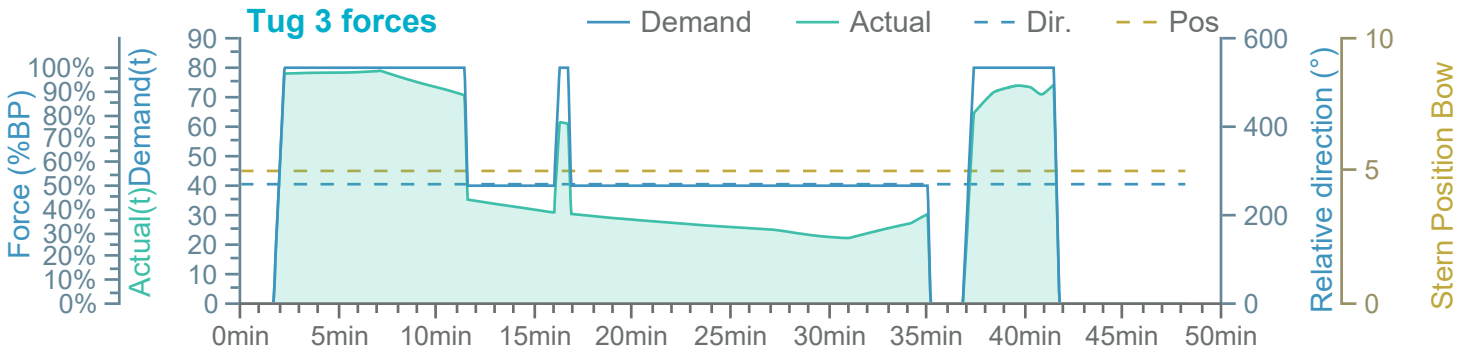


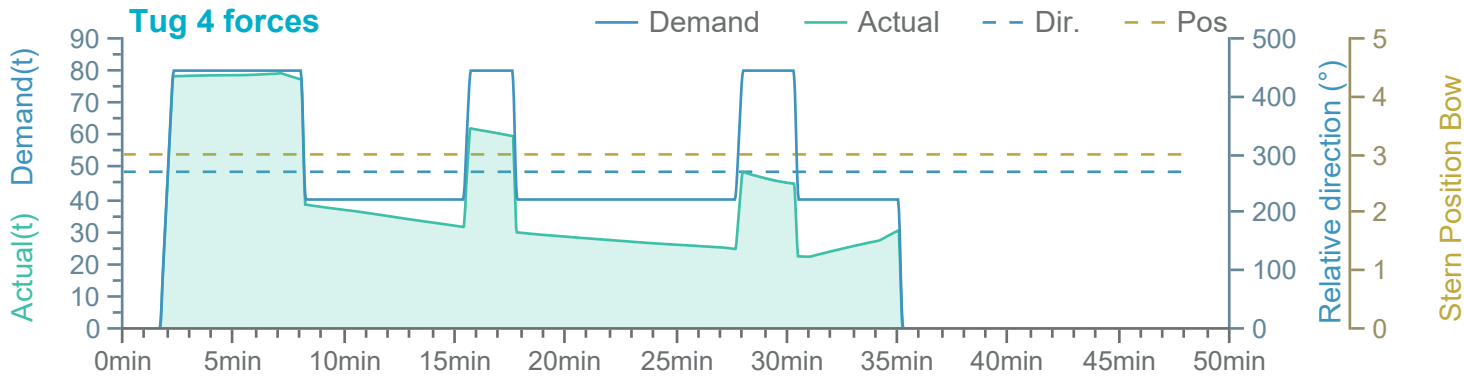
Tug position: Final

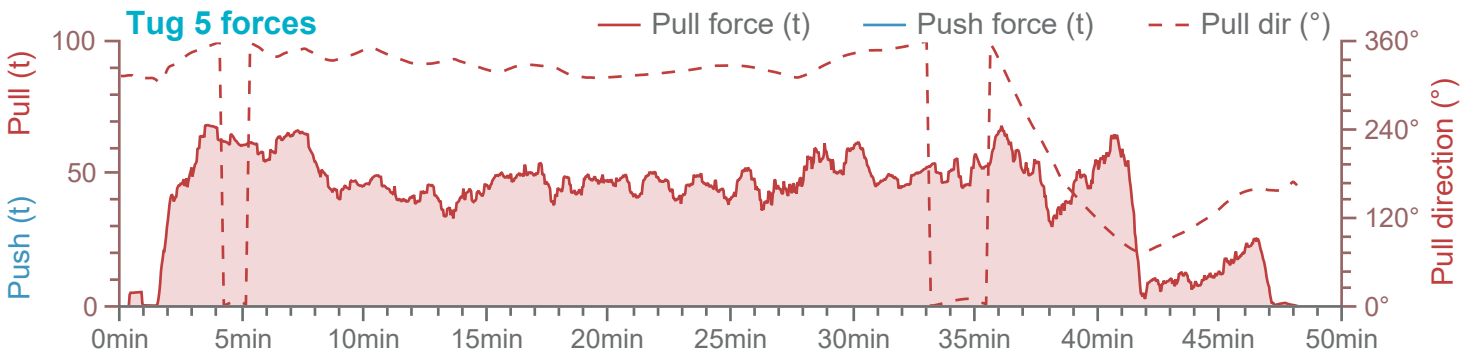



Tug 1 forces
Demand
Actual
Dir.
Pos.
Force (%BP)
Actual(t)Demand(t)
Relative direction (°)
Stern Position Bow
0min 5min 10min 15min 20min 25min 30min 35min 40min 45min 50min

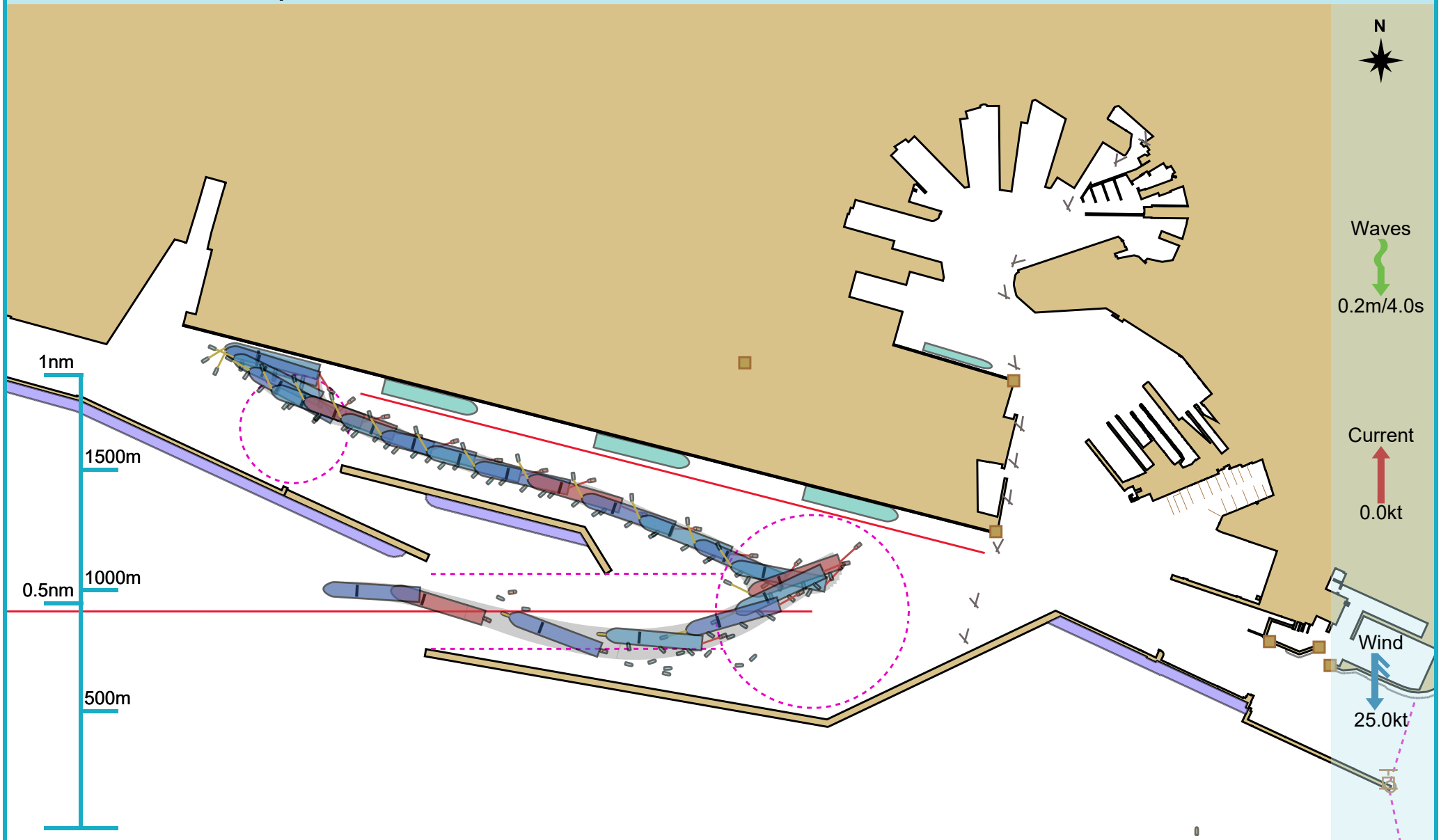

Tug 2 forces
Demand
Actual
Dir.
Pos
Force (%BP)
Actual(t)Demand(t)
Relative direction (°)
Stern Position Bow
0min 5min 10min 15min 20min 25min 30min 35min 40min 45min 50min


Tug 3 forces
Demand
Actual
Dir.
Pos
Force (%BP)
Actual(t)Demand(t)
Relative direction (°)
Stern Position Bow
0min 5min 10min 15min 20min 25min 30min 35min 40min 45min 50min


Tug 4 forces
Demand
Actual
Dir.
Pos
Actual(t) Demand(t)
Relative direction (°)
Stern Position Bow
0min 5min 10min 15min 20min 25min 30min 35min 40min 45min 50min


Tug 5 forces
Pull force (t)
Push force (t)
Pull dir (°)
Pull (t)
Push (t)
Pull direction (°)
0min 5min 10min 15min 20min 25min 30min 35min 40min 45min 50min

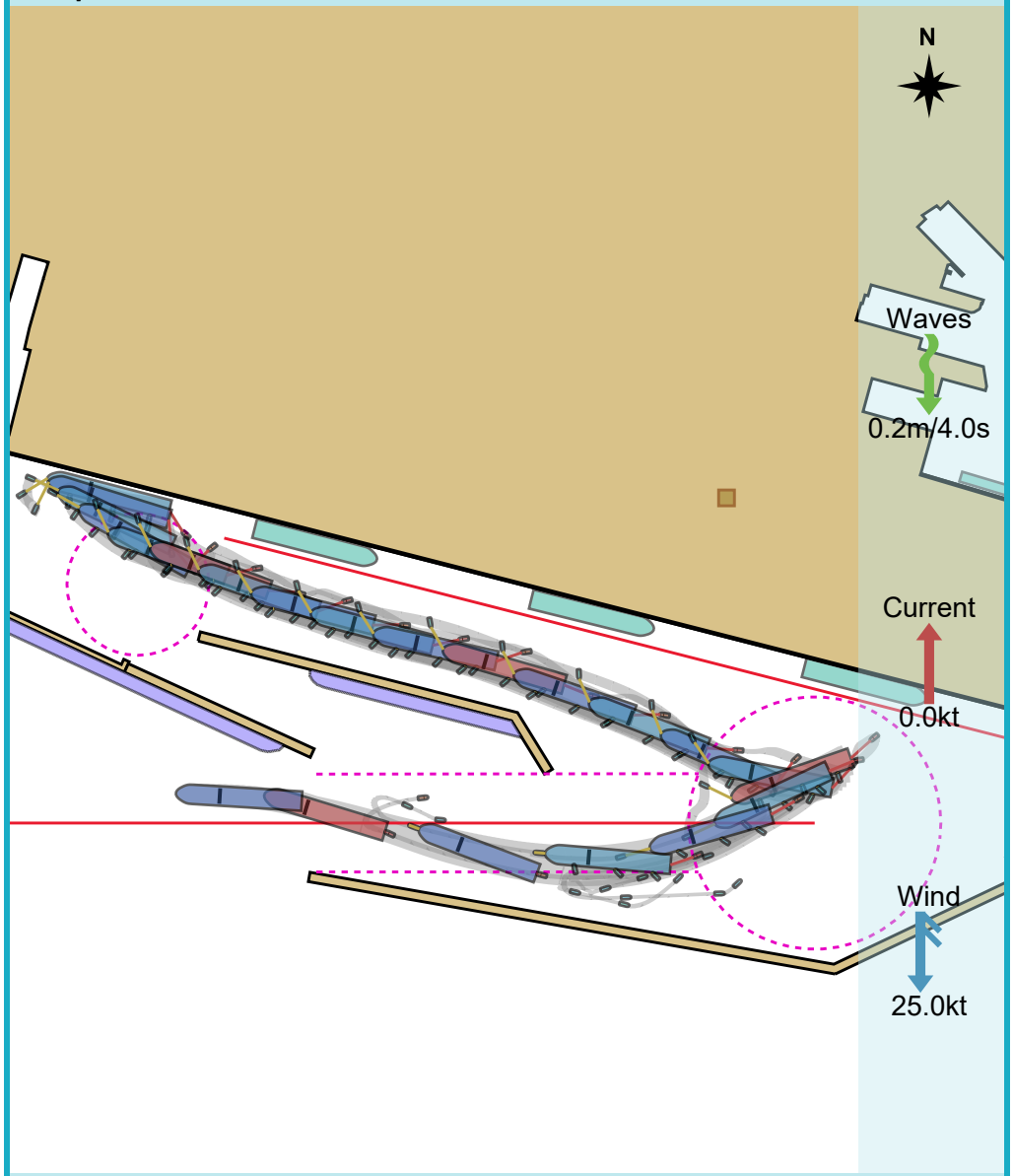
Manoeuvre track plot



0.00 kts

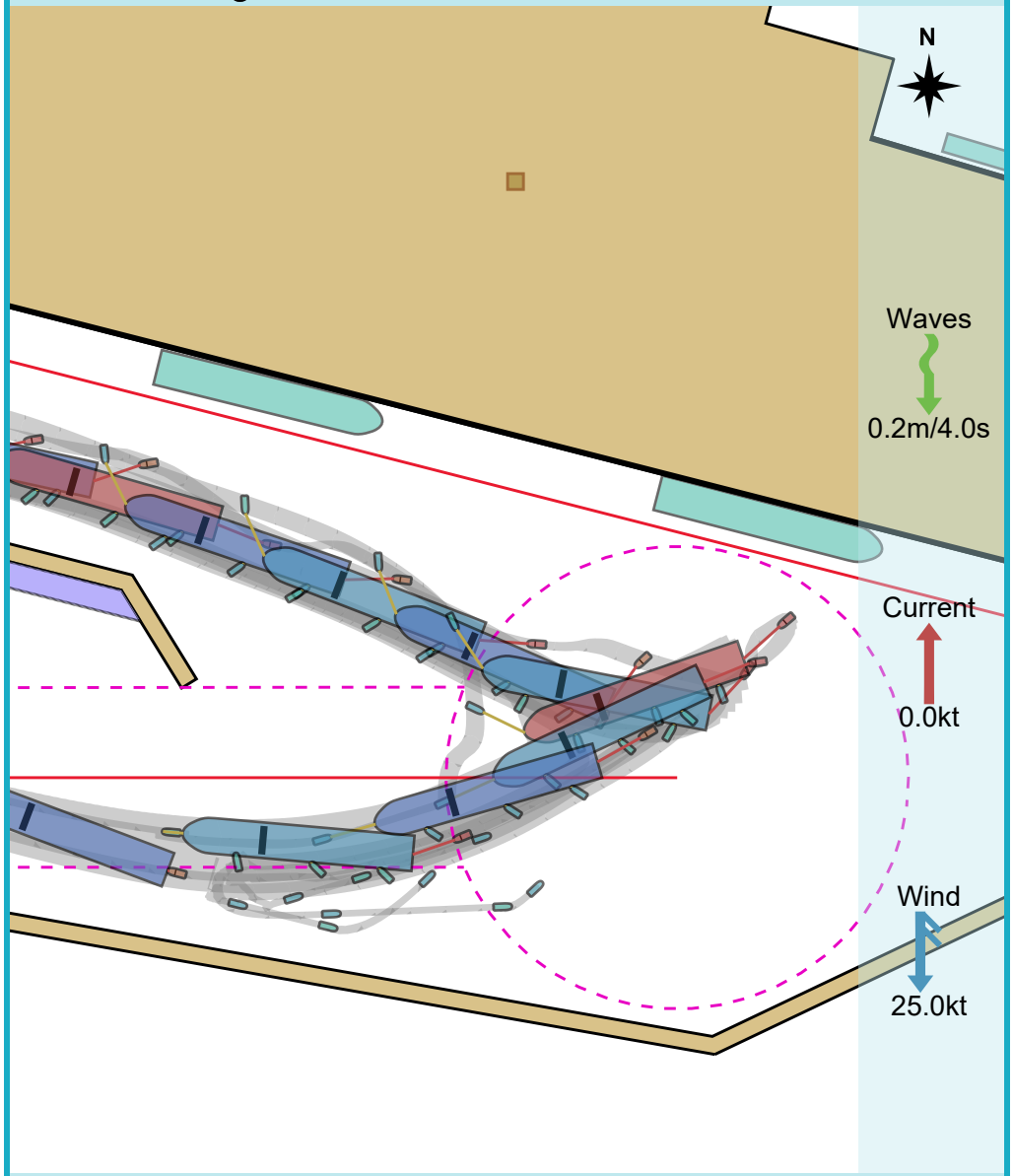
Ships plotted every 2 mins, highlight every 10 mins

Departure Channel

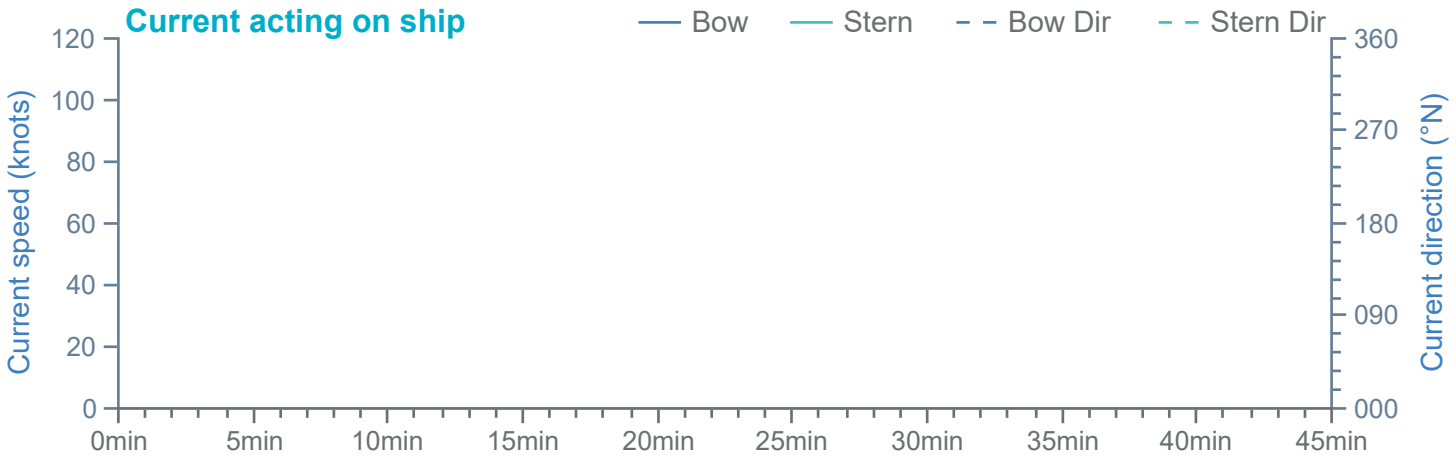


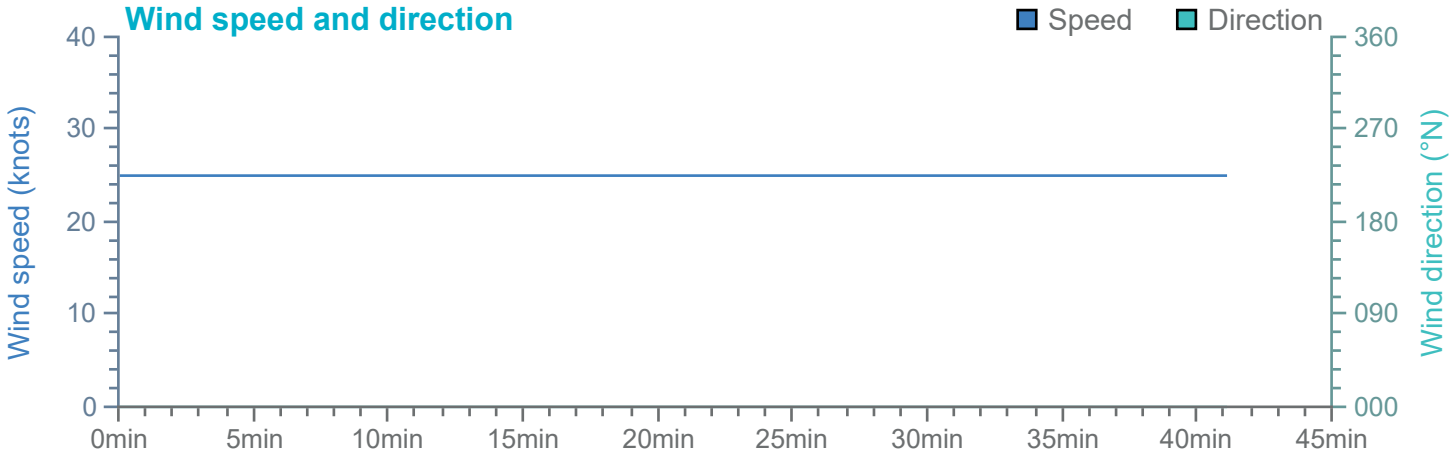
Ships plotted every 2 mins, highlight every 10 mins

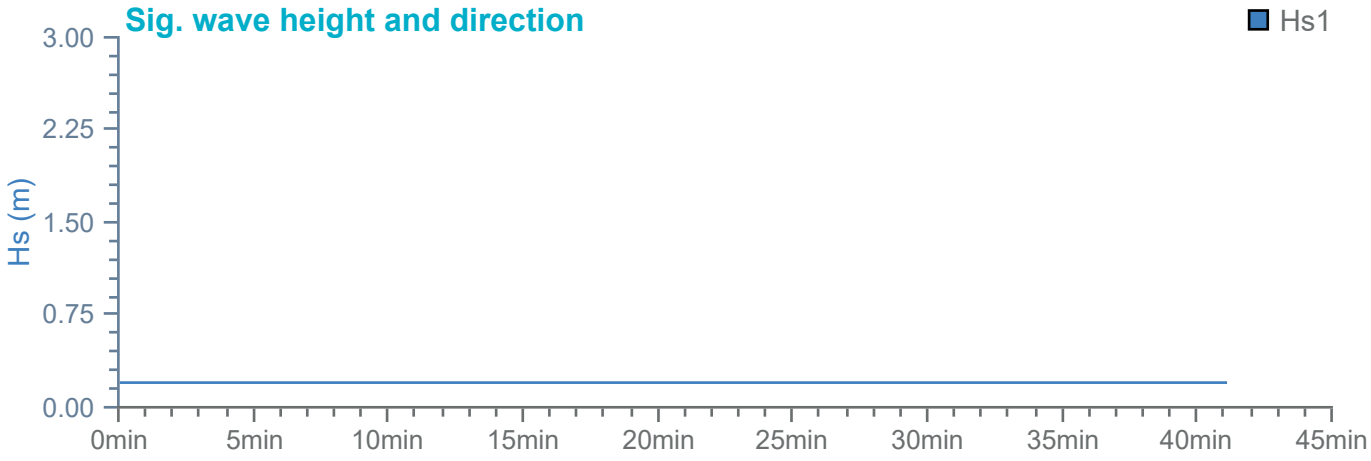
Manoeuvring area

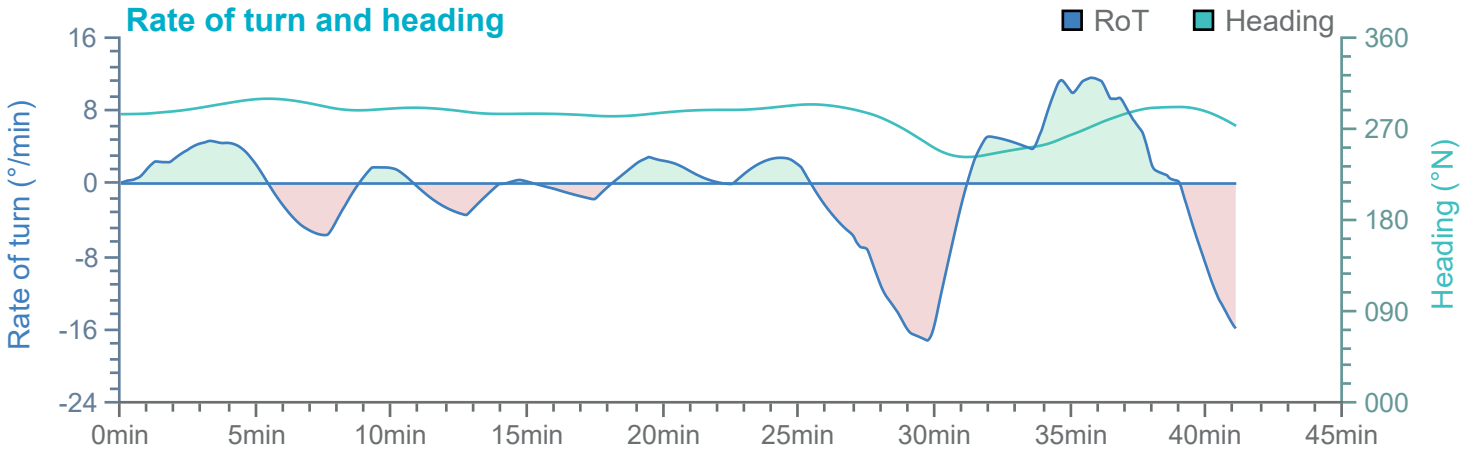


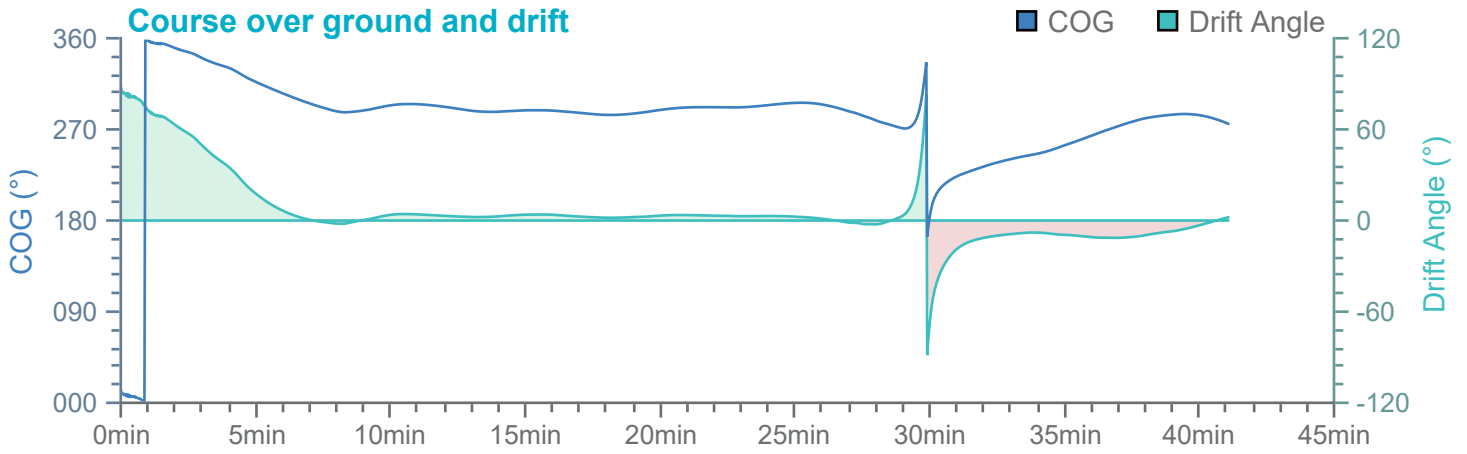
Ships plotted every 2 mins, highlight every 10 mins

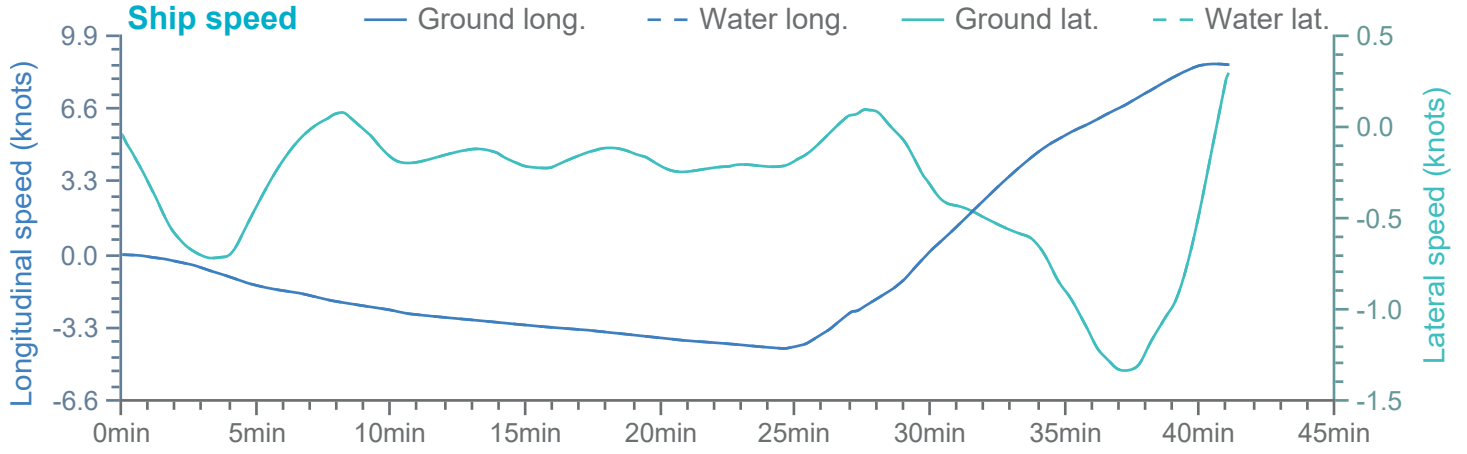

Current acting on ship
Bow
Stern
Bow Dir
Stern Dir
Current speed (knots)
Current direction (°N)
120
100
80
60
40
20
0
360
270
180
090
000
0min
5min
10min
15min
20min
25min
30min
35min
40min
45min

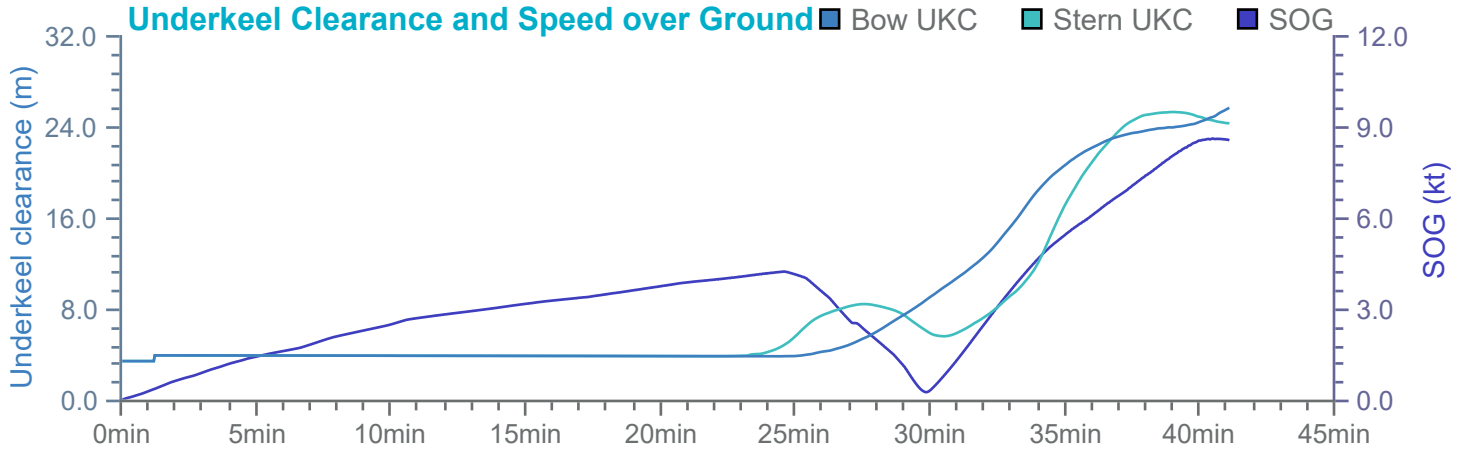

Wind speed and direction
Speed
Direction
Wind speed (knots)
Wind direction (°N)
40
30
20
10
0
360
270
180
090
000
0min
5min
10min
15min
20min
25min
30min
35min
40min
45min

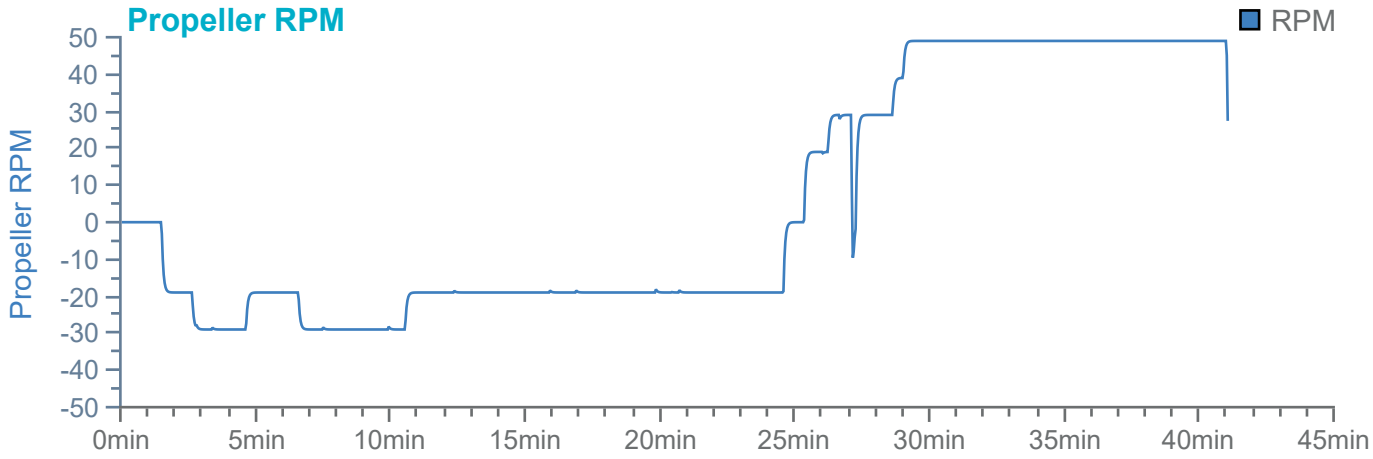

Sig. wave height and direction
Hs1
Hs (m)
3.00
2.25
1.50
0.75
0.00
0min
5min
10min
15min
20min
25min
30min
35min
40min
45min

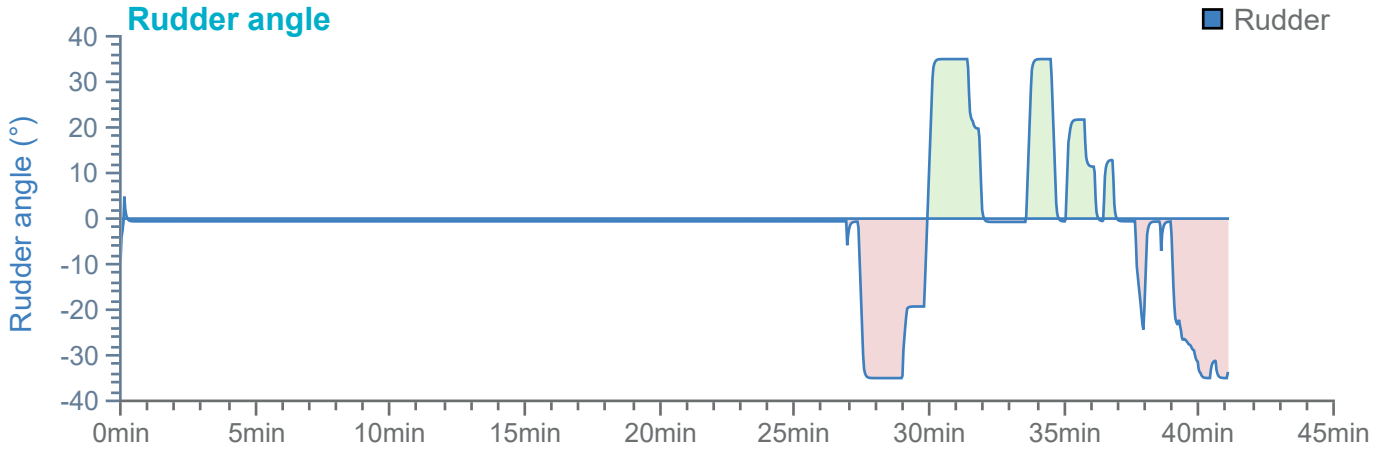

Rate of turn and heading
RoT
Heading
Rate of turn (°/min)
Heading (°N)
16
8
0
-8
-16
-24
360
270
180
090
000
0min
5min
10min
15min
20min
25min
30min
35min
40min
45min

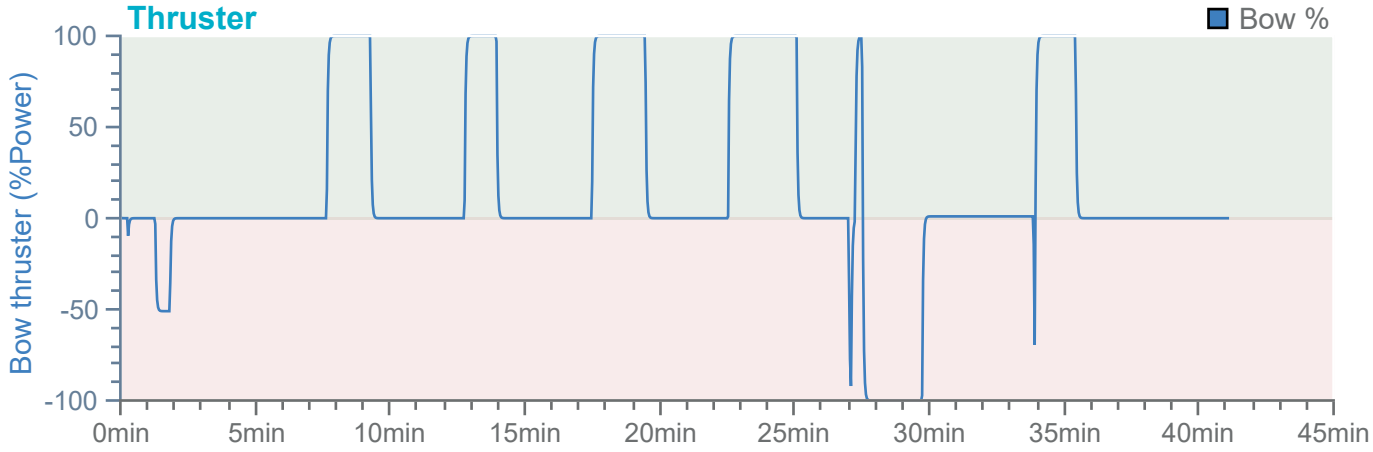

Course over ground and drift
COG
Drift Angle
COG (°)
Drift Angle (°)
360
270
180
090
000
120
60
0
-60
-120
0min
5min
10min
15min
20min
25min
30min
35min
40min
45min


Ship speed
Ground long.
Water long.
Ground lat.
Water lat.
Longitudinal speed (knots)
Lateral speed (knots)
9.9
6.6
3.3
0.0
-3.3
-6.6
0.5
0.0
-0.5
-1.0
-1.5
0min
5min
10min
15min
20min
25min
30min
35min
40min
45min

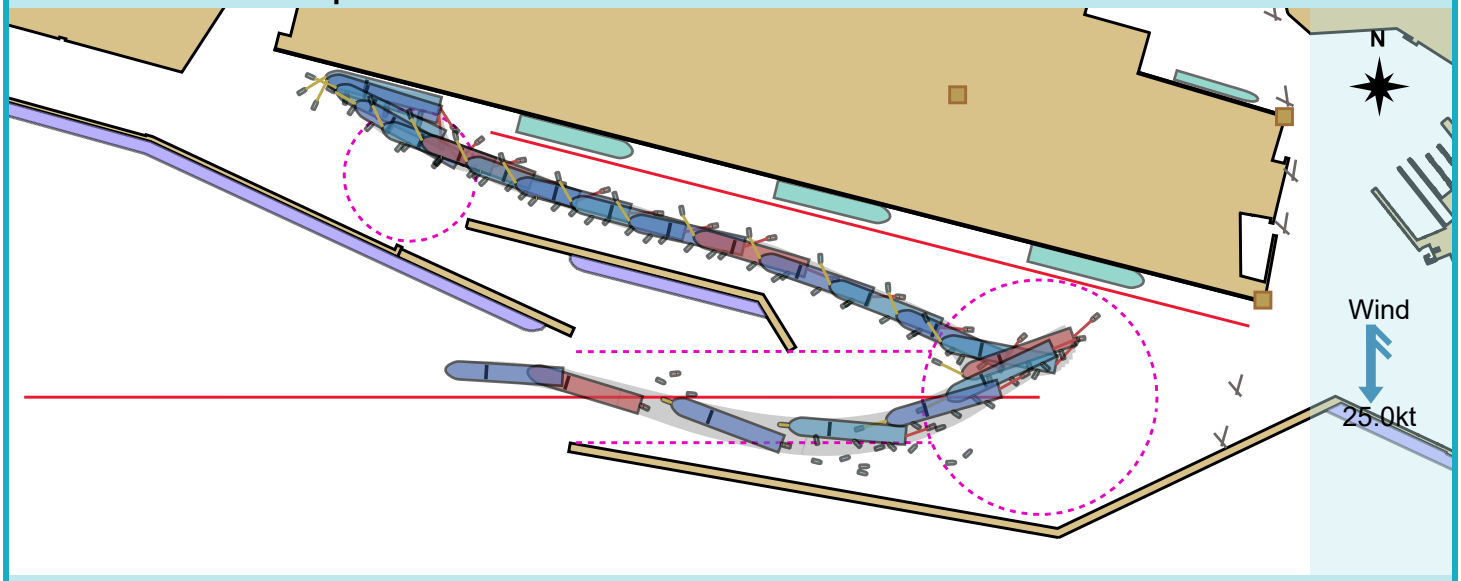

Underkeel Clearance and Speed over Ground
Bow UKC
Stern UKC
SOG
Underkeel clearance (m)
SOG (kt)
32.0
24.0
16.0
8.0
0.0
12.0
9.0
6.0
3.0
0.0
0min
5min
10min
15min
20min
25min
30min
35min
40min
45min


Propeller RPM
RPM
Propeller RPM
50
40
30
20
10
0
-10
-20
-30
-40
-50
0min
5min
10min
15min
20min
25min
30min
35min
40min
45min


Rudder angle
Rudder
Rudder angle (°)
40
30
20
10
0
-10
-20
-30
-40
0min
5min
10min
15min
20min
25min
30min
35min
40min
45min

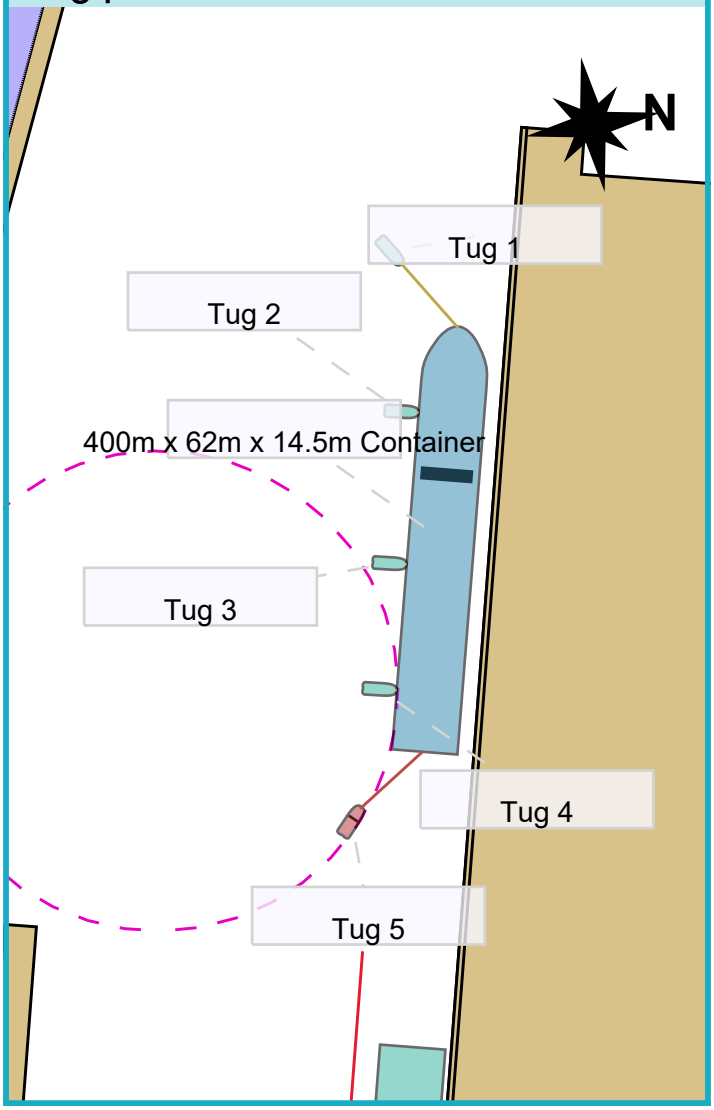

Thruster
Bow %
Bow thruster (%Power)
100
50
0
-50
-100
0min
5min
10min
15min
20min
25min
30min
35min
40min
45min

Manoeuvre track plot

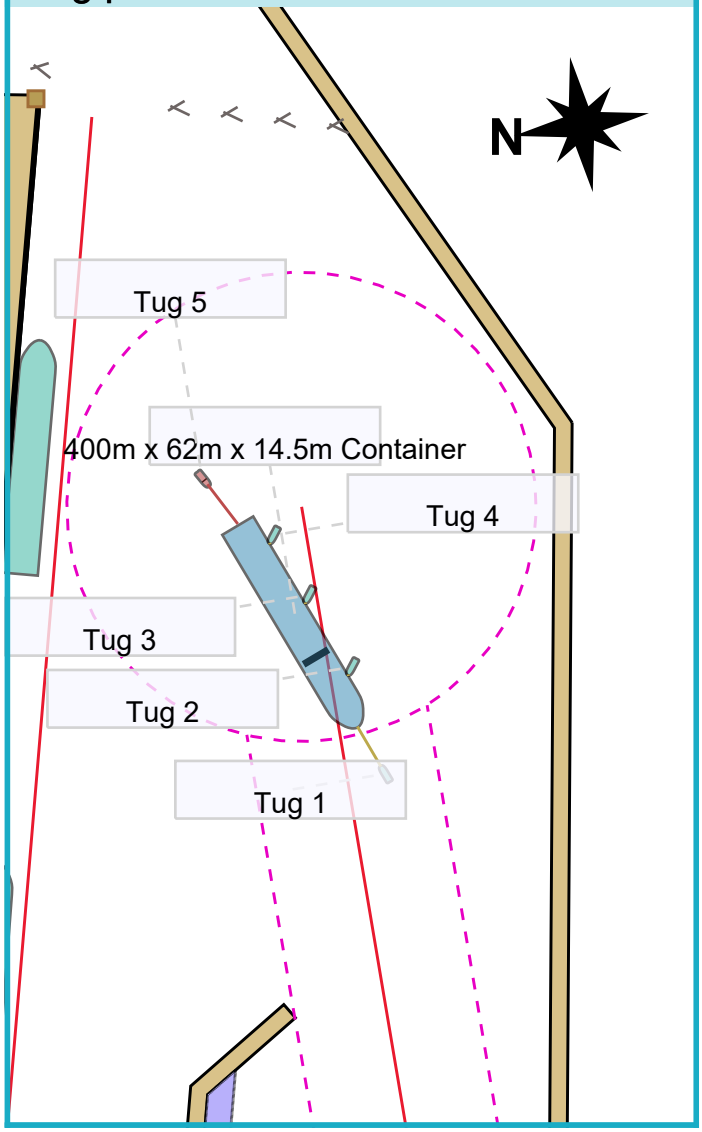


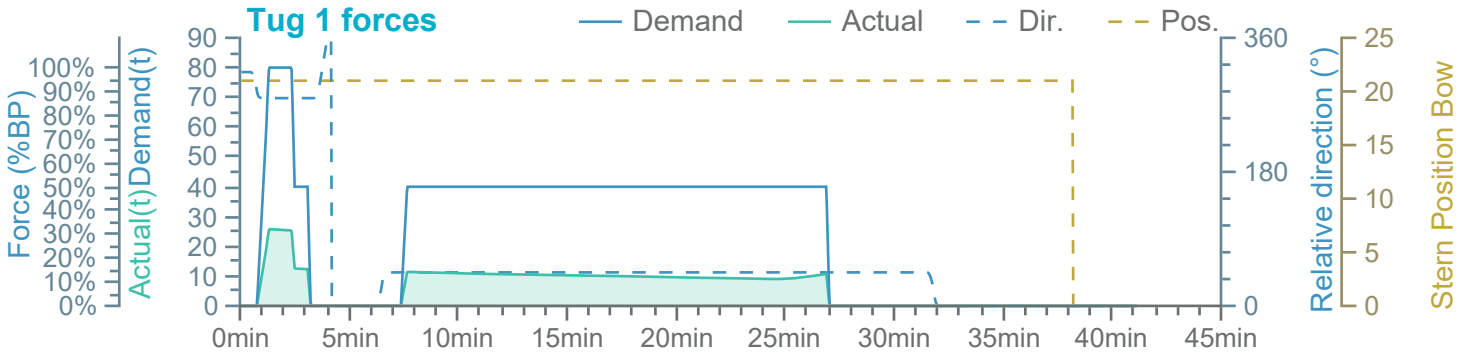
Ships plotted every 2 mins, highlight every 10 mins

