



GREENPORT
Alliances



Co-funded by
the European Union

Sustainable Maritime Operations and Green Port Technologies

Module number 7

Lecturer Name Surname

Lecturer contact info

ECO NAVIGATION

Module number 7



GREENPORT
Alliances



Co-funded by
the European Union

Objectives

This module is designed to provide pilots and tug masters with practical experience in eco-navigation and ship handling by using simulators to test how operational choices affect safety, fuel efficiency, and emissions during port approaches and berthing.

Navigation scenario objectives:

- Identify key environmental best practices during port approach
- Evaluate the fuel and emission impact of inefficient vs. efficient manoeuvring
- Apply sustainable navigation and shiphandling principles
- Reflect on how real-world decisions impact emissions

Scope of simulation:

Observe and identify energy-efficient ship-handling behaviours that achieve safe and effective outcomes with minimal power

Recognise when momentum, wind, and tide can be harnessed to support manoeuvring

Compare strategies that use tugs at lower power for longer durations versus short bursts at high power

Lesson plan



[1] Presentation of Simulation scenario and its objective

Use Navigation Simulator to run a 2-stage exercise: Case 1 - without concern for best practices, and Case 2 - applying all the best practices {Table 1}

[2] Bridge Procedures Guide - Brief review of the the four stages to achieve a safe passage plan

Appraisal, Planning, Execution, Monitoring

[3] Pre-exercise quiz

Assess learners' understanding of eco-navigation before starting the simulator session

[4] Conduct the exercise

Maintain records (Table 2) and prepare the comparison data for the two Cases (Table 3)

[5] Debriefing and evaluation

Session guided by questions – individual and group debriefing

[6] Case study

Reflect on how a typical tugboat engine responds across various RPM levels

1. Simulation scenario

Simulator system: Wartsila - Transas Navi-Trainer Pro 5000, Kongsberg, or similar	
Scenario: Large vessel approaching port, requiring tug assistance, with tide and wind. The vessel must be swung to face the tide and placed safely alongside.	
Navigation area: Port approach (based on the areas available at the training centre)	
Environmental settings: Tide and wind	
Traffic: Moderate density, 1 outbound ferry, 1 tug available	
Sensors Enabled: ECDIS, Radar, Engine output monitor	
Route scenario: Approach to Port through fairway Buoy xx to Berth xx	
Case 1. Simulate inefficient arrival manoeuvring Objective: Highlight the environmental and operational inefficiencies from inefficient practices Conditions: - Excessive engine use (frequent RPM changes) - Abrupt rudder movements and hard helm orders - Tug engaged late, forced to use high bollard pull - Poor use of current (tide – depending of navigation area) and wind (counteracting forces instead of using them) - No use of ECDIS for advance planning Outcomes: - Higher fuel consumption & emissions - Longer time to berth - Unstable approach, requiring repeated course corrections - Increased tug workload - Delayed docking Notes to be recorded: - Engine RPM log - Fuel/emissions output - Time to berth - Number of tug interventions	Case 2: Best practice manoeuvring Objective: Apply eco-navigation principles for optimal environmental performance Conditions: - Maintain steady RPM (eco-speed steaming) - Advance route planning with ECDIS, including wind/tidal/current optimisation - Early coordination with tug and VTS - Use tide and wind to assist swing manoeuvre - Tug applies moderate, steady thrust rather than repeated high-power pushes - Real-time monitoring of engine load and tug fuel consumption Outcomes: - Lower fuel consumption - Precise docking with minimal delays - Reduced emissions and better energy profile - Stable vessel handling with fewer corrections Notes to be recorded: - Log engine RPM - Fuel usage / emissions - Time to berth - Number of tug interventions

2. Bridge Procedures Guide

The four stages to achieve a safe passage plan:

- Appraisal – collect and assess all relevant information required for the intended voyage
- Planning – develop and approve the passage plan, based on the outcome of appraisal
- Execution – navigate in accordance with the passage plan
- Monitoring – check the progress of the ship against the passage plan



2. Bridge Procedures Guide (cont.)

Coastal routes:

- ☐ Charted features and other features for safe distance;
- ☐ Available depth of water including tidal water level information;
- ☐ UKC requirements and other limiting conditions;
- ☐ Currents, tidal currents;
- ☐ Landmarks and AtoNs, availability of visual and radar fixing opportunities;
- ☐ Recommended routes and channel information, local conditions and restrictions on navigation, traffic likely to be encountered;
- ☐ Navigational warnings;
- ☐ Pilotage requirements and services, procedures (a pilotage plan is required);
- ☐ Port requirements, port facilities, procedures for port entry;
- ☐ Reporting and communication procedures;
- ☐ Details of the prospective berth and anchorages;
- ☐ Meteorological information;
- ☐ Environmental protection measures.
- ☐ Ship' routing and reporting system, VTS;
- ☐ MSI services and communications

Berthing / pilotage:

- ☐ Arrival intentions including embarkation time, arrangements for cargo discharge and bunkering;
- ☐ Communications should be established with Pilot, port VTS and port authorities as appropriate;
- ☐ Pilotage plan subject of Master/pilot information exchange;
- ☐ Updates on local conditions such as weather, depth of water, tides and tidal streams, traffic conditions;
- ☐ Information on berthing arrangements including the use, characteristics and number of tugs, mooring boats, mooring arrangements and other external facilities.

3. Pre-exercise quiz



1. When handling a vessel in port, what strategies could you use to reduce engine or tug power without compromising safety? Can you think of a past example where momentum, tide, or wind helped in manoeuvring?
2. What role does early coordination with tugboats and VTS play in reducing fuel consumption during port manoeuvring?

Focus areas during simulation

- Digital modelling: use port-specific ECDIS and tide/current overlays
- Momentum management: allow vessel inertia to assist manoeuvres instead of overusing engines
- Safety first: efficiency gains must not compromise navigational safety
- Optimised tug use: identify when tug masters can achieve more with less energy input
- Joint communication: ensure pilot and tug master exchange intentions early and clearly

4. Conduct the exercise

Requirements from trainees

- Complete records to be maintained throughout exercise
- Use of appropriate checklists relevant to operation
- Reference to sustainability and ships performance to be made during set up and throughout exercise
- Reference to environmental throughout exercise
- Clear and relevant communications to all parties

Metric	Case 1	Case 2
Distance travelled		
Fuel used/ CO2 emitted		
Time to berth		
Course deviation		
Tug interventions		
Fuel used by tug/ CO2 emitted		
Total emissions		



5. Debriefing and evaluation



1. What specific decisions or actions in Case 1 led to higher fuel use and emissions?

Reflect on poor practices like excessive throttle use, delayed tug calls, or ignoring ECDIS guidance.

2. How did you change your navigation plan or execution in Case 2 to align with eco-navigation principles?

Reflect on strategies like early tug coordination, route monitoring, use momentum to assist manoeuvres.

3. If you were to apply what you learned from Case 2 in real port operations, what would you prioritise and why?

Connect simulator experience with real-world actions, such as planning for engine load zones or reducing thruster overuse.

