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MANAGEMENT TOOL ON ENERGY EFFICIENCY FOR SHIPS

Guidance on the Development of a Ship Efficiency Management Plan

Submitted by ICS, BIMCO, INTERCARGO, INTERTANKO and OCIMF

SUMMARY

Executive summary:	A revised guidance document on the development of a Ship Efficiency Management Plan (SEMP) is forwarded for consideration by the intersessional meeting of the working group
Strategic direction:	7.1
High-level action:	7.1.1
Planned output:	7.3.1.3
Action to be taken:	Paragraph 5
Related documents:	MEPC 58/INF.7, MEPC 58/WP.8 and MEPC 58/23

Introduction

1 MEPC 58 considered a first draft of "guidance on the development of a Ship Efficiency Management Plan" developed by Industry Groups and requested the authors to continue to develop the guidance and to make a further submission to the GHG Working Group at its second intersessional meeting.

General

2 In response to the MEPC 58 request, the co-sponsors have further developed and revised the SEMP guidance taking into account the outcome of discussions in the working group at MEPC 58 and considerable inter-industry work in the interim period.

3 The intersessional meeting is requested to note that, in order to provide meaningful guidance across the industry as a whole, a wide range of potential efficiency measures have been included in the guidance document. However, not all measures can be applied to all ships, or even to the same ship under different operating conditions; some of them are mutually exclusive and others depend upon variable factors such as the trading pattern of the voyage and the operational constraints of specific cargoes and trades.

4 The guidance document is intended to indicate the factors to be considered in developing a Ship Efficiency Management Plan for a ship or ships in a fleet; it should not be interpreted as a model plan in its own right. Its contents and the subject areas included are indicative, not prescriptive. Companies will need to develop their own unique plan designed to accommodate the particular circumstances of the operation of their ships and trading patterns.

Action requested of the Intersessional Meeting

5 The Intersessional Meeting is invited to consider the guidance for the development of a ship efficiency management plan that is provided at the annex to this document and to take action as appropriate. It is for consideration that such action might include forwarding the guidance document to MEPC 59.

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ANNEX

DRAFT GUIDANCE ON THE DEVELOPMENT OF A SHIP EFFICIENCY MANAGEMENT PLAN (SEMP)

CONTENTS

INTRODUCTION

There are around 70,000 ships engaged in international trade and this unique industry carries 90% of world trade. Sea transport has a justifiable image of conducting its operations in a manner that creates remarkably little impact on the global environment. Compliance with the MARPOL Convention and other IMO instruments and the actions that many companies take beyond the mandatory requirements serve to further limit the impact. It is nevertheless the case that efficiencies can be found to reduce fuel consumption and to produce directly related reductions in CO_2 emissions for individual ships. While the yield of individual measures may be small, the collective effect across the entire fleet will be significant.

The price of fuel has been described, with justification, as an efficiency driver greater than any legislation and in response many owners and operators are concentrating considerable effort on finding more and more innovative ways to reduce fuel consumption and to improve efficiency across the supply chain.

In global terms it should be recognized that operational efficiencies delivered by a large number of ship operators will make an invaluable contribution to reducing global carbon emissions.

Provisions already exist in the ISM Code for owners and operators to monitor environmental performance and to establish a programme for continuous improvement. A Ship Efficiency Management Plan is simply an environmental procedure, which could be included alongside existing ISM requirements. It provides a possible approach for monitoring ship and fleet efficiency performance over time and some options to be considered when seeking to optimize the performance of the ship.

PART 1 – SEMP AS PART OF THE COMPANY ENVIRONMENTAL MANAGEMENT PLAN

1.1 GENERAL

1.1.1 In the context of this document, the impact of the SEMP within the company environmental management plan is simply a revision of existing plans and procedures already established within a company in the form of the "Safety and Environmental Protection Policy" and the "Development of Plans for Shipboard Operations" under the relevant provisions of the International Management Code for the Safe Operation of Ships and for Pollution Prevention (ISM Code).

1.1.2 Many companies will already have an environmental management system (EMS) in place under ISM and/or ISO14001 which contain procedures for selecting the best measures for particular vessels and then setting objectives for the measurement of relevant parameters, along with relevant control and feedback features. The monitoring of operational environmental efficiency should therefore be treated as an integral element of broader company management systems.

1.1.3 This document provides guidance for the development of a SEMP that should be adjusted to the characteristics and needs of individual companies and ships. The ship efficiency management plan, as outlined in part 2 of this document, is intended to be a management tool to assist a company in managing the ongoing environmental performance of its vessels and as such, it is recommended that a company develops procedures for implementing the plan in a manner which limits any onboard administrative burden to the minimum necessary.

1.2 APPLICATION

1.2.1 It is likely that company environmental management plans will cover the areas listed below. As noted above, many of these areas will already be considered under existing procedures and in addition, the format and content of such plans will need to be tailored to specific company and vessel needs, appropriate to the vessel types and trading patterns.

1. General
2. Definitions
3. Environmental considerations
4. Legal considerations
    - 4.1 International
    - 4.2 Regional
    - 4.3 National
5. Company efficiency management policy
6. Objectives and targets
7. Efficiency measures and options
8. Operational control and monitoring (reference to and explanation of the Operational Indicator)
9. Measuring and recording – development of ship board plans (connected with Part 2)

10. Training and awareness
11. Company verification and control
12. Certification, verification and control

1.3 OPERATIONAL INDICATOR

The monitoring of efficiency gains by use of a procedure based on the principles in the IMO Operational Indicator but developed to suit the individual company and ship should be implemented along with the SEMP.

It should be noted that, in order to avoid unnecessary administrative burdens on ships' staff, monitoring should be carried out as far as possible by shore staff, utilizing data obtained from existing required records such as the official and engineering logbooks and oil record books, etc. Additional data could be obtained during internal audits under ISM, routine visits by superintendents, etc.

1.4 GUIDANCE ON BEST PRACTICES FOR FUEL-EFFICIENT OPERATION OF SHIPS

1.4.1 The search for efficiency across the entire transport chain takes responsibility beyond what can be delivered by the owner/operator alone. A list of all the possible stakeholders in the efficiency of a single voyage is long; obvious parties are designers, shipyards and engine manufacturers for the characteristics of the ship, and charterers, ports and vessel traffic management services, etc., for the specific voyage. All involved parties should consider the inclusion of efficiency measures in their operations both individually and collectively.

Fuel Efficient Operations

Improved voyage planning

1.4.2 The optimum route and improved efficiency can be achieved through the careful planning and execution of voyages. Thorough voyage planning needs time, but a number of different software tools are available for planning purposes.

1.4.3 IMO resolution A.893(21) (25 November 1999) on voyage planning provides essential guidance for the ship's crew and voyage planners.

Weather routeing

1.4.4 Weather routeing has a high potential for efficiency savings on specific routes. It is commercially available for all types of ship and for many trade areas. Significant savings can be achieved, but conversely weather routeing may also increase fuel consumption for a given voyage.

Just in time

1.4.5 Good early communication with the next port should be an aim in order to give maximum notice of berth availability and facilitate the use of optimum speed where port operational procedures support this approach.

1.4.6 Optimized port operation could involve a change in procedures involving different handling arrangements in ports. Port authorities should be encouraged to maximize efficiency and minimize delay.

Speed optimization

1.4.7 Speed optimization can produce significant savings. However, optimum speed means the speed at which the fuel used per tonne mile is at a minimum level for that voyage. It does not mean minimum speed; in fact, sailing at less than optimum speed will consume more fuel rather than less. Reference should be made to the engine manufacturer's power/consumption curve and the ship's propeller curve. Possible adverse consequences of slow speed operation may include increased vibration and sooting and these should be taken into account.

1.4.8 As part of the speed optimization process, due account may need to be taken of the need to coordinate arrival times with the availability of loading/discharge berths, etc., The number of ships engaged in a particular trade route may need to be taken into account when considering speed optimization.

1.4.9 A gradual increase in speed when leaving a port or estuary whilst keeping the engine load within certain limits may help to reduce fuel consumption.

1.4.10 It is recognized that under many charter parties the speed of the vessel is determined by the charterer and not the operator. Efforts should be made when agreeing charter party terms to encourage the ship to operate at optimum speed in order to minimize CO_2 emissions.

Optimized shaft power

1.4.11 Operation at constant shaft RPM can be more efficient than continuously adjusting speed through engine power (see 1.4.7). The use of automated engine management systems to control speed rather than relying on human intervention may be beneficial.

Optimized ship handling

Optimum trim

1.4.12 Most ships are designed to carry a designated amount of cargo at a certain speed for a certain fuel consumption. This implies the specification of set trim conditions. Loaded or unloaded, trim has a significant influence on the resistance of the ship through the water and optimizing trim can deliver significant fuel savings. For any given draft there is a trim condition that gives minimum resistance. In some ships it is possible to assess optimum trim conditions for fuel efficiency continuously throughout the voyage. Design or safety factors may preclude full use of trim optimization.

Optimum ballast

1.4.13 Ballast should be adjusted taking into consideration the requirements to meet optimum trim and steering conditions and optimum ballast conditions achieved through good cargo planning for both dry cargo ships and liquid cargo ships.

1.4.14 When determining the optimum ballast conditions, the limits, conditions and ballast management arrangements set out in the ship's Ballast Water Management Plan are to be observed for that ship.

1.4.15 Ballast conditions have a significant impact on steering conditions and autopilot settings and it needs to be noted that less ballast water does not necessarily mean the highest efficiency.

Optimum propeller and propeller inflow considerations

1.4.16 Selection of the propeller is normally determined at the design and construction stage of a ship's life but new developments in propeller design have made it possible for retrofitting of later designs to deliver greater fuel economy. Whilst it is certainly for consideration, the propeller is but one part of the propulsion train and a change of propeller in isolation may have no effect on efficiency and may even increase fuel consumption.

1.4.17 Improvements to the water inflow to the propeller using arrangements such as fins and/or nozzles could increase propulsive efficiency power and hence reduce fuel consumption.

Optimum use of rudder and heading control systems (autopilots)

1.4.18 There have been large improvements in automated heading and steering control systems technology. Whilst originally developed to make the bridge team more effective, modern autopilots can achieve much more. An integrated Navigation and Command System can achieve significant fuel savings by simply reducing the distance sailed "off track". The principle is simple; better course control through less frequent and smaller corrections will minimize losses due to rudder resistance. Retrofitting of a more efficient autopilot to existing ships could be considered.

1.4.19 During approaches to ports and pilot stations the autopilot cannot always be used efficiently as the rudder has to respond quickly to given commands. Furthermore at certain stage of the voyage it may have to be de-activated or very carefully adjusted, i.e. heavy weather and approaches to ports.

1.4.20 Consideration may be given to the retrofitting of improved rudder blade design (e.g., "twist-flow" rudder).

Hull maintenance

1.4.21 Docking intervals should be integrated with ship operator's ongoing assessment of ship performance. Hull resistance can be optimized by new-technology coating systems, possibly in combination with cleaning intervals. Regular in-water inspection of the condition of the hull is recommended.

1.4.22 Propeller cleaning and polishing or even appropriate coating may significantly increase fuel efficiency. The need for ships to maintain efficiency through in-water hull cleaning should be recognized and facilitated by port States.

1.4.23 Consideration may be given to the possibility of timely full removal and replacement of underwater paint systems to avoid the increased hull roughness caused by repeated spot blasting and repairs over multiple dockings.

1.4.24 Generally, the smoother the hull, the better the fuel efficiency.

Propulsion system

1.4.25 Marine diesel engines have a very high thermal efficiency (~50%). This excellent performance is only exceeded by fuel cell technology with an average thermal efficiency of 60%. This is due to the systematic minimization of heat and mechanical loss. In particular, the new breed of electronic controlled engines can provide efficiency gains. However, specific training for relevant staff may need to be considered to maximize the benefits.

Propulsion system maintenance

1.4.26 Maintenance in accordance with manufacturers' instructions in the company's planned maintenance schedule will also maintain efficiency. The use of engine condition monitoring can be a useful tool to maintain high efficiency.

1.4.27 Additional means to improve engine efficiency might include:

Use of fuel additives
Adjustment of Cylinder lubrication oil consumption
Valve improvements
Torque analysis
Automated engine monitoring systems

Waste heat recovery

1.4.28 Waste heat recovery is now a commercially available technology for some ships. Waste heat recovery systems use thermal heat losses from the exhaust gas for either electricity generation or additional propulsion with a shaft motor.

1.4.29 It may not be possible to retrofit such systems into existing ships. However, they may be a beneficial option for new ships. Shipbuilders should be encouraged to incorporate new technology into their designs.

Improved fleet management

1.4.30 Better utilization of fleet capacity can often be achieved by improvements in fleet planning. For example, it may be possible to avoid or reduce long ballast voyages through improved fleet planning. There is opportunity here for charterers to promote efficiency. This can be closely related to the concept of "just in time" arrivals.

1.4.31 Efficiency, reliability and maintenance-oriented data sharing within a company can be used to promote best practice among ships within a company and should be actively encouraged.

Improved cargo handling

1.4.32 Cargo handling is in most cases under the control of the port and optimum solutions matched to ship and port requirements should be explored.

Energy management

1.4.33 A review of electrical services on board can reveal the potential for unexpected efficiency gains. However, care should be taken to avoid the creation of new safety hazards when turning off electrical services (e.g., lighting). Thermal insulation is an obvious means of saving energy. Also see comment below on shore power.

1.4.34 Optimization of reefer container stowage locations may be beneficial in reducing the effect of heat transfer from compressor units. This might be combined as appropriate with cargo tank heating, ventilation, etc. The use of water-cooled reefer plant with lower energy consumption might also be considered.

Fuel Type

1.4.35 Use of emerging alternative fuels may be considered as a CO_2 reduction method but availability will often determine the applicability.

Other measures

1.4.36 Development of computer software for the calculation of fuel consumption, for the establishment of an emissions "footprint", to optimize operations, and the establishment of goals for improvement and tracking of progress may be considered.

1.4.37 Renewable energy sources, such as wind, solar (or photovoltaic) cell technology, have improved enormously in the recent years and should be considered for onboard application.

1.4.38 In some ports shore power may be available for some ships but this is generally aimed at improving air quality in the port area. If the shore-based power source is carbon efficient, there may be a net efficiency benefit. Ships may consider using on-shore power if available.

1.4.39 Even wind assisted propulsion may be worthy of consideration.

1.4.40 Efforts could be made to source fuel of improved quality in order to minimize the amount of fuel required to provide a given power output.

Compatibility of measures

1.4.41 This document indicates a wide variety of possibilities for CO_2 emission reduction for the existing fleet. While there are many options available, they are not cumulative, are often area and trade dependent and likely to require the agreement and support of a number of different stakeholders if they are to be utilized most effectively.

Age and operational service life of a ship

1.4.42 All measures identified in this paper are potentially cost-effective as a result of high oil prices. Measures previously considered unaffordable or commercially unattractive may now be feasible and worthy of fresh consideration. Clearly, this equation is heavily influenced by the remaining service life of a ship and the cost of fuel.

Trade & sailing area

1.4.43 The feasibility of many of the measures described in this guidance will be dependant on the trade and sailing area of the vessel. Sometimes ships will change their trade areas as a result of a change in chartering requirements but this cannot be taken as a general assumption. For example, wind enhanced power sources might not be feasible for short sea shipping as these ships generally sail in areas with high traffic densities or in restricted waterways. Another aspect is that the world's oceans and seas each have characteristic conditions and so ships designed for specific routes and trades may not obtain the same benefit by adopting the same measures or combination of measures as other ships. It is also likely that some measures will have a greater or lesser effect in different sailing areas.

1.4.44 The trade a ship is engaged in will also determine the feasibility of some of the measures. Ships that perform services at sea (pipe laying, seismic survey, OSVs, dredgers, etc.) are likely to choose different methods of carbon reductions when compared to conventional cargo carriers. The length of voyage will also be an important parameter as will safety considerations imposed upon some vessels. As a result, it is likely that the pathway to the most efficient combination of measures will be unique to each vessel within each shipping company.

PART 2 – ILLUSTRATIVE SHIP EFFICIENCY MANAGEMENT PLAN (SEMP)

2.1 Illustrative Ship Efficiency Management Plan

Name of vessel:	**Capacity (TEU/dwt/Pax/TLM):**
Vessel Type:	
GRT:	**…………………………………………………………**

Energy Efficiency Measures Ship/Fleet Management Measures	**Ship/Company Appraisal Comments**
1. Fleet Management	
a. Measure 1a (e.g., best utilization of fleet capacity) – [measure summary]	
2. Cargo Flow	
a. Measure 2a (e.g., optimize cargo flow) - coordination with port or shipper/charterer for better cargo flow	
3. Voyage Planning & Routeing	
a. Measure 3a (e.g., voyage planning) - [measure summary] (e.g., acquisition and application of ABC software tool for voyage planning)	

Energy Efficiency Measures Ship/Fleet Management Measures	**Ship/Company Appraisal Comments**
b. Measure 3b (e.g., weather routeing) - [measure summary]	
c. Measure 3c (e.g., optimized arrival) - [measure summary]	
4. Communication & Training	
a. Measure 4a (e.g., energy conservation awareness training) - Onboard training for energy efficient operation	

Energy Efficiency Measures Operational Measures	**Ship/Company Appraisal Comments**
5. Ship Operation & Handling	
a. Measure 5a (e.g., speed optimization) - [measure summary]	
b. Measure 5b (e.g., trim optimization) - [measure summary]	
c. Measure 5c (e.g., optimum ballast) - [measure summary]	
d. Measure 5c (e.g., optimizing auto-pilot function) - [measure summary]	
6. Engine Performance & Propulsion	

Energy Efficiency Measures Ship/Fleet Management Measures	**Ship/Company Appraisal Comments**
a. Measure 6a (e.g., engine performance optimization) - [measure summary]	
b. Measure 6b (e.g., fuel quality) - [measure summary]	
c. Measure 6c (e.g., propeller maintenance) - [measure summary]	
d. Measure 6d (e.g., propeller modification) - Fitting of propeller boss fin caps to eliminate hull vortices	
e. Measure 6e (e.g., optimum use of bow thrusters) - [measure summary]	
f. Measure 6f (e.g., shaft generator) - [measure summary]	

Energy Efficiency Measures Ship/Fleet Management Measures	**Ship/Company Appraisal Comments**
7. Hull Resistance Management	
a. Measure 7a (e.g., performance monitoring) - [measure summary]	
b. Measure 7b (e.g., hull maintenance) - [measure summary]	
c. Measure 7c (e.g., advanced hull coating systems) - [measure summary]	

Energy Efficiency Measures Energy Management Measures	**Ship/Company Appraisal Comments**
8. Monitoring Energy Consumption	
9. Engine Cooling Water	
10. Thermal Heat Recovery	
11. Pumps, Fans & Electrical Equipment	
12. Incinerators	
13. Shore power supply	

Energy Efficiency Measures Ship/Fleet Management Measures	**Ship/Company Appraisal Comments**
14. Lighting	
15. Air Conditioner systems/cooling systems	