

SHIP-PORT INTERFACE GUIDE

— Practical Measures to Reduce GHG Emissions —



GLOBAL INDUSTRY ALLIANCE
TO SUPPORT LOW CARBON SHIPPING



GREENVOYAGE
2050



Norwegian Ministry
of Climate and Environment



INTERNATIONAL MARITIME ORGANIZATION

Ship-Port Interface Guide

Practical Measures to Reduce GHG Emissions



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The IMO-Norway GreenVoyage2050 Project is an initiative to support shipping's transition towards a low carbon future. The project supports developing countries, including SIDS and LDCs, to reduce GHG emissions from shipping through supporting effective implementation of key IMO policy documents relating to GHG emissions, namely, the Initial IMO Strategy on reduction of GHG emissions from ships (resolution MEPC.304(72)) and resolution MEPC.323(74) encouraging voluntary cooperation between the port and shipping sectors to contribute to reducing GHG emissions from ships.

The Global Industry Alliance to Support Low Carbon Shipping (Low Carbon GIA) was officially launched on 29 June 2017. The aim of the Low Carbon GIA is to develop innovative solutions to address common barriers to decarbonizing the shipping sector. The Low Carbon GIA was established under the framework of the GEF-UNDP-IMO GloMEEP Project and now continues to operate under the framework of IMO-Norway GreenVoyage2050 Project.

For more information, please visit <https://greenvoyage2050.imo.org>.

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List of abbreviations

AIS	Automatic Identification System
BIMCO	Baltic and International Maritime Council
CD	Chart Datum
ECA	Emissions Control Area
ENC	Electronic Navigational Chart
FAL	Facilitation Committee (of IMO)
FONASBA	Federation of National Associations of Ship Brokers and Agents
GHG	Greenhouse Gas
GIA	Global Industry Alliance
GISIS	Global Integrated Shipping Information System
GLN	Global Location Number
GloMEEP	Global Maritime Energy Efficiency Partnerships Project
HO	Hydrographic Office
IAPH	International Association of Ports and Harbors
ICHCA	International Cargo Handling Coordination Association
ICS	International Chamber of Shipping
IHMA	International Harbour Masters Association
IHO	International Hydrographic Organization
IMO	International Maritime Organization
IMPA	International Maritime Pilots' Association
IPCSA	International Port Community System Association
ISSA	International Ship Suppliers Association
JIT	Just in Time
LAT	Lowest Astronomical Tide
LFO	Light Fuel Oil
LNG	Liquefied Natural Gas
MARPOL	International Convention for the Prevention of Pollution from Ships
MDO	Marine Diesel Oil

ME	Main Engine
MGO	Marine Gas Oil
MLC	Maritime Labour Convention
NAP	National Action Plan to address GHG emissions from ships
NP	Nautical Publication
OPS	Onshore Power Supply
PCS	Port Community System
PBP	Pilot Boarding Place
ROV	Remotely Operated Vehicle
RTA	Requested Time of Arrival
SDG	Sustainable Development Goal
SECA	Sulphur Emissions Control Area
Simops	Simultaneous operations
SME	Subject Matter Expert
SOLAS	International Convention for the Safety of Life at Sea
TEU	Twenty-foot Equivalent Unit
UKC	Under Keel Clearance
UNLOCODE	United Nations Code for Trade and Transport Locations
VTS	Vessel Traffic Service

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The views expressed in this Guide are those of the authors and do not necessarily represent the opinion of the organizations they work for, or any organization that provided inputs as per list of contributing entities below.

List of entities that provided inputs (Low Carbon GIA members are highlighted in bold):

ABB

APM Terminals

Association of Bulk Terminal Operators (ABTO)

BIMCO

BP Shipping

Bureau Veritas Marine & Offshore SAS

Cargill

Digital Container Shipping Association (DCSA)

DNV SE

Exmile Solutions Ltd

Federation of National Associations of Ship Brokers & Agents (FONASBA)

Grimaldi Group

Hamburg HVCC

HPA Hamburg

Inchcape Shipping Services

International Association of Dry Cargo Shipowners (INTERCARGO)

International Association of Ports and Harbors (IAPH)

International Cargo Handling Coordination Association (ICHCA)

International Chamber of Shipping (ICS)

International Federation of Shipmasters' Associations (IFSMA)

International Harbour Masters Association (IHMA)

International Parcel Tankers Association (IPTA)

International Ship Suppliers Association (ISSA)

A.P. Moller-Maersk A/S

MPA Singapore

MSC Mediterranean Shipping Company S.A.

Nautical Institute

North Sea Port

Port of Gothenburg

Port of Oostende

Port of Rotterdam

Port of Tanger Med

PortXchange

Royal Caribbean Cruises Ltd

Shell International Trading and Shipping Company Ltd

Silverstream Technologies (UK) Ltd

Stena AB

Stolt Tankers B.V.

Swedish Maritime Administration

Terminal Investment Ltd

Torm A/S

Total Marine Fuels Pte Ltd

Wärtsilä Corporation

World Ports Climate Action Program (WPCAP)

Executive summary

International efforts to address GHG emissions include the Paris Agreement and its goals, and the United Nations 2030 Agenda for Sustainable Development and its SDG 13: “Take urgent action to combat climate change and its impacts”. With a view to contributing to global emission reduction efforts, IMO in April 2018 adopted resolution MEPC.304(72) on the *Initial IMO Strategy on reduction of GHG emissions from ships*, setting out a vision to reduce GHG emissions from international shipping and phase them out as soon as possible in this century.

The Strategy includes a list of candidate short-, mid- and long-term measures which IMO could further develop with a view to achieving the ambitious targets as set out in the Strategy. As part of the list of candidate short-term measures, the Strategy calls for the encouragement of port developments and activities globally to facilitate reduction of GHG emissions from shipping, including provision of ship and shoreside/onshore power supply from renewable sources, infrastructure to support supply of alternative low-carbon and zero-carbon fuels, and to further optimize the logistics chain and its planning, including ports.

Furthermore, the important role of ports in the wider supply chain and the action that ports can take to facilitate the reduction of GHG emissions from shipping has been recognized through the adoption of resolution MEPC.323(74) in May 2019 on *Invitation to member states to encourage voluntary cooperation between the port and shipping sectors to contribute to reducing GHG emissions from ships*.

With a view to supporting the maritime industry in achieving IMO’s emission reduction goals and contributing to greener shipping, this Guide is a Call for Action to port and shipping sectors to facilitate the reduction of GHG emissions in the ship-port interface. This Guide is a particularly useful document for shipowners, ship operators, charterers, ship agents, shipbrokers, port authorities, terminals and nautical services providers, and other relevant stakeholders, who ultimately play a key role in implementing the necessary changes and facilitating the uptake of emission reduction measures in the ship-port interface.

