EUROPEAN MARITIME SAFETY AGENCY

Unit D – Implementation EU maritime legislation

FINAL REPORT

Study on Ships producing reduced quantities of ships generated waste – present situation and future opportunities to encourage the development of cleaner ships

EMSA /OP/05/05

Report submitted by:

HPTI Hamburg Port Training Institute GmbH
In cooperation with:
TUTech Unit ISSUS Maritime Logistics

EUROPEAN MARITIME SAFETY AGENCY

Unit D – Implementation EU maritime legislation

FINAL REPORT

Study on Ships producing reduced quantities of ships generated waste – present situation and future opportunities to encourage the development of cleaner ships

EMSA /OP/05/05

This report has been prepared by

HPTI Hamburg Port Training Institute GmbH
Überseezentrum, Schumacherwerder
20457 Hamburg
Germany
Tel: +49-40-788 78 0
Fax: +49-40-788 78 178
e-mail: tatiana.eggert@hpti.de

Contents

List of Tables, Figures and Boxes

Tables:

Figures:

Boxes:

List of Annexes

List of Abbreviations

AFS Convention	International Convention on the Control of Harmful Anti-fouling Systems on ships of the IMO
AIS	Automated Identification System
AMP	Alternative Marine Power
ABS	American Bureau of Shipping
BEP	Best environmental practice
BIMCO	Baltic and International Maritime Council
BLG	Bulk Liquids and Gases
BWM Convention	International convention to prevent the spread of harmful aquatic organisms carried by ship's ballast water
CARB	California Air Resources Board
CBT/CAT	Computer Based/Assisted Training
CI	Conversation International
CO, CO_2	Carbon Monoxide, Carbon Dioxide
DC/AC	Direct Current / Alternating Current
DM	German Mark
DNV	Det Norske Veritas
DSC	Digital Selective Call
DWT	Deadweight tonne
ECA	Emission Control Areas
EMAS	European Eco-Management and Audit Scheme
EMS	Environmental management systems
EMSA	European Maritime Safety Agency
EP	Environmental protection → class notation of LR
EPA	Environmental Protection Agency
ESPO	European Sea Port Organization
FoC	Flags of convenience
FSC	Flag state control
GL	Germanischer Lloyd
GRT	Gross registered tons
HC	Hydrocarbons
HELCOM	Helsinki Commission
HFO	Heavy Fuel Oil
IACS	International Association of Classification Societies
ICCL	International Council of Cruise Lines
ICS	International Chamber of Shipping
IMDG-Code	International Maritime Dangerous Goods Code
IMO	International Maritime Organization
INTERCARGO	International Association of Dry Cargo Shipowners
INTERTANKO	International Association of Independent Tanker Owners
IPSEM	International Port Safety & Environment Protection Management
ISM Code	International Ship Management Code of the IMO
ISO	International Standard Organisation
ITF	International Transport Workers' Federation
kW	Kilo watts
LAN	Local Area Network
LNG	Liquefied natural gas
LR	Lloyds Register
MARPOL 73/78	International Convention for the Prevention of Pollution from Ships, 1973, as modified by the Protocol of 1978 relating thereto

MDO	Marine Diesel Oil
ME	Main engine
MEPC	Maritime Environmental Protection Committee of the IMO
MGO	Marine Gas Oil
MJ	Mega Joule
MOU	Memorandum of Understanding on Port State Control
MSC	Maritime Safety Committee of the IMO
MSD	Maritime Sanitation Device
MW	Mega Watts
NG	Natural Gas
NLS	Noxious liquid substances
NTSB	National Transport Safety Board (U.S.)
NOAA	National Oceanic and Atmospheric Administration (U.S.)
NO_x	Nitrogen oxides ,various possible oxides of nitrogen, NO, NO_2, NO_3 and NO_4, of which NO_2 is the main emission of concern
OECD	Organisation for Economic Co-operation and Development
OWS	Oil Water Separator
PAWDS	Plasma Arc Shipboard Waste Destruction System
PM	(diesel) particulate matter
PSC	Port State Control
PCTC	Pure car and truck carrier
RCCL	Royal Caribbean Cruise Line
RINA	Registro Italiano Navale
RO	Residual Oil
Ro/Pax	Roll on, roll off cargo and passengers
RoRo	Roll on, roll off
SBT	Segregated ballast tank
SCR	Catalytic exhaust emission control
SECA	SOx Emission Control Area
SEK	Swedish kroner
SERS	Ship Emergency Response Service of LR
SMA	Swedish Maritime Administration
SO_x	Sulphur oxides
SOFC	Solid Oxide Fuel Cell
TBT	Tributyl tin
ToR	Terms of Reference
TUP	Tariff on port use
USGC	United States Coast Guard
VDR	Verband Deutscher Reeder
VOC	Volatile organic compounds
VSRP	Voluntary vessel speed reduction program
WBS	White Box System
WMU	World Maritime University
WOR	Waste Oil Regeneration

0. Executive Summary

(1) Introduction

The European Commission highlights in its Directive 2000/59/EC that "*ships producing reduced quantities of ship-generated waste should be treated more favourably in the cost recovery systems. Common criteria could facilitate the identification of such ships*" (Preamble 15), and that "*fees may be reduced if the ship's environmental management, design, equipment and operation are such that the master of the ship can demonstrate that it produces reduced quantities of ship-generated waste*" (Article 8 (c)). Considering the tough international competition in the shipping industry, it is of great importance to identify these "common criteria" which should be, at best, applicable in all European ports alike, in order to avoid distortion of competition.

Surveillance and control of environmental and marine pollution by the shipping industry is regulated by international conventions and national legislation, which form the "bottom line" of requirements for legal shipping. Economic incentives can serve as a complement to these obligatory measures to further prevent pollution from ships. Therefore, some of the Member States of the European Union as well as other countries worldwide have chosen to implement incentive schemes to promote the use of "cleaner" ships.

These incentive schemes, which are based on advanced technology or on best operational and environmental practices, or on both, provide either a direct monetary benefit to the vessel operator (e.g. reduced harbour dues), or an indirect benefit by requiring less stringent controls (e.g. Port State Control), or by using it as a marketing tool.

In this context, the European Maritime Safety Agency EMSA has decided to launch the "*Study on Ships producing reduced quantities of ships generated waste – present situation and future opportunities to encourage the development of cleaner ships*" in order to "*obtain an inventory of the green technologies (available and prototypes), the management systems and the incentives already existing to identify criteria and propose to the European Commission Guidelines that could be used in cooperation with Member States in defining environmental performance of a ship and to establish a basis for incentive schemes that contribute in making 'green shipping' profitable*".

(2) Inventory of Technical Equipment

The report provides an inventory of existing state-of-the-art technology as well as for new and innovative technical developments as new energy sources like fuel cells, and also pioneering ideas like building a zero-emission cargo ship, etc.

The results revealed during the investigations are classified according to their contribution to meet the requirements of the Annexes I to VI of the MARPOL Convention. State-of-the-art methodology and equipment and new methodologies, prototypes and new equipment are listed, and, wherever feasible, their prices and the possibility for retrofitting older vessels as well are described.

New systems and developments that aim to help vessels to comply with international regulations and at the same time enhance efficiency of operation are discussed, inter alia

- White Box System (WBS)
- DC-WOR System (waste Oil Regeneration)
- Poseidon Grey and Black Water Treatment
- PyroGenesis
- Zero Emission Car Carrier
- SkySails
- Siemens SISHIP Fuel Cell Air for cargo and passenger vessels
- Superconductivity onboard of vessels
- Wärtsila's Fuel Cell Technology
- LNG Powered Ferries

(3) Best Operational Practices

A number of environmental measures, which go beyond existing regulations, voluntarily taken by various stakeholders of the shipping industry are described, ranging from simply "common sense" or "good housekeeping" measures, to more sophisticated systems based on ISO elements.

The term "Best Environmental Practice" (BEP) is introduced, in the sense of the "application of the most appropriate combination of environmental control measures and strategies"[1].
BEP measures discussed are:

[1] Convention for the Protection of the Marine Environment of the North East Atlantic (1992)

- The "Poseidon Challenge" or "Zero Concept" as an integrated concept
- Fuel saving measures, reducing waste according to MARPOL Annex I and VI, like:
  - Optimum speed
  - Speed reduction and speed control
  - Fuel quality management
  - New kinds of hull paint and underwater cleaning
- "Alternative" Fuel concepts, also reducing waste according to MARPOL Annex I and VI:
  - Biodiesel
  - "Dual Fuel"
  - Liquefied Natural Gas (LNG)
- "Cold Ironing"
- Waste Management, primarily reducing waste according to MARPOL Annex I and V
- Ballast water management,

For the majority of BEP measures it is hardly possible to proof compliance, as they are based on environmental conscious behaviour of ship management and crew.

For some of these measures, however, compliance can be determined by presenting the respective documents, as for example:

BEP-Measure	Proof
Fuel Quality Management:	▪ Delivery notes for the fuel oil containing information on the sulphur content ▪ Receipt of fuel supplier ▪ Fuel analysis report
Biocide-free Hull Paint:	▪ Specifications by the manufacturer ▪ Documentary proof of application through the certificate issued in accordance with the AFS Convention (International Convention on the Control of Harmful Anti-fouling Systems on ships) and EU Regulation (EC) No 782/2003. The certificate is the same for TBT-free and biocide-free hull paints, but the type of paint is specifically mentioned in the certificate.
Waste Management	▪ Entries in Garbage Record Book ▪ Documentary proof of disposal on land ▪ Notification form

In voluntarily complying with international standards like ISO 14001 or EMAS (European Eco-Management and Audit Scheme), a number of vessel operating companies demonstrate and document that they

- comply with environmental regulations, and
- take substantial steps in improving their environmental performance.

(4) Environmental Management System (EMS)

Participating in an internationally accepted EMS like EMAS or ISO 14001 is generally to be considered as beneficial, as it signifies that the respective institution of the shipping industry is conforming to all the regulatory environmental standards, and additionally, sets targets for continuous improvement of its environmental performance. Consequently, a number of shipping lines have been found to be certified, most of them (48) according to ISO 14001, whereas only one shipping line has decided to be certified according to EMAS standards.

The benefits gained by an EMS can be realised focussing of five different categories:

- Environmental benefits:
  An EMS specifies the process for controlling and improving the company's environmental performance.

- Legal benefits:
  One benefit of implementing an EMS is that it ensures the company's compliance with environmental laws and regulations, thus avoiding charges or fines for non-compliance.

- Economic benefits:
  Companies which implement EMS often achieve improved efficiency and cost savings as benefits. By reducing any environmental impacts (e.g. reducing fuel consumption and waste generation), cost savings often follow.

- Marketing benefits:
  An “enhanced corporate image” is a further benefit of an EMS, which might lead to better competitiveness, and stronger customer satisfaction.

- Safety benefits:
  As operational procedures are included in an EMS, involving all people concerned (e.g. the crew of a ship), in-depth reviews of procedures for monitoring

significant operations, including a review of emergency preparedness and response procedures, have to be carried out accordingly. Furthermore, an EMS should include awareness building and regular training. This will lead to significant safety improvements.

The publicly available Environmental Reports provide a clear and transparent picture of the environmental targets to be reached within a defined period of time.

(5) Inventory and Analysis of the Different Economic Incentives

An inventory of the different economic incentives for ship operators (like offering reduced port dues and other direct financial incentives, such as reduced pilotage fees, waste reception charges and insurance premiums to ships and shipping companies that meet certain criteria) and other initiatives as awarding systems without a direct pecuniary value, which give positive publicity for environmentally responsible shipping is elaborated.

An in-depth review of central initiatives given in the report comprises:

- The Green Award
- The Bonus / Malus System as applied e.g. in Sweden
- The U.S. Coast Guard Qualship 21
- The "Blue Angel"
- Environmental Class Notations and
- The Green Passport of the IMO

(5.1) The Green Award:

The Green Award is the only international certification and incentive scheme, as it is applied in roughly 40 ports in seven different countries, not only in Europe, but also in South Africa and New Zealand. It is well known also in Canada, Australia and Japan. It offers economic incentives in the form of reduced port dues/fees and reduced fees for related vessel services including waste reception, training courses and pilotage fees.

This award is not only based on the technical qualities of the ship, but also on the qualities of its crew and management. Different basic and ranking lists are used for audit and inspection.

However, in contrast to being well known, implementation is low: only 196 vessels are certified at present, all of them are oil or product tankers.

Reasons for this low acceptance might be that the system is

- too complicated, surveyors need a special training before auditing
- limited to tankers and bulk vessels only
- limited geographical application: Certified vessels get discounts in participating ports only

The Green Award certificate is valid for a period of three years.

The GREEN AWARD – participating ports and port states
Source: www.greenaward.com

Country	Port	Incentive
Belgium	Port of Ghent	6% premium on the port fees for Crude oil / Product Tankers and for Dry Bulk Carriers
Lithuania	Klaipeda State Seaport	5% premium on vessel dues for Crude oil / Product Tankers
New Zealand	Westgate Port Taranaki	5% discount on its marine tariff for any Green Award vessel
Portugal	Porto de Sines	5% premium on Tariff of port use (TUP) for Crude oil / Product Tankers
	Portos do Douro e Leixões	3% premium on Tariff of port use (TUP) for Crude oil / Product Tankers
	Porto da Lisboa	5% premium on Tariff of port use (TUP) for Crude oil / Product Tankers
	Porto de Setúbal	3% premium on Tariff of port use (TUP) for Crude oil / Product Tankers and for Dry Bulk Carriers
South Africa	National Ports Authority of South Africa, Ports of Richards Bay, Durban, East London, Port Elisabeth, Mossel Bay, Cape Town, Saldanha	5% port dues rebate in all South African national ports, if not enjoying already a 5% rebate in terms of double-hulled / SBT scheme.
Spain	Puertos del Estado (Bilbao, Santander, A Coruña, Huelva, Bahia de Cádiz, Bahía de Algeciras, Málaga, Cartagena, Valencia, Castellón, Tarragona, Barcelona, S.C. de Tenerife and other ports)	As from 1st January 2004 a new port law has become effective in Spain. The reimbursement for Green Award certified vessels has been postponed until after implementation of modifications to the new law. (clarification sought from ESPO)
The Netherlands	Port of Amsterdam	6% premium on the port fees for Crude oil / Product Tankers and for Dry Bulk Carriers
	Port of Rotterdam	6% premium on the port fees for Crude oil / Product Tankers
	Zeeland Seaports (Vlissingen, Terneuzen)	6% premium on the port fees for Crude oil / Product Tankers
United Kingdom	Port of Sullom Voe (Shetlands)	5% reduction on the payable harbour dues for Crude oil / Product Tankers

(5.2) The Bonus / Malus System

The Bonus / Malus system, as it is applied in Sweden, is offering reduced harbour and fairway dues, differentiated according to the ship-generated emissions of NOx and SOx. This philosophy of differentiated dues does not find universal acceptance: The Australian Marine Environmental Protection Agency (AUSMEPA), for example, stated that "*Australian ports have consistently rejected the concept of reduced port fees for quality and environmentally conscious ships....Their view being that if port fees are discounted for some ships other ships will need to pay higher fees than the service provided is worth.*"

The advantages and disadvantages of the system can be summarised as follows:

Pros	Cons
▪ High environmental benefits with regard to reduction of air pollutants ▪ High monetary incentive for high standard vessels ▪ Very transparent system	▪ Limited to air pollution only ▪ Vessels of lower standard pay a "malus" thus paying more on fairway and in the port than the service provided is worth

As the system is more or less restricted to air pollution only, it can be easily controlled:

SOx-Emission:
The installation of catalytic converters is controlled by SMA inspectors, who are also checking the bunker receipts for controlling the use of low-sulphur fuel. Furthermore, fuel analysis are carried out by different Swedish laboratories.