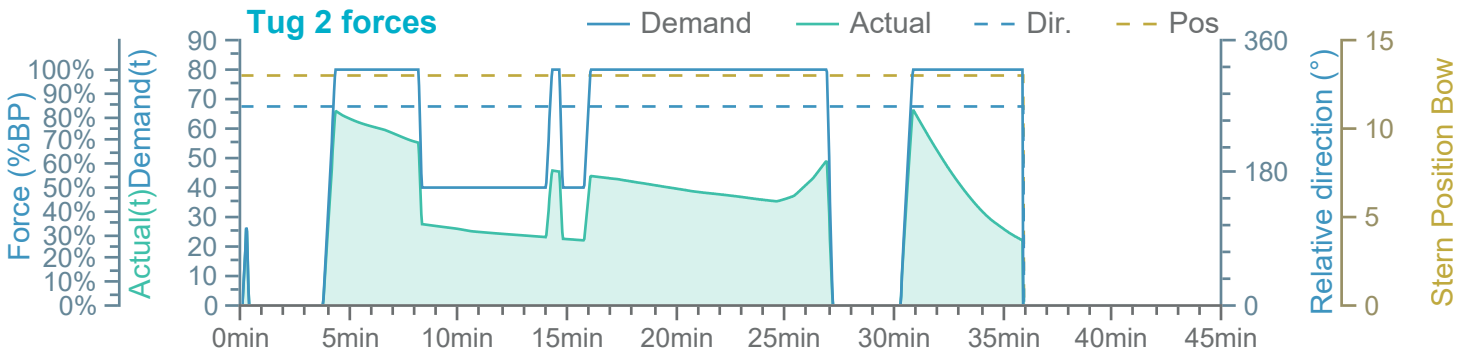
Tug position: Initial

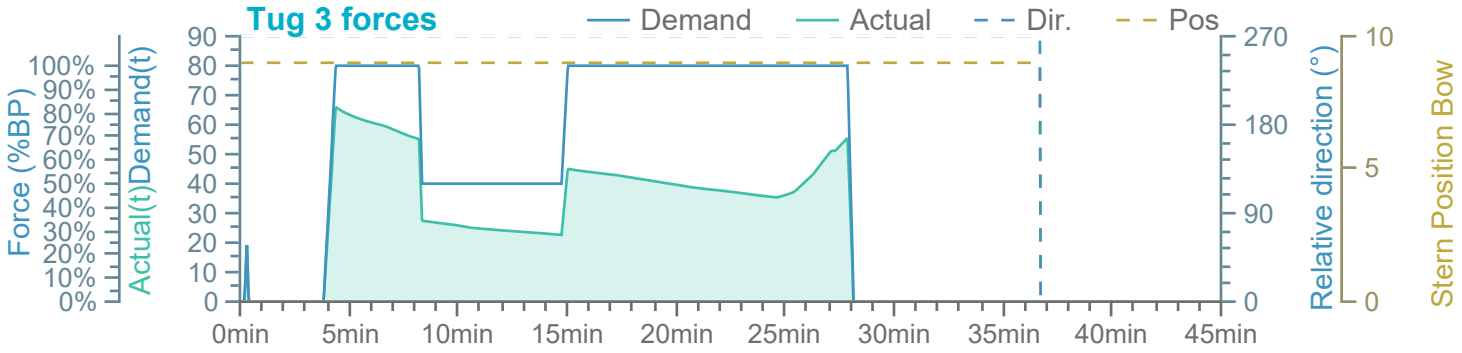


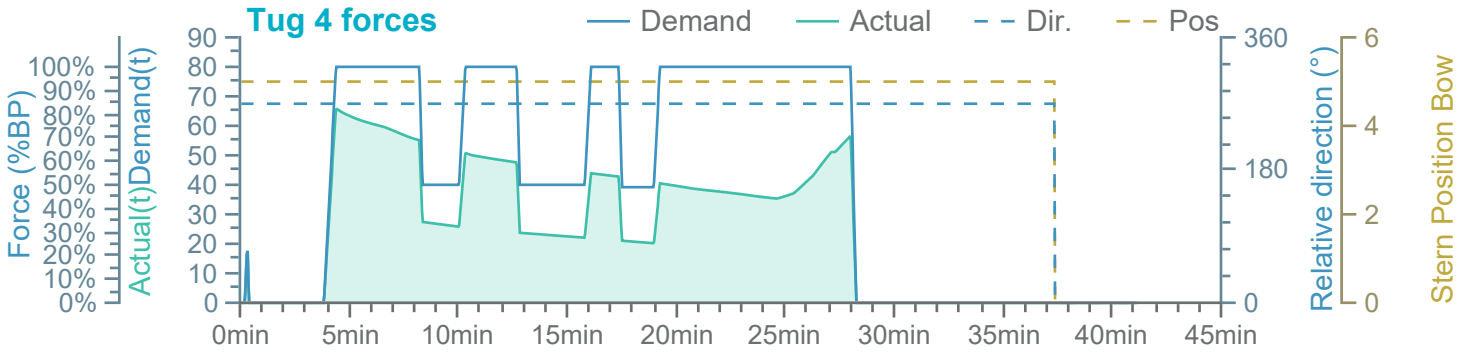
Tug position: Final

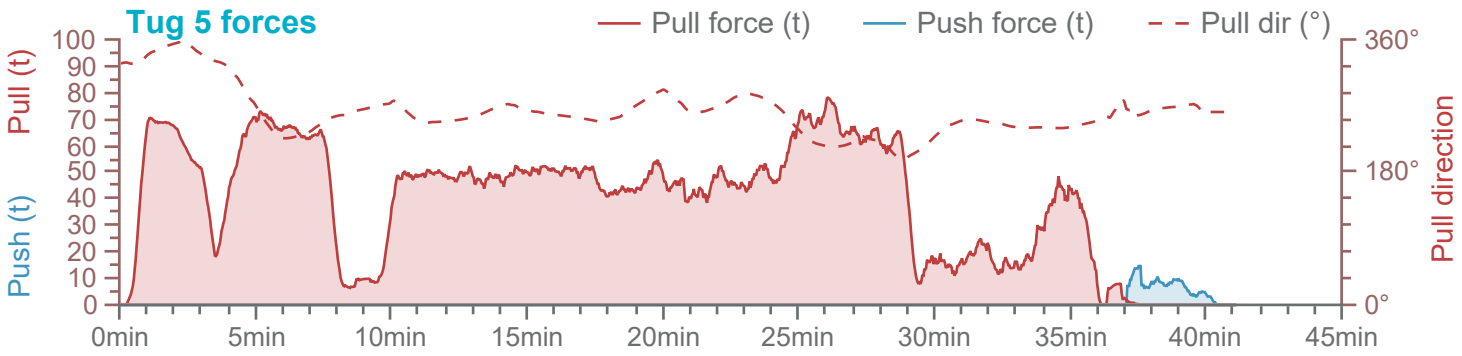



Tug 1 forces
Demand
Actual
Dir.
Pos.
Force (%BP)
Actual(t)Demand(t)
Relative direction (°)
Stern Position Bow
0min
5min
10min
15min
20min
25min
30min
35min
40min
45min

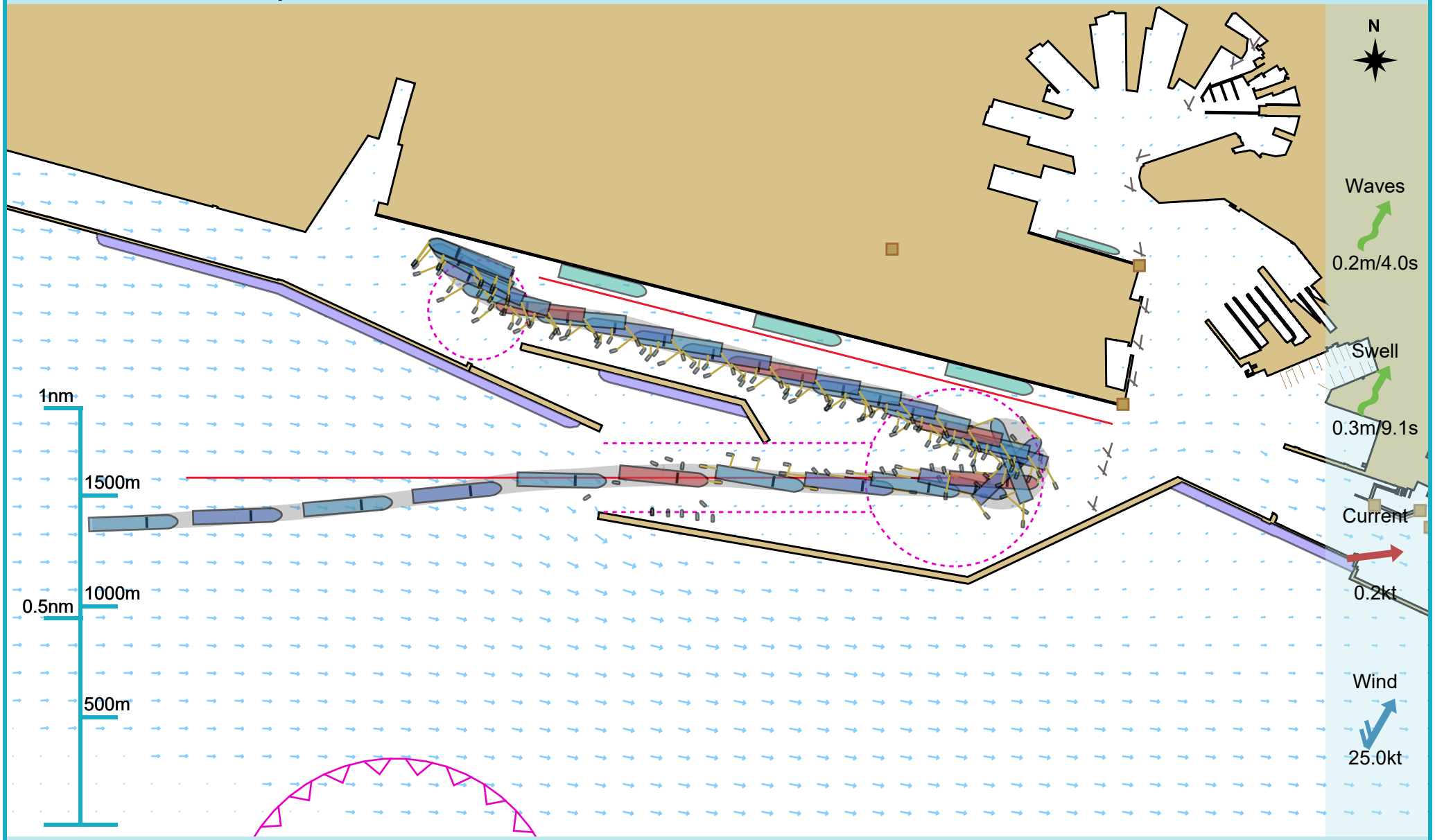

Tug 2 forces
Demand
Actual
Dir.
Pos
Force (%BP)
Actual(t)Demand(t)
Relative direction (°)
Stern Position Bow
0min
5min
10min
15min
20min
25min
30min
35min
40min
45min


Tug 3 forces
Demand
Actual
Dir.
Pos
Force (%BP)
Actual(t)Demand(t)
Relative direction (°)
Stern Position Bow
0min
5min
10min
15min
20min
25min
30min
35min
40min
45min

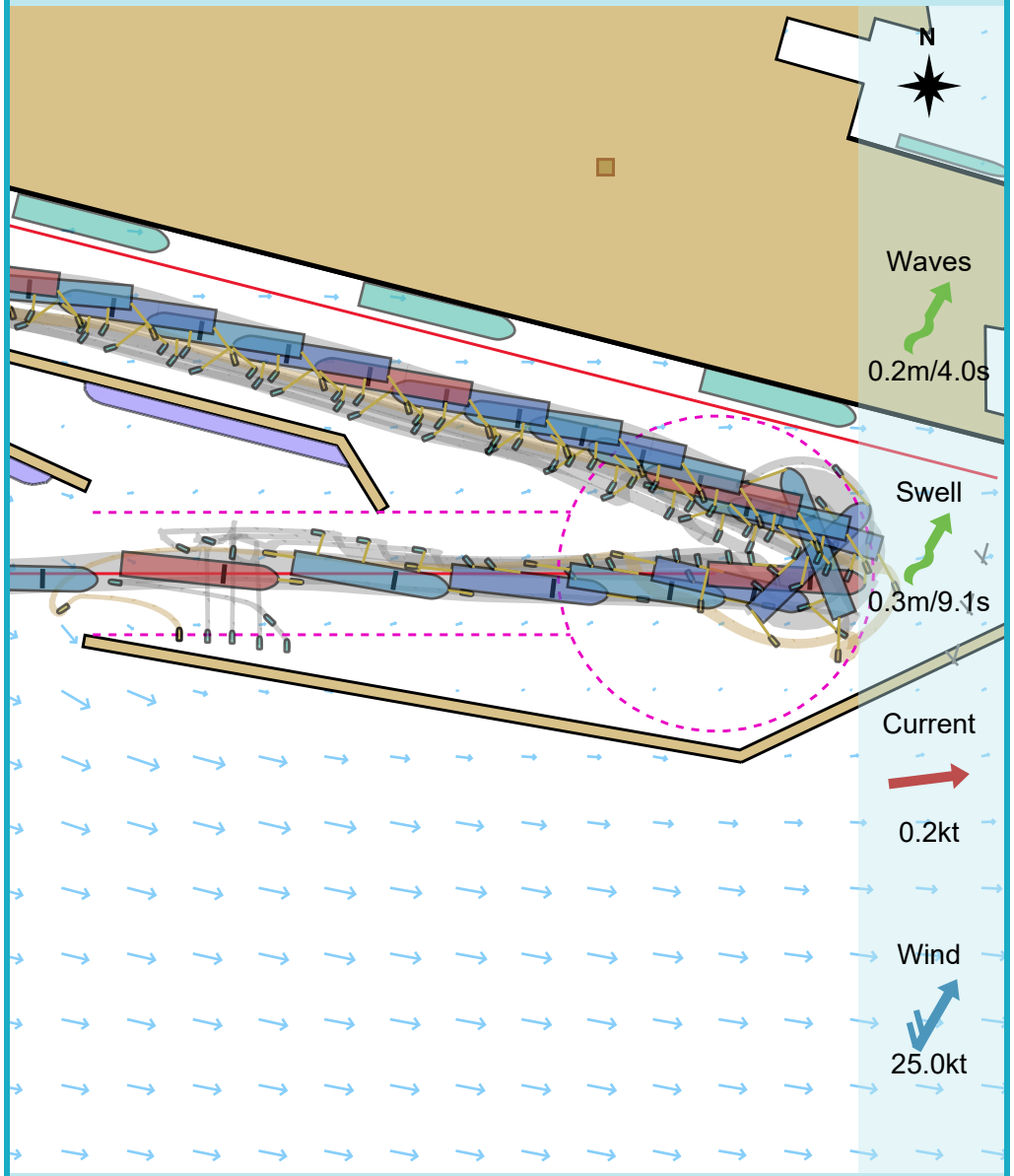

Tug 4 forces
Demand
Actual
Dir.
Pos
Force (%BP)
Actual(t)Demand(t)
Relative direction (°)
Stern Position Bow
0min
5min
10min
15min
20min
25min
30min
35min
40min
45min


Tug 5 forces
Pull force (t)
Push force (t)
Pull dir (°)
Pull (t)
Push (t)
Pull direction
0min
5min
10min
15min
20min
25min
30min
35min
40min
45min

Manoeuvre track plot

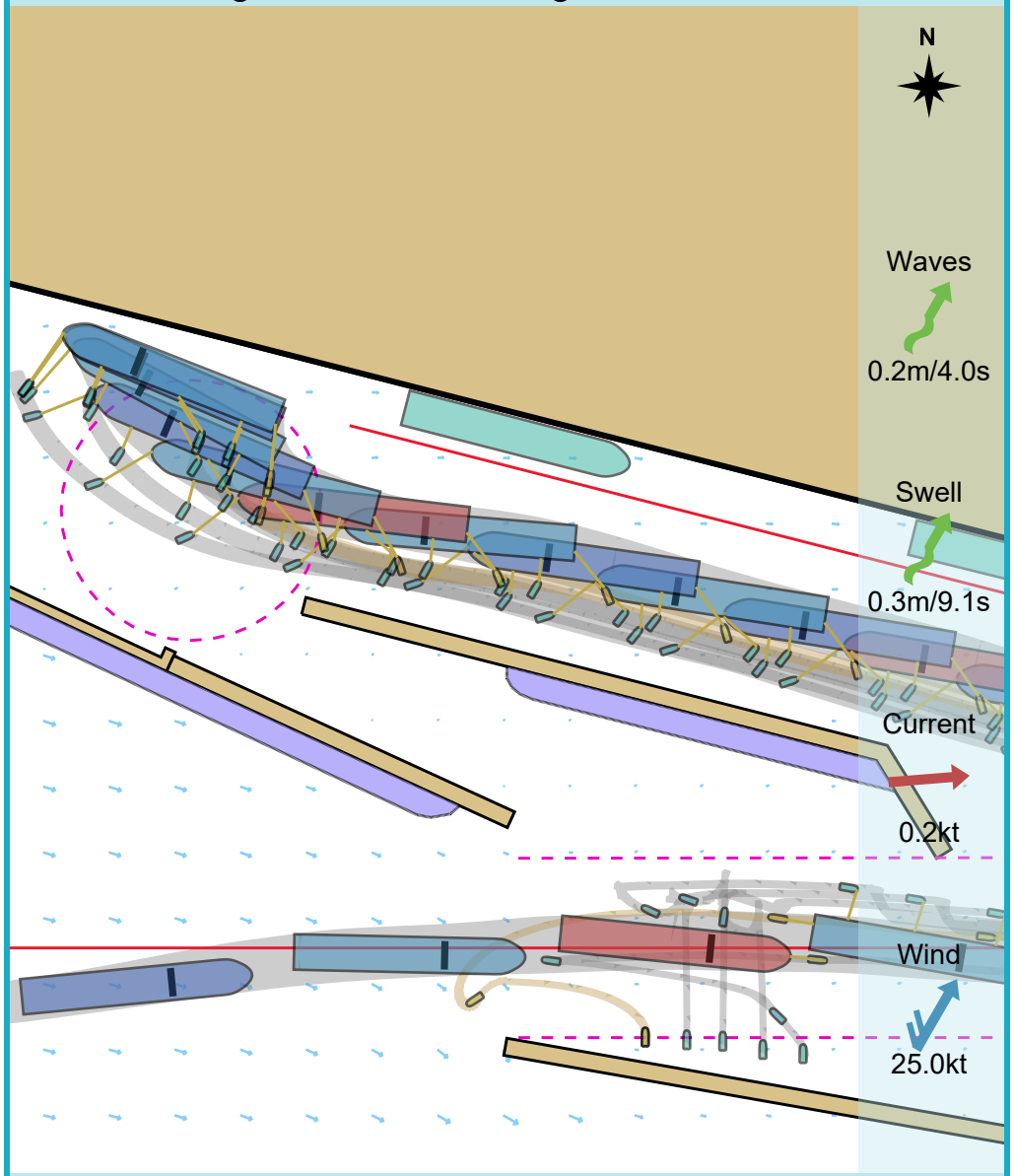


Arrival Channel

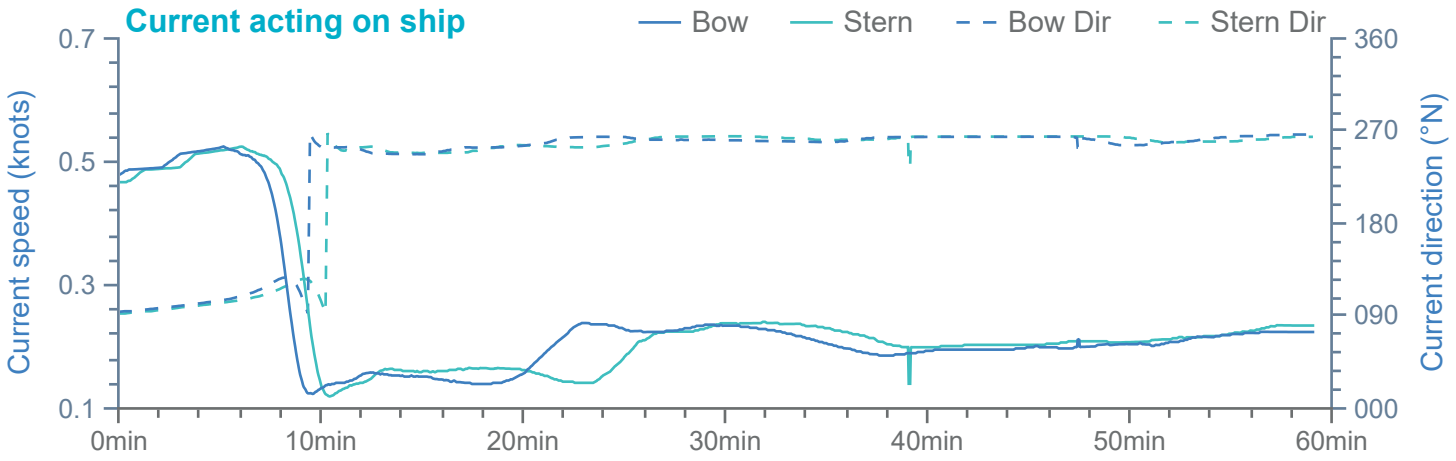


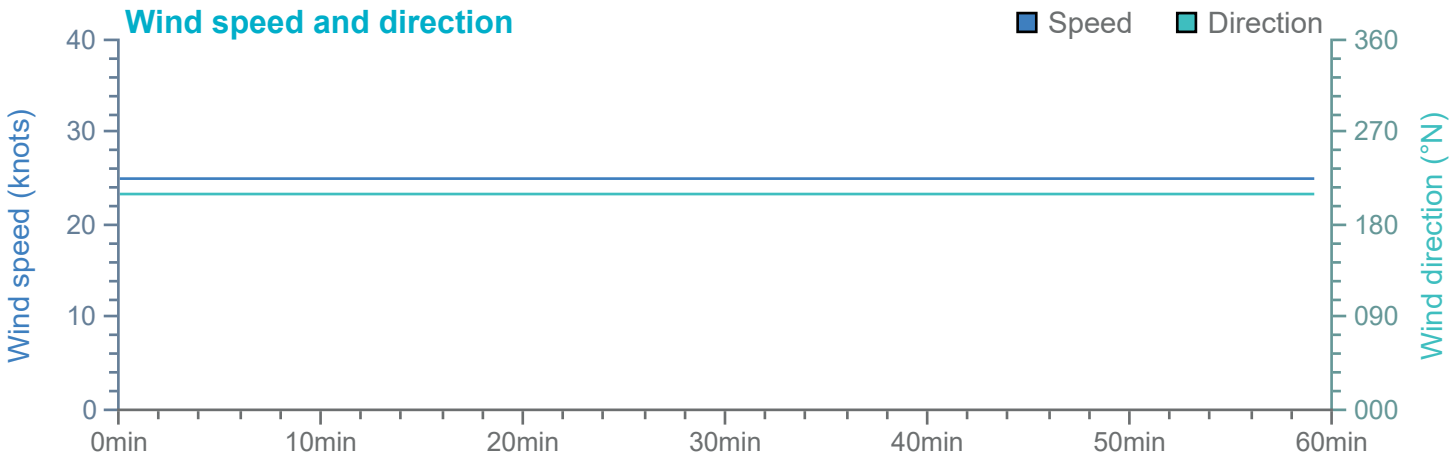
Ships plotted every 2 mins, highlight every 10 mins

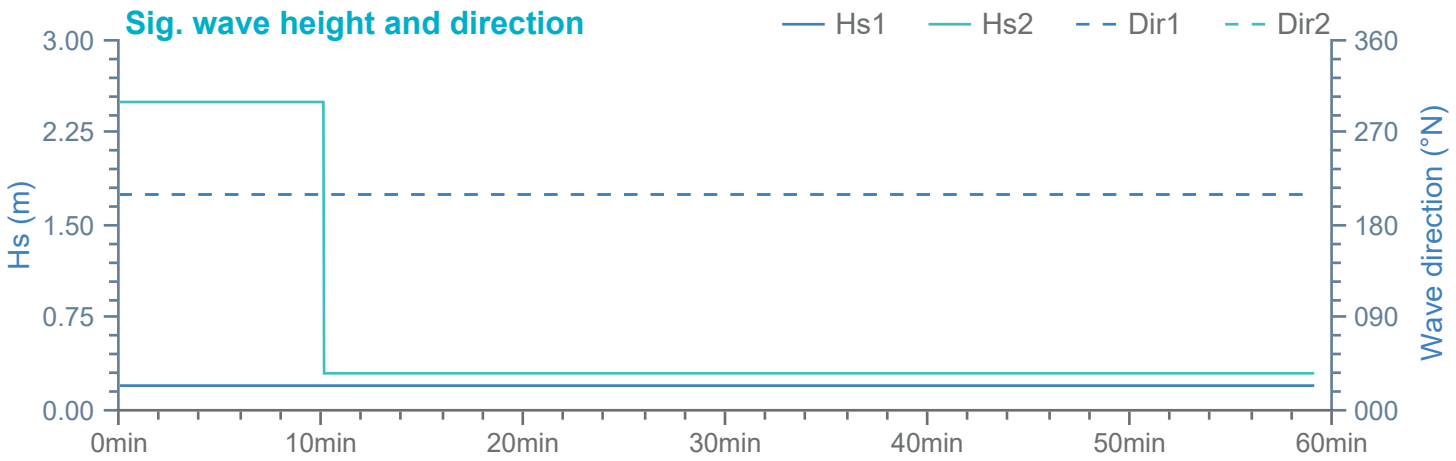
Manoeuvring area and berthing

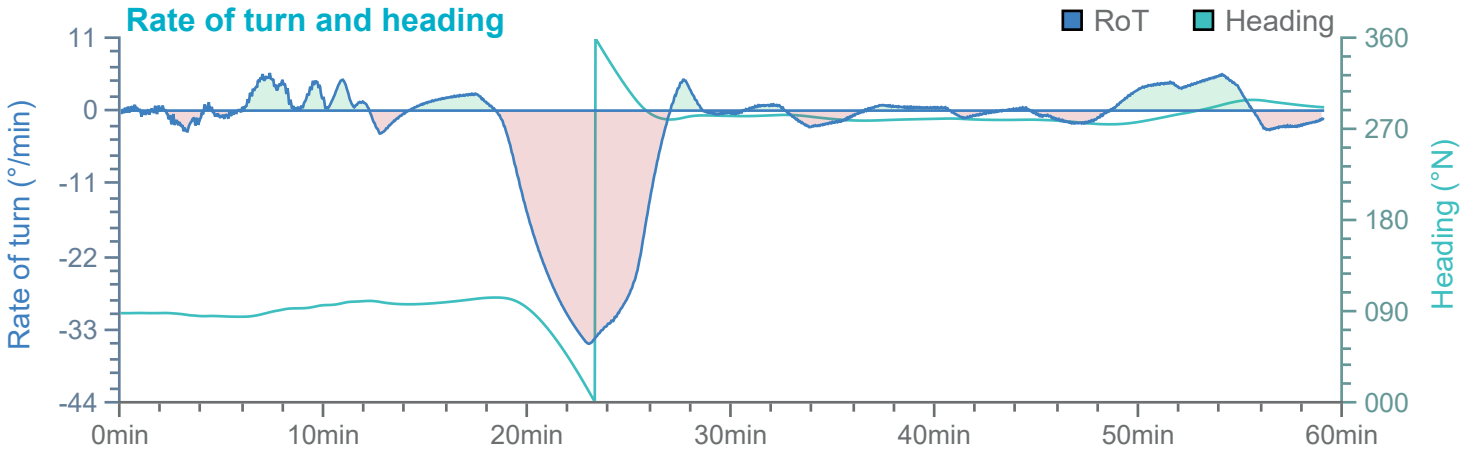


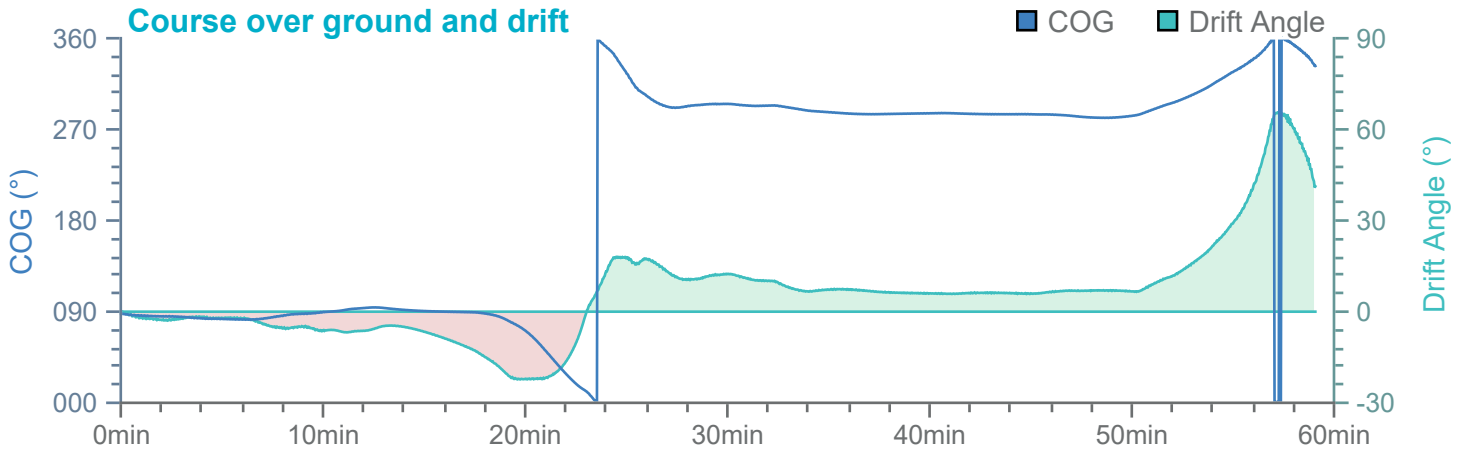
Ships plotted every 2 mins, highlight every 10 mins

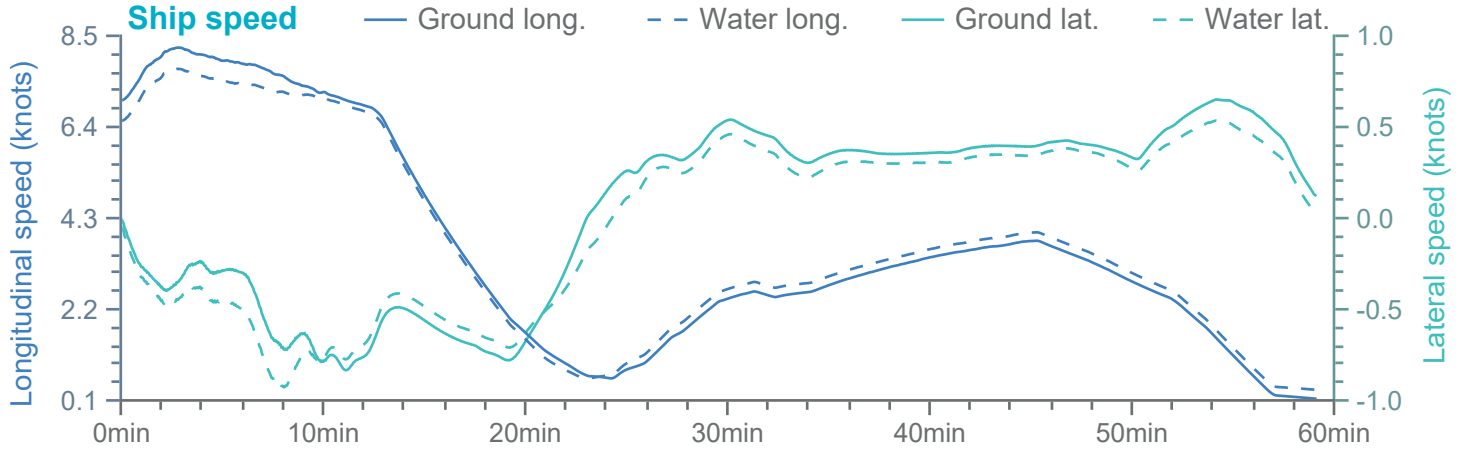

Current acting on ship
Bow
Stern
Bow Dir
Stern Dir
Current speed (knots)
0.7
0.5
0.3
0.1
Current direction (°N)
360
270
180
090
000
0min
10min
20min
30min
40min
50min
60min

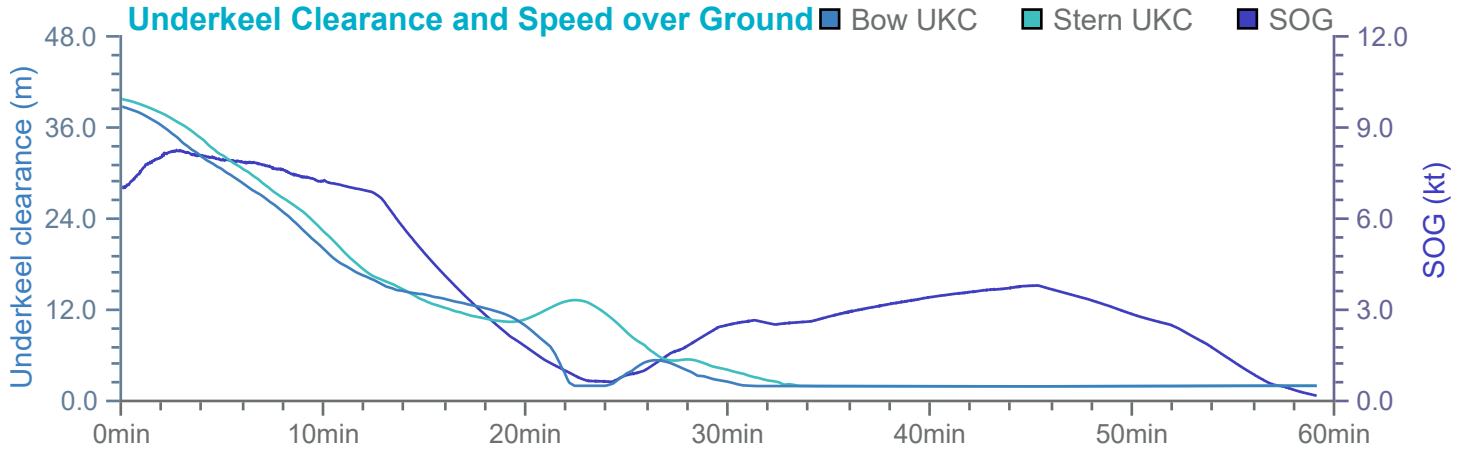

Wind speed and direction
Speed
Direction
Wind speed (knots)
40
30
20
10
0
Wind direction (°N)
360
270
180
090
000
0min
10min
20min
30min
40min
50min
60min

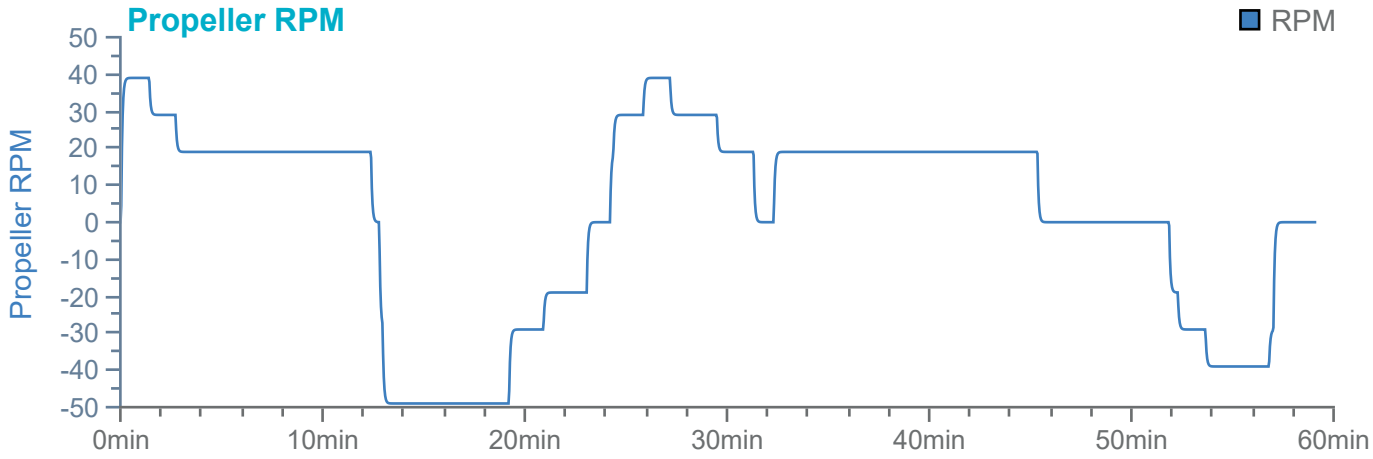

Sig. wave height and direction
Hs1
Hs2
Dir1
Dir2
Hs (m)
3.00
2.25
1.50
0.75
0.00
Wave direction (°N)
360
270
180
090
000
0min
10min
20min
30min
40min
50min
60min

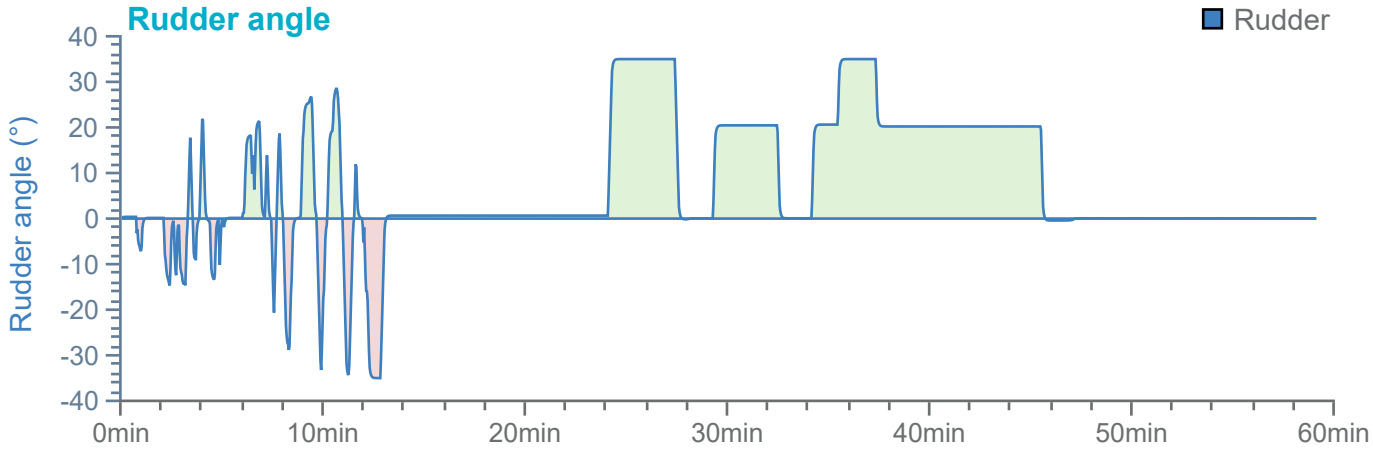

Rate of turn and heading
RoT
Heading
Rate of turn (°/min)
Heading (°N)
11
0
-11
-22
-33
-44
360
270
180
090
000
0min
10min
20min
30min
40min
50min
60min

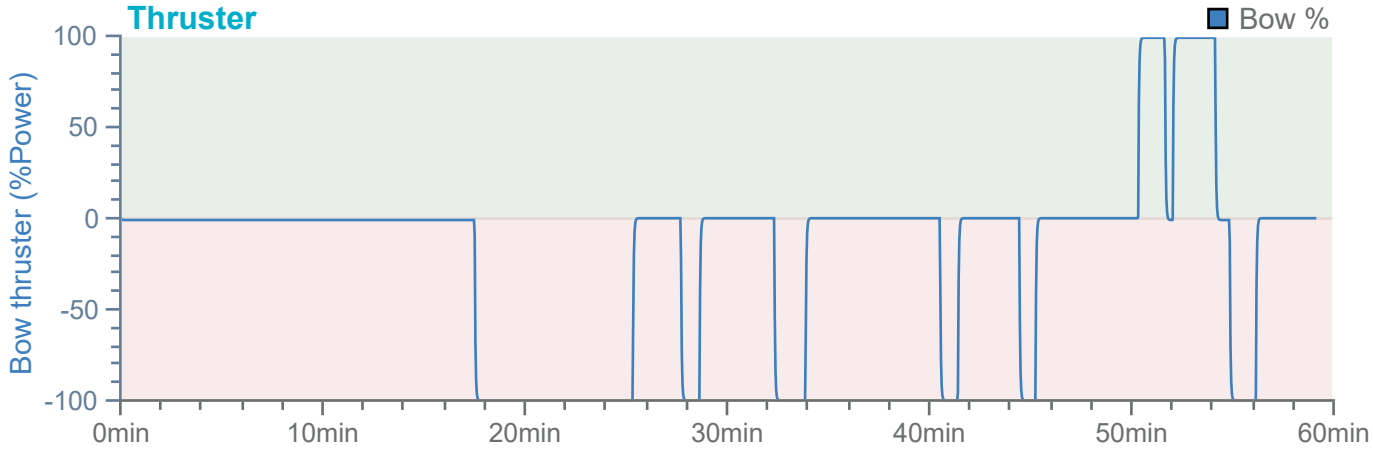

Course over ground and drift
COG
Drift Angle
COG (°)
Drift Angle (°)
360
270
180
090
000
90
60
30
0
-30
0min
10min
20min
30min
40min
50min
60min


Ship speed
Ground long.
Water long.
Ground lat.
Water lat.
Longitudinal speed (knots)
Lateral speed (knots)
8.5
6.4
4.3
2.2
0.1
1.0
0.5
0.0
-0.5
-1.0
0min
10min
20min
30min
40min
50min
60min

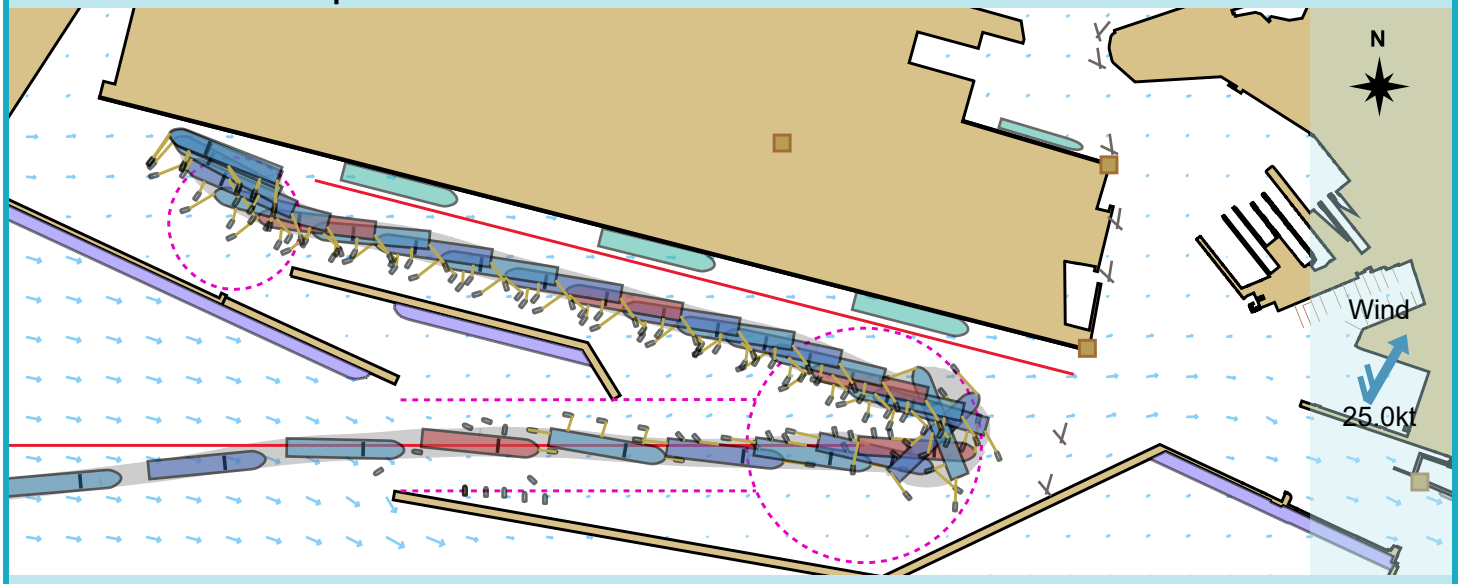

Underkeel Clearance and Speed over Ground
Bow UKC
Stern UKC
SOG
Underkeel clearance (m)
SOG (kt)
48.0
36.0
24.0
12.0
0.0
12.0
9.0
6.0
3.0
0.0
0min
10min
20min
30min
40min
50min
60min


Propeller RPM
RPM
Propeller RPM
50
40
30
20
10
0
-10
-20
-30
-40
-50
0min
10min
20min
30min
40min
50min
60min


Rudder angle
Rudder
Rudder angle (°)
40
30
20
10
0
-10
-20
-30
-40
0min
10min
20min
30min
40min
50min
60min

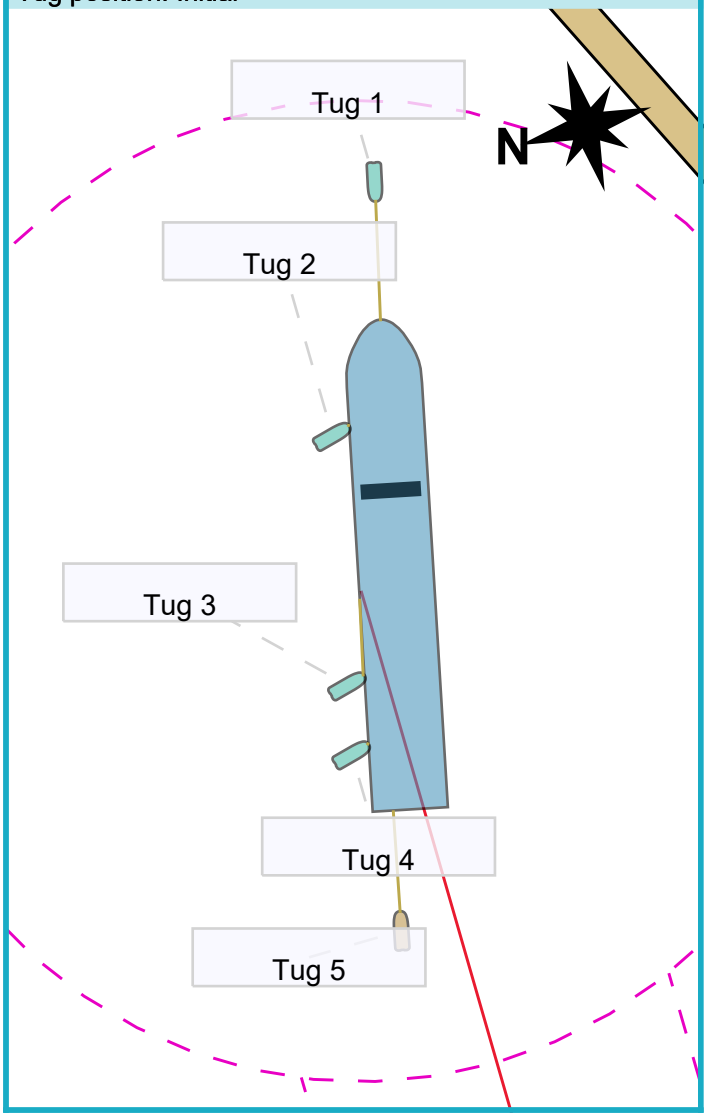

Thruster
Bow %
Bow thruster (%Power)
100
50
0
-50
-100
0min
10min
20min
30min
40min
50min
60min

Manoeuvre track plot

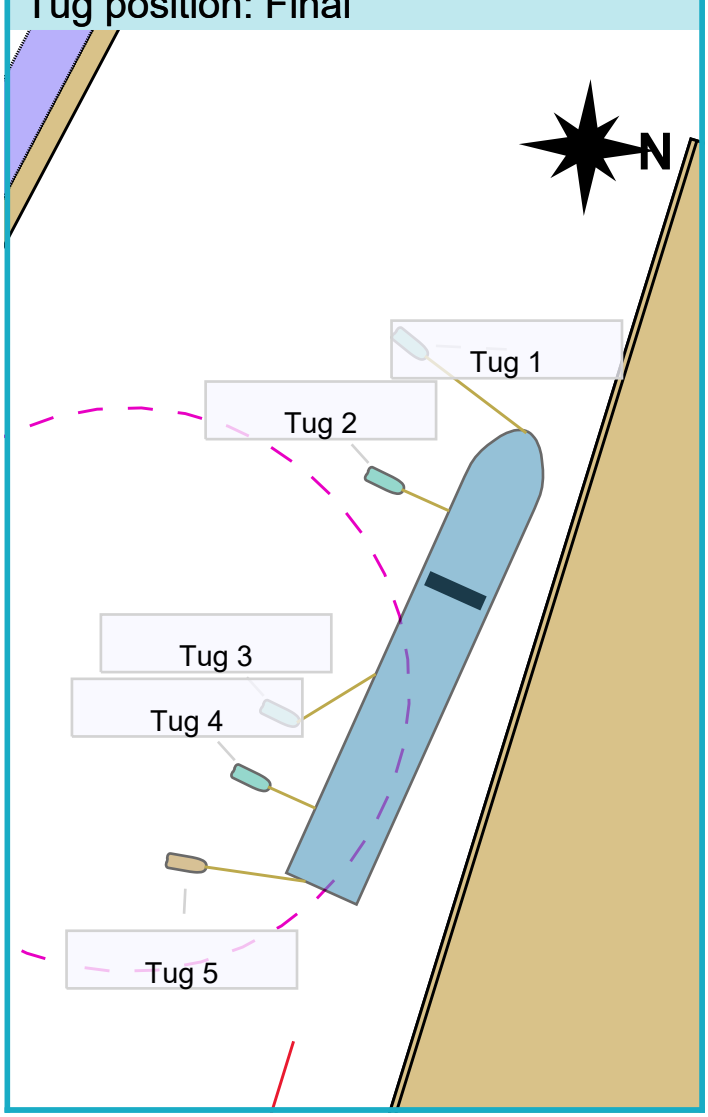


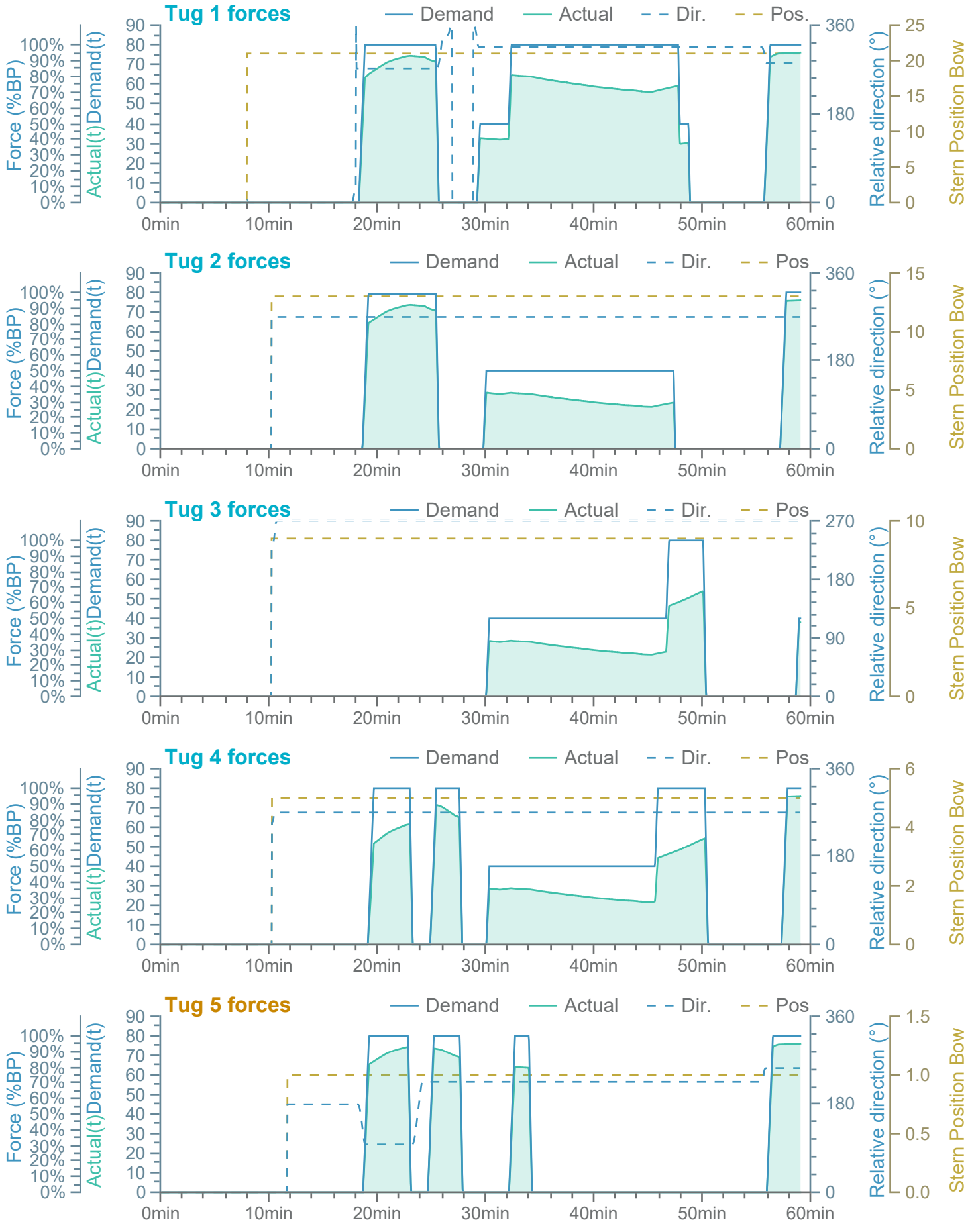
Ships plotted every 2 mins, highlight every 10 mins