This Guide presents several practical measures that:

- .1 can be applied today with limited or low capital and operational investments;
- .2 are relatively easy and quick to implement; and
- .3 have the potential to contribute to GHG emission reduction with additional benefits.

With the average economic lifetime of a ship of approximately 25 years¹ and the prospect of zero emission ships entering the market from 2030 onwards, measures that have relatively short payback times with additional benefits for safety and security can be considered low-risk investments.

With this in mind, this Guide presents eight practical measures that can be implemented with limited capital. The measures have not been ranked in terms of emission reduction potential, but have been ordered into measures related to port operations, administrative data, nautical data and speed optimization as follows:

Measure 1: Facilitate immobilization in ports

Measure 2: Facilitate hull and propeller cleaning in ports

Measure 3: Facilitate simultaneous operations (simops) in ports

Measure 4: Optimize port stay by pre-clearance

Measure 5: Improve planning of ships calling at multiple berths in one port

Measure 6: Improve ship/berth compatibility through improved Port Master Data

Measure 7: Enable ship deadweight optimization through improved Port Master Data

Measure 8: Optimize speed between ports

¹ <https://www.statista.com/statistics/1102659/average-age-of-ships-scrapped-worldwide/>

The Guide presents an explanation of each of these measures and identifies how their implementation can lead to GHG emission reductions and further benefits for the maritime sector (e.g. for the safety and security of shipping). Barriers to the global implementation of each measure are identified and preliminary potential solutions and next steps are suggested which could be taken to progress implementation further.

The annex of this Guide provides an idea of the potential fuel savings which can be achieved through implementation of some of the measures presented in this Guide. Data used in this Guide is based on real fuel consumption data and was provided and analysed in-kind by two GIA members (A.P. Møller-Mærsk A/S and the Port of Rotterdam).

It should be noted that while the Guide in general refers to GHG emissions, the calculations presented in the annex show the differences in potential fuel consumption. The calculations therefore provide only an indication of the potential CO₂ savings, under the specified conditions, and further deeper analysis of the fuel and emission reduction potential of each measure is required.

The eight measures presented in this Guide have been selected for their potential application on a global scale. Measures can be implemented individually as well as collectively, which would maximize the emission reduction benefit. Some of the measures would be applicable each time a ship calls a port (e.g. simultaneous operations, pre-clearance), while others may be applicable less frequently but can have a large impact on fuel consumption (e.g. immobilization, hull and propeller in-water cleaning). Measures such as Onshore Power Supply (OPS) fall outside the scope of this Guide, given the higher capex.

The list of presented measures is non-exhaustive and should serve to raise awareness of preliminary ideas which the maritime community could potentially implement. Recognizing that every port is different and has its unique challenges and characteristics, readers are encouraged to use this Guide as a starting point for discussions and explore these opportunities further within their own port community. Furthermore, the cost of implementation of each of these measures is difficult to assess given the variety of stakeholders involved in their implementation and therefore, the applicability of each measure should be individually assessed for each port and, if needed, explored to see how their uptake could be incentivized.

It should be noted that in all cases, measures to reduce GHG emissions in the ship-port interface will require a triangular collaboration (between ships, ports and terminals) and that none of these measures can be implemented by one stakeholder alone. Furthermore, the speed of implementation will largely depend on the strength of that collaboration and the willingness of all stakeholders to play a part, even if they may not be the direct beneficiaries.

This Guide has been developed by the Global Industry Alliance to Support Low Carbon Shipping (Low Carbon GIA), a public-private partnership originally established under the framework of the GEF-UNDP-IMO Global Maritime Energy Efficiency Partnerships Project (GloMEEP Project). The Low Carbon GIA was launched with the aim to identify and develop innovative solutions to address common barriers to the uptake and implementation of energy efficiency technologies and operational measures. Since January 2020, the Low Carbon GIA has been operating under the GreenVoyage2050 Project, a joint IMO-Norway initiative to support implementation of the Initial IMO GHG Strategy.

This Guide, based on research and discussions undertaken by members of the Low Carbon GIA and other subject matter experts in this field, does not intend to showcase fully developed measures. Instead, this Guide presents initial ideas which require further work and deeper assessment.

Looking into the near future, Low Carbon GIA Members will, based on this Guide and bringing together ports, shipping lines and terminal operators, encourage implementation of these practical measures. With a view to contributing to scaling-up and increasing the uptake of these ship-port interface measures, experiences and best practices will be shared with the global maritime community and contribute to future iterations of this publication.

Measure 1: Facilitate immobilization in ports

Brief description of the measure

Implementation of this measure would allow for maintenance and repairs of the main engine (ME) to occur simultaneously with cargo operations. This would contribute to a reduction in GHG emissions as it would optimize the time spent in port, and eliminate the need for the ship to transit to another location for work to be undertaken.



Further details

In many ports, maintenance and repairs of the main engine are performed at a lay-by berth, outside of the normal ship schedule. Subsequently, ships may need to speed-up to recover the lost time and meet their voyage onward schedule, negatively impacting on emissions (both in port, due to the longer port stay, and at sea, due to higher transit speeds).

Allowing ships to undertake ME maintenance and repairs simultaneously with cargo operations would reduce the time spent in port. As most ships only have one main engine, once repairs have started, the ship cannot depart from her berth under own power. This condition is called “immobilization” and is not currently permitted by many port authorities.

Main engines of ships on average have 6 to 10 cylinders. While new container ships could have 2 MEs with 7 or 8 cylinders each, older container ships may only have 1 ME with 10 to 14 cylinders. Each cylinder has many different components (e.g. fuel pump, fuel injector, exhaust valve, piston ring or cylinder liner) which may require planned maintenance or unplanned repairs. Proper functioning of these components is critical to maintaining the engine in a condition that combustion is optimal (i.e. causes the least possible emissions under any given engine load condition).

The duration of maintenance jobs may range from 3 hours (e.g. exchange of a fuel injector) to 12 hours (e.g. replacing a piston) and up to 24 hours (e.g. replacing a cylinder liner). The frequency of maintenance jobs also varies per type and make of engine and component, e.g. piston rings need replacement approximately every 16,000 running hours, an exhaust valve overhauled after 16,000 running hours and a fuel injector after 8,000 running hours. Depending on engine load and quality of fuel and lubrication oil, there is a tendency for condition-based maintenance in lieu of running hours-based maintenance. All maintenance is required to be in compliance with class requirements.

Example ports (not exhaustive) which have implemented this measure

Ports of Bremerhaven, Gothenburg, Hamburg and Rotterdam allow maintenance to main engines and grant immobilization under normal weather conditions.

Other benefits

- Reduced risk of breakdown due to maintaining optimal engine condition.
- Improved operational reliability as the ship has better planned maintenance opportunities.
- Improved safety for crew on board due to less time pressure to do the job.
- Improved navigational safety, as shifting the ship to a lay-by berth is always an additional manoeuvre with the corresponding nautical risk.
- Availability of technical expertise in port, to support ship’s staff, if required.