NOx-Emission:
Measures to reduce NOx-emissions are controlled and certified by an independent accredited control laboratory.

The certificate is renewed after three years.

(5.3) The U.S. Coast Guard- Qualship 21

For awarding the Qualship 21 certificate, the US Coast Guard checks all foreign vessels with regard to:

- The vessel's performance at complying with standards. The vessel may not have been detained and determined to be substandard in U.S. waters within the previous 36 months.

- The vessel's violation history. The vessel may not have had any marine violations, any reportable marine casualties that meet the definition of a serious marine incident, or any major marine casualties in U.S. waters within the previous 36 months. Also, the vessel may not have had more than one paid notice of violation case (ticket) during the same period.
- The vessel's recent inspection history. The vessel must have completed a successful U.S. Coast Guard Port State Control examination within the previous twelve months.
- The vessel's flag state. Although QUALSHIP 21 is a vessel-focused initiative, the flag state is a relevant factor in identifying quality ships. To qualify for a QUALSHIP 21 designation, a vessel may not be registered with a flag state that has a detention ratio that is greater than one third of the overall U.S. detention ratio, as determined on a three-year moving average
- The vessel's flag state must have submitted its self-assessment of flag state performance to the IMO and have provided a copy of the self-assessment to the United States

All Qualship 21 designated vessels will receive a Certificate, issued by the Office of Compliance staff. This certificate has a maximum 2-year period of validity.

(5.4) The "Blue Angel"

As the requirements for awarding the "Blue Angel" are based on already existing certified systems, compliance can easily be demonstrated by presenting the respective documents.

Ten binding and at least 3 out of 20 optional requirements have to be chosen to be awarded.

Examples:

Requirement / *proof*	**Obligatory**	**Optional**
Quality Management:	▪ ISM Code	▪ ISO 9001
proof:	▪ *ISM Certificate*	▪ *Certificate of ISO 9001 compliance*
Personnel Management	▪ ITF-tariff provision or equal standard	▪ language proficiency
proof	▪ *Blue Card or valid ITF contract document*	▪ *passed IMO language test*

The advantages of this system are, inter alia, that:

- the criteria are applicable to existent and new ships as well as to different ship types.
- management instruments as well as social conditions, operation and technology are covered.

Environmental benefits can be summarised as follows:

A Blue Angel ship emits only half of its previous SOx-emissions (by obligation) or even about 85% less (optional). The NOx emissions will be reduced by 20 % (obligatory) or by more than 50 % (optional).

Despite being uncomplicated and transparent, this system has a very low acceptance in the shipping industry, at present there is only one shipping line having its vessel certified.

(5.5) Class Notation

Even though the fundamental objective of vessel classification is to promote safety, several classification societies have broadened their scope by offering a special class notation to vessels that comply with requirements for environmentally safe design, construction, and operation, which go beyond the requirements of MARPOL. The following table gives an overview about the environmental class notations discussed in this study.

Classification Society		Class Notation
American Bureau of Shipping	ABS	Environmental Safety (ES)
Det Norske Veritas	DNV	"Clean" "Clean Design"
Registro Italiano Navale	RINA	Green Star "Clean Air" Green Star "Clean Seas"
Lloyds Register	LR	Environmental Protection (EP)

Environmental Class Notations

(5.6) The Green Passport

In order to make sure that the recycling of ships is carried out in an environmentally friendly manner, the IMO adopted "Guidelines on Ship Recycling" in 2003, introducing the "Green Passport".

The Green Passport is a document that contains guidelines and details of all potentially hazardous and high-risk materials on board a vessel. It should accompany the ship throughout its whole operating life. New owners of the vessel are obliged to maintain the accuracy of the Green Passport and to incorporate it into any relevant design and equipment changes. At the end of the vessel's life, the final owner would present it to the scrapping yard.

Examples of acceptance in the shipping industry are given in the study.

(6) Evaluations of Results and Findings

Analysis of all measures and discussion of the strong points and possible draw-backs of all systems and initiatives leads to the following conclusions and recommendations when composing a European system to enhance environmental performance of ships:

A European "Clean Ship" Award System for environmental-conscious ship operation should be implemented that is comprehensive, complete, flexible and of high public visibility. The "Blue Angel" label award is a suitable candidate.

- A "data pool" should be established, a knowledge network administration entity to identify relevant centres of excellence, associations and best practice operators. Their competence should be linked to this virtual knowledge pool.

- A "help desk" will make it easier for small and medium shipping companies, which are clearly overstrained to continuously monitor and assess technical developments and best practice solutions

- A wide variety of combinations of all kind of measures exists, from technical and organisational measures to attitudes. Therefore, in order to provide incentives, no individual measures should be assessed but the overall environmental balance of the vessel (integrated approach).

- The incentive system must motivate for continuous improvement within the range of feasible and reasonable measures.

There must be a system to finance all costs for the a.m. measures equally within all EU member states and states associated to the programme. A solution distinct from port to port is not reasonable and will impede competition between ports. From the study results the Swedish approach to first impose dues (fairway dues) to all ships to

then be able to reduce fees for the green ships appears to be the most favourable approach.

Chapter 1: Introduction and Scope

Maritime transport has – compared to other modes of transport – the standing to be environmental friendly, as it has comparatively low demands on infrastructure, and ships can transport large quantities of goods at low energy consumption.

But nevertheless, the world's oceans are increasingly polluted by ships' illegal and legal discharges of waste, including oil, garbage, toxic paints, cargo residues and hazardous substances. This is mainly due to the international character of shipping which has let to an exemption from a large portion of the environmental demands put on land based means of transport and enterprises.

The discharge of waste and other vessel generated pollutants is regulated by international standards set by the International Maritime Organization (IMO), its Maritime Safety Committee (MSC) and its Maritime Environmental Protection Committee (MEPC). Even though this regulatory framework – the MARPOL 73/78 Convention in particular – has been expanded over time in line with the awareness of the various environmental impacts caused by the shipping industry, it is often considered to be the "lowest common denominator", which could be found among the IMO Member States, and therefore to be a "minimum standard" to allow for a legal operation of ships.

However, despite the relatively low international requirements and despite increasing vessel controls, there are still vessel operators intentionally breaking the rules ("sub-standard" vessel operators). Actually, they are virtually "rewarded" for doing so, as savings gained from non-compliance with IMO's regulations lead to lower operation costs for the vessels. This may lead to an unfair advantage in the extremely competitive shipping market. As marine litter, for example, is concerned, the Annex V of MARPOL 73/78 prohibits the dumping of any kind of litter in the North Sea, but nevertheless 20,000 tonnes of marine litter are dumped there by shipping annually[2] to avoid disposal charges in the EU ports.

The European Commission highlights in its Directive 2000/59/EC that "*ships producing reduced quantities of ship-generated waste should be treated more favourably in the cost recovery systems. Common criteria could facilitate the identification of such ships*" (Preamble 15), and that "*fees may be reduced if the ship's environmental management, design, equipment and operation are such that the master of the ship*

[2] Implementing the Clean Ship Approach: Closing the gap between what is possible and what is required by law *Eelco Leemans, Seas at Risk* - seminar "Mind the Gap" at Svenska Mässan Conference Center, Gothenburg, 3 May 2006.

can demonstrate that it produces reduced quantities of ship-generated waste" (Article 8 (c)).

Considering the tough international competition in the shipping industry, it is of great importance to identify these "common criteria" which should be, at best, applicable in all European ports alike, in order to avoid distortion of competition.

In order to take substantial steps in improving the environmental performance of the maritime industry, a new approach towards the use of best available technology and/or management practices has been introduced in several countries and ports around the world. By now, a wide range of "green shipping" initiatives exists, but only few of them are compatible.

1.1 Scope and Objective of the Study

Regarding this background, the European Maritime Safety Agency EMSA has decided to launch the "*Study on Ships producing reduced quantities of ships generated waste – present situation and future opportunities to encourage the development of cleaner ships*" in order to "*obtain an inventory of the green technologies (available and prototypes), the management systems and the incentives already existing to identify criteria and propose to the European Commission Guidelines that could be used in cooperation with Member States in defining environmental performance of a ship and to establish a basis for incentive schemes that contribute in making 'green shipping' profitable*".

To reach this aim, the measures taken by the maritime industry (marine equipment manufacturers, shipping lines and managers, port authorities, etc.) should be investigated.

These measures which go beyond the regulatory requirements are based on:

- Technology, which is the pre-condition for clean shipping. This includes a broad range of technological developments, ranging from new materials, more efficient propulsion, catalysts, to innovative hull design, etc.;
- Best operational practice and/or management systems, as awareness rising has to go in line with the technical development in order to be effective;
- Compliance with environmental best practices, proven by documents and international certificates (e.g. EMAS, ISO 14001);
- Financial or other instruments as incentives to encourage "clean" shipping. These incentives are either monetary or non-monetary. Examples could be: positive criteria for Port State Control, good publicity, which leads to better im-

age in public or more charter orders, lower insurance costs, differentiated harbour dues, etc.;

The variety of measures shows that the identification of "common criteria" for environmental performance, as proposed in the Directive 2000/59/EC, is not an easy task. In practice the "clean ship" concept consists of an integrated model covering more than one, if not all, of the aspects mentioned above: management, design, equipment, and operation. Furthermore, looking at the wide range of concepts and measures, it is often difficult to quantify the benefits of such "clean ships" initiatives, as direct environmental and economic advantages are at times difficult to substantiate.

Therefore, guidelines on common criteria of economic and/or other incentive approach are elaborated in this study, addressing the variety of aspects mentioned above.

1.2 Terms of the Study

According to the Terms of Reference (ToR), the study consists of six tasks (see table 1 next page).

This Final Report provides the results of the study on "Ships Producing Reduced Quantities of Ship Generated Waste – Present Situation and Future Opportunities to Encourage the Development of Cleaner Ships" carried out by HPTI Hamburg Port Training Institute and ISSUS Maritime Logistics on behalf of the European Maritime Safety Agency EMSA.

#	Task	Points to be addressed
1.	**Produce an inventory of the technical equipment available in the market and prototypes placed on board for testing, if any**	a) Inventory of technical equipment available b) Information about investment and operation costs for different types of technologies in relation to MARPOL 73/78 waste categorisation c) Estimate of the potential for exceeding the MARPOL 73/78 standards in reducing quantities of waste d) Benefits for environment (reduced discharge) e) Availability of technology to different types of ships, new – old ships, practicalities of installation and usage of equipment (by ship types, new/old ships) f) Prototypes for all types of wastes falling in the scope of MARPOL 73/78
2.	**Identify the best operational practices and environmental management systems which result in reduced waste production**	a) Best operational practices b) Environmental Management Systems (EMS)
3.	**Determining compliance, based on the existing and possible practices**	a) Certification and documentation b) Class notation c) Proof of compliance, enforcement, monitoring requirements, updating criteria
4.	**Obtain an inventory and a detailed analysis of the different economic incentives**	a) Inventory of the different economic incentives b) Analysis of the different economic incentives
5.	**Draft guidelines on common criteria of economic and/or other incentive approach**	
6.	**Draft final recommendations on the best common economic and/or other incentive based framework in relation to green technology (equipment) and best operational and management practice (port waste fee, port dues, fairway dues, infrastructure charging etc.)**	

Table 1: Tasks to be performed in the Study

1.3 Approach

Results and findings of this study are based on data collection, desk analysis and inquiries. At a very early stage of these investigations it became obvious that a lot of information is available, however, it tends to be random and often complicate to access.

Different methods were used to collate data and information. Primary source for information was the Internet. Furthermore, representatives of the following organisations have been contacted, by e-mail and / or by phone / fax:

- Maritime Equipment Manufacturers

- Classification Societies
- Shipping Lines
- Different Seaports
- Environmental Authorities

Furthermore, leading shipping personnel and management representatives of different shipping lines have been interviewed in order to get insight into their problems from an operational view.

First-hand information on technical and operational innovations have been obtained from international conferences and fairs which took place within the study time (Green Ship Technology, Hamburg, March 2006, SMM shipbuilding – machine & marine technology international trade fair, Hamburg, September 2006, Green Shipping World Conference, Copenhagen, October 2006). A list of contacted persons and organisations is linked to this study (see: link contacts1).

1.4 Report Organisation

The main part of the study is divided into two sections. The first following section (Chapter 2: Results and Findings) provides an inventory of measures (including technical equipment) and initiatives (incentive programmes, awarding systems), parallel to a description of the different approaches undertaken by the various stakeholders: the shipping industry, authorities, classification societies etc., and their common rationale focusing on the improvement of the environmental performance of vessels.

In the second section (Chapter 3: Appraisal and Recommendations), the findings are evaluated, and the benefits and draw-backs of each measure and initiative are discussed, in order to derive guidelines and recommendations from the experiences gained.

In the final chapter of the report, problems encountered in the run of the study are described.

Together with this print-out version, an electronic version of the study is provided on a CD. References, which the Consultants consider important as useful background information or further explanatory details, are linked with the text and are available on the CD.

