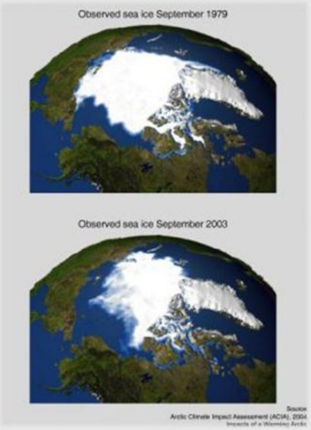
Ship Energy Efficiency Management

Personnel Awareness and Training Seminar



Philip Tsichlis
Naval Architect &
Marine Engineer

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Who we are and what we do (WWAAWWD)

Company Profile

Alpha Marine Consulting Ltd. is based in Piraeus, Greece and has been providing consultancy services to the maritime industry since 1984

Technical Department

- Ship Design / New Buildings & Conversions
- Technical support
- Hull & Machinery Surveys
- Research & Development Projects

Marine Department

- Incident investigations
- Training Services
- Ship-Shore Interface / Vetting procedures
- Consultancy for ISM/ISPS, ISO, TMSA & other Management systems
- Independent audits (Internal, Navigational, Environmental, Energy)

Expertise

Ship Energy Efficiency Management Plans
Energy / Environmental Management Systems

- Since 2006, over 30 **Ship Energy Audits** have been conducted as part of Oil Majors' requirements / research projects (mainly on Tankers, but also on Bulk Carriers, Car Carriers and Container Ships). Feedback from these Energy Audits has been input into our SEEMPs.
- Since 2008 we have been providing consultancy services and support for the development and implementation of **SEEMPs and Energy / Environmental Management Systems** (acc. to TMSA, ISO 14001, ISO 50001, etc. requirements) to more than 100 shipping companies.
- Over the past 2 years we have successfully prepared **more than 1,200 SEEMPs** for all types of vessels.
- We maintain a database for **Energy / Environmental Performance Indicators (e.g. EEOI, SOxI, NOxI)** – used for industry benchmarking purposes – for over 1,200 vessels of various types and have accumulated in-depth knowledge regarding a vast number of energy efficiency improvement devices / systems / applications on ships.

Expertise

Major Clients (for SEEMP)

- ANDRIAKI SHIPPING CO. LTD.
- ATLANTIC BULK CARRIERS LTD.
- GOLDEN UNION SHIPPING CO S.A.
- DELTA TANKERS LTD.
- KASSIAN NAVIGATION AGENCY LTD.
- MARAN TANKERS MANAGEMENT INC.
- MINERVA MARINE INC.
- NEDA MARITIME AGENCY CO. LTD.
- SUN ENTERPRISES LTD.
- TSAKOS COLUMBIA SHIPMANAGEMENT S.A.
- ARCADIA SHIPMANAGEMENT CO. LTD.
- ELETSON CORPORATION
- SPRINGFIELD SHIPPING CO.
- TMS-TANKERS LTD.

Expertise

Major Clients (for SEEMP)

- FLEET MANAGEMENT LTD.
- ANCORA INVESTMENT TRUST INC.
- ATHENIAN SEA CARRIERS LTD.
- AVIN INTERNATIONAL S.A.
- NEWLEAD SHIPPING S.A.
- ALASSIA NEWSHIPS MANAGEMENT INC.
- AEGEAN BULK CO. INC.
- ALLSEAS MARINE S.A.
- ANANGEL MARITIME SERVICES INC.
- BENELUX OVERSEAS INC.
- EUROBULK LTD.
- LOMAR SHIPPING LTD.
- MARYVILLE MARITIME INC.
- STAR BULK CARRIERS CORP.

Expertise

Research on Ship Energy Efficiency

Over the past years, Alpha Marine (member of the European Council of Maritime Applied Research – ECMAR) has invested in R&D and participated in various EU-funded Research Projects, such as:

- Green Retrofitting of Existing Ships (**REFRESH**)
- European Framework for Safe, Efficient and Environmentally-friendly Ship Operations (**FLAGSHIP**)
- Targeted Advanced Research for Global Efficiency of Transportation Shipping (**TARGETS**)

Partners include: HSVA (DE), University of Strathclyde (UK), NTUA (GR), University of Newcastle (UK), BMT (UK), Eniram (FI), MARIN (NL), MARINTEK (NO), Meyer-Werft (DE), Aker (FI), CMT (DE), Force (DE), Maersk (DK), all IACS Members, etc.

Background – Environmental Aspects of Shipping – International Legislation

Section 1

Background – Environmental Aspects of Shipping – Regulatory Framework

UNFCCC, the Kyoto Protocol and Shipping

- The United Nations Framework Convention on Climate Change (UNFCCC) entered into force in 1994.
- Under the Convention, parties share data, launch national strategies to address emissions and cooperate for the adaptation to climate change.
- While the Convention does not provide commitments to stabilize emissions, the Kyoto Protocol sets binding targets for countries. The latter agreed to reduce their overall emissions of six greenhouse gases by an average of 5.2% below 1990 levels between 2008 and 2012. In doing so, the Kyoto Protocol offers several mechanisms to reduce emissions such as Emissions Trading, etc.
- While emissions from maritime transport have been part of the UNFCCC agenda, **these emissions were not included** in the Kyoto Protocol.
- The current debate at IMO is focusing on similar emissions reduction mechanisms called "Market Based Measures (MBMs)" (i.e. "**Emissions Trading**" and "**Bunker Levy**").

Background – Environmental Aspects of Shipping – Regulatory Framework

What is Exhaust Gas Pollution?

Sulphur Oxides or SOx: *come from burning the sulphur present in fuel oils. Corrosive and harmful to life.*

Particulate matter (PM) or soot: *consists of unburned fuel or incombustible elements in the fuel. Highly carcinogenic. The very small or ultrafine particles are the most harmful ones. Not targeted as yet.*

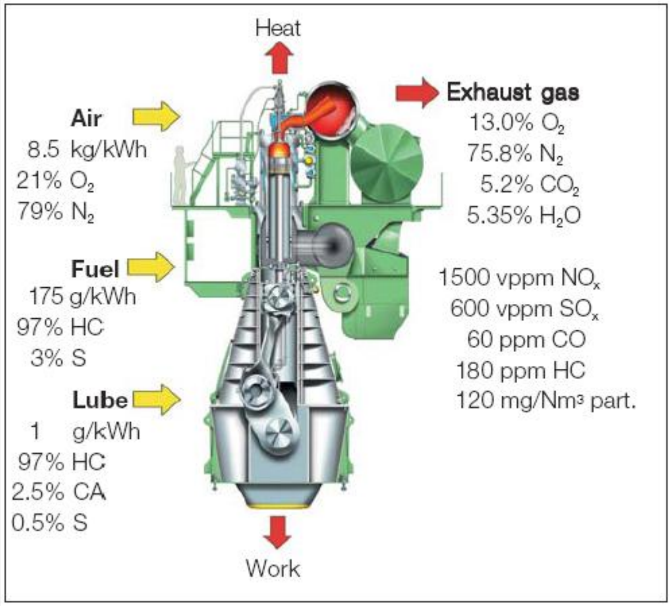
Nitrogen Oxides (NOx): *are produced when engines heat up the Nitrogen and Oxygen in air. Highly toxic and dangerous form of pollution.*

Carbon Dioxide (CO_2): *is an inevitable product when we get energy from burning the carbon in fuel. Responsible for global warming and climate change. Directly proportional to the amount of energy released.*

Background – Environmental Aspects of Shipping – Regulatory Framework

Why does exhaust gas production occur?

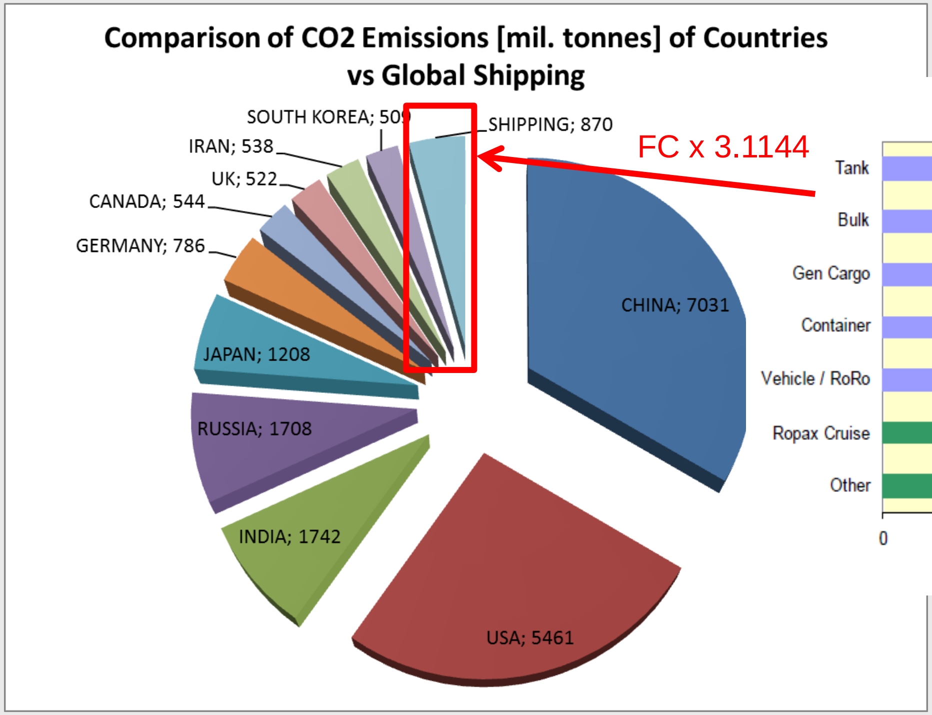
- Carbon Monoxide (CO).
- Carbon Dioxide (CO_2).
- Sulphur Oxides (SOx).
- Nitrogen Oxides (NOx).
- Unburned Hydrocarbons (HxCx).
- Particulate Matters (PM).

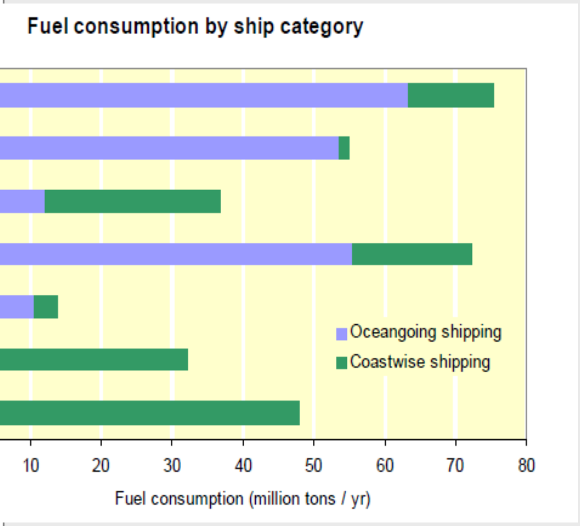


Source: MAN Diesel

Emissions from Shipping

- Comparison of Shipping with most pollutant Countries:



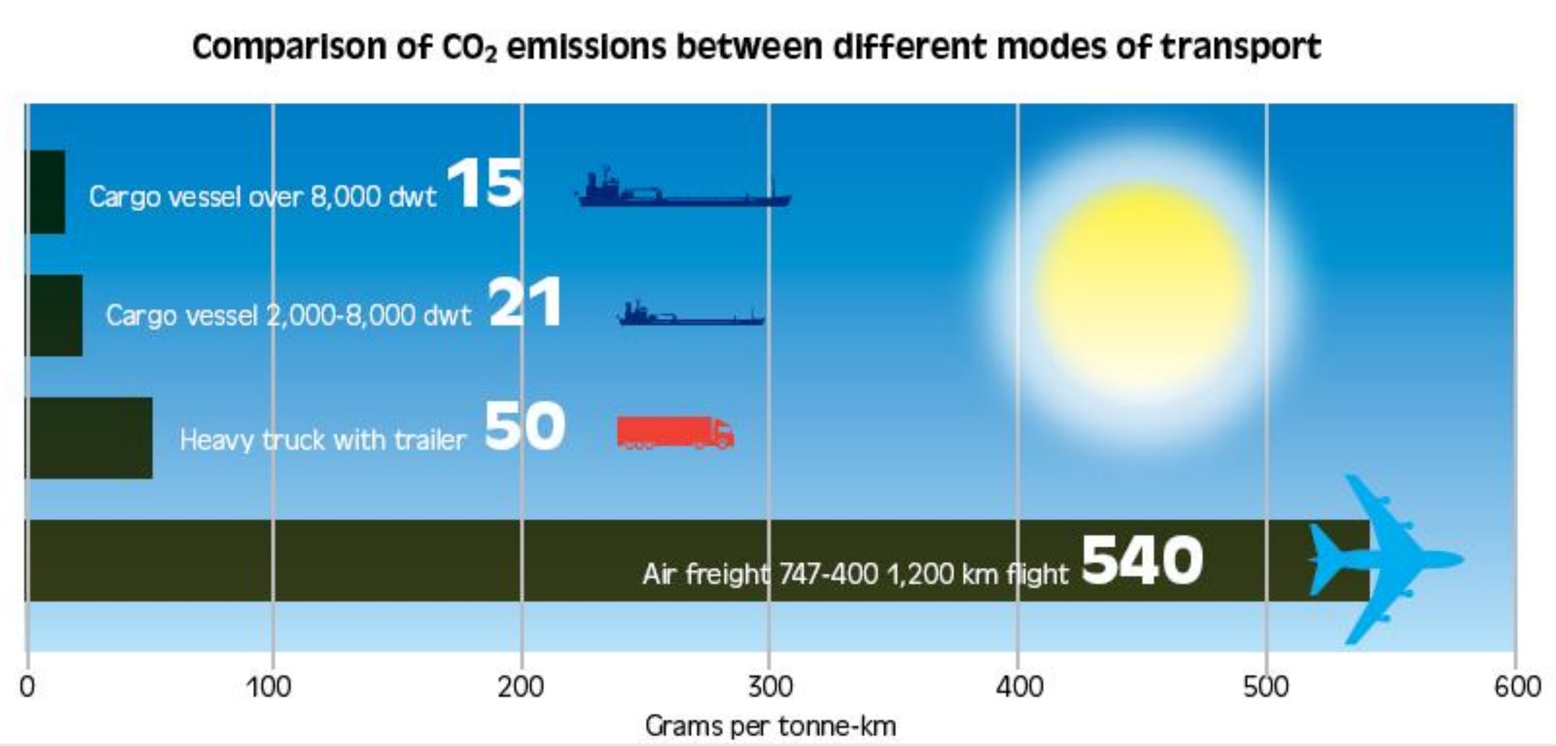


Source: IMO

Background – Environmental Aspects of Shipping – Regulatory Framework

Emissions from Shipping

- Comparison of Shipping with other modes of transport:

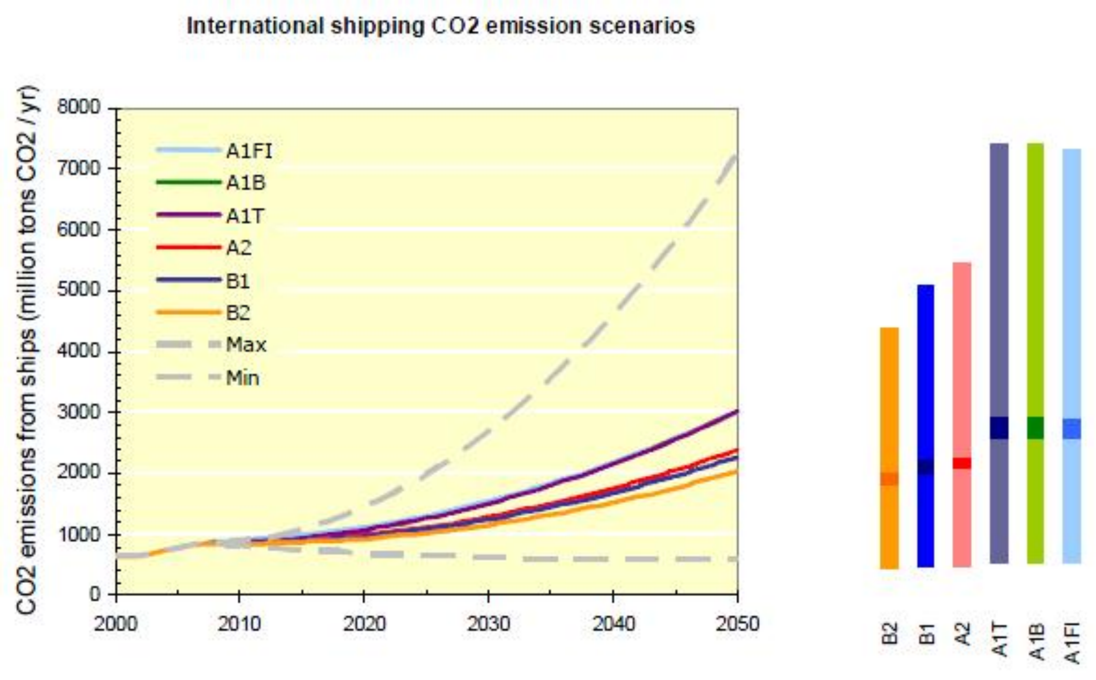


Source: NTM, Sweden

Background – Environmental Aspects of Shipping – Regulatory Framework

Emissions from Shipping

- Projection scenarios for shipping GHG emissions:
  - Annual increase of 1.9 – 2.7% extreme 5.2% per year
  - Can reach from 2.7% today, up to 18% of permissible GHG emissions



Source: IMO

Background – Environmental Aspects of Shipping – Regulatory Framework

Legislation Towards SEEMP

- TMSA – Element 10 A (Environmental Management)

STAGE	KEY PERFORMANCE INDICATORS	BEST-PRACTICE GUIDANCE
3.1	An energy conservation program is in place and monitored throughout the fleet.	Actions that promote energy conservation are recorded and reviewed at the periodic meetings held by senior managers. Any non-conformity should be identified and corrected.

Legislation Towards SEEMP

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- OCIMF – Energy Efficiency and Fuel Management Guide

STAGE	KEY PERFORMANCE INDICATORS	BEST-PRACTICE GUIDANCE
1	The company has an Energy management Policy that addresses vessel operations.	The Energy Management Policy includes the requirement of an Energy Management Plan that is regularly reviewed by senior management.
	An Energy Management Plan demonstrates effective on-board implementation of the company energy policy.	Personnel are made aware of the content of the Energy Management Plan by the use of appropriate training and communication.
	An Energy Management Plan addresses voyage management and includes appropriate measurement and reporting requirements	Systems are in place for monitoring and recording of data. Such Systems may comprise of a database for recording information that included in noon reports. The Company should be able to demonstrate where practical, backhaul opportunities are maximized and idle time is minimized though good liaison with charterers.

Background – Environmental Aspects of Shipping – Regulatory Framework

Legislation Towards SEEMP

- Oil Majors requirement since 2004 through TMSA Element 10A
- Oil Majors supplementary requirement since 2009 (OCIMF Energy Efficiency and Fuel Management).
- Res. MEPC.203(62) July 2011. **EEDI and SEEMP mandatory** from 01 January 2013
- MEPC.1/Circ.683 provides the guidelines for SEEMP implementation
- Updated through Resolution MEPC.213(63) ("2012 Guidelines") adopted on 2 March 2012

RESOLUTION MEPC.213(63)

Adopted on 2 March 2012

2012 GUIDELINES FOR THE DEVELOPMENT OF A SHIP ENERGY EFFICIENCY MANAGEMENT PLAN (SEEMP)

THE MARINE ENVIRONMENT PROTECTION COMMITTEE,

RECALLING article 38(a) of the Convention on the International Maritime Organization concerning the functions of the Marine Environment Protection Committee (the Committee) conferred upon it by international conventions for the prevention and control of marine pollution,

RECALLING ALSO that, at its sixty-second session, the Committee adopted, by resolution MEPC.203(62), amendments to the Annex of the Protocol of 1997 to amend the International Convention for the Prevention of Pollution from Ships, 1973, as modified by the Protocol of 1978 relating thereto (inclusion of regulations on energy efficiency for ships in MARPOL Annex VI),

NOTING the amendments to MARPOL Annex VI adopted at its sixty-second session by inclusion of a new chapter 4 for regulations on energy efficiency for ships, are expected to enter into force on 1 January 2013 upon their acceptance on 1 July 2012,

NOTING ALSO that regulation 22 of MARPOL Annex VI, as amended, requires each ship to keep on board a ship specific Ship Energy Efficiency Management Plan taking into account guidelines developed by the Organization,

RECOGNIZING that the amendments to MARPOL Annex VI requires the adoption of relevant guidelines for smooth and uniform implementation of the regulations and to provide sufficient lead time for industry to prepare,

HAVING CONSIDERED, at its sixty-third session, the draft 2012 Guidelines for the development of a Ship Energy Efficiency Management Plan (SEEMP),

1. ADOPTS the 2012 Guidelines for the development of a Ship Energy Efficiency Management Plan (SEEMP), as set out at annex to the present resolution;

2. INVITES Administrations to take the annexed Guidelines into account when developing and enacting national laws which give force to and implement provisions set forth in regulation 22 of MARPOL Annex VI, as amended;

3. REQUESTS the Parties to MARPOL Annex VI and other Member Governments to bring the annexed Guidelines related to the Ship Energy Efficiency Management Plan (SEEMP) to the attention of masters, seafarers, shipowners, ship operators and any other interested groups;

4. AGREES to keep these Guidelines under review in light of the experience gained; and

5. REVOKES the Guidance circulated by MEPC.1/Circ.683, as from this date.

Ship Energy Efficiency Management Plan (SEEMP) – Requirements / EnPIs (EEDI, EEOI)

Section 2

Ship Energy Efficiency Management

Energy Performance Indicators (EnPIs)

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Energy Efficiency Design Index (EEDI):

$$\frac{\left(\prod_{j=1}^{M} f_j\right)\left(\sum_{i=1}^{nME} P_{ME(i)} \cdot C_{FME(i)} \cdot SFC_{ME(i)}\right) + \left(P_{AE} \cdot C_{FAE} \cdot SFC_{AE}\right) + \left[\left(\prod_{j=1}^{M} f_j \cdot \sum_{i=1}^{nPTI} P_{PTI(i)} - \sum_{i=1}^{neff} f_{eff(i)} \cdot P_{AEeff(i)}\right) \cdot C_{FAE} \cdot SFC_{AE}\right] - \left(\sum_{i=1}^{neff} f_{eff(i)} \cdot P_{eff(i)} \cdot C_{FME} \cdot SFC_{ME}\right)}{f_i \cdot Capacity \cdot V_{ref} \cdot f_W}$$

Correction factor for power f_j for ice-classed ships

For further information on approximate correspondence between ice classes, see HELCOM Recommendation 25/7*

Ship type	f_j	Limits depending on the ice class			
		IC	IB	IA	IA Super
Tanker	$\frac{0.516 L_{pp}^{1.87}}{\sum_{i=1}^{nME} P_{iME}}$	$\begin{cases} max\ 1.0 \\ min\ 0.72 L_{pp}^{0.06} \end{cases}$	$\begin{cases} max\ 1.0 \\ min\ 0.61 L_{pp}^{0.08} \end{cases}$	$\begin{cases} max\ 1.0 \\ min\ 0.50 L_{pp}^{0.10} \end{cases}$	$\begin{cases} max\ 1.0 \\ min\ 0.40 L_{pp}^{0.12} \end{cases}$
Dry cargo carrier	$\frac{2.150 L_{pp}^{1.58}}{\sum_{i=1}^{nME} P_{iME}}$	$\begin{cases} max\ 1.0 \\ min\ 0.89 L_{pp}^{0.02} \end{cases}$	$\begin{cases} max\ 1.0 \\ min\ 0.78 L_{pp}^{0.04} \end{cases}$	$\begin{cases} max\ 1.0 \\ min\ 0.68 L_{pp}^{0.06} \end{cases}$	$\begin{cases} max\ 1.0 \\ min\ 0.58 L_{pp}^{0.08} \end{cases}$
General cargo ship	$\frac{0.0450 \cdot L_{pp}^{2.37}}{\sum_{i=1}^{nME} P_{iME}}$	$\begin{cases} max\ 1.0 \\ min\ 0.85 L_{pp}^{0.03} \end{cases}$	$\begin{cases} max\ 1.0 \\ min\ 0.70 L_{pp}^{0.06} \end{cases}$	$\begin{cases} max\ 1.0 \\ min\ 0.54 L_{pp}^{0.10} \end{cases}$	$\begin{cases} max\ 1.0 \\ min\ 0.39 L_{pp}^{0.15} \end{cases}$

For other ship types, f_j should be taken as 1.0.