Tug position: Initial

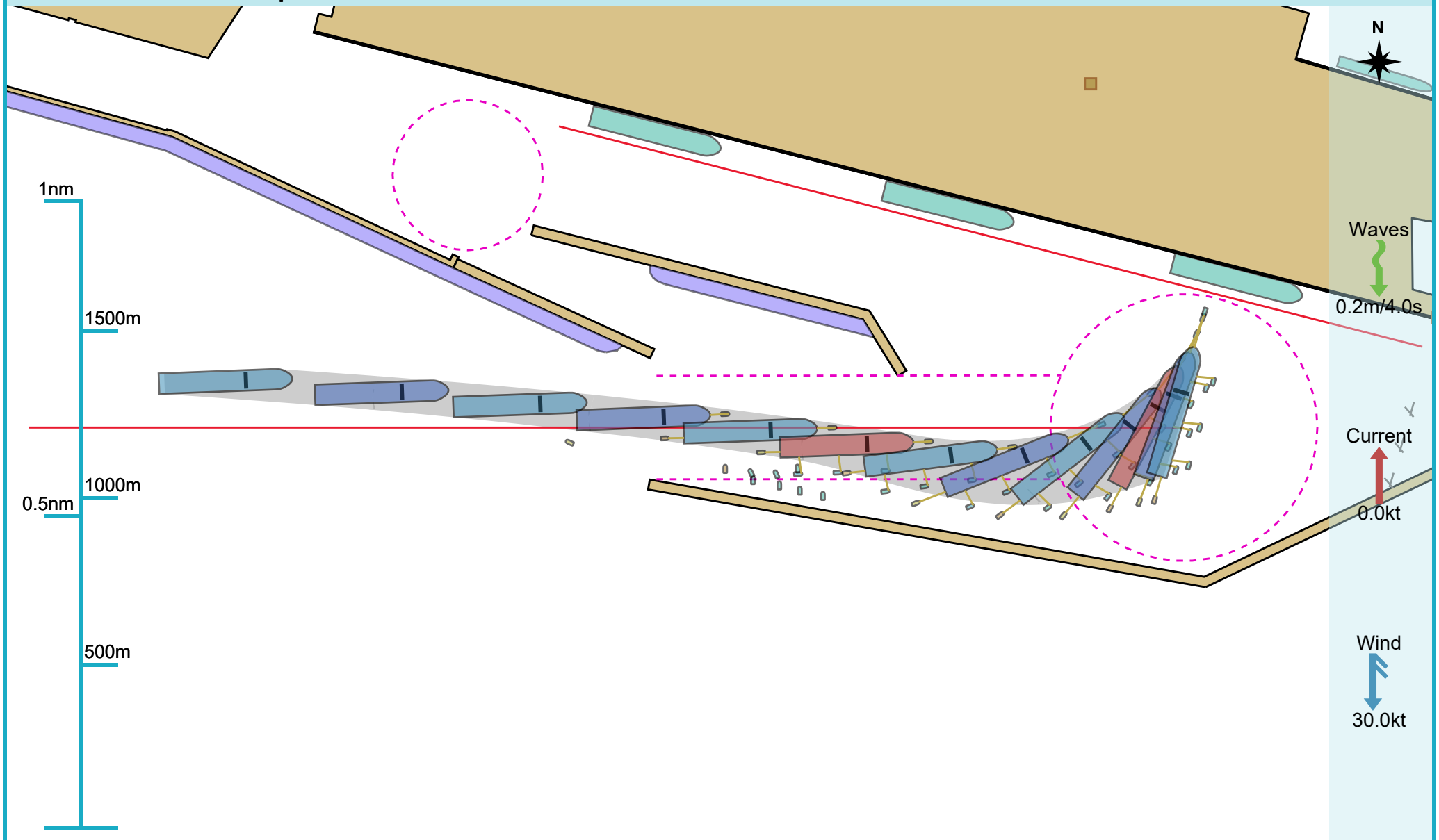


Tug position: Final




Tug 1 forces
Demand
Actual
Dir.
Pos.
Force (%BP)
Actual(t)Demand(t)
Relative direction (°)
Stern Position Bow
0min
10min
20min
30min
40min
50min
60min
Tug 2 forces
Demand
Actual
Dir.
Pos
Tug 3 forces
Demand
Actual
Dir.
Pos
Tug 4 forces
Demand
Actual
Dir.
Pos
Tug 5 forces
Demand
Actual
Dir.
Pos

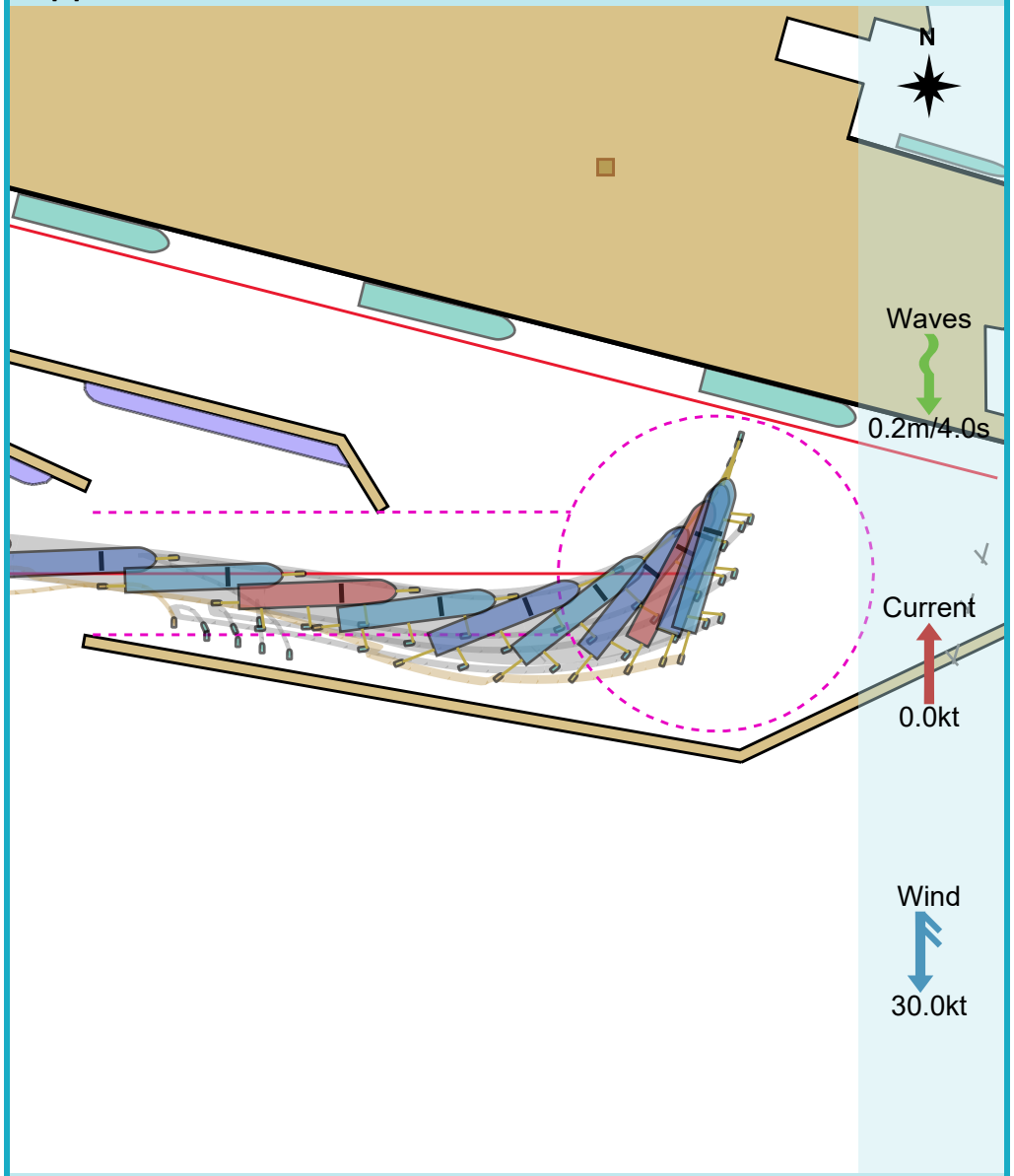
Manoeuvre track plot



0.00 kts

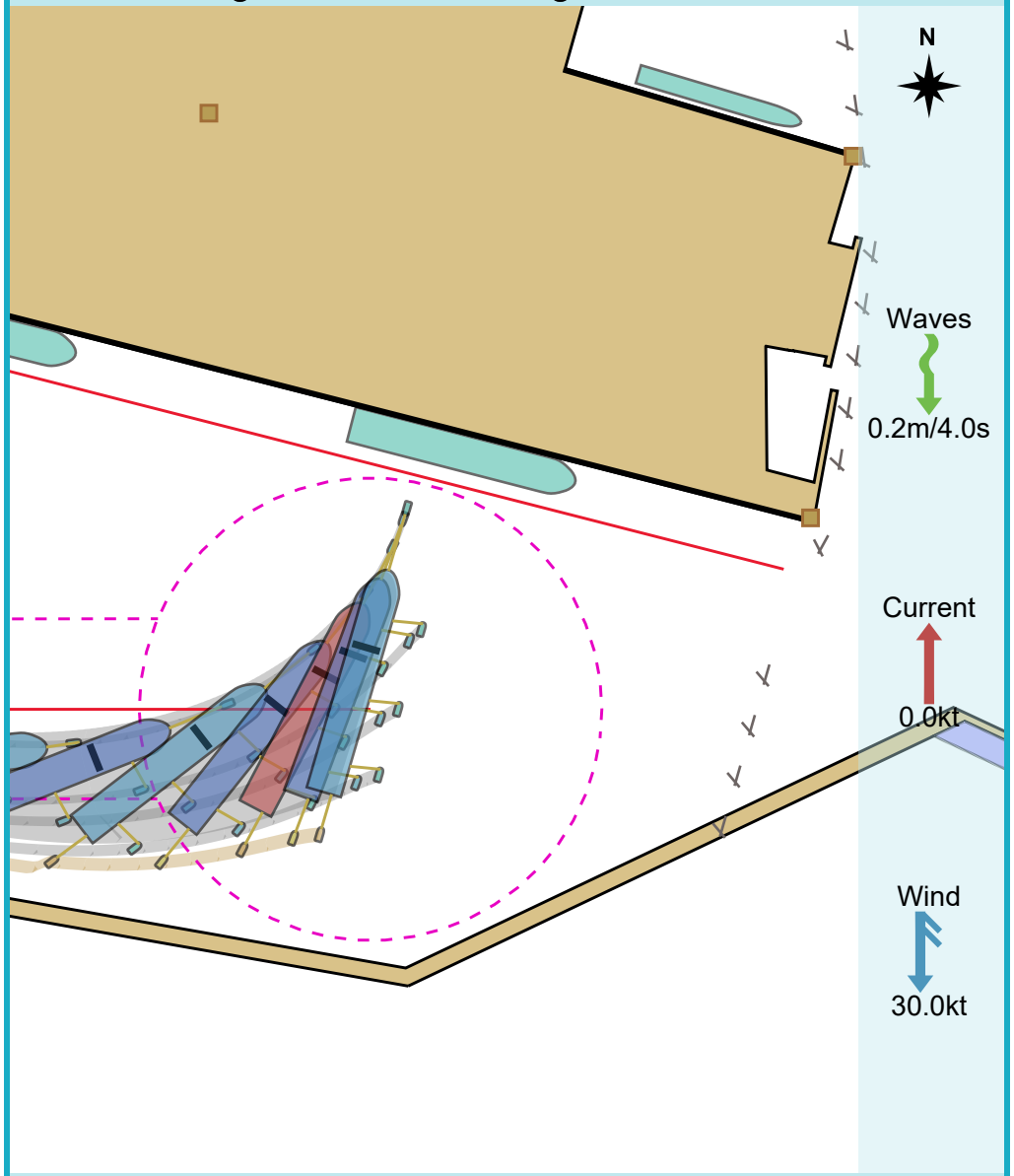
Ships plotted every 2 mins, highlight every 10 mins

Approach Channel

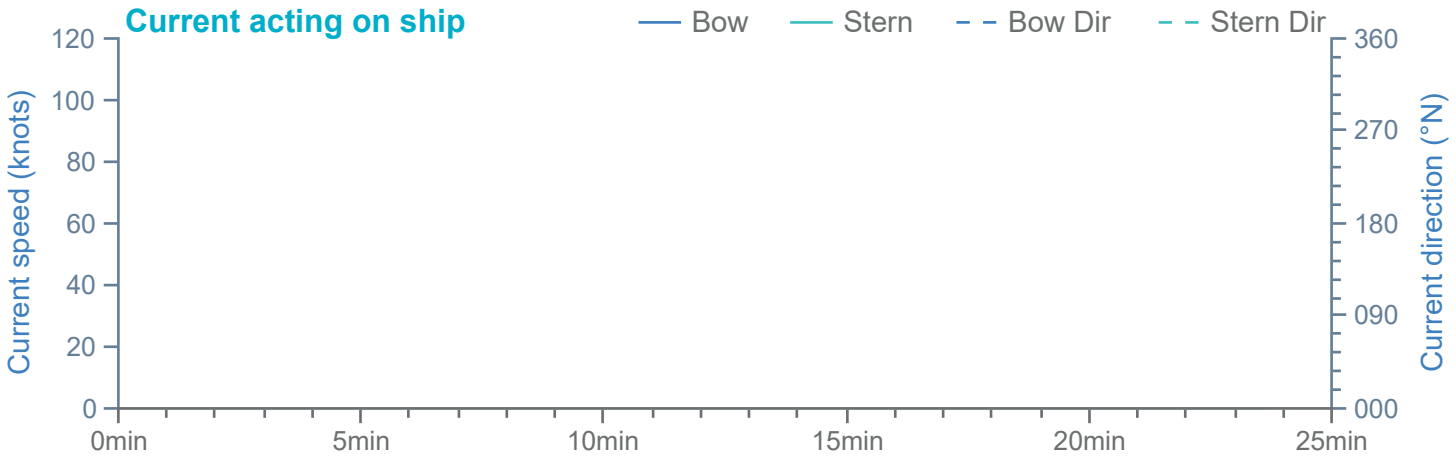


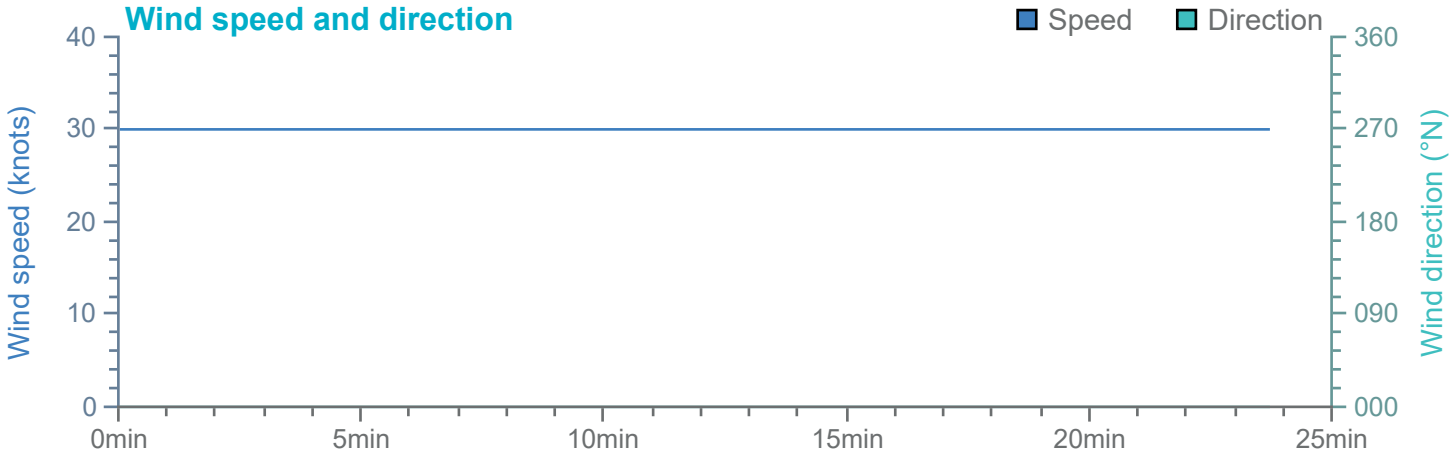
Ships plotted every 2 mins, highlight every 10 mins

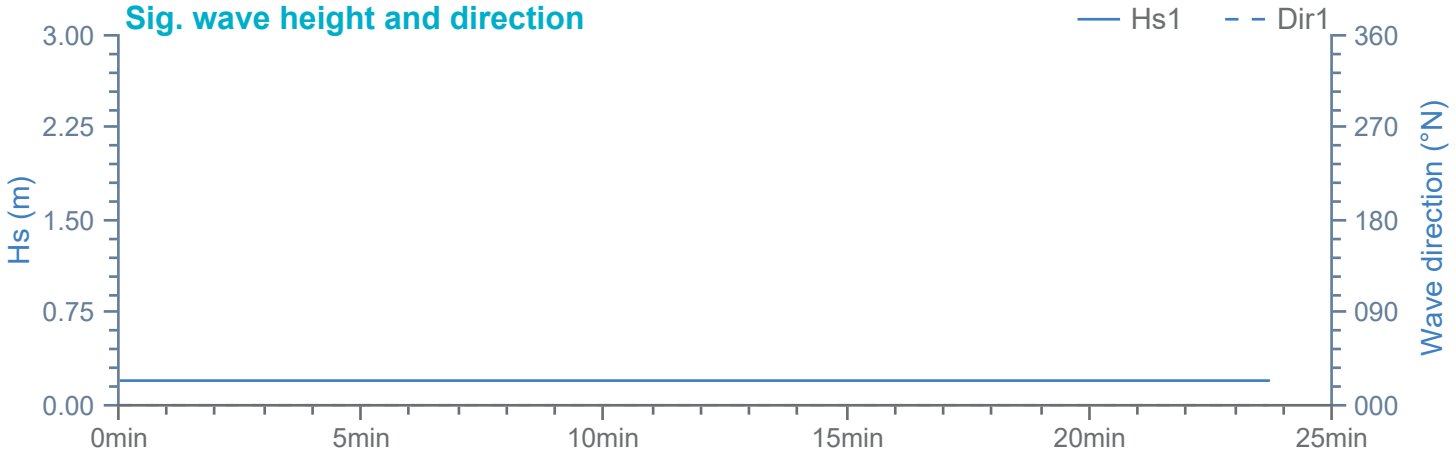
Manoeuvring area and berthing

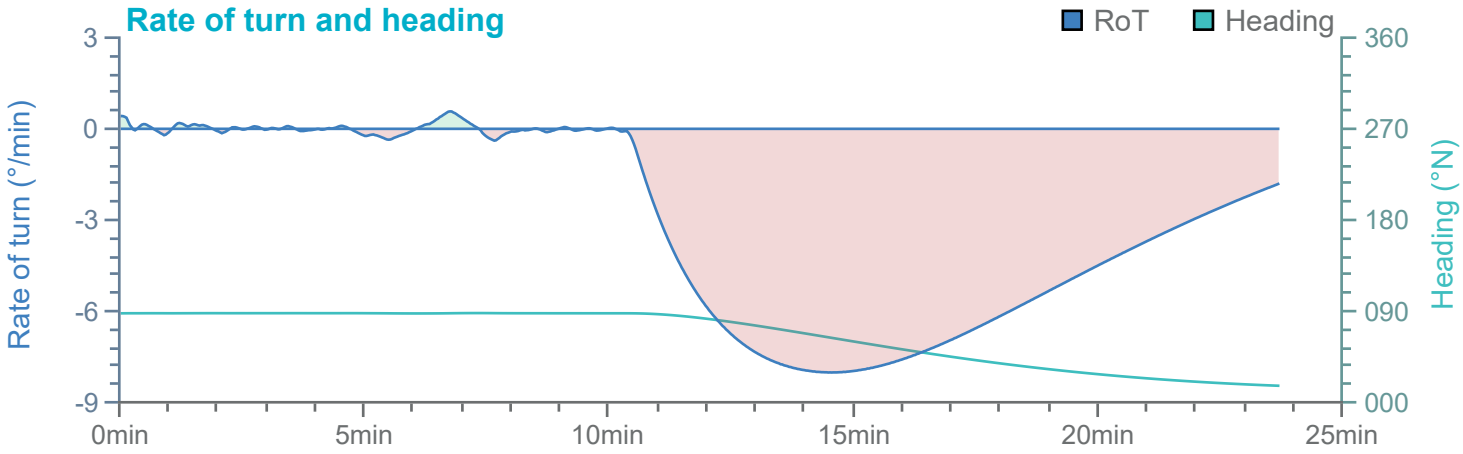


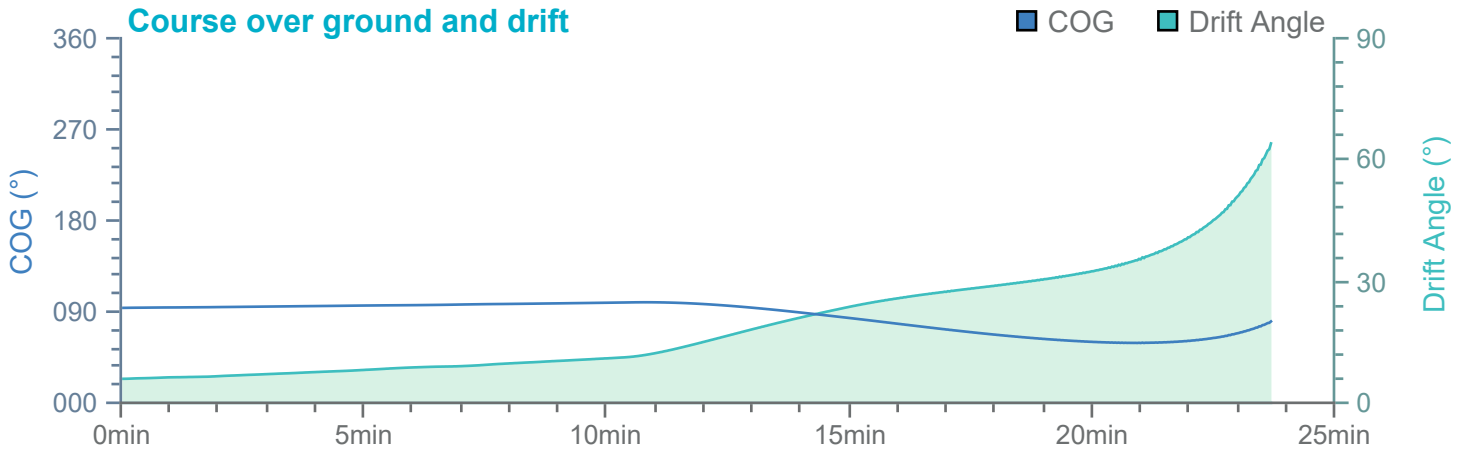
Ships plotted every 2 mins, highlight every 10 mins

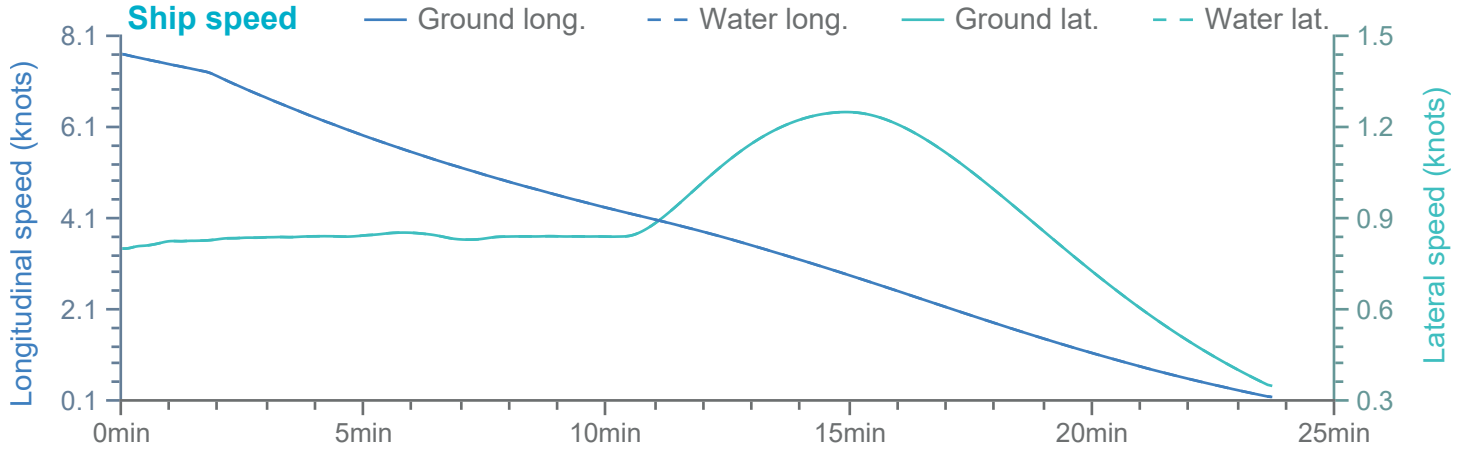

Current acting on ship
Bow
Stern
Bow Dir
Stern Dir
Current speed (knots)
Current direction (°N)
0
20
40
60
80
100
120
000
090
180
270
360
0min
5min
10min
15min
20min
25min

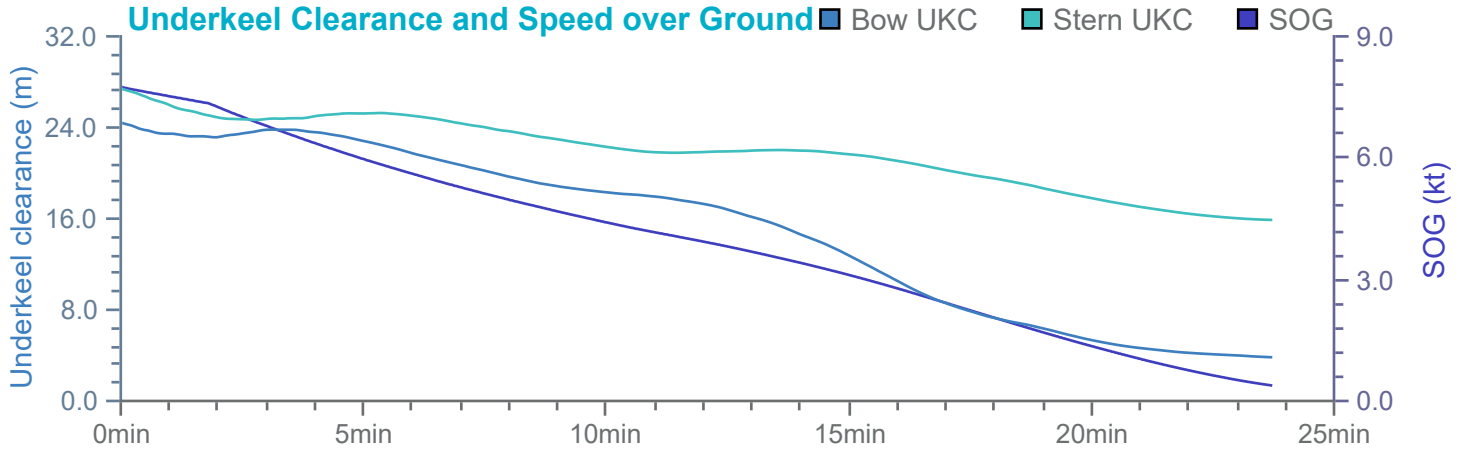

Wind speed and direction
Speed
Direction
Wind speed (knots)
Wind direction (°N)
0
10
20
30
40
000
090
180
270
360
0min
5min
10min
15min
20min
25min

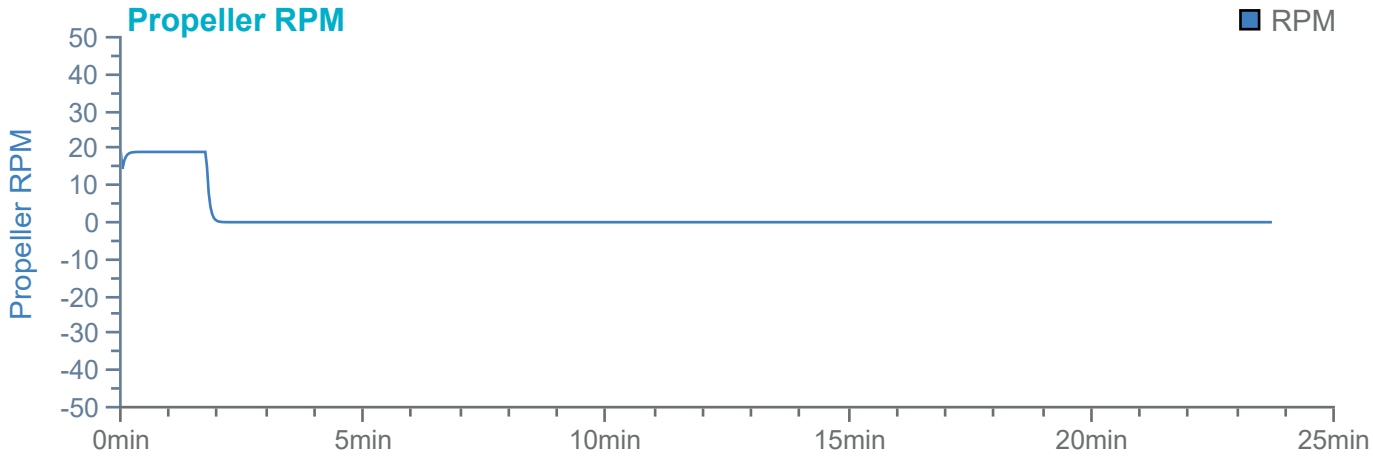

Sig. wave height and direction
Hs1
Dir1
Hs (m)
Wave direction (°N)
0.00
0.75
1.50
2.25
3.00
000
090
180
270
360
0min
5min
10min
15min
20min
25min

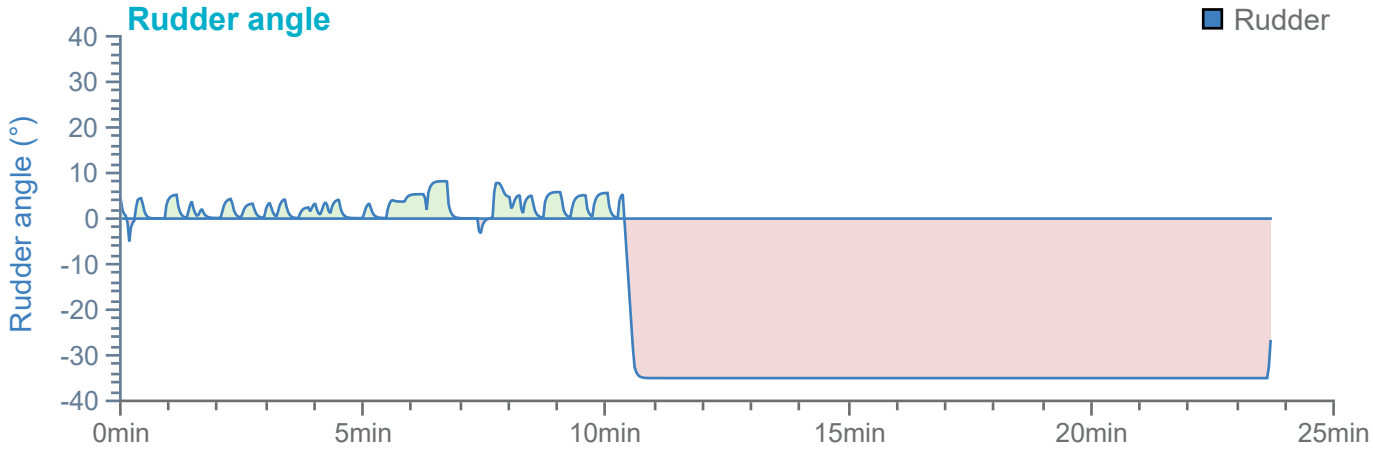

Rate of turn and heading
RoT
Heading
Rate of turn (°/min)
Heading (°N)
3
0
-3
-6
-9
360
270
180
090
000
0min
5min
10min
15min
20min
25min

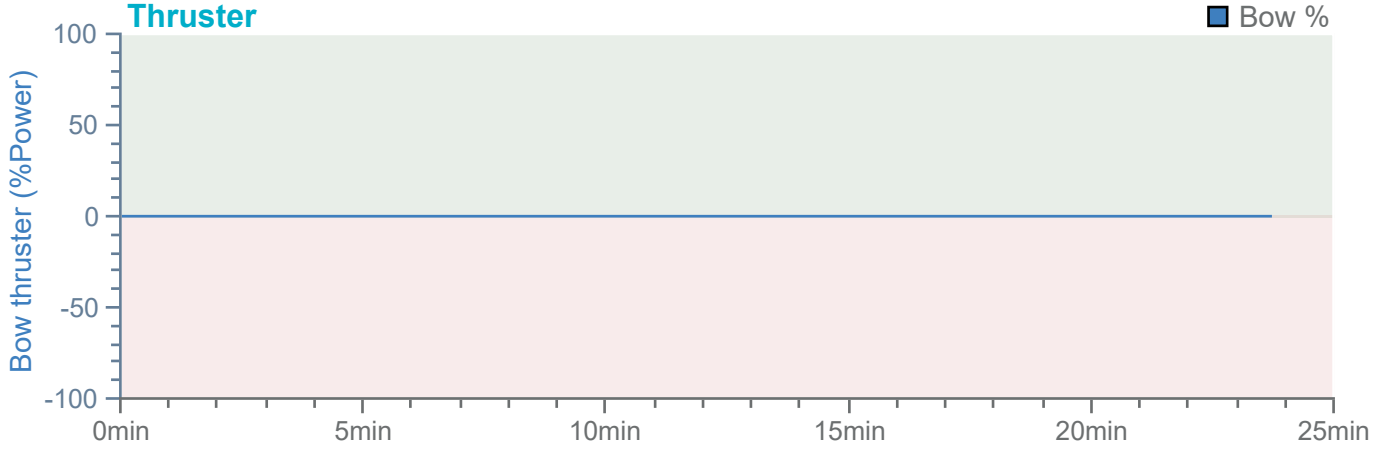

Course over ground and drift
COG
Drift Angle
COG (°)
Drift Angle (°)
360
270
180
090
000
90
60
30
0
0min
5min
10min
15min
20min
25min


Ship speed
Ground long.
Water long.
Ground lat.
Water lat.
Longitudinal speed (knots)
Lateral speed (knots)
8.1
6.1
4.1
2.1
0.1
1.5
1.2
0.9
0.6
0.3
0min
5min
10min
15min
20min
25min

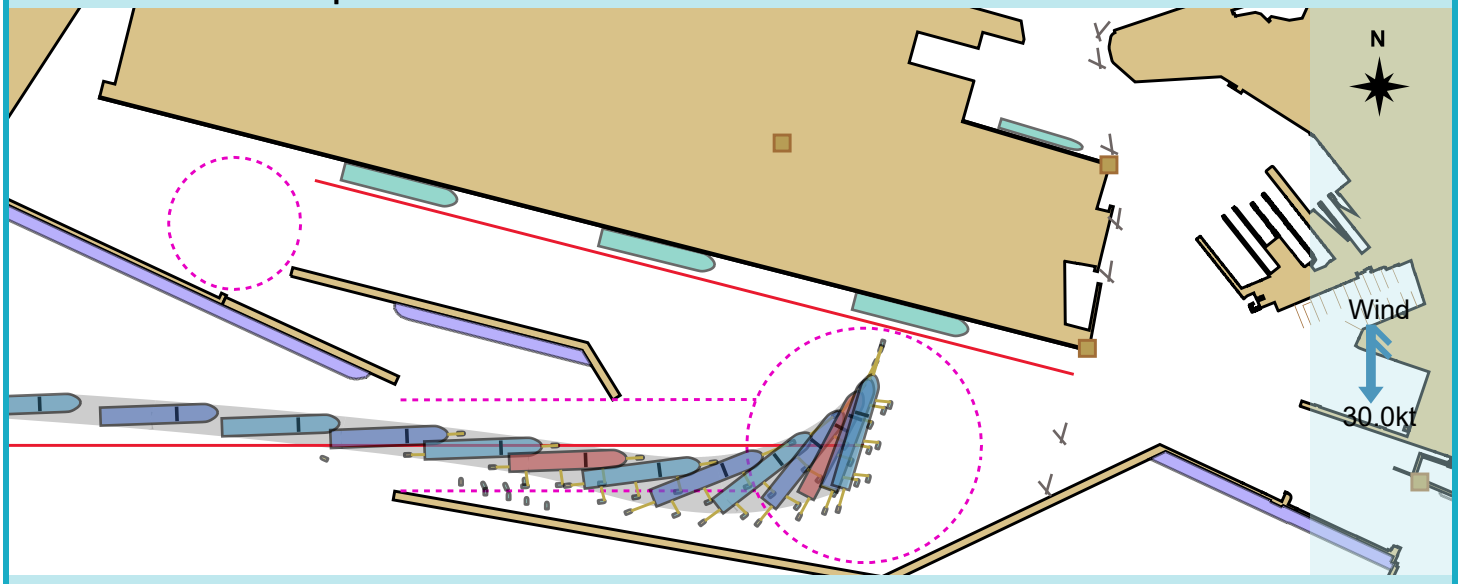

Underkeel Clearance and Speed over Ground
Bow UKC
Stern UKC
SOG
Underkeel clearance (m)
SOG (kt)
32.0
24.0
16.0
8.0
0.0
9.0
6.0
3.0
0.0
0min
5min
10min
15min
20min
25min


Propeller RPM
RPM
Propeller RPM
50
40
30
20
10
0
-10
-20
-30
-40
-50
0min
5min
10min
15min
20min
25min


Rudder angle
Rudder
Rudder angle (°)
40
30
20
10
0
-10
-20
-30
-40
0min
5min
10min
15min
20min
25min

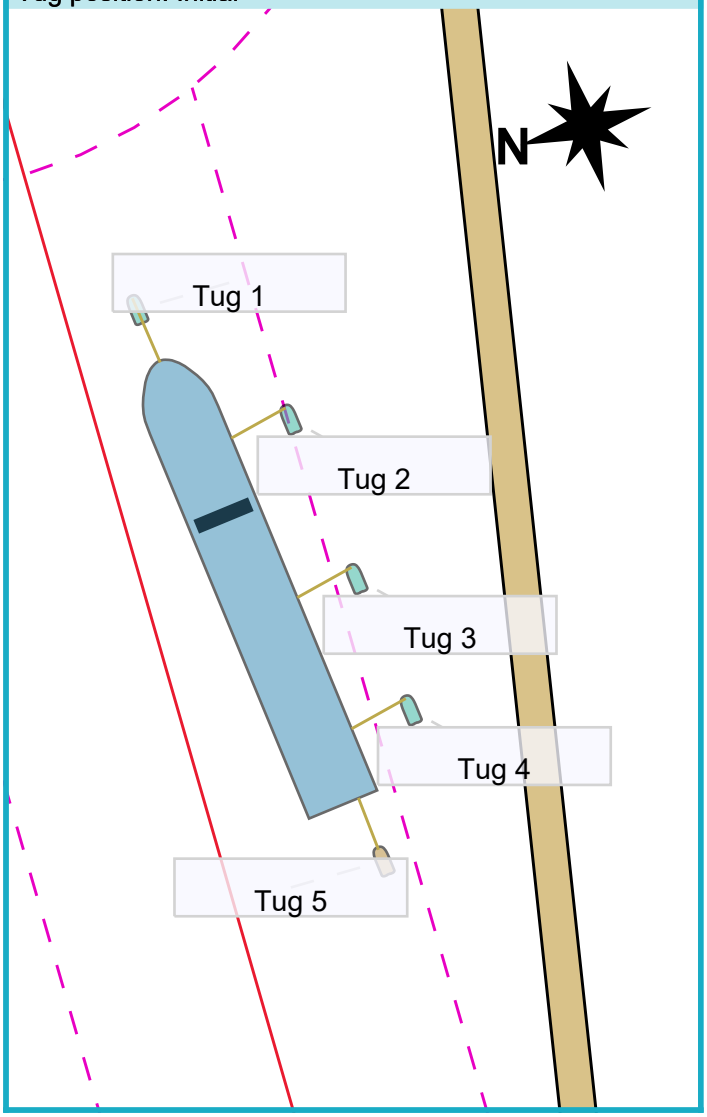

Thruster
Bow %
Bow thruster (%Power)
100
50
0
-50
-100
0min
5min
10min
15min
20min
25min

Manoeuvre track plot

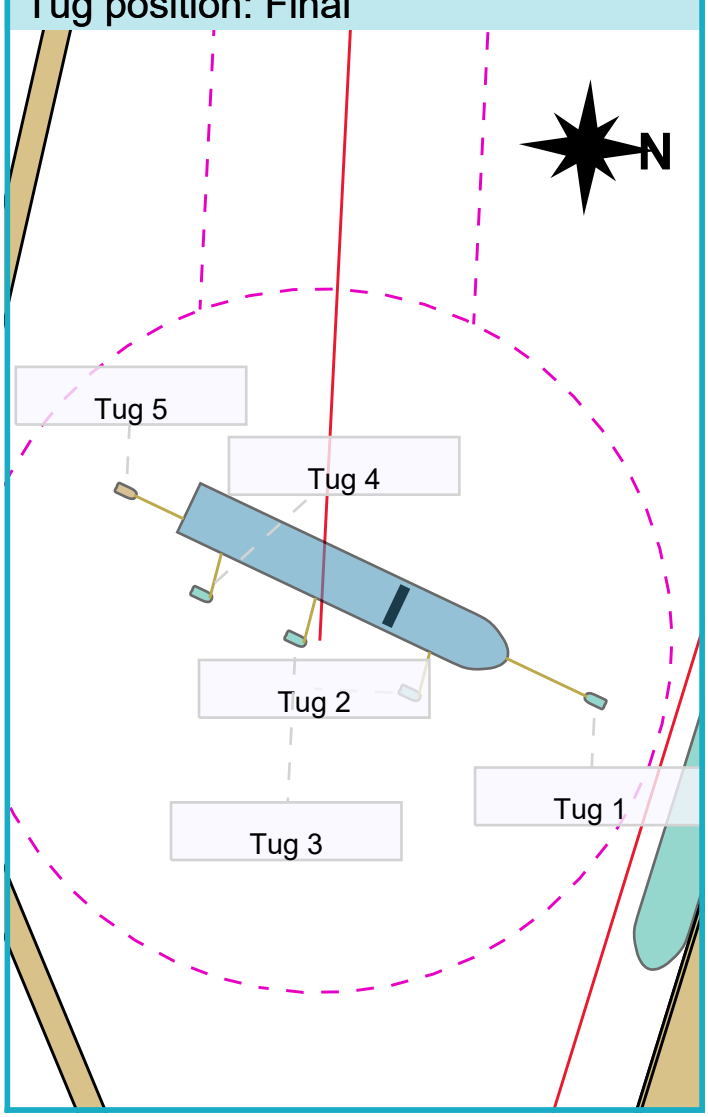


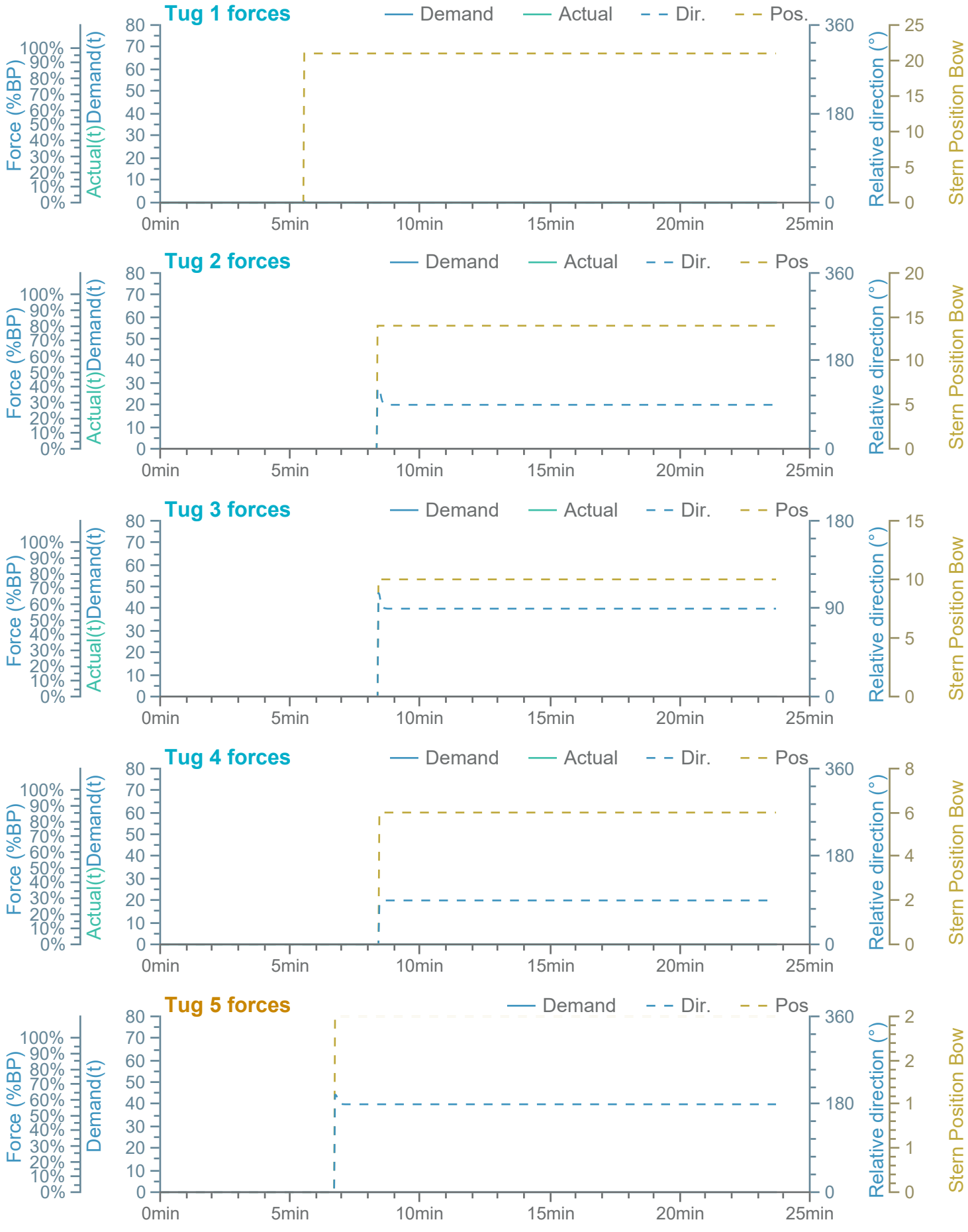
Ships plotted every 2 mins, highlight every 10 mins