Chapter 2: Results and Findings

2.1 Inventory of Technical Equipment

Historically, ship board waste was disposed of over board. In 1973, the International Convention for the Prevention of Pollution from Ships was adopted by the International Maritime Organisation.

Proper technical facilities are a pre-condition to environmentally clean shipping. Through purchasing and applying appropriate new equipment and safety systems, a vessel operator can clearly demonstrate his commitment to an environmentally responsible operating strategy.

This chapter will provide information on a broad range of existing technology and new and innovative technical developments which covers new materials, revolutionary hull design, new propulsion systems, new energy sources like fuel cells, and also pioneering ideas like building a zero-emission cargo ship, etc.

The results revealed during the investigations are classified according to their contribution to meet the requirements of the Annexes I to VI of the MARPOL Convention. State-of-the-art methodology and equipment are shown in Annex I, table 1 and new methodologies, prototypes and new equipment in Annex I, table 2. Some equipment classified according to a MARPOL Annex might as well contribute to fulfil the requirements of another MARPOL Annex such as incinerators. The equipment is listed once in the MARPOL Annex where it contributes most to fulfil the requirements. Where possible, the investment and operation costs as well as the practicability of installing and using the equipment in new and old ships are shown. It is very difficult to retrieve investment and operation costs for mainly two reasons:

- Most of the equipment must be customised and therefore the prices are an issue of negotiation
- Some maker's policy is to provide commercial information only to ship owners as potential buyers.

Spreadsheet files with links to more detailed information are provided as part of the report (see Annex 1 of the report).

2.1.1 State-of-the-Art Equipment

A brief explanation of the MARPOL Annexes and their requirements[3] is included in the classification of equipment:

2.1.1.1 Annex I: Regulations for the Prevention of Pollution by Oil

Annex I requires an oil-water separating system. Since 1 January 2005 all new buildings have to be equipped with an MEPC 107(49) compliant Bilge Oily Water separating system with an oil content monitor.

The main components of such a system are:

- Bilge pump
- Oily-water collection tank
- Oil-water separating device (OWS)
- Piping to the OWS
- An overboard discharge pipe out of the OWS connected to an oil content monitor
- A two-way shut-off valve on the discharge pipe capable of shunting any discharge over 15 ppm back into the oily water collection tank
- Piping for extracting oil from the OWS
- Oil collection/slops tank for oil extracted by the OWS.

The regulation MEPC 107(49) was introduced because the previous devices compliant with the former regulation MEPC 60(33) did not reduce the concentrations of emulsified to the 15 ppm level. The pump type used affects the emulsification characteristics of the oil/water mixture and therefore the performance of OWS. Pumps running at a lower speed will cause less emulsification of the bilge. This may be less efficient because the emulsification of the oils will be reduced, but in this case a gravity separation OWS can be applied. The pump type and the operating conditions influence the OWS performance.

OWS costs range from USD 10.000,- to more than USD 100.000,-[3]. The simplest system is a parallel plate system and the most advanced ones are composed of a membrane system with a centrifuge pre-treatment unit.

[3] Cost Savings Stemming from non-compliance with international Environmental Regulations in the maritime sector, Maritime Transport Committee, pages 18-32.

An OWS system for a 4,000 TEU container vessel with a crew of 18 would cost around 17,000 USD.

Maintenance costs for an OWS are from USD 3 000 per year upwards.

2.1.1.2 Annex II: Regulation for the Control of Pollution by Noxious Liquid Substances in Bulk

Annex II sets specific discharge requirements for tank wash water of chemical tankers. Furthermore, ships carrying noxious liquid substances in bulk must be designed and approved for the class of chemicals they are carrying.

To comply with Annex II discharge requirements a functioning discharge recording equipment that can record the time, date and flow rate and duration of the discharge is required onboard. If the equipment fails during operation, rinse water must be kept onboard and discharged into an appropriate port waste reception facility.

2.1.1.3 Annex III: Prevention of Pollution by Harmful Substances Carried by Sea in Packaged Form

To comply with Annex II, carriers are required to have a plan for the storage of harmful substances in packaged form onboard and keep a manifest of dangerous and/or harmful packaged cargoes onboard.

2.1.1.4 Annex IV: Prevention of Pollution by Sewage from Ships

Annex IV aims to reduce the sanitary risk from "black water" (discharges containing human, animal and/or medical wastes) and “grey water” (waste water from showers, sinks, washing machines, etc.). The vessels have to carry an International Sewage Pollution Certificate which is usually issued for a period of five years and implies a periodical survey of the ship's sanitation and piping systems.

In the cruise industry, the most advanced wastewater purification systems are used. The most common systems use biological reactors in which waste particles are broken down and consumed by bacteria. The reactor has a fix-film media that provides the bacteria with a surface on which to attach themselves. Afterwards, the waste stream is mechanically and chemically processed to remove the remaining solids from the water, and then the water is pumped through an ultraviolet light reactor for

disinfection before being discharged. The solids are sent to a holding tank and afterwards incinerated. The most advanced systems have membrane fibres that are submerged within the biological reactor to create a physical barrier between the water and the small particles of solid materials. Using a slight vacuum, water is pulled through the membranes filtering out the bacteria that have been generated in the process. This stream is afterwards treated by ultraviolet light as in the other systems.

A wastewater treatment system for a 4.000 TEU vessel with 18 persons onboard costs around EUR 270.000,-. Further costs are installation and assembling costs. Crew training for the operation costs around EUR 4.000,-.

2.1.1.5 Annex V: Prevention of Pollution by Garbage from Ships

Annex V does not require ships to have any equipment to process garbage. Nevertheless, if a vessel has such equipment the requirements can be found in this MARPOL Annex.

Waste processing onboard allows a flexible storing and disposing of waste onboard and helps to reduce port waste reception fees which are already costly. On the other hand storage of ship generated waste requires valuable space on board.

Incinerators also may solve the onboard storage problem. However, a certain level of maintenance and manpower as well as fuel oil is required for their operation.

In the following, an example for estimated operation cost for an Atlas Incinerator, Type 600 SL WS P, of a combustion capacity of 500,000 kcal/h is given:

Waste burning capacity:

- Oil Sludge: 66 l/hour with 20 % water (max. 100 L/H)
- Solid Waste: 100 kg/h

Required marine diesel oil:

- 30 Liter per start
- 200 Starts per year
- Price: Euro 200 per 1.000 Liter

Total costs:

- Marine diesel - 200 starts x 30 l x 0,2 €/l = € 1,200
- Spare Parts = € 1,000

Total = € 2,200

Total electric consumption:
30 KW with electric heated oil sludge mixing tank.
Maintenance costs:
70 man hours per year.

Total purchasing price for incinerator and sludge oil mixing tank, approx. = € 57,000

2.1.1.6 Annex VI: Prevention of Air Pollution from Ships

Annex VI of MARPOL sets the requirements to reduce the emissions of SOx and NOx. Furthermore, it prohibits deliberate emissions of ozone depleting substances.

According to the Annex, the sulphur content of marine bunkers can be up to 4.5 % except in SECA (Sulphur Emission Control Areas) areas where the sulphur content may not exceed 1.5%. IMO has indicated that further limitations will be imposed on SOx as well as on other exhaust gases as NOx, HC (Hydrocarbons) and CO in future.

In a study carried out in 2005 (see footnote 5 above), it was found that the sulphur content in heavy fuels varies regionally from 1.9 % (South America) to 3.07 % (Asia). The average sulphur content of bunkers was found to be around 2.7 %. To achieve the requirements of the SECA regions (at the present the Baltic Area and in 2007 the North Sea), vessels will have to use low sulphur bunkers which are normally more expensive because of the increasing demand and the higher costs of the desulphurisation process (see figure 1). To meet the requirements of SECA for new ships or older ships that were designed to use marine diesel oil for manoeuvring in ports shouldn't be difficult as they usually have a dual fuel system onboard, but retrofitting the fuel system configuration of older ships with such a system is very expensive.

An alternative to using low sulphur fuel is to reduce the amount of SOx in the exhaust gas stream by applying the so-called "scrubber" technique. The sea water scrubber technique works by mixing the hot exhaust gases with sea water in a turbulent cascade. In this process exhaust SO_x is transferred to the sea water, which is then recirculated to allow the solid particles from the exhaust gases to be trapped and removed. The sea water, with its increased content of sulphate, is released into the sea. The problem of using seawater scrubbers to reduce the sulphur content of exhaust emissions to below 6 g SOx/kW h (around 75% of SO_2 reduction) is that the high acidity of the scrubber waste water makes the disposal at ports expensive. Capital costs and operating costs of scrubbers in different vessel sizes are shown in table 2 below.

The scrubber technique is still in the prototype phase[4], even though the first prototype exhaust gas seawater system for ship emission control was installed in 1991 already[5]. This first test demonstrated that a reduction of SO_2 emissions up to 92 % was possible. At the normal load conditions measured however, the prototype demonstrated a sulphur removal rate in the range of 71 % to 73 %.

The seawater from the scrubber is re-circulated, and the solid particles removed from the exhaust gas are trapped in a settling or sludge tank where they are collected for disposal. Disposal involves either burning the sludge in the ship's incinerator or disposing of it ashore. Filtered and used seawater can then pass onto the ship's existing bilgewater treatment system.

Scrubber technology gives ship owners more flexibility to meet emission control limits, e.g. in SECAs, and is included in Annex VI. However, scrubbers cannot be used in ports because of their effect on water quality.

The use of this technology is discussed controversially:

INTERTANKO does not recommend the use of scrubbers for the cleansing of exhaust gases as they potentially relocate the pollutant material to alternatives areas of the environment.

According to the INTERSESSIONAL MEETING OF THE BLG (Bulk Liquids and Gases) WORKING GROUP ON AIR POLLUTION of IMO on the 20 October 2006, both SCR and scrubbers (flue gas desulphurization) are considered to be established, proven technologies and have been used with great success in a wide variety of land-based applications on combustion sources both smaller and larger than marine engines[6].

Monitoring the use of scrubbers:

The rate of pH change in the re-circulating water is a simple indicator of SO_2 removal and may therefore have an implication for monitoring applications.

[4] Presentation: SOx SCRUBBER TECHNOLOGY AND SECA, Service Seminar, 12 December 2006 Gothenburg Torbjörn Henriksson, Propulsion and Applications Expert, Technical Service, Wärtsilä Finland Oy
[5] European Commission Directorate General Environment – Service Contract on Ship Emissions: Assignment, Abagement and Market-bsed Instruments – Task 2c – SO2 Abatement – Final Report, August 2005 – Entec UK Limited
[6] see http://www.munters.dk/home.nsf/FS1?ReadForm&content=/home.nsf/ByKey/CKIL-5ZCKSL

Capital Cost of SO_2 Abatement Options by Vessel Size (€ / Year)

	Small		Medium		Large	
	New	Young and Old	New	Young and Old	New	Young and Old
1.5% Sulphur Fuel	0	0	0	0	0	0
0.5% Sulphur Fuel	0	0	0	0	0	0
0.1% Sulphur Fuel	0	0	0	0	0	0
Scrubber	37,700	61,750	121,460	199,090	304,630	499,440

Source: Entec 2005d and NERA calculations based on Entec 2005d.

Operating Cost of SO_2 Abatement Options by Vessel Size (€/Year)

	Small		Medium		Large	
	New	Young and Old	New	Young and Old	New	Young and Old
1.5% Sulphur Fuel	93,620	93,620	307,219	307,219	769,302	769,302
0.5% Sulphur Fuel	234,051	234,051	768,048	768,048	1,923,255	1,923,255
0.1% Sulphur Fuel	441,458	441,458	1,448,662	1,448,662	3,627,568	3,627,568
Scrubber	12,560	12,560	27,001	27,001	33,869	33,869

Source: Entec 2005d and NERA calculations based on Entec 2005d. Where applicable, fuel switching costs are from CONCAWE estimates.

Table 21 combines the fixed and variable costs for SO_2 technologies shown above and displays the total cost of installing each technology, using the operating characteristics described in Table 10.

Total Cost of SO_2 Abatement Options by Vessel Size (€/Year)

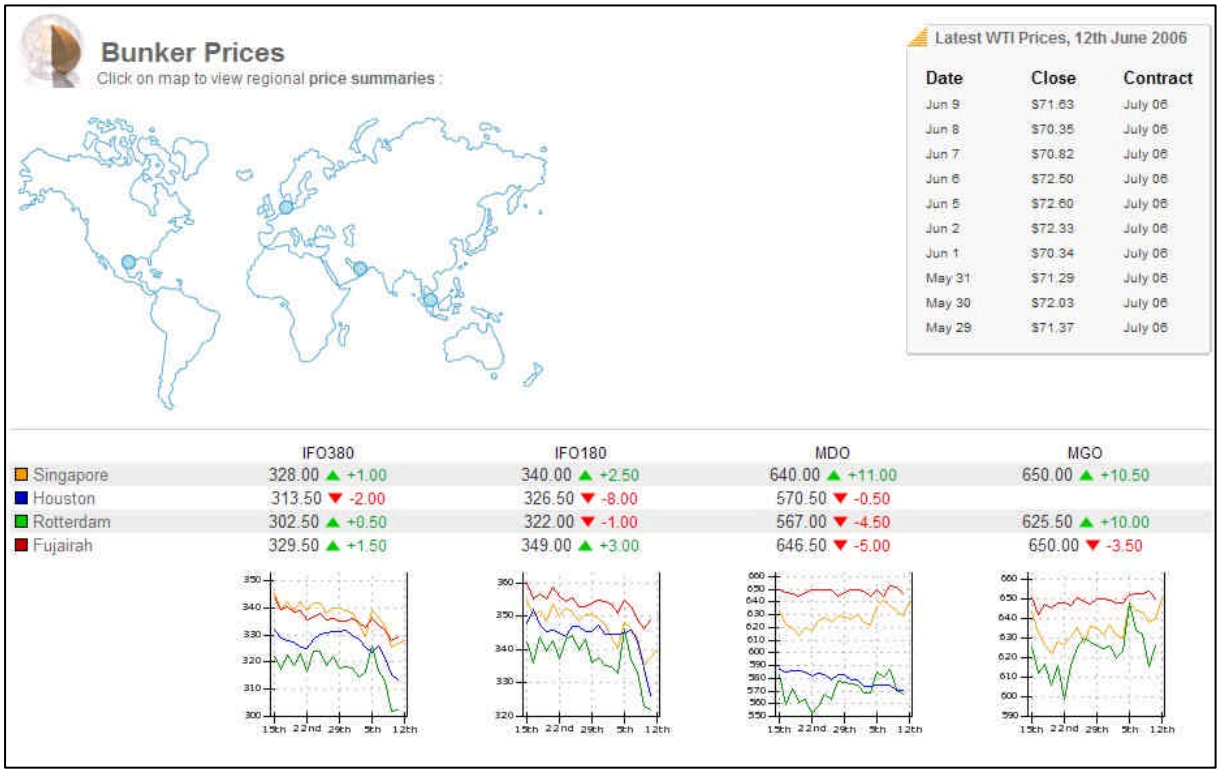
	Small		Medium		Large	
	New	Young and Old	New	Young and Old	New	Young and Old
1.5% Sulphur Fuel	93,620	93,620	307,219	307,219	769,302	769,302
0.5% Sulphur Fuel	234,051	234,051	768,048	768,048	1,923,255	1,923,255
0.1% Sulphur Fuel	441,458	441,458	1,448,662	1,448,662	3,627,568	3,627,568
Scrubber	50,260	74,310	148,461	226,091	338,499	533,309

Source: Entec 2005d and NERA calculations based on Entec 2005d. Where applicable fuel switching costs are from CONCAWE estimates.