Capacity correction factor f_i for ice-classed ships

For further information on approximate correspondence between ice classes, see HELCOM Recommendation 25/7*

Ship type	f_i	Limits depending on the ice class			
		IC	IB	IA	IA Super
Tanker	$\frac{0.00115 Lpp^{3.36}}{capacity}$	$\begin{cases} max\ 1.31 Lpp^{-0.05} \\ min\ 1.0 \end{cases}$	$\begin{cases} max\ 1.54 Lpp^{-0.07} \\ min\ 1.0 \end{cases}$	$\begin{cases} max\ 1.80 Lpp^{-0.09} \\ min\ 1.0 \end{cases}$	$\begin{cases} max\ 2.10 Lpp^{-0.11} \\ min\ 1.0 \end{cases}$
Dry cargo carrier	$\frac{0{,}000665 \cdot Lpp^{3.44}}{capacity}$	$\begin{cases} max\ 1.31 Lpp^{-0.05} \\ min\ 1.0 \end{cases}$	$\begin{cases} max\ 1.54 Lpp^{-0.07} \\ min\ 1.0 \end{cases}$	$\begin{cases} max\ 1.80 Lpp^{-0.09} \\ min\ 1.0 \end{cases}$	$\begin{cases} max\ 2.10 Lpp^{-0.11} \\ min\ 1.0 \end{cases}$
General cargo ship	$\frac{0{,}000676 \cdot L_{PP}^{3.44}}{capacity}$	1.0	$\begin{cases} max\ 1.08 \\ min\ 1.0 \end{cases}$	$\begin{cases} max\ 1.12 \\ min\ 1.0 \end{cases}$	$\begin{cases} max\ 1.25 \\ min\ 1.0 \end{cases}$
Containership	$\frac{0.1749 \cdot Lpp^{2.29}}{capacity}$	1.0	$\begin{cases} max\ 1.25 Lpp^{-0.04} \\ min\ 1.0 \end{cases}$	$\begin{cases} max\ 1.60 Lpp^{-0.08} \\ min\ 1.0 \end{cases}$	$\begin{cases} max\ 2.10 Lpp^{-0.12} \\ min\ 1.0 \end{cases}$
Gas tanker	$\frac{0.1749 \cdot Lpp^{2.33}}{capacity}$	$\begin{cases} max\ 1.25 Lpp^{-0.04} \\ min\ 1.0 \end{cases}$	$\begin{cases} max\ 1.60 Lpp^{-0.08} \\ min\ 1.0 \end{cases}$	$\begin{cases} max\ 2.10 Lpp^{-0.12} \\ min\ 1.0 \end{cases}$	1.0

For other ship types, f_i should be taken as 1.0.

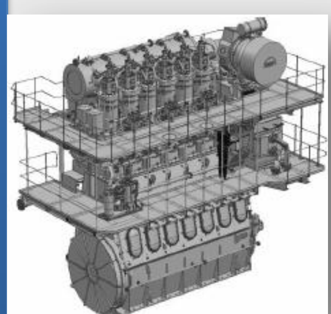
Ship Energy Efficiency Management

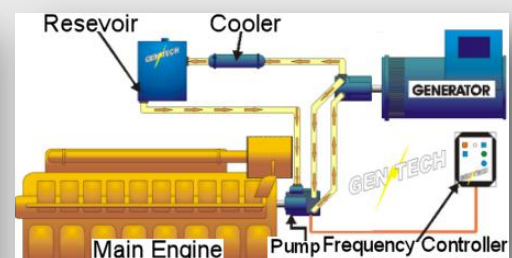
Energy Performance Indicators (EnPIs)

EEDI Equation – Key Components:

Main engine(s)	Aux. engine(s)	Energy saving tech. for auxiliary power	Energy saving tech. for main power

$$\frac{\left(\prod_{j=1}^{M} f_j\right)\left(\sum_{i=1}^{nME} P_{ME(i)} \cdot C_{FME(i)} \cdot SFC_{ME(i)}\right) + \left(P_{AE} \cdot C_{FAE} \cdot SFC_{AE}\right) + \left[\left(\prod_{j=1}^{M} f_j \cdot \sum_{i=1}^{nPTI} P_{PTI(i)} - \sum_{i=1}^{neff} f_{eff(i)} \cdot P_{AEeff(i)}\right) \cdot C_{FAE} \cdot SFC_{AE}\right] - \left(\sum_{i=1}^{neff} f_{eff(i)} \cdot P_{eff(i)} \cdot C_{FME} \cdot SFC_{ME}\right)}{f_i \cdot Capacity \cdot V_{ref} \cdot f_W}$$





Ship Energy Efficiency Management

Energy Performance Indicators (EnPIs)

EEDI Equation – Parameters / Coefficients:

Ice class factor

Electric-Diesel

Energy Saving

$$\frac{\left(\prod_{j=1}^{M} f_j\right)\left(\sum_{i=1}^{nME} C_{FME(i)} \cdot SFC_{ME(i)} \cdot P_{ME(i)}\right) + \left(P_{AE} \cdot C_{FAE} \cdot SRC_{AE}\right) + \left[\left(\sum_{i=1}^{nPTI} P_{PTI(i)} - \sum_{i=1}^{nWHR} P_{WHRf(i)}\right) \cdot C_{FAE} \cdot SFC_{AE}\right] - \left(\sum_{i=1}^{neff} f_{eff} \cdot P_{eff} \cdot C_{Feff} \cdot SFC_{ME(i)}\right)}{f_i \cdot Capacity \cdot V_{ref} \cdot f_W}$$

Main power: PME=0.75MCR

Capacity factor

Wave factor

Carbon factor

Attained Speed

Auxiliary power:
PME >= 10000kW
PAE = 0.025Me + 250
PME < 10000kW
PAE =0.05Me

Capacity:
DWT: BC, Container Vessel,
MPC: RoRo and RoPax
GTR: Passenger Ship

Ship Energy Efficiency Management

Energy Performance Indicators (EnPIs)

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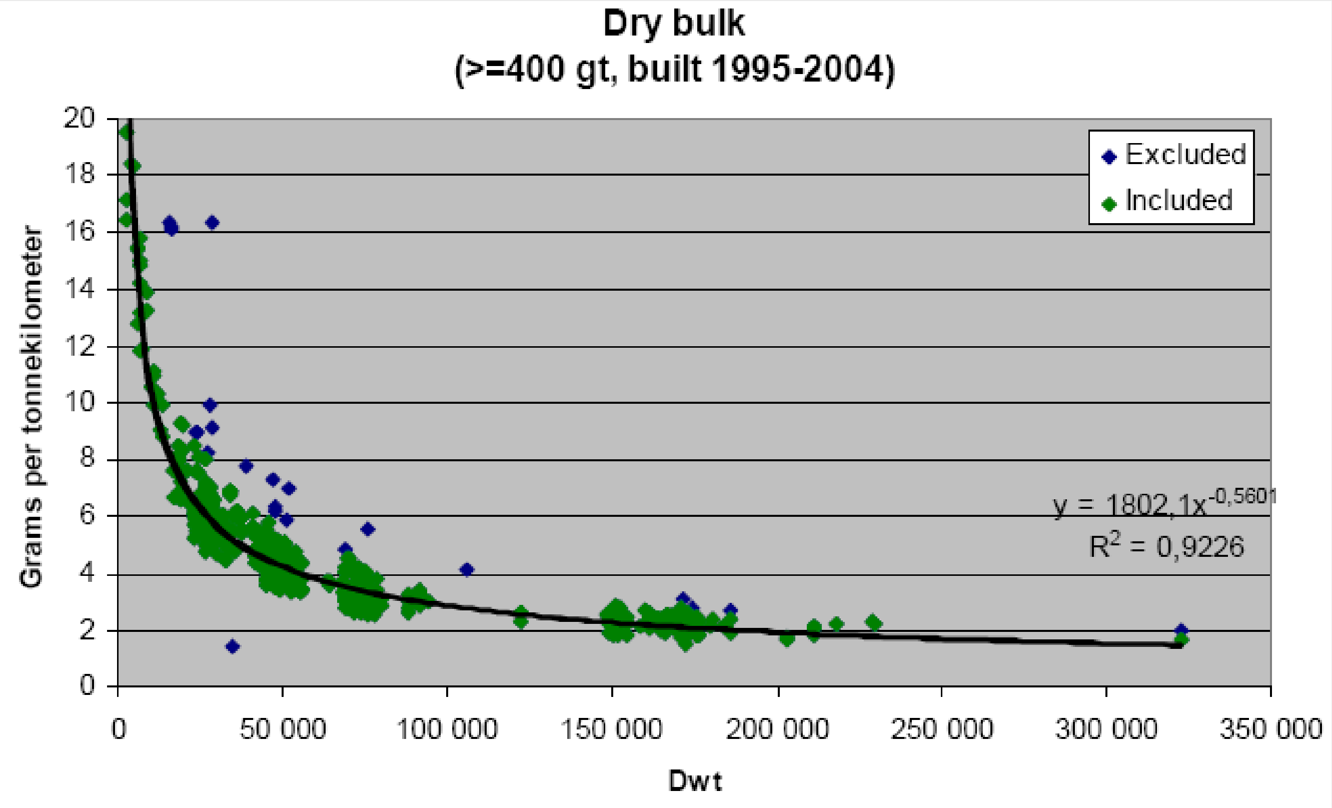
EEDI Baselines:



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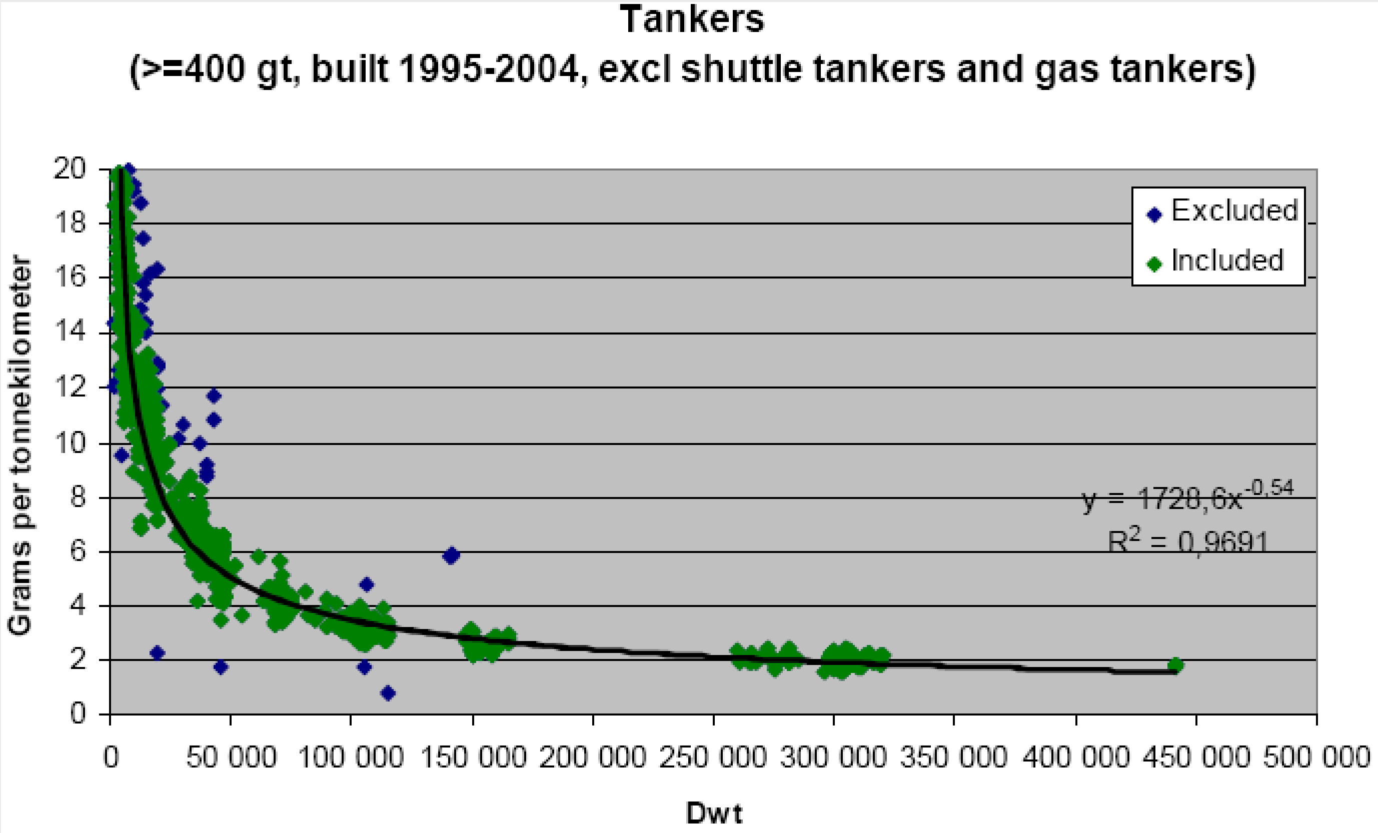
EEDI Baselines:



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EEDI Baselines:

Baseline EEDI figure = a x b-c

Where, a, b, c are given in the below Table :

Ship type defined in regulation 2	a	b	c
Bulk carrier	961.79	DWT of the ship	0.477
Gas carrier	1120.00	DWT of the ship	0.456
Tanker	1218.80	DWT of the ship	0.488
Container ship	174.22	DWT of the ship	0.201
General cargo ship	107.48	DWT of the ship	0.216
Refrigerant cargo carrier	227.01	DWT of the ship	0.244
Combination carrier	1219.00	DWT of the ship	0.488

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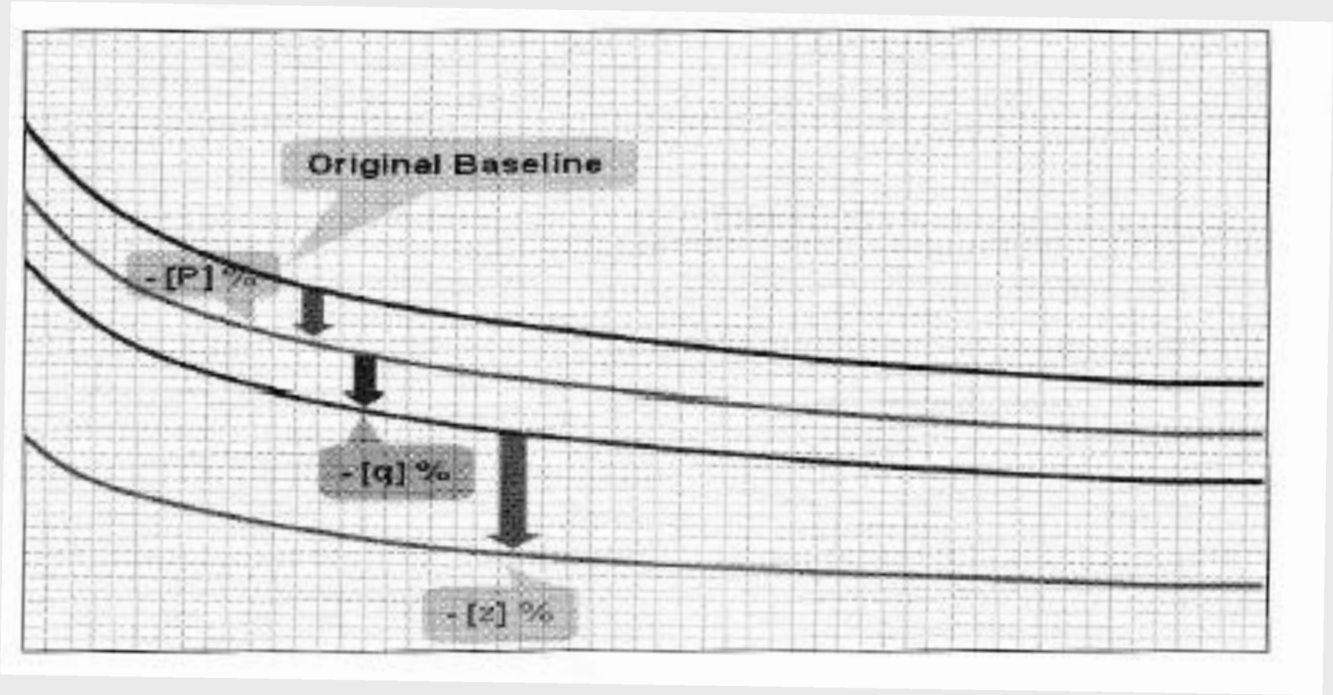
EEDI Baseline Trends and baseline reductions:



$$EEDI_{ATTAINED} < EEDI_{REQUIRED}$$

$$EEDI_{REQUIRED} = (1-X/100) \times \text{Baseline Value}$$

EEDI Baseline Trends and baseline reductions:

Ship Type	Size	Phase 0 1 Jan 2013-31 Dec 2014	Phase 1 1 Jan 2015-31 Dec 2019	Phase 2 1 Jan 2020-31 Dec 2024	Phase 3 1 Jan 2025 and onwards
Bulk carrier	20,000 DWT and above	0	10%	20%	30%
	10,000-20,000 DWT	n/a	0-10%	0-20%	0-30%
Gas carrier	10,000 and above	0	10%	20%	30
	2,000-10,000 DWT	n/a	0-10%	0-20%	0-30%
Tanker	20,000 and above	0	10%	20%	30%
	4,000-20,000 DWT	n/a	0-10%	0-20%	0-30%
Container ship	15,000 DWT and above	0	10%	20%	30%
	10,000-15,000 DWT	n/a	0-10%	0-20%	0-30%

Energy Performance Indicators (EnPIs)

EEDI Applicability:

- **Vessels of > 400 GT**
- **Building contract placed on/after January 2013**;
- In the absence of contract, keel laid after 1 July 2013; or
- The delivery of which is on / after 1 July 2015; or
- in cases of a major conversion of a new or existing ship, on / after 1 January 2013
- NOT applicable to vessels sailing entirely within flag state waters
- NOT applicable to vessels with Diesel-Electric, Turbine or Hybrid Propulsion

Energy Efficiency Operation Index (EEOI):

•EEOI is an approach to assess the efficiency of a ship with respect to CO_2 emissions.

<u>EEOI = Environmental Cost / Benefit to Society</u>

(measured as grams CO_2 / tonnes x nautical mile)

•EEOI = (Emitted CO_2)/(Transport Work), i.e. the ratio of mass of CO_2 (M) emitted per unit of transport work.

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Energy Efficiency Operation Index (EEOI):

$$\text{EEOI} = \frac{\sum_j FC_j \times C_{Fj}}{m_{cargo} \times D}$$

$$\text{Average EEOI} = \frac{\sum_i \sum_j (FC_{ij} \times C_{Fj})}{\sum_i (m_{cargo,i} \times D_i)}$$

Type of fuel	Reference	Carbon content	C_F (t-CO_2/t-Fuel)
1. Diesel/Gas Oil	ISO 8217 Grades DMX through DMC	0.875	3.206000
2. Light Fuel Oil (LFO)	ISO 8217 Grades RMA through RMD	0.86	3.151040
3. Heavy Fuel Oil (HFO)	ISO 8217 Grades RME through RMK	0.85	3.114400
4. Liquified Petroleum Gas (LPG)	Propane Butane	0.819 0.827	3.000000 3.030000
5. Liquified Natural Gas (LNG)		0.75	2.750000

j, fuel type

i, No of voyage

C_{Fj}, Equivalent factor for CO_2 dependent on fuel type (j)

FC_{ij}, Metric tonnes of consumed fuel type (j) in voyage (i)

$m_{cargo,i}$, cargo present during voyage (i) [Payload, TEUs (or 80%DWT), GT, Passengers]

D_i, Distance covered by vessel carrying $m_{cargo,i}$ during voyage (i)

Energy Efficiency Operation Index (EEOI):

• Calculation Example:

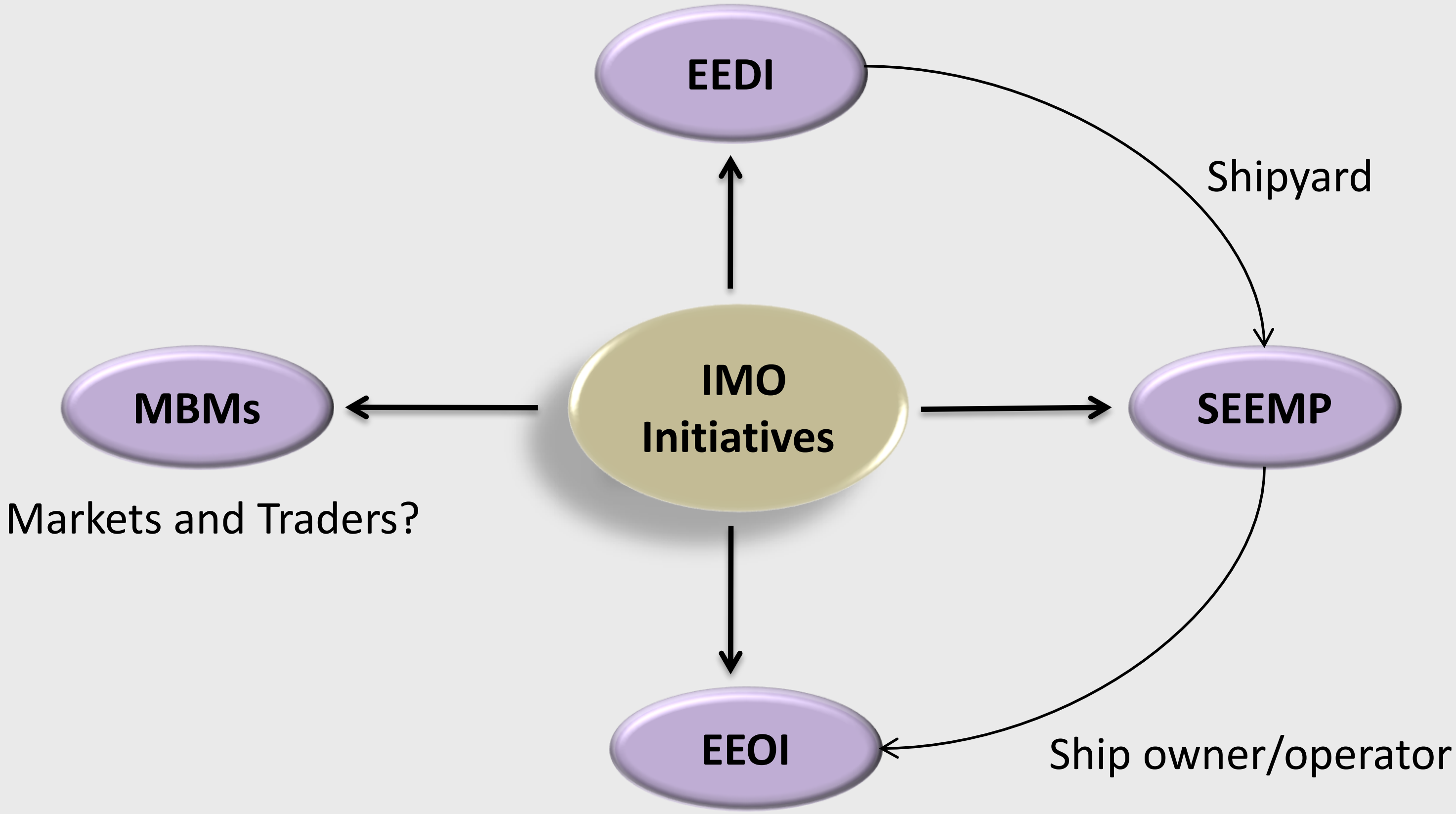
NAME AND TYPE OF SHIP						
Voyage or day (i)	Fuel consumption (FC) at sea and in port in tonnes				Voyage or time period data	
	Fuel type (HFO)	Fuel type (LFO)	Fuel type ( )		Cargo (m) (tonnes or units)	Distance (D) (NM)
1	20	5			25,000	300
2	20	5			0	300
3	50	10			25,000	750
	10	3			15,000	150

$$EEOI = \frac{100 \times 3.114 + 23 \times 3.151}{(25{,}000 \times 300) + (0 \times 300) + (25{,}000 \times 750) + (15{,}000 \times 150)} = 13.47 \times 10^{-6}$$

unit: tonnes CO_2/(tons • nautical miles)