Tug position: Initial

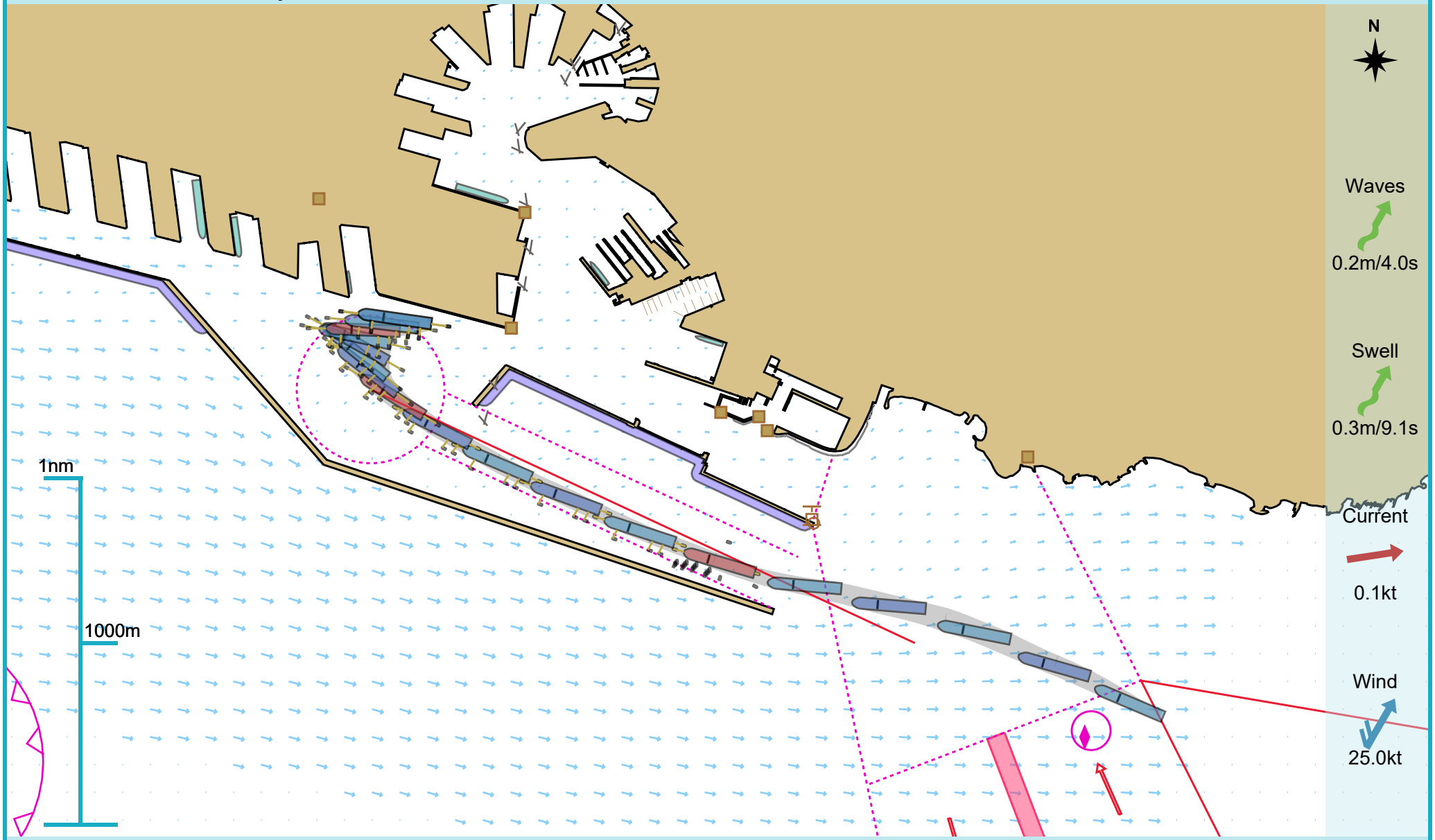


Tug position: Final

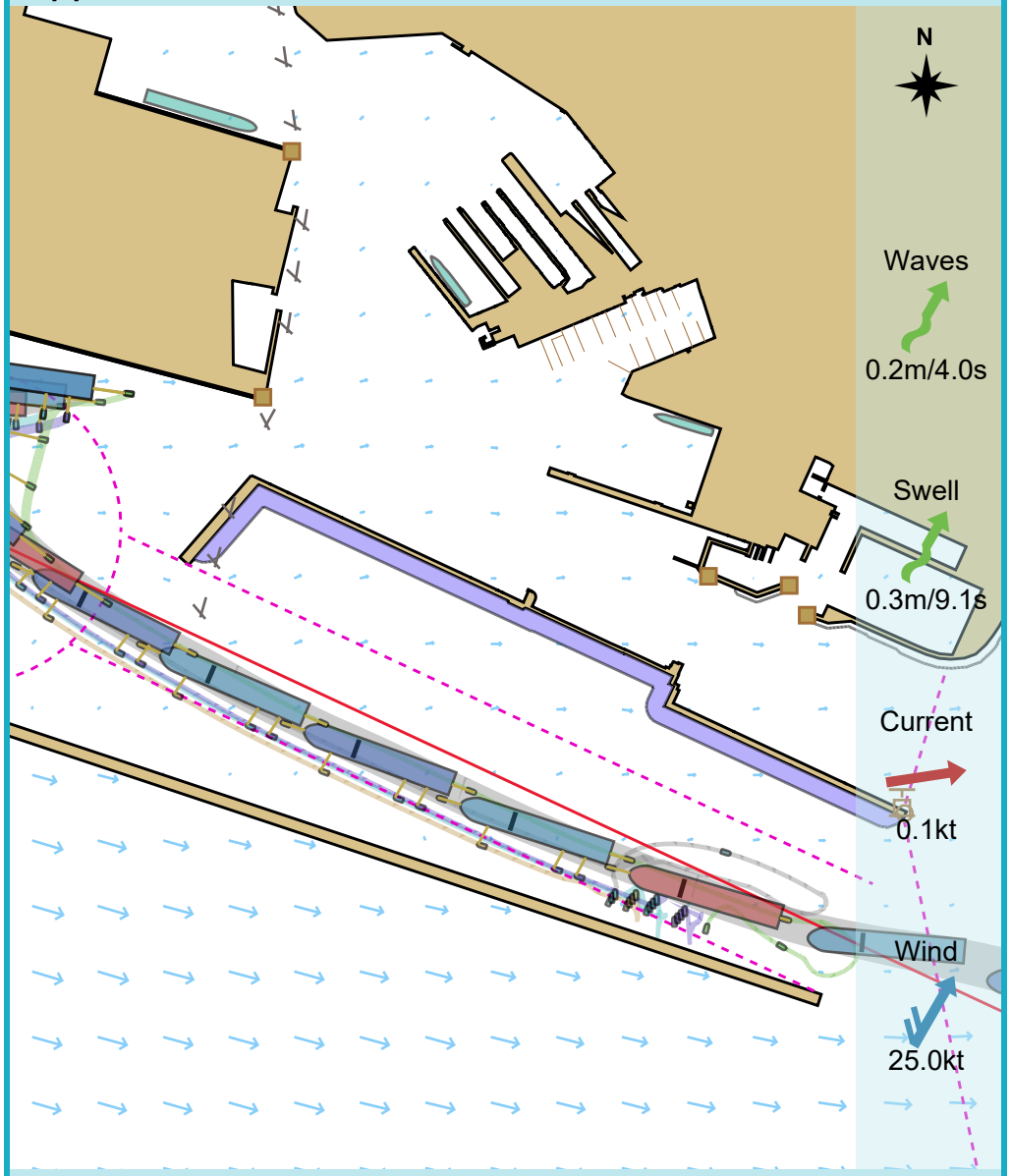



Tug 1 forces
Demand
Actual
Dir.
Pos.
Force (%BP)
Actual(t)Demand(t)
Relative direction (°)
Stern Position Bow
0min
5min
10min
15min
20min
25min
Tug 2 forces
Demand
Actual
Dir.
Pos
Tug 3 forces
Demand
Actual
Dir.
Pos
Tug 4 forces
Demand
Actual
Dir.
Pos
Tug 5 forces
Demand
Dir.
Pos
Demand(t)

Manoeuvre track plot

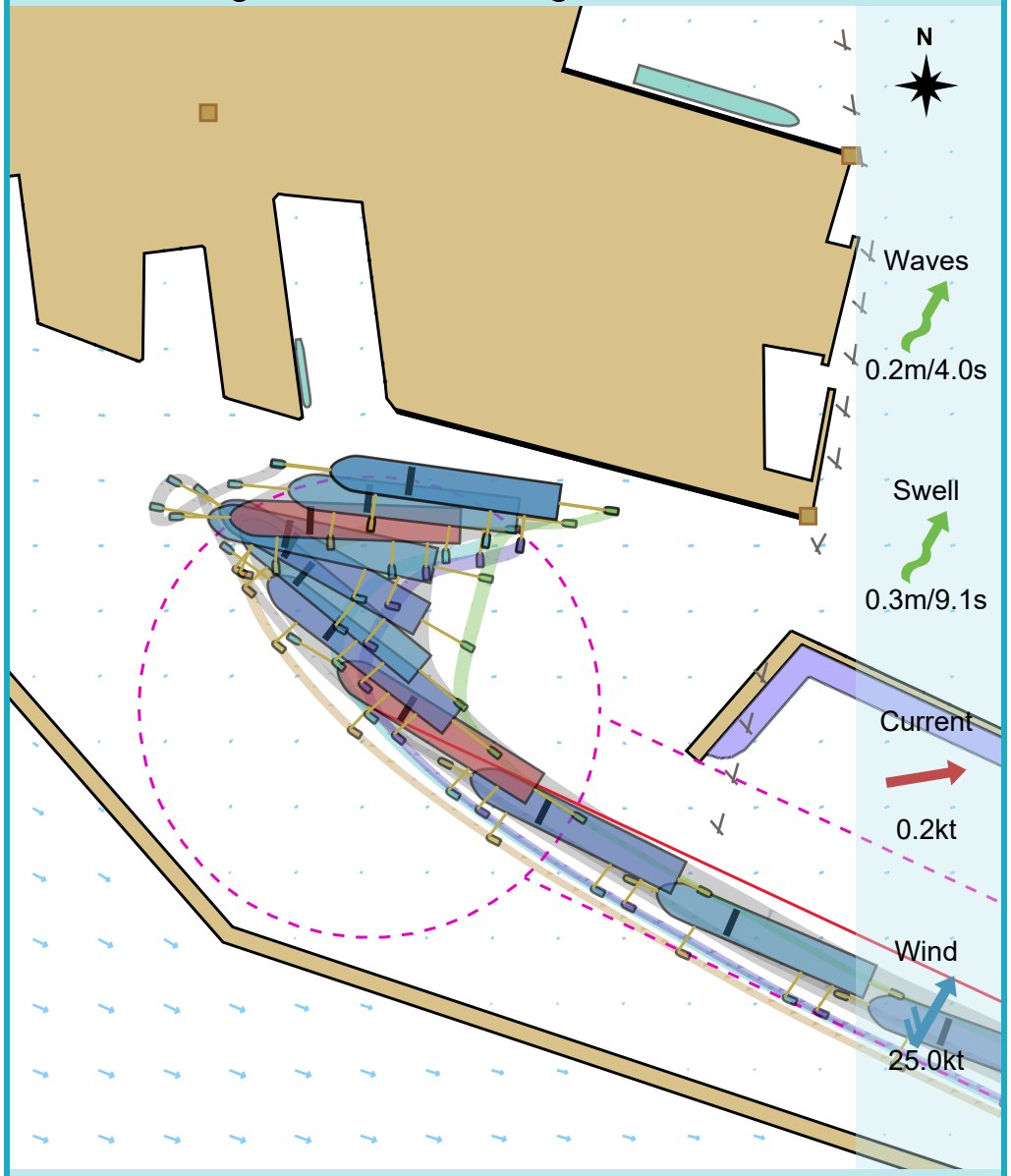


Approach Channel

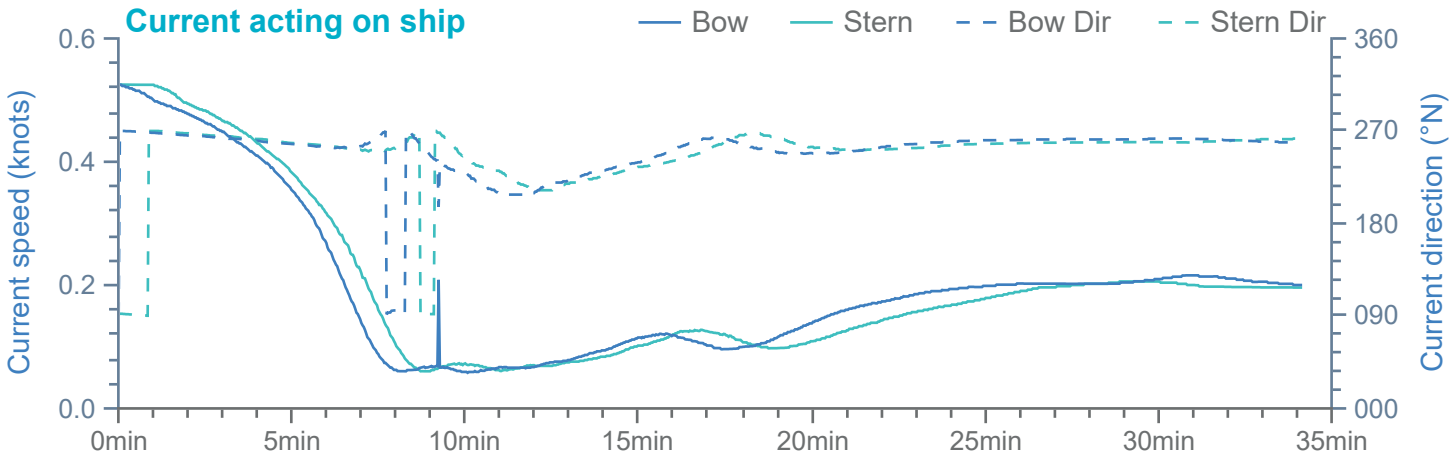


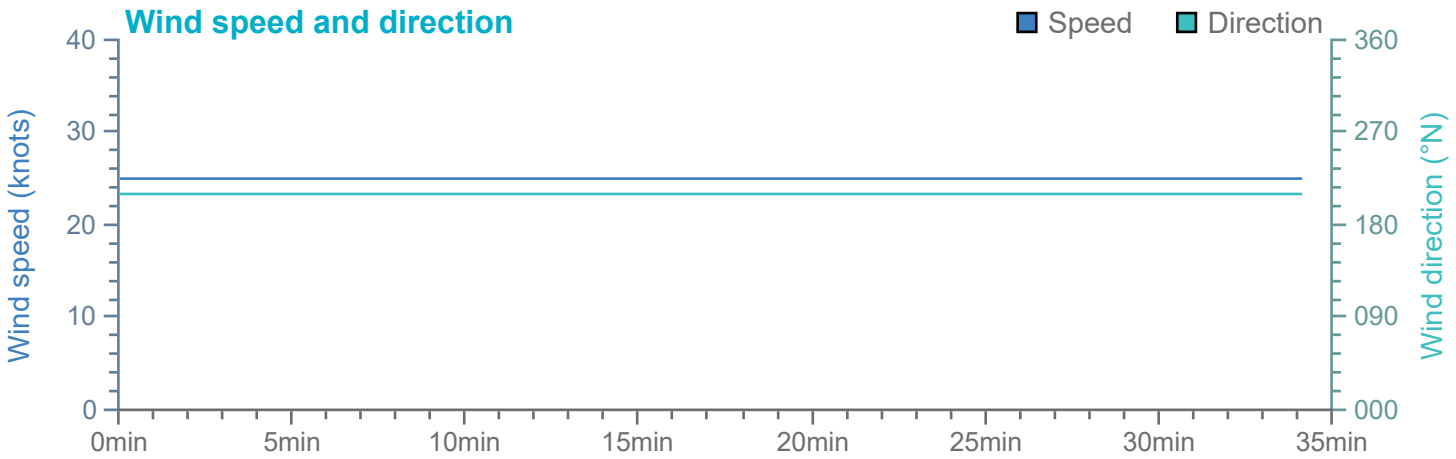
Ships plotted every 2 mins, highlight every 10 mins

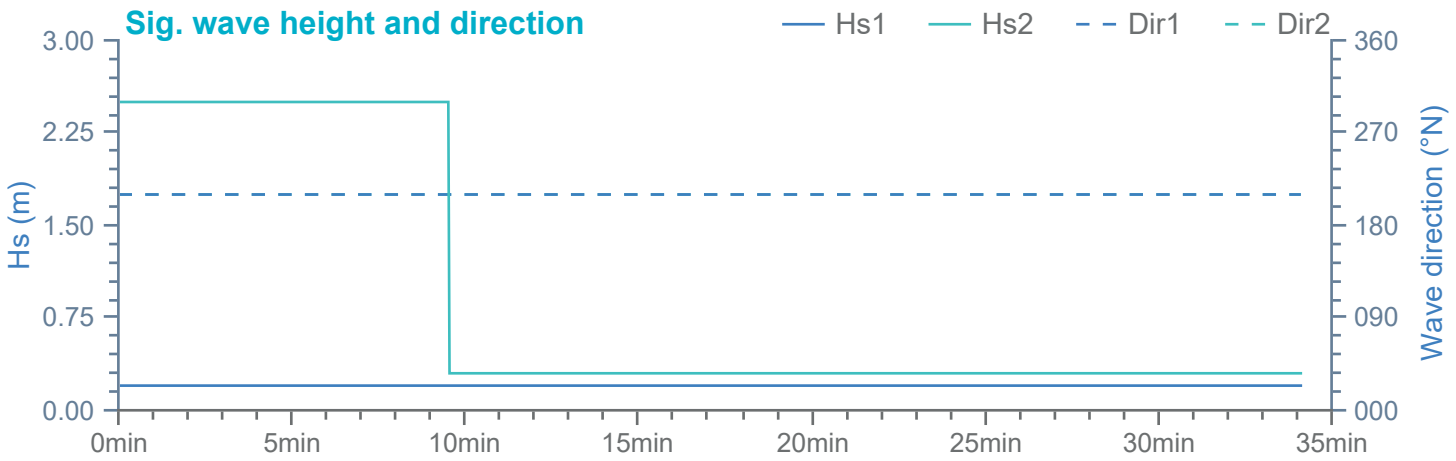
Manoeuvring area and berthing

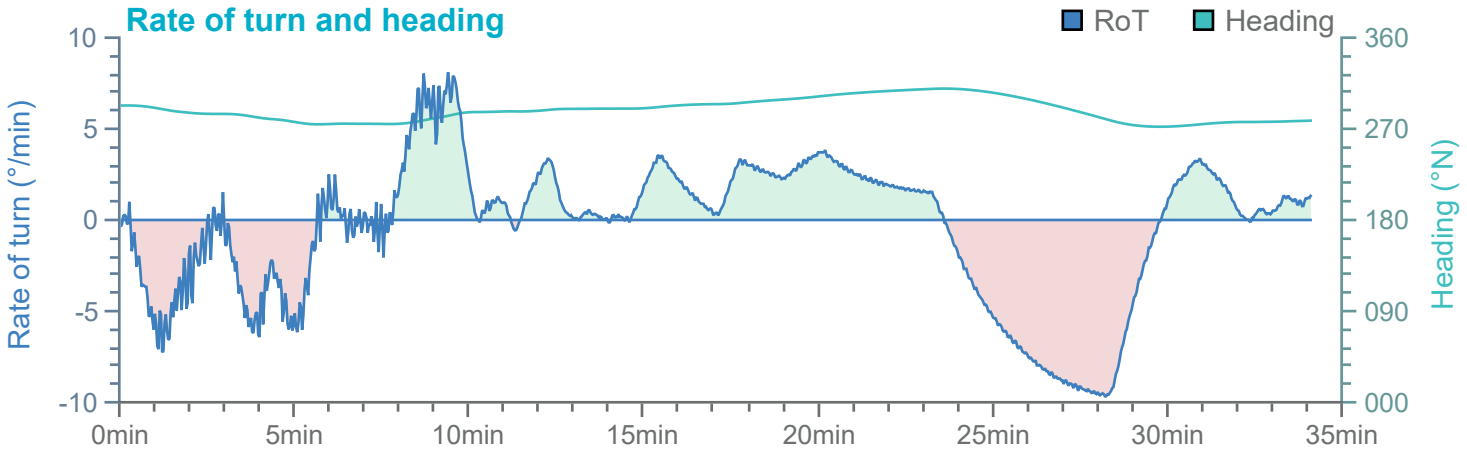


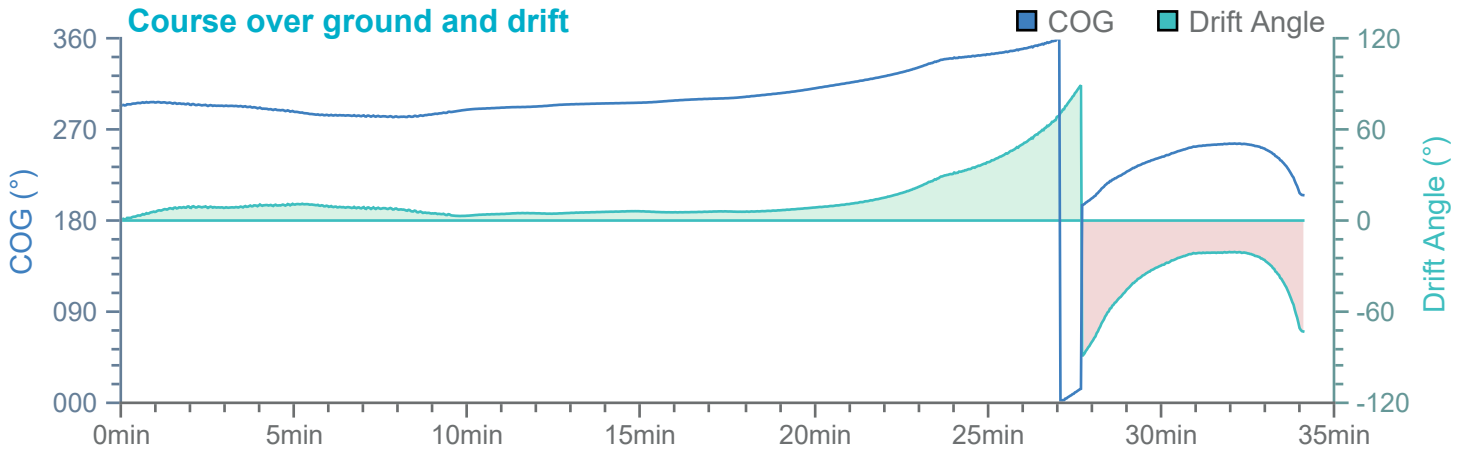
Ships plotted every 2 mins, highlight every 10 mins

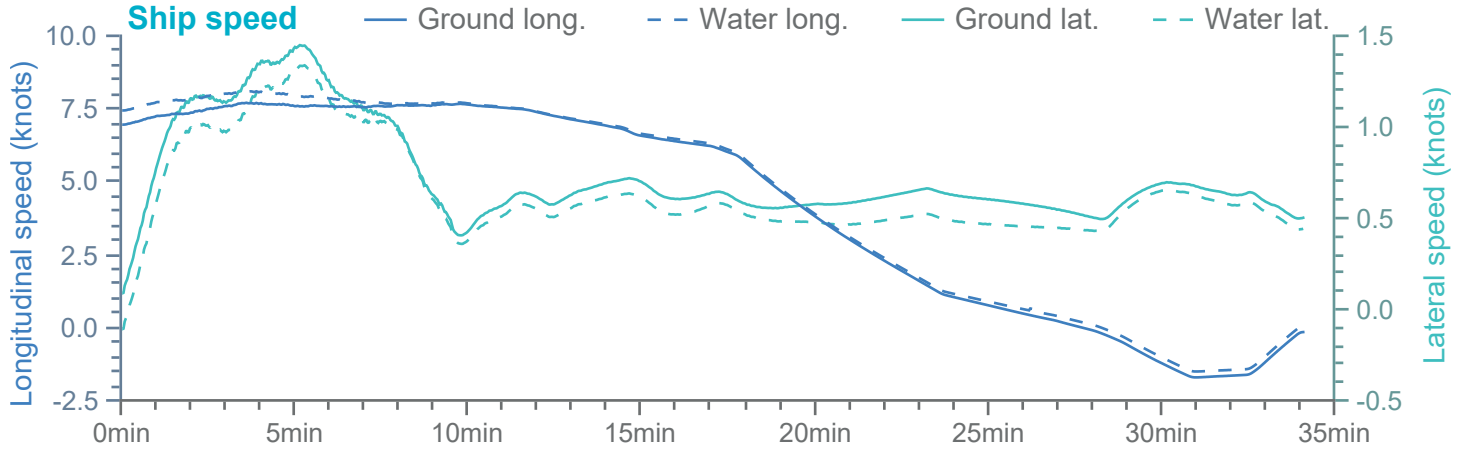

Current acting on ship
Bow
Stern
Bow Dir
Stern Dir
Current speed (knots)
Current direction (°N)
0.6
0.4
0.2
0.0
360
270
180
090
000
0min
5min
10min
15min
20min
25min
30min
35min

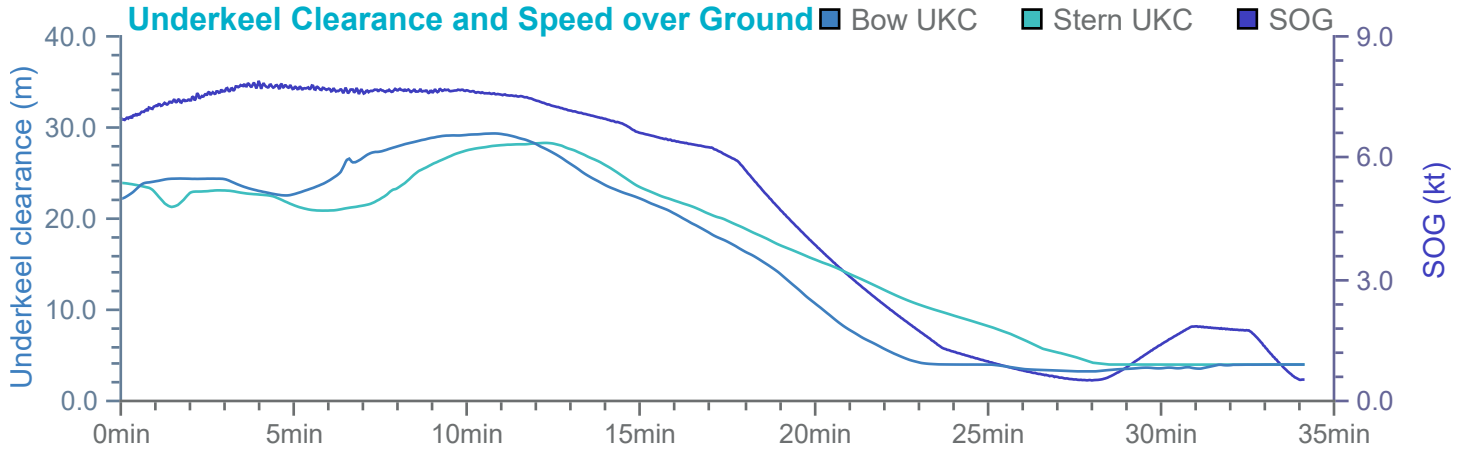

Wind speed and direction
Speed
Direction
Wind speed (knots)
Wind direction (°N)
40
30
20
10
0
360
270
180
090
000
0min
5min
10min
15min
20min
25min
30min
35min

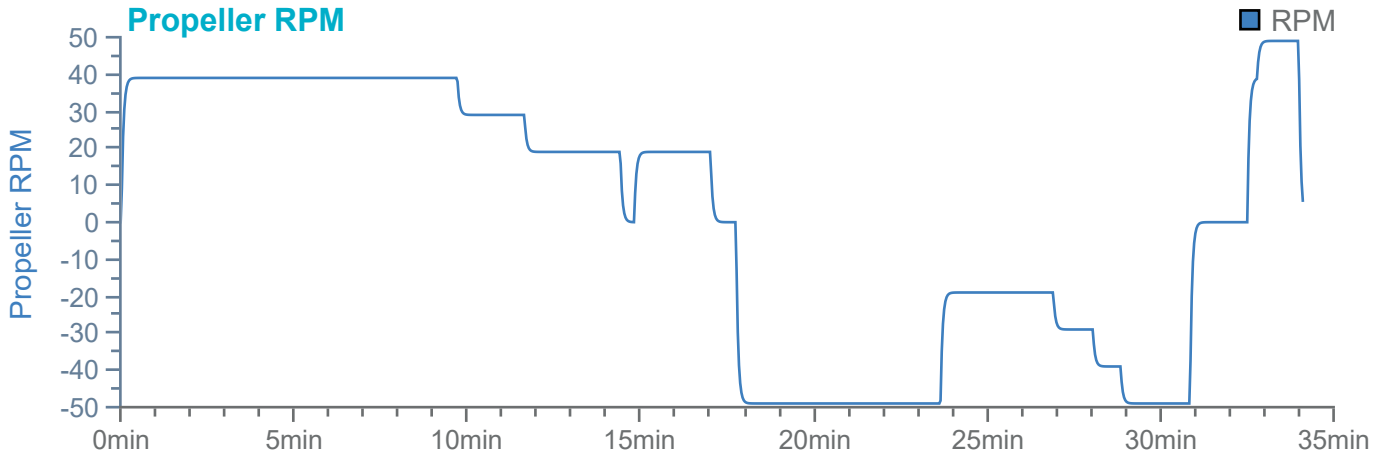

Sig. wave height and direction
Hs1
Hs2
Dir1
Dir2
Hs (m)
Wave direction (°N)
3.00
2.25
1.50
0.75
0.00
360
270
180
090
000
0min
5min
10min
15min
20min
25min
30min
35min

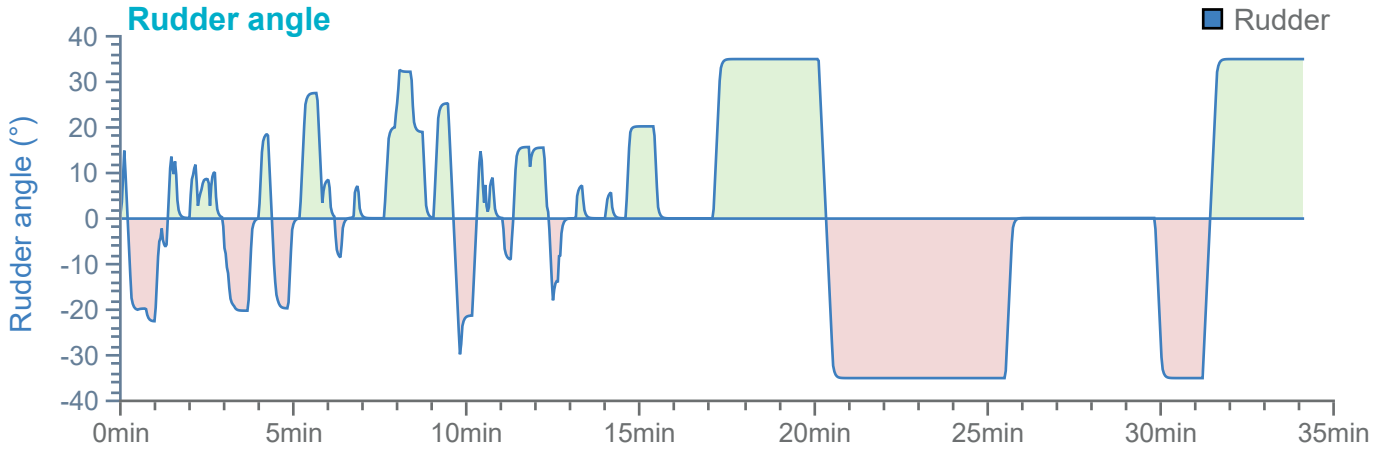

Rate of turn and heading
RoT
Heading
Rate of turn (°/min)
Heading (°N)
10
5
0
-5
-10
360
270
180
090
000
0min
5min
10min
15min
20min
25min
30min
35min

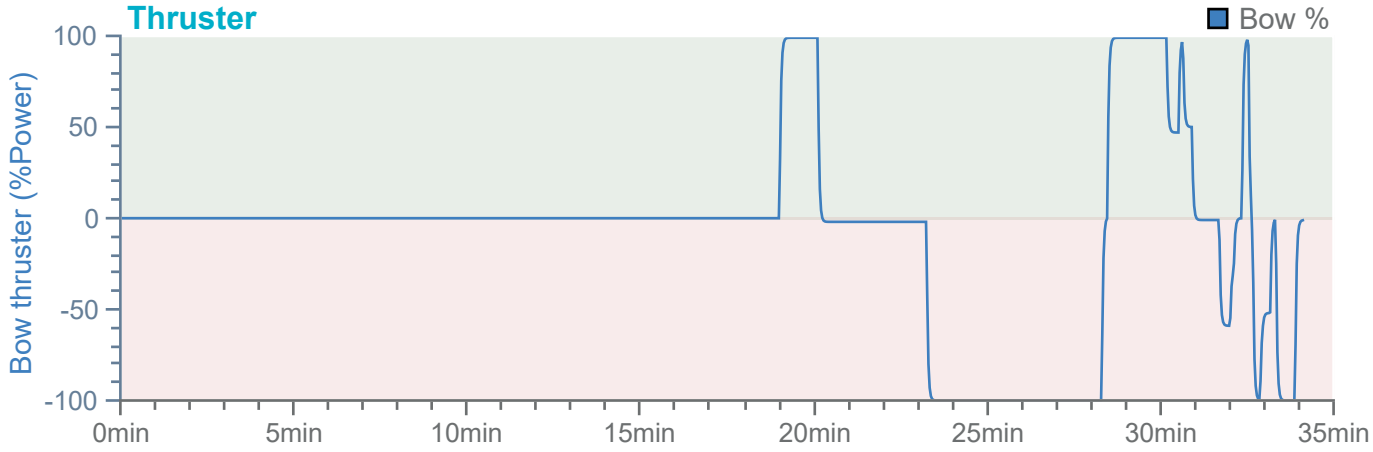

Course over ground and drift
COG
Drift Angle
COG (°)
Drift Angle (°)
360
270
180
090
000
120
60
0
-60
-120
0min
5min
10min
15min
20min
25min
30min
35min


Ship speed
Ground long.
Water long.
Ground lat.
Water lat.
Longitudinal speed (knots)
Lateral speed (knots)
10.0
7.5
5.0
2.5
0.0
-2.5
1.5
1.0
0.5
0.0
-0.5
0min
5min
10min
15min
20min
25min
30min
35min

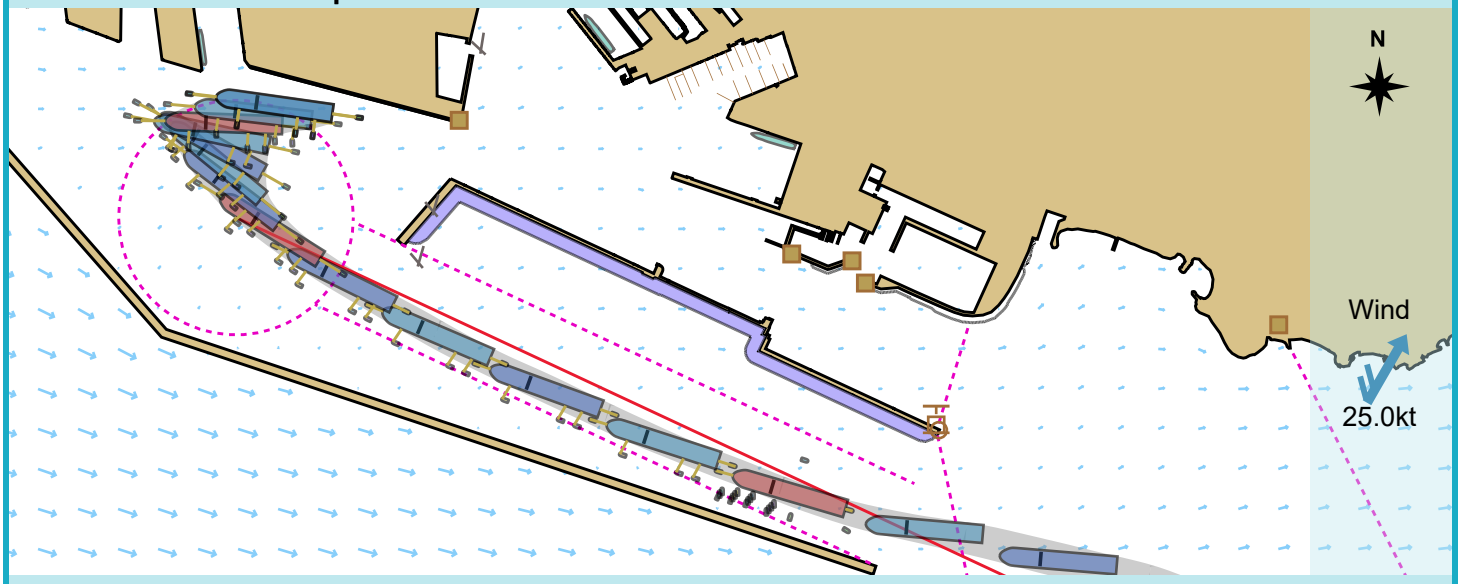

Underkeel Clearance and Speed over Ground
Bow UKC
Stern UKC
SOG
Underkeel clearance (m)
SOG (kt)
40.0
30.0
20.0
10.0
0.0
9.0
6.0
3.0
0.0
0min
5min
10min
15min
20min
25min
30min
35min


Propeller RPM
RPM
Propeller RPM
50
40
30
20
10
0
-10
-20
-30
-40
-50
0min
5min
10min
15min
20min
25min
30min
35min


Rudder angle
Rudder
Rudder angle (°)
40
30
20
10
0
-10
-20
-30
-40
0min
5min
10min
15min
20min
25min
30min
35min

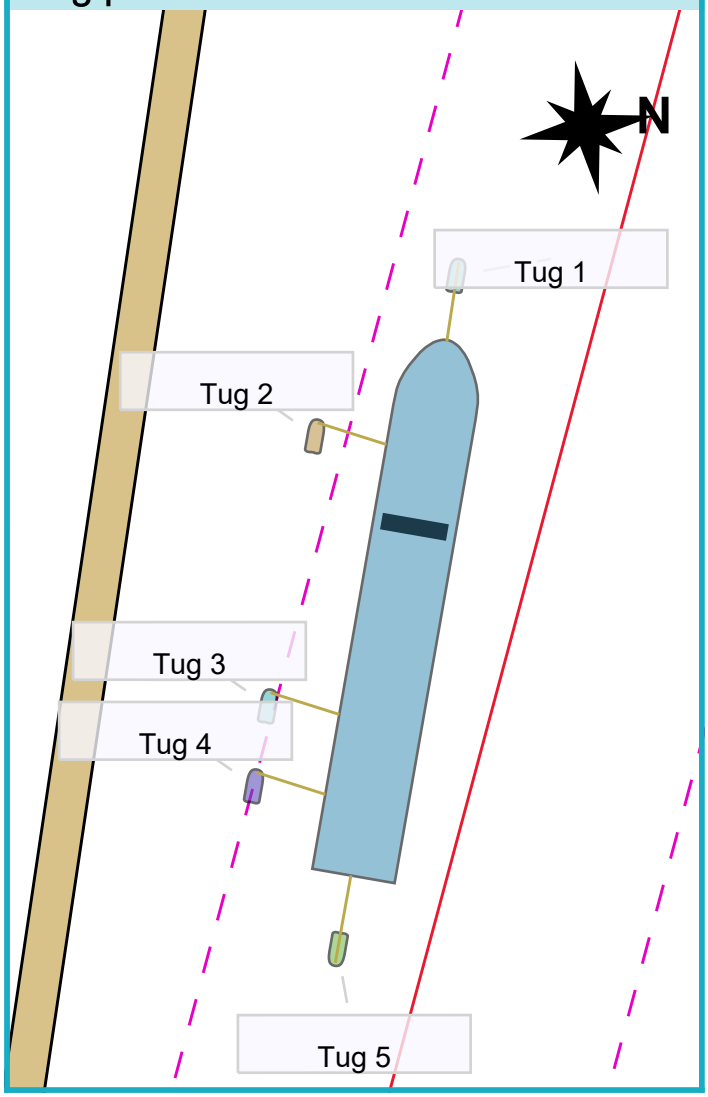

Thruster
Bow %
Bow thruster (%Power)
100
50
0
-50
-100
0min
5min
10min
15min
20min
25min
30min
35min

Manoeuvre track plot

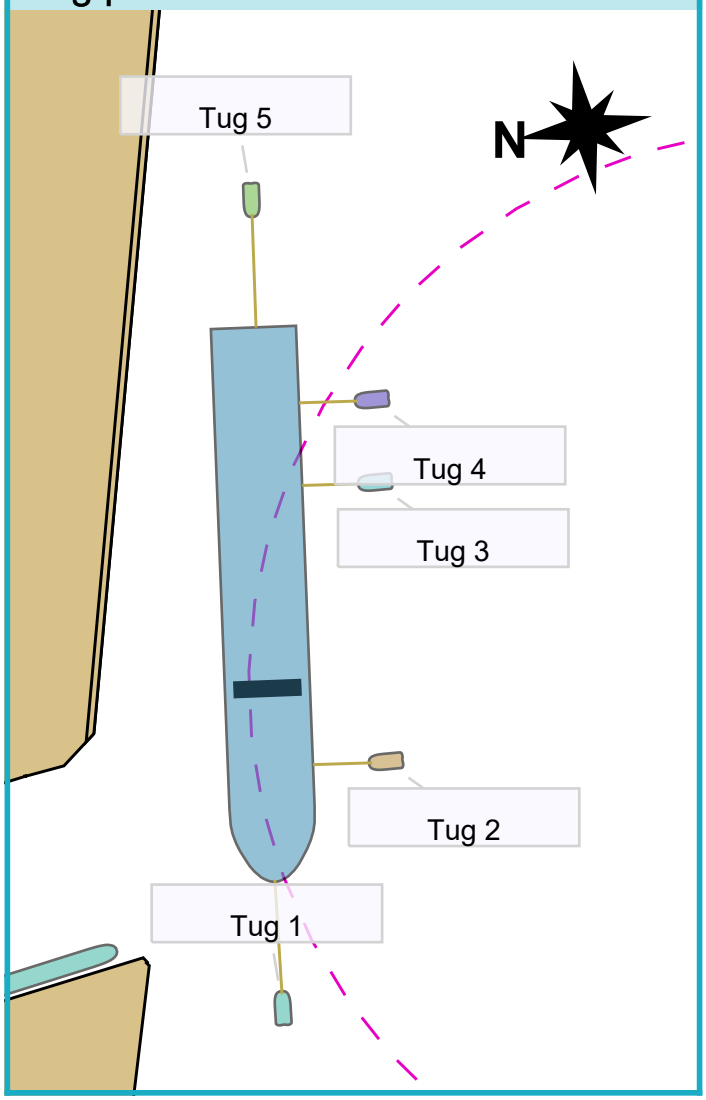


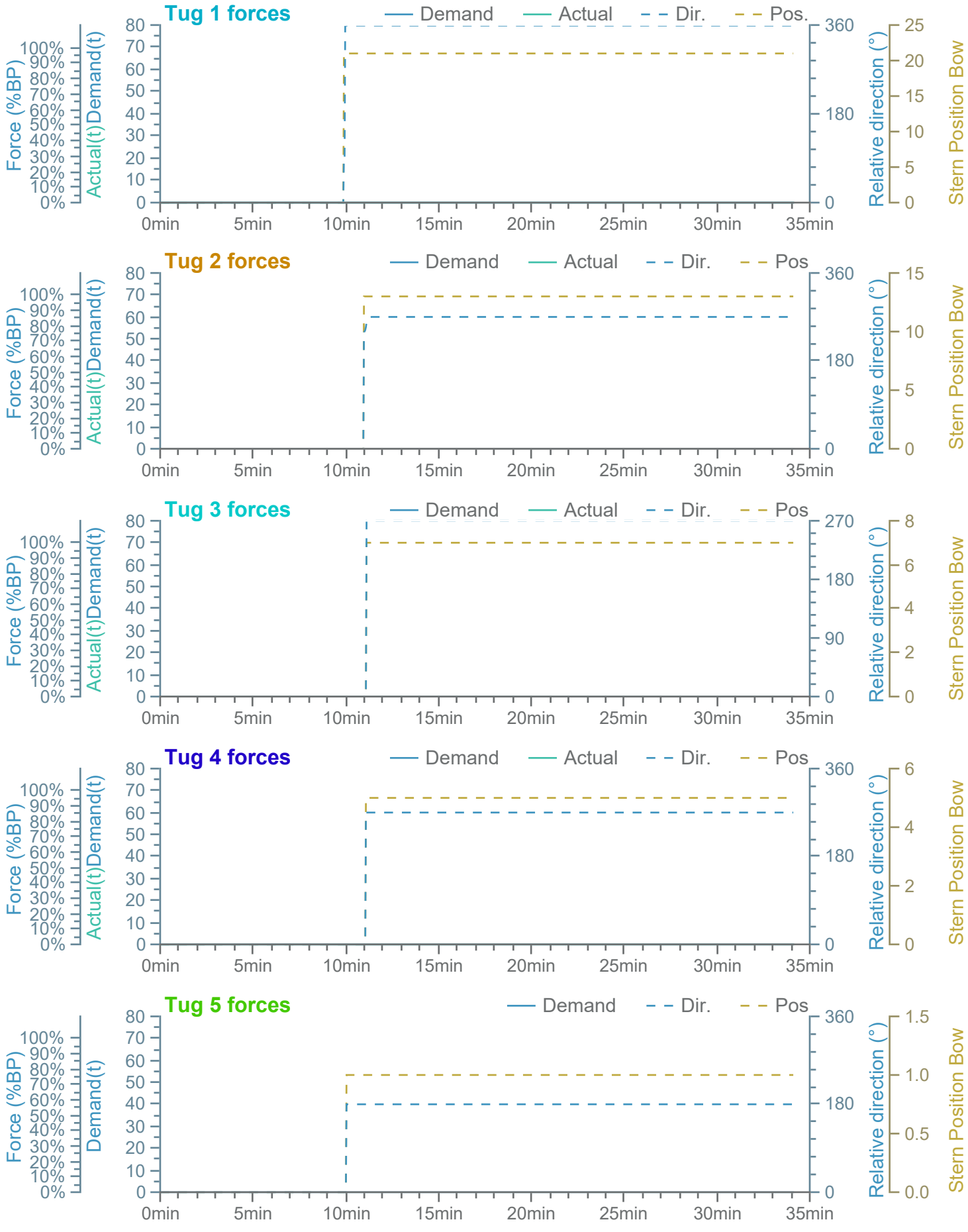
Ships plotted every 2 mins, highlight every 10 mins

Tug position: Initial

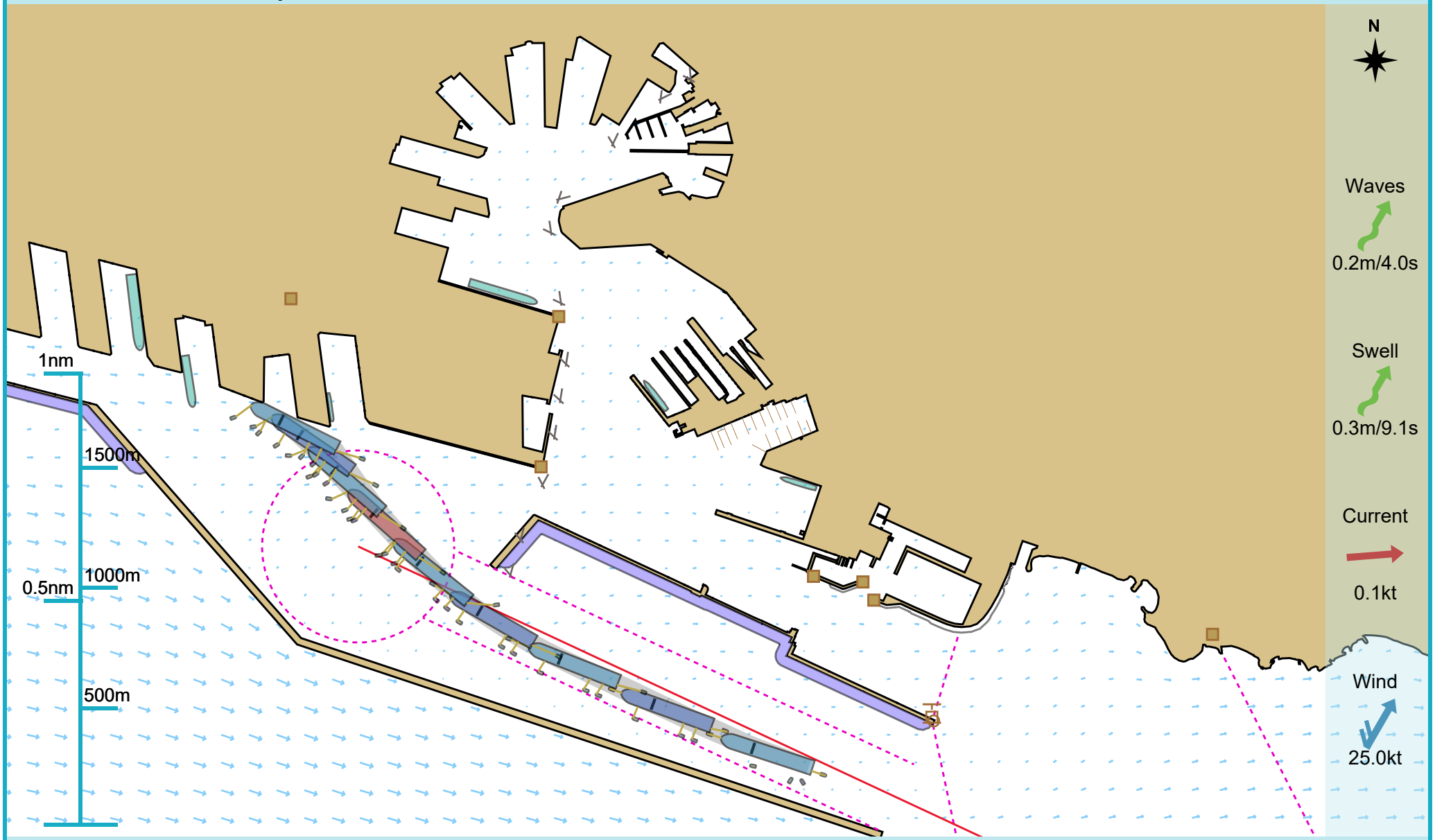


Tug position: Final

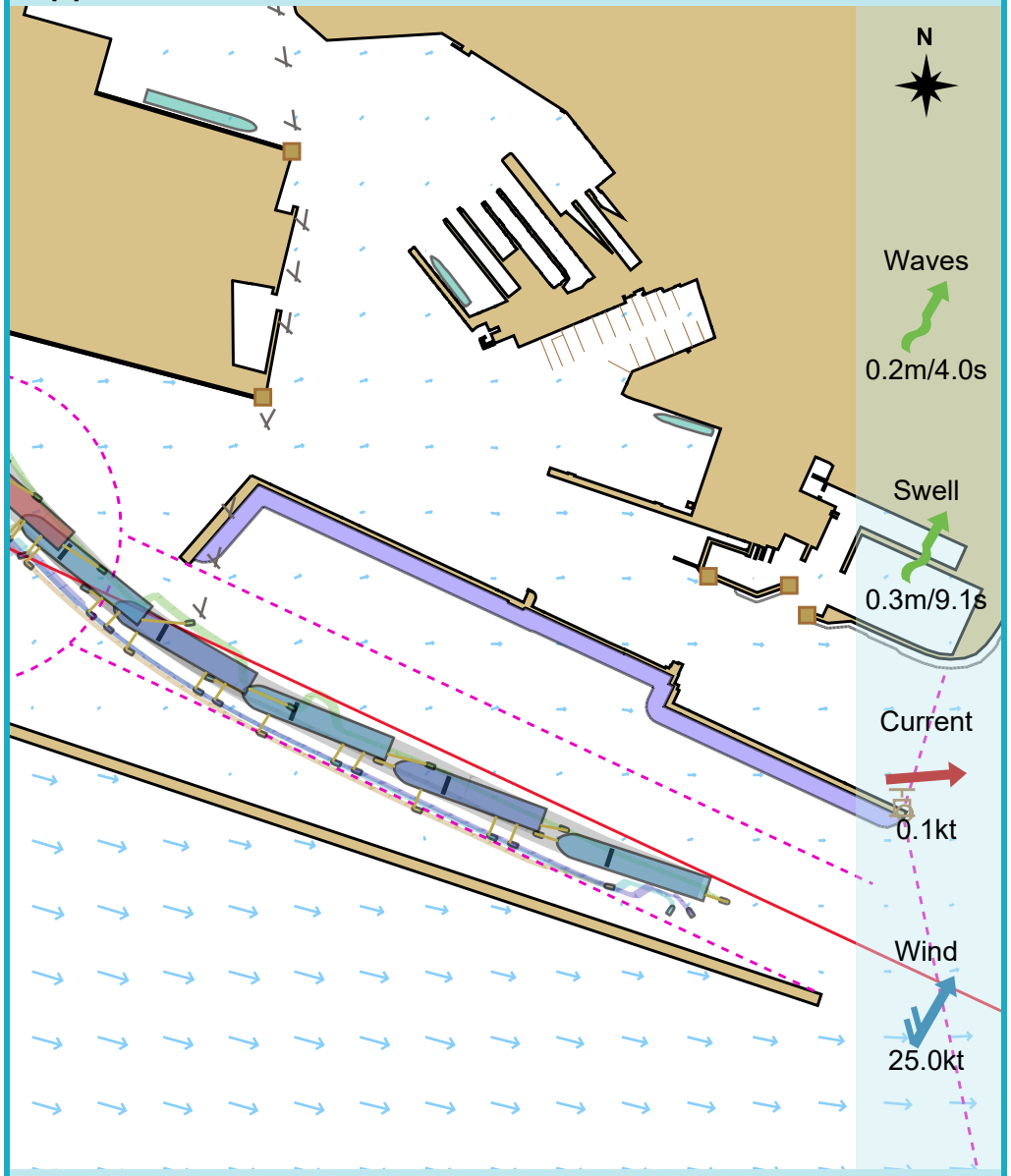



Tug 1 forces
Demand
Actual
Dir.
Pos.
Force (%BP)
Actual(t)Demand(t)
Relative direction (°)
Stern Position Bow
0min
5min
10min
15min
20min
25min
30min
35min
Tug 2 forces
Demand
Actual
Dir.
Pos
Force (%BP)
Actual(t)Demand(t)
Relative direction (°)
Stern Position Bow
Tug 3 forces
Demand
Actual
Dir.
Pos
Force (%BP)
Actual(t)Demand(t)
Relative direction (°)
Stern Position Bow
Tug 4 forces
Demand
Actual
Dir.
Pos
Force (%BP)
Actual(t)Demand(t)
Relative direction (°)
Stern Position Bow
Tug 5 forces
Demand
Dir.
Pos
Force (%BP)
Demand(t)
Relative direction (°)
Stern Position Bow