Table 2: SO_2 Abatement Costs[7]

[7] Economic Instruments for Reducing Ship Emissions in the European Union, NERA Consulting

Figure 1: Fuel Prices[8]



Regarding the NOx emissions, all propulsion systems installed onboard after January 2000 or engines having undergone a major conversion after that date have to comply with the Annex's NOx Technical Code which calls for significant reductions in NOx emissions. The NOx Technical Code, developed by IMO, defines how this has to be done.

The methods to reduce NOx are[9]:

- Internal modification of the engine
- Direct Water Injection
- Humid Air Motor
- Exhaust Gas Recirculation
- Selective Catalytic Reduction

There are basic and advanced ways of modifying the engine: In the basic method conventional fuel valves are exchanged with low-NOx slide valves, a method that is currently applicable only to slow speed two-stroke engines. Virtually all new engines of this type are thought to have these valves fitted as standard, as a means of meeting the IMO NOx standard. Retrofitting is considered easy. Cost is estimated at 9 - 12 €/tonne NOx.

[8] See www.bunkerworld.com/prices
[9] NOx abatement techniques, Final Report, C. Hugi - Entec UK, 2005.

The advanced method involves combinations of a number of techniques such as retarded injection, higher compression ratio, increased turbo efficiency, common rail injection, etc., optimized for particular engine types. Producers claim that reductions of 40 per cent of NOx can be attained now, and that further improvements can be expected. Costs are estimated at 19 - 98 €/tonne NOx.

In the Direct Water Injection fresh water is injected to cool the combustion chamber, which requires storage and bunkering of fresh water on board the ship. Installation can be done while the ship is in service. Cost is estimated at 345 - 411 €/tonne NOx.

The Humid Air Motor system uses heated charge air enriched with evaporated seawater. Cost is estimated at 198 - 306 €/tonne NOx.

In the Exhaust Gas Recirculation a fraction of the exhaust gases are filtered, cooled and redirected into the engine intake air, thus reducing the combustion temperature. This technique may be best suited to engines running on high-grade low-sulphur fuels. No cost estimate is provided.

In the Selective Catalytic Reduction process, a urea solution is injected into the exhaust gas stream, which then passes through a catalyst housing, which usually also makes the silencer redundant. The system is suitable for both new vessels and retrofit installations. Cost is estimated at 313 - 809 €/tonne NOx.

Box 1: NOx Production Per Day

A simple method to calculate NOx production is based on average figures derived from technical data on engine specific NOx emissions and brake specific fuel consumption. The greenhouse gas study by the International Maritime Organization (IMO 2000) established two emission factors, 87 g NOx/kg furl for 2-sstroke engines and 57 g NOx/kg fuel for 4-stroke engines.
(Source: www.bsr.org/sustainabletransport)

For a container vessel (2-stroke engine) consuming 150 tons of fuel per day, this would result in an emission of 13.05 tons of NOx per day

2.1.2 New Methods and Systems to Achieve Clean Shipping

There are several new systems and developments that aim to help vessels to comply with international regulations and at the same time enhance efficiency of operation. If properly applied, such systems can be amortized in a few years, and more important, they foster preparation for future stricter regulations, e.g. regarding exhaust gases. Some examples are given below.

2.1.2.1 White Box System (WBS)

The White Box System is a fail-safe system to discharge bilge water with higher oil content than required overboard. The oil content of the pumping water is adjustable between15 ppm and 5 ppm.

The system is composed of:

- a pressure control valve,
- an oil content meter (ppm monitor adjustable between 15 to 5 ppm),
- a flow control device (flow switch + filter),
- an electro pneumatic 3-way valve, a flow meter inc. a pulse transmitter and
- a recorder.

The effluent water from the Oily Water Separator or Bilge Water Cleaning System that will be discharged overboard goes through the WBS. The water flows to the oil content meter via the flow control device. The 3-way valve will be in the return position until the oil content meter and flow control device instructs the 3-way valve to open for discharge overboard. As soon as the 3-way valve starts to open to it's overboard position, the recorder starts. Before the water is discharged overboard, it passes through a flow meter with a pulse transmitter connected to the recorder.

The standard recorder saves the following information:

- start and stop time of the discharge cycle,
- the oil content meter level over the discharge cycle and
- the total quantity of water pumped over board in a discharge cycle.

The WBS can be supplied with a more sophisticated recorder to enable interfacing with the ships LAN (Local Area Network) to additional also record e.g. the ship's position and course.

2.1.2.2 CD-WOR™ System

The CD-WOR™ System offers a functional solution for efficient pre-treatment of fuel oil sludge and ordinary waste oils.

A blend of fuel oil sludge and waste oils can be burned in boilers and incinerators like conventional fuel, which is mostly consumed in such plants. Additionally, the blend made by the plant can be transferred to the fuel oil settle tank for consumption in main engines and/or generators.

2.1.2.3 Poseidon Grey and Black Water Treatment:

The chemical composition of black water and grey water is different. Both must be treated separately. As shown in the figure below, the treatment plants have evolved from conventional mechanical filter plants to ultraviolet light plants.

The advantages of ultra violet (uv) plants with advanced ozone reactors are that the system leaves a smaller footprint in the effluent water than conventional systems.

The functional process of an advanced uv treatment plant as the Navalis Poseidon treatment plant is shown in the next figure.

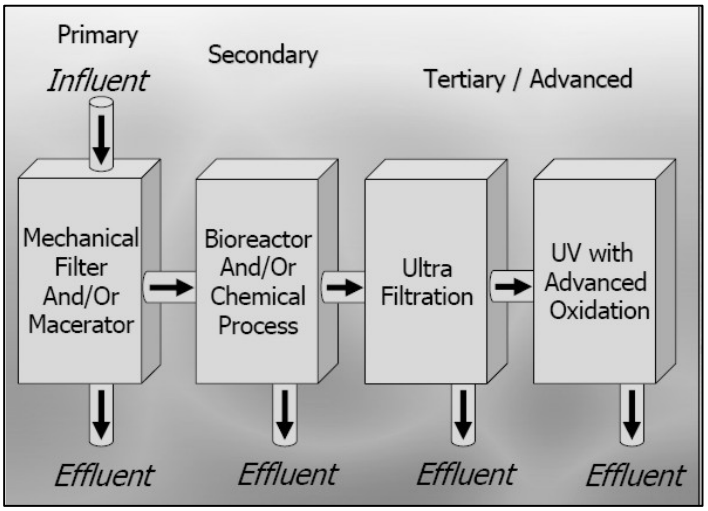


Figure 2: Evolution of marine waste water treatment[10]

[10] See Waste Water Management Systems, Stephen Markle, Green Ship Technology Conference, 30.03.06 Hamburg, Germany.

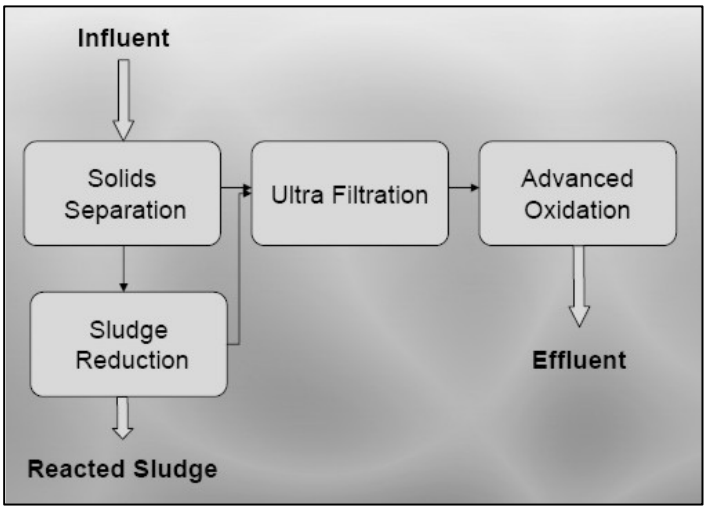


Figure 3: Functional diagram of the Navalis uv treatment plant[11]

Advantages of the system are, among others:

- a real time effluent quality monitoring,
- colorless and odor free effluent water,
- treats black and grey water separately,
- reduces the volume of solids/sludges,
- grey water can be reused.

The system is designed in conformance with the MARPOL Annex IV Marine Sanitation Devices (Flow Through Treatment).

2.1.2.4 PyroGenesis

The technology combines a milling process for converting solid waste into lint, which burns in a plasma-assisted compact combustor. The waste pre-processing section consists of a shredder, a storage conveyor, and a mill. The milled waste is fed into the eductor. The eductor then forces the waste into a zone of high turbulence and high temperature (plasma), which results in rapid gasification of the waste material. Additional air, added in the combustion chamber, ensures complete combustion of the gases prior to their cooling, cleaning and discharge.

The system can be started and shut down in less than 10 minutes. This equipment burns up to 230 kg of solid waste per hour and is appropriate for vessels where a big amount of waste is generated, e.g. Cruise Ships, cargo ships, ferries and super-

[11] See Waste Water Management Systems, Stephen Markle, Green Ship Technology Conference, 30.03.06 Hamburg, Germany

yachts. The PAWDS (Plasma Arc Shipboard Waste Destruction System) technology can be used on land as the provider offers a portable waste treatment technology.

2.1.2.5 Zero Emission Car Carrier

Wallenius Wilhelmsen's is developing a zero emission car carrier for the year 2025. The concept vessel will have a capacity of 10,000 standard cars and will use only renewable energy sources and naturally-charged fuel cells for power.

It picks up wind energy in its large sails and generates electricity by using solar cells fitted to their entire surface. A system of horizontal fins will also make use of wave energy.

The main hull and four sponsons will provide stability and eliminate the need for ballast water.

2.1.2.6 SkySail

The SkySail-System consists of a towing kite propulsion and a wind routeing system. The towing kite is connected to the ship through a towing rope (see figure 4 below). The system offers the ship an auxiliary wind propulsion and virtually all cargo vessels can be retrofitted with the technology.

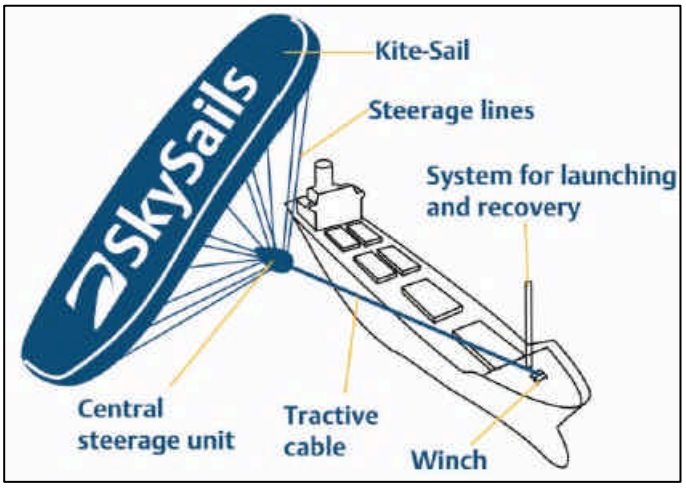


Figure 4: SkySails-System[12]

The nominal power of the kite propulsion system is 5,000 kW. The towing kite is made of robust and weatherproof materials and is fitted with double walls, made up

[12] See SkySails Technology Information, April 2006

of chambers along the entire length and ports at the front end. A line tree defines the requested kite shape by spanning various cord lengths between the pod and the towing kite. In case of strong winds the power of the kite can be curtailed by changing the kite's position relative to the horizon.

The steering system operates automatically and aligns the kite according to wind direction and force, taking into account the ship's speed and route. The force of the kite is transferred to the ship's structure at deck level. The lever arm which causes the inclined position of conventional sailing ships is shortened and therefore the inclined position is irrelevant for the safety and operation of the ship (see figure 5 below). Furthermore, at sea the system damps the waves because the uplifting forces of the kite effect a smoother slicing of the ship's hull into the wave.

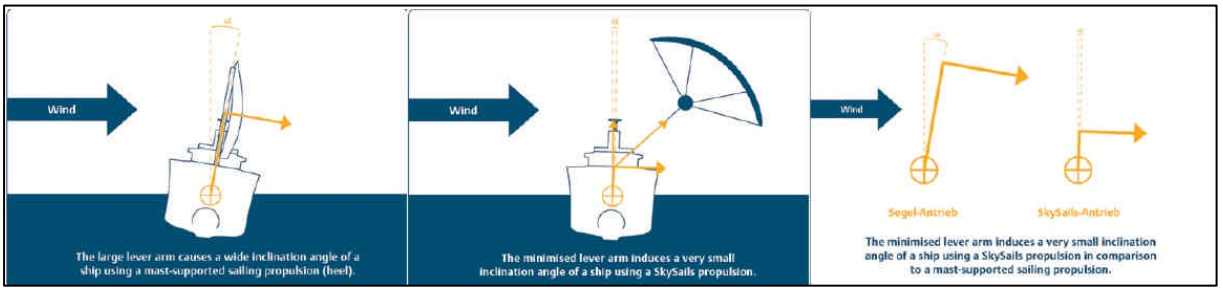


Figure 5: Minimised lever arm of the SkySails-System[13]

According to the manufacturers the annual fuel costs can be lowered between 10-35 % depending on the wind conditions. Under optimal wind conditions fuel savings even up to 50 % are possible. At the current oil price the system can be amortised within 3 to 5 years. The calculations were done for a container feeder (87 m length, 2.000 kW installed power main engine) and a bulk carrier (177 m length, 5.900 kW installed power main engine). For the container feeder travelling at an average speed of 13 kt and using MGO as fuel, the estimated acquisition price of the system is EUR 442.000,- and the operational costs are EUR 35.000,-. For the bulk carrier travelling at an average speed of 14 kt and using IFO 380 as fuel, the acquisition price is EUR 672.000,- and the operational costs are EUR 70.000,-.