Ship Energy Efficiency Management

IMO Initiatives for Controlling GHG Emissions from Ships



EEDI and SEEMP **mandatory** from 1/1/2013
EEOI **voluntary -** MBMs are currently **under discussion**

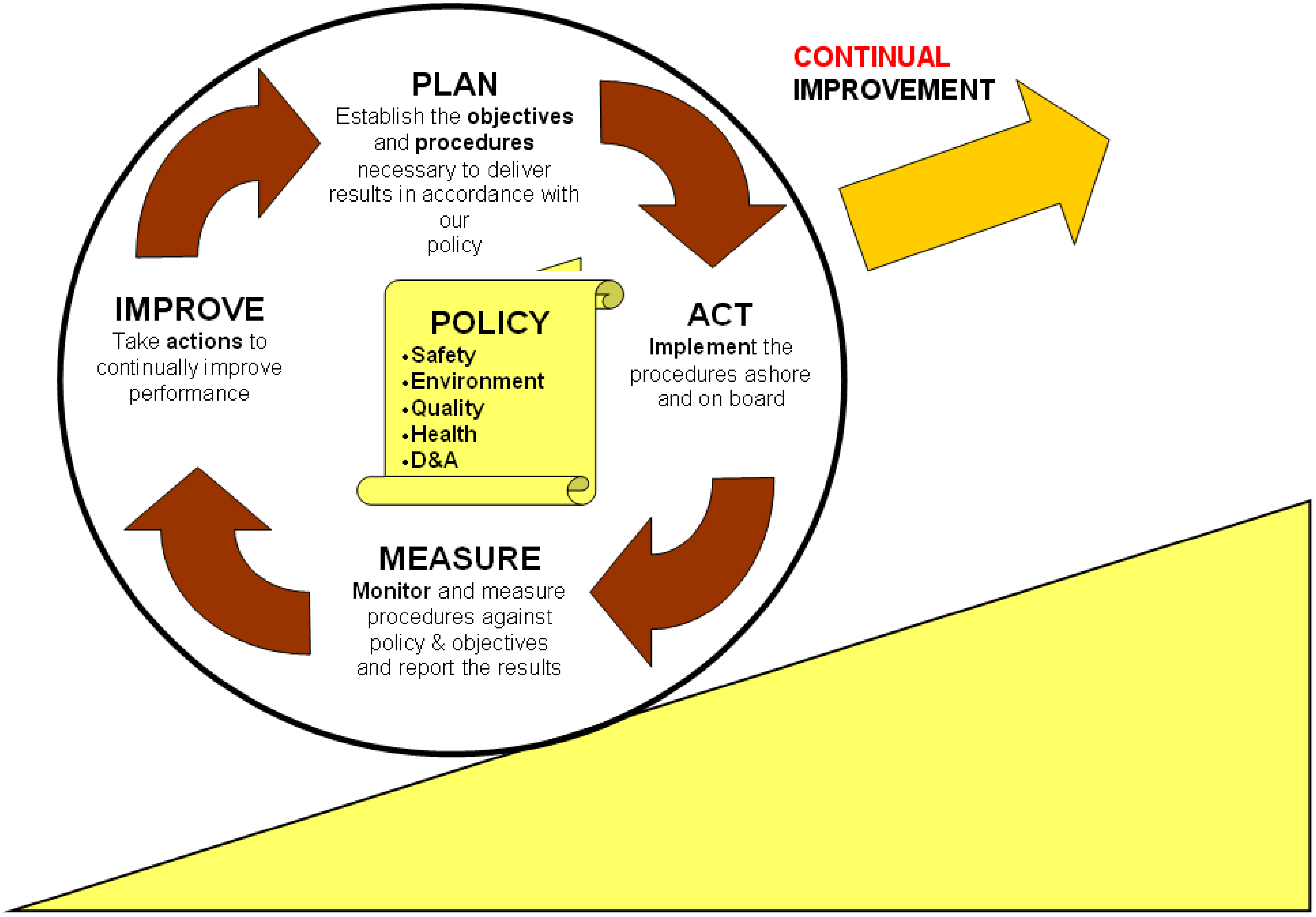
SEEMP Requirements

The SEEMP seeks to improve a ship's energy efficiency through four steps:

- **Planning** is crucial since it determines both the current status of ship energy usage and the expected improvement of energy efficiency;
- **Implementation**; Record-keeping for the implementation of each measure is beneficial for self-evaluation;
- **Monitoring and measure** through continuous and consistent data collection; and
- **Self-evaluation and improvement** to evaluate the effectiveness of the planned measures and their implementation, to deepen the understanding on the overall characteristics of ship's operation such as what types of measures can/cannot function effectively, and how and/or why, to comprehend the trend of the efficiency improvement of the ship and to develop an improved SEEMP for the next spiral.

Ship Energy Efficiency Management Plan (SEEMP)

SEEMP Requirements



Ship Energy Efficiency Management Plan

SEEMP Applicability:
(according to Resolution MEPC.203(62))

- All vessels of > 400 GT
- Each vessel to be provided with a ship-specific SEEMP not later than the first intermediate or renewal survey (whichever is first) on or after 1 January 2013.
- The attending Class surveyor will check that the SEEMP is onboard and subsequently issue the International Energy Efficiency Certificate (IEEC).
- PSC inspection is limited to verifying that there is a valid IEEC onboard.

Ship Energy Efficiency Management Plan (SEEMP)

Through the SEEMP, a Shipping Company can:

- Comply with relevant IMO requirements - Res. MEPC.203(62)
- Comply with OCIMF TMSA requirements - Element 10A
- Comply with OCIMF Energy Efficiency and Fuel Management guidelines
- Focus on the implementation of CO_2 reducing practices / technologies as part of a culture of fostering continuous improvement.
- Define **time-specific, measurable and attainable** targets based on a combination of in-service performance monitoring and best-practice operational processes.
- Monitor Environmental and Energy Performance Indicators holistically
- Develop a proactive approach to dealing with coming Market Based Measures (MBMs) to come in force in the future through IMO
- Have in place most (90%) of relevant required procedures as per ISO 50001:2011 “Energy Management System“

Unnecessary additional administrative burden on ship / shore staff should be avoided.

Example Cases of Ship Energy Efficiency Management / Monitoring Tools / Energy Efficiency Benchmarking

Section 3

Example Cases of Ship Energy Efficiency Management

Ship Energy Efficiency Management Plan - Part A

Section 1
Section 2
Section 3
Section 4
Section 5

The SEEMP may be separated into two parts:
The generic (Part A) and the ship-specific part (Part B)

- **Company Policy (Section 1)**
- **Measures for Improving Energy Efficiency (Section 4):**
- **Voyage Optimization (4.1)**
  - No hardware modifications
  - Aim at efficient ship operation
- **Propulsion Resistance Management (4.2)**
  - Hull & Propeller Cleaning
  - Propulsion Hydrodynamic Improvement Devices
  - Resistance Monitoring Programs
- **Machinery Optimization (4.3)**
  - Performance Monitoring Tools (M/E – D/Gs)
  - Machinery Retrofitting / Upgrading / Replacements
  - Thrust, power &torque measurements (propeller efficiency)
  - De-rated engines, etc.
- **Bunker Management (4.4)**
- **Personnel Awareness & Training (4.8)**

Part A

Full Compliance with
Res. MEPC.213(63)
Based on
INTERTANKO
guidance

Example Cases of Ship Energy Efficiency Management

Measures for Improving Energy Efficiency – Examples:

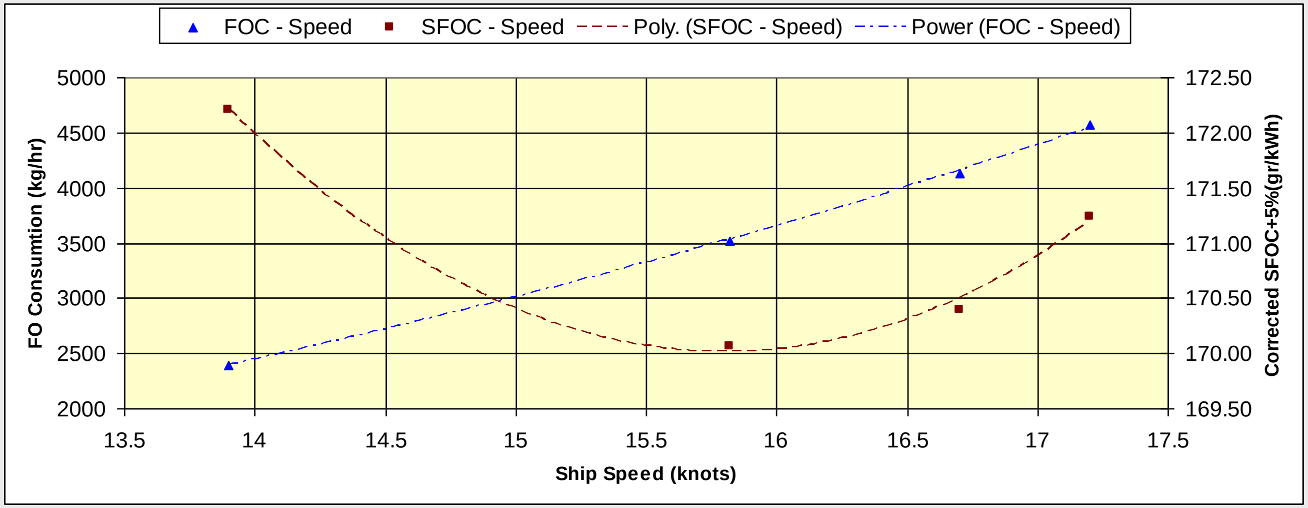
- Section 1
- Section 2
- **Section 3**
- Section 4
- Section 5

- Speed Selection Optimization – Slow Steaming

M/E load increase should be avoided when no benefit is observed.

The vessel's Speed – Power – FO consumption relationship depends on a number of factors i.e.:

- Power – speed curve for a specific displacement.
- Load diagram and optimization point of the main engine.
- Weather conditions. - Hull fouling, etc.



Example Cases of Ship Energy Efficiency Management

Measures for Improving Energy Efficiency – Examples:

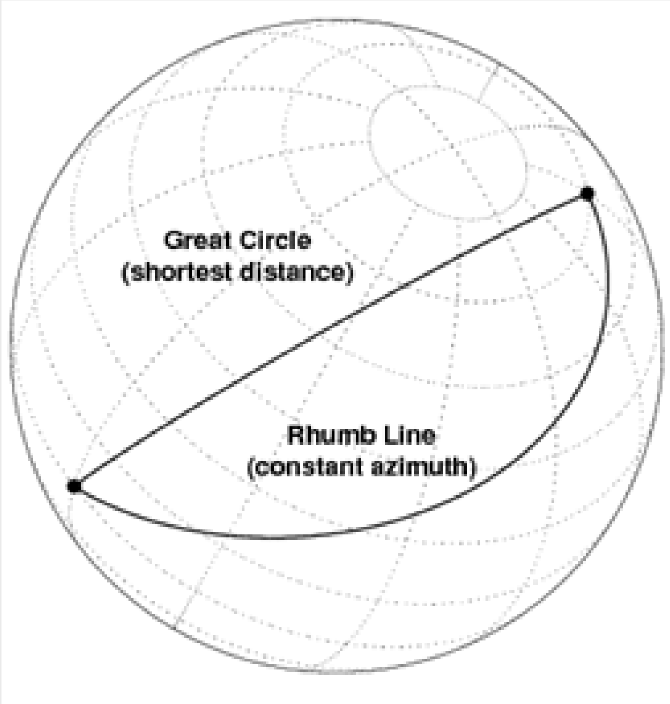
- Optimized Voyage Planning

Masters should optimize route planning to avoid high storm or wave frequency and maximize calm sea state taking into consideration:

  - the effects of ocean current and tides
  - the effects of weather systems
  - the crew safety and comfort, based on trade and route

Voyage routes can be charted with the use of ***Rhumb Lines*** and / or the ***Great Circle*** methodology.

APPLICABLE TO CROSS-OCEAN VOYAGES ONLY (WSNP)



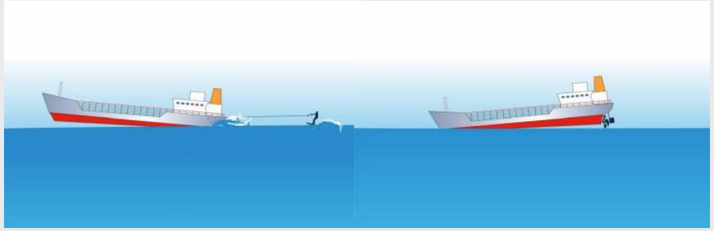
EnPI EXAMPLE = EEOI
GOAL EXAMPLE = EEOI TO BE ANNUALLY REDUCED BY 1% (AVG. OVER THE WHOLE FLEET).

Example Cases of Ship Energy Efficiency Management

Measures for Improving Energy Efficiency – Examples:

- Trim and Ballast Optimization:
  - 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.
  - Trim has a significant influence on ship's resistance through the water.
  - Ballast should be adjusted taking into consideration the requirements to meet optimum trim & steering conditions.
  - Optimal trim & ballast could be determined by full-scale measurements onboard the ship and good cargo planning. The best trim for the ballast passage should be tested and compared with other ballast conditions.
  - Optimal trim & ballast is sometimes a difficult consideration, as it also affects the comfort and safety of the crew.
  - Savings of about 0.5-1.0%.

Less ballast water does not necessarily mean the highest efficiency.



Section 1
Section 2
Section 3
Section 4
Section 5

Example Cases of Ship Energy Efficiency Management

Measures for Improving Energy Efficiency – Examples:

Section 1

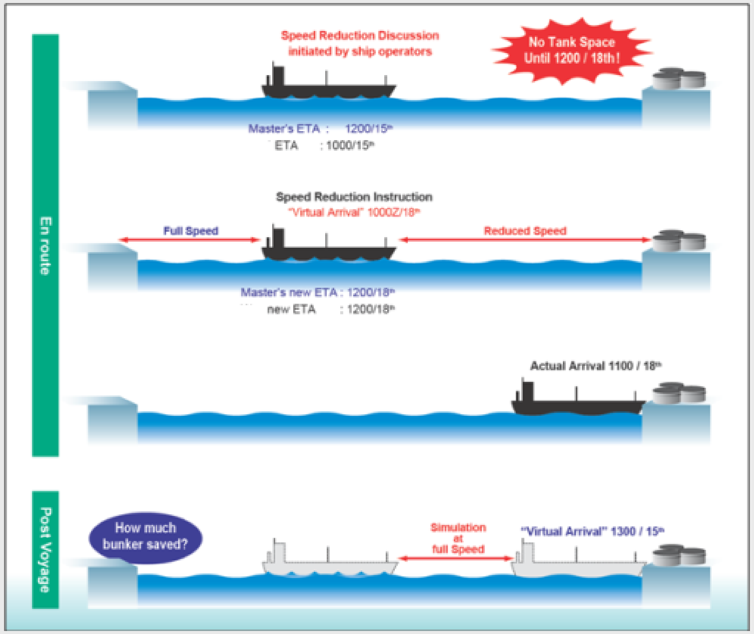
Section 2

Section 3

Section 4

Section 5

- Just in Time/ Virtual Arrival:
  - A known delay at the discharge port;
  - Whenever an opportunity exists, the operator requests permission from Charterers to reduce speed;
  - A mutual agreement between the Company and the Charterer. Other parties may be involved in the decision making process, such as terminals, cargo receivers and commercial interests.



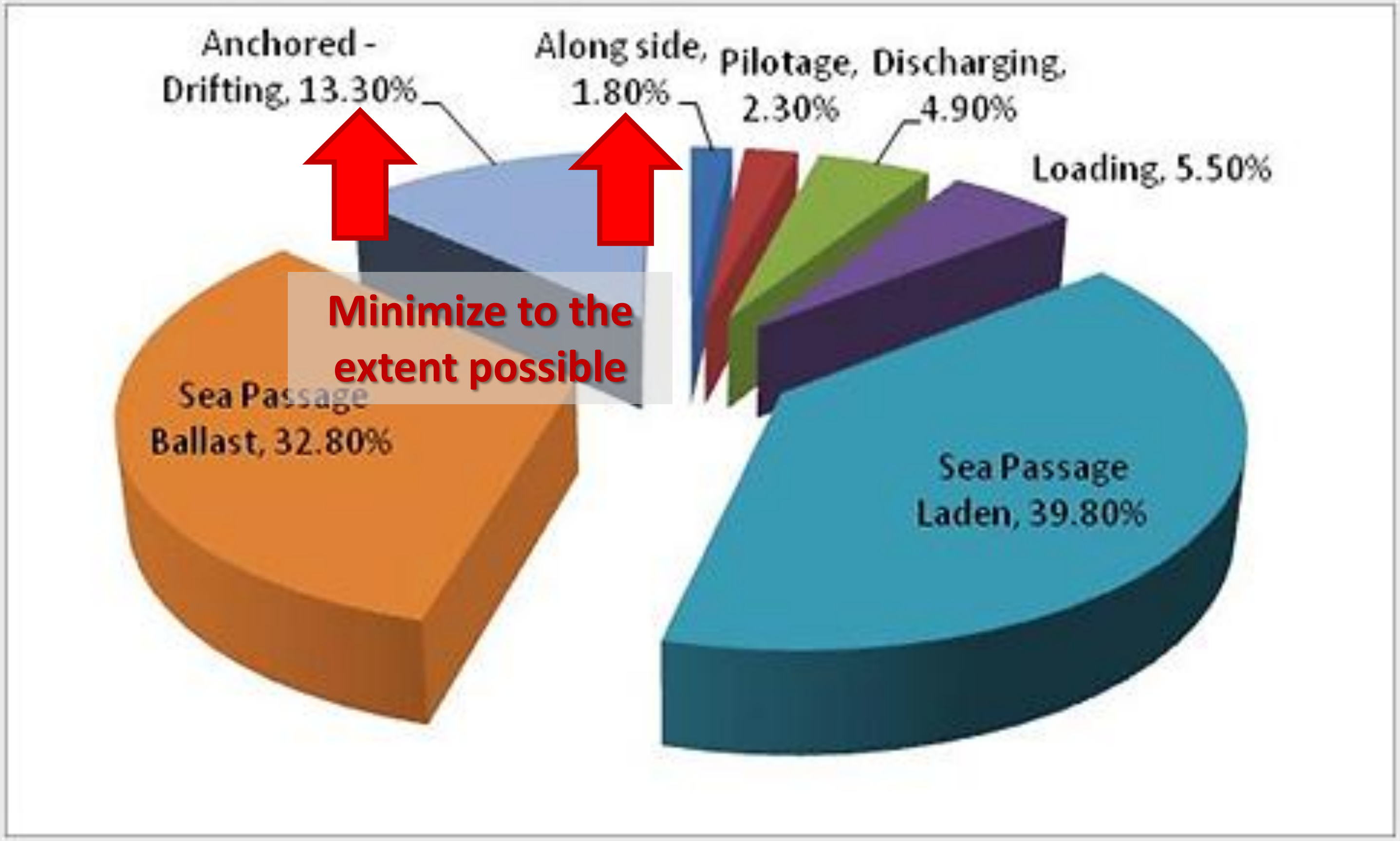
EnPI EXAMPLE = WAITING (IDLE) TIME

GOAL EXAMPLE = FLEET-WIDE AVERAGE RATIO OF WAITING TIME SPENT AT ANCHORAGE OR DRIFTING AT WAITING AREAS OVER TOTAL OPERATIONAL TIME (I.E. BALLAST AND LADEN CONDITIONS AND LOADING/DISCHARGING) TO BE ANNUALLY REDUCED BY 0.5%.

Example Cases of Ship Energy Efficiency Management

Measures for Improving Energy Efficiency – Examples:

- Just in Time/ Virtual Arrival:

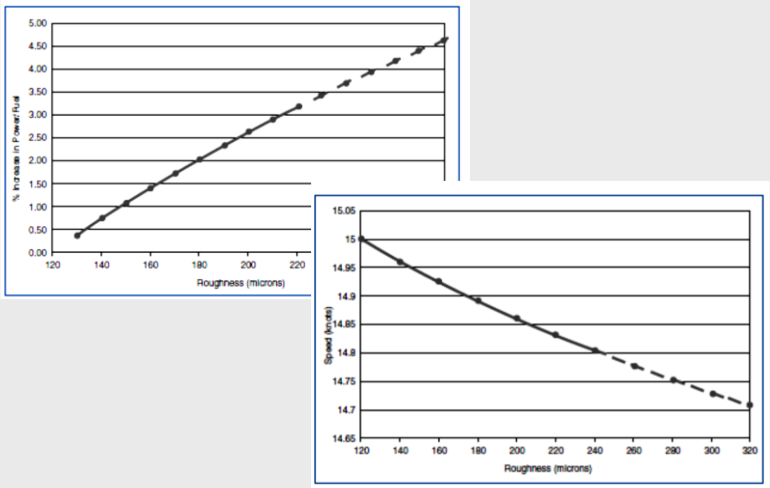


Example Cases of Ship Energy Efficiency Management

Measures for Improving Energy Efficiency – Examples:

- Hull and Propeller Cleaning Program

Monitor the propeller slip and overall efficiency of the vessel to look for possible hull fouling signs and schedule cleaning WHENEVER THERE ARE CLEAR INDICATIONS OF DETERIORATING PERFORMANCE.