Manoeuvre track plot

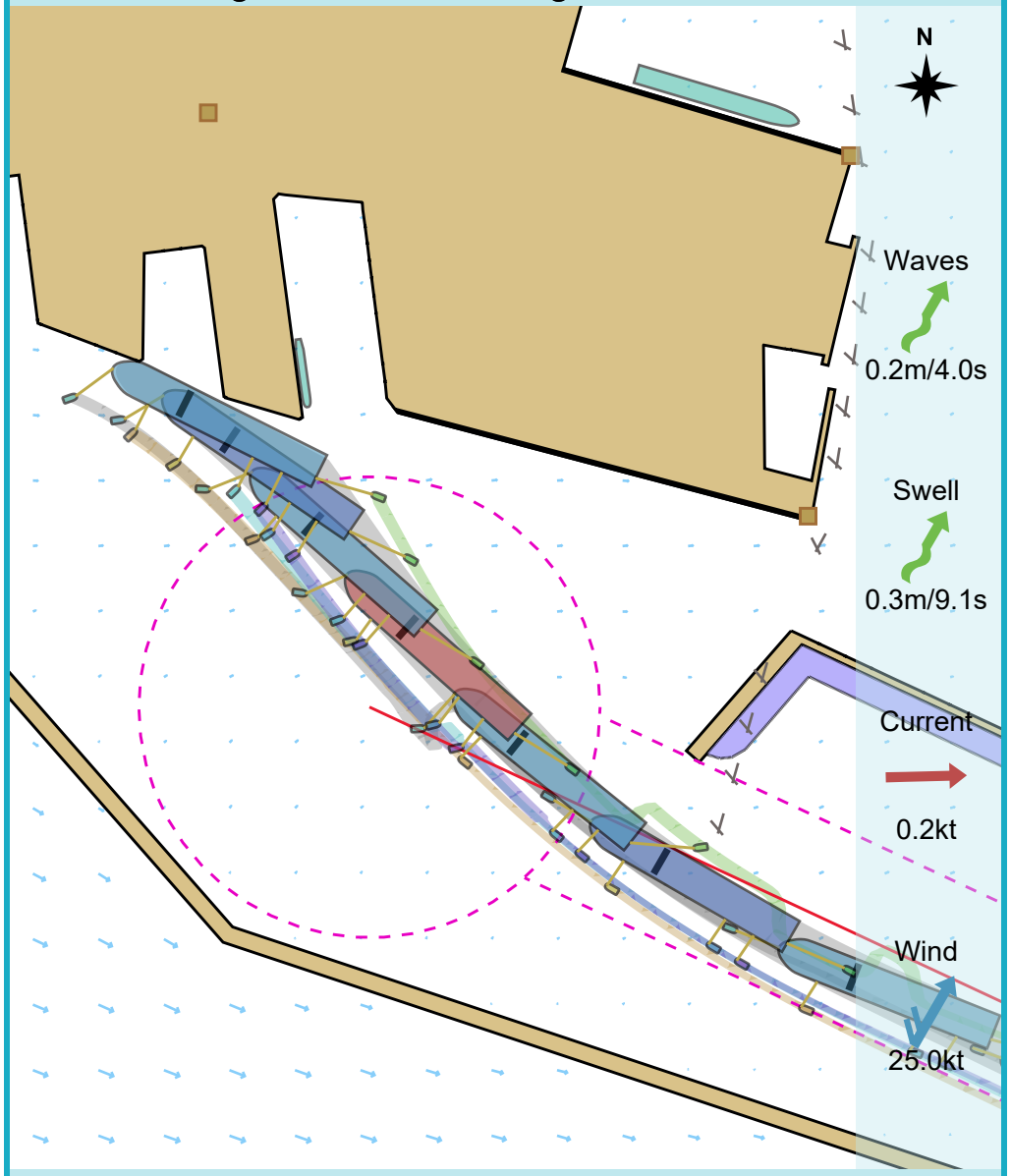


Approach Channel

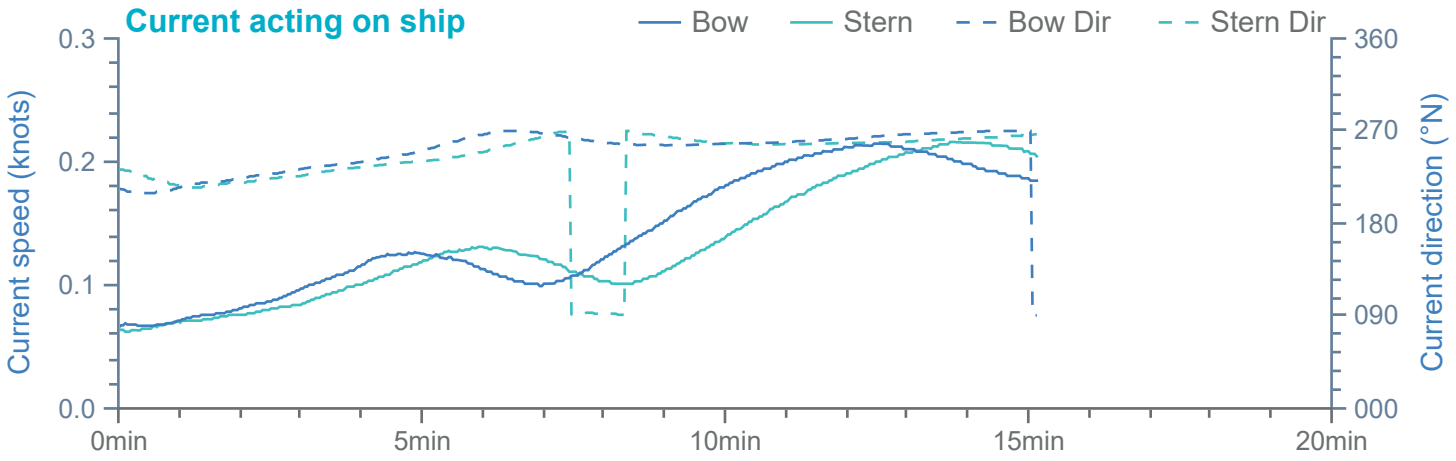


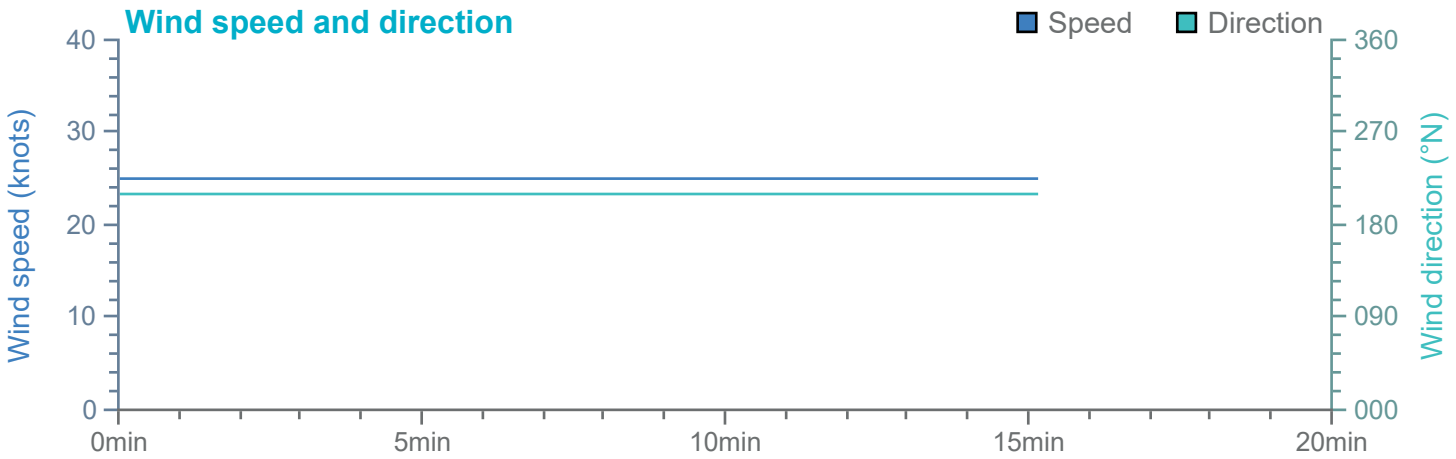
Ships plotted every 2 mins, highlight every 10 mins

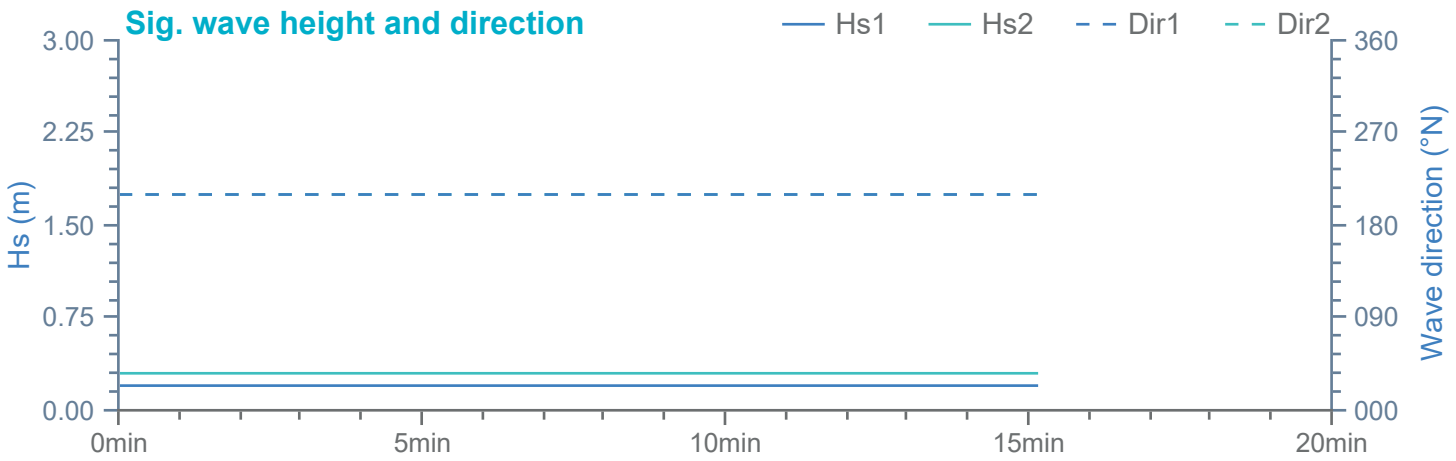
Manoeuvring area and berthing

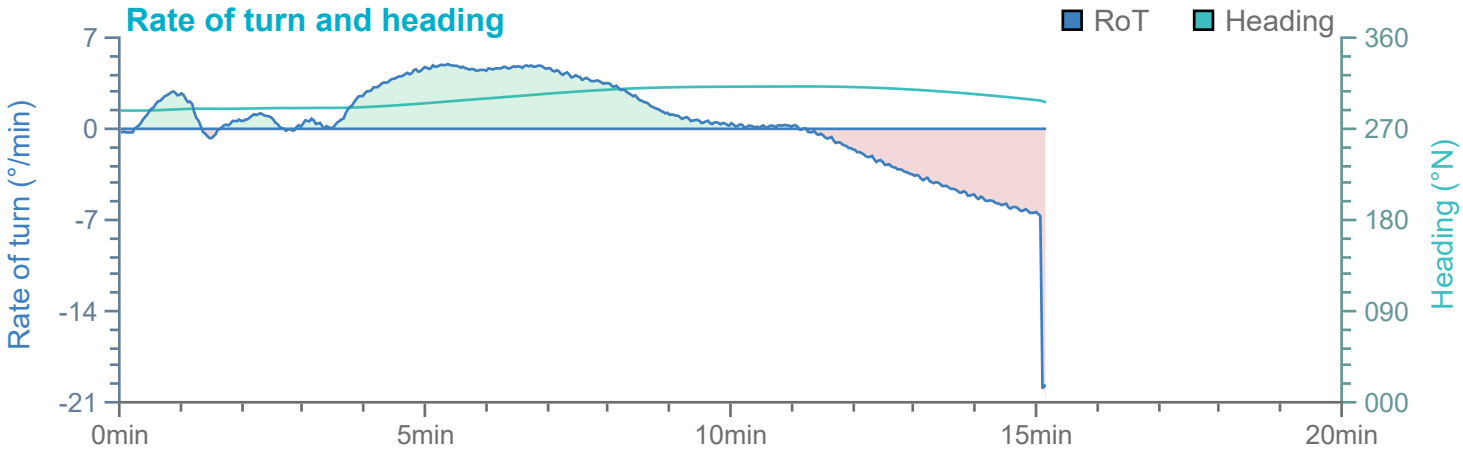


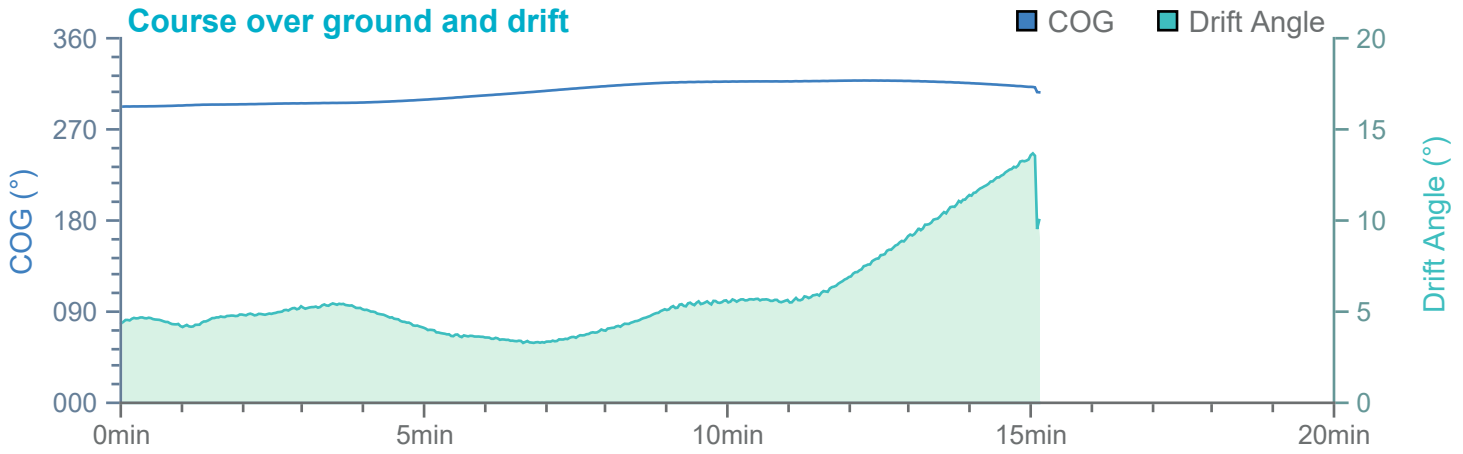
Ships plotted every 2 mins, highlight every 10 mins

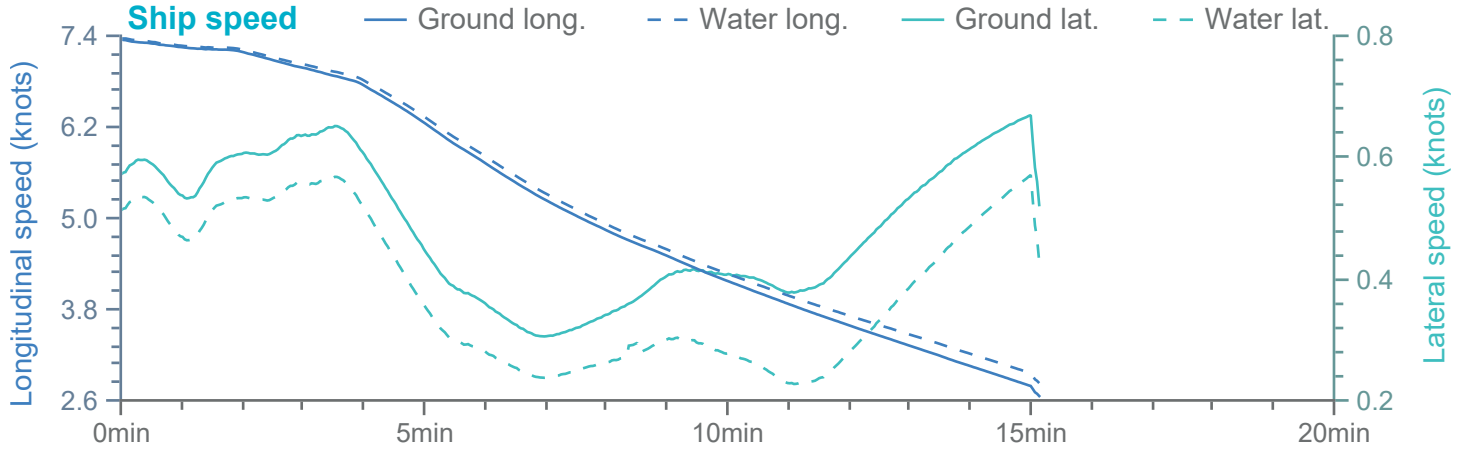

Current acting on ship
Bow
Stern
Bow Dir
Stern Dir
Current speed (knots)
0.3
0.2
0.1
0.0
Current direction (°N)
360
270
180
090
000
0min
5min
10min
15min
20min

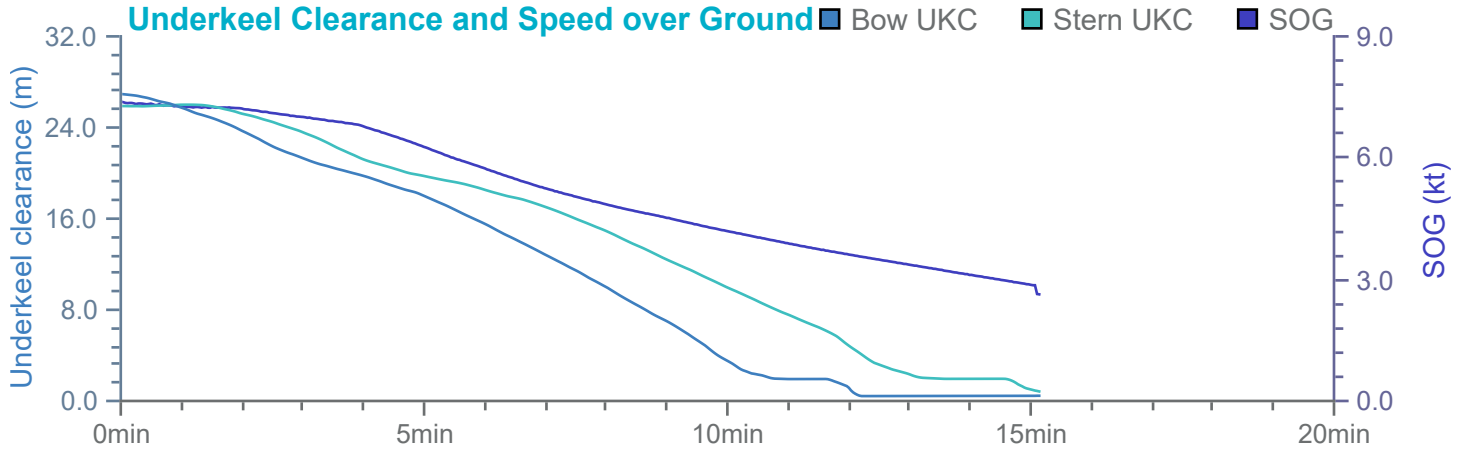

Wind speed and direction
Speed
Direction
Wind speed (knots)
40
30
20
10
0
Wind direction (°N)
360
270
180
090
000
0min
5min
10min
15min
20min

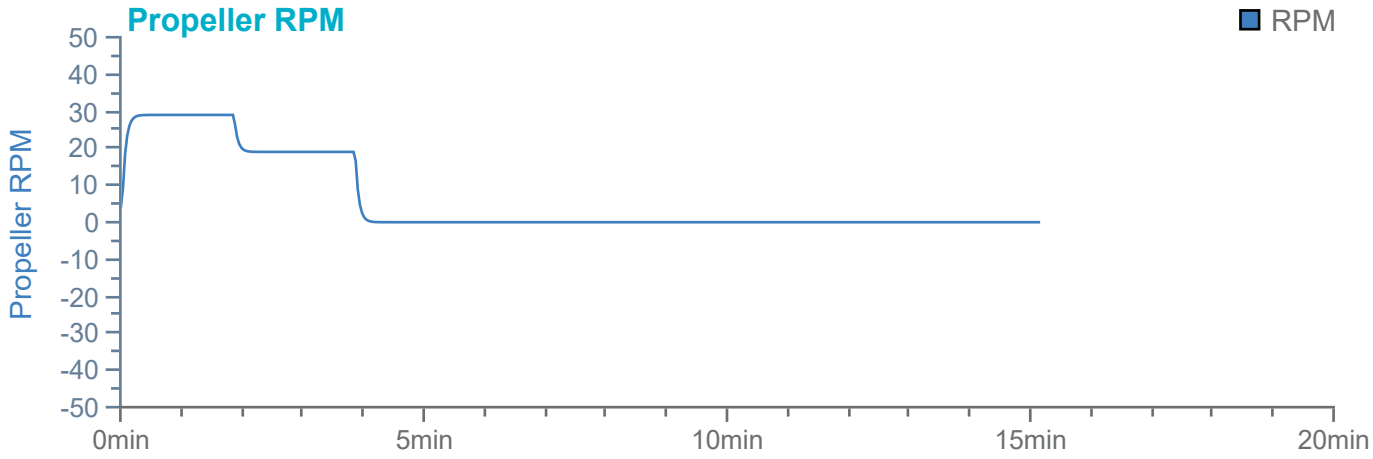

Sig. wave height and direction
Hs1
Hs2
Dir1
Dir2
Hs (m)
3.00
2.25
1.50
0.75
0.00
Wave direction (°N)
360
270
180
090
000
0min
5min
10min
15min
20min

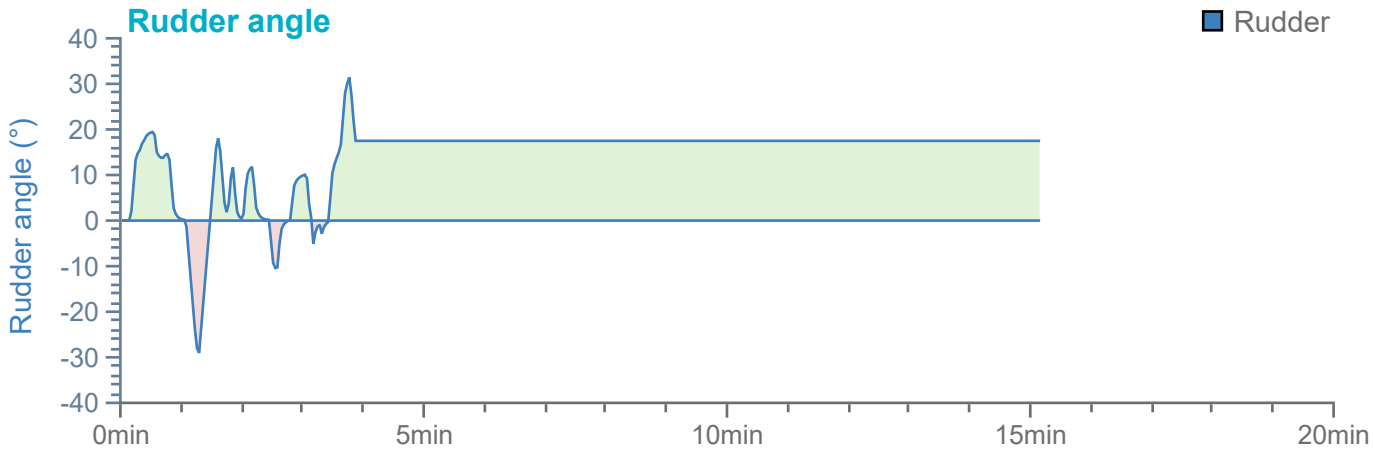

Rate of turn and heading
RoT
Heading
Rate of turn (°/min)
Heading (°N)
7
0
-7
-14
-21
360
270
180
090
000
0min
5min
10min
15min
20min

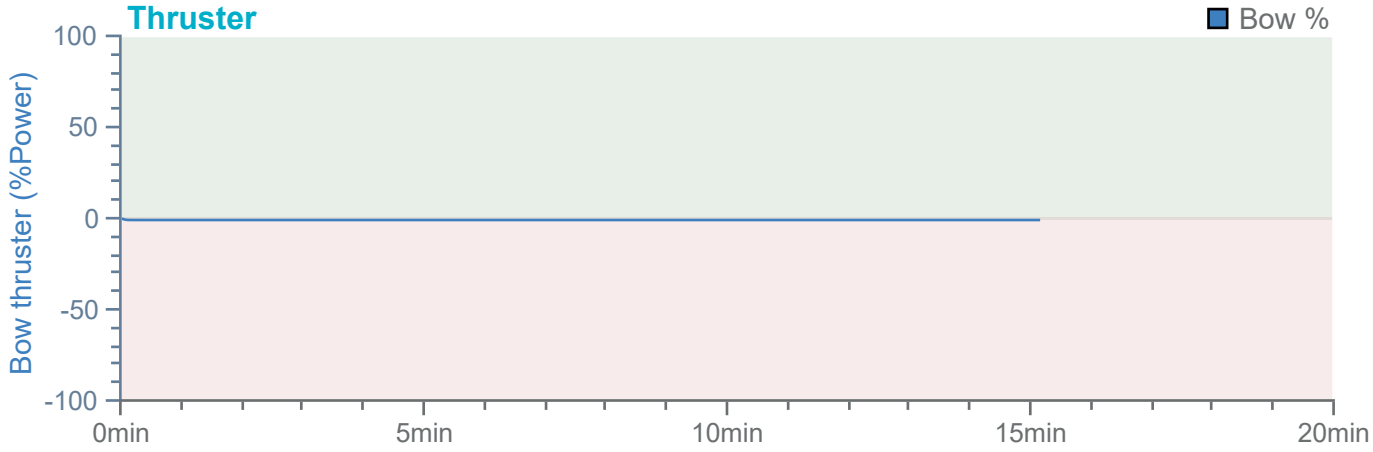

Course over ground and drift
COG
Drift Angle
COG (°)
Drift Angle (°)
360
270
180
090
000
20
15
10
5
0
0min
5min
10min
15min
20min

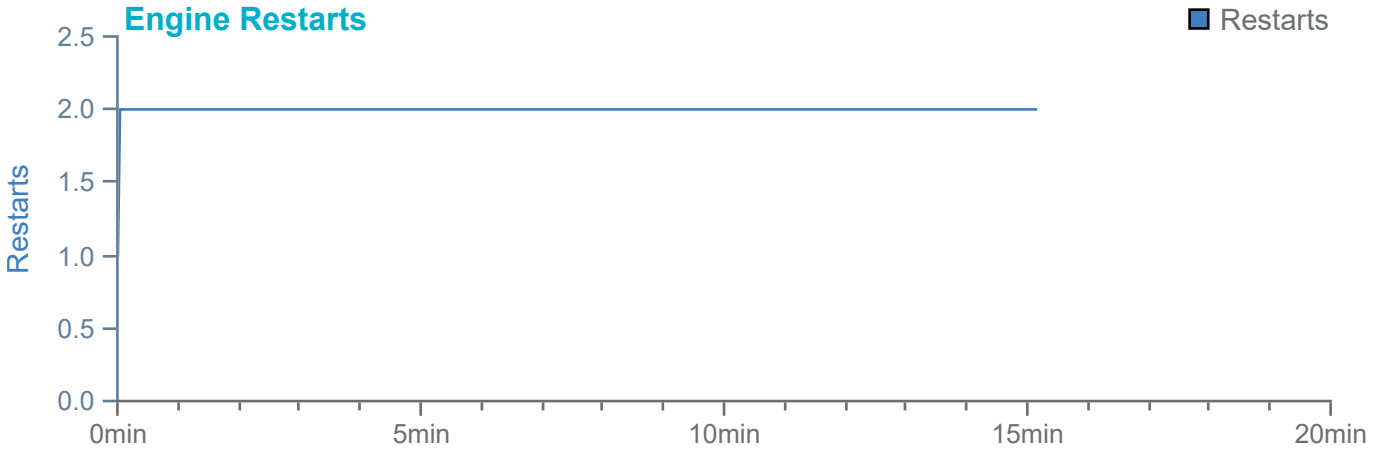

Ship speed
Ground long.
Water long.
Ground lat.
Water lat.
Longitudinal speed (knots)
Lateral speed (knots)
7.4
6.2
5.0
3.8
2.6
0.8
0.6
0.4
0.2
0min
5min
10min
15min
20min


Underkeel Clearance and Speed over Ground
Bow UKC
Stern UKC
SOG
Underkeel clearance (m)
SOG (kt)
32.0
24.0
16.0
8.0
0.0
9.0
6.0
3.0
0.0
0min
5min
10min
15min
20min

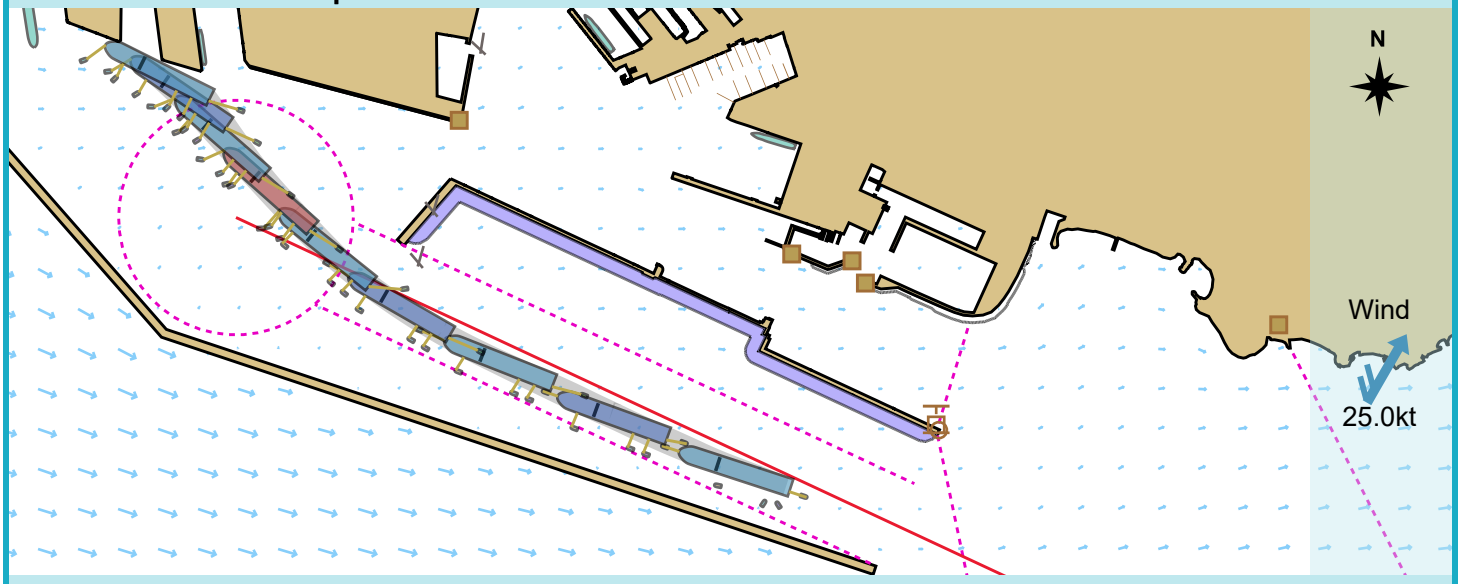

Propeller RPM
RPM
Propeller RPM
50
40
30
20
10
0
-10
-20
-30
-40
-50
0min
5min
10min
15min
20min


Rudder angle
Rudder
Rudder angle (°)
40
30
20
10
0
-10
-20
-30
-40
0min
5min
10min
15min
20min


Thruster
Bow %
Bow thruster (%Power)
100
50
0
-50
-100
0min
5min
10min
15min
20min

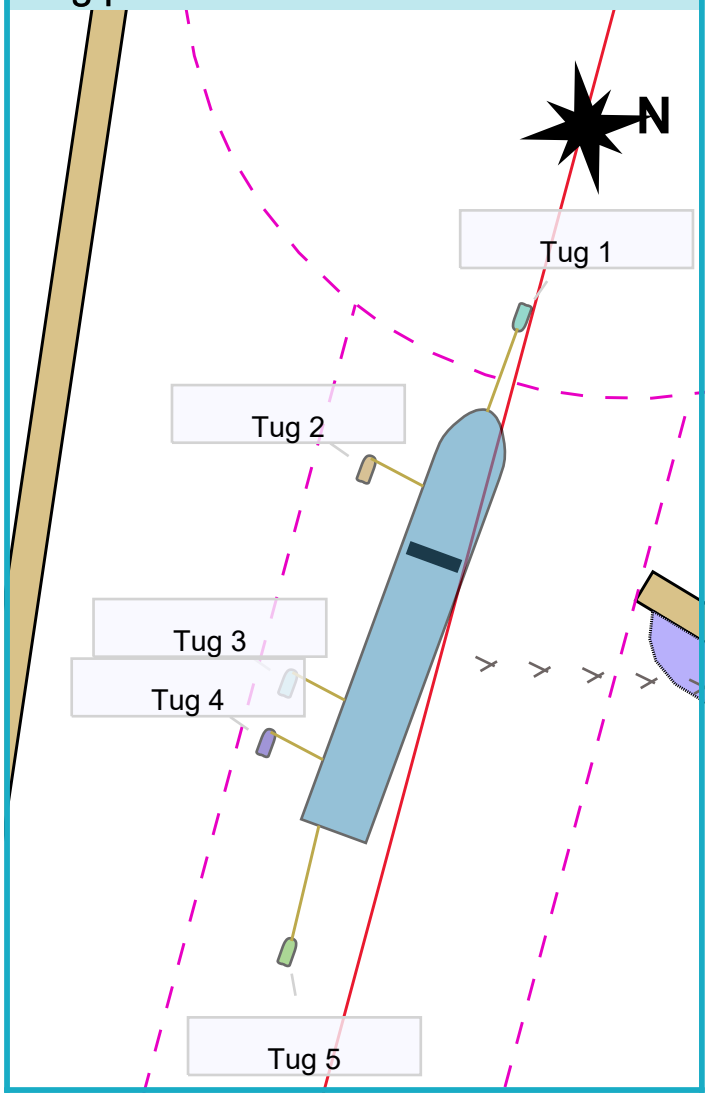

Engine Restarts
Restarts
Restarts
2.5
2.0
1.5
1.0
0.5
0.0
0min
5min
10min
15min
20min

Manoeuvre track plot

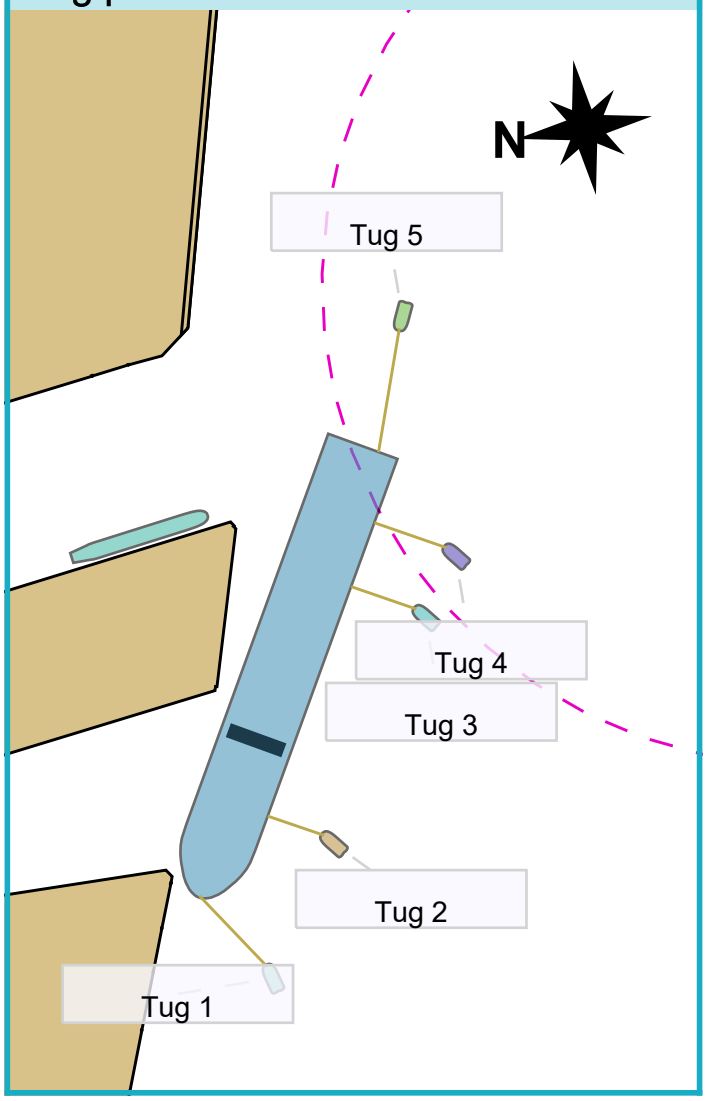


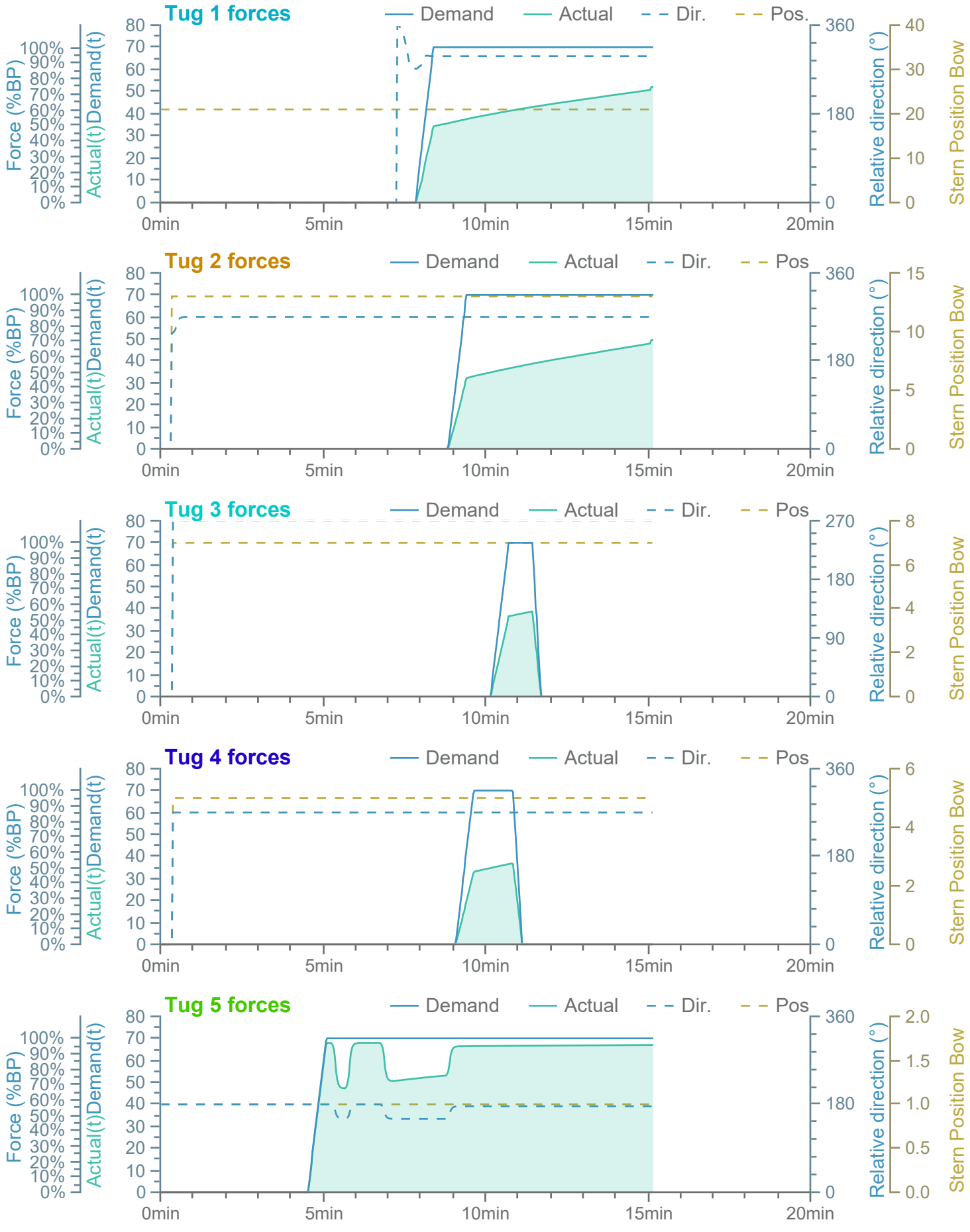
Ships plotted every 2 mins, highlight every 10 mins

Tug position: Initial

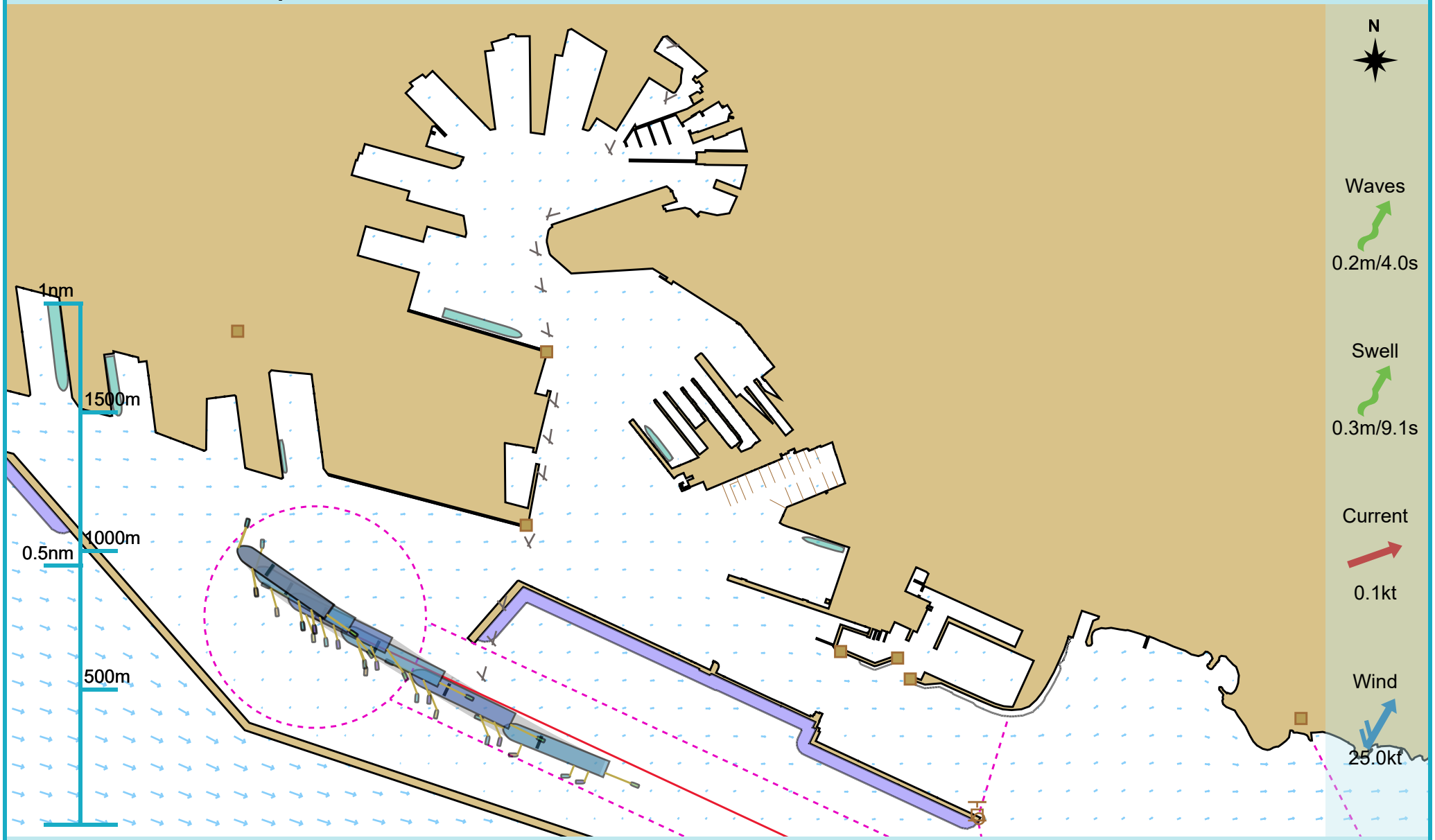


Tug position: Final

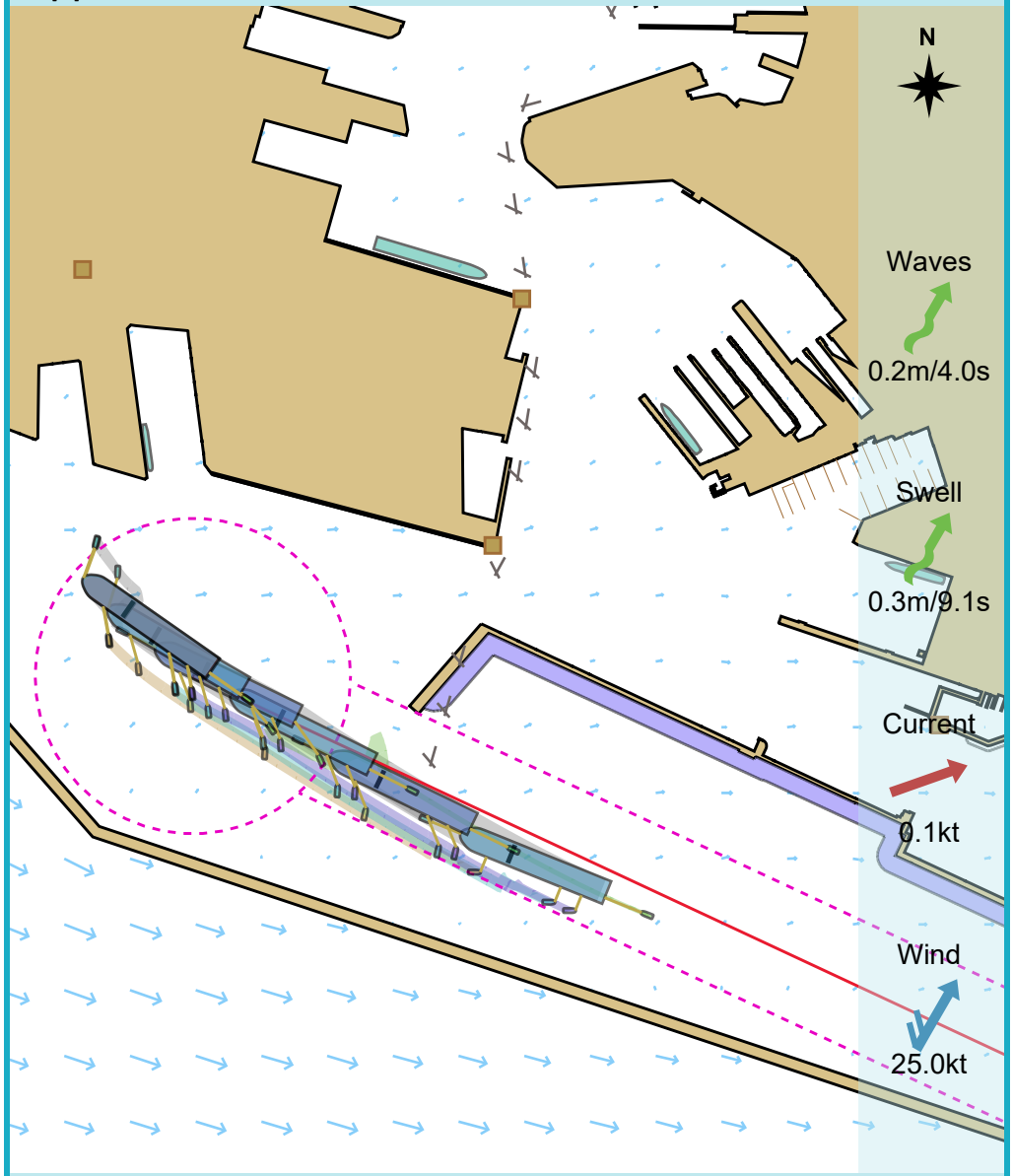



Tug 1 forces
Demand
Actual
Dir.
Pos.
Force (%BP)
Actual(t)Demand(t)
Relative direction (°)
Stern Position Bow
0min
5min
10min
15min
20min
Tug 2 forces
Demand
Actual
Dir.
Pos
Tug 3 forces
Demand
Actual
Dir.
Pos
Tug 4 forces
Demand
Actual
Dir.
Pos
Tug 5 forces
Demand
Actual
Dir.
Pos