By reducing the fuel consumption, the system helps to reduce sludge generation and to avoid emission dependent charges. In case of insufficient wind conditions the main engine of the ship shall be available.

[13] See SkySails Technology Information, April 2006

2.1.2.7 Siemens SISHIP Fuel Cell Air for Cargo and Passenger Vessels

Siemens Zero-emission fuel cell installations generate electrical energy and emit pure water and heat. The system is composed of:

- Gas treatment (e.g. air filtering and humidification)
- Water management (cooling water supply and disposal)
- Connection between the internal and external installation cooling circuit via a water/water heat interchanger
- An automatic control system.

The control system controls the processes that are necessary during activation/deactivation and operation of the system with respective load steps. In addition, it assumes the internal installation security monitoring, particularly at the fuel cell level. Operational anomalies can be identified and the system can be shut down safely in the event of a system failure. Optionally, a redundant control hardware with a watchdog function can be delivered. It identifies hardware problems of the control system and also shuts the installation down safely. A display screen provides information on the process flow. Hydrogen sensors in the installation ensure that no unusually high hydrogen concentrations occurs. In the event of a failure, the installation is switched to a safe mode. A DC/AC inverter converts the direct current into a network compliant alternating current. A hydrogen and electrical connection for the energy production at start-up, and for the network feed form the interfaces to the outside. Depending on the inverter applied, varying networks can be fed. The fuel cell system can be water-cooled or air-cooled.

Fuel cells, running on pure hydrogen, convert the chemical energy at a higher level of electrical efficiency than with a comparable internal combustion engine and connected generator. It also allows a quiet and vibration-free operation. According to the company, long-term test series indicate a life span expectancy of fuel cells of several years if operated properly. The first customer order with an output of 160 kW is currently being realized.

2.1.2.8 Superconductivity Onboard of Vessels

I&S Marine Solutions in Hamburg developed a small, light weight, high efficient synchronous generator with high-temperature superconducting (HTS) rotor windings. The generator will be used for power generation onboard of vessels. The 4 megavolt ampere generator development has been realized in co-operation with the business unit Automation & Drives (A&D) and Corporate Technology (CT) of Siemens.

The advantages are the savings in terms of mass, volume and losses. The generator is more compact and silent and will be also a smaller source of vibration. It is capable for multiple overloads and insensitive in case of load changes.

In 2005, the generator was tested extensively during a test program in the A&D system test facility for electric drives in Nuremberg. The generator may be applied for the installation onboard of vessels and offshore-platforms.

2.1.2.9 Wärtsila's Fuel Cell Technology

Wärtsilä fuel cell technology for marine focuses on Solid Oxide Fuel Cell (SOFC) systems using methanol together with natural gas (NG) and liquefied natural gas (LNG) as fuel.

The fuel cell technology will first be suitable for auxiliary power generation on small passenger vessels, ferries and selected cargo vessels, as well as propulsion power for small short route ferries.

In April 2005, Wärtsilä unveiled a 20 kW fuel cell power unit prototype. The company plans to demonstrate its first commercial units in the 50 kW power class within 2007. Larger commercial products in the 250 kW power class are planned to follow by 2010.

Fuel cell technology offers significant environmental advantages due to its use of clean-burning fuels. LNG is relatively free of contaminants. The use of LNG compared to marine diesel oil (MDO) can reduce emissions of carbon dioxide (CO_2) by over 20%, Nitrogen Oxides (NOx) by around 80%, as well as causing less particulate emissions.

Fuel cells running on LNG don't produce Sulphur Oxide (SOx) emissions. The disadvantages are the high investment costs and the loss of cargo capacity because LNG machinery and storage tanks require more space than conventional systems.

The success and viability of fuel cell technology for ships will depend on the price and availability of LNG compared to conventional marine fuels with low sulphur content.

2.1.2.10 LNG Powered Ferries

A Norwegian Company, LNG Marin, is developing LNG powered ferries. In January 2007, 5 Units shall commence operation.

The LNG systems and the propulsion plant are located below the car deck. LNG installations are characterized by demanding large LNG storage tanks. Due to safety these tanks have to be separated from other systems of the ship. The engine rooms need more interior space than in conventional ferries.

The advantage of the system beside lower exhaust gas emissions is that at present the price of LNG is only 72% of Marine Gasoil and its availability is increasing.

2.1.2.11 Chemical / Physical Treatment of Bilge Water

The company Burmester M-S-T Marine-Service-Technik GmbH in Hamburg, Germany, has developed a chemical / physical procedure to reduce the oil-content of the bilge water to a value of less than 0.5 ppm (link:BIWA). The result is a treated bilge water that can be re-used as technical water on board, e.g. for toilet flushing. The low oil content can be achieved by adding a special active agent which is environmental compatible and non-hazardous according to EU-Safety data sheets to the bilge water treatment plant. The design plans have already been assessed by the American Bureau of Shipping, the active agent is applied for patent.

This chemical / physical treatment can be used independently from vessel size and it can be retrofitted also in old vessels.

The costs for this system are:

Operational costs: approx. 15.-- € for treatment of 1 m³ bilge water.
Investment costs: 48,000,-- € for a 2.5 m³ plant.

2.2 Best Operational Practices

This chapter introduces a number of environmental measures, which go beyond existing regulations, voluntarily taken by various stakeholders of the shipping industry. The measures comprise a wide spectrum, ranging from proactive behaviour, to implementation of environmental effective instruments and finally tackling all actual environmental issues related to the maritime industry. While some of the measures described hereunder are simply "common sense" or "good housekeeping" measures, others are more sophisticated and based on EMAS or ISO 14000 elements.

In line with the necessity for "Best Available Technology" as discussed in chapter 2.1, "Best Operational Practices" in the sense of "Best Environmental Practice (BEP)" should be promoted in order to realise sustainability in the maritime transport sector.

The term "Best Environmental Practice" means the "application of the most appropriate combination of environmental control measures and strategies"[14].

Hereunder, an overview on the broad variety of measures and strategies for BEP in the shipping industry is provided, ranging from "basics", like sorting of solid waste for recycling, to “advanced”, like paint and maintenance management or speed control.

These BEP measures discussed in the following are:

- The "Poseidon Challenge" or "Zero Concept" as an integrated concept
- Fuel saving measures, reducing waste according to MARPOL Annex I and VI, like:
  - Optimum speed
  - Speed reduction and speed control
  - Fuel quality management
  - New kinds of hull paint and underwater cleaning
- "Alternative" Fuel concepts, also reducing waste according to MARPOL Annex I and VI:
  - Biodiesel
  - "Dual Fuel"
  - Liquefied Natural Gas (LNG)
- "Cold Ironing"
- Waste Management, primarily reducing waste according to MARPOL Annex I and V
- Ballast water management,

[14] Convention for the Protection of the Marine Environment of the North East Atlantic (1992)

2.2.1 The "Poseidon Challenge" or "Zero Concept"

The "Poseidon Challenge" is one of the youngest BEP-schemes; it was initiated during an INTERTANKO event in Athens in April 2005. In the course of this conference, a group of tanker owners and other tanker industry representatives agreed to "encourage and inspire" all major players in the oil transportation sector not only to set new goals of excellence, but also to reach them within the next five years.

These goals are:

- Zero fatalities
- Zero pollution
- Zero detentions.

It is remarkable that this concept addresses all "links in the chain of responsibility" (see figure 6 below).

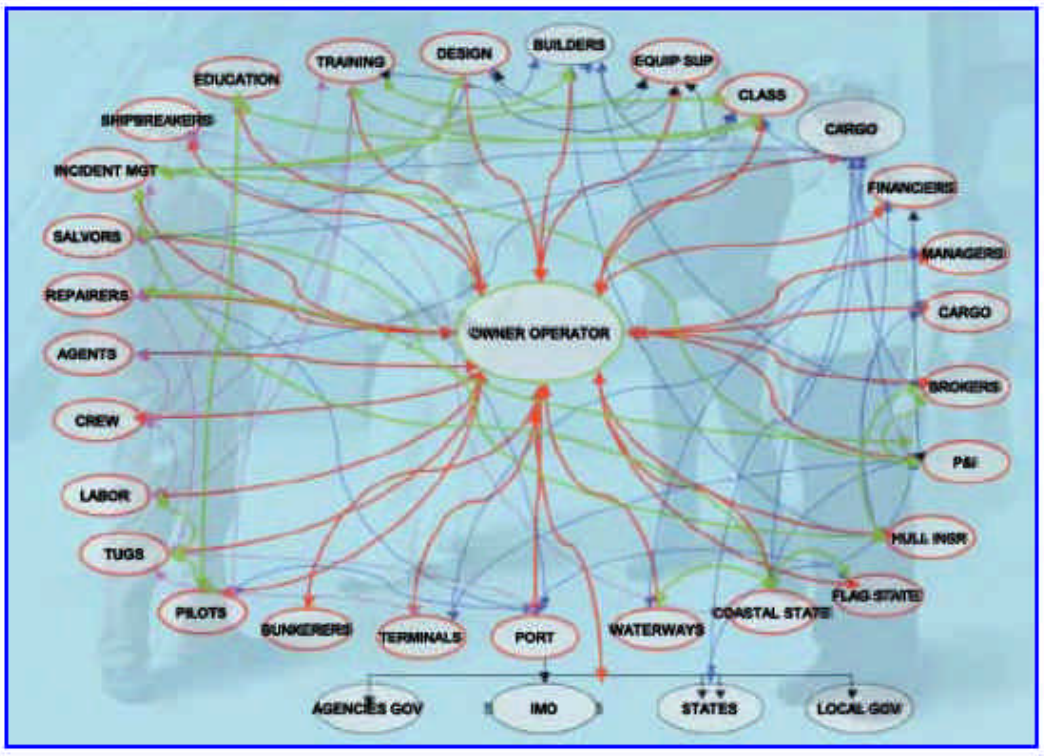


Figure 6: All links in the chain of responsibility
Source: Poseidon Challenge 2006

At the first Poseidon Challenge gathering in April 2006 in Singapore, representatives of the following fields of activity met:

- Shipping Agents
- Bunker Provider
- Classification Societies
- Cargo Owners
- Educationist
- Flag and Port State
- Insurance (Hull)
- Insurance (P&I)
- Salvors
- Seafarers
- Shipbrokers
- Shipbuilders
- Ship Managers
- Ship Owners and Operators
- Training Providers

Box 2: The "Zero Concept "

"The primary purpose of the Poseidon Challenge, and its meaningful and realistic goal, is to look back in 5 years and see serious accidents and fatalities reduced to zero, accident and pollution rates reduced to zero and port state control detentions reduced to zero.
To successfully strive for zero, every link in the chain of responsibility has to be striving voluntarily, and all links in the chain of responsibility have to work effectively together."

Stephen Van Dyck, Chairman of INTERTANKO, "Poseidon Challenge" 2006

Each organisation was asked to introduce different BEP-measures, in line with their possibilities and respective field of activity.

Examples:

- The **ship owners**, represented by Teekay Marine Services, Teekay Shipping (Canada) Limited, introduced an integrated concept of compliance including management systems, advanced technology and training and awareness building for all their employees.
- The **bunker suppliers'** commitments proposed: improved measurement procedures and monitoring of sulphur content.
- The **class**, represented by IACS, announced a number of initiatives, among them: assistance to poorly performing Flag States, unified requirements for hull surveys during new constructions, etc.
- The commitment of the group **"education"**, expressed by the President of the WMU, is, *inter alia*, to enhance global standards of marine safety and marine environment protection, producing a steadily increasing international network of highly-qualified maritime professionals, etc.

For further details and other examples please refer to the link: Poseidon Challenge

Incentive / Award:

During the Poseidon Challenge 2006 meeting, Mr Stephen Van Dyck, Chairman of INTERTANKO, announced that it is intended to *"sponsor a Poseidon Prize to be awarded annually to the association, company, society, link in the chain of responsibility, individual, team that/who has done the most to meet the Poseidon Challenge in*

the past year. A committee will be set up to establish the nomination and evaluation process and how the award will be made".

2.2.2 Fuel and Air Related Measures

Fuel consumption and fuel quality are of central importance, when discussing oily wastes (fuel residues) as well as emissions generated by the shipping industry. Both, waste oil generation and air emissions of a ship depend also on technical conditions, as for example efficiency of the main engine or of the propeller, or shape and condition of the hull, etc. Generally, however, the amount of power generated by a vessel is critical to its fuel consumption, and thereby, indirectly, to its waste oil generation.

Measures discussed hereunder are:

- Optimum Speed
- Speed Reduction
- Fuel Quality Management
- Permanent Global Use of Marine Diesel Oil (MDO)
- Further Measures for Fuel Reduction as Hull Paint and Underwater Cleaning
- "Alternative" Fuel like Biodiesel, "Dual Fuel", or Liquefied Natural Gas (LNG)
- "Cold Ironing"

2.2.2.1 Optimum Speed

Fuel efficiency, which means running ships' engines at the optimum output to fuel consumption ratio, has become an increasing issue for ship owners, not primarily for environmental reasons, but more for the fact that the costs of fuel oil are the largest operational cost of a traditional vessel.

Example 1:

The Germanischer Lloyd (GL) has undertaken studies[15] on the relations between bunker costs and speed for individual containerships of different sizes, as well as for whole fleets, an example of which has been published in Lloyds List[16]:

Running a containership of 8,000 TEU costs at current fuel prices:

- at 26 knots costs about $ 24 million per year;

[15] Studies not published; presented by Dr Sames, 5 Dec 2006, Germanischer Lloyd, Hamburg
[16] Lloyd's List daily, Wednesday September 27 2006: "Burning issue will be optimum speed against bunker costs"

- at 20 knots costs about $ 10 million per year.