EnPI EXAMPLE = TIME INTERVAL BETWEEN PEROPELLER POLISHINGS / HULL CLEANINGS
GOAL EXAMPLE = PROPELLER POLISHING / HULL CLEANING TO BE CONDUCTED WHENEVER REQUIRED, BUT THE INTERVAL OF 2.5-3 YEARS SHOULD NOT BE EXCEEDED.

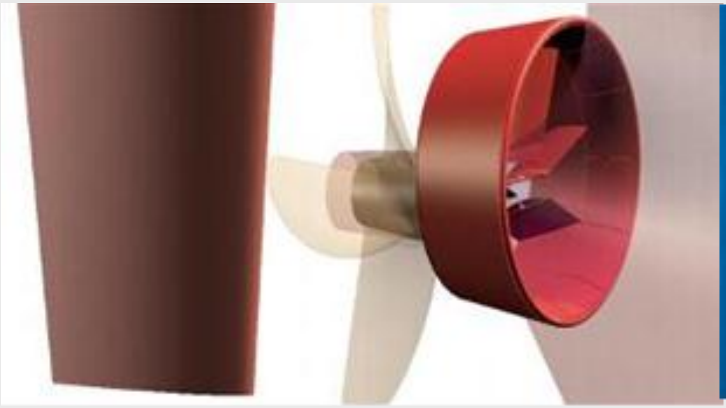
Example Cases of Ship Energy Efficiency Management

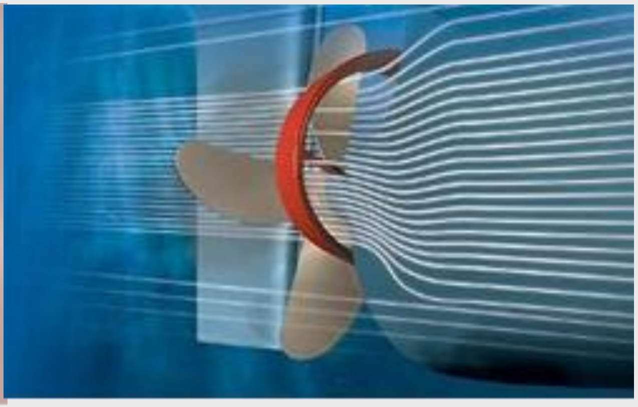
Measures for Improving Energy Efficiency – Examples:

- Mewis Duct

The Mewis Duct is a novel power-saving device which has been developed for slower ships with full form hull shape, that allows either a significant fuel saving at a given speed or alternatively for the vessel to travel faster for a given power level. The Mewis Duct consists of two strong fixed elements mounted on the vessel: a duct positioned ahead of the propeller together with an integrated fin system.

- Savings up to 5%.





Example Cases of Ship Energy Efficiency Management

Measures for Improving Energy Efficiency – Examples:

- Schneekluth Nozzles (Wake Equalizing Ducts)

They consist of two nozzle-shaped half ring ducts which are installed on both sides of the stern ahead of the propeller. Their diameters are about the same as the radius of the propeller and their chord is smaller than the diameter. Sometimes, only one duct is fitted to the stern on one side of the propeller.

- – Wake behind single screw is non-homogenous → improve it
- – **Savings up to 2%.**

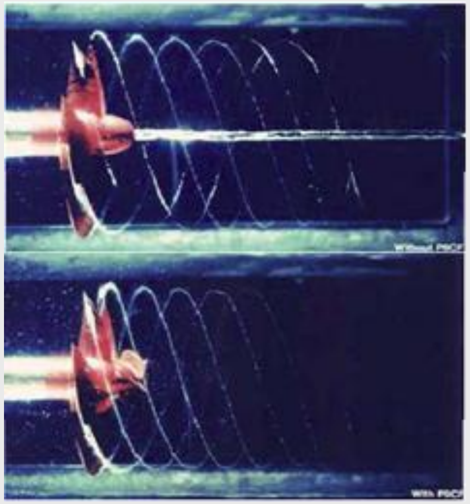
Example Cases of Ship Energy Efficiency Management

Measures for Improving Energy Efficiency – Examples:

- Propeller Boss Cap Fins

A propeller generates vortices from its hub, which reduce its efficiency, and is prone to cavitation. The magnitude of these vortices will depend on the blade radial loading distribution, and on the size and design of the hub.

  - Application to every ship type
  - No mechanical Parts → increased robustness
  - Savings up to 4% according to ITTC (1999)



Measures for Improving Energy Efficiency – Examples:

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- Use of silicone/fluoropolymer anti-fouling paints

A new generation of paints which are employing a **Foul Release** mechanism. Foul release is the name given to technology which does not use biocides to control fouling but provides an ultra-smooth, slippery, low friction, hydrophobic or hydrophobic/hydrophilic combination surface onto which fouling organisms have difficulty in settling. Foul Release products contain no added biocides and are based on silicone/ fluoro-polymer based technology.

Measures for Improving Energy Efficiency – Examples:

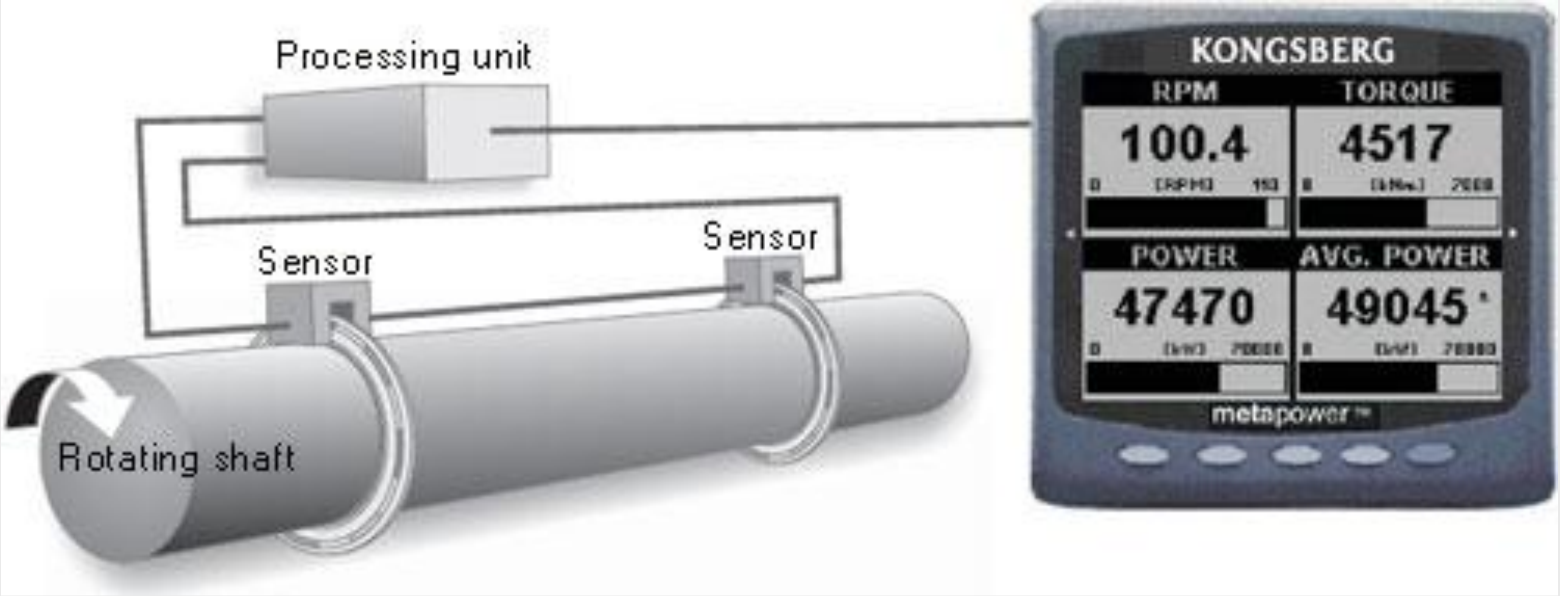
- KYMA Performance Monitoring System

Instrument for continuous measurements of energy input (fuel flow) to the engine and energy output (power) to the shaft. Provides continuous measurements of torque, power and revolutions of rotating propeller shaft (using strain gauge technology), fuel consumption and ship's speed. Performance data, such as specific fuel consumption and ship efficiency is presented on the shaft power meter display unit.

Measures for Improving Energy Efficiency – Examples:

- Shaft Torque Meters

Equipment installed on the main shaft which measures the developed torque of the M/E. It is a digital measuring system using a laser beam for detection of shaft torque, shaft RPM and consequently the transferred power. The system offers high accuracy and good long term stability.



Measures for Improving Energy Efficiency – Examples:

- Main Engine Performance Monitoring

Main Engine Performance Reports to be forwarded to the Company every 2 months. Main Engine SFOC to be measured and compared to sea trials records by the Technical Dept. on a periodical basis, with the aim of identifying cases where the vessel is underperforming, thus corrective action is needed.

EnPI EXAMPLE = M/E SFOC
GOAL EXAMPLE = KEEP DEVIATION FROM THE SEA TRIALS MAIN ENGINE SFOC TO LESS THAN 5% (normalizing as per ISO standard and taking sea margin into account).

Example Cases of Ship Energy Efficiency Management

Measures for Improving Energy Efficiency – Examples:

Section 1
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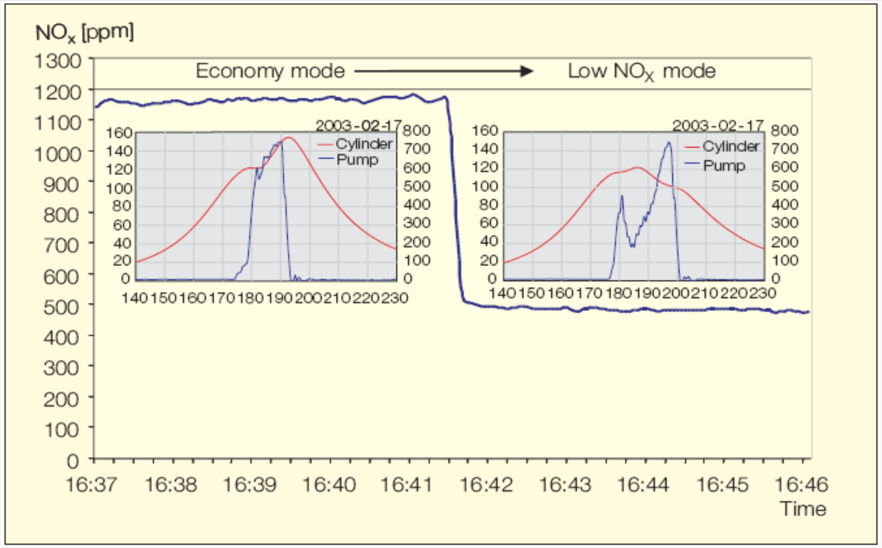
- Electronically Controlled Main Engines:
  - Optimal combustion at all operation speeds and loads.
  - Reduced part load fuel consumption.
  - Smokeless operation at all operation speeds.
  - Reduced cylinder lubricating oil consumption.
  - Easy adaptation to different fuel types.
  - Lower dead slow running and slow steaming, down to 10% RPM.
  - Possibility for different operation modes.
  - Improved engine acceleration.



Measures for Improving Energy Efficiency – Examples:

Section 1
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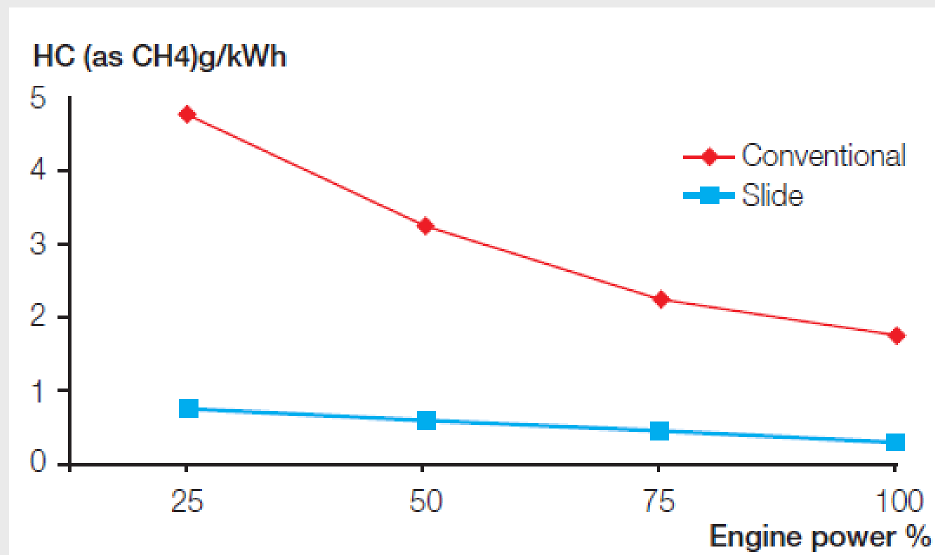
- Fuel Injection Slide Valves

Slide fuel valves have shown significant savings, lower emissions and lower fuel consumption. The slide fuel valves both optimize the combustion of the fuel and ensure a cleaner engine. The spray pattern of the fuel is further optimized and therefore leads to an improved combustion process.



Example Cases of Ship Energy Efficiency Management

Measures for Improving Energy Efficiency – Examples:

- Section 1
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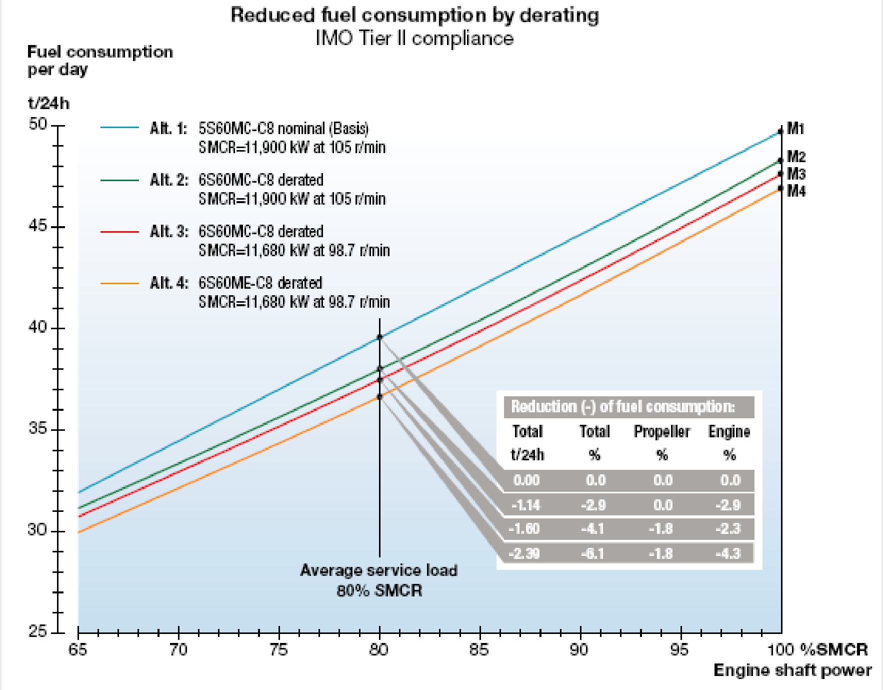
- Installation of De-rated Main Engines:

De-rating is the available option to reduce the specific fuel oil consumption of Diesel engines. It is also called 'economy' rating. This means that the operation of the engines takes advantage of the maximum cylinder pressure for the design continuous service rating (CSR) while the mean effective pressure and shaft speed is lower, at an operational point lower of the propeller normal operating curve.



Example Cases of Ship Energy Efficiency Management

Measures for Improving Energy Efficiency – Examples:

- Aux. Engine Load Optimization – Efficient Use of E/R Pumps:

Management:

- Low engine loads (below 40%) have an adverse effect to the engine operation (particularly the FO system & cylinders) leading to increased maintenance costs & engine accelerated wear.
- Exercise efficient load management, when possible and safe.
- Minimize the number of running generators and maximize their load factor.
- A good practice during sea passage is the operation of a single D/G with a load approx 70% - Avoid the operation of a D/G with FO and load less than 50%.
- In case that two (2) D/Gs have to be in operation, try, if possible, to have one with FO and load 75% and the remaining loads on the other generator which has to be in operation with DO (of course existing arrangements should permit such arrangements).
- Follow the “Odd/Even” policy.

Measures for Improving Energy Efficiency – Examples:

- Aux. Engine Load Optimization – Efficient Use of E/R Pumps:

Management:

- Large cooling FW and SW pumps which operate for long time intervals are important for energy efficiency.
- Use as many pumps as indicated in the Electric Load Analysis for each operation mode (sea passage, alongside, etc.)
- Use Port Facilities
- Minimize piping resistance

Example:

A close cooling water supply to the air cooler when at port or anchorage for long time.

This way the number of running pumps and /or pump load is decreased. Reducing the number of running pumps, <u>even at port and anchorage</u>, can lead to energy savings.

Example Cases of Ship Energy Efficiency Management

Measures for Improving Energy Efficiency – Examples:

- Aux. Engine Load Optimization – Efficient Use of E/R Fans:

The E/R fans should be operated taking into account the E/R air balance study and the actual temperatures in the E/R.

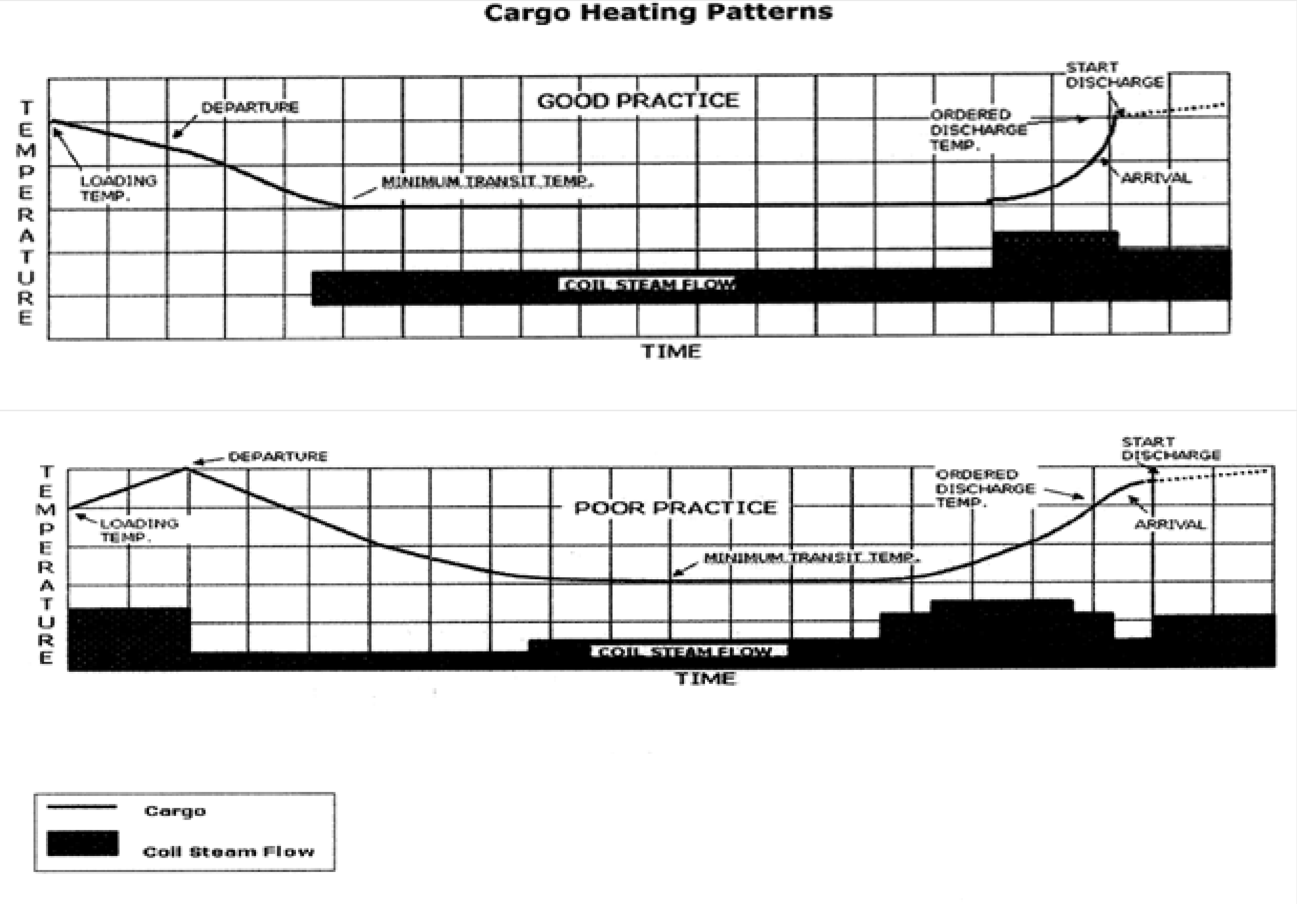
ELECTRIC LOAD TABLE

NO	NAME OF CONSUMER	MOTOR CAPACITY				AT SEA												MANEUVERING				AT CARGO HANDLING				AT HARBOUR				PT
						NORMAL SEA GOING				INERTING				TANK CLEANING																
		NO	Output kw	Eff'y (%)	Input (kw)	NO	%	C.L	I.L	NO	%	C.L	I.L	NO	%	C.L	I.L	NO	%	C.L	I.L	NO	%	C.L	I.L	NO	%	C.L	I.L	
	07. VENT. FANS																													
1	E/R VENT FAN	4	15.0	88.5	16.9	4	70	47.5		4	70	47.5		4	70	47.5		4	70	47.5		3	70	35.6		2	70	23.7		
2	PURIFIER ROOM EXH. FAN	1	1.9	82.5	2.3	1	70	1.6		1	70	1.6		1	70	1.6		1	70	1.6		1	70	1.6		1	70	1.6		
3	DECK STORE EXH. FAN	1	1.5	82.5	1.8	1	70	1.3		1	70	1.3		1	70	1.3		1	70	1.3		1	70	1.3		1	70	1.3		PT
4	FOAM ROOM EXH. FAN	1	0.2	75.0	0.3	1	70	0.2		1	70	0.2		1	70	0.2		1	70	0.2		1	70	0.2		1	70	0.2		PT
5	BOSUN STORE FAN	1	1.5	75.0	2.0	1	70	1.4		1	70	1.4		1	70	1.4		1	70	1.4		1	70	1.4		1	70	1.4		PT
6	S/G ROOM SUPPLY FAN	1	1.5	80.5	1.9	1	70	1.3		1	70	1.3		1	70	1.3		1	70	1.3		1	70	1.3		1	70	1.3		
7	HYD. POWER PACK ROOM EXH. FAN	1	1.5	82.5	1.8	1	70	1.3		1	70	1.3		1	70	1.3		1	70	1.3		1	70	1.3		1	70	1.3		PT
8	GALLEY EXH. FAN	1	1.5	82.5	1.8	1	70	1.3		1	70	1.3		1	70	1.3		1	70	1.3		1	70	1.3		1	70	1.3		PT
9	GALLEY SUPPLY FAN	1	0.7	80.5	0.9	1	70	0.6		1	70	0.6		1	70	0.6		1	70	0.6		1	70	0.6		1	70	0.6		PT
10	DRY PROV. STORE EXH. FAN	1	0.3	80.5	0.4	1	70	0.3		1	70	0.3		1	70	0.3		1	70	0.3		1	70	0.3		1	70	0.3		PT
11	SANITARY FAN	1	2.5	82.5	3.0	1	70	2.1		1	70	2.1		1	70	2.1		1	70	2.1		1	70	2.1		1	70	2.1		PT
12	CO2 ROOM EXH. FAN	1	0.4	75.0	0.5	1	70	0.4		1	70	0.4		1	70	0.4		1	70	0.4		1	70	0.4		1	70	0.4		PT
13	EM'CY GEN. ROOM SUPPLY FAN	1	1.5	80.5	1.9	1	70	1.3		1	70	1.3		1	70	1.3		1	70	1.3		1	70	1.3		1	70	1.3		
14	HOSPITAL EXH. FAN	1	0.1	76.0	0.1	1	70	0.1		1	70	0.1		1	70	0.1		1	70	0.1		1	70	0.1		1	70	0.1		PT