Manoeuvre track plot

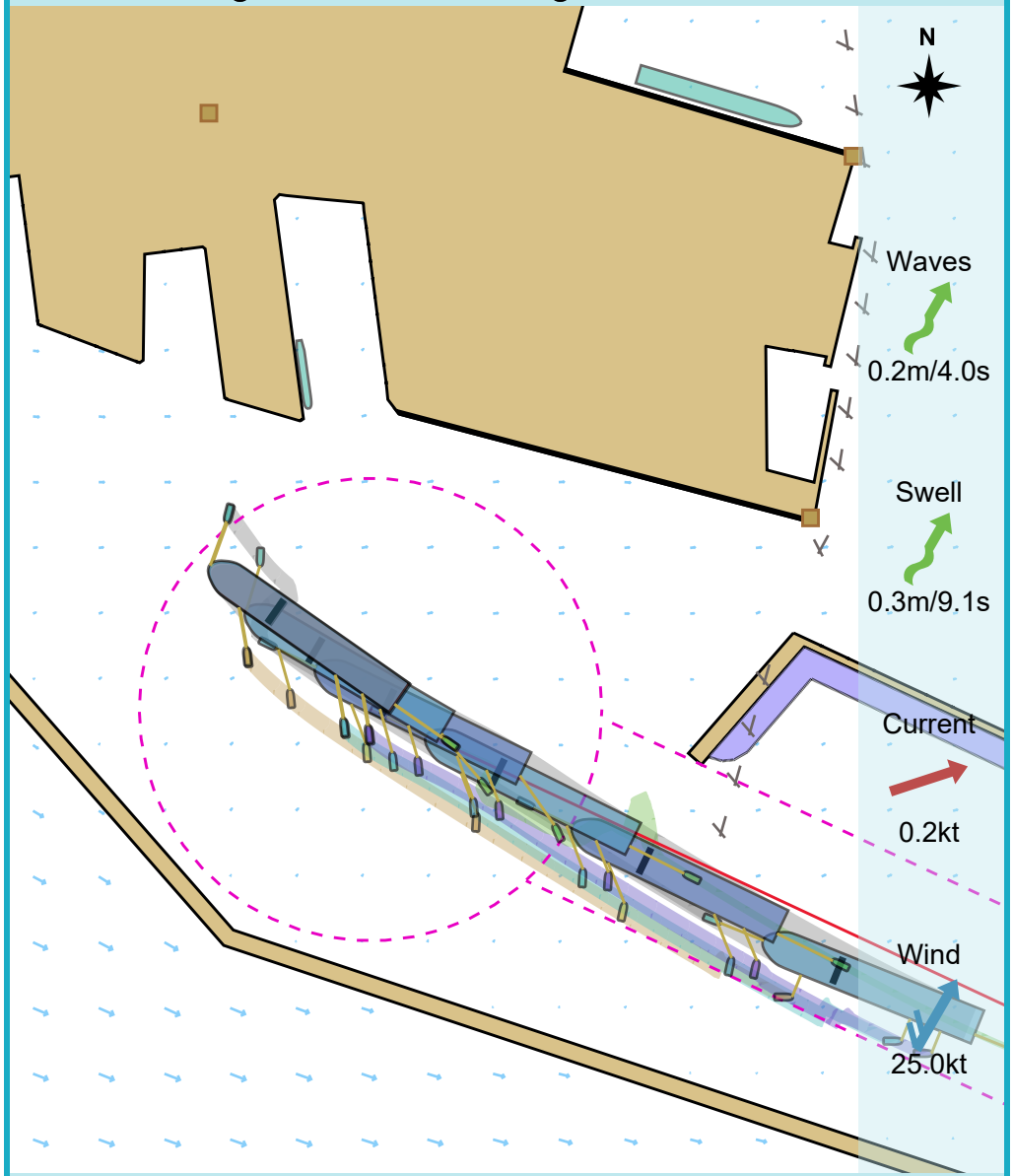


Approach Channel

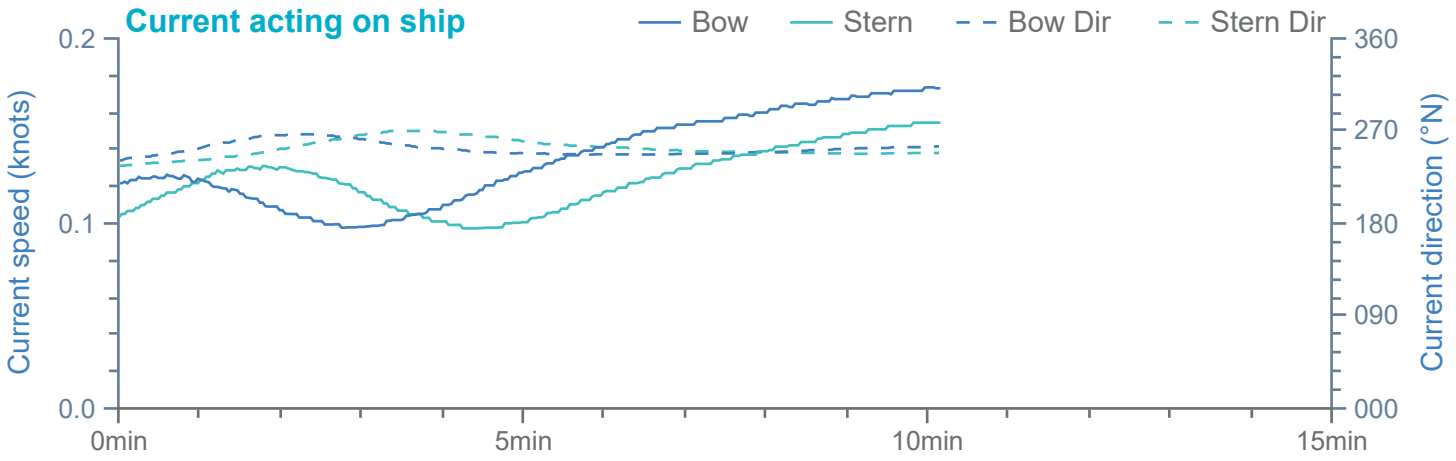


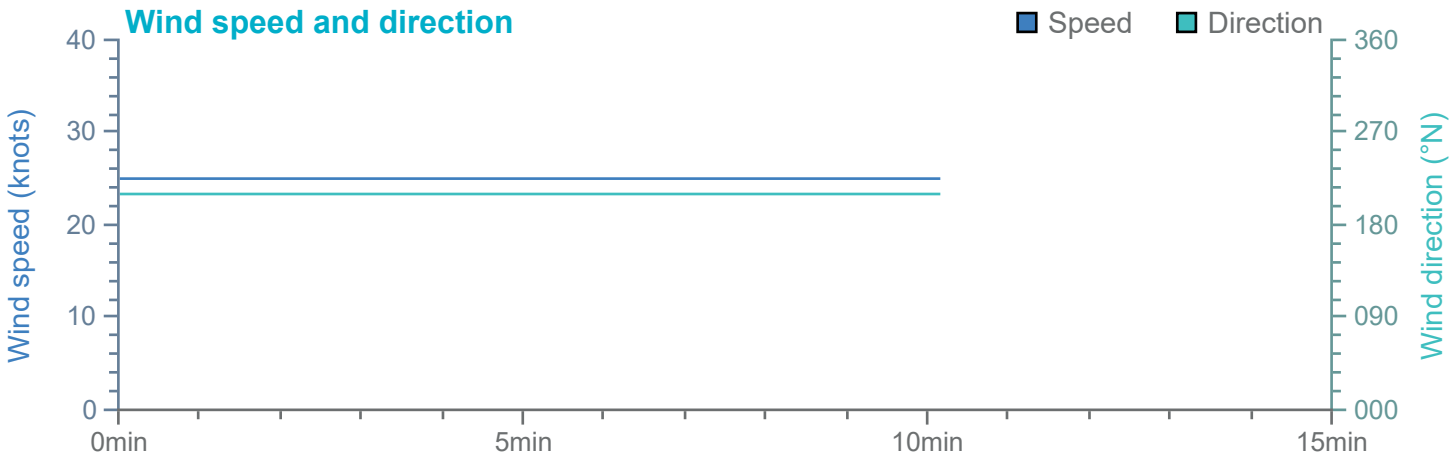
Ships plotted every 2 mins, highlight every 10 mins

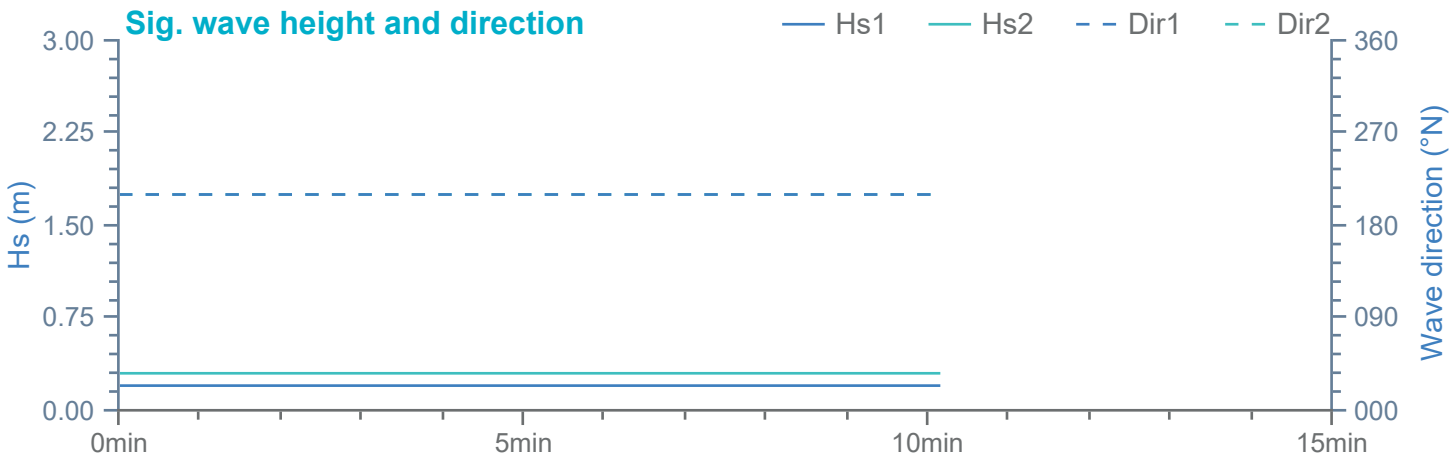
Manoeuvring area and berthing

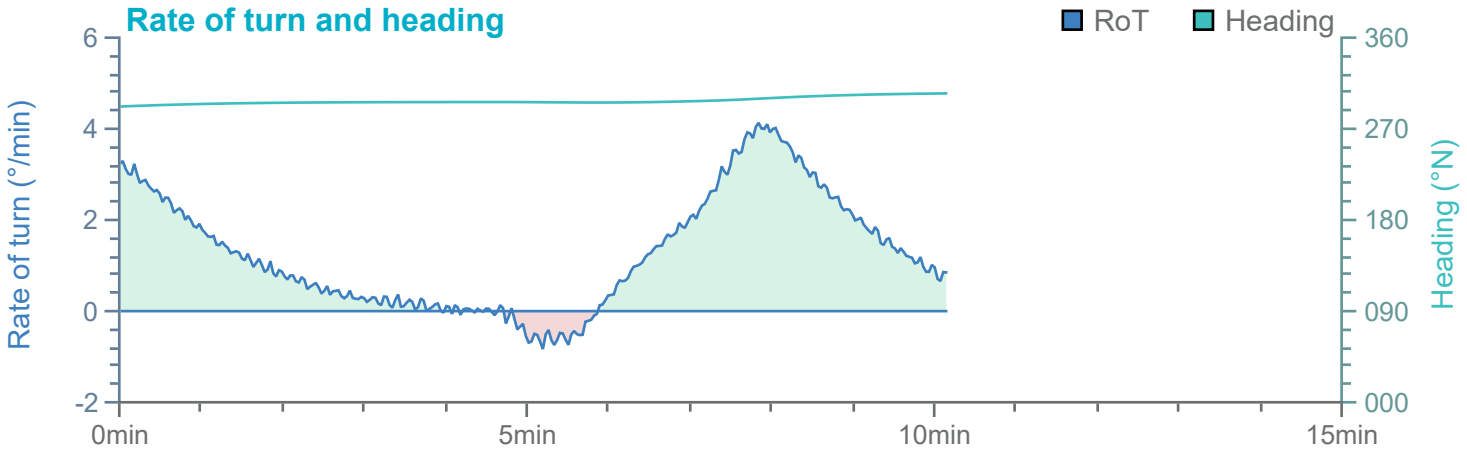


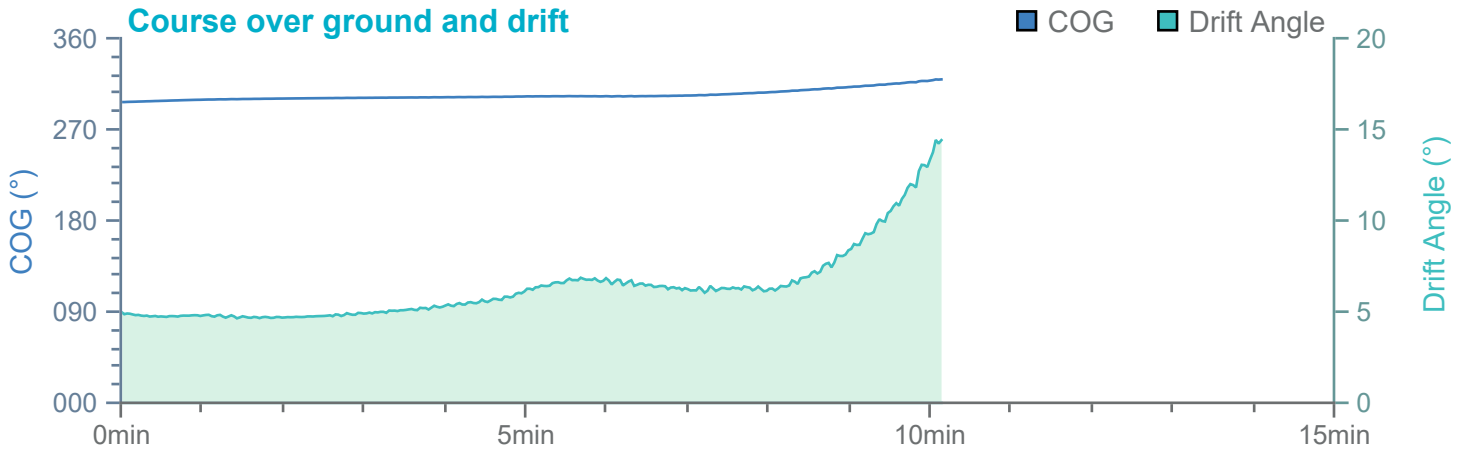
Ships plotted every 2 mins, highlight every 10 mins

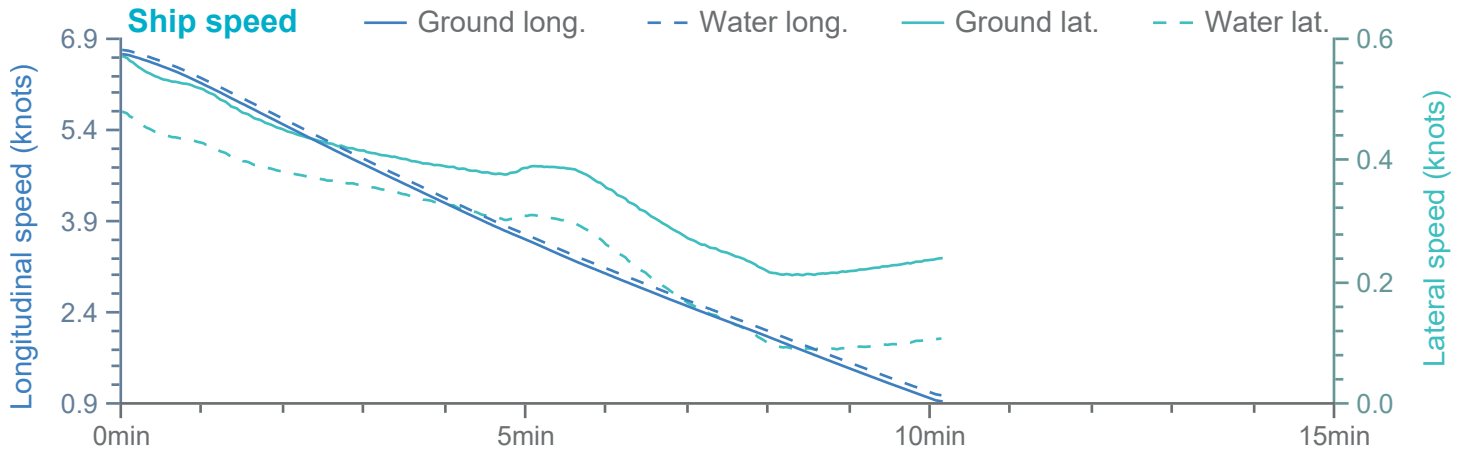

Current acting on ship
Bow
Stern
Bow Dir
Stern Dir
Current speed (knots)
0.2
0.1
0.0
Current direction (°N)
360
270
180
090
000
0min
5min
10min
15min

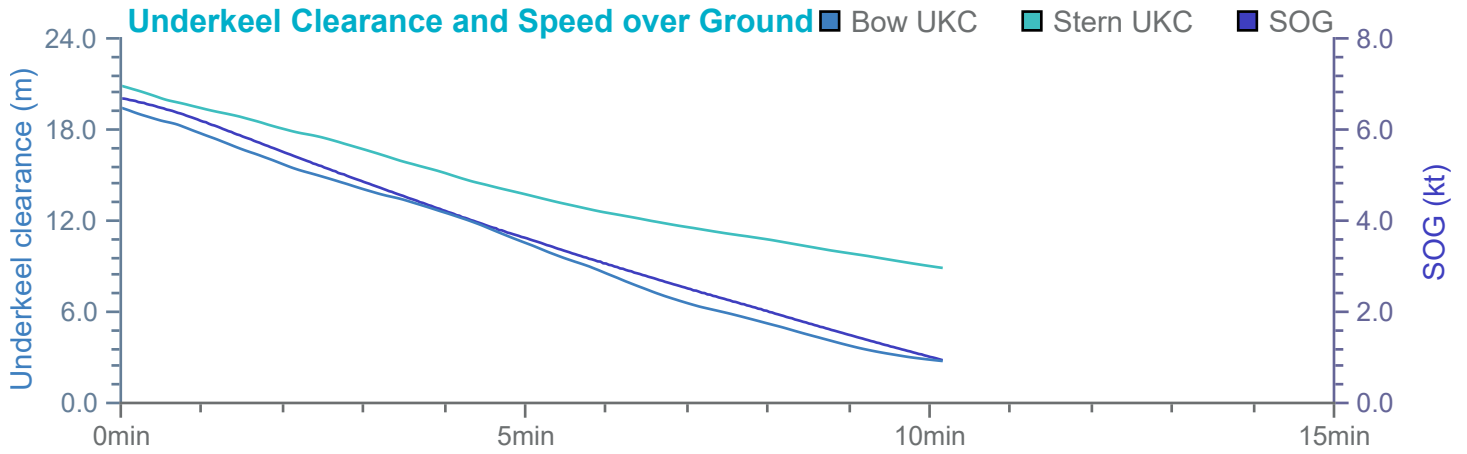

Wind speed and direction
Speed
Direction
Wind speed (knots)
40
30
20
10
0
Wind direction (°N)
360
270
180
090
000
0min
5min
10min
15min

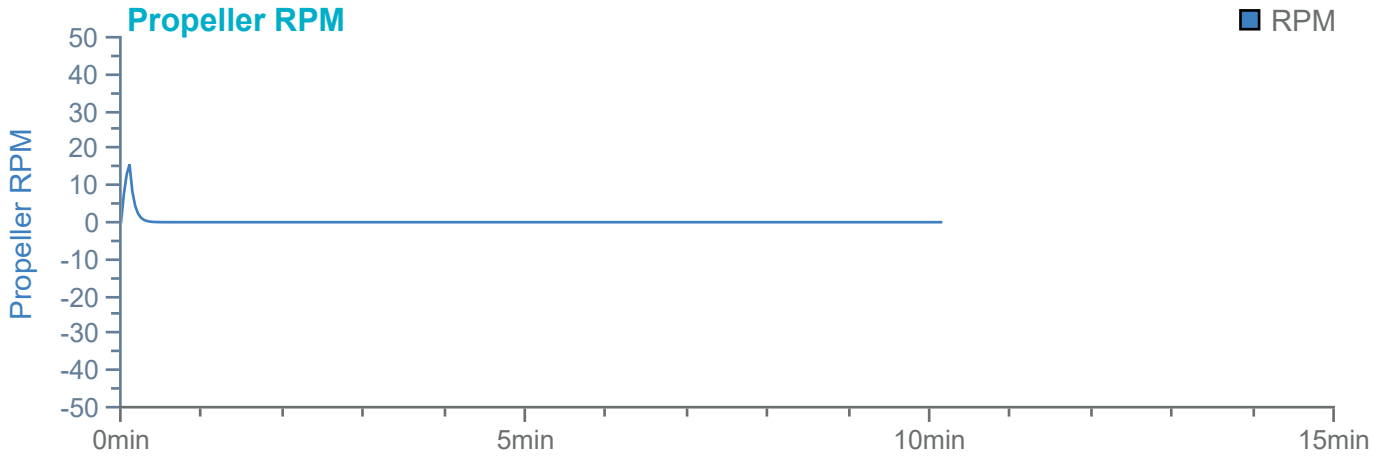

Sig. wave height and direction
Hs1
Hs2
Dir1
Dir2
Hs (m)
3.00
2.25
1.50
0.75
0.00
Wave direction (°N)
360
270
180
090
000
0min
5min
10min
15min

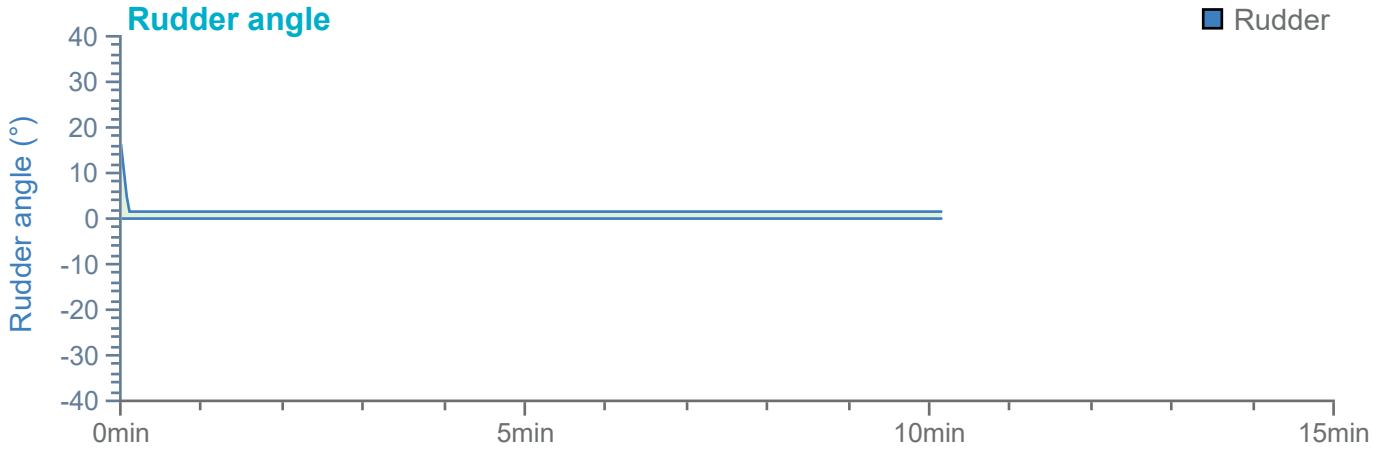

Rate of turn and heading
RoT
Heading
Rate of turn (°/min)
Heading (°N)
6
4
2
0
-2
360
270
180
090
000
0min
5min
10min
15min

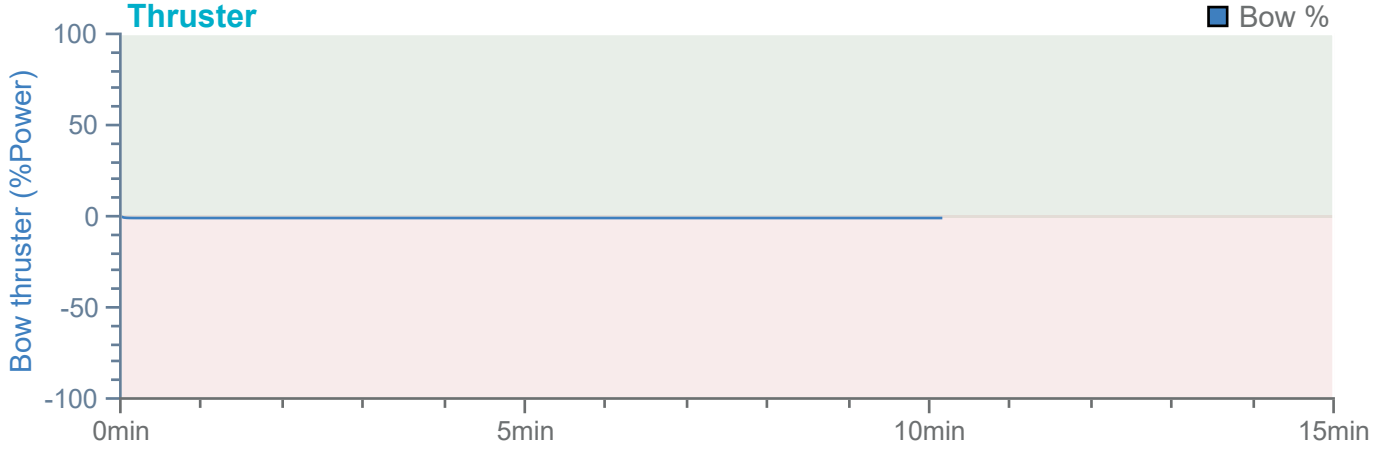

Course over ground and drift
COG
Drift Angle
COG (°)
Drift Angle (°)
360
270
180
090
000
20
15
10
5
0
0min
5min
10min
15min


Ship speed
Ground long.
Water long.
Ground lat.
Water lat.
Longitudinal speed (knots)
Lateral speed (knots)
6.9
5.4
3.9
2.4
0.9
0.6
0.4
0.2
0.0
0min
5min
10min
15min

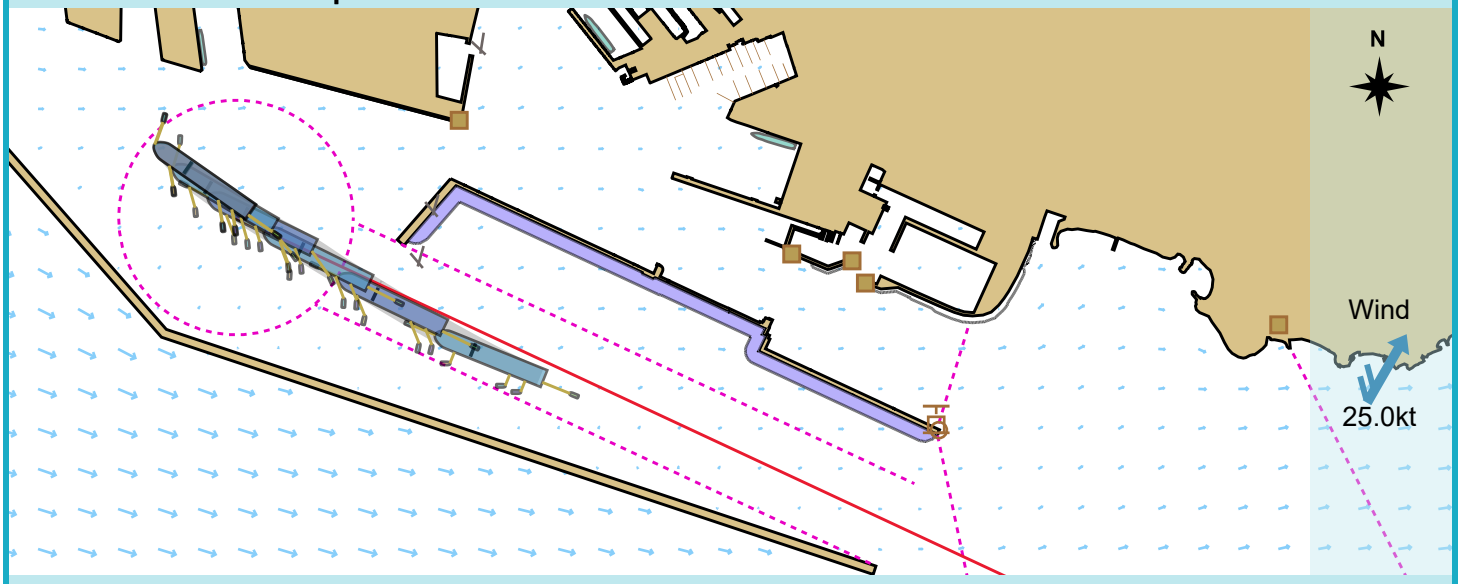

Underkeel Clearance and Speed over Ground
Bow UKC
Stern UKC
SOG
Underkeel clearance (m)
SOG (kt)
24.0
18.0
12.0
6.0
0.0
8.0
6.0
4.0
2.0
0.0
0min
5min
10min
15min


Propeller RPM
RPM
Propeller RPM
50
40
30
20
10
0
-10
-20
-30
-40
-50
0min
5min
10min
15min


Rudder angle
Rudder
Rudder angle (°)
40
30
20
10
0
-10
-20
-30
-40
0min
5min
10min
15min

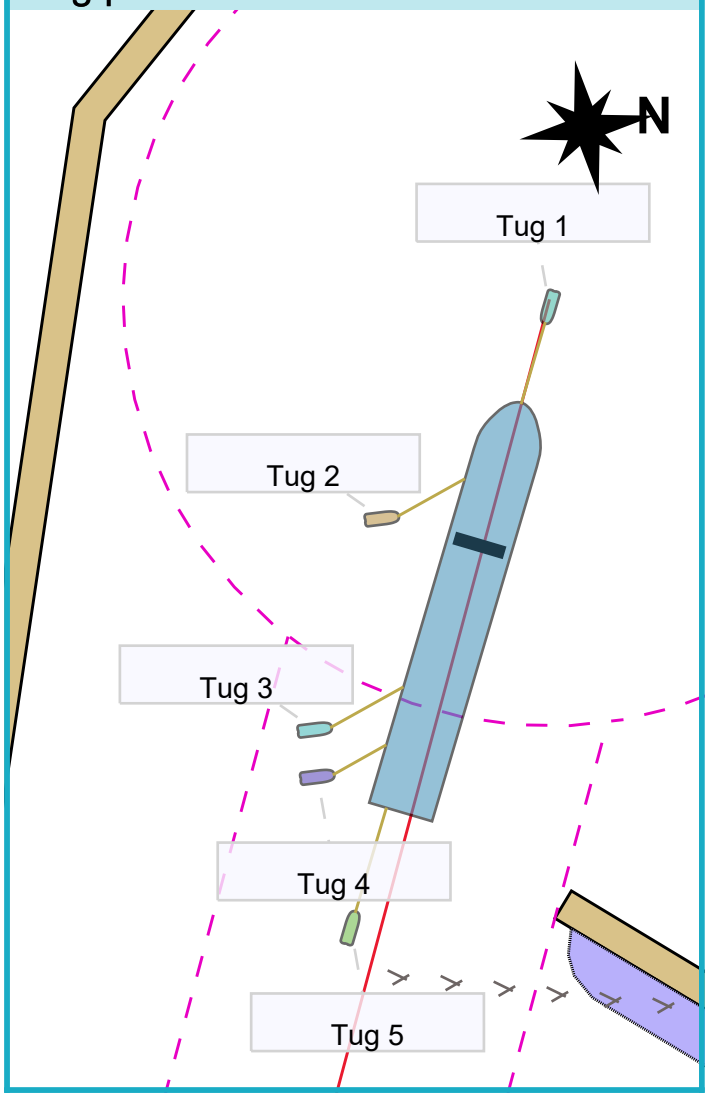

Thruster
Bow %
Bow thruster (%Power)
100
50
0
-50
-100
0min
5min
10min
15min

Manoeuvre track plot

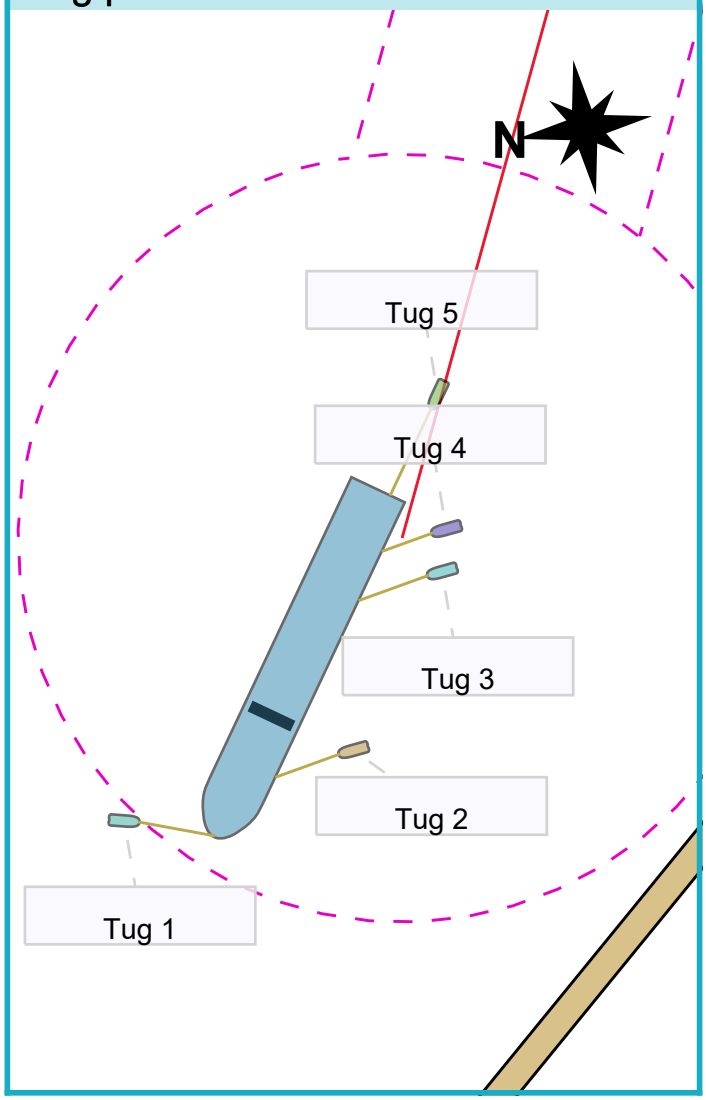


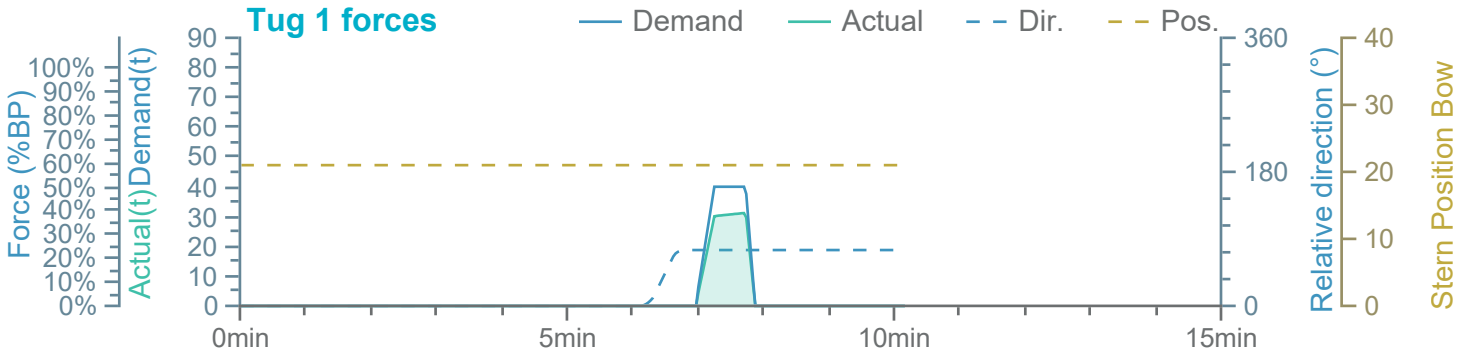
Ships plotted every 2 mins, highlight every 10 mins

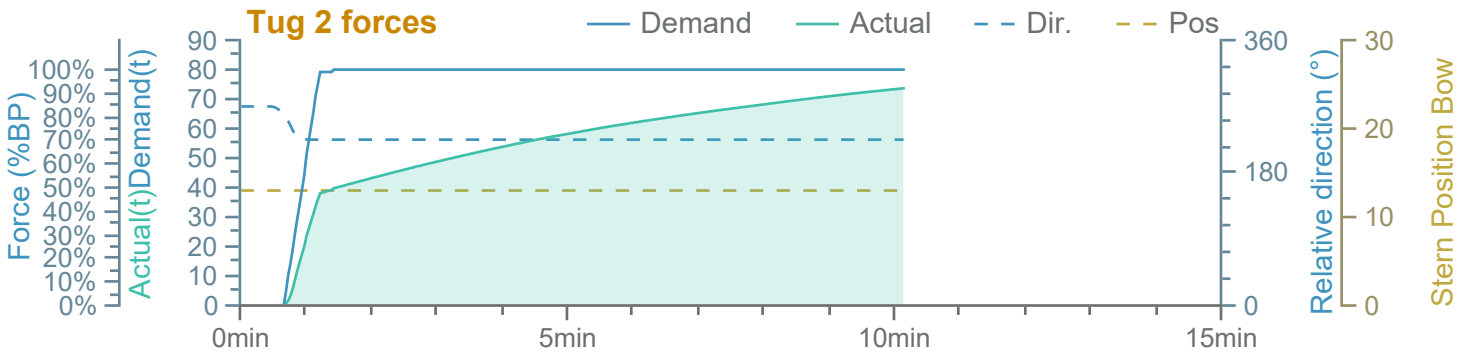
Tug position: Initial

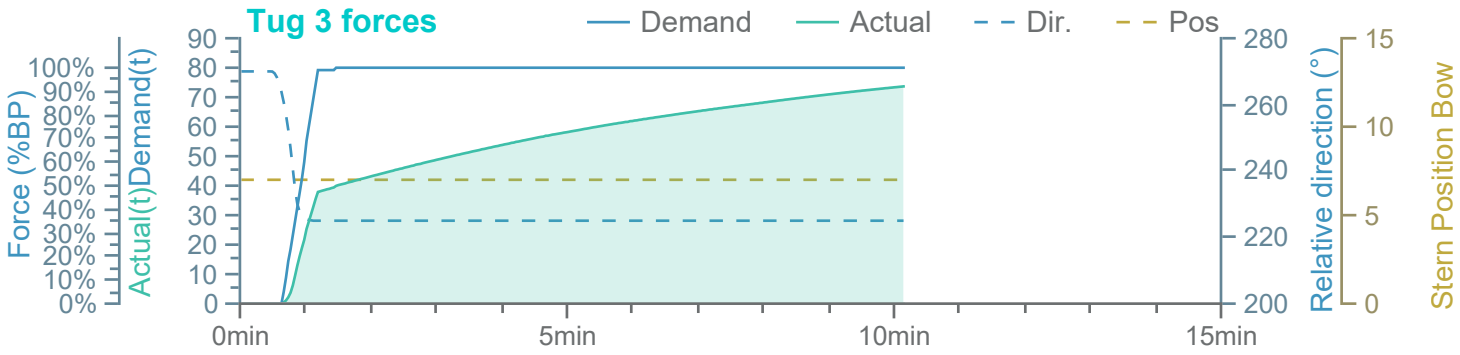


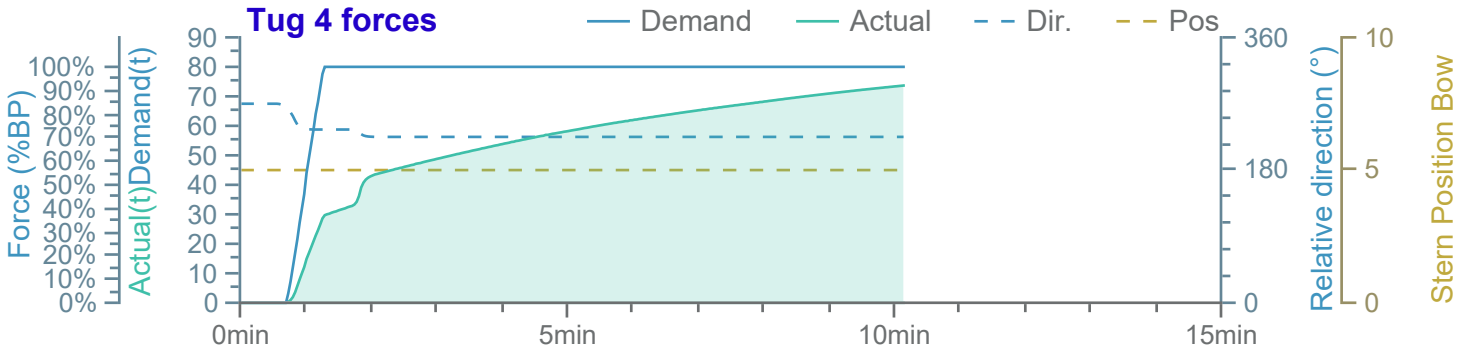
Tug position: Final

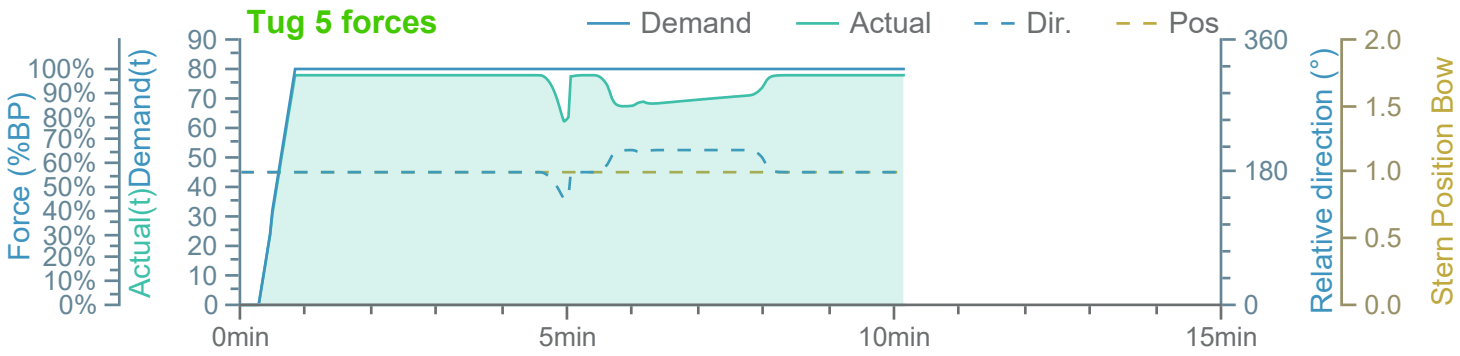



Tug 1 forces
Demand
Actual
Dir.
Pos.
Force (%BP)
Actual(t)Demand(t)
Relative direction (°)
Stern Position Bow
0min
5min
10min
15min

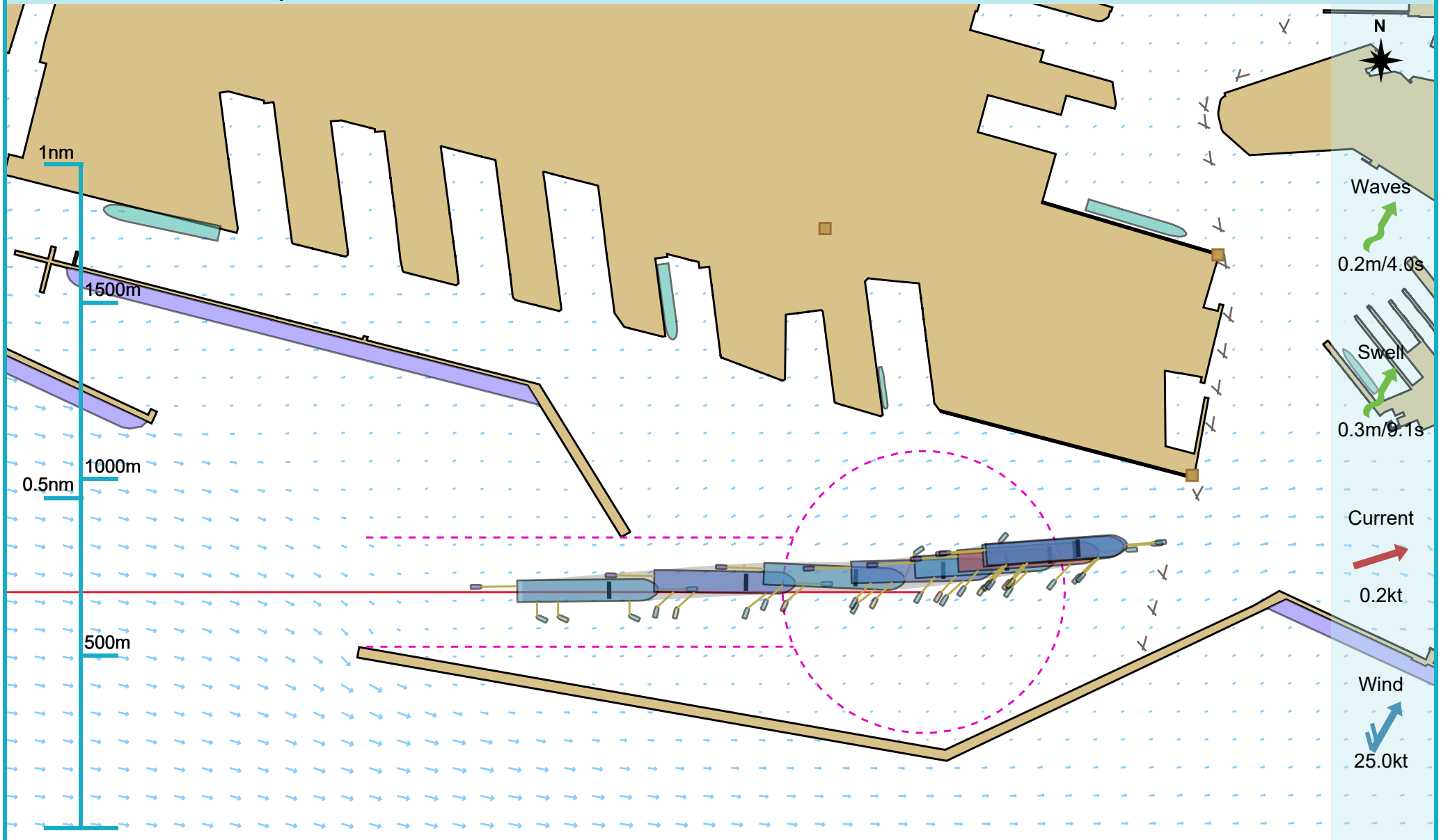

Tug 2 forces
Demand
Actual
Dir.
Pos
Force (%BP)
Actual(t)Demand(t)
Relative direction (°)
Stern Position Bow
0min
5min
10min
15min


Tug 3 forces
Demand
Actual
Dir.
Pos
Force (%BP)
Actual(t)Demand(t)
Relative direction (°)
Stern Position Bow
0min
5min
10min
15min


Tug 4 forces
Demand
Actual
Dir.
Pos
Force (%BP)
Actual(t)Demand(t)
Relative direction (°)
Stern Position Bow
0min
5min
10min
15min


Tug 5 forces
Demand
Actual
Dir.
Pos
Force (%BP)
Actual(t)Demand(t)
Relative direction (°)
Stern Position Bow
0min
5min
10min
15min

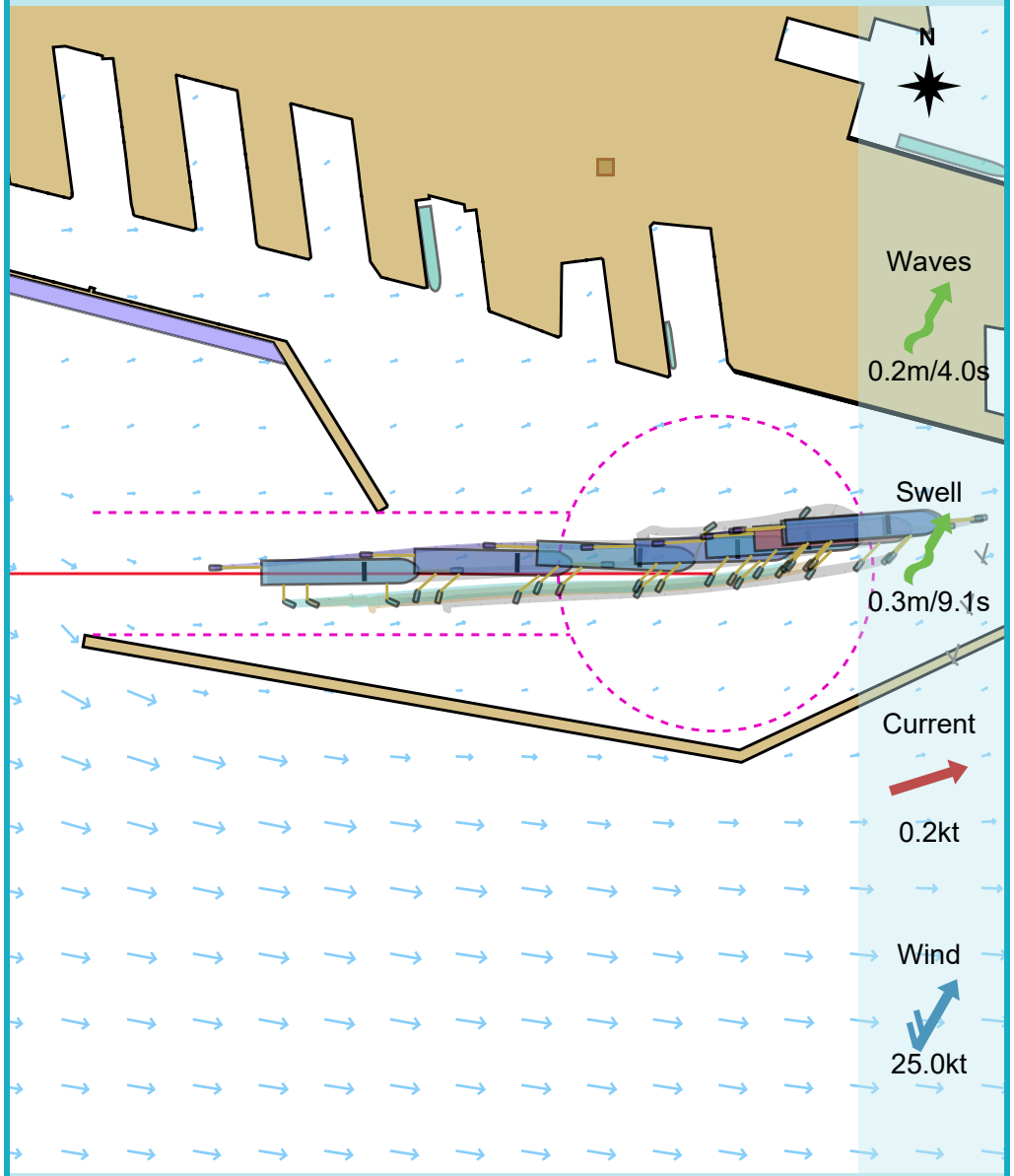
Manoeuvre track plot



0.76 kts

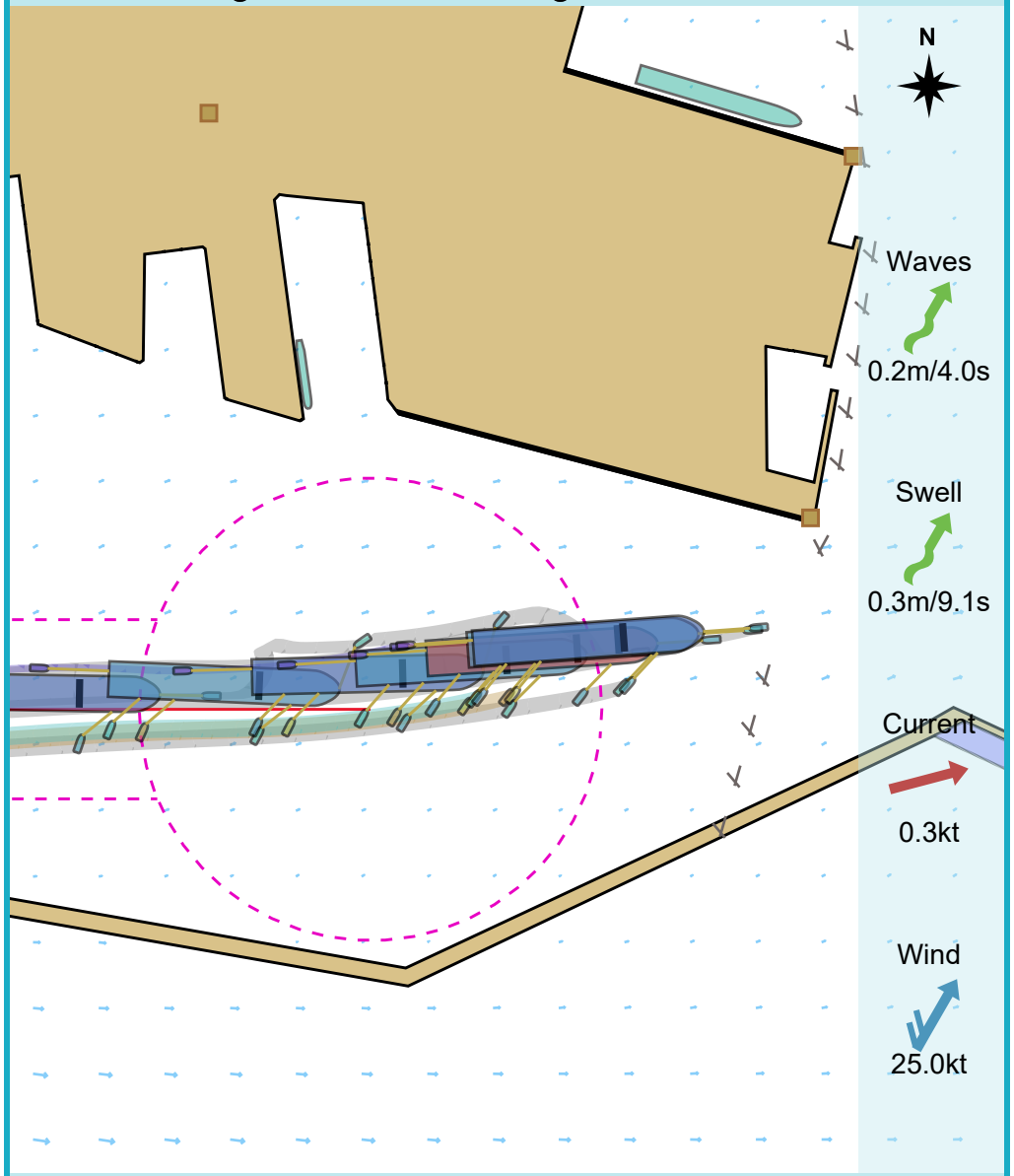
Ships plotted every 2 mins, highlight every 10 mins