These figures can roughly be converted to waste oil production, respectively to the reduction thereof[17]. The model ship uses:

- 80,000 tonnes/year bunker = 219 tonnes/day at 26 knots
- 33,333 tonnes/year bunker = 91 tonnes/day at 20 knots

The amount of fuel residues (sludge) generation for motor propelled ships lies in the range of 1.5 – 2 %[18] respectively 2 – 3 %[19] of the daily fuel consumption. For the purpose of this study, calculations are based on an average percentage of 2.

This means that sludge generation in this model calculation is:

- 4.38 tonnes/day at 26 knots
- 1.83 tonnes/day at 20 knots

Even though these figures have to be considered with care as they are based on very rough data sets only, it can be stated that it is possible to reduce waste oil production significantly by choosing a more economical speed.

Example 2:

This can be underlined by the following data collected on a ferry running between Hook van Holland and Harwich on the English Channel, which again clearly shows the connection between fuel consumption and speed[20]:

Speed through water	Fuel consumption [liters/hour]
10.4	650
13.2	875
17.0	1,300
20.1	2,120
20.7	2,900

Table 3: Relation Fuel Consumption to Speed

Fuel consumption on a ship not only depends on the speed, it is also a function of the environmental conditions, such as wind, waves, water depth, temperature and salin-

[17] For calculation, a fuel price of $ 300 per ton is assumed.
[18] IMO, MEPC 38/11/rev2 Annex: Manual on Shipboard Waste Management
[19] IMO International Maritime Organization, London 1995: Comprehensive Manual on Port Reception Facilities
[20] SeaPacer Route Planning on Ships – www.cs.umu.se/~thomash/seapac1.htm

ity. Since the external conditions vary it is not possible to maintain minimum fuel consumption at constant speed.

In order to find the optimum speed, different route planning systems have been developed and tested, as for example the "SeaPacer" route planning system for seagoing vessels or the "Tempomaat" for inland vessels.
(links: www.cs.umu.se/~thomash/seapac1.htm
http://www.tresconavigationsystems.com/en/products/tempomaat.htm)

State-of-the art route planning systems take all necessary factors into consideration for optimal route planning:

- Ship specific parameters such as form of the hull, weight, type of main engines, etc.
- Water currents
- Water depth
- The ship's draft (depending on board condition)
- Wind (direction and strength)
- Schedule

These route planning systems are based on a real-time measurement of the fuel consumption, for example by a flow meter connected to a special software advising the ship's command on the optimal use of the engines.

The results of the route planning are described to be a fuel reduction (and sludge reduction at the same time) of 10 to 15 %.[21, 22]

According to information from the manufacturer of the "Tempomaat" system, this route planning system is on the market and in use, however, "*not too many*" of them are sold up to now[23]. The "SeaPacer" system was introduced in 2003 as a pilot project, it has been installed in twenty vessels. Even though the project was very successful and fuel savings of 10 % could be proved, the "SeaPacer" system is not on the market, and the project was discontinued. According to Prof. Hellström, who developed the system, this could be due to the fact that nowadays route planning devices are often included in new radar systems on board already. The costs for the "SeaPacer" system were 50,000 €.

[21] http://www.tresconavigationsystems.com/en/products/tempomaat.htm
[22] Phone conversation with Prof. Thomas Hellström, SeaPacer, 29.12.06
[23] Phone conversation with "Tempomaat", 29.12.07

2.2.2.2 Speed Reduction

As ships travelling at lower speed use less fuel and produce fewer emissions, several ports, mainly in the U.S., initiated projects to motivate vessels to reduce their speed within a certain distance from shore.

In California, for example, the Ports of Los Angeles and Long Beach have introduced a voluntary Vessel Speed Reduction Programme (VSRP) in 2001, which calls for ships to reduce their speed to 12 knots or less within a 20-mile radius of the ports. Currently, nearly 70% of shipping lines calling at these ports participate in the voluntary programme.

Next to this, the Port of Long Beach also provides an incentive in order to motivate the shipping lines by its "Green Flag Incentive Program", a clean air initiative. Vessels that dock at the port will earn a Green Flag environmental achievement award when they attain 100% compliance with the voluntary vessel speed reduction programme for a 12-month period (measurement beginning in January 2005). Carriers that achieve a 90% or more compliance rate in a 12-month period (measurement beginning in January 2006) will be eligible for a 15 % reduced dockage rate (Green Rate) in the following year.

The speed of every vessel in the speed reduction zone is measured by RADAR/AIS and recorded by the Marine Exchange of Southern California, the local vessel traffic service (VTS).

Environmental benefits:

According to a news release[24], this project saved – among other pollutants - more than 100 tonnes of nitrogen oxide (NO_x) from going into the air in the first quarter of 2005. This translates into average daily savings of 1.1 tonnes of NO_x.

2.2.2.3 Fuel Quality Management

Marine fuel is available in different grades, such as Heavy Fuel Oil (HFO or Bunker Fuel), Marine Diesel Oil (MDO) and Marine Gas Oil (MGO). There is a direct relationship between fuel quality, air pollution and waste oil production. Therefore, a change of fuel quality provides immediate reduction of waste and emission, without any further technical requirements.

[24] http://www.findarticles.com/p/articles/mi_m0EIN/is_2005_August_17/ai_n14928214

Box 3: Heavy Fuel Oil (IFO 380 or 180)

This product, commonly known as bunker fuel, is a mixture of hydrocarbons composed of residual fractions from crude oil distillation and processing. This fuel contains from 1.5% to 5% sulphur (15,000 - 50,000 ppm) and is used during "underway" travel in the open seas. HFO can be run in both main and auxiliary engines.

Box 4: Marine Diesel Oil (MDO) and Marine Gas Oil (MGO)

These are distillate fuels with most properties nearly identical to diesel fuel. These lighter fuels allow for better speed adjustment and control during manoeuvring and contain on average 0.5% (5,000 ppm) sulphur. The drawback is that this product is almost twice as expensive as HFO.

In the following, two examples of shipping lines voluntarily using MDO instead of HFO clearly demonstrate the environmental benefits of using a "clean" distillate:

Maersk Line has voluntarily switched from "bunker" fuel with relatively high sulphur content to low-sulphur distillate fuel on the main and auxiliary engines of its vessels as they approach 24 miles from the Ports of Los Angeles and Oakland, while docked and until 24 miles out on departing journeys. First results from this switch show substantial reductions in key pollutants that have potential health effects. Reductions of

- 73 % in particulate matter (PM)
- 92 % in SO_x
- 10 % in NO_x

are projected annually[25].

The first vessel that performed the fuel switch was MS SINE MAERSK in Los Angeles on March 31, 2006. The program is presently being implemented on all vessels calling California.

The fuel switch enables the ports of Los Angeles and Oakland to achieve immediate emissions reductions, unlike shore-side power programmes such as cold ironing (which means to shut all auxiliary engines down and hence kept the engines cold) that would take years to implement on this scale.

Wallenius Lines[26] has carried out an "MDO project" with one of its most modern PCTC vessels (Pure Car and Truck Carrier) by using Marine Diesel Oil (MDO) only

[25] Source: Maersk Line Press Release: Maersk Line Announces Fuel Switch for Vessels Calling California; Friday May 26, 2006

as fuel for the main engines, auxiliary engines and generator, instead of Heavy Fuel Oil (HFO). The test vessel is M/S TURANDOT, one of Wallenius Lines' 37 vessels, currently operated on a global basis carrying cars and other heavy vehicle cargoes.

Results of the Project:

- Lower fuel consumption:
  The higher thermal value of diesel oil means lower fuel consumption. The typical thermal value for MDO is about 42 MJ/kg and for HFO it is about 40 MJ/kg, a difference that in theory represents a reduction in fuel consumption of around 5 %. Furthermore, diesel oil properties of a lower viscosity and particle content mean less friction in the engine's moving parts, which in turn leads to reduced fuel consumption. The measurements taken on board the MS TURANDOT indicate a reduction for the main engines of about 1.0–1.5 tonnes / 24 hours at sea.
  As the MDO fuel tanks need be warmed to only 30° C compared to at least 50° C for HFO tanks, fuel consumption for firing the boiler has been reduced by about 1 tonne / 24 hours at sea, and about 0.5 tonne / 24 hours in port.

- SO_x-emission:
  The level of SO_x in the exhaust fumes is directly proportional to the sulphur content of the fuel. Therefore, operation with MDO (< 1 % sulphur) is the best way to achieving the 1.5 % SO_x target.
  In some areas, low SO_x emissions also lead to financial savings (see chapter 3.2.2: The Bonus / Malus System). Exact figures, however, have not yet been provided.

- NO_x-emission:
  Levels of NO_x in the exhaust gases are not as fuel-dependent as SO_x. There were expectations of a reduction of the NO_x emissions of 10-15%, but measurements onboard have indicated that the difference is much smaller and almost neglectable.

- CO_2-emission:
  The amount of carbon dioxide in the exhaust gas is directly proportional to the fuel consumption. Therefore, running on MDO instead of HFO will reduce carbon dioxide emissions by about 5 %.

[26] MDO vs HFO in Deep Sea RoRo Service - Is there a financial break-even? Bunker Conference 2000 Per Croner, Wallenius Lines

- Sludge-production:
  The volume of sludge (i.e. waste oil, sediment, oil residues and water from the separators, settling tanks etc.) is directly dependent on fuel quality. By using MDO, the volume of sludge production is reduced by half, compared to HFO. With HFO, an equivalent to just over 1 per cent of the total fuel consumption is generated as sludge. This means that HFO involves an extra cost of US$ 23,000 per year, assuming a price of US$ 140 / tonne (in Rotterdam currently about 280 U$/tonne for common HFO of about 3 % sulphur) for Low Sulphur HFO. In addition to the above described saving in fuel, the substantial reduction in sludge volumes means also a better environment, less labour on board and reduced handling costs for deposing sludge on shore.

- Service intervals, consumption of lubricating oils:
  Less heating requirement of low viscosity fuel as well as fewer amounts of particles in the fuel means reduced wear and tear on machinery components. Therefore, service intervals can be considerably extended. The results, which have been obtained so far, are shown in table 4 below. It is likely that service intervals can be increased even more when more experience is gained with running on MDO and after joint discussion and analysis with the suppliers of engines and supporting systems. Furthermore, reduced wear and less friction also help to reduce the consumption of lubricating oil.

Time interval between service (hrs)	HFO	MDO
Pistons	12,000	18,000*
Fuel Separators, opening	2,000	4,000
Cleaning of Turbo chargers	3 times/week	Once a week
Fuel valves	4,000	6,000
Exhaust valves	6,000	8,000

Table 4: Example of extended service intervals by using MDO instead of HFO
* Limit not reached. A longer trial period is required to obtain a final result.

- Cleaning and work environment:
  The greatest difference experienced by this project is the better onboard working environment and that less cleaning labour is needed. Due to the properties of the MDO, such as lower viscosity and reduced particle content, the quantity of detergent can be reduced and it is possible to use less strong, more environmentally friendly detergents. This applies to the cleaning of all oil handling equipment, such as separators, pumps, filters, heaters, etc.

Less soot deposits on the upper deck mean that less frequent repainting is required.
The boiler is cleaned with water only once every third month, when the vessel is moored, as opposed to every month, as previously. This in turn reduces corrosion problems and increases the boiler's lifetime.

Area	Saving in US$/year
Reduced labour time (cleaning, maintenance of boiler, sludge)	120,000
Longer service interval, ME & Supp. systems	35,000
Lubrication oil, reduced consumption	15,000
Spare part, reduced consumption	25,000
Reduced Fairway Fees, SOx	30,000
TOTAL	***225,000***

Table 5: Estimated operational savings with MDO

- Operational savings:
  A summary of the estimated operational savings that have been achieved after using MDO for approximately one and a half year is shown in table 5 above. The comparison has been made with a sister ship of the MS TURANDOT that uses HFO with a maximum sulphur content of 3 per cent. However, it is still too soon to give an exact amount of cost savings for labour and materials.

2.2.2.4 Permanent Global Use of MDO

The International Association of Independent Tanker Owners, INTERTANKO, presents a proposal to the IMO to consider a global Sulphur Emission Control Area (SECA) based purely on distillate fuels by 2010[27].

By this, INTERTANKO is responding to MARPOL Annex VI, however, as discussed in the examples above, also waste according to Annex I will be reduced significantly by using distillate instead of residual fuel.

This proposal has been discussed and was according to newspaper release[28] supported by the so-called Round Table, consisting of INTERTANKO, INTERCARGO, BIMCO, and the International Chamber of Shipping (ICS).

[27] BUNKERWORLD News 05.10.06: INTERTANKO stuns Bunker Forum with IMO proposal

However, during later verbal communication[29] with INTERTANKO and the VDR (German member of ICS) the following state of discussion was reported:

The INTERTANKO-proposal is still supported by INTERCARGO, whereas ICS and BIMCO are submitting own proposals to IMO's Bulk Liquids and Gases (BLG) Working Group on Air Pollution.

The MARPOL Annex VI review is expected to be completed by the end of 2007[30]. Whatever finally will be decided, INTERTANKO's proposal gave the discussion a new dimension.

The "permanent switch" to MDO could solve a number of environmental problems discussed for decades, as the use of distillate fuels will result in significant decreases of the major vessel pollutants.

Box 5: Statement of the German Federal Environmental Agency - Umweltbundesamt

Das Umweltbundesamt beurteilt die Verwendung von Schwerölen in der Seeschifffahrt wie folgt:

"Für die Mineralölindustrie ist der Absatz minderwertiger, schwefelreicher und hochviskoser Rückstandsöle aus der Mineralölverarbeitung ein kostengünstiger und bequemer Entsorgungspfad zu Lasten der Umwelt."

The German Umweltbundesamt (Federal Environmental Agency) described in 1991 as a result of the "Free of Charge Disposal" project in the Port of Hamburg the use of HFO as a "low-cost and convenient" way for the refineries to get rid of the refined residues, however, at the expense of the environment.

2.2.2.5 Further Measures for Fuel Reduction

a) Hull Paint

Better antifouling and better hull surface smoothness have the potential to reduce fuel consumption up to 6 to 7 %.[31]

[28] Fairplay, 05.10.06: Intertanko to explode $50Bn bunker bombshell
[29] Telephone conversation on 21 December 2006 with Mr. Bill Box, Communications Manager of INTERTANKO; and with Mr. Braun, VDR, Bereich Umweltschutz und Gefahrgut (Department Environmental Protection and Dangerous Cargo)
[30] www.marisec.org/news/mariscne/maritext.htm
[31] Delta Marine Presentation at the "Green Shipping World Workshop", Copenhagen, 3rd October 2006

Antifouling in general is a very important topic, when talking about BEP. The impact of TBT antifouling paints on the environment has resulted in a new public awareness regarding methods of fouling control.