Main barriers

- Lack of understanding of risks associated with immobilization which results in port authorities not granting permission. In some cases, immobilization may be granted by the port authority but refused by the terminal operator.
- Lack of understanding by terminal or harbour master that maintenance and repairs on the main engine do not have any impact on the capability of the ship to be safely moored, as the mooring winches are not powered by the main engine but by the auxiliary engines.
- Potential increase of need for tugs, if the ship has to leave the berth in the event of an emergency.
- Concerns that ME repairs will take longer than envisaged, causing the ship to remain alongside for longer than planned.
- Availability of qualified crew for the intended work on the ME in conjunction with rest hour planning.

Suggested next steps/potential solutions

- Gain deeper understanding of the main barriers for relevant stakeholders involved in immobilization.
- Review current practices and motivation for allowing/denying immobilization.
- Explore potential incentives for port authorities and terminal operators to facilitate this measure.
- Explore implementation through segmented approach – is the measure more easily implemented for certain ports based on topography, availability of resources like workshops, maintenance staff expertise and facilities and certain ship types?
- Publish a best practice for ports, terminals and shipping indicating risks, measures to counter these risks and framework to issue permission for immobilization.
- Ship Masters should inform port authorities of their overhaul plans in advance, with the reminder that ship's routine operations will be maintained through auxiliary engines/shore supply (if available), so that the port authority can have ample time to assess the request and grant permission if appropriate.
- Promote transparent communication from the port authority and terminal operator on whether immobilization is permitted and under what circumstances so ship agents can plan accordingly.
- Ports to undertake risk assessments to better understand and mitigate potential risks.
- Ships to undertake risk assessments for the maintenance to be undertaken in conjunction with qualified crew availability and prevailing circumstances at time of intended maintenance (terminal planning, weather outlook, ship rest hour planning).

Measure 2: Facilitate hull and propeller cleaning in ports

Brief description of the measure

Implementation of this measure would allow hull and propeller cleaning to take place in port, ideally simultaneously with cargo operations. This would contribute to a reduction in GHG emissions as it would optimize the time spent in port and eliminate the need for the ship to transit to another location for hull and propeller cleaning to be performed, as well as the reduced GHG emissions as a result of the hull and propeller cleaning itself.



Further details

Many ports do not currently allow hull and propeller cleaning during the port stay. As a consequence, it can be challenging for ship operators to maintain a clean hull and propeller, which would reduce resistance of the hull and propeller through the water while steaming. Hull and propeller fouling results in increased fuel consumption and hence higher GHG emissions. Therefore, it is important for ships to regularly clean their hull and propeller. Allowing ships to clean their underwater hull and propeller, ideally simultaneously with cargo operations alongside, will optimize the time it spends in port and avoid that the ship may have to speed up in order to make up for lost time.

Hull and propeller cleaning does not need to be undertaken at every single port call and also largely depends on the trading pattern and region where the ship trades. Cleaning the hull too early may damage the anti-fouling coating system, which could in turn increase fouling.

Some ports do not allow in-water cleaning at all due to sediment/scrapings of the hull and propeller cleaning process entering the port waters, and in this respect the industry has developed the first industry standard on in-water cleaning with capture.²

² <https://www.bimco.org/news/priority-news/20210402-shipping-industry-takes-new-step-to-protect-marine-environments>

Example ports (not exhaustive) which have implemented this measure

Ports of Algeciras, Antwerp, Ghent, Gothenburg, Rotterdam, Zeebrugge

Other benefits

- Reduced hull and propeller fouling.
- Reduced risk of invasive species polluting local waters (provided the fouling is collected).

Main barriers

- Environmental concerns regarding discharge of removed biomass.
- Lack of port reception facilities for collected biomass.
- Availability of crew/personnel to supervise operation.
- Risk owing to other simultaneous operations (such as bunkering, or cargo operations which may require the use of cooling/ballast water pumps. Use of these may create pressure differentials in the water which poses a safety risk for divers under the ship).
- ROVs are not able to undertake the cleaning process (especially in cases of propeller and heavier biofouling).

Due to these barriers, local authorities often do not issue operating permits to hull and propeller cleaning companies.

Suggested next steps/potential solutions

- Use of hull and propeller cleaning remotely operated vehicles (ROVs), which may reduce the risk associated with divers under the ship during cargo operations. Furthermore, use of ROVs with collecting abilities to eliminate discharge of scrapings into local waters.
- Ports to undertake risk assessments to better understand and mitigate potential risks associated with hull and propeller cleaning simultaneously with cargo operations.
- Establishment of harmonized procedures for issuance of operator licences to minimize the impact on the aquatic environment and to create a level playing field.
- Transparent communication from the port authority and terminal operator on whether hull and propeller cleaning during cargo operations is permitted and under what circumstances so ship agents can plan accordingly.
- Promote industry standard to enable the provision of environmentally-sound hull and propeller cleaning services.
- Incorporate guidelines as laid down in the Guidance for the Selection of Diving Contractors to Undertake Underwater Ship Husbandry issued by the IMCA (publication IMCA M 210).

Measure 3: Facilitate simultaneous operations (simops) in ports

Brief description of the measure

Implementation of this measure would allow operations to occur simultaneously (e.g. cargo, bunkering, provisioning, tank cleaning etc.). This would contribute to a reduction in GHG emissions as it would optimize the time spent in port, as operations can be concluded in parallel rather than in sequence.

Further details

Depending on the size of the ship and the capabilities of the port, bunker operations would normally require a minimum of 6 hours, while taking provisions, spares or consumables on board could require about 1 to 4 hours. These operations fall under the responsibility of different onboard departments (i.e. bunker operations are normally under the responsibility of the chief engineer, while cargo operations are under the responsibility of the chief officer). Therefore, these can occur simultaneously, taking into consideration that crew rest hour requirements are not compromised.



Example ports (not exhaustive) which have implemented this measure

Bunkering of HFO during cargo operations is allowed in most ports. In the tanker segment this is sometimes prohibited by the terminal. Bunkering of LNG is more often than not allowed during cargo operations; however, it is becoming available in a wider range of ports, such as Ports of Barcelona, Gothenburg and Rotterdam.

Other benefits

- Improved navigational safety, as shifting the ship to a lay-by berth (for completion of bunkering operations, loading provisions, spares and consumables) may require an additional manoeuvre with the corresponding nautical risk.
- Manoeuvring the ship to a lay-by berth is an additional burden on the ship complement who are all required for shifting.
- Less demand on nautical service providers in the port.

Main barriers

- Perceived safety risk with respect to bunkering operations and potential fire/explosion hazards (in particular in dangerous goods terminals).
- Willingness of terminal and/or port authority to permit simultaneous operations to be carried out.
- In some cases, lack of available crew to support simultaneous operations with a potential effect on crew rest hours (although under certain circumstances, shore assistance can be ordered).
- Non-transparent information sharing to facilitate planning of services, hampering a proper rest hour planning for the ship and service providers.