Arrival Channel

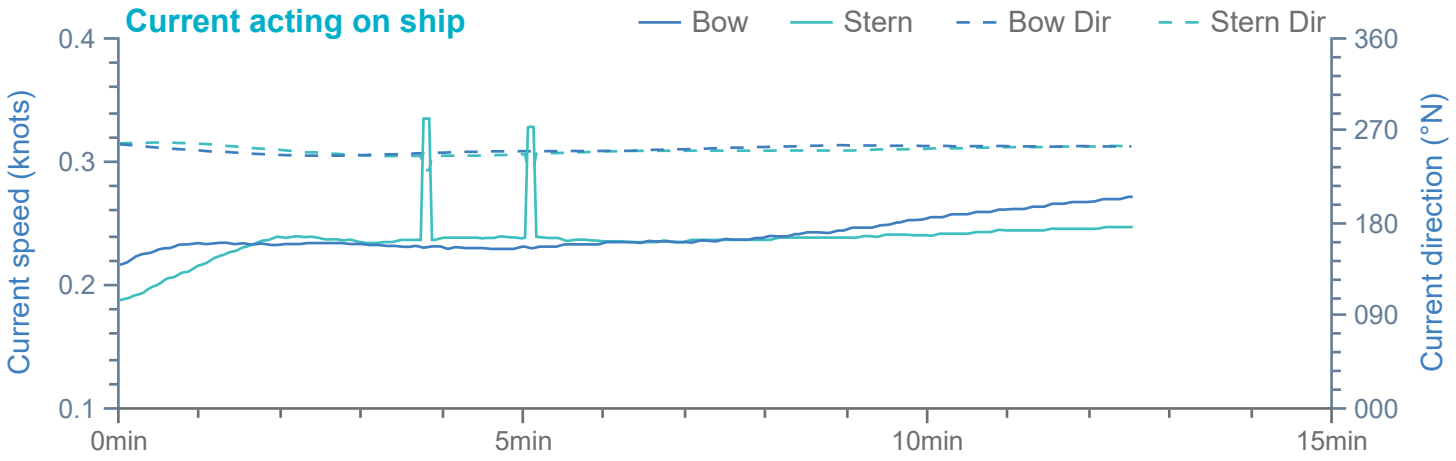


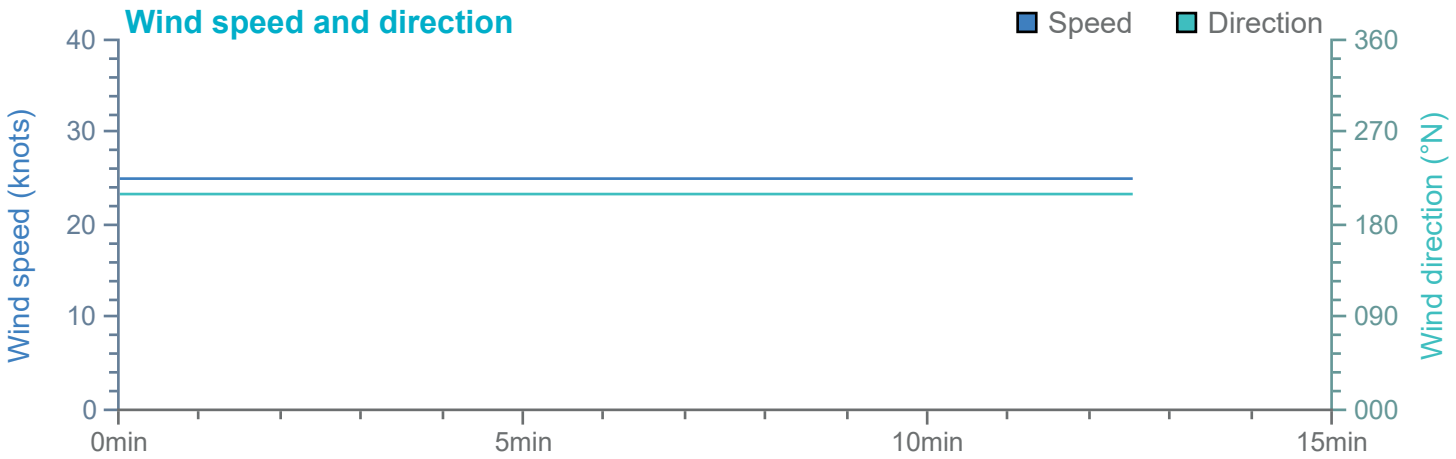
Ships plotted every 2 mins, highlight every 10 mins

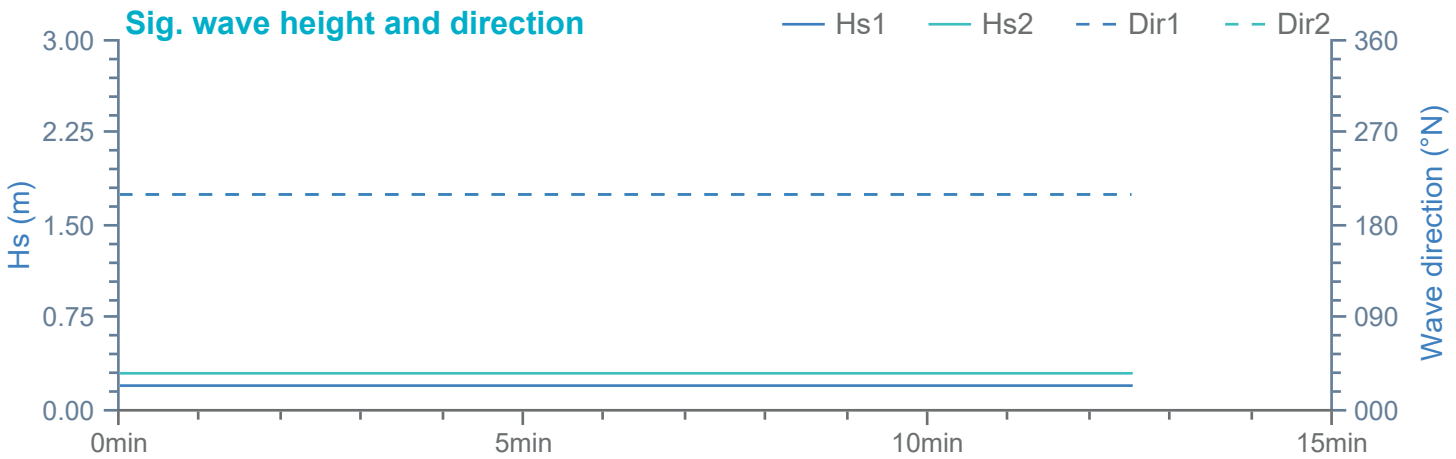
Manoeuvring area and berthing

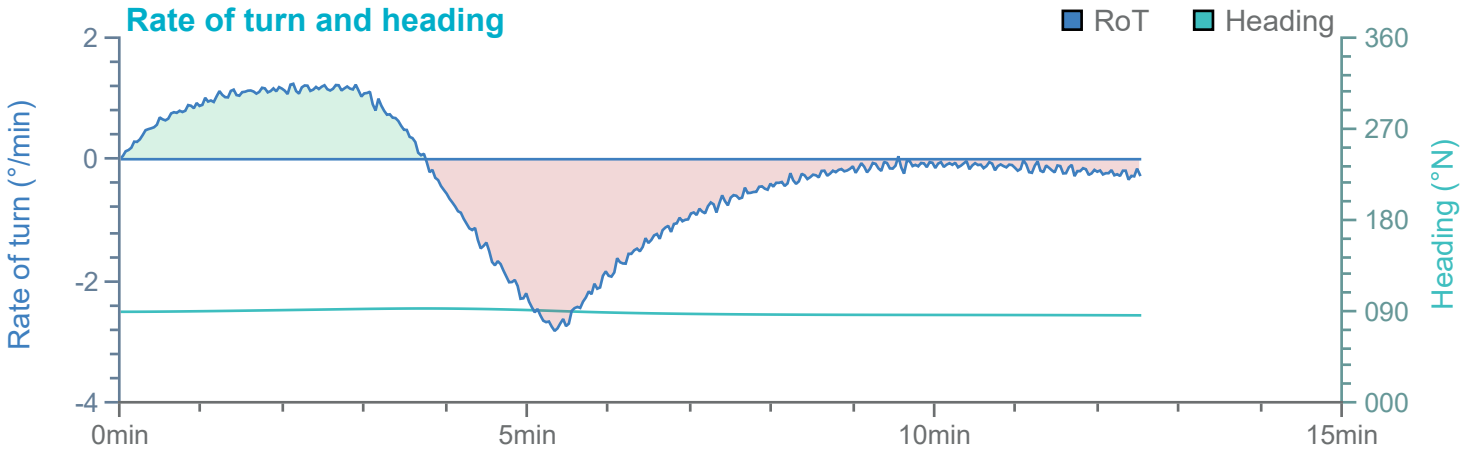


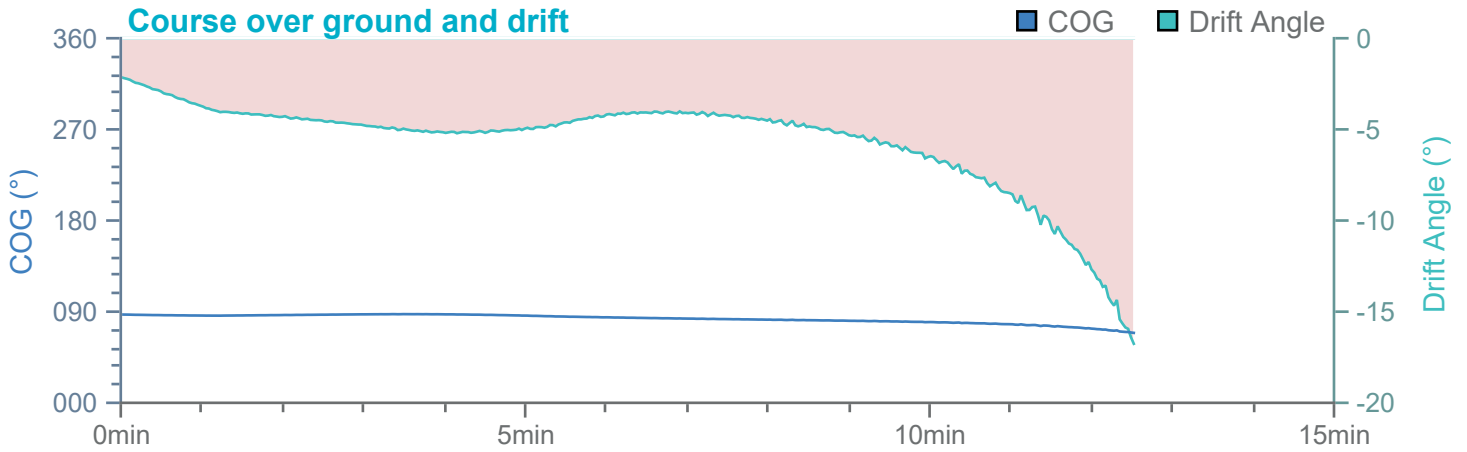
Ships plotted every 2 mins, highlight every 10 mins

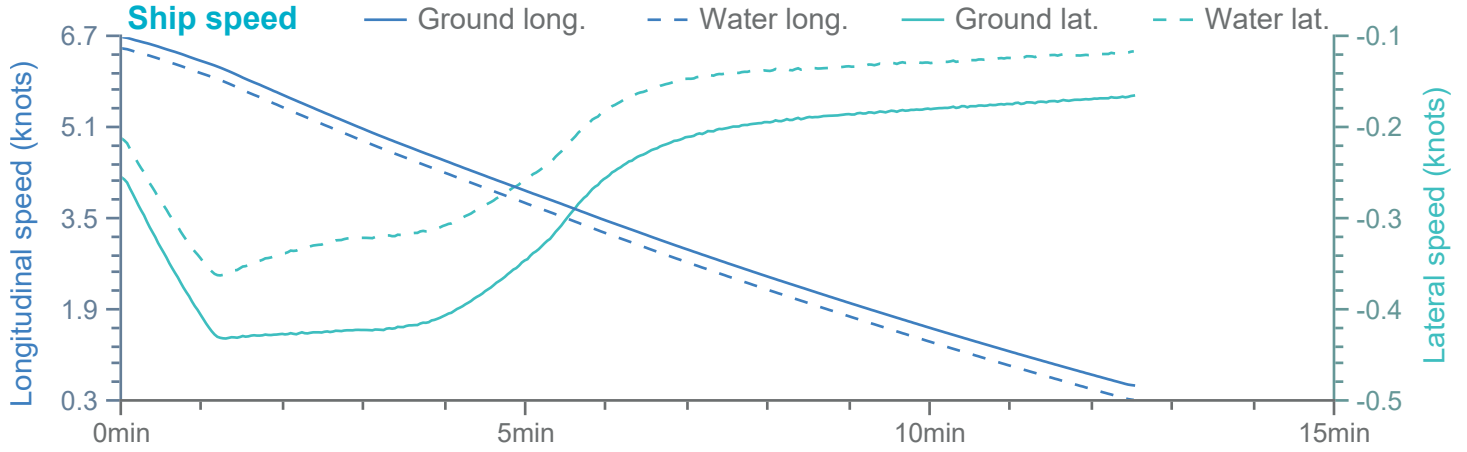

Current acting on ship
Bow
Stern
Bow Dir
Stern Dir
Current speed (knots)
0.4
0.3
0.2
0.1
Current direction (°N)
360
270
180
090
000
0min
5min
10min
15min

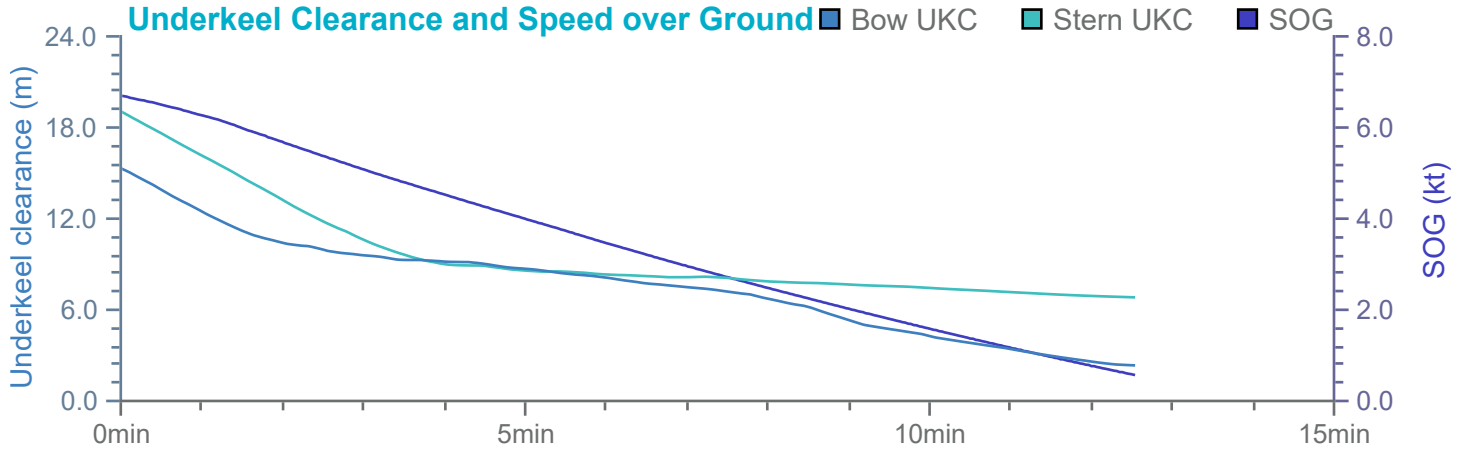

Wind speed and direction
Speed
Direction
Wind speed (knots)
40
30
20
10
0
Wind direction (°N)
360
270
180
090
000
0min
5min
10min
15min

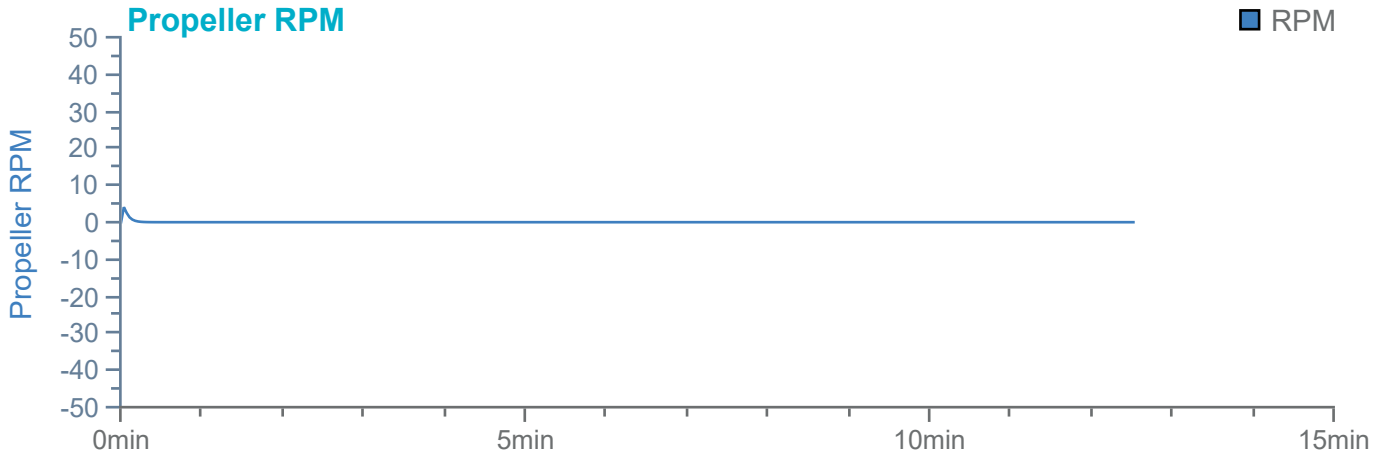

Sig. wave height and direction
Hs1
Hs2
Dir1
Dir2
Hs (m)
3.00
2.25
1.50
0.75
0.00
Wave direction (°N)
360
270
180
090
000
0min
5min
10min
15min

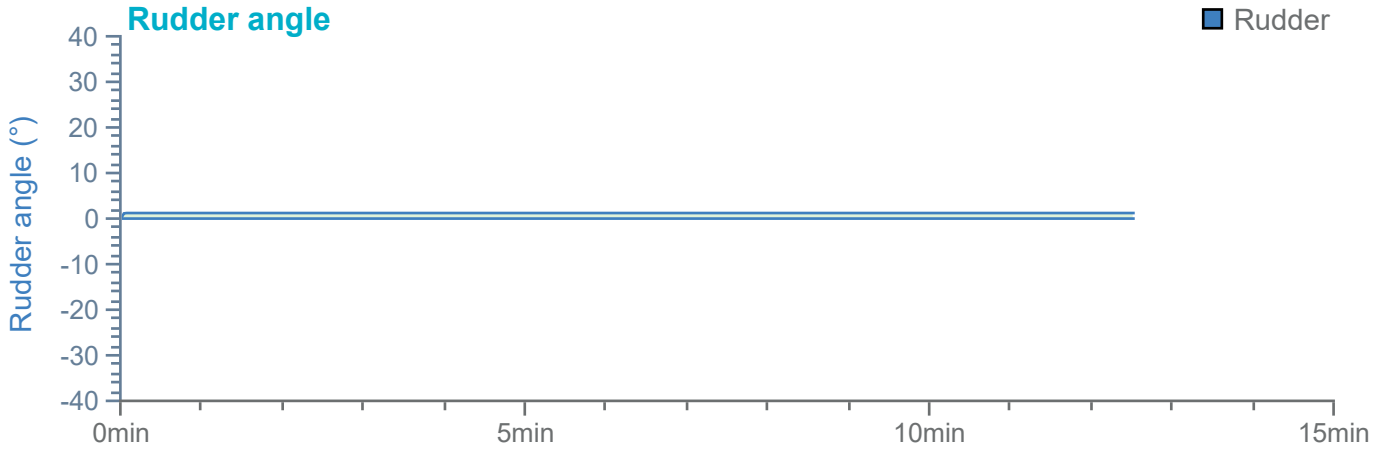

Rate of turn and heading
RoT
Heading
Rate of turn (°/min)
Heading (°N)
2
0
-2
-4
360
270
180
090
000
0min
5min
10min
15min

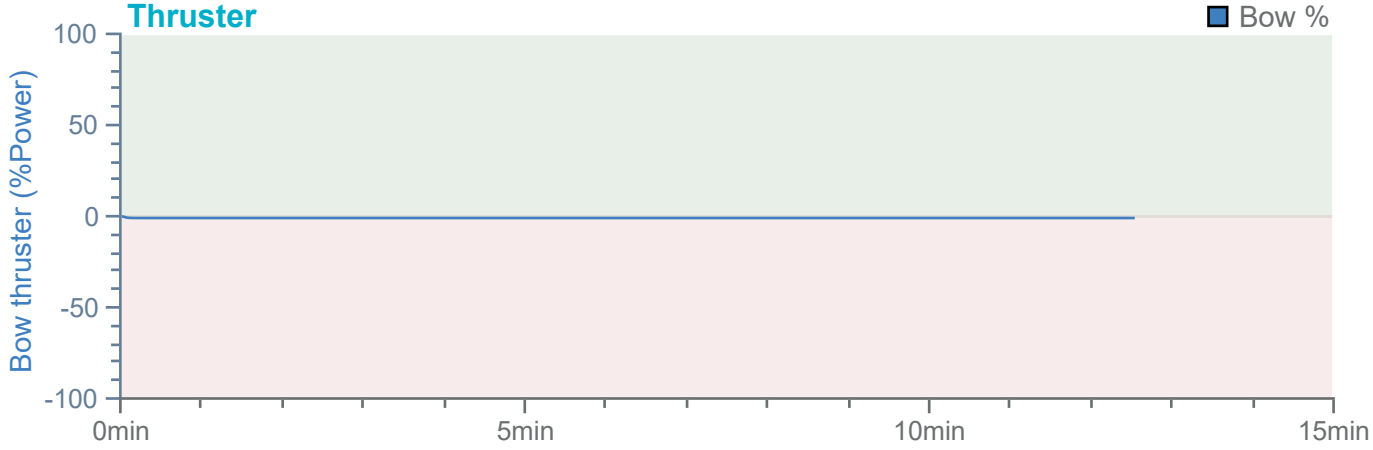

Course over ground and drift
COG
Drift Angle
COG (°)
Drift Angle (°)
360
270
180
090
000
0
-5
-10
-15
-20
0min
5min
10min
15min


Ship speed
Ground long.
Water long.
Ground lat.
Water lat.
Longitudinal speed (knots)
Lateral speed (knots)
6.7
5.1
3.5
1.9
0.3
-0.1
-0.2
-0.3
-0.4
-0.5
0min
5min
10min
15min

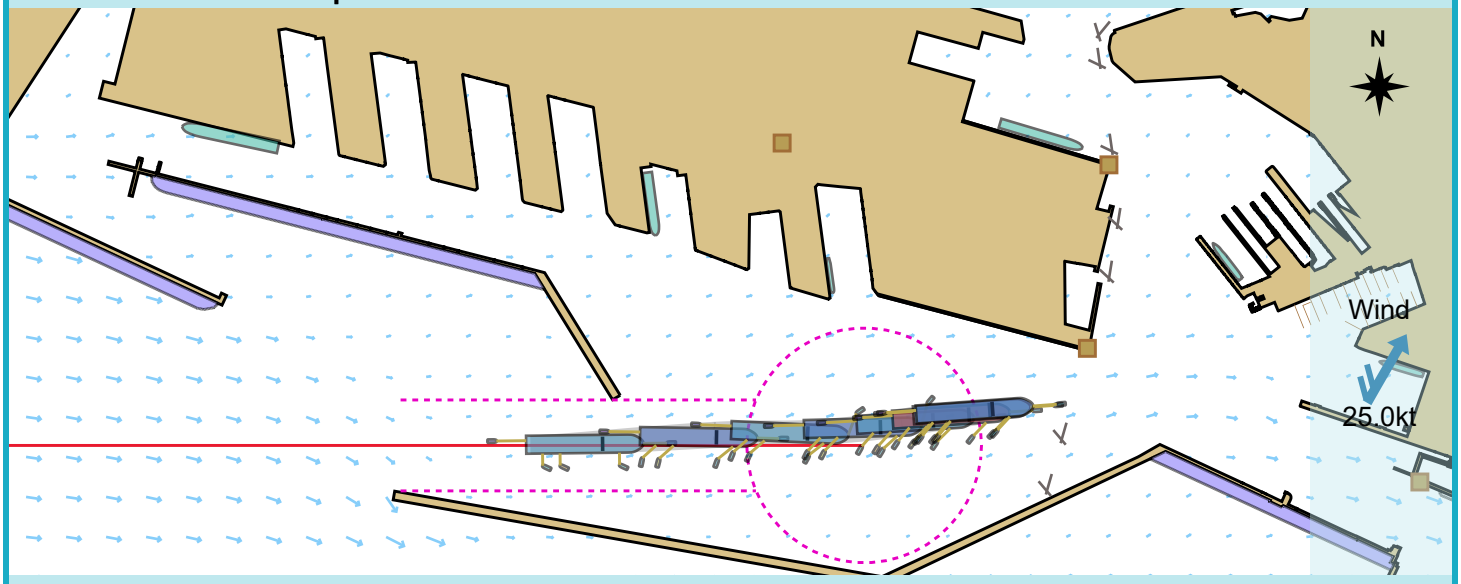

Underkeel Clearance and Speed over Ground
Bow UKC
Stern UKC
SOG
Underkeel clearance (m)
SOG (kt)
24.0
18.0
12.0
6.0
0.0
8.0
6.0
4.0
2.0
0.0
0min
5min
10min
15min


Propeller RPM
RPM
Propeller RPM
50
40
30
20
10
0
-10
-20
-30
-40
-50
0min
5min
10min
15min


Rudder angle
Rudder
Rudder angle (°)
40
30
20
10
0
-10
-20
-30
-40
0min
5min
10min
15min

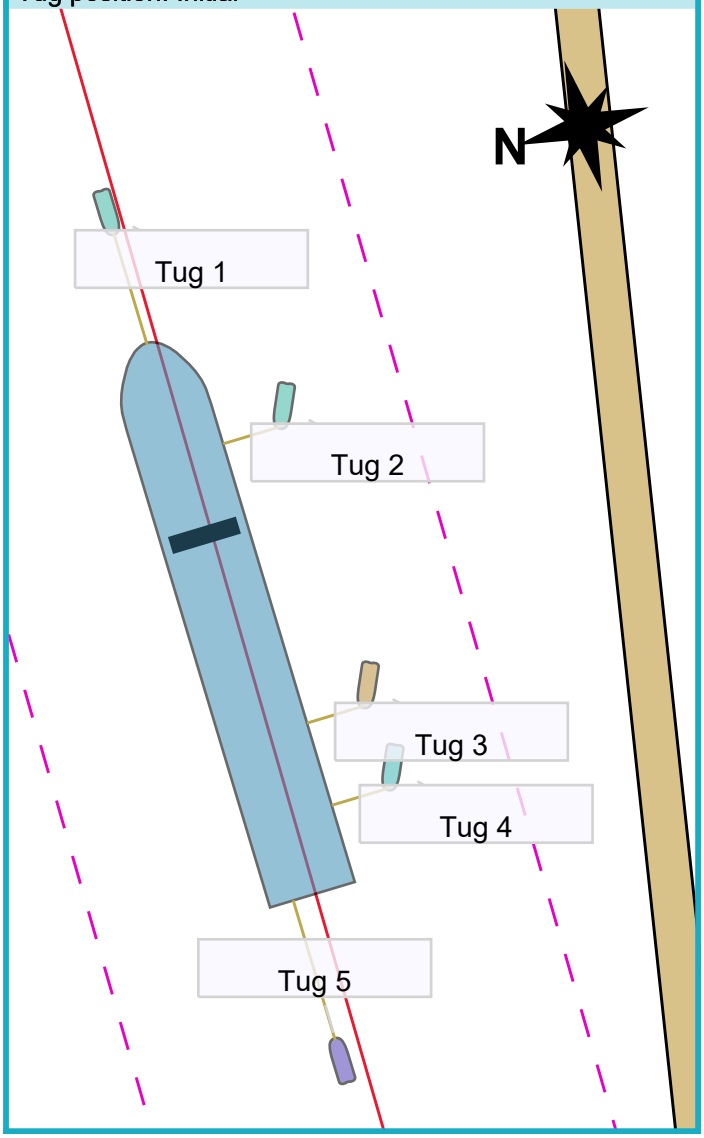

Thruster
Bow %
Bow thruster (%Power)
100
50
0
-50
-100
0min
5min
10min
15min

Manoeuvre track plot

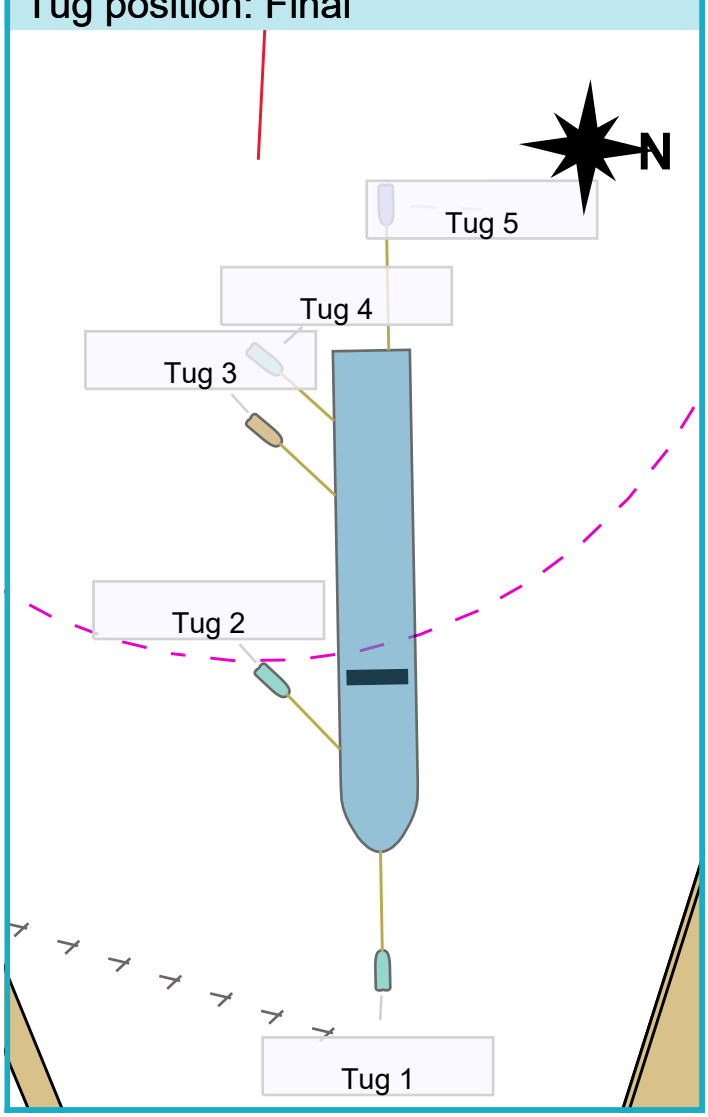


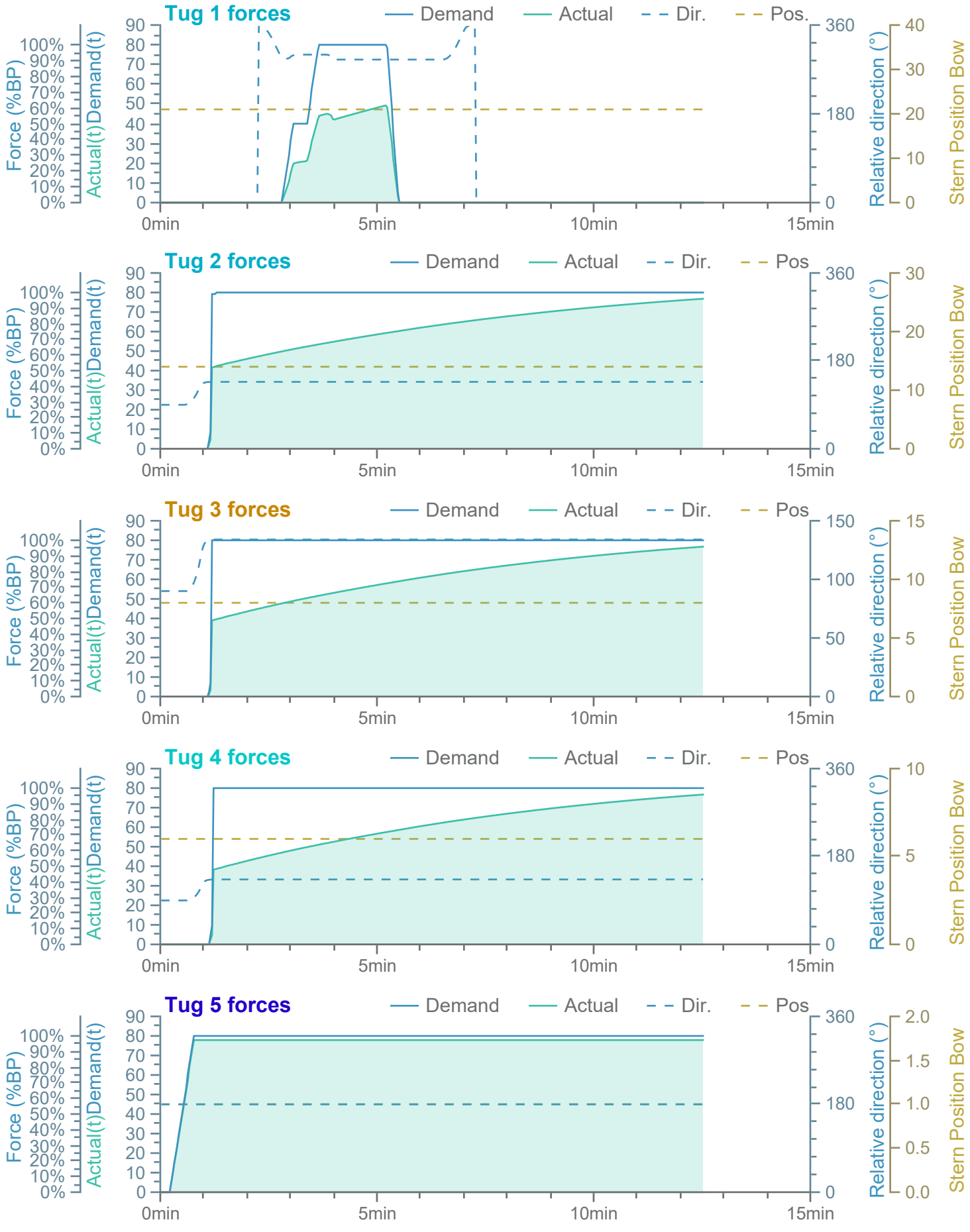
Ships plotted every 2 mins, highlight every 10 mins

Tug position: Initial

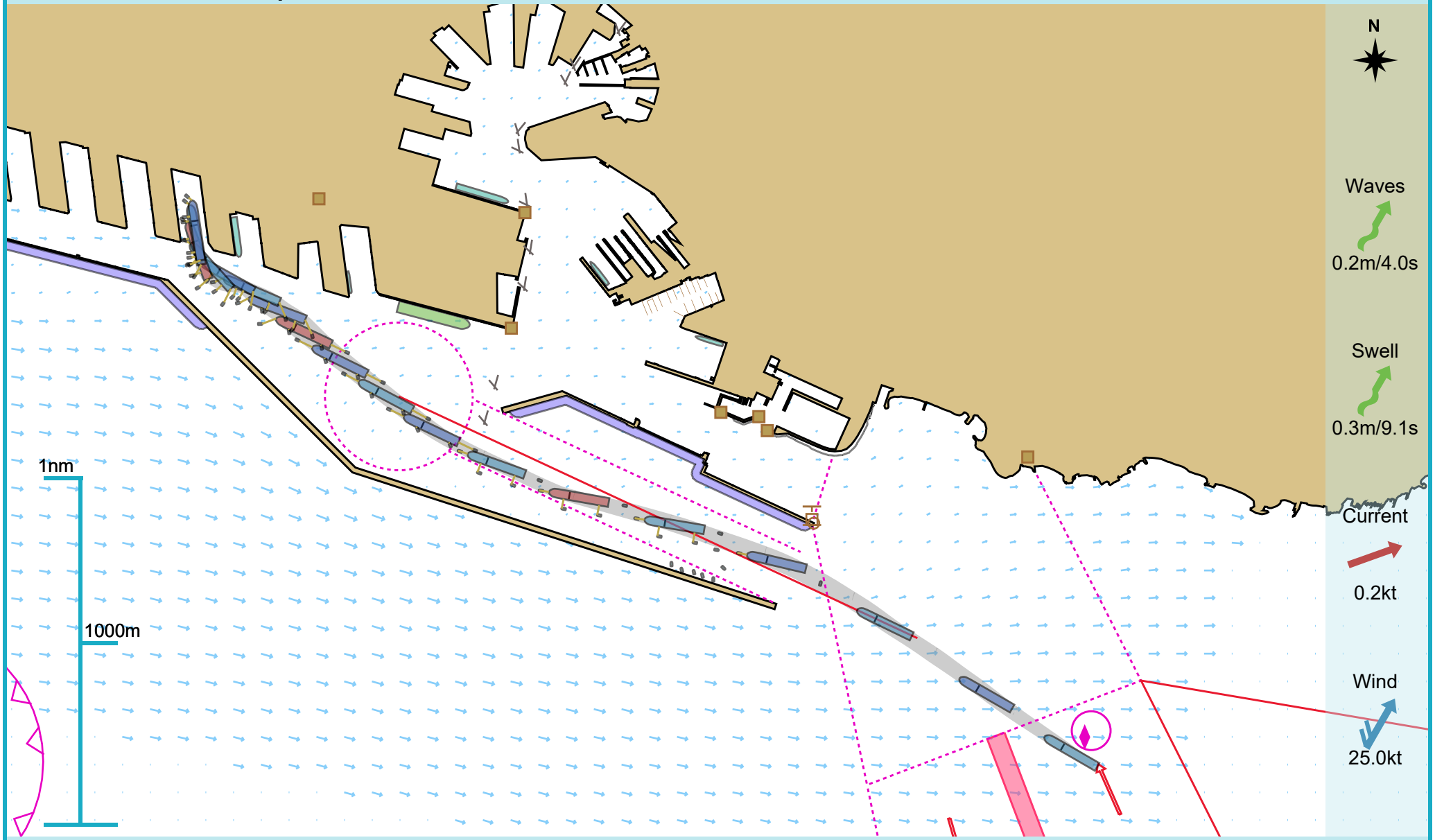


Tug position: Final

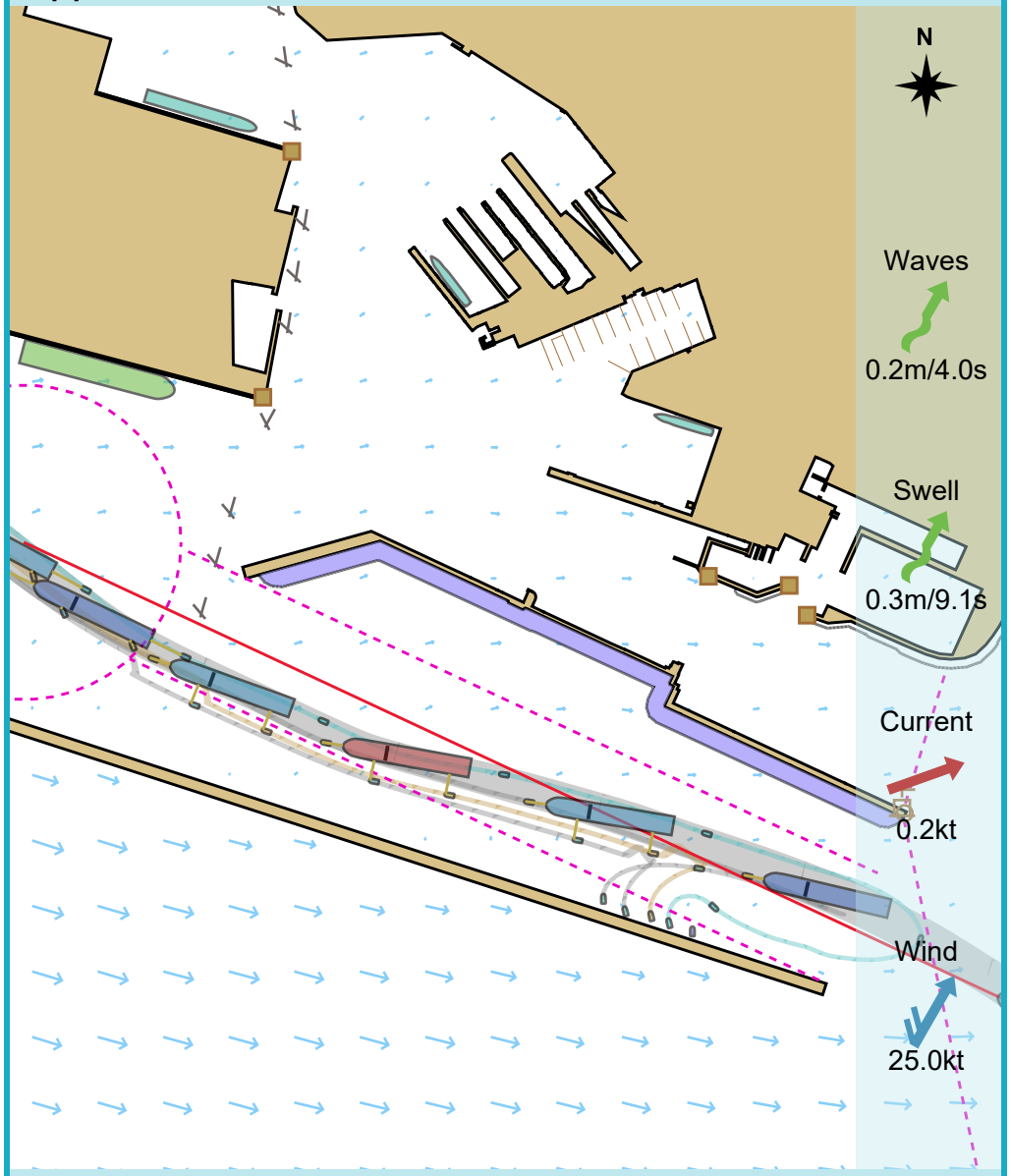



Tug 1 forces
Demand
Actual
Dir.
Pos.
Tug 2 forces
Demand
Actual
Dir.
Pos
Tug 3 forces
Demand
Actual
Dir.
Pos
Tug 4 forces
Demand
Actual
Dir.
Pos
Tug 5 forces
Demand
Actual
Dir.
Pos
Force (%BP)
Actual(t)Demand(t)
Relative direction (°)
Stern Position Bow
0min
5min
10min
15min

Manoeuvre track plot

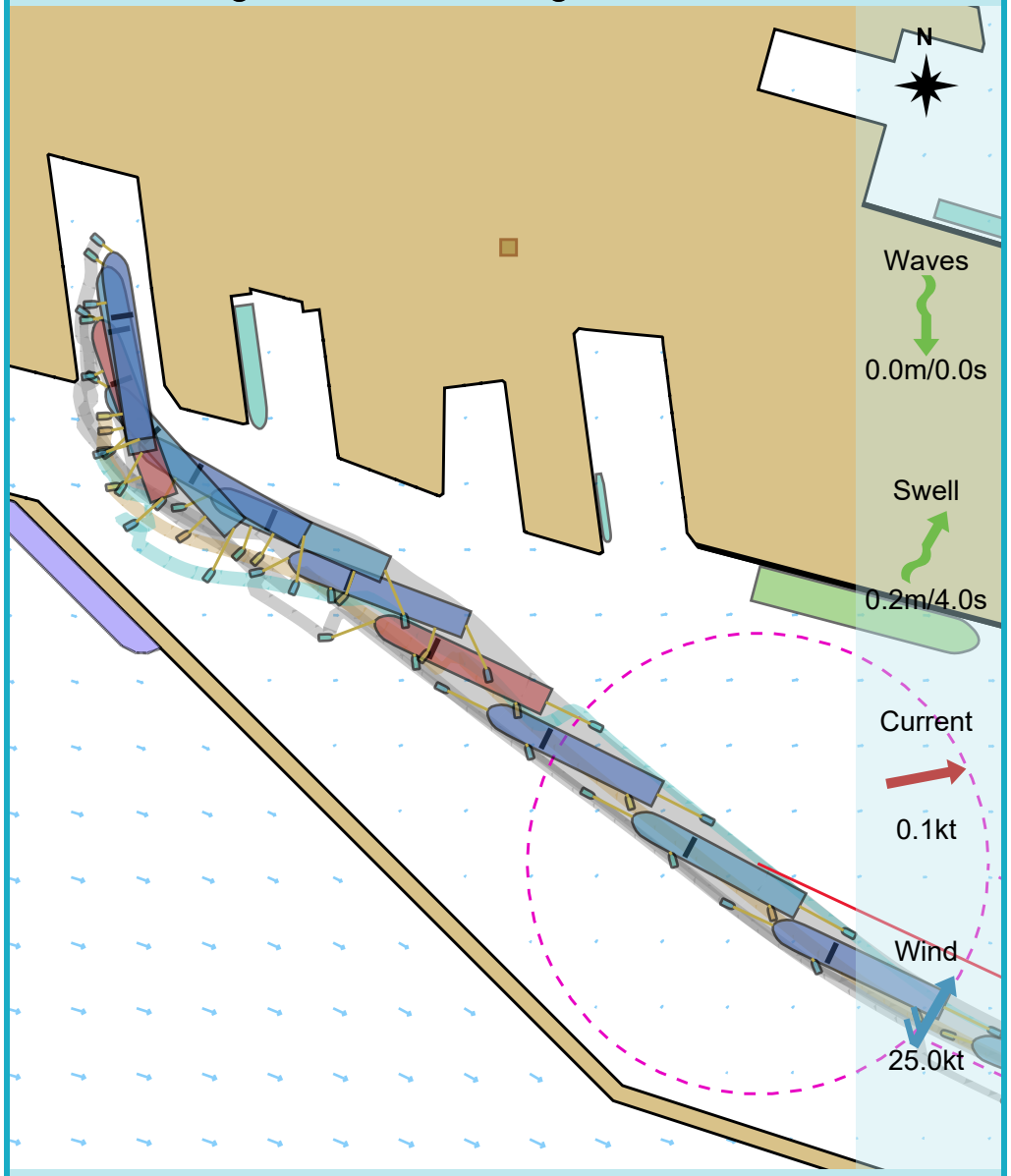


Approach Channel

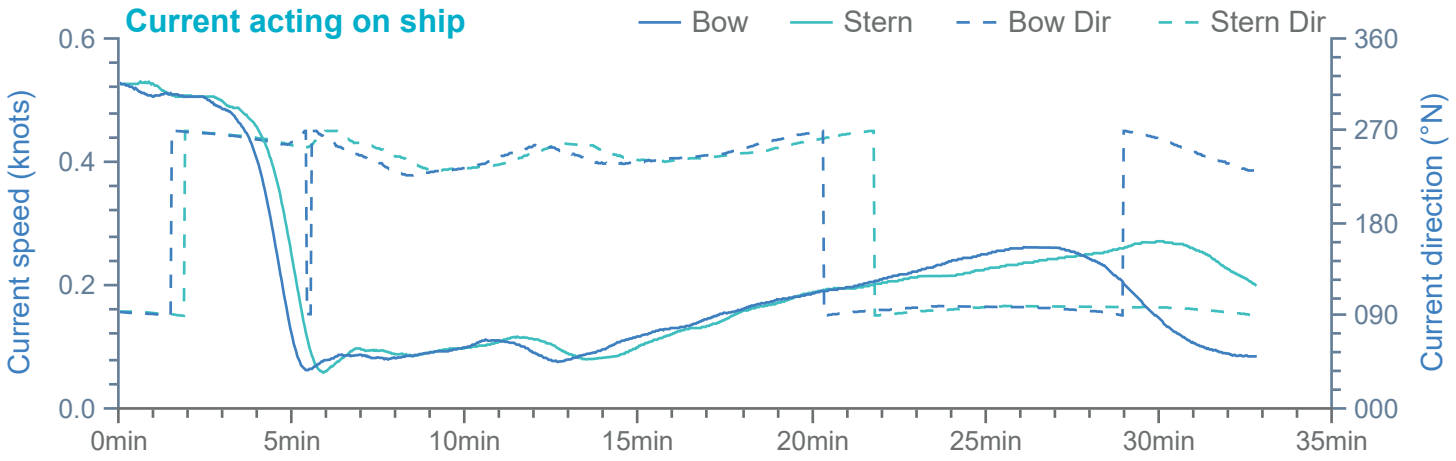


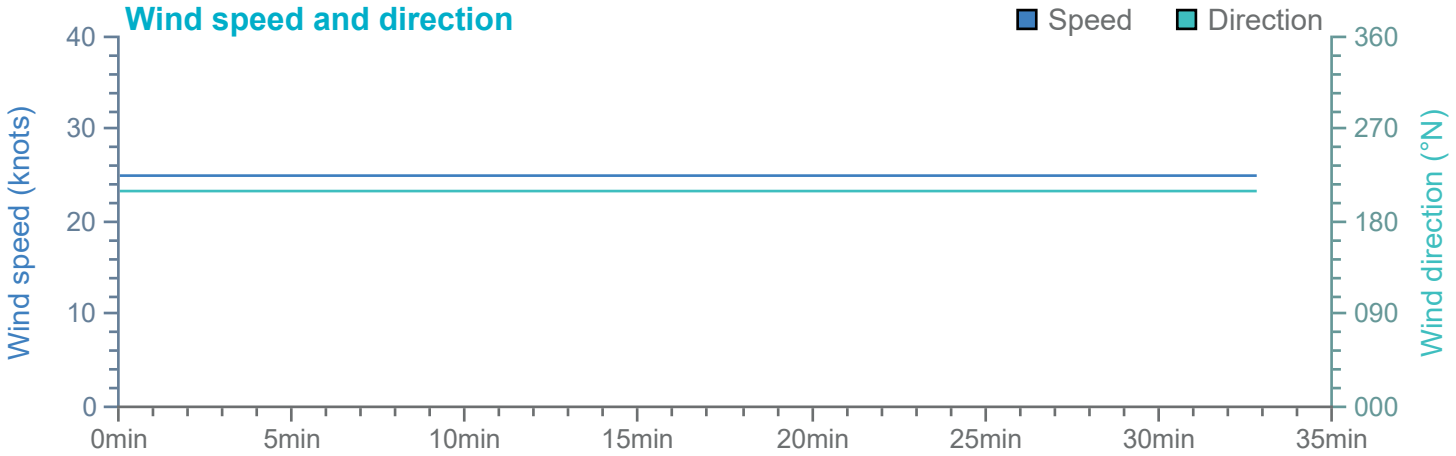
Ships plotted every 2 mins, highlight every 10 mins