At present, there are two main groups of antifouling paints on the market; copper-based and silicone-based respectively. Research studies show that copper-based antifoulings are not the best option, as they contain persistent toxic compounds to control fouling. They can leach into the water and affect growth, development, reproduction, and survival of marine life such as mussels, oysters, scallops, sea urchins, and crustaceans[32]. This is considered to be neither socially acceptable nor economically viable. In the short-term, copper-based antifouling paints will continue to be used by the majority of vessels, but regulations to reduce copper released by marine craft are being planned and will likely include non-toxic antifouling strategies.
(links: WWF paint study, Marine biofouling – a sticky problem)

Silicone antifouling coatings have been developed as an alternative to biocide-containing paints. They function by minimising the adhesion strength of attached organisms. They have been tested, for example, on the underwater areas on four Hapag-Lloyd vessels. The result shows that it is possible to reduce the fuel consumption by 6 %.

There are different silicone based antifouling coatings on the market, as for example the "Intersleek" system, manufactured by the British paint producer International Paint, or "HEMPASIL", produced by the Danish company HEMPEL A/S. According to information obtained from paint producers[33], the shipping industry shows considerable interest in their products. At present, approximately 5 % of vessels operating worldwide are coated with silicone based antifouling.

b) Underwater Cleaning

Since a big part of a ship's propulsive energy is needed to overcome hydrodynamic resistance (friction), keeping the hull and propeller surfaces smooth will minimise waste and improve the speed of the vessel.

- Regular underwater hull cleaning has the potential of fuel reduction of 1 to 3%.

[32] Nontoxic Antifouling Strategies Demonstration Project, University of California Cooperative Extension—Sea Grant Extension Program, Fact Sheet 04-2 May 2004
[33] Phone conversation with Mr Goretzka, Hempel Germany (27.12.06) and Mr Thomsen, International Paint (29.12.06)

- A regular underwater propeller polishing will result in a fuel reduction of 1 to 2%.
- The grinding off the welding seams will reduce fuel consumption of 3 to 4%.[34]

2.2.2.6 "Alternative" Fuel

a) Biodiesel

At present, there are only few ships powered by Biodiesel, these are mainly government ships, research vessels, coast guard, or naval ships.

Box 6: Biodiesel

Biodiesel (or biofuel) is the name for a variety of ester-based fuels (fatty esters) generally defined as the monoalkyl esters made from vegetable oils, such as soybean oil, rapeseed, canola or hemp oil, or sometimes from animal fats through a simple transesterification process. This renewable source is as efficient as petroleum diesel in powering unmodified diesel engine.

The U.S. National Oceanic and Atmospheric Administration (NOAA) operates a fleet of research vessels and small boats on the Great Lakes through its Great Lakes Environmental Research Laboratory (GLERL). As part of its larger stewardship mission in the marine environment, NOAA, over the past 7 years, has been exploring options to convert its research vessels (age 30-50 years) from petroleum-based fuels and lubricants to full use of renewable and environmentally friendly products (NOAA "Green Ship Initiative"). One of their vessels, the Huron Explorer, a former Coast Guard vessel now serving on the Great Lakes, is the first U.S. research vessel to operate free of petroleum products.[35].

b) "Dual Fuel"

A Dual Fuel engine can be run alternatively in gas mode or liquid fuel mode. It is also fully capable of switching over from gas to liquid fuel (marine diesel oil) automatically should the gas supply be interrupted, while continuing to deliver full power.
The advantage of dual-fuel is: larger cargo capacity, lower fuel consumption, more flexible operations, and lower emissions.

Gaz de France was the first company operating dual-fuel vessels. Most recently, BP Shipping has ordered four 155,000 m^3 LNG carriers, with an option for four more, all

[34] Delta Marine Presentation at the "Green Shipping World" Workshop, Copenhagen 3rd October 2006
[35] http://www.canamglass.org/index.php?news=true

to be powered by dual-fuel engines. The first four ships are due for delivery in 2007 and 2008.

c) Liquefied Natural Gas (LNG)

Up to now only comparatively small ships are powered by LNG, among them ferries and oil rig supply vessels, one of them is the "Viking Energy", a North Sea supply ship of the fleet of Eidesvik, Norway. Even though being small compared to cargo ships, the North Sea supply vessels are very powerful, They are used to tow oil rigs, and on these jobs they usually use a lot of diesel, thus producing as much NOx pollution each day as several thousand cars[36]. By using LNG as fuel, NOx emissions can be cut by 85 percent.

2.2.2.7 "Cold Ironing"

One method to control ship emissions while a ship is in the port is to use shore-supplied electricity to run lights, heating, air conditioning and hot water for the ship's crew and for vessel (e.g. winches) and cargo-related operations (e.g. reefer containers). This method of supplying electricity is called "Cold Ironing" or "Alternative Marine Power (AMP)". Power is supplied to the ship to operate its machinery, but not its main engines. This allows the ship to shut down the diesel engines that normally drive the ship's electrical generators. Thereby, cold ironing could produce large emission reductions. It could be installed at nearly all terminals and be used by a large percentage of ships. The most attractive ship categories are container ships, passenger ships and reefer vessels.

Box 7: "Cold Ironing", AMP

"Cold Ironing" or Alternative Marine Power (AMP) is the practice of "plugging in" a vessel to shore-side power rather than having its engines run while it is in the port. In order for a ship to cold iron, it must be equipped with special power cables and defined connectors, and the terminal at which it is docked must be equipped to provide the additionally required power.

Box 8: "Hotelling"

While docked, most cargo and passenger vessels shut off their main engines but use auxiliary diesel and petroleum-fired steam engines to run power generators that supply electricity for refrigeration, lights, pumps and other functions. In the shipping industry, this act is called "hotelling." The resultant emissions, chiefly NOx, SOx, CO, volatile organic compounds (VOC) and diesel particulates (PM) contribute to the higher pollution related health risks near ports.

[36] http://www.planetark.org/avantgo/dailynewsstory.cfm?newsid=11943

A number of ports are using AMP, or are indicating that they are planning to adopt alternative power solutions, among them:

- USA – Los Angeles, Long Beach, Juneau (Alaska), Houston, Richmond (Virginia), New York/New Jersey, Seattle, Oakland, Tacoma, and Philadelphia
- Canada - Vancouver
- Baltic Area: Lübeck (New Hansa Project), Gothenburg
- North Sea: Seebrucke

The idea of shore-to-ship power is not a new one, the port of Gothenburg (Sweden) provides AMP for Ferries since 1988, and for icebreakers since 1992. In the U.S., shore-to-ship power for US Cost Guard is supplied since 2001.

A number of shipping lines have adapted some of their ocean going carriers committed/fitted with AMP, among them:

- NYK Japan
- CSL China
- Peter Doehle Germany
- NSB-Conti Germany
- Evergreen Taiwan
- MSC Switzerland
- CP Offen Germany for P&O
- Patjens Germany for P&O
- Yang Ming Taiwan
- B & N Transocean Finland
- China Shipping Lines
- Hansa Shipping
- Lloyd Triestino
- K-Lines

In total, 75 container ships are delivered, on order or prepared for AMP[37].

In its Commission Recommendation (2006/339/EC) of 8 May 2006, the EU proposes that the Member States should consider the installation of shore-side electricity "*particularly in ports where air quality limit values are exceeded or where public concern is expressed about high levels of noise nuisance, and especially in berths situated near residential areas*". Furthermore, it is recommended, that "*Member States should consider offering economic incentives to operators to use shore-side electricity pro-*

[37] Cavotec: Alternative Maritime Power supply, presentation at the 4th ASEAN Ports and Shipping –Kuala Lumpur June 5-7, 2006

vided to ships, taking advantage of the possibilities set out in Community legislation".[38]

Resume:

Measures to reduce fuel consumption and thereby waste oil generation are too numerous to be mentioned exhaustively. Some of these measures require comprehensive technical modifications of the vessel or engine; others require just "common sense" measures, like route planning and optimisation, etc.

Figure 7 provides an overview on different fuel saving measures, for further information please refer to Report of Finnish Environment Institute 8 2006 and clean solutions for ships Göteborg.

[38] COMMISSION RECOMMENDATION of 8 May 2006 on the promotion of shore-side electricity for use by ships a berth in Community ports. Official Journal of the European Union, 12.5.2006

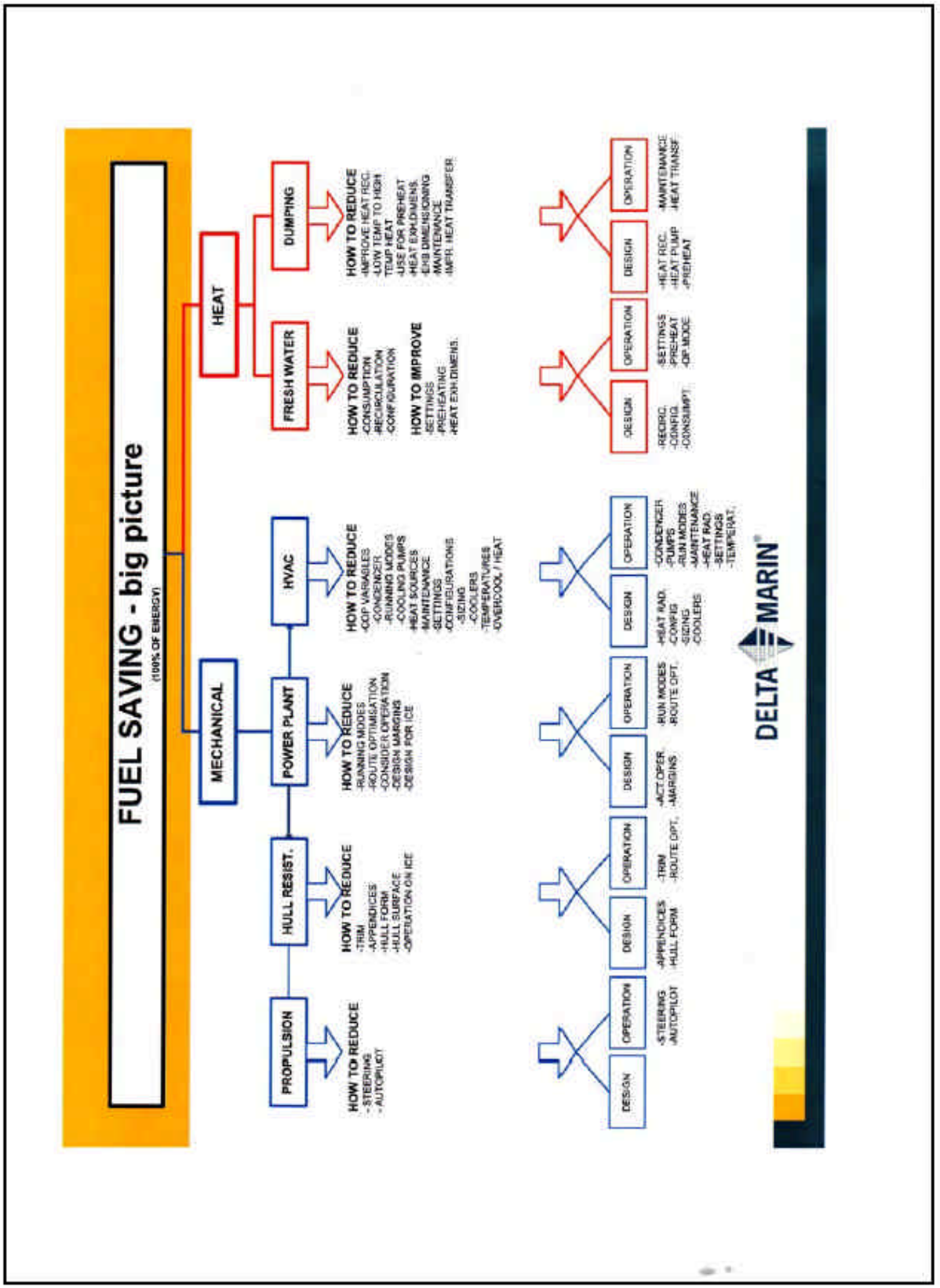


Fig. 7: Fuel saving measures
Source: Jari Nurmi, Deltamarin Contracting Ltd, presentation at the Green Shipping World, Copenhagen September 2006-10-20

2.2.3 Waste Management

A properly planned and executed onboard waste management programme can reduce the basic categories of ship generated wastes:

(1) Oily waste, usually some oil mixed with large quantities of water, but also fuel residues and sludge
(2) Sewage, generated by passengers and crew
(3) Garbage, originating from the crew and passengers, maintenance of the ship, cargo and fishing activities,

MARPOL 73/78 Waste Category	Type of Waste
Annex I	Oily Waste: ▪ Bilge Water ▪ Sludge from fuel Oil Purifier ▪ Scale and Sludge from Tank ▪ Ballast Water ▪ Tank Washings ▪ Waste from exhaust gas cleaning (SOx-scrubber) which contain besides acid also poly-aromatic residues , heavy metals, soot, etc.
Annex IV	Waste Water: ▪ Grey Water ▪ Black Water
Annex V	Garbage: ▪ Mixed Garbage ▪ Plastic Waste ▪ Food Waste ▪ Cargo-associated Waste ▪ Maintenance Waste

Table 6: MARPOL 73/78 Waste Categorisation

Waste referring to Annex III (Prevention of pollution by harmful substances in packaged form) is subject to the IMDG-Code.

Operational measures to reduce emissions to air (Annex VI: Prevention of Air Pollution from Ships) have already been discussed before.

The MARPOL Convention requires that ships retain their wastes on board until reaching a port. However, certain wastes are allowed to be discharged at sea under specific conditions, depending on the type of waste, minimum distance from the next shore, and condition of the waste MARPOL discharge criteria. Plastics of any kind are under no circumstances allowed to be discharged. The vessels must be equipped with dedicated holding tanks for sewage and oily wastes and have the capacity to

compact and store garbage. This is required for all vessels belonging to or trading with MARPOL contracting countries.

In the following, the majority of examples given for waste management stem from the cruise industry as one of the fastest growing sectors of the shipping industry. Concerning waste generation, the cruise industry needs special attention, as

- Large cruise vessels with 4,500 passengers are the equivalent of small cities in regard to waste production
- An average cruise vessel passenger generates up to 4.5 kg of dry garbage, 3.5 kg of food waste, and disposes of two bottles and two cans a day[39] (A Shifting Tide)
- The waste comprises also hospital waste and chemicals from photo processing and dry cleaning
- Seventy percent of cruise destinations are located in "biodiversity hotspots"
- Cruise ships bring millions of tourists to these fragile ecosystems and protected areas each year, which could threaten the sustainability of the resources on which the industry depends.

Because of this and also because of the increased public (customers) awareness, many cruise lines are voluntarily developing comprehensive waste management policies.

2.2.3.1 MARPOL Annex I - Oil

Methods for the reduction of oily waste have already been discussed in this Report (see: "Fuel Management", "Speed Reduction" in this chapter above).

For cruise vessels operational methods for waste oil reduction are limited. In general the vessels are not very old and have diesel electric propulsion, which generates low amounts of waste oil anyhow. Some of the newest cruise ships, as for example **Celebrity Cruises'** ship "Summit" and **Royal Caribbean Cruises' (RCI's)** "Radiance of the Seas" have gas turbine engines. Instead of diesel fuel, turbine technology requires cleaner burning fuel in the quality of Jet A-1 fuel. Emissions (NOx by 80 % and SOx by 98 %) as well as sludge and oil waste are significantly reduced.

[39] James E.N. Sweeting and Scott L Wayne: A Shifting Tide – Environmental Challenges and Cruise Industry Responses -The Center for Environmental Leadership in Business, Conservation International, Suite 600, 1919 M Street NW, Washington, DC 20036

However, methods for fuel reduction are possible, which means in general also less waste oil generation. One method used by cruise vessels to decrease the overall energy required to operate the vessels and thereby reduce the fuel consumption, is to utilise the heat produced from incineration or engines as a co-generative source for other energy demanding activities, as for example to heat the water used aboard the ships[40].

The **Norwegian Cruise Lines (NCL)** gives an example for sludge reduction: their older vessel, the *Norway,* cannot accommodate as much waste as the newer ships. Therefore, their incineration rate is comparatively high. In order to run the incinerator, NCL engineers collect oil sludge from other cruise lines and use it for the *Norway*'s boilers. Sludge, which would otherwise be disposed of on land, is used as an alternative fuel source.

2.2.3.2 MARPOL Annex V - Garbage

Annex V of the MARPOL Convention prohibits all overboard disposal of plastics and limits discharges of other kind of garbage, based on the material and the vessel's location and distance from shore.

According to Regulation 9(2) of Annex V of MARPOL,

> *"Every ship of 400 tons gross tonnage and above, and every ship which is certified to carry 15 persons or more, shall carry a garbage management plan which the crew shall follow. This plan shall provide written procedures for collecting, storing, processing and disposing of garbage, including the use of the equipment on board. It shall also designate the person in charge of carrying out the plan. Such a plan shall be in accordance with the guidelines developed by the Organization and written in the working language of the crew."*

MEPC/Circ.317 of 10 July 1996 provides guidelines assisting the ship-owner and/or operator in the implementation of this Regulation (MEPC/Circ.317).

Furthermore, each vessel shall be provided with a Garbage Record Book in which each discharge operation, or completed incineration, shall be recorded.

[40] NATIONAL POLLUTION PREVENTION CENTER FOR HIGHER EDUCATION, Pollution Prevention in the Coastal Zone Waste Reduction at Sea: Pollution Prevention Strategies on Miami-Based Cruise Lines

In general, a waste minimisation policy for the shipping industry should follow the list of preferences in industrial waste management options:

- waste avoidance
- re-use
- recycling
- treatment and disposal.

Waste avoidance and re-use:

By simple common-sense practices it is possible for all ships to drastically reduce waste stemming from packing materials. Excess material can be left on shore, and larger and reusable storage containers can be utilised.

This applies in particular to cruise vessels, as they produce large amounts of waste due to the high number of passengers and crew.

Princess Cruises, one of the leading cruise lines worldwide, carrying more than a million passengers each year, has replaced individual plastic packets of cream, preserves, and other such items with larger, reusable containers. The company has also replaced aluminium cans with soda fountains. Similarly, **Royal Caribbean Cruise Line (RCCL)** has substituted aluminium cans by a multi-flow beverage syrup system. The company estimates that this saves more than two million cans per year. RCCL has also replaced on-deck plastic plates and utensils with reusable plastic or china ware dishes and steel cutlery.

Waste recycling:

Up to 30 percent of the total waste produced by each vessel is recyclable[41]. Therefore, on-board storage of waste for recycling on land is the second option to reduce waste discharges into the marine environment. This method is less desirable to cruise lines because of space limitations and sanitation concerns. In order to store waste on board and maximise space, cruise vessels have to use a variety of equipment, including compactors, crushers, and shredders. The items that are put through these volume-reducing devices are mostly recycled on land, as for example compacted aluminium cans.

[41] Pollution Prevention in the Coastal Zone - Waste Reduction at Sea: Pollution Prevention Strategies on Miami-Based Cruise Lines. National Pollution Prevention Center for Higher Education, University of Michigan, October 1998

Waste treatment and disposal:

Waste, which can neither be re-used nor recycled, is often incinerated on board. Incinerators are still used onboard of all vessels to burn waste. This should be the least option, as the emissions are discharged into the air

Other methods of waste reduction are:

- Treatment of wastewater to a level that renders it usable for toilet flushing, laundry and deck washing (Carnival)
- Collection of air conditioning condensation as water to perform on-board laundry (RCCL vessels)
- Storage of cooking oil and grease in special holding tanks for recycling in port

Awareness training:

Essential to environmental initiatives are training and education programmes. At **Carnival Cruises**, for example, all shipboard employees attend a familiarisation course, which provides instruction on shipboard waste management. Additionally, specialised environmental training is provided to all shipboard as well as relevant shore side employees. Advanced training is also given to certain key positions.

Programmes like **Crystal Cruises'** "Crystal Clean", enlist passenger cooperation in anti-litter efforts. Passengers' activities are included in the on-board recycling programmes. Specialties of this programme are biodegradable golf balls and packaging of in-cabin toiletries.

Cruise lines have developed environmental programmes on board their vessels in compliance with environmental standards and regulations set by the IMO, the International Council of Cruise Lines (ICCL), various maritime classification societies, as well as national environmental laws.

The ICCL, whose members include the largest passenger cruise lines, have developed the "Cruise Line Waste Management Standards" (see box 8 next page below). Furthermore, ICCL and Conservation International (CI) are carrying out a joint initiative to develop a global map that integrates additional sensitive marine areas into cruise line navigational charts where wastewater discharge should be avoided[42].

[42] www.iccl.org - Press Release March 14, 2006

Box 9: Cruise Line Waste Management Standards[43]

ICCL member cruise vessel operators have agreed to incorporate the following standards for waste stream management into their respective Safety Management Systems.

1. Photo Processing, Including X-Ray Development Fluid Waste: *Member lines have agreed to minimize the discharge of silver into the marine environment through the use of best available technology that will reduce the silver content of the waste stream below levels specified by prevailing regulations.*
2. Dry-cleaning waste fluids and contaminated materials: *Member lines have agreed to* prevent *the discharge of chlorinated dry-cleaning fluids, sludge, contaminated filter materials and other dry-cleaning waste by-products into the environment*
3. Print Shop Waste Fluids: *Member lines have agreed to prevent the discharge of hazardous wastes from printing materials (inks) and cleaning chemicals into the environment.*
4. Photo Copying and Laser Printer Cartridges: *Member lines have agreed to initiate procedures so as to maximize the return of photo copying and laser printer cartridges for recycling. In any event, these cartridges will be landed ashore.*
5. Unused And Outdated Pharmaceuticals: *Member lines have agreed to ensure that unused and/or outdated pharmaceuticals are effectively and safely disposed of in accordance with legal and environmental requirements.*
6. Fluorescent And Mercury Vapour Lamp Bulbs: *Member lines have agreed to prevent the release of mercury into the environment from spent fluorescent and mercury vapour lamps by assuring proper recycling or by using other acceptable means of disposal.*
7. Batteries: *Member lines have agreed to prevent the discharge of spent batteries into the marine environment.*
8. Bilge and Oily Water Residues: *Member lines have agreed to meet or exceed the international requirements for removing oil from bilge and wastewater prior to discharge.*
9. Glass, Cardboard, Aluminium and Steel Cans: *Member lines have agreed to eliminate, to the maximum extent possible, the disposal of MARPOL Annex V wastes into the marine environment. This will be achieved through improved reuse and recycling opportunities. They have further agreed that no waste will be discharged into the marine environment unless it has been properly processed and can be discharged in accordance with MARPOL and other prevailing requirements.*
10. Incinerator Ash: *Member lines have agreed to reduce the production of incinerator ash by minimizing the generation of waste and maximizing recycling opportunities.*
11. Graywater: *Member lines have agreed that graywater will be discharged only while the ship is underway and proceeding at a speed of not less than 6 knots; that graywater will not be discharged in port and will not be discharged with in 4 nautical miles from shore or such other distance as agreed to with authorities having jurisdiction or provided for by local law except in an emergency, or where geographically limited. Member lines have further agreed that the discharge of graywater will comply with all applicable laws and regulations.*
12. Blackwater: *ICCL members have agreed that all blackwater will be processed through a Marine Sanitation Device (MSD), certified in accordance with U.S. or international regulations, prior to discharge. Discharge will take place only when the ship is more than 4 miles from shore and when the ship is travelling at a speed of not less than 6 knots.*

[43] ICCL INDUSTRY STANDARD E-01-01 (Revision 2) CRUISE INDUSTRY WASTE MANAGEMENT PRACTICES AND PROCEDURES Effective: January 1, 2006

2.2.4 Ballast Water Management

According to estimates, globally over 12 billion tonnes of ballast water is moved annually and 3,000 – 4,000 species are carried around each day with potentially devastating environmental and economic effects in many areas of the world.

The problem of harmful aquatic organisms in ballast water was first raised by the IMO in 1988. In 2004, a new International Convention to prevent the spread of harmful aquatic organisms carried by ships' ballast water was adopted (BWM Convention). The BWM Convention requires all ships to implement a Ballast Water and Sediments Management Plan, to carry a Ballast Water Record Book and to carry out ballast water management procedures to a given standard. The Convention will enter into force 12 months after ratification by 30 states, representing 35 per cent of world merchant shipping tonnage. Up to now, only 6 States, representing 0.62 % of the world tonnage, have ratified the BWM Convention[44]

Treatment methods for ballast water can either be mechanical (filtration, cyclonic separation), physical (UV radiation, heat treatment) or chemical (chemical additives as chlorine, biocides).

An **operational method** for ballast water management is to **exchange the ballast water** in the open ocean during a voyage in order to replace coastal water with open-ocean water. By this procedure the amount of coastal organisms in ballast tanks that may be able to invade a recipient port is reduced, as coastal organisms are replaced by oceanic organisms with a lower probability of survival in near shore waters.

There are two main types of ballast water exchange: sequential and flow-through. Sequential ballast water exchange involves completely emptying segregated ballast tanks and thereafter refilling them with open ocean water. Flow-through ballast water exchange involves pumping open ocean water into a full ballast tank for a certain length of time, sufficiently to flush the ballast water tank.

Sequential ballast water exchange is considered the more effective method, since it involves almost completely emptying the ballast water and refilling it with clean open-ocean water. However, ship stability, draft and trim might significantly change during sequential exchange, making this option unfeasible for some ships.

[44] IMO Status of Conventions (as at 30 April 2006)

Some shipping lines, as for example **P&O Nedlloyd** (since August 05 taken over by AP Moeller-Maersk), or **Teekay Shipping** voluntarily carry out ballast water exchange also in areas where it is not required by law.

(P&O Nedlloyd vessels made use of the Mid-Atlantic water to supply the zoo of Rotterdam with urgently needed ocean water for the aquarium).

The costs for ballast water exchange are relatively low and involve merely the development of ballast water management plans as well as increased pumping and fuel costs. Most crude oil tankers already have ballast water management plans in place.

The disadvantage of this procedure is that the ability to safely conduct ballast water exchange depends upon weather and sea surface conditions, and it is not always – and not for all vessels – possible to perform the exchange. Furthermore, there might be still some residual density of coastal organisms in ballast tanks after exchange, so this process might only be partly effective.

Resume:

All examples given above demonstrate the broad range of BEP-measures. However, there are a number of further measures planned and/or applied. To find and name them all would go beyond the scope of this study.

In order to provide an overview on all environmental programmes, policies and guidelines, a database is being established by the Shipping Federation of Canada[45] which will officially be launched first quarter of 2007. This database is at present in the validation process with all members of the Shipping Federation of Canada[46].

[45] Database of Marine Industry Anne Legars Director, Policy & Government Affairs Presentation at the "Green Shipping World" Workshop, Copenhagen 3rd October 2006

[46] Phone conversation with Ms Caroline Gravel, Director Environmental Affairs, The Shipping Federation of Canada, 01.02.07

2.3 Environmental Management System (EMS)

An Environmental Management System (EMS) can be described as a voluntary programme of continuous environmental improvement that follows a defined sequence of steps drawn from established project management practice and routinely applied in business management. In simple terms these steps are as follows:

- Review the environmental consequences of the operations.
- Define a set of policies and objectives for environmental performance.
- Establish an action plan to achieve the objectives.
- Monitor performance against these objectives.
- Report the results appropriately.
- Review the system and the outcomes and strive for continuous improvement[47].

Not every system will present these steps in exactly the same way, but the basic principles should be alike:

- The company commits itself to measuring its environmental performance in certain key areas, and to make steady progress.
- Top management commitment is of utmost importance.
- The indicators of performance are chosen from a range of possibilities, and the final choice reflects the specific impacts which the type of vessel operating company is most likely to generate (of course, there are different environmental impacts to be expected from cruise vessels, chemical tankers, container vessels, etc.).

Linked to this report is an example of an environmental plan from Hanjin Shipping (Hanjin Plan), which details the identified environmental impacts, objectives, and the targets that have to be reached within a certain time.

Such systematised environmental management instruments are international standards like ISO 14001 or EMAS (European Eco-Management and Audit Scheme). In