Suggested next steps/potential solutions

- Undertake a comprehensive risk assessment with all parties (shipping, terminals and ports etc.) to analyse the potential risks of simultaneous operations and to identify possible mitigation measures. The risk assessment could also identify exactly which operations can take place simultaneously and under what conditions.
- Sharing of best practices from ports which allow simultaneous operations (e.g. in the case of chemical tankers some ports allow pre-washing of tanks to be carried out at berth simultaneously with loading/discharging of other tanks). Sharing this experience would be helpful for other ports to understand and mitigate associated risks.
- Facilitate clear information sharing between all stakeholders involved, so as to ensure proper planning of services to the ship.

Measure 4: Optimize port stay by pre-clearance

Brief description of the measure

This measure optimizes the port call and aims to eliminate unnecessary waiting time by facilitating all required clearances in advance, thereby contributing to a reduction in GHG emissions through the optimized port stay.

Ships may experience operational delays on arrival, during port operations or at departure due to clearance processes in ports. The delays may need to be recovered in transit, often resulting in higher transit speeds, and thereby increased fuel consumption and emissions. Port stay optimization can be supported by introducing pre-clearance of e.g. customs, immigration, port health or port authority formalities, avoiding waiting time to arrive, during operations alongside or to depart, in line with standard 2.1.2 of the FAL Convention: *“Public authorities shall develop procedures for the lodgement of pre-arrival and pre-departure information in order to facilitate the processing of such information for the expedited subsequent release/clearance of cargo and persons.”*



Further details

Notifications and declarations must be provided by the ship to the authorities concerned for cargo and persons' clearances. Typical clearances are granted by customs, immigration, port health and port authorities. Furthermore, there are additional clearances required on the cargo side (e.g. cargo sampling/checks to ensure quality) although this may be dependent on ship segment.

Frequently, ships face delays on arrival or departure because clearances from the relevant authorities have not been obtained. In some cases, ships may anchor, wait for port clearance, and retrieve anchor before proceeding to the port, which takes considerable time. E.g. not having received port health clearance (free pratique) can lead to delays in entering the port, and not having received customs clearance can delay the start of cargo operations, and lead to idle waiting time alongside. These delays, many of which are experienced on arrival, lead to an increased number of port hours versus planned port time, the timing of which can typically range from half an hour up to 5 hours.

Normally, the ship agent sends the reporting and data format requirements to the ship. The Master compiles and completes this data, which can be resource intensive (as the authorities in most countries require their own format), and returns it to the ship agent, who then processes this data into an electronic application (e.g. maritime single window, port community system). Since April 2019, in accordance with the revised requirements in the FAL Convention, public authorities have to establish systems for the electronic exchange of information, and hard copies are only allowed in case of force majeure where means of electronic transmission are unavailable.

In most ports it is unknown if and when authorities are boarding the ship. Often authorities board the ship at different times. Immigration officers may come on board at any time, forcing all crew to wake up for a "face check", custom officers may board several hours later. Both can significantly impact crew rest hours, causing even a violation of rest hours (and hence the Maritime Labour Convention, MLC).

The current situation is expected to improve over time; however, it requires acceleration. A group of global industry associations in consultative status with IMO representing the maritime transportation and port sectors, consisting of IAPH, BIMCO, ICHCA, ICS, IHMA, IMPA, IPCSA, ISSA, FONASBA and the PROTECT Group, issued a joint statement on 2 June 2020 calling for intergovernmental collaboration to drive the acceleration of digitalization of maritime trade and logistics. In addition, owing to the COVID-19 pandemic, many port authorities do not board the ship anymore, demonstrating that physical presence is not necessarily required to clear the ship.

Example ports (not exhaustive) which have implemented this measure

Port of Singapore has implemented pre-clearance.

Other benefits

- Improved safety by better crew rest hour planning; often the Master and/or the crew are woken up by authorities to provide documents or to present themselves. Pre-arrival clearance would potentially eliminate this disturbance to crew rest hours.

Main barriers

- Compliance with different administrative requirements (e.g. immigration, health, security) of the port State.
- Capacity of ship operator to provide required information in the correct format in a timely manner.
- Capability of the port and the relevant authorities to handle and process digital standardized declarations and notifications.

- Willingness of port and relevant authorities to grant and accept clearances in a digital format. Digital clearances are not always accepted in the next port of call: some ports require seal and signature.
- Lack of harmonization between standards.

Suggested next steps/potential solutions

- Implementation of electronic data exchange systems.
- The Expert Group on Data Harmonization (EGDH) set up by IMO's FAL Committee should continue working on harmonizing data models, data elements and definitions for declarations and notifications. To succeed this should be implemented by the port community as well as all ship systems in order to facilitate a seamless exchange of information across borders and IT platforms.
- IMO FAL EGDH should facilitate the inclusion of new data elements into the FAL Compendium, such as time definitions related to boarding times and clearances by local authorities.
- Authorities should be clear and transparent about their clearance process, in order for the maritime community to know what to expect in advance and to be able to plan and act upon that process.

Measure 5: Improve planning of ships calling at multiple berths in one port

Brief description of the measure

This measure aims to improve the planning of ships calling at multiple berths in one port, as is often the case with container feeder ships, chemical and parcel tankers. This measure aims to ensure:

- Just in Time shifting of ships between berths; and
- Optimization of cargo operations.

Addressing the planning would result in lower GHG emissions as the ship's time under engine in port, the terminal operations as well as all services ordered (e.g. nautical service providers) are aligned which result in improved port turnaround times and present an opportunity for bunker savings in subsequent voyage to the next port of call, thereby contributing to a reduction of GHG emissions.

Further details

Today, ship agents need to collect information from all sources, usually by phone, which is very labour intensive and inefficient. There is a huge dependency on the manual follow-up of any unforeseen changes in port operations delivered to the ship, terminal completion times, completion of bunker provisions, booking of pilots and tugs etc. The process of updating all parties involved is fragmented and extremely manual in terms of manpower. While shipping is a 24/7 operation, not all crucial stakeholders might be available around the clock.

This is further exacerbated when ships call at multiple berths in one port (which is common for container feeder ships, chemical and parcel tankers) as there is no overview of the berth planning for multiple berths. Individual terminals are responsible for their own berth planning, and the port authority is responsible for the port planning. Today, most ports and terminals do not have a neutral unit that acts as a coordinating entity, which has full overview of activity within the port. As a result, the planning of a ship calling at multiple berths in one port is fragmented, and often results in unnecessary ship movements, additional shifting to lay-by berth or waiting times at the terminals, which in turn causes unnecessary GHG emissions.