Example Cases of Ship Energy Efficiency Management

Measures for Improving Energy Efficiency – Examples:

- Cargo Temperature Control Optimization:



Example Cases of Ship Energy Efficiency Management

Measures for Improving Energy Efficiency – Examples:

- Section 1
- Section 2
- **Section 3**
- Section 4
- Section 5

- Cargo Heating Plan & Abstract

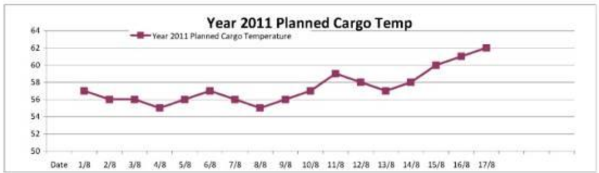
In accordance with OCIMF guidelines - MEPC.62/INF.10

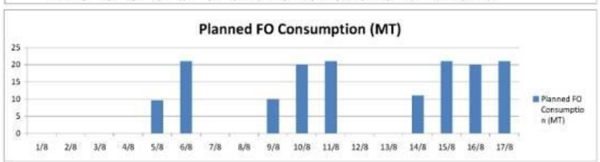
Cargo Heating Plan

			Cargo		
Vessel	TBN				
Voyage No	100	Grade	Qin Huang Dao	Tolerance	
Load Port	Qin Huang Dao	Quantity (MT)	85000	Pour Point (deg C)	-12
Discharge port	Barbers Pt	API	16.6	Cloud Point (deg C)	4
ETD Load Port	1/8/2010	Loaded Temp (deg C)	60		
ETA Disch Port	17/8/2010	Carriage Temp (deg C)	60	Discharge Temp	60

Year 2011	Effective Ambient Temperature (deg C)	Planned Cargo Temperature (deg C)	Recommended Heating Hrs and corresponding Boiler settings: Planned Heating Schedule		Planned FO Consumption (MT)	Recom. Condensate Temperature (deg C)	Boiler Load (%)	Steam Output (kg/hr)	Boiler Efficiency (%)
Date			Total Hrs	From - To					
1/8	32	57.0							
2/8	32	56.0							
3/8	33	56.0							
4/8	32	55.0	12	4th/12:00 - 4th/24:00	9.5	50	45	11300	85
5/8	33	56.0	20	5th/00:00 - 5th/20:00	21.0	50	50	12500	85
6/8	32	57.0							
7/8	33	56.0							
8/8	32	55.0	12	8th/12:00 - 8th/24:00	10.0	50	48	12000	85
9/8	31	56.0	24	9th/00:00 - 9th/24:00	20.0	50	48	11800	85
10/8	30	57.0	12	10th/00:00 - 10th/12:00	21.0	50	50	12000	85
11/8	28	59.0							
12/8	28	58.0							
13/8	27	57.0	12	13th/12:00 - 13th/ 24:00	11.0	50	48	11800	85
14/8	26	58.0	24	Full day	21.0	55	48	12000	85
15/8	26	60.0	24	Full day	20.0	55	50	12200	85
16/8	25	61.0	24	Full day	21.0	60	49	12400	85
17/8	25	62.0	24	Full day	21.0	65	50	12500	85

Total FO Cons for Cargo Heating (during sailing)	175.5

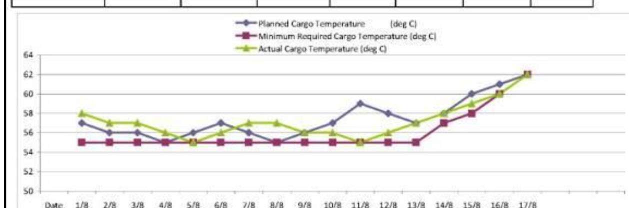


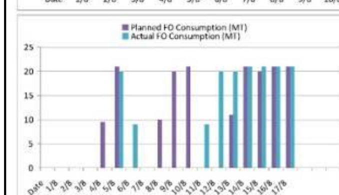


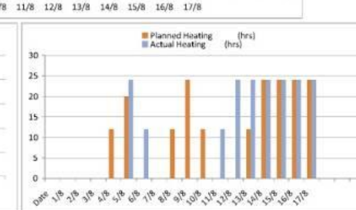
Heating Abstract

Vessel	TBN
Voyage No	100

Year 2011	Planned Cargo Temperature (deg C)	Minimum Required Cargo Temperature (deg C)	Actual Cargo Temperature (deg C)	Planned FO Consumption (MT)	Actual FO Consumption (MT)	Planned Heating (hrs)	Actual Heating (hrs)
Date							
1/8	57.0	55	58.0	0.0	0	0	0
2/8	56.0	55	57.0	0.0	0	0	0
3/8	56.0	55	57.0	0.0	0	0	0
4/8	55.0	55	56.0	9.5	0	12	0
5/8	56.0	55	55.0	21.0	20	20	24
6/8	57.0	55	56.0	0.0	9	0	12
7/8	56.0	55	57.0	0.0	0	0	0
8/8	55.0	55	57.0	10.0	0	12	0
9/8	56.0	55	56.0	20.0	0	24	0
10/8	57.0	55	56.0	21.0	0	12	0
11/8	59.0	55	55.0	0.0	9	0	12
12/8	58.0	55	56.0	0.0	20	0	24
13/8	57.0	55	57.0	11.0	20	12	24
14/8	58.0	57	58.0	21.0	21	24	24
15/8	60.0	58	59.0	20.0	21	24	24
16/8	61.0	60	60.0	21.0	21	24	24
17/8	62.0	62	62.0	21.0	21	24	24

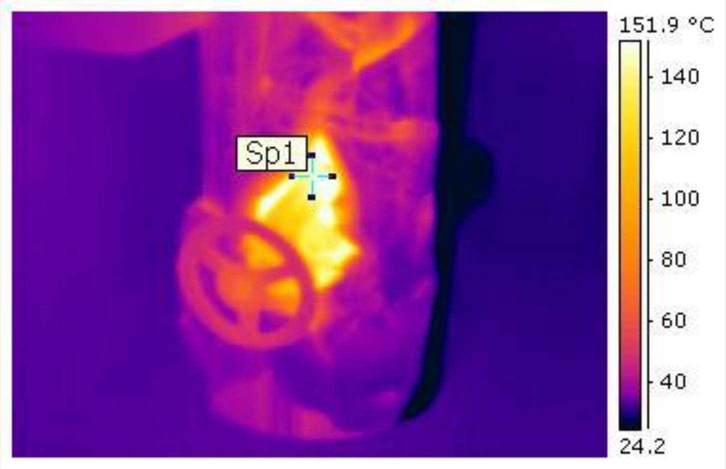






Measures for Improving Energy Efficiency – Examples:

- Insulation Maintenance (Steam distribution and Condensate Return System):
  - Steam and condensate return piping insulation should be regularly inspected. External surface temperatures should generally not exceed 50^0C.
  - Ensure valve blankets and piping insulation is restored to original condition after repairs.



Example Cases of Ship Energy Efficiency Management

Measures for Improving Energy Efficiency – Examples:

- Fuel Oil Purchasing / Analysis:

– Fuel purchased for use onboard to be in accordance with ISO 8217:2010 standard requirements.

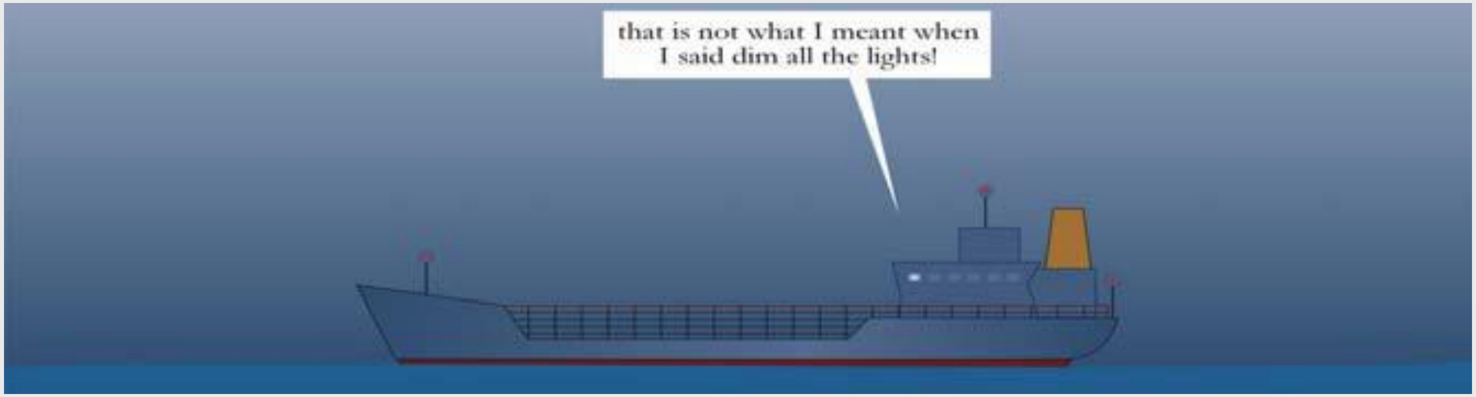
– Fuel oil samples to be taken during bunkering, sent to shore facilities for analysis and relevant reports to be forwarded to the vessel with instructions, as necessary.

– Appropriate corrective action to be taken in case of sub-standard fuel.

Example Cases of Ship Energy Efficiency Management

Measures for Improving Energy Efficiency – Examples:

- Lighting Management Optimization
  - Turn off cabin lights when off for work.
  - Turn off the lights in usually unoccupied spaces. This includes the cabin WC.
  - Lamp flickering without starting means the lamp's cathodes are worn out. Such lamps should be removed since repeated attempts to start the lamp cause over-heating and energy loss.
  - A review of the 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.



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Break

Example Cases of Ship Energy Efficiency Management

Measures for Improving Energy Efficiency – Examples:

- Ship Energy Audits:

An Energy Audit is performed in order to assess the deficiencies of operation, find the gaps between actual and sea trial performance.

End Goal: To identify a number of **Energy Saving Potentials (ESPs)**.

- Comparison between the vessel's & the machinery's energy performance against sea & shop trials.
- Increase of the crew's energy efficiency & conservation awareness.
- Identification of gaps for further energy efficiency improvements.
- Investigate a best practice list for energy efficiency improvement.
- Rank identified ESPs through a Cost-Benefit Analysis (CBA).

Follow-up Audit conducted after 1-1.5 year to check effectiveness of ESPs adopted / identify new ESPs.

Example Cases of Ship Energy Efficiency Management

Measures for Improving Energy Efficiency – Examples:

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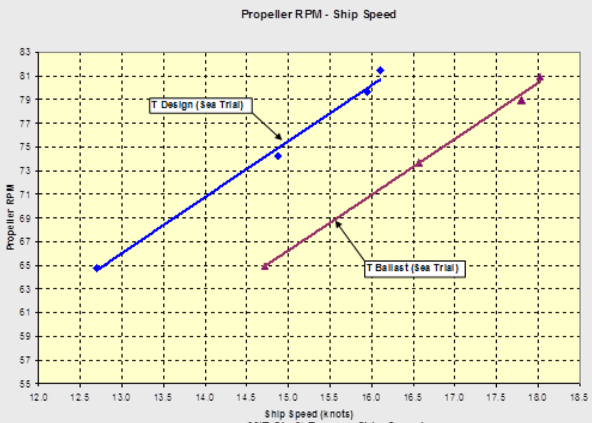
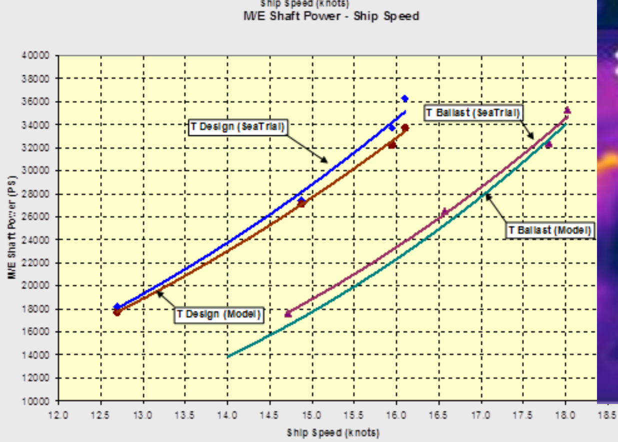
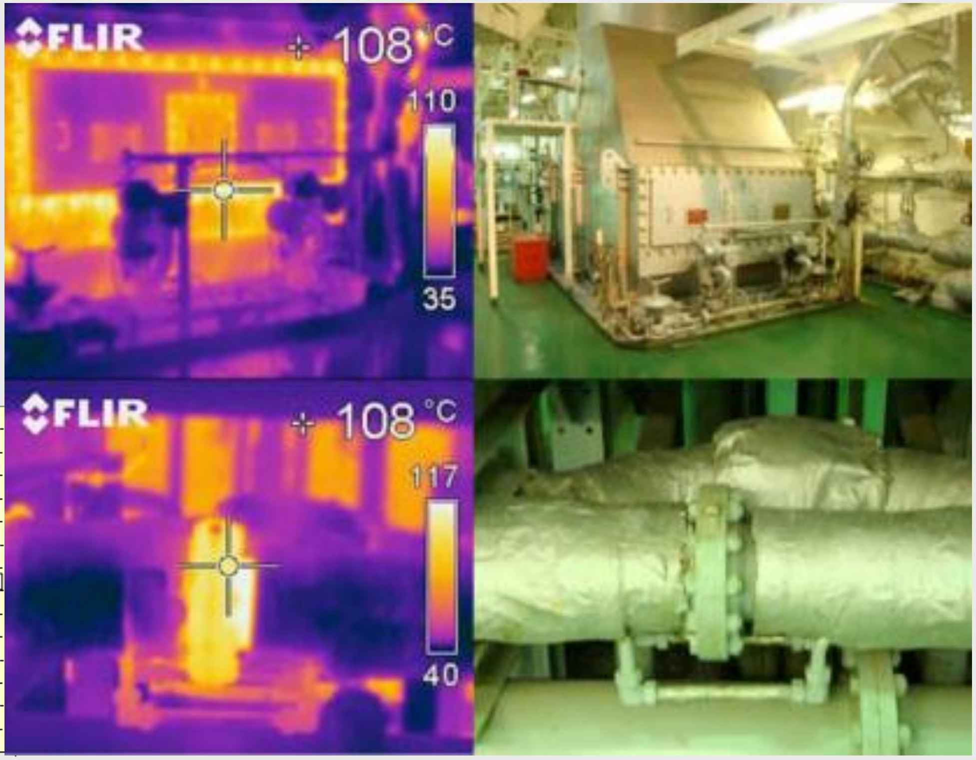
- Ship Energy Audits:







Example Cases of Ship Energy Efficiency Management

Measures for Improving Energy Efficiency – Examples:

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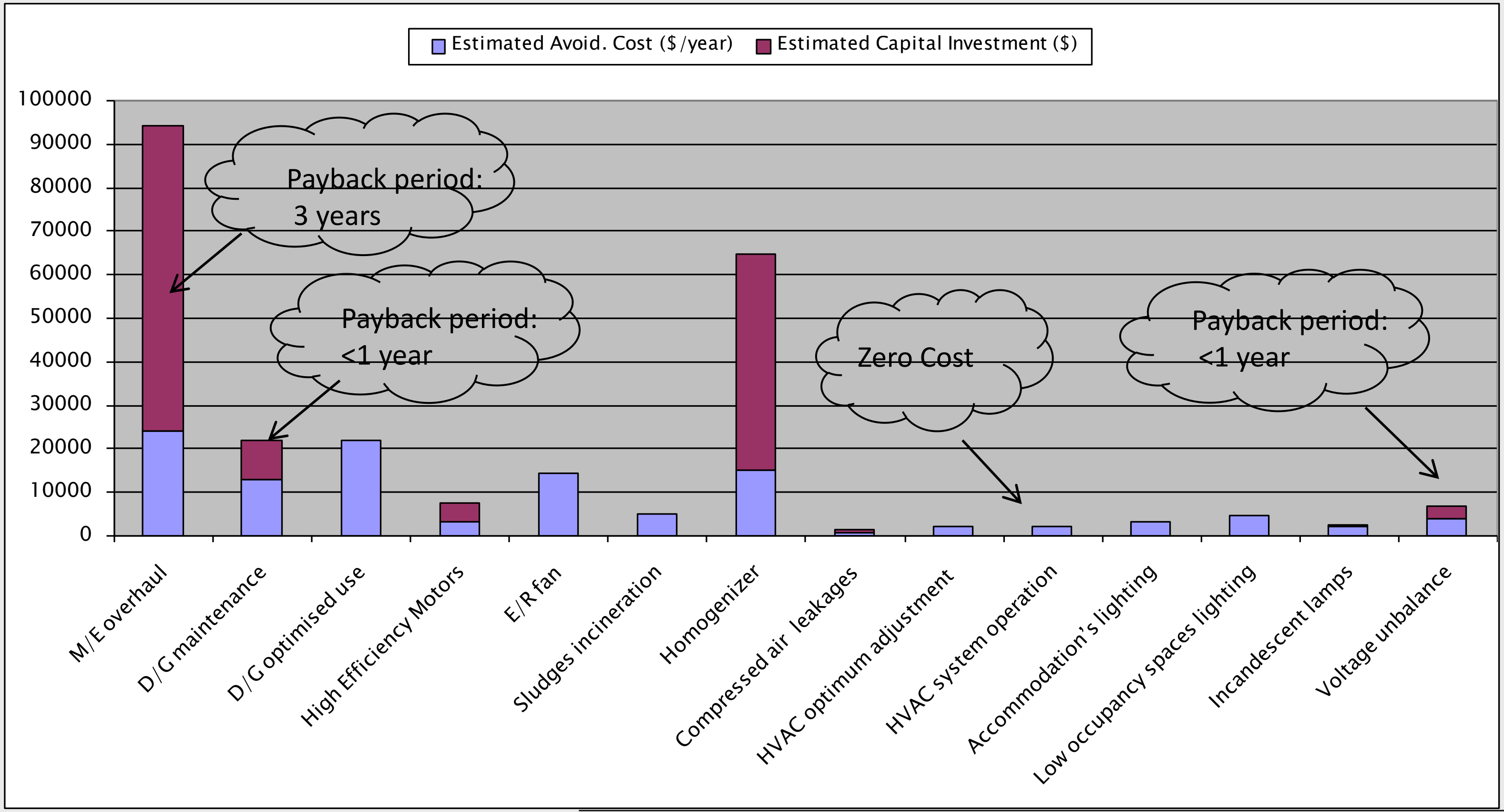
- Ship Energy Audits – Example of ESP Ranking:



Example Cases of Ship Energy Efficiency Management

Measures for Improving Energy Efficiency – Examples:

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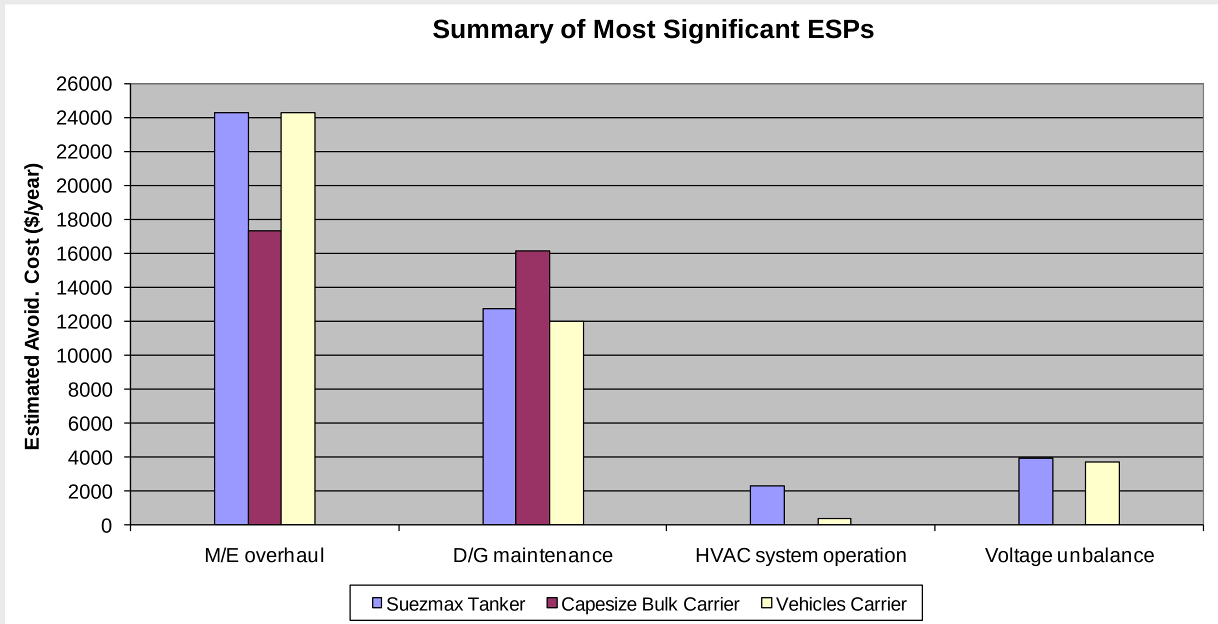
- Ship Energy Audits – Example of ESP Comparison:



➢ Total benefit from the above ESPs : Suezmax Tanker → 43,252 $/year

Capesize Bulk Carrier → 33,488 $/year

➢ Total benefit from zero cost ESPs : Suezmax Tanker → 53,803 $/year

Capesize Bulk Carrier → 33,006 $/year

Measures for Improving Energy Efficiency – Examples:

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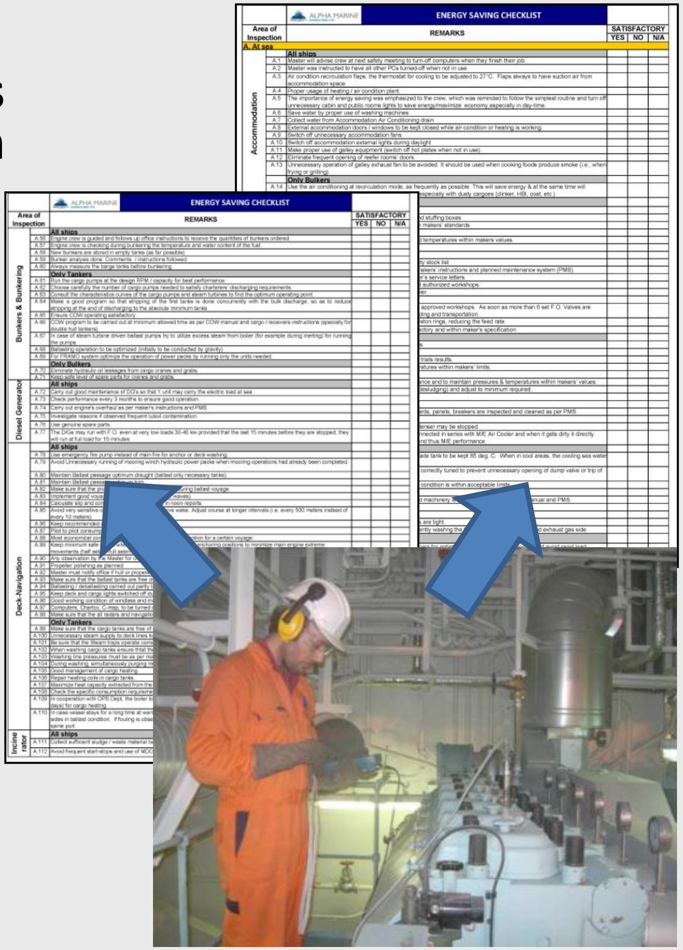
- Other Measures:
  - **Crew Personnel Awareness Training / Energy Conservation Checklists for Superintendents:**

    Crew Awareness may be increased through the use of appropriate Energy Savings Checklists, developed based on Best Practices identified after numerous Energy Audits.