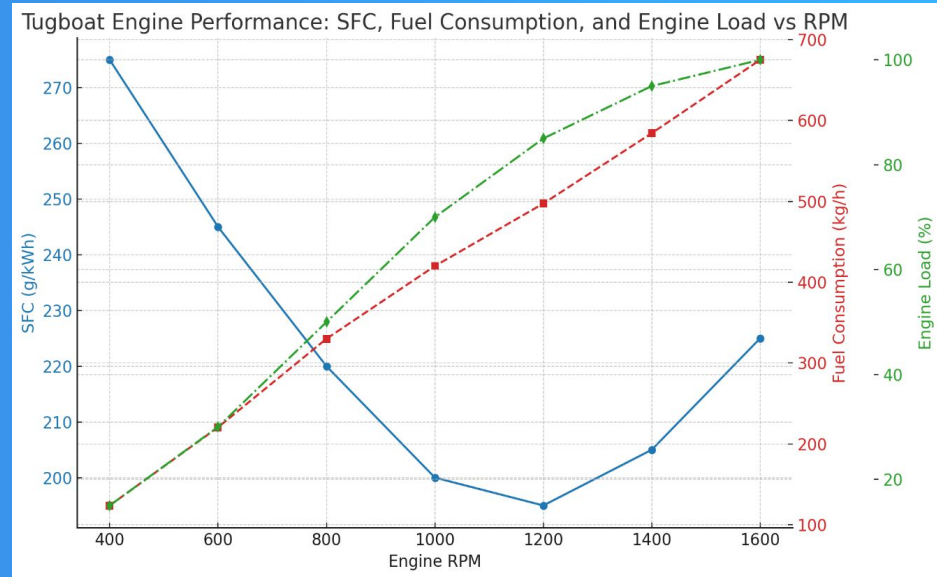


5. Case study

Eco-navigation is more than a regulatory requirement

It is a practical strategy to reduce fuel consumption, lower greenhouse gas (GHG) emissions, and improve operational efficiency.

Among the many factors that influence a ship's environmental footprint, one of the most critical is the engine's operational behaviour, particularly regarding RPM, fuel efficiency, and load management



Three key indicators



Specific Fuel Consumption (SFC)

which measures efficiency (in grams per kilowatt-hour)



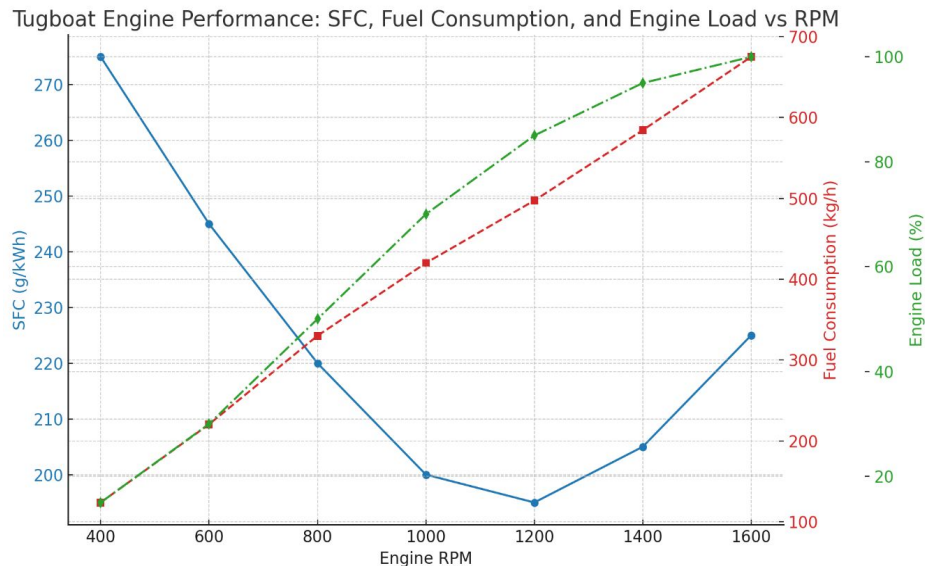
Total fuel consumption

which shows absolute fuel usage (in kg/h)



Engine load dynamics

which reflects the engine's power output relative to its full capacity (in %)



Discussions

Case	Engine RPM	Engine Load (%)	Power Output (kW)	Specific Fuel Consumption (g/kWh)	Fuel Consumption (kg/h)	CO ₂ Emissions (kg/h)
Case A Low Load	600	30%	900.0	245	220.50	686.64
Case B Optimal Load	1200	85%	2550.0	195	497.25	1548.44
Case C Full Load	1600	100%	3000.0	225	675.00	2101.95

- **Case A** reflects low-load operation, with the engine running inefficiently. The SFC is high (245 g/kWh), and despite lower power output, the emissions per unit of power are excessive.
- **Case B** represents the optimal operating range. Here, the engine operates most efficiently with the lowest SFC (195 g/kWh), achieving a good balance between power output and environmental performance.
- **Case C** shows maximum engine load, where total fuel and emissions are highest. Although more power is generated, the efficiency drops compared to the optimal zone.



Module number 7 | Course Name: Sustainable Maritime Operations and Green Port Technologies



**Co-funded by
the European Union**

Disclaimer:

This project has been funded with support from the European Commission. This publication reflects the views only of the author, and the Commission cannot be held responsible for any use which may be made of the information contained therein. Project no. 101139879.