Improving this coordination would result in an improved turnaround time in port, enabling speed optimization opportunities on the outbound voyage, thereby reducing GHG emissions. This measure would encourage increased exchange of high-quality and up-to-date information in order to improve planning and optimize the port stay.

The ease of implementation will depend on the existing digital infrastructure e.g. a PCS. If such a PCS is present, it may still require a change of procedures to develop the capability to exchange the event data required for implementation of the measure.



Example ports (not exhaustive) which have implemented this measure

Port of Hamburg (with the Hamburg Vessel Coordination Centre (HVCC) acting as a neutral overseeing entity)

Other benefits

- Improved safety when shifting ships within a port.
- Effective use of port infra- and suprastructure as well as service providers.
- Increased crew awareness of exact shifting times and cargo operations and therefore, improved crew rest hour planning.
- Improved planning of services and resources across the port.
- Exchange of data and information in a standardized way.

Main barriers

- The absence of a digital interoperable way of exchanging data.
- Reluctance to share relevant information (e.g. berth planning) amongst stakeholders.
- Lack of overview of activities within the port.
- Lack of neutral coordination between port stakeholders (connecting potential competitors).

Suggested next steps/potential solutions

- Incentivize and reward a collaborative approach for all stakeholders to share data.
- Establish means for electronic data exchange (e.g. through electronic PCS).

- Promote data exchange and use of international standards for electronic data exchange (IMO Compendium).
- In the longer term, explore establishment of neutral coordination centres between shipping companies and terminals that could take over key-roles for affected ships such as berth planning (instead of each individual terminal) and stow planning (instead of each individual carrier). This could act as a central round-the-clock point of contact for terminals, shipping companies, ship crews and nautical service providers (such as pilots, tugs and linesmen).

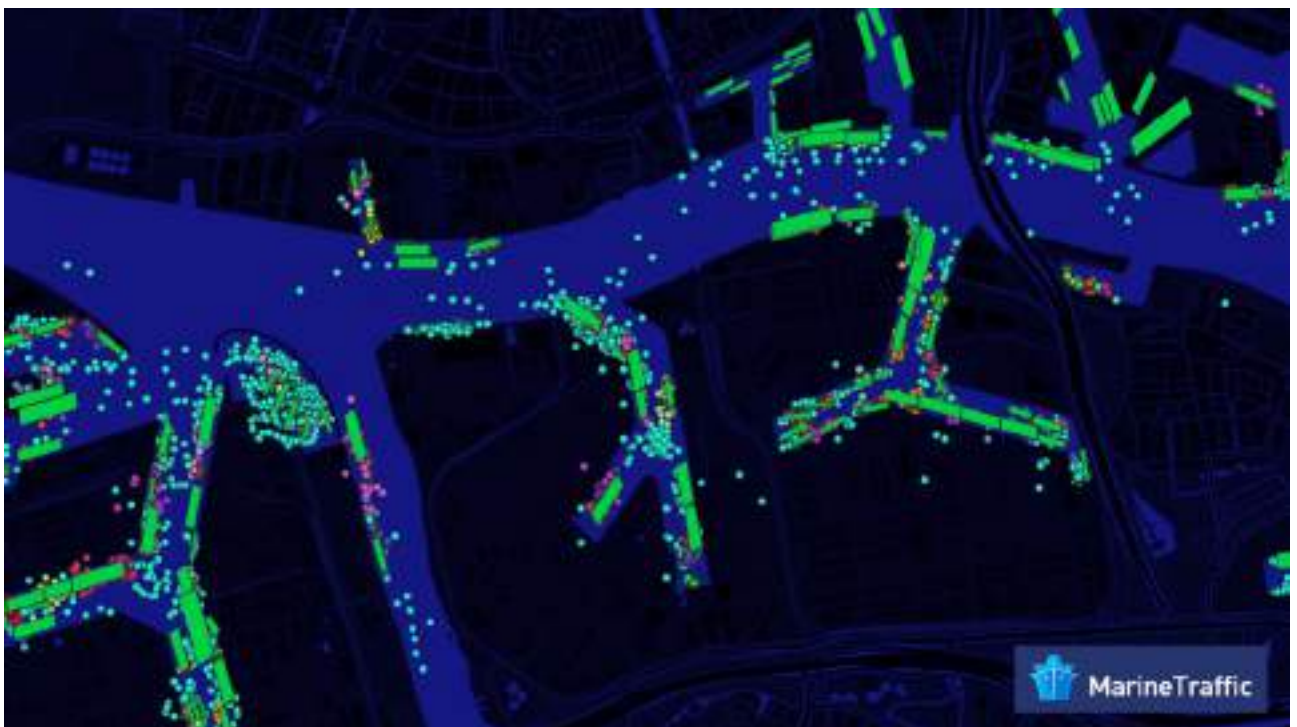
Measure 6: Improve ship/berth compatibility through improved Port Master Data

Brief description of the measure

This measure involves improving Port Master Data to ensure that the right ship size is utilized, by:

- a) reliable identification of the terminal and berth, and
- b) reliable maximum length and beam per berth.

Having the right ship size utilized results in lower GHG emissions per carried ton of cargo.



Further details

Today, many ports and terminals do not have easily accessible and high quality data available about the maximum ship sizes that can be accommodated. AIS data can increase the understanding of the maximum ship sizes for ports, terminals and berths, based on metadata of many ships calling at a particular port, terminal and berth. This data is key for 85 per cent of the shipping business: deploying the right ship that fits at the berth of both the load and discharge port.

Furthermore, many ports and terminals do not have unique identifiers for individual berths that are used on a global level. This can result in misunderstandings and miscommunications regarding which berth a ship should be going to. Without a common understanding of which terminal and berth the ship should go to, it is difficult to obtain accurate information on the maximum length and beam of the ship that the terminal can accommodate. As a result, a ship may not be optimized for that particular berth.

According to regulation 19 of Chapter V of SOLAS,³ AIS is compulsory. Data entry in the AIS equipment is also compulsory; however, it is inputted manually and it is not specified in what format. Currently, the metadata inputted for AIS to identify the next port of call is a freetext field (UNLOCODE), which makes it difficult to analyse the data. The UNLOCODE, which is used to identify the port, is typed in manually, allowing for human error and different codes to be used. The terminal and berth identifiers are currently not inputted into AIS. Inclusion of the identifiers for the terminal and berth in the AIS metadata would allow for the proper and efficient identification of the terminal and berth.

Collating all this AIS data from ships could support efficient identification of the next port of call, including identification of the terminal and berth, taking into account ship length and beam. Analysis of this data could contribute to improving the global availability of Port Master Data.

Example ships which have implemented this measure

Currently, no ships are completing the AIS data in a uniform fashion.

Other benefits

- Facilitate berth to berth passage planning as per IMO resolution A.893(21).
- Enable clarification of locations in sales contract and charterparty to facilitate safe berth clauses.
- Increased safety – as risk of collisions is decreased (when destination of ship is known to other ships).
- Automatic validation of the IMO GISIS database.
- Automatic reporting about the last 10 port visits for the security declaration.
- Automatic validation if the ship called at a terminal with a higher security risk (ISPS level 2 or 3).
- Automatic validation of Electronic Navigational Chart (ENC) data.
- Automatic alerts if too many ships will end up in the same VTS section.
- Automatic reporting to VTS sector re. destination, especially for inland ships.
- Automatic collection of port passage information to a particular berth (e.g. route, number of tugs, etc.).
- Automatic validation of sailing time from Pilot Boarding Place to berth.

Main barriers

- Ambiguous identification of port, terminal and berth.
- Maximum number of characters in the AIS freetext field.
- Concern over the disclosure of commercially sensitive data about the terminal of destination.
- Concern over security risk from AIS metadata when transiting high risk areas.

³ Regulation 19, Chapter V, SOLAS: “Carriage requirements for shipborne navigational systems and equipment – sets out navigational equipment to be carried on board ships, according to ship type. In 2000, IMO adopted a new requirement (as part of a revised new chapter V) for all ships to carry automatic identification systems (AISs) capable of providing information about the ship to other ships and to coastal authorities automatically.”

- The terminal identifier exists but is not easily accessible (IMO Port facility number in the GISIS database).
- The berth identified does not exist on a global level (in the supply chain industry, unique identifiers do exist for locations, i.e. the Global Location Number (GLN)).

Suggested next steps/potential solutions

- Promote accessibility of Port Master Data to all relevant stakeholders (e.g. charterers, traders etc.).
- To mitigate concerns over disclosure of commercially sensitive data regarding the destination terminal, the ship to only disclose the terminal data close to arrival at the berth.
- Link and expand Port Master Data to existing terminal databases to close the gap between port and terminal data (e.g. OCIMF Marine Terminal Information System).
- Develop best practice and guidance to complete AIS data in a uniform fashion.
- Long term solution is an AIS menu to select the port, terminal and berth of destination via the Electronic Chart Display Information System (ECDIS).

Measure 7: Enable ship deadweight optimization through improved Port Master Data

Brief description of the measure

This measure involves improving Port Master Data (depths, water density, tidal heights) to enable optimization of the draught of the ship, eliminating unnecessary allowances and additional buffers in the Under Keel Clearance (UKC).

Improved access to reliable and up to date Port Master Data allows for better optimization of the deadweight capacity and therefore contributes to a reduction in GHG emissions per cargo ton transported.



Further details

Today, ships face many challenges in the availability of reliable and up to date Port Master Data, such as the depths of the deep-water route, fairway, harbour basin and the berth pocket. Owing to the lack of this information, many ships sail with underutilized capacity, as Masters often maintain an additional buffer in the UKC when assessing the allowable draught of the ship on arrival and departure. In applying this measure, and optimizing the deadweight at the loading port, the depth of the discharge port and the approaches in both ports also need to be taken into consideration.

Port authorities face challenges in collecting and publishing port infrastructure data (e.g. name and location of berth, depths). This could be for several reasons (see barriers below), including that the port authority may not be the data owner of all port data (e.g. terminals may be the data owner of depths at the berth). Furthermore, the information gathered is not necessarily shared with the national hydrographic office. Sometimes the data is published directly by the port (e.g. on websites) in a format that conflicts with official ENC, either by different values and/or by different (local) reference levels (Chart Datums, CD). In such cases, the data cannot be readily used.

As a result of this lack of sharing and inconsistency in data formats, some national hydrographic offices are unable to publish this information in their official Nautical Publications (NPs) as they cannot guarantee the correctness of the data. Without access to reliable data, those requiring the information will often resort to collecting the data themselves, through various means such as questionnaires to mariners, ship agents etc. in order to make the most informed decisions, but will take into consideration additional UKC allowances because the data is not verified.

In addition, most NPs do not display the accurate height of tide – usually, only predictions for astronomical tide are displayed. However, since ports are affected by environmental conditions such as wind direction, river flow or barometric pressure, deviations to the astronomical predictions occur. Some ports do publish the local height of tide, but not in a standardized manner and not always with the same timeframe or accuracy.

Most NPs do not display the accurate water density; normally they only display an average water density for the entire port area. Most ports however have different water densities, ranging from e.g. 1025 kg/m³ close to the harbour entrance (sea water) to 1000 kg/m³ further inland (fresh water). Water density may also change with the tide.

To cater for these uncertainties, Masters often apply allowances for the maximum draught in their UKC calculations, especially at the berth, where the ship will also be positioned during low tide.

It should be noted that, in accordance with regulation 9 of Chapter V of SOLAS, “*Contracting Governments undertake to arrange for the collection and compilation of hydrographic data and the publication, dissemination and keeping up to date of all nautical information necessary for safe navigation.*”

Example ports (not exhaustive) which have implemented this measure

Ports of Brisbane, Cairns

The Port of Rotterdam shares its local ENC with the HO and is working to change the format allowing automatic processing of the data. Also, the local Chart Datum (Normaal Amsterdams Peil, NAP) is changed to an international Chart Datum (Lowest Astronomical Tide, LAT).

Other benefits

- Improved safety of navigation – this is predominantly the main reason why accurate and up-to-date Port Master Data is crucial. Most incidents happen in the approaches, anchorages or harbour basins of ports,⁴ as this is by far the busiest time for the Mariner and ship. Therefore, improving the quality and the availability of port information is an important risk mitigation strategy as it will help the Mariner to execute safe navigation from Pilot Boarding Place to berth and vice versa.
- Ensuring that accurate data is provided strengthens the legal position of the port in the event of an incident.

Main barriers

- Lack of accurate and up to date Port Master Data
 - Ports and/or terminals may be reluctant to share depth data because of lack of knowledge of potential legal consequences.

⁴ <http://www.emsa.europa.eu/publications/item/3734-annual-overview-of-marine-casualties-and-incidents-2019.html>

- Ports and/or terminals may have legacy systems and local standards that would require alignment and harmonization with international standards in order to ensure compliance. For example, local port authorities may use different Chart Datum, employ different methodologies for taking soundings or use different terminology in their local standards, so additional efforts may be required to bridge any differences in order to comply with international standards.
- Ports and/or terminals may not have the resources (financial or technical/technological capacity) to implement a scheme to improve its Port Master Data.
- Lack of trust in available Port Master Data, which in turn leads to additional buffers added to the UKC.

Suggested next steps/potential solutions

- Developing incentives for ports and terminals to share data regularly.
- Increasing awareness and strengthening international compliance with the IHO S-44 standard⁵ including gathering of data to ensuring compability of Chart Datum with the IHO S-44 standard (otherwise the hydrographic office is unable to use that survey in an official ENC, or paper chart).
- Promote publication of Port Master Data in a digital format in a standardized way (alignment of current data).
- Promote accessibility of up-to-date Port Master Data to all nautical staff on board and raise awareness of how that information can be used to eliminate unnecessary buffers in UKC.
- Sharing best practice with ports and terminals together with HOs on how to share data, in which format, and with which Notice of Intended Use.
- Sharing knowledge about their legal position regarding not sharing data versus being forced to share data after an incident has happened.

⁵ The S-44 Publication sets out the “Standards for Hydrographic Surveys”, developed by the International Hydrographic Office (IHO)

Measure 8: Optimize speed between ports

Brief description of the measure

This measure would allow for ships to optimize speed between ports, to arrive “Just In Time” when the berth, fairway and nautical services are all available. This “Just In Time Arrival” concept (JIT Arrival) will improve the port call process and ultimately reduce GHG emissions.

Through the application of JIT Arrival, GHG emissions and air pollutants can be reduced in a twofold manner:

- for the ship voyage through the optimization of the sailing speed and hence more optimal engine efficiency resulting in lower fuel consumption; and
- for the port area as the amount of time ships manoeuvring in the approaches or waiting at anchorage is reduced.

Further details

The process of a port call nowadays is not really optimized, because of the late availability and inaccuracy of information. This can result in a suboptimal port call process, due to unnecessary waiting time, which in turn results in excess GHG emissions from the ship. Ships, in general, “hurry” at full sea speed to the next port, only to find out that the berth is not available because of e.g. another ship is alongside, the cargo is not available for loading, or there is no tank available for discharging. This results in either having to “wait” outside the port at anchorages for many hours, days or even weeks, or manoeuvre at very low speeds in the port area while waiting for the availability of berth, fairway and nautical services. This “hurry up and wait” ship operation has many disadvantages and from an environmental, safety and economic perspective can be improved significantly.

Sending a Requested Time of Arrival (RTA) Pilot Boarding Place (PBP) (ideally, at least 12 hours before arrival) would allow the ship to optimize its speed to arrive Just In Time at the PBP when the availability of: 1. berth; 2. fairway; and 3. nautical services (pilots, tugs and linesmen) is ensured. This may still include anchor time as the optimized speed may take the ship to PBP before the RTA PBP. In a JIT Arrival scenario, the RTA PBP is frequently communicated to the ship, thereby enabling the Master to take a decision to optimize the ship’s speed.

JIT Arrival is not to be confused with slow steaming or an average/absolute speed limit. Through the application of JIT Arrival, the overall length or duration of a voyage is not impacted and remains the same. Instead, the voyage overall is optimized – the ship may spend more days sailing, but the aim is to minimize and preferably eliminate waiting time and enable sailing at a speed which gives reduced fuel consumption per mile steamed.

The ease of implementation will depend on the existing digital infrastructure e.g. a PCS. If such a PCS is present, it may still require a change of procedures to develop the capability to exchange the event data required for implementation of the measure.

Example ports (not exhaustive) which have implemented this measure

Port of Newcastle (AU) for bulk sector, ports with locks (e.g. Amsterdam, Ghent), Port of Busan (new port section), Port Everglades for cruise liners.



Other benefits

- Optimized port processes.
- Better capacity planning of nautical services (pilots, tugs and linesmen).
- Better capacity planning of terminals, berths and related resources.
- Better capacity planning of ship services (bunkers, MARPOL/waste, provisions, surveys etc.).
- Enhanced supply chain visibility due to improved predictability of cargo whereabouts.
- Optimized stock and asset management.
- Better planning of type and timing of hinterland modalities.
- Improved compliance to MLC due to improved rest hour planning.
- Reduced lube oil consumption.
- Less risk on piracy.
- Less accidents in anchorages.
- Less hull fouling.

Main barriers

- Today, there is no requirement or incentive for Ports and Terminals to facilitate the shipping sector to realize reduction of GHG emissions from ships at sea.
- Contractual barriers exclusively apply to those ships that operate under voyage charter (i.e. most bulkers and tankers), during the laden voyage. This is because voyage charter parties include a Due Despatch clause which obliges the ship's Master contractually to proceed to the next port with utmost despatch, regardless of whether a berth is available or not. Additional complications are e.g. when a ship carries several different cargoes, cargoes which may be traded many times between the load and discharge port, and shipping industry being rather reluctant to make amendments to charter parties.⁶

⁶ IMO GIA Just In Time Arrival Guide

- Reluctance of key stakeholders (port, terminals and shipping) and data owners in the port call process to share information and data.
- Lack of data quality, timeliness and standardization of data being shared.
- The Master/Charterer is not always aware of the latest update of the RTA Berth to the Cargo buyer/seller, preventing further optimization of the ship's speed.

Suggested next steps/potential solutions

- Promote inclusion of a JIT Arrival standard clause in the voyage charter party to allow the ship's Master to optimize speed, without being in breach of contract (see BIMCO clause).⁷
- Incentivize and reward a collaborative approach for all stakeholders to participate (including encouraging terminals not to give berthing priority by arrival order).
- Promote data exchange and use of international standards for electronic data exchange (IMO Compendium).
- Demonstrate proof of concept and share experience from ports implementing JIT Arrivals. Port authorities could introduce JIT Arrivals by requiring the ship to be at the PBP at a specific agreed time.

For further information, please refer to the *Just In Time Arrival Guide – Barriers and Potential Solutions* (GloMEEP, Low Carbon GIA, 2020).

⁷ <https://www.bimco.org/contracts-and-clauses/bimco-clauses/current/just-in-time-arrival-clause-for-voyage-charter-parties-2021>

Annex

The information set out in this annex aims to provide an idea of the potential fuel savings which may be achieved through implementation of some of the measures presented in this Guide. Data used in this Guide is based on real fuel consumption data and was provided and analysed in-kind by two GIA members (A.P. Møller-Mærsk A/S and the Port of Rotterdam).

It should be noted that while the Guide in general refers to GHG emissions, the calculations presented in this annex show the differences in potential fuel consumption and therefore provide an indication of the potential effect on CO₂ emissions.

In all of the calculations, the fuel consumption data used was that of a large containership (ULCV / 16000 TEU).

The calculations are in no way absolute and any reduction in fuel consumption stated in these calculations should not be considered a reflection of all ship types and voyages. The calculations merely provide an indication of the potential saving, under the specified conditions.

Where applicable, “Port area” is defined as the area from the Pilot Boarding Place to the berth, and the “Sea area” is defined as the area between the Pilot Boarding Place of one port to the Pilot Boarding Place of the next port.

Calculations related to measures 1 to 5

(immobilization, hull cleaning, simops, pre clearance, multiple berth planning)

Measures 1 to 5 refer to the optimization of the time a ship spends at port and therefore implementing these measures can reduce the overall length of the port stay and allow for more efficient planning of port and terminal resources.

In the following calculations, it is assumed that **not** being able to perform simops (bunkering, provisioning), hull cleaning or repairs to the main engine in the most optimal way (i.e. in parallel as far as possible while the ship is alongside) would lead to the ship having to manoeuvre to another location, such as a lay-by berth/anchorage, which would lead to longer port stay. It is further assumed that the ship would speed up on voyage to the next port in order to compensate for the lost time. While this will not always be the case, and will be dependent on several factors, the calculations assume that the ship will speed up to meet its RTA PBP at the next port. This speeding up would ultimately result in extra fuel consumption and therefore an increase in CO₂ emissions. In the calculations, only the extra fuel consumption has been calculated (not the CO₂ emissions).

The length of “delay” or extra time spent at port (which could be reduced through implementation of these measures) will naturally vary depending on the circumstances but are typically as follows:

Delays due to:	Time	Related measure
Transit to lay-by berth for ME repairs	12 hours	Immobilization (measure 1)
Transit to lay-by berth for hull and propeller cleaning	9 hours	Hull and propeller cleaning (measure 2)
Transit to lay-by berth to complete bunker operations	6 hours	Simops (measure 3)
Transit to lay-by berth to complete provisioning, acquiring of spare parts	3 hours	Simops (measure 3)
Clearances not granted (e.g. immigration, health, security)	1 hour	Pre-clearance (measure 4)
Waiting for transit to next berth for loading/discharge of cargo (at the same port)	variable	Multiple berth planning (measure 5)

Recognizing that the calculated extra fuel consumption expressed as a percentage of the baseline scenario (i.e. all measures implemented as far as possible and no delays) will vary depending on the length of voyage and therefore the calculations simulate a 24 hr voyage and a 6 day voyage (144 hrs).

		BASELINE SCENARIO 'NO DELAY'	DELAY (hours)				
			12	9	6	3	1
24 hr voyage	Speed needed (knots)	11.50	23.00	18.40	15.33	13.14	12.00
Distance 276 nm	Consumption (tons)	52.2	127.2	85.6	68.2	58.8	54.0
	Extra consumption (tons)		75.0	33.4	16.0	6.6	1.8
	Extra consumption (%)		143.6	64.0	30.7	12.6	3.5
6 day voyage (144 hrs)	Speed needed (knots)	11.50	12.55	12.27	12.00	11.74	11.58
Distance 1656 nm	Consumption (tons)	313.3	337.5	330.7	324.3	318.6	315.0
	Extra consumption (tons)		24.2	17.4	11.0	5.3	1.7
	Extra consumption (%)		7.7	5.6	3.5	1.7	0.6

Calculations related to measure 7

(deadweight optimization)

For this calculation, the following assumptions have been made:

- Ship: large container ship (ULCV / 16000 TEU) with average draught (13.5m)
- Departure: Port of Bremerhaven, Terminal 1, Berth 7
- Arrival: Port of Rotterdam, Terminal APM2, Berth APM2
- Port area: from Berth 7 until RW buoy, MC buoy until Berth APM2
- **Sea area:** from RW buoy until MC buoy
- Average container weight for calculation 14 Ton/TEU
- Water density of 1025 kg/m³
- Cargo to optimize draught is available (in bulk and tanker trade this is done more in advance)

Baseline scenario

- Average draught (13.5m)
- Deadweight is 99.000 Ton, 7071 TEU on board (not including potable and ballast water)

Leg	Distance Nautical Miles	Speed Knots	Duration Hours	Fuel consumption Main Engine Tons	Fuel consumption Auxiliary Engine Boiler Tons	Total Fuel consumption (Main Engine, Auxiliary Engine, Boiler) Tons
RW buoy MC buoy	200.0	15.0	13.3	42.16	5.32	47.48
Total						0.00671 Ton/TEU

Scenario – Measure applied

- The measure is applied with draught increase of 0,5 metre
- Deadweight is 107.000 Ton, 7642 TEU on board (not including potable and ballast water)

Leg	Distance Nautical Miles	Speed Knots	Duration Hours	Fuel consumption Main Engine Tons	Fuel consumption Auxiliary Engine Boiler Tons	Total Fuel consumption (Main Engine, Auxiliary Engine, Boiler) Tons
RW buoy MC buoy	200.0	15.0	13.3	42.69	5.32	48.01
Total						0.00628 Ton/TEU

Baseline Scenario	Scenario – Measure applied	Difference
<i>Tons / TEU</i>	<i>Tons / TEU</i>	<i>Tons / TEU / %</i>
0.00671	0.00628	0.00043 / 6,4

Calculations related to measure 8

(speed optimization between ports)

For this calculation, the following assumptions have been made:

- Ship: large container ship (ULCV / 16000 TEU) with average draught (13.5m)
- Departure: Port of Bremerhaven, Terminal 1, Berth 7
- Arrival: Port of Rotterdam, Terminal APM2, Berth APM2
- **Port area:** from Berth 7 until RW buoy, MC buoy until Berth APM2
- **Sea area:** from RW buoy until MC buoy

Baseline scenario

- Update RTA Pilot Boarding Place at first Calling In Point (CIP), delay 3 hours

Leg	Distance Nautical Miles	Speed Knots	Duration Hours	Fuel consumption Main Engine Tons	Fuel consumption Auxiliary Engine Boiler Tons	Total Fuel consumption (Main Engine, Auxiliary Engine, Boiler) Tons
Berth 7 Fairway	10.0	VAR	1.0	1.4	0.6	2.0
Fairway RW buoy	30.0	15.0	2.0	6.4	0.8	7.2
RW buoy CIP	190.0	19.0	10	60.4	0.0	60.4
CIP MC buoy	16.8	4.2	4.0	2.0	2.5	4.5
Total						74.1

Scenario – Measure applied, allowing ship to optimize speed to arrive JIT

- Update RTA Pilot Boarding Place 12 hours before arrival Pilot Boarding Place

Leg	Distance Nautical Miles	Speed Knots	Duration Hours	Fuel consumption Main Engine Tons	Fuel consumption Auxiliary Engine Boiler Tons	Total Fuel consumption (Main Engine, Auxiliary Engine, Boiler) Tons
Berth 7 Fairway	10.0	VAR	1.0	1.4	0.6	2.0
Fairway RW buoy	30.0	15.0	2.0	6.4	0.8	7.2
RW buoy CIP	190.0	14.7	13.0	39.5	5.5	45.0
CIP MC buoy	16.8	14.7	1.1	3.5	0.7	4.2
Total						58.4

Baseline Scenario	Scenario – Measure applied	Difference
<i>Tons / TEU</i>	<i>Tons / TEU</i>	<i>Tons / TEU / %</i>
74.1	58.4	15.7 / 21

An aerial photograph of a port and city. The top half shows a large body of blue water with a white ship docked at a pier. The bottom half shows a dense urban area with many buildings and streets. The text is overlaid on a white rectangular box in the center.

MORE INFORMATION?

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