Example Cases of Ship Energy Efficiency Management

Ship Energy Efficiency Management Plan - Part B

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The SEEMP may be separated into two parts:
The generic (Part A) and the ship-specific part (Part B)

- **Energy Saving Measure:** Options already implemented, under trial, as well as options being considered.
- **Assignment of responsible / monitoring personnel both ashore and onboard**
- **Description of monitoring methods:** Each measure will most likely require different methods & units of measurement.
- **Target:** It is the specific, measurable target that the Company aims to achieve through the adoption of a measure.
- **Records:** The relevant records that will be kept in order to monitor the performance of each measure.
- **Implementation Period:** The period during which the Company will implement and monitor each measure.

Part B

Full Compliance with
Res. MEPC.213(63)

Example Cases of Ship Energy Efficiency Management

SEEMP - Part B (Example)

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Energy Saving Measure:	Speed Selection Optimization (see Part A 4.1.1)
Responsible ashore:	Operations Department / Operator.
Responsible onboard:	Master / Chief Engineer.
Records:	Daily Noon Reports / Voyage Abstracts / EEOI form
Implementation Period:	Continuous (as requested and/or allowed by Charterers, weather and safe navigation permitting - WSNP).
Target:	~~Decrease the fuel consumption by up to **2%**~~ a. During ballast voyages: Reduce vessel's speed to be within ±0.5 knots of the vessel's Practical Economical Speed. b. During laden voyages: Taking into account the restrictions imposed by the Charter Party, optimize the speed in order to keep the used fuel per tonne-mile at a minimum level so as to ultimately reduce time spent in anchorage or drifting at waiting areas annually by 1%. c. Reduce annual fleet EEOI average by 1% annually.
Monitoring Method:	a. Random checking of Daily Noon Reports by the Operations Dept. to establish the vessel's speed during ballast voyages. b. Review of voyage data to establish time spent in anchorage or drifting at waiting areas. Statistical data on the calculated quantity of bunkers saved through the implementation of this procedure should be kept by Operations Dpt. (per voyage / per vessel). c. Review of EEOI forms to establish the annual fleet EEOI average.

Example Cases of Ship Energy Efficiency Management

SEEMP - Part B (Example)

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Energy Saving Measure:	Auxiliary Engine Load Optimization (see Part A 4.3.8)
Responsible ashore:	Technical Department.
Responsible onboard:	Chief Engineer.
Records:	C/E Standing Orders / Superintendent Inspection Reports.
Implementation Period:	Continuous (whenever possible - WSNP).
Target:	- Strict adherence to C/E Standing Orders. - Zero non-conformances during normal operations.
Monitoring Method:	The C/E should review yard's electric balance study, operate E/R pumps accordingly while at port, if possible, and compare on a quarterly basis the expected power consumption against actual data based on the operational profile of the vessel. The C/E should also review yard's air balance study and operate E/R fans accordingly. This involves reduction of number of E/R fans operating while at port based on prevailing ambient conditions. Checks during shipboard attendances by Technical Superintendents.

Example Cases of Ship Energy Efficiency Management

SEEMP - Part B (Example)

Energy Saving Measure:	Auxiliary Engine Load Optimization (cont'd)

Guidelines:

1. At Sea :

- Use only one Auxiliary Engine – Associated fuel saved = up to approx. 0.1 MT/day
- Turn off lighting at non-frequented spaces – Associated reduction in electric load= approx. 1.5 kW
- Auxiliary Boiler – Associated fuel saved = up to approx. 0.5 MT/day

2. At Anchorage:

- 50% of E/R Fans – Associated reduction in electric load = approx. 20 kW

3. In Port with Cargo Operation:

- 50% of E/R Fans – Associated reduction in electric load = approx. 20 kW
- Main Engine LO Pump – Associated reduction in electric load = approx. 40 kW (safety permitting) Main Engine LO Pump may be stopped if the port stay exceeds 24 hours, the vessel is in safe sheltered port &approx. 6-hours are available for notice prior departure.

4. Sea Load with Cargo Heating:

- Use only one Auxiliary Engine – Associated fuel saved = up to approx. 0.1 MT/day
- Turn off lighting at non-frequented spaces – Associated reduction in electric load= approx. 1.5 kW

Example Cases of Ship Energy Efficiency Management

SEEM Monitoring Tool (Vessel Energy & Environmental Performance)

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YEAR:	

WELCOME TO THE VESSEL'S ENVIRONMENTAL PERFORMANCE REPORTING WORKBOOK

VESSEL NAME (Select from dropdown list):

The purpose of this form is to gather all necessary data in order to evaluate vessel's environmental performance with emphasis to aerial emissions (CO_2,SOx,NOx)

Vessel's performance data is collected on a **QUARTERLY** basis by completion of the relevant Report.
All cells highlighted with **grey colour** are calculated **automatically**. **NO DATA SHOULD BE ENTERED IN THESE CELLS.**
In order to complete the quartely Report **click** below on the respective reporting Quarter:

QUARTER 1 QUARTER 2 QUARTER 3 QUARTER 4

VESSEL's YEAR (Please enter the year that best reflects the vessel's M/E year of installation or the year of M/E major conversion):

NOTE : The Workbook should be used in electronic format ONLY!

Example Cases of Ship Energy Efficiency Management

SEEM Monitoring Tool (Vessel Energy & Environmental Performance)

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VESSEL ENVIRONMENTAL PERFORMANCE REPORT

VESSEL :		
QUARTER 1	JANUARY-FEBRUARY-MARCH	
DATE OF REPORT (DD/MM/YY):		

<---- BACK

CO_2 EMISSIONS CALCULATION (ENERGY EFFICIENCY OPERATIONAL INDICATOR-EEOI)						
	Fuel consumption (FC) in tonnes (M/E, A/E, Boiler, Incinerator)			Voyage data		PRODUCT (Tonnes x Nautical Miles)
	Type of Fuel - ISO Specification					
	ISO 8217 Grades DMX through DMC	ISO 8217 Grades RME through RMK	ISO 8217 Grades RMS through RMA			
VOYAGE No. (click to see NOTE 1)	Diesel / Gasoil	Heavy Fuel Oil (HFO)	Light Fuel Oil (LFO)	Cargo (m_{cargo}) (Tonnes)	Distance (D) (Nautical Miles)	(m_{cargo} x D)
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						
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	F_D	F_{HFO}	F_{LFO}	0	0	
TOTAL	0	0	0		$\Sigma(m_{cargo}$ xD)	0

NOTE 1: The term VOYAGE refers to the period between a departure from a port to the departure from the next port (both Ballast & Laden voyages). Voyages for the purpose of securing the safety of a ship or saving life at sea are excluded. ONLY voyages which have been completed during the quarter (i.e. departure ->departure) are reported.

CO_2 EMISSIONS DURING QUARTER 1 (gr CO_2)	VESSEL IDLE	CO_2 EMISSIONS DURING QUARTER 1 (Tonnes CO_2)	VESSEL IDLE	EEOI (gr CO_2/tonne*mile)	VESSEL IDLE

Example Cases of Ship Energy Efficiency Management

SEEM Monitoring Tool (Vessel Energy & Environmental Performance)

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SOx EMISSIONS CALCULATION

BUNKERING OPERATIONS DURING REPORTING PERIOD - QUARTER 1 (If any, otherwise leave blank)

BUNKERING No.	DATE (dd/mm/yy)	HEAVY FUEL OIL (HFO) RECEIVED (TONNES)	HFO sulphur content (%) according to BDN	DIESEL OIL/GAS OIL RECEIVED (TONNES)	DO sulphur content (%) according to BDN	LIGHT FUEL OIL (LFO) RECEIVED (TONNES)	LFO sulphur content (%) according to BDN
# 1 (if applicable)							
# 2 (if applicable)							
# 3 (if applicable)							
# 4 (if applicable)							
# 5 (if applicable)							
# 6 (if applicable)							
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		TOTAL HFO (tonnes)		TOTAL DO (tonnes)		TOTAL LFO (tonnes)	
		0		0		0	

SOx EMISSIONS DURING QUARTER 1 (gr SOx) IN DIESEL OIL	0
SOx EMISSIONS DURING QUARTER 1 (gr SOx) IN LIGHT FUEL OIL	0
SOx EMISSIONS DURING QUARTER 1 (gr SOx) IN HEAVY FUEL OIL	0

Example Cases of Ship Energy Efficiency Management

SEEM Monitoring Tool (Vessel Energy & Environmental Performance)

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NOx EMISSIONS CALCULATION

INPUT DATA FROM MAIN ENGINE SHOP TRIALS:

ENGINE LOAD	RPM	BHP (kW)
50%		
75%		
85% or 90%		
100%		

INPUT DATA FROM MAIN ENGINE NOx TECHNICAL FILE:

ENGINE LOAD	BHP (kW)	NOx EMISSION (gr/kWh)
25%		
50%		
75%		
100%		

	Voyage data	
VOYAGE No. (click to see NOTE 1)	M/E TOTAL RUNNING HOURS WITHIN QUARTER 1	M/E TOTAL REVOLUTIONS WITHIN QUARTER 1
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
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NOx EMISSIONS DURING QUARTER 1 (gr NOx)	VESSEL IDLE	NOx EMISSIONS DURING QUARTER 1 (Tonnes NOx)	VESSEL IDLE	NOx EMISSION INDICATOR (gr NOx/tonne*mile)	VESSEL IDLE

Example Cases of Ship Energy Efficiency Management

SEEM Monitoring Tool (Vessel Energy & Environmental Performance)

GARBAGE DISPOSAL DATA				
Description	Disposed at sea (m^3)	Disposed through shore subcontractor	Incinerated (m^3)	Total (m^3)
GROUP 1 all plastics, including but not limited to synthetic ropes, synthetic fishing nets, plastic garbage bags and incinerator ashes from plastic products which may	Prohibited			0.00
GROUP 2 dunnage, lining and packing materials which will float				0.00
GROUP 3 comminuted or grounded food wastes, paper products, rags, glass, metal, bottles, crockery and similar refuse				0.00
GROUP 4 cargo residues, paper products, rags, glass, metal, bottles, crockery and similar refuse				0.00
GROUP 5 non-comminuted or grounded food waste				0.00
GROUP 6 incinerator ash	Prohibited		Not applied	0.00

MANAGEMENT OF SLUDGE ONBOARD			
SLUDGE DISPOSED TO SHORE FACILITIES (m^3)		SLUDGE PRODUCED ONBOARD (m^3)	
SLUDGE INCINERATED ONBOARD (m^3)			

FRESH WATER CONSUMPTION DATA			
FRESH WATER PURCHASED FOR USE ONBOARD (m^3)		FRESH WATER INDICATOR (m^3 / tonne x mile)	

OZONE DELPETING SUBSTANCES (O.D.S)	
LIST OF EQUIPMENT CONTAINING ODS	Click here for update
ODS RECORD BOOK	Click here for update

SEEM Monitoring Tool (Vessel Energy & Environmental Performance)

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VOC EMISSIONS CALCULATION FORM

[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]
Date	Time at Start of Release	Time at Stop of Release	Duration of Release (Minutes)	Tank Pressure at Start of release (mmWG)	Tank Pressure at Stop of Release (mmWG)	Mean Pressure during Release (mWG)	Diameter of Release pipeline opening (m)
29/9/2009	10:20	10:28	8	1200	800	1.072	0.508
Total for QUARTER 1							
Chief Officer (name / signature)							

VOC EMISSIONS CALCULATION FORM (cont'd)

[9]	[10]	[11]	[12]	[13]	[14]	[15]
Length of Release Pipeline from Tank (m)	Mean Velocity of Release (m/sec)	Total Vapour Volume of Release (m^3)	% of VOC	VOC Vapour Release (m^3)	VOC equiv. Liquid Release (m^3)	VOC equiv. Weight Release (Tonnes)
30	4.22	410.60	80	328.48	1.314	0.716
						0.716

Example Cases of Ship Energy Efficiency Management

SEEM Monitoring Tool (Vessel Energy & Environmental Performance)

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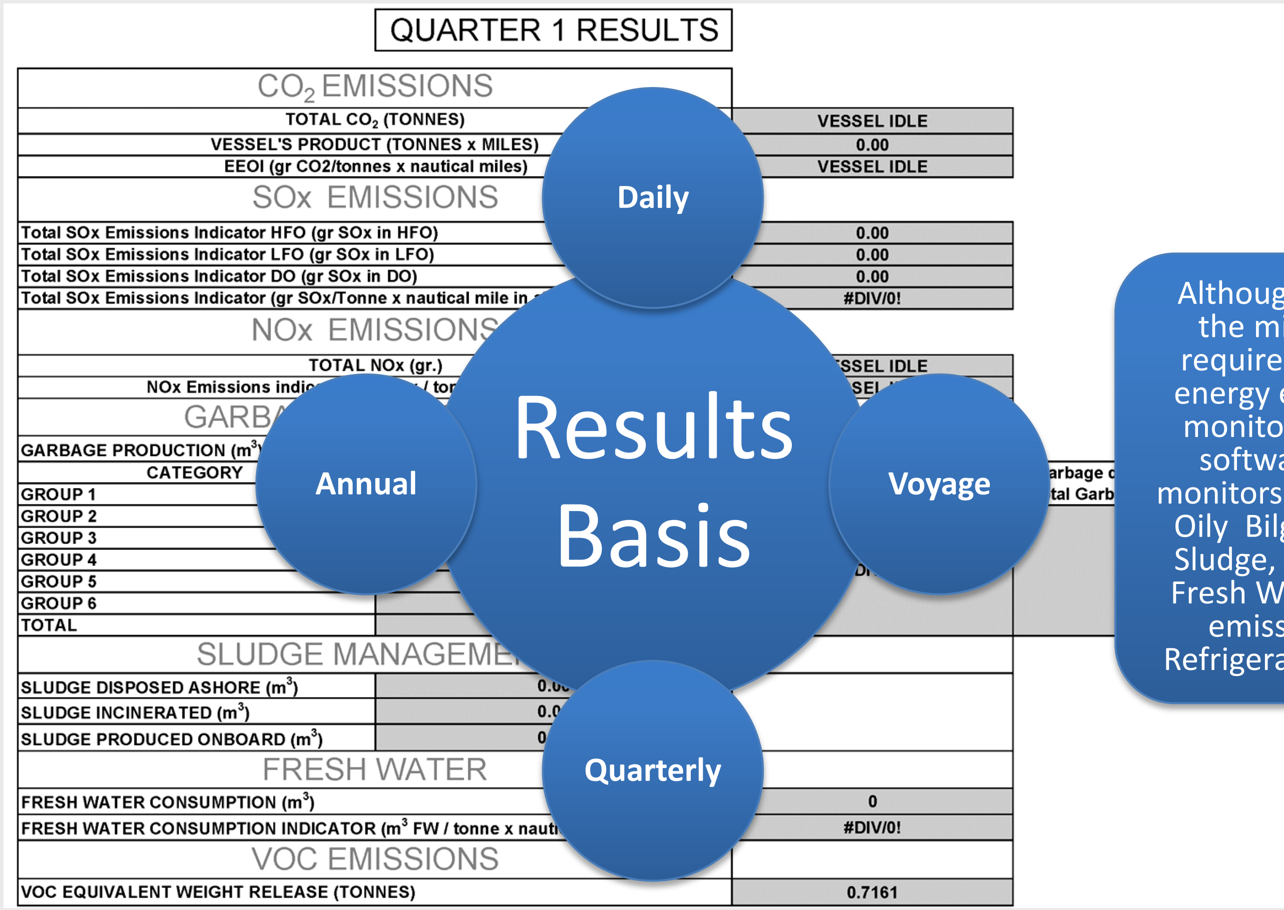

Although EEOI is the minimum requirement for energy efficiency monitoring, the software also monitors SOx, NOx, Oily Bilge Water, Sludge, Garbage, Fresh Water, VOC emissions & Refrigerants (ODS)

Example of Integrating the Energy Efficiency Monitoring Tool into Existing Noon Reporting Software (BENEFIT)

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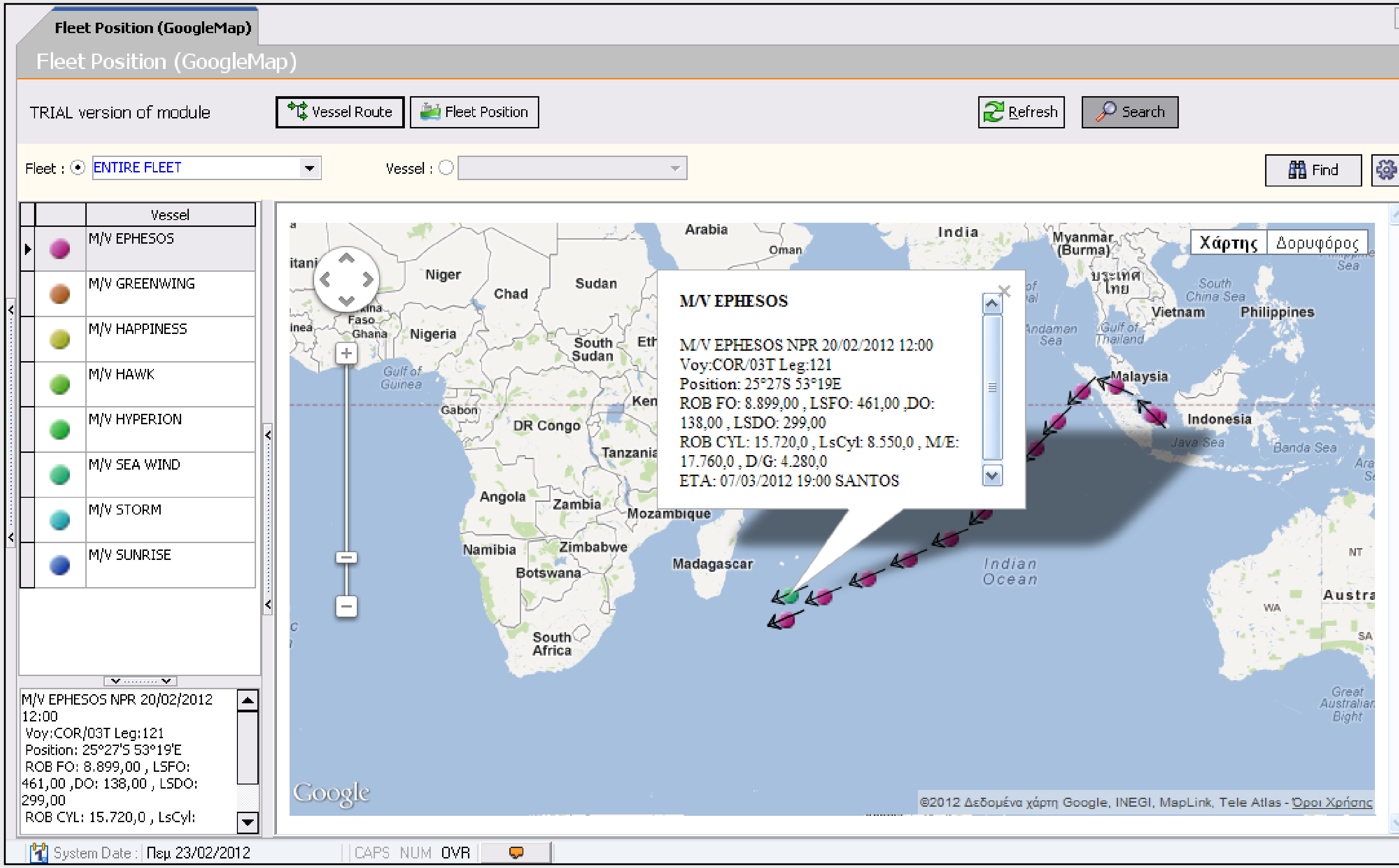
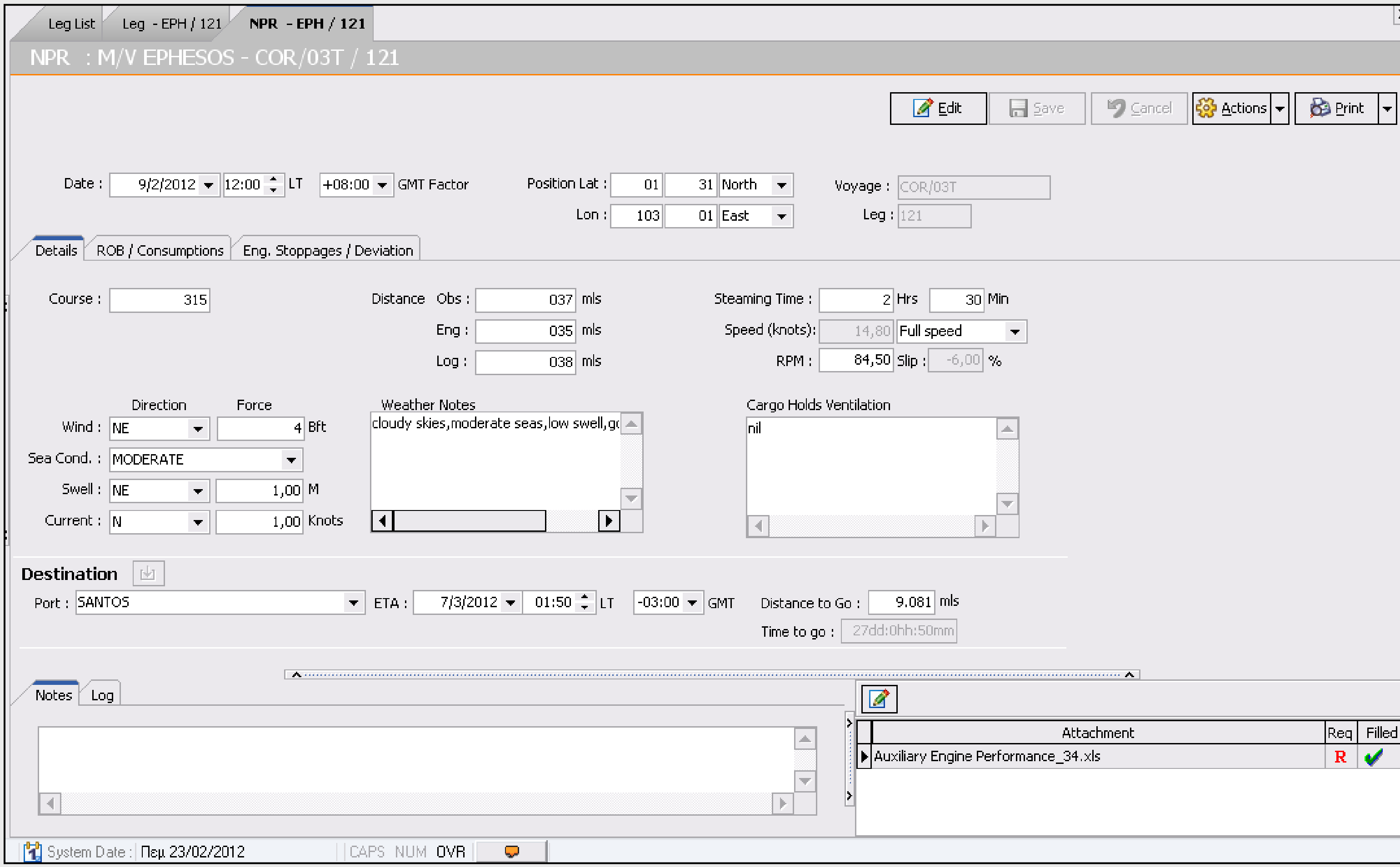
Environmental module retrieves data from Benefit ERP