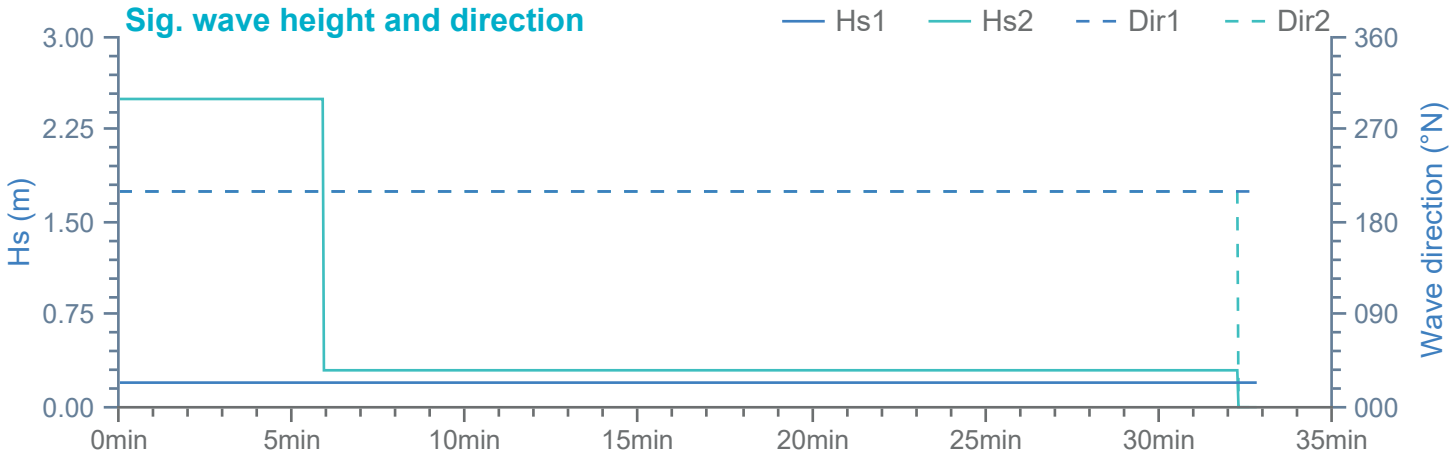
Manoeuvring area and berthing

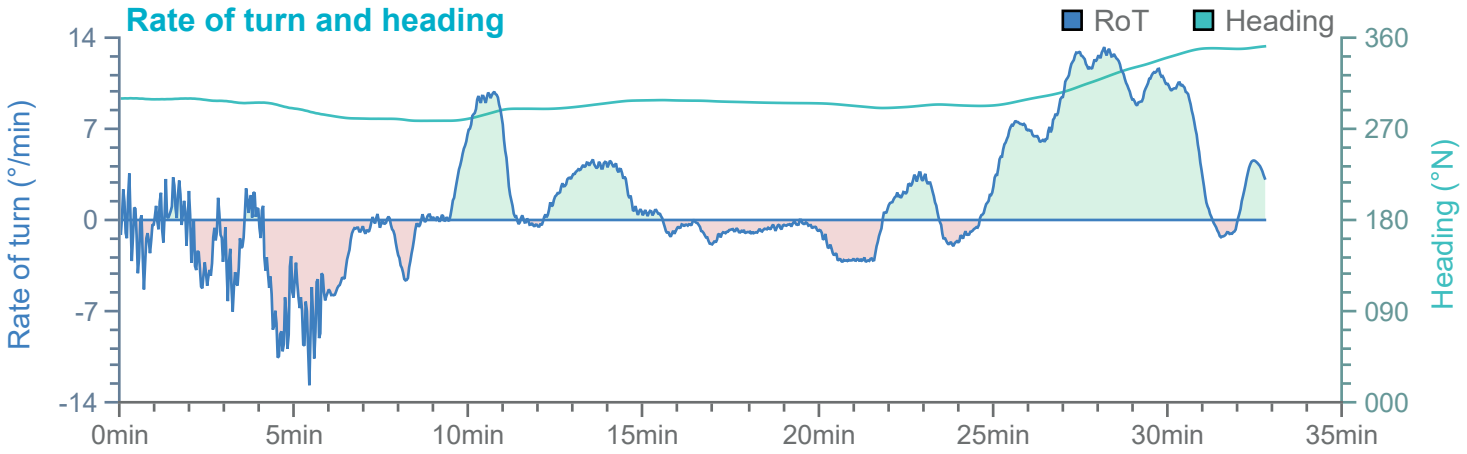


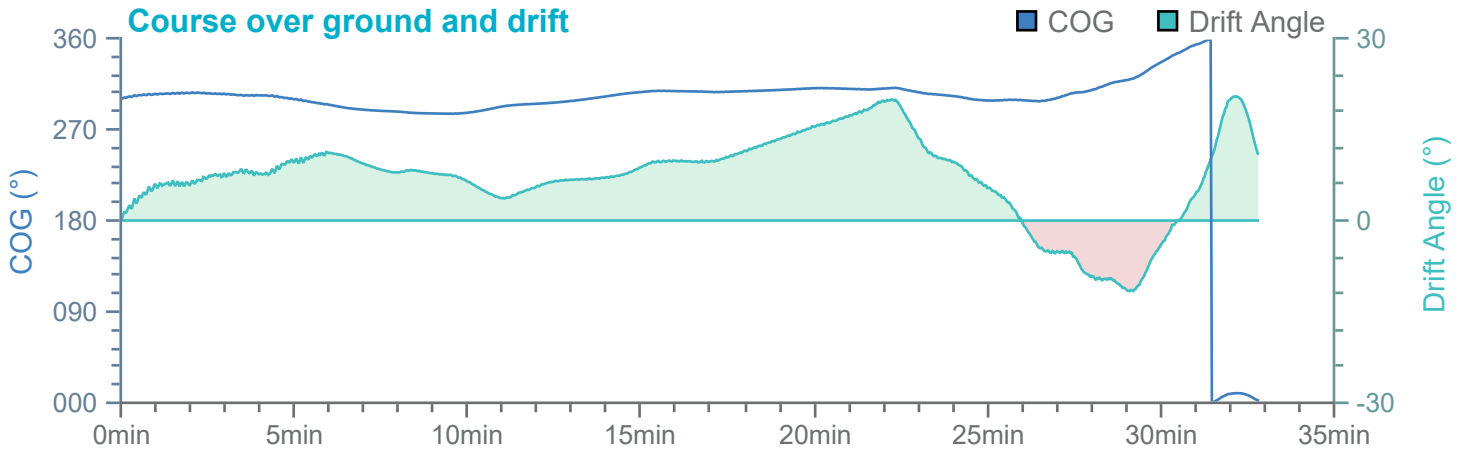
Ships plotted every 2 mins, highlight every 10 mins

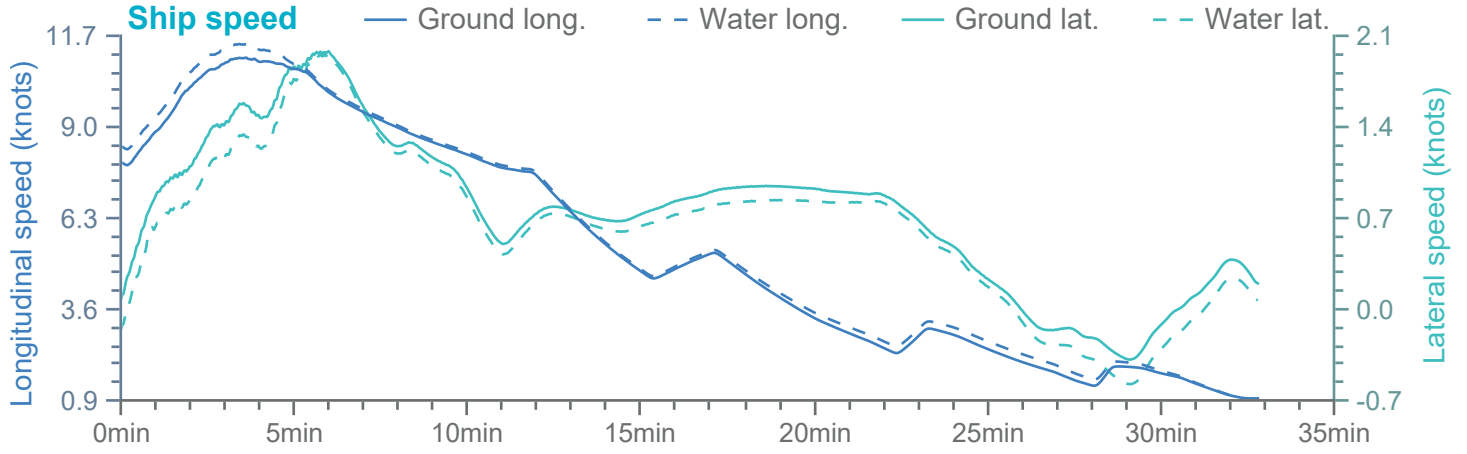

Current acting on ship
Bow
Stern
Bow Dir
Stern Dir
Current speed (knots)
Current direction (°N)
0.6
0.4
0.2
0.0
360
270
180
090
000
0min
5min
10min
15min
20min
25min
30min
35min

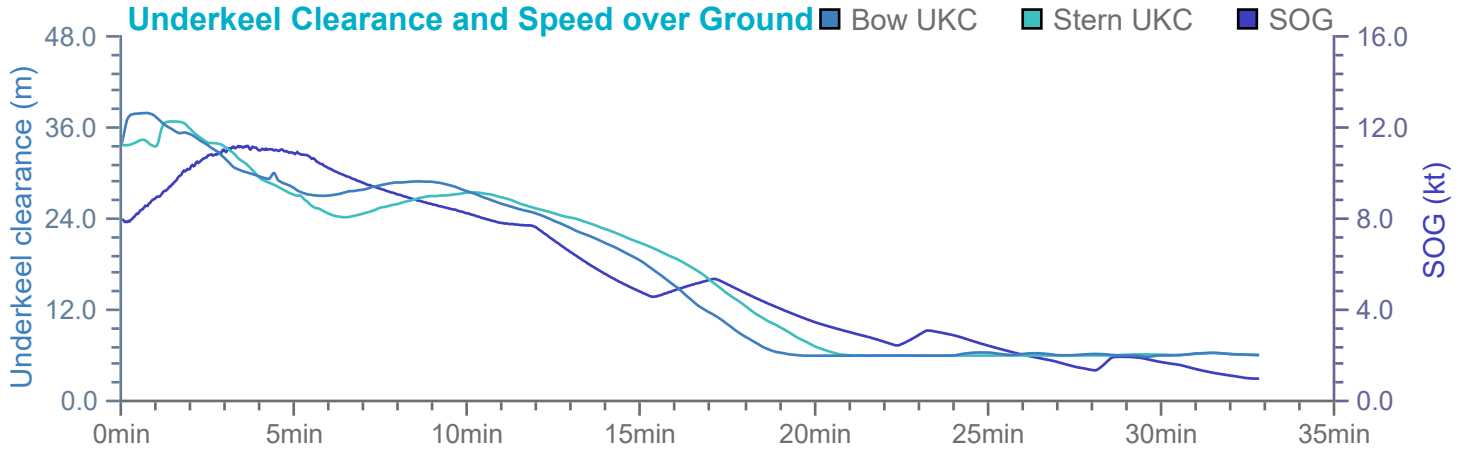

Wind speed and direction
Speed
Direction
Wind speed (knots)
Wind direction (°N)
40
30
20
10
0
360
270
180
090
000
0min
5min
10min
15min
20min
25min
30min
35min

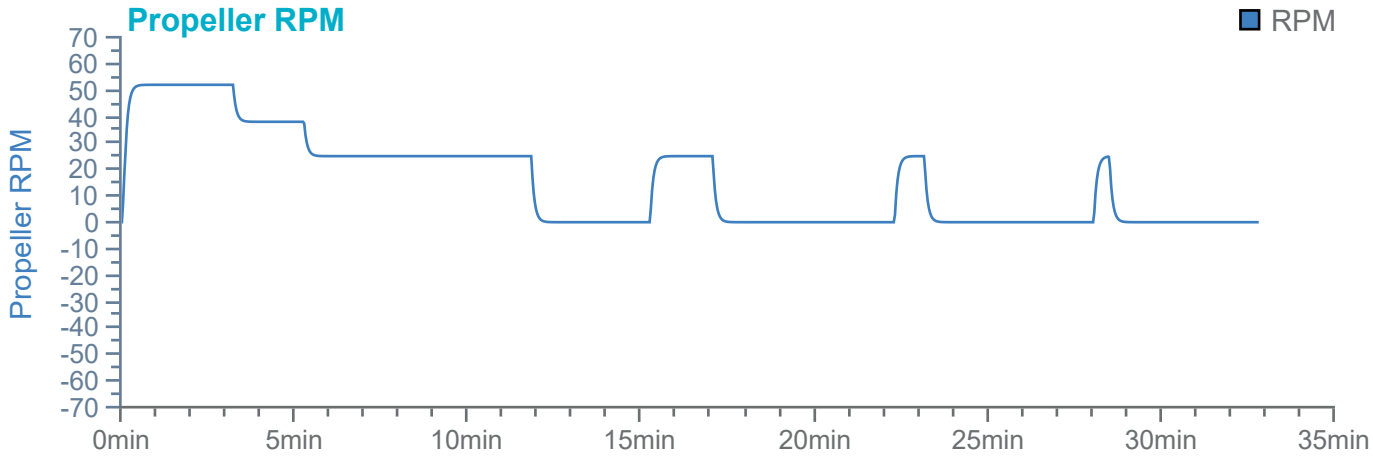

Sig. wave height and direction
Hs1
Hs2
Dir1
Dir2
Hs (m)
Wave direction (°N)
3.00
2.25
1.50
0.75
0.00
360
270
180
090
000
0min
5min
10min
15min
20min
25min
30min
35min

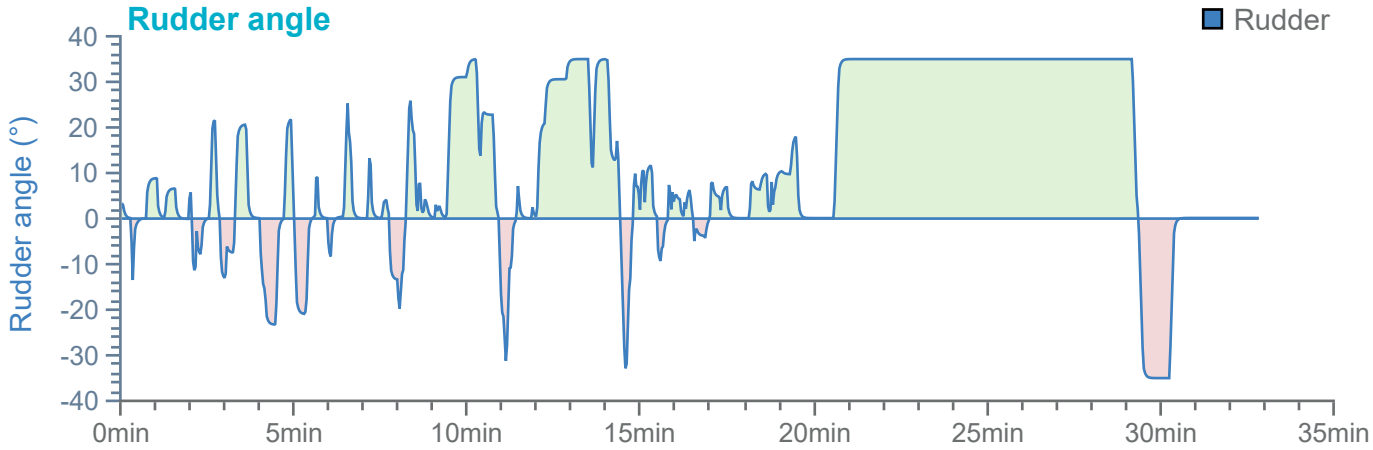

Rate of turn and heading
RoT
Heading
Rate of turn (°/min)
Heading (°N)
14
7
0
-7
-14
360
270
180
090
000
0min
5min
10min
15min
20min
25min
30min
35min

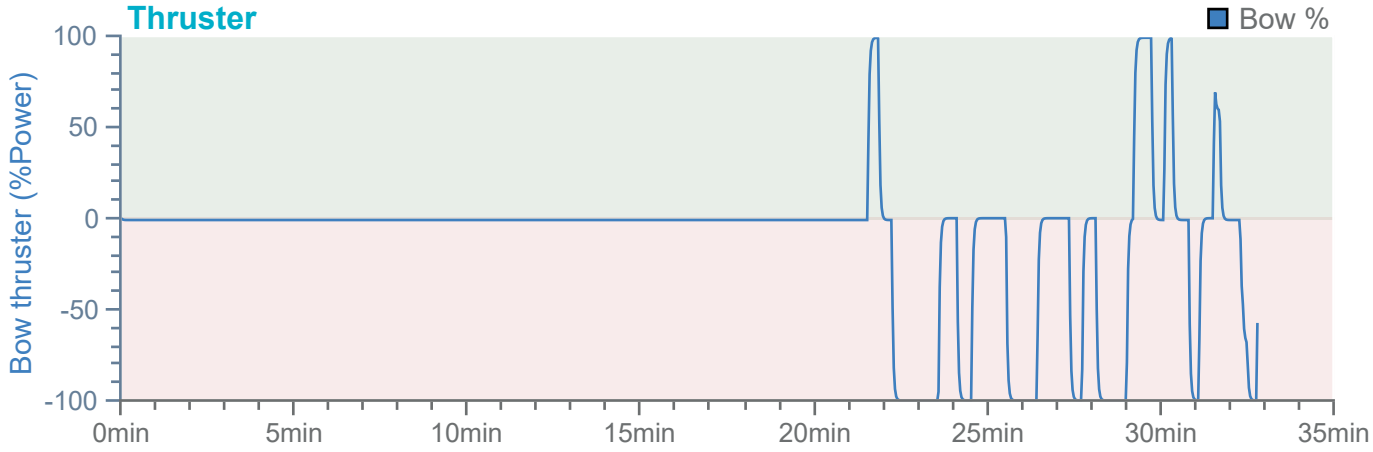

Course over ground and drift
COG
Drift Angle
COG (°)
Drift Angle (°)
360
270
180
090
000
30
0
-30
0min
5min
10min
15min
20min
25min
30min
35min


Ship speed
Ground long.
Water long.
Ground lat.
Water lat.
Longitudinal speed (knots)
Lateral speed (knots)
11.7
9.0
6.3
3.6
0.9
2.1
1.4
0.7
0.0
-0.7
0min
5min
10min
15min
20min
25min
30min
35min

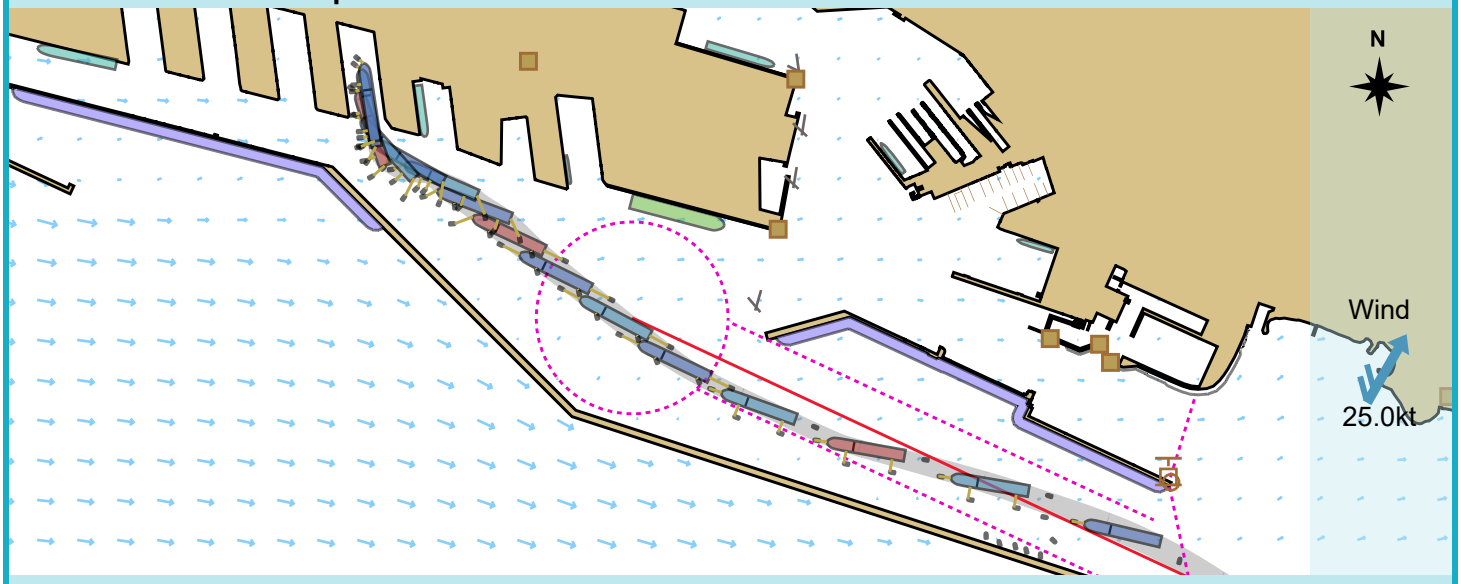

Underkeel Clearance and Speed over Ground
Bow UKC
Stern UKC
SOG
Underkeel clearance (m)
SOG (kt)
48.0
36.0
24.0
12.0
0.0
16.0
12.0
8.0
4.0
0.0
0min
5min
10min
15min
20min
25min
30min
35min


Propeller RPM
RPM
Propeller RPM
70
60
50
40
30
20
10
0
-10
-20
-30
-40
-50
-60
-70
0min
5min
10min
15min
20min
25min
30min
35min


Rudder angle
Rudder
Rudder angle (°)
40
30
20
10
0
-10
-20
-30
-40
0min
5min
10min
15min
20min
25min
30min
35min

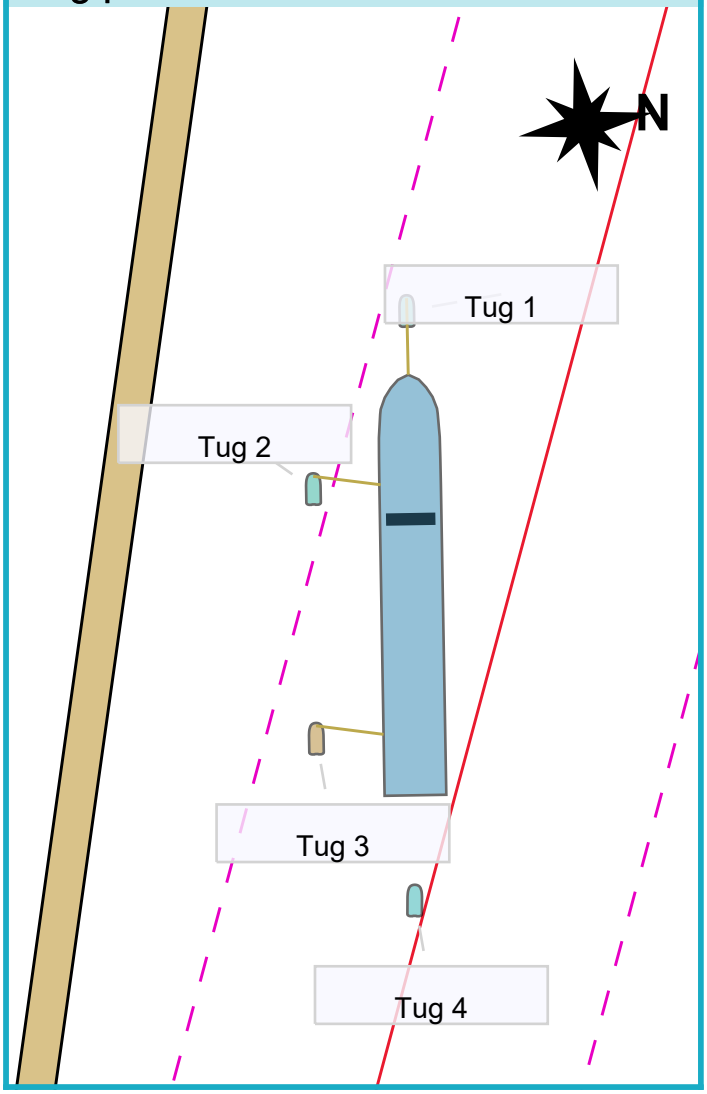

Thruster
Bow %
Bow thruster (%Power)
100
50
0
-50
-100
0min
5min
10min
15min
20min
25min
30min
35min

Manoeuvre track plot

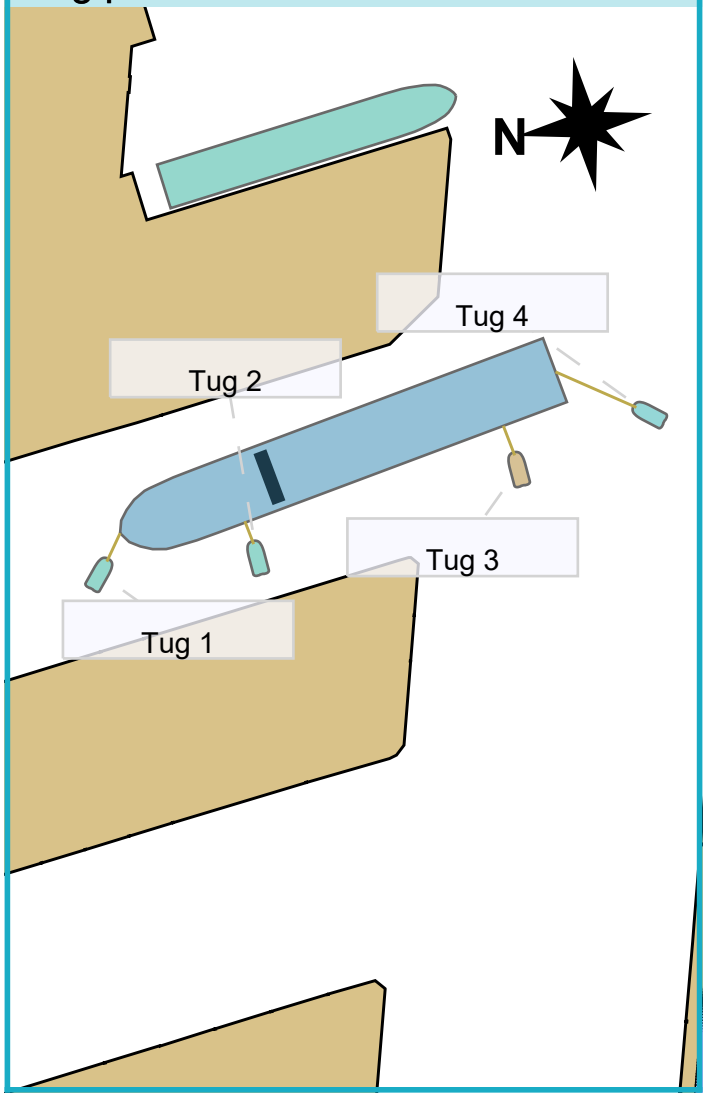


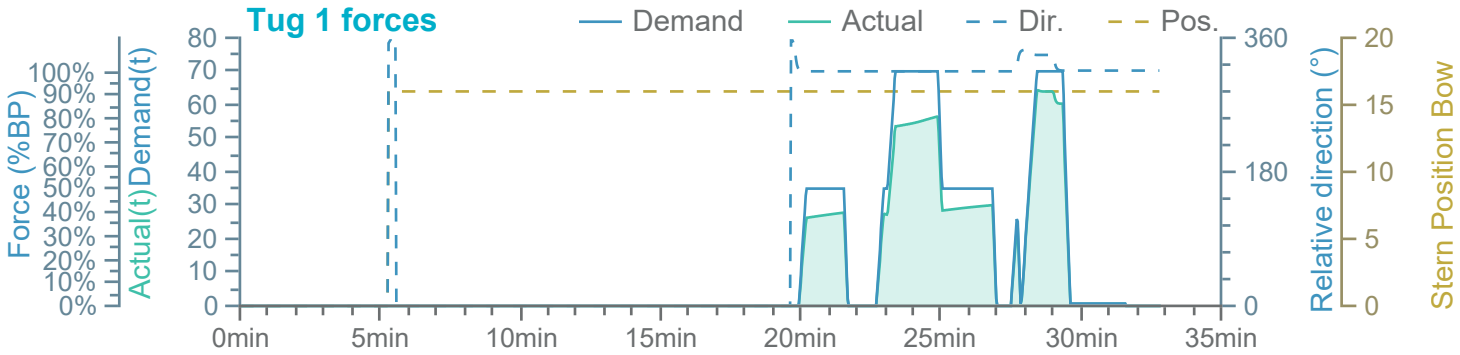
Ships plotted every 2 mins, highlight every 10 mins

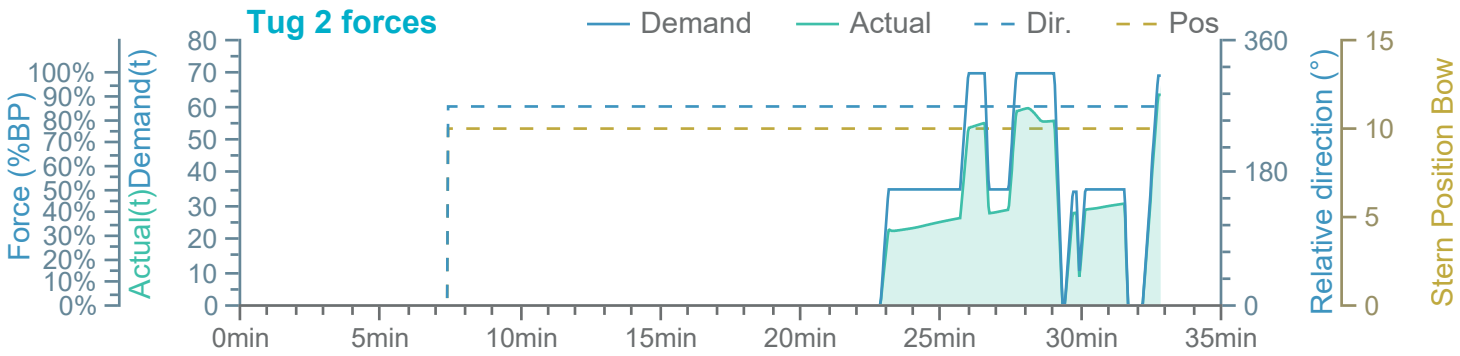
Tug position: Initial

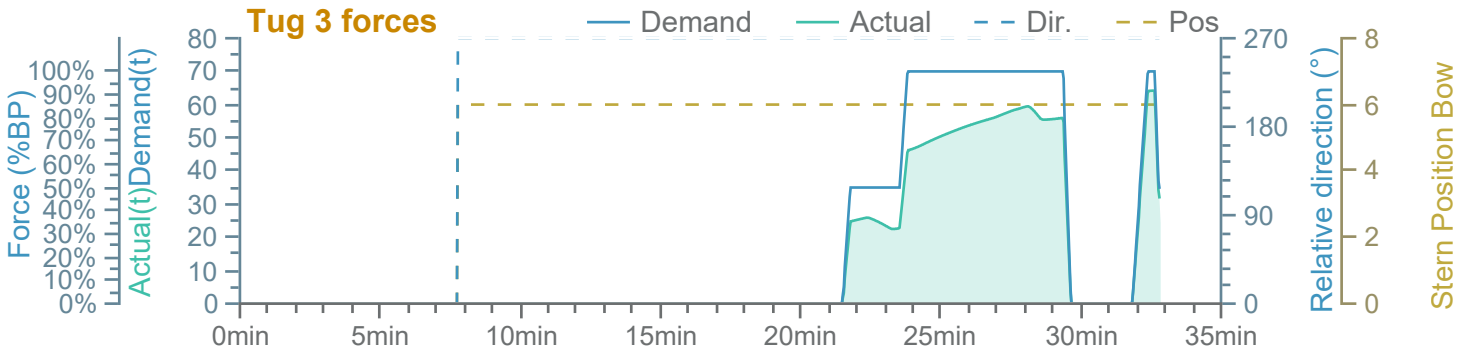


Tug position: Final




Tug 1 forces
Demand
Actual
Dir.
Pos.
Force (%BP)
Actual(t)Demand(t)
Relative direction (°)
Stern Position Bow
0min
5min
10min
15min
20min
25min
30min
35min


Tug 2 forces
Demand
Actual
Dir.
Pos
Force (%BP)
Actual(t)Demand(t)
Relative direction (°)
Stern Position Bow
0min
5min
10min
15min
20min
25min
30min
35min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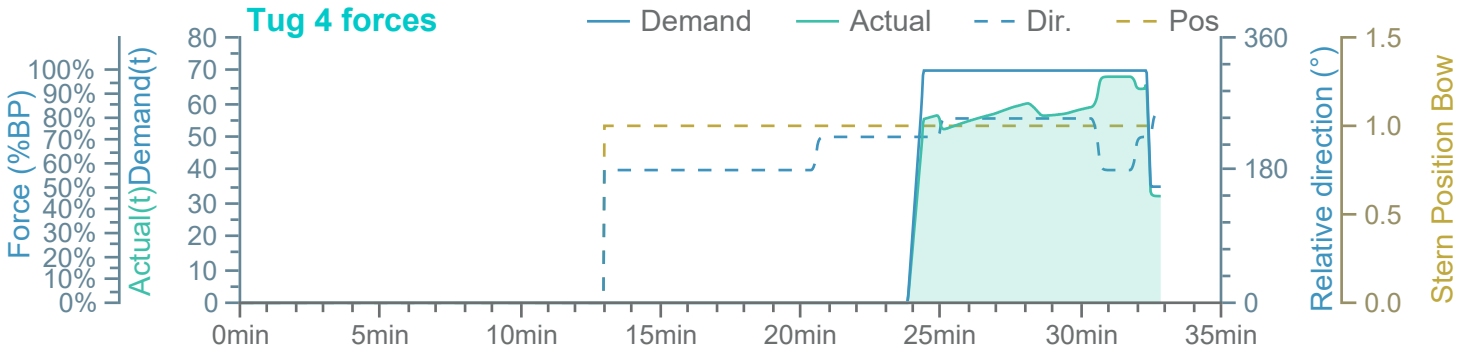
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D. HR Wallingford selected track record

HR Wallingford
Working with water

Track record

Container ship navigation

Selected container ship navigation projects

Port of Southampton pilot and tug master training

Ongoing (since 2017)
ABP Southampton
UK

The Port of Southampton undertake regular simulator based training for both their marine pilots and the tug masters that assist with manoeuvring large ships at the port including ultra large container ships. These training sessions are held at HR Wallingford's state of the art UK Ship Simulation Centre, using integrated ship and tug bridge simulators.

Dover Port pilot and tug master training

Ongoing (since 2017)
Dover Harbour Board
UK

HR Wallingford provided simulator facilities for Dover Harbour to carry out CPD sessions for container ships, cruise ships and ferries. These include integrated ship and tug simulations.

Harwich Haven Authority pilot and tug master training

Ongoing (since 2005)
Harwich Haven Authority
UK

Harwich Haven undertake regular simulator based training for both their marine pilots and the tug masters that assist with manoeuvring large ships at the port including ultra large container ships. These training sessions are held at HR Wallingford's state of the art UK Ship Simulation Centre, using integrated ship and tug bridge simulators.

Antioquia Multipurpose Port

2020
Sociedad Portuaria Puerto Antioquia De Uraba
Colombia

Puerto Antioquia Multipurpose Port is being developed to include facilities to service container, bulk and RoRo vessels. A navigation simulation study was carried out to optimise the approach channel dimensions and to identify the tug requirements.

Abu Qir

2020
DEME
Egypt

The Egyptian Navy is planning to develop a new container terminal at Abu Qir Port near to Alexandria in Egypt. Dredging and reclamation works will be required for the construction. HR Wallingford provided maritime consultancy services to DEME to assess if the proposed layout meets the necessary project performance requirements. We undertook a number of studies including navigation simulation, dynamic mooring analysis overtopping of the quay area, sedimentation risk and port operability (including downtime).

Southampton research and develoment

2020
ABP Southampton
UK

A number of ship simulation studies were carried out to investigate the dredging requirements necessary to improve the navigation of ultra large container ships calling at Southampton Port.

Port of Dakar new multi user port

2019
Mott MacDonald
Senegal

The Government of Senegal is planning to develop a new port at a site located about 34 kilometres south east of the existing Port of Dakar. DP World are assisting the Government of Senegal to develop the facility and in particular its container terminal. Mott MacDonald is assisting DP World to prepare a phased master plan for the new port and appointed HR Wallingford to carry out real time navigation simulation and underkeel clearance studies in support of the project.

Tuticorin navigation simulation

2019
V.O. Chidambaranar Port Trust
India

A real time navigation simulation study was carried out to examine the accessibility of the existing Tuticorin port entrance for 330m container ships and smaller Capesize bulk carriers.

Toamasina Port development

2019
Oriental Consultants Global
Madagascar

As part of developments at the Port of Toamasina, there was a need to examine the requirements for safe ship navigation. HR Wallingford carried out a navigation simulation study to identify possible improvements to the design to ensure safe navigation of container ships, up to 400m in length, and bulk carriers.

Panama Port dredging works

2019
Panama Ports Company
Panama

During the dredging works of port of Balboa, we provided on-site supervision of dredging works and UK based support including real time simulation of container ships, to assist Panama Ports Company (Hutchinson group). HR Wallingford helped the client deliver the project on time, within budget and with no claims.

Harwich Haven Authority pilot assessment for prospective pilots

2018
Harwich Haven Authority
UK

HR Wallingford provided simulator facilities for Harwich Haven Authority to carry out assessments for prospective pilots.

Port of Salerno navigation study

2018
Salerno Container Terminal
Italy

The Port of Salerno has commissioned the design and construction of a new breakwater. There was a need to verify that the largest ships using the port were not negatively affected by the new structure. The verification was carried out with the aid of a navigation simulation study.

Veracruz Container Terminal dredging technical advice

2018
Internacional de Contenedores Asociados
Mexico

A technical review was carried out to ensure the scope of work is as per HPH requirements. This included: review of channel design; assistance with preparing RFP documents; review of all Tenderers' technical proposals and confirmation of dredging costs; recommendation of winning technical proposal.

San Vicente navigation simulation study

2017
San Vincente Terminal Internacional
Chile

As part of a development for a container terminal in San Vicente, Chile, a ship navigation simulation study was carried out to examine the manoeuvring strategies and limiting environmental conditions required for safe ship arrival and departure at the new terminal. This was followed by a pilot and tug master familiarisation training session in our UK Ship Simulation Centre, where the local pilots and tug masters had the opportunity to familiarise themselves with the proposed manoeuvres using four of our ship and tug bridge simulators, all integrated to allow a pilot and three tug masters to operate within the same simulated environment in a realistic manner.

Jazan Economic City hydraulic modelling

2017
CH2M Hill
Saudi Arabia

A real time navigation simulation study was used to examine container ship and bulk carrier operations for the first phase of a major new port being developed in support of the Jazan Economic City Project on the Red Sea Coast of Saudi Arabia.

Rosyth container terminal

2017
Babcock International Group
UK

Studies were carried out in support of regulatory approval for a new container port and dredged approach channel at Rosyth. These comprised a desk study of sediment transport based on our own earlier flow, wave and sediment modelling for the same project and a desk study of vessel effects on water and sediment movement. Ad hoc advice and assistance was provided in responding to external review comments and requests.

Dover Port pilot assessment for prospective pilots

2017
Dover Harbour Board
UK

HR Wallingford provided simulator facilities for Dover Harbour to carry out assessments for prospective pilots.

Abidjan Port extension, design review

2016
Brighten Development FZE
Ivory Coast

HR Wallingford carried out a high level review of studies by the EPC contractor for the Port Authority for design and construction of an upgrade of the port of Abidjan in Ivory Coast. The studies included wave studies to determine design conditions, breakwater design studies and container and RoRo quay design studies. A high level assessment, including a navigation simulation, was also carried out of the impact of using larger ships and cranes on the container quay than accounted for in the design basis. Based on this assessment we advised that no significant impediments were found and that a more detailed analysis of technical feasibility for use of larger ships and cranes was justified.

Rosyth Port - further modelling

2016
Babcock International Group
UK

Wave, flow and sediment modelling were undertaken in support of an environmental impact assessment for the proposed Rosyth International Container Terminal. The purpose of the modelling was to quantify any changes in current speeds or wave heights that might occur post-construction, to assess long-term changes to the dredged channel, and to assess the possibility of unwanted dispersion of dredged material. Results were to be used to assess the potential effects on environmental interests, navigation, sediment movement and the inter-tidal zone.

San Antonio STI navigation study

2015
San Antonio Terminal
Chile

Navigation simulation was used to investigate whether post-Panamax container ships could manoeuvre at San Antonio Container Terminal (STI) Berths 2-3 as part of developments at the Port. Familiarisation training was also provided for the local pilots.

Jebel Ali LNG navigation study review

2015
Dubai Supply Authority
United Arab Emirates

The proposed plans for a significant expansion of Jebel Ali port showed the new works extending close to the existing LNG Terminal. A navigation review was carried out to examine the requirements for safe LNG and container ship manoeuvring in the vicinity of the LNG terminal.

Red Sea Gateway Terminal, pilot familiarisation

2015
Red Sea Gateway Terminal
Saudi Arabia

Navigation simulation techniques were used to investigate the requirements for handling ultra large container ships as part of the developments at the Red Sea Gateway Terminal. Familiarisation training was also provided for the local pilots.

Antofagasta - additional navigation STUDY

2015
ATI
Chile

Additional simulations were carried out for Antofagasta Port to look at arrival and departures of container ships using real time navigation simulation.

Harwich Haven Authority - new ship manoeuvring simulation

2015
Harwich Haven Authority
UK

As a result in the growth of container ship sizes, the Harwich Haven Authority, whose maritime pilots serve the Port of Felixstowe, needed to establish the navigation and operational procedures for bringing such ships into the port. This was achieved using HR Wallingford's ship simulators, where the manoeuvres of the large, new ships could be practised and investigated before they arrive at the port.

Saudi Ports masterplan

2015
Atkins
Saudi Arabia

HR Wallingford provided specialist port planning expertise to Saudi Ports Authority (SPA) for the strategic master plan study of the major commercial and industrial ports of Dammam and Jubail. The work was carried out over a twelve month period in association with Atkins, MDS Transmodal and ADI Consulting. The study identified options for the additional facilities required to handle the rapidly increasing exports of solid petrochemical products arising from the Jubail Industrial City development, and the rise in general and bulk cargo and container handling demands at Dammam, based on the independent traffic forecasting carried out by the team. Each of the options was evaluated and a preferred phased development strategy for each of the two ports was prepared. The work included a number of site visits to review the existing port operations and the detailed planning of the future container and bulk terminals and other specialist terminals, including berth requirements, cargo handling equipment, landside handling and storage areas and requirements for future hinterland links which were identified. In addition, an assessment was made of the marine access channels, navigational requirements and future ship handling requirements to cater for the larger number and size of vessels anticipated to service future demand. As part of this assignment HR Wallingford coordinated a study tour for SPA to leading container ports in Europe and arranged a technical seminar for SPA senior management in Saudi covering all aspects of strategic port planning.

Valparaiso navigation simulation study

2013 - 2015
Terminal Pacifico Sur Valparaiso
Chile

As part of the development of the Port of Valparaiso there was a need to explore several expansion options for the berths. Real time navigation simulation was carried out to examine the implications of the expansion options on ship manoeuvring within the port, to ensure safe ship navigation. Real time navigation simulation for larger ship manoeuvres was subsequently carried out to identify the conditions for safe operations. Pilot and tug master familiarisation training was also provided to the. The training utilised one ship bridge simulator and two tug bridge simulators, which were all acting simultaneously within the same simulated environment, allowing the pilot to interact with two tug masters interactively.

CCNI Antartico expert witness

2014
Ince & Co
UK

We provided expert witness on CCNI Antartico case to provide evidence on ship handling issues between container vessels of different sizes in shallow water.

Port of London Authority - Maersk Triple E simulation session

2013
Port Of London Authority
UK

As part of the development of the London Gateway container terminal, the Port of London Authority needed to understand the manoeuvring implications of operating Maersk Triple E Class ships. We provided the use of one of our Ship Simulators and our well established and validated ship manoeuvring model of the Triple E ship to allow the PLA pilots to examine the manoeuvring requirements.

Northport CT4 Port Klang - ship mooring and passing ship study

2013
Muhibbah
Malaysia

A ship mooring and passing ship study was undertaken as part of the development of Container Terminal 4 at Northport, Port Klang. This was used to examine the proposed mooring arrangements and to ensure that they were adequate for the anticipated conditions and passing ships.

San Antonio Terminal - manoeuvres at STI Berths 1 and 2

2013
San Antonio Terminal
Chile

As part of the development of the San Antonio Terminal Internacional (STI) container terminal in Chile, a navigation simulation study was undertaken to examine manoeuvres of ships at STI Berth No. 2 past the recently upgraded STI Berth No. 1.

Suez Canal Container Terminal - E-Class Maersk navigation simulation study

2013
Suez Canal Container Terminal
Egypt

As part of the development of the Suez Canal Container Terminal the navigational aspects of operating the largest classes of container ships at the terminal were investigated. This was undertaken using a real time navigation simulation study that simulated the manoeuvring of E and EEE class Maersk container ships. This enabled the limiting conditions for safe navigation to be identified, along with the associated tug and aids to navigation needs.

San Antonio, Chile

2013
Puerto Central
Chile

A navigation simulation was carried out for a new container terminal development at the port of San Antonio in Chile. The simulation investigated the terminal's accessibility to post Panamax container ships with a geometric capacity in the order of 11,400 TEU with particular attention being paid to investigation of any impacts on operations at adjacent berths, particularly adjacent container berths.

Port Qasim - turning basin extension

2012
China Harbour Engineering Company (CHEC)
Pakistan

China Harbour Engineering Co. Ltd. (CHEC) was tendering for maintenance dredging of the approach channel to Port Qasim and the design and capital dredging of an extended turning basin adjacent to Container Terminal 2. The Port Qasim Authority required that the design of the new turning basin be independently vetted prior to the capital dredging taking place. CHEC asked HR Wallingford to provide a proposal for undertaking this work in the event that CHEC won the dredging and design contract. The Scope of Work was to assess the dredging aspects of the turning basin and to comment on the size, location or suitability of the turning basin for vessel navigation and manoeuvring purposes according to PIANC guidance. The proposed dredging and disposal methodology was also reviewed.

Borouge-3 EPC

2012
Hyundai Engineering and Construction Company
United Arab Emirates

HR Wallingford provided a wide range of specialist design support services in connection with the development of the marine works infrastructure for the Utilities & Offsites EPC Contract associated with the Borouge 3 Project at Ruwais. Studies included assessment of design and operational metocean conditions and a range of navigation and berth design studies for the port expansion works together with design and performance validation studies for the seawater intake/outfall facilities.

Melbourne - deep draught ship access review

2011
Port Of Melbourne Corporation
Australia

As part of the development of the Port of Melbourne, larger container ships will need to access the port than those that operated previously. A navigation simulation study was undertaken and an independent review provided of large container ship access.

Keamari Groyne navigation simulation

2011
Royal Haskoning
Pakistan

Karachi Port Trust planned to develop a new container terminal on a site adjacent to the existing port. This will require different maneuvering strategies to those used at present on arrival and departure, especially in the wave conditions expected during the monsoon season. Consequently, HR Wallingford undertook a navigation simulation study that was used to examine the limiting conditions for safe ship arrival and departure manoeuvres, including the use of tugs. The study was also used to identify additional aids to navigation that may be required to ensure safe navigation.

Kattupalli Port development, navigation simulation study

2010
L&T Shipbuilding
India

As part of the development of a shipyard and container terminal at Kattupalli, the proposed design layout was evaluated from a navigational perspective, to ensure safe access by the design ships. Real time navigation simulation was used to focus on approach, turning, berthing and departure maneuvers in a range of environmental conditions. The results enabled the design layout to be optimised and tug requirements identified.

Port of Felixstowe - ship handling familarisation workshop

2010
Felixstowe Dock & Railway Company
UK

HR Wallingford's Ship Simulation Centre hosted a workshop attended by Port of Felixstowe operations personnel and the Harwich Haven Authority ship-handling personnel. The aim was to use navigation simulation exercises to explore and communicate the local ship handling and operational issues at the port to improve understanding and effectiveness.

HHA E-Class Maersk navigation simulation

2010
Harwich Haven Authority
UK

Navigation simulation sessions were carried out to review operating limits for E-Class Maersk container ships within Harwich Haven, and to provide familiarisation training for handling E-Class Maersk ships for a new group of HHA Special Category Pilots.

Jaigarh Port - navigation and manoeuvring study

2009
JSW Jaigarh Port
India

A real time ship simulation study was carried out to examine the maneuvering aspects of a new green field port near Jaigarh which is to be used for bulk coal import and a possible container terminal. The simulation was used to confirm that the port is accessible to laden bulk carriers and identified layout improvements.

Bristol CT - pilot familiarisation

2009
The Bristol Port Company
UK

A series of pilot familiarisation sessions were carried out on one of the Ship Simulators at HR Wallingford. These were used to familiarise the Bristol Port Pilots with proposed development plans and the associated manoeuvring issues.

Bristol Deep Sea Container Terminal - navigation assessment of approach channel

2009
The Bristol Port Company
UK

HR Wallingford carried out an approach channel design study for a proposed container terminal at the Port of Bristol. This involved the combination of desk study and navigation simulation techniques to identify the optimum channel dimensions.

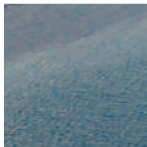
HR Wallingford
Working with water

HR Wallingford
Howbery Park
Wallingford
Oxfordshire OX10 8BA
United Kingdom

tel +44 (0)1491 835381
fax +44 (0)1491 832233
email info@hrwallingford.com

www.hrwallingford.com

HR Wallingford is an independent engineering and environmental hydraulics organisation. We deliver practical solutions to the complex water-related challenges faced by our international clients. A dynamic research programme underpins all that we do and keeps us at the leading edge. Our unique mix of know-how, assets and facilities includes state of the art physical modelling laboratories, a full range of numerical modelling tools and, above all, enthusiastic people with world-renowned skills and expertise.



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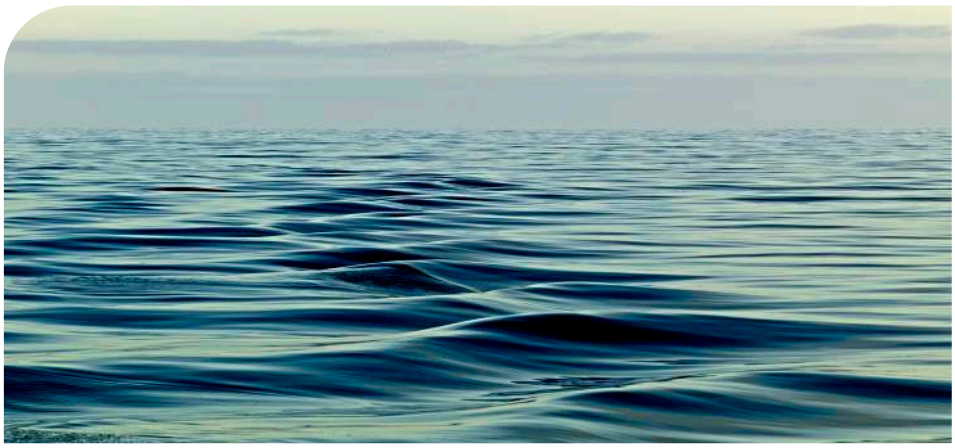

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HR Wallingford, Howbery Park, Wallingford, Oxfordshire OX10 8BA, United Kingdom
tel +44 (0)1491 835381 fax +44 (0)1491 832233 email info@hrwallingford.com
www.hrwallingford.com

FS 516431
EMS 558310
OHS 595357