Example of Integrating the Energy Efficiency Monitoring Tool into Existing Noon Reporting Software (BENEFIT)

Distance and consumptions are retrieved from NRP



Example of Integrating the Energy Efficiency Monitoring Tool into Existing Noon Reporting Software (BENEFIT)

Cargo quantity, consumption and distance in port are retrieved from Port Activities

BENEFIT Software

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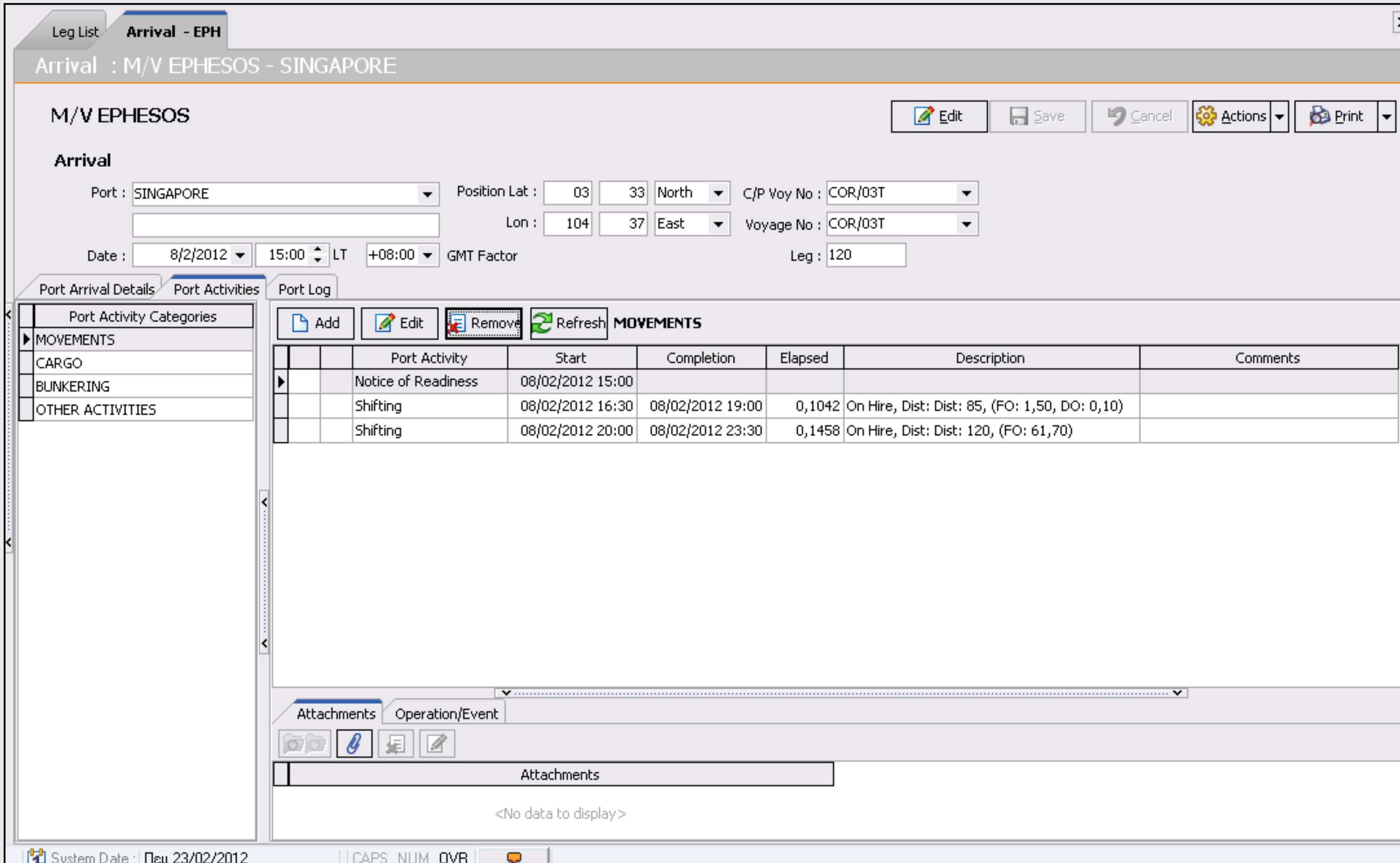
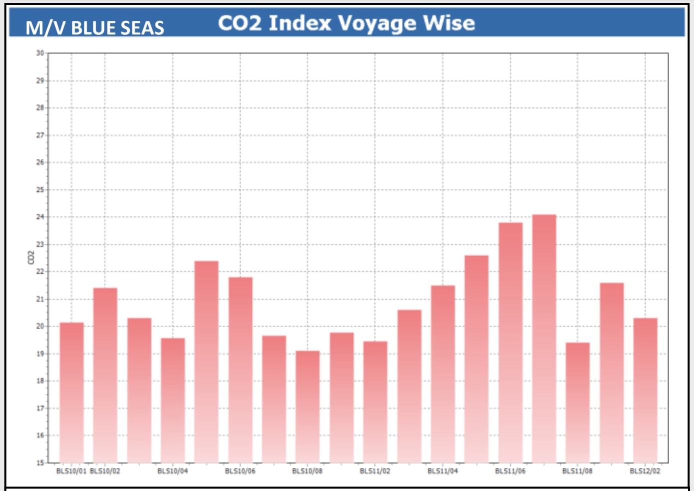
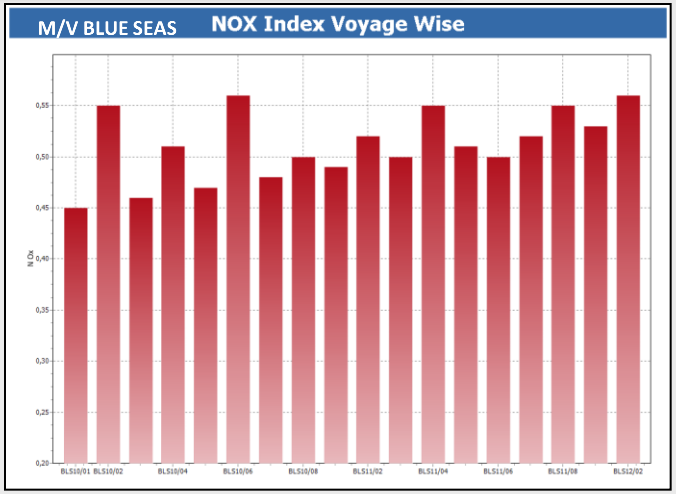
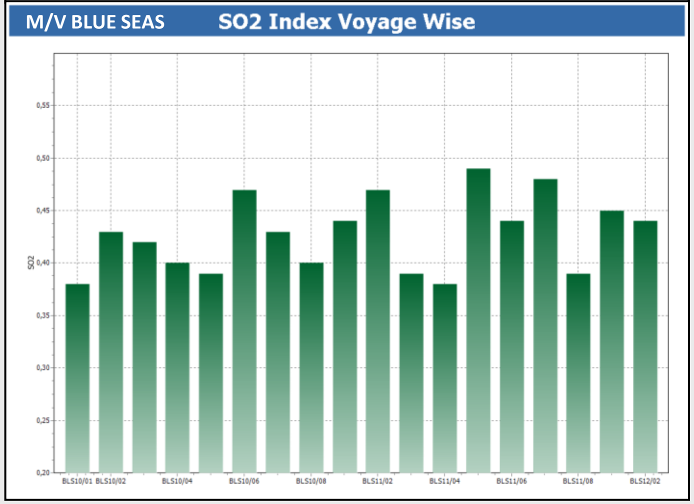


Example of Integrating the Energy Efficiency Monitoring Tool into Existing Noon Reporting Software (BENEFIT)

EEOI (gr CO_2/tonne-mile), SOxI (gr SOx/tonne-mile), NOxI (gr NOx/tonne-mile) are calculated and analyzed per vessel per voyage

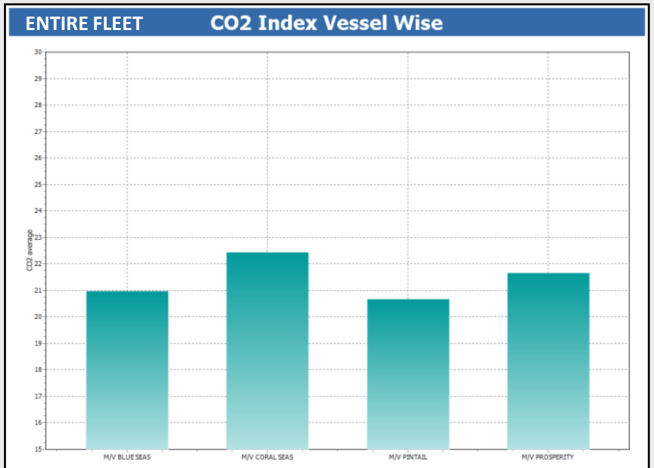


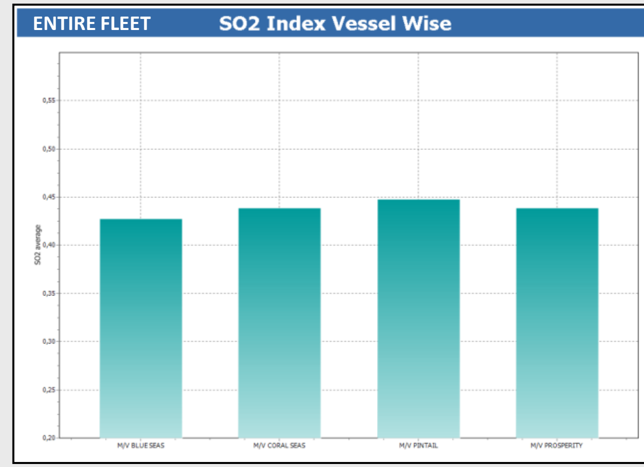


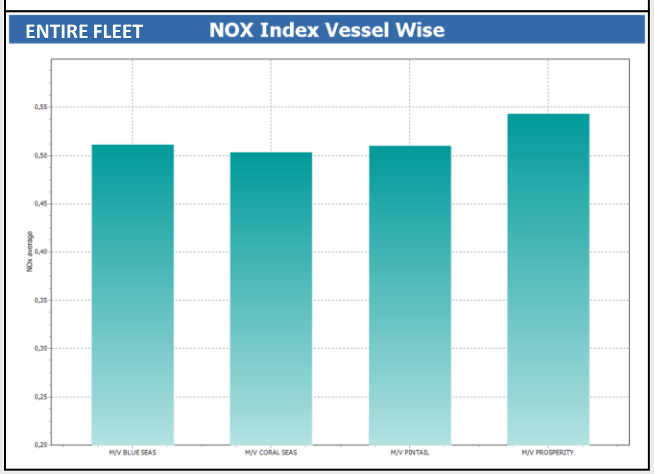


Example of Integrating the Energy Efficiency Monitoring Tool into Existing Noon Reporting Software (BENEFIT)

EEOI (gr CO_2/tonne-mile), SOxI (gr SOx/tonne-mile), NOxI (gr NOx/tonne-mile) are analyzed and compared per vessel over a given time period







Example of Integrating the Energy Efficiency Monitoring Tool into Existing Noon Reporting Software (BENEFIT)

EEOI (gr CO_2/tonne-mile), SOxI (gr SOx/tonne-mile), NOxI (gr NOx/tonne-mile) are analyzed and compared per vessel quarterly

BENEFIT Software

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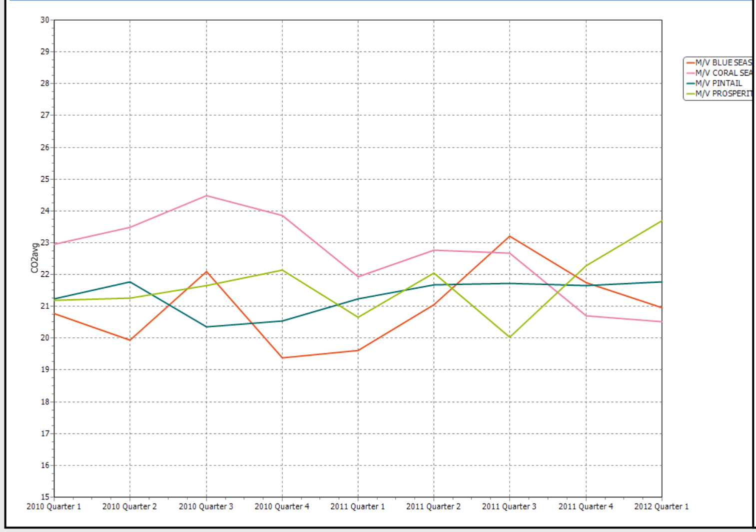
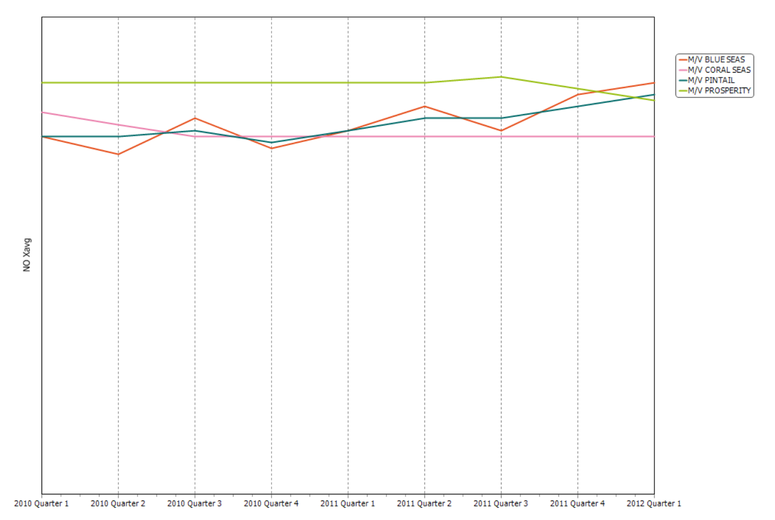
Fleet CO2 Index

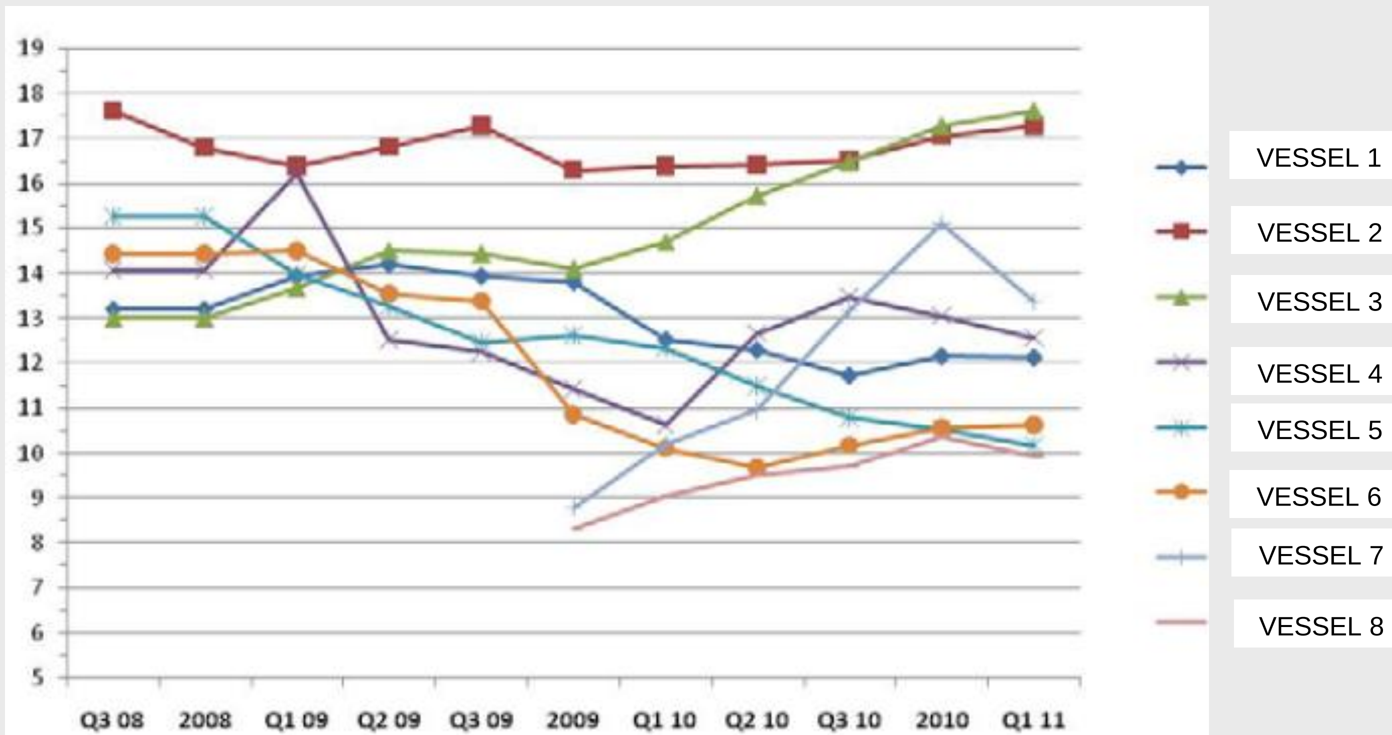


Fleet Nox Index



Energy Efficiency Benchmarking

Example - EEOI Benchmarking within Fleet



Energy Efficiency Benchmarking

Example - Benchmarking Across the Industry

EEOI / SOx / NOx Benchmarking

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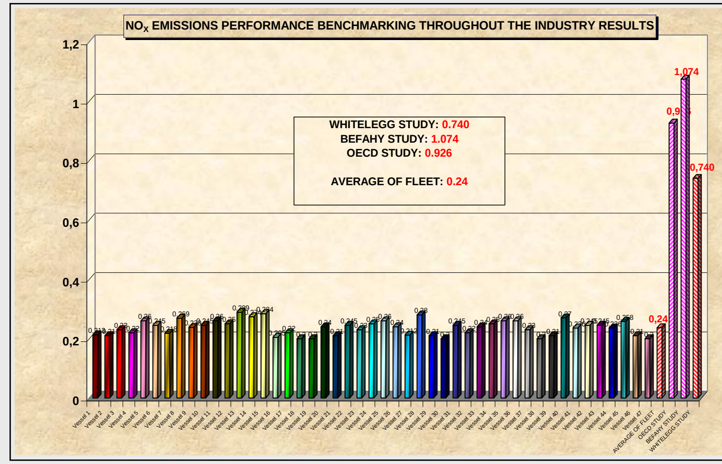
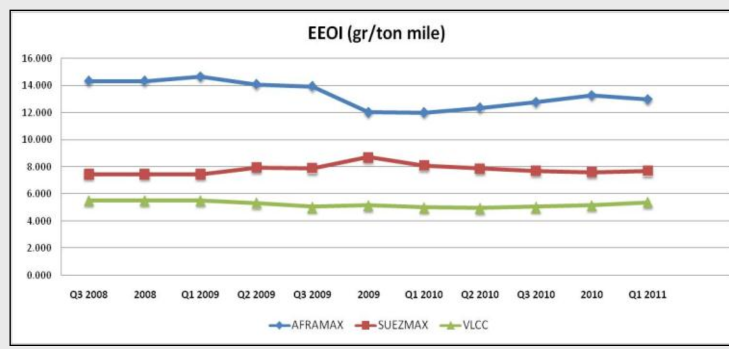
EEOI BENCHMARKING ACROSS THE INDUSTRY (gr. CO_2/ tonne mile)

Vessel Type	Vessel Category	NTUA [2008]	IMO [2006]	ASBJØRNSLETT [2010]	MAERSK [2007]	AMS [2011]
Chemical/ Product Carriers	15-25 (DWTx1000)	21.17	23.5	35.2	-	19.28
	25-40 (DWTx1000)	27.60				13.03
	40-60 (DWTx1000)	17.24				16.93
	>60 (DWTx1000)	10.19				18.0
Crude Oil Carriers	AFRAMAX 80- 120 (DWTX1000)	10.5	8	12.13	9.55	5.9
	SUEZMAX 120- 200 (DWTx1000)	7.59		7.56	-	5.92
	VLCC / ULCC > 200 (DWTx1000)	6.66		7.07	4.68	5.86
Bulk Carriers	Handysize 15-35 (DWTx1000)	16.48	7.6	20.37	-	-
	Handymax 35-65 (DWTx1000)	11.67		12.96		8.37
	Panamax 65-85 (DWTx1000)	8.70		11.11		5.56
	Post-Panamax 85-120 (DWTx1000)	6.72		9.26		6.98
	Capesize >120 (DWTx1000)	5.00		7.41		8.39
Container Vessels	Very Large >10 (TEUsx1000)	20	24.4	44.45	10.59	-
	Large 5-10 (TEUsx1000)				14.11	
	Medium-Large 3.5-5 (TEUsx1000)	21.85			15.76	27.27
	Medium 2-3.5 (TEUsx1000)	22.59			19.71	16.17
	Small <2 (TEUsx1000)	25.37			21.58	29.86
	Feeder <1 (TEUsx1000)	31.9				-





Brief Introduction to ISO 50001:2011 (Energy Management Systems)

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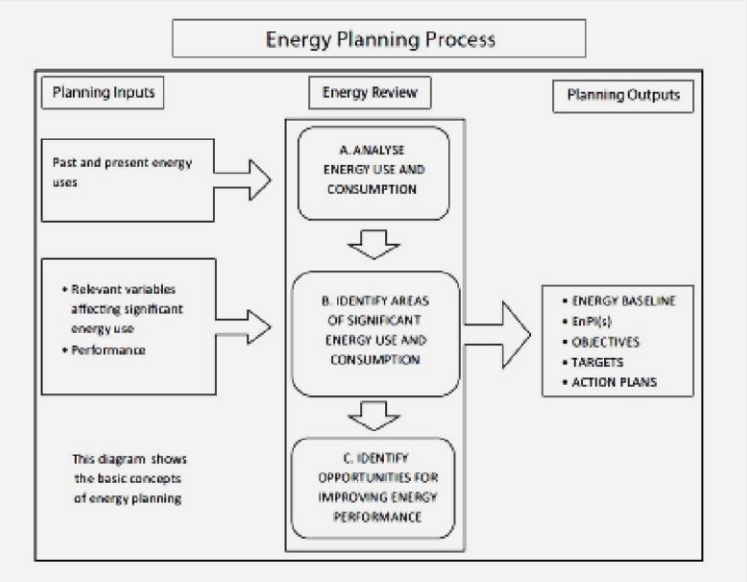
- Management Responsibility:
  - Top Management Commitment to be laid out;
  - Management Representative (usually the HSQE Manager);
  - Energy Management Team (Technical / Operations Manager)
- Energy Management Policy (already adopted through SEEMP)
- Energy Planning Process
- Energy Review
- Energy EnPIs (EEOI, SOx, NOx – see SEEMP)



ISO 50001:2011 Energy Management System

- Energy Performance Indicators (EnPIs):
  - Quantitative value or measure of energy performance, as defined by the Company
  - As included in the Company's SEEMP
  - To be monitored, analysed and evaluated
  - Results to be presented during quarterly / annual Management Reviews
  - Ability to adjust them as necessary

- EnMS Responsibilities - Company Representative:
  - Ensure the EnMS is established, implemented, maintained, and continually improved in accordance with ISO 50001 and other relevant legal and industry requirements;
  - Identify person(s), authorized by an appropriate level of management, to work with the management representative in support of energy management activities;
  - Monitor and report to top management on energy performance.
  - Report to top management on the performance of the EnMS;
  - Ensure that the planning of energy management activities is designed to support the Company's energy policy.
  - Define and communicate responsibilities and authorities in order to facilitate effective energy management;
  - Determine criteria and methods needed to ensure that both the operation and control of the EnMS are effective.
  - Promote awareness of energy policy & objectives at all levels of Company.

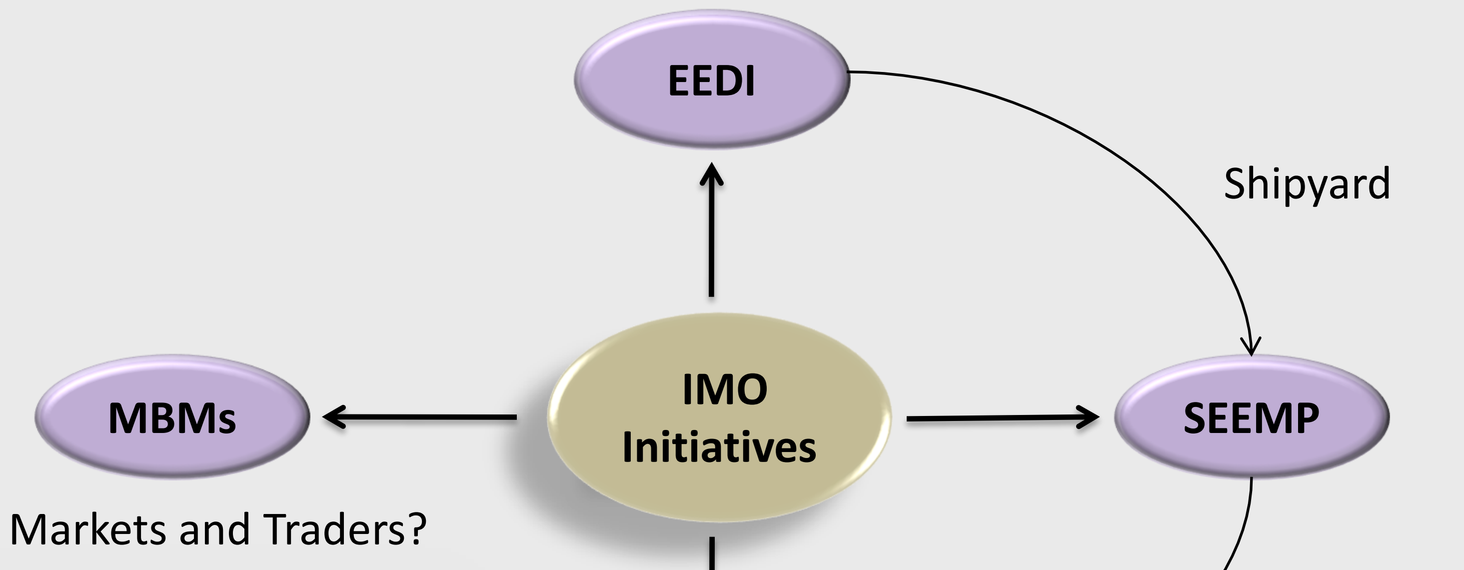
ISO 50001:2011 Energy Management System

- Implementation:
  - Reference to SEEMP
  - Training
  - Design (New buildings)
  - Procurement of energy services / products / equipment (e.g. Energy Star)
  - Monitoring, analysis, evaluation (refer to SEEMP)
  - Internal audits (as per ISM / ISO 14001) – Non-conformities
  - Records (as per SEEMP / ISO 14001 / ISM)
  - Management Review (again ISM / ISO 14001)
- EnMS Application: **Only to shipboard operations**

Commercial Issues – Ship Energy Rating

Section 5

Commercial Issues – Ship Energy Rating



EEDI and SEEMP **mandatory** from 1/1/2013
EEOI **voluntary**
MBMs are currently **under discussion**

Commercial Issues – Ship Energy Rating

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RIGHTSHIP Rating - The SVIS© system searches for a ship by name or IMO number. It then instantly shows key details about the ship and a risk evaluation, from one to five stars.

Vetting Data Entry

Ex Names	
Year Built	2000
Date Built	23/Jun/00
Current Age	11.8 year(s)
Summer DWT	171,199

Note:
1. To vet a ship you **MUST** complete the vetting form and **MUS**
2. If you are just browsing, NO ACTION is required.

Risk Rating	4 ★★★★☆
Action Required	This vessel can be approved by the user. C
Date of Risk Rating	17/Apr/12 18:13

Vetting Data Entry

Ex Names	
Year Built	2003
Date Built	09/Jun/03
Current Age	8.9 year(s)
Summer DWT	52,425

Note:
1. To vet a ship you **MUST** complete the vetting form and **MUST** click the Request Vetting button.
2. If you are just browsing, NO ACTION is required.

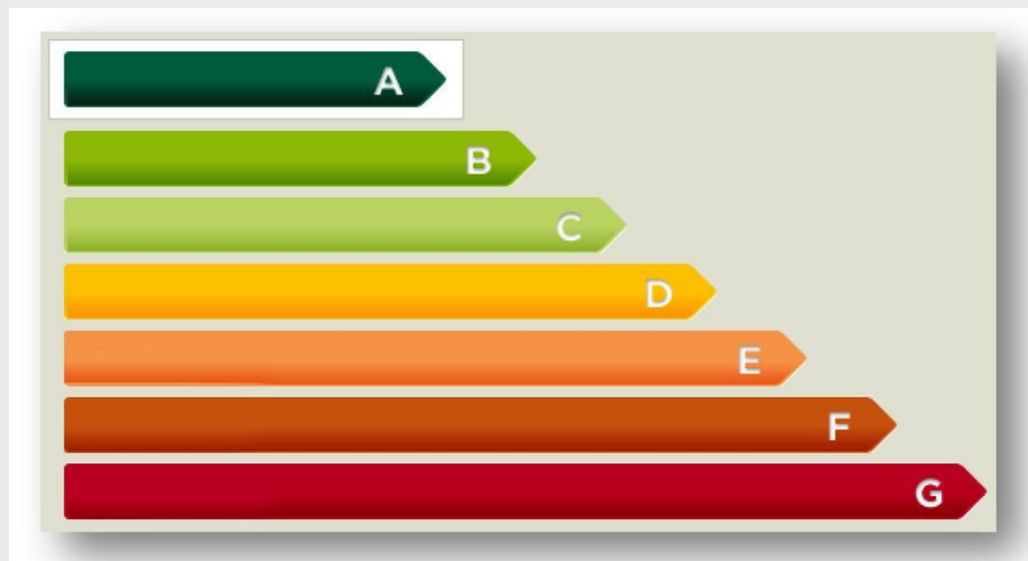
Risk Rating	4 ★★★★☆
Action Required	This vessel can be approved by the user. Click REQUEST VETTING.
Date of Risk Rating	17/Apr/12 18:13

Commercial Issues – Ship Energy Rating

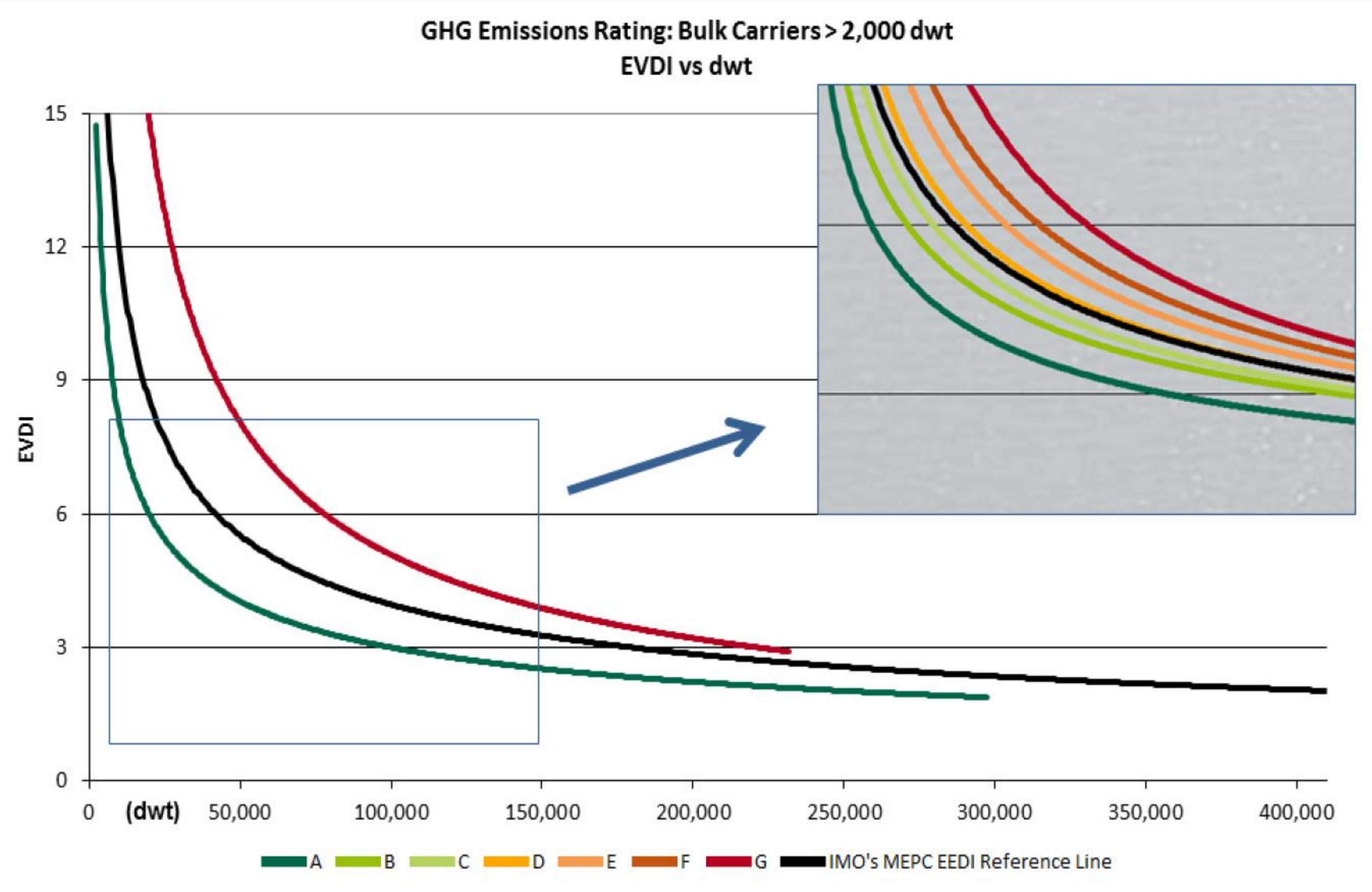
In late 2010, RIGHTSHIP teamed up with Sir Richard Branson's Carbon War Room to create **ShippingEfficiency.org** which provides Energy Rating for Ships, using their own Energy Efficiency Indicator called **EVDI** (Existing Vessel Design Index), based on the EEDI methodology.

RIGHTSHIP + CARBON WAR ROOM → SHIPPINGEFFICIENCY.ORG Information for a more efficient market

A vessel's GHG Emissions Rating is presented using the standard European A – G scale. The efficiency is rated from A through G, the most efficient being A, the least efficient being G.



Commercial Issues – Ship Energy Rating



Commercial Issues – Ship Energy Rating

Vessel Environmental Rating (BETA) Display

Section 1 - Vessel Information

Year Built	2000
Current Age	11.8 year(s)
DWT	171,199
Vessel Type	Bulk Carrier
Hull Type	
Beneficial Owner	
EVDI information verified by Class / Third Party	No
EVDI information verified by Beneficial Owner	No

Section 2.0 - Existing Vessel Design Index (EVDI) HIDE DETAILS

EVDI Ship Type, Comparison Factor	Bulker, DWT
EVDI (grams CO2 per tonne nautical mile)	3.035
In(EVDI)	1.110
EVDI Size Score	-0.399

GHG Emissions Rating

Vessel Environmental Rating (BETA) Display

Section 1 - Vessel Information

Year Built	2003
Current Age	8.9 year(s)
DWT	52,425
Vessel Type	Bulk Carrier
Hull Type	
Beneficial Owner	
EVDI information verified by Class / Third Party	No
EVDI information verified by Beneficial Owner	No

Section 2.0 - Existing Vessel Design Index (EVDI) HIDE DETAILS

EVDI Ship Type, Comparison Factor	Bulker, DWT
EVDI (grams CO2 per tonne nautical mile)	4.799
In(EVDI)	1.568
EVDI Size Score	0.857

GHG Emissions Rating

SHIPPINGEFFICIENCY.ORG
Information for a more efficient market

The GHG Emissions Rating we have calculated is an estimate. This means that the rating is unverified by a classification society or another independent body. The GHG Emissions rating is available for 60,000 vessels and compares each vessel's rating against its ship size and type average.

The vessel's benchmark EVDI Size Score compared to similar vessels is presented as an A to G Rating - so we only compare vessels on a like for like basis. If you are a shipowner, operator or manager and would like to see your own EVDI data on the site or verified by a classification society, please e-mail:

verify@shippingefficiency.org

Commercial Issues – Ship Energy Rating

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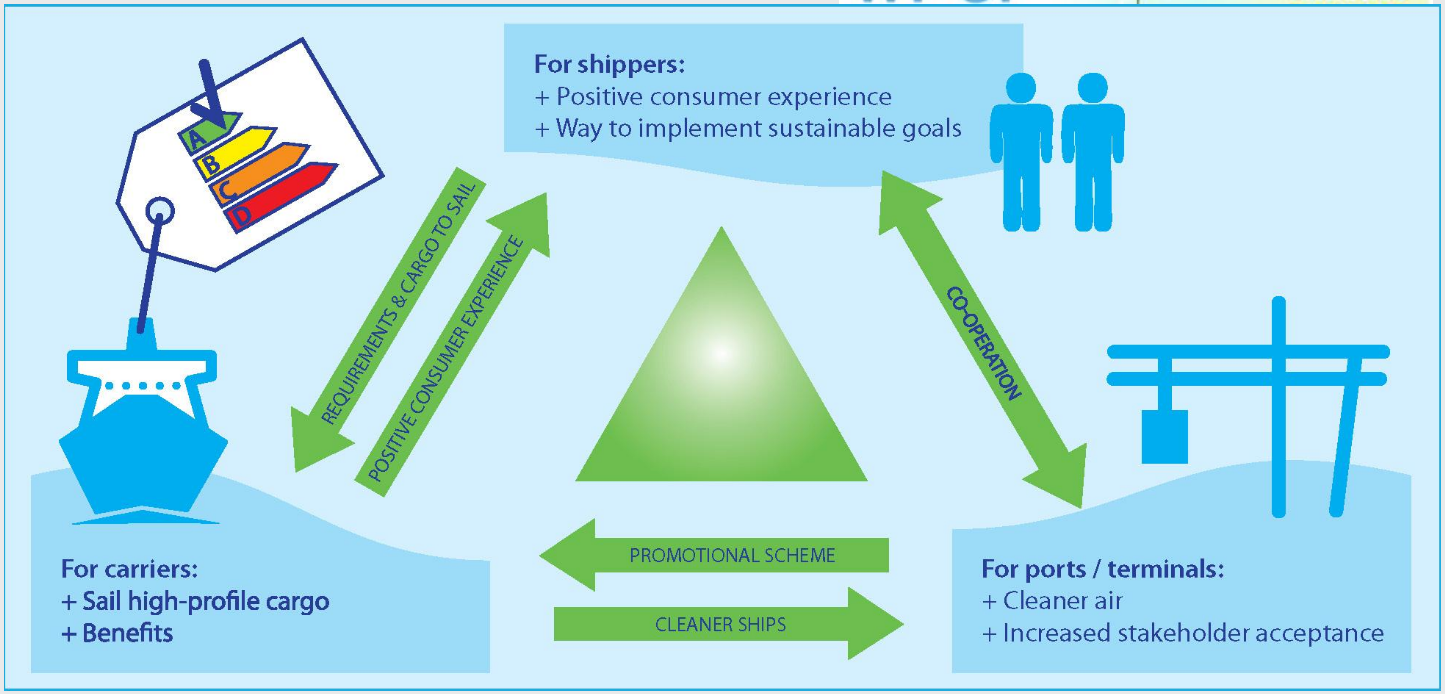
Another Ship Energy Rating scheme has been introduced by the World Ports Climate Initiative (WPCI – lead by the Port of Rotterdam). This scheme rates not only CO_2 emissions from ships (as EEOI and EVDI do), but also takes into account SOx and NOx emissions by use of the **Environmental Ship Index (ESI).**



Environmental Ship Index (ESI)

Calculation Formulas:

World Ports Climate Initiative

$$ESI_{OVERALL} = \frac{1}{3.1}(2 \times ESI\_NOx + ESI\_SOx + RR\_CO_2)$$

$$ESI\_NOx = \frac{100}{\sum_{i=1}^{n} P_i} \times \sum_{i=1}^{n} \frac{(NOx\_limit\_value_i - NOx\_rating_i) \times P_i}{NOx\_limit\_value_i}$$

Where:

P_i is the rated power of engine i

NOx_rating_i is the certified NOx emissions of engine i in g/kWh

$NOx\_limit\_value_i$ is the maximum allowable NOx emissions for an engine with the speed of engine i

n is the number of engines

ESI_NOx can be unequivocally calculated using the EIAPP certificates of the engines onboard a ship. Ships that do not have an EIAPP onboard can not obtain points for ESI_NOx.

Commercial Issues – Ship Energy Rating

Environmental Ship Index (ESI)
Calculation Formulas:

IAPH - PORT ENVIRONMENT COMMITTEE WPCI World Ports Climate Initiative

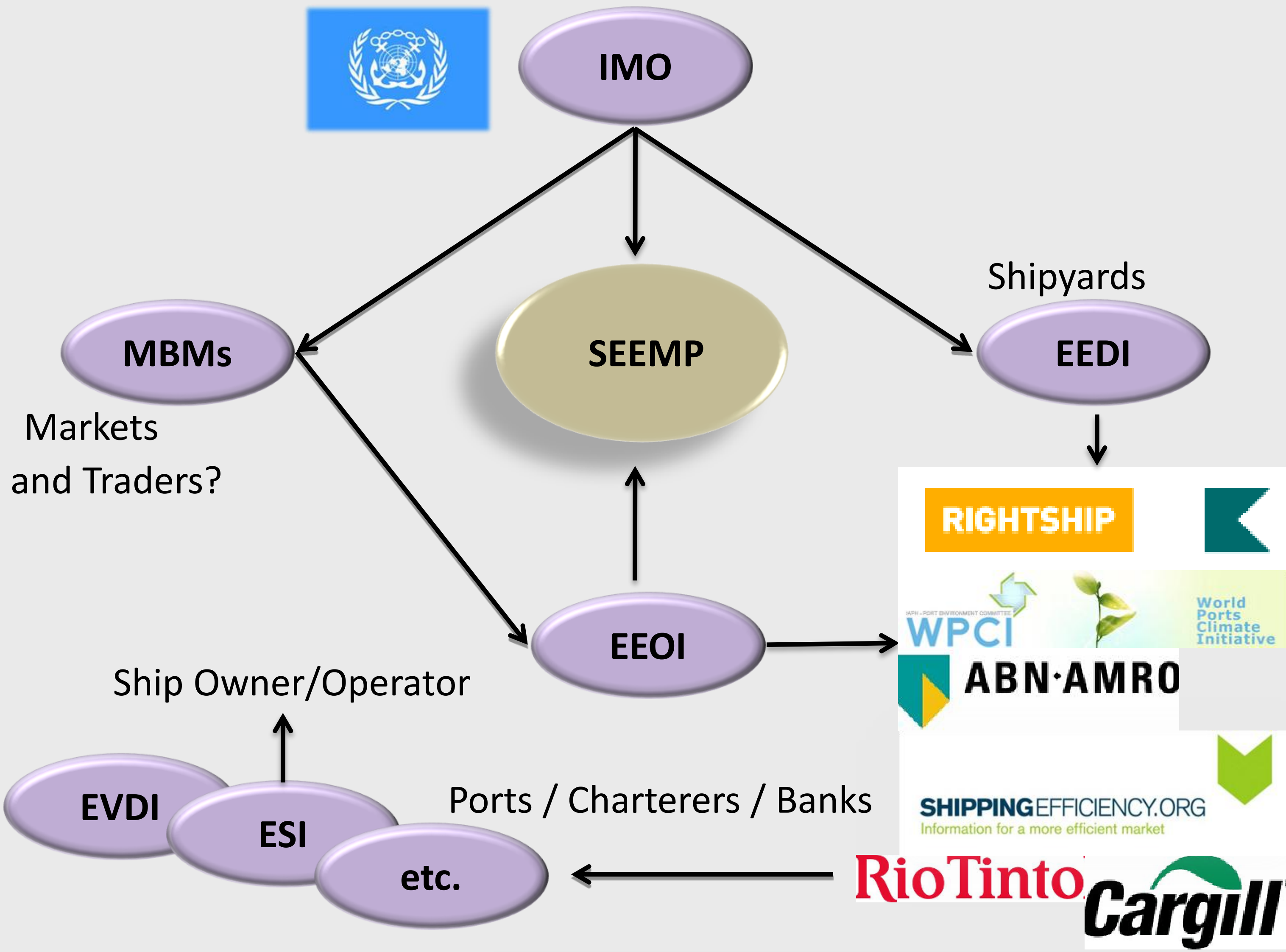
$$ESI\_SOx = a\% \times 30 + b\% \times 35 + c\% \times 35$$

Where:

a = the relative reduction of the average sulphur content of HFO.
b = the relative reduction of the average sulphur content of MDO/Gasoil used.
c = the relative reduction of the average sulphur content of MDO/Gasoil where part of the MDO/Gasoil has a sulphur content <= 0.5 %.

ESI_SOx can be established after inspection of the bunker fuel delivery notes (BDNs) of a ship over the past year.
CO_2 emissions are not reflected in the index directly. However, the ESI gives points to ships that report on energy efficiency with 10 points (EEOI).
The ESI can either be used as a whole, or the different parts for NOx, SOx and CO_2 can be used separately.
Currently **more than 20 ports worldwide and more than 1,400 ships participate** in the scheme.

In a Nutshell:



Alpha Marine Consulting Ltd.

Thank you for your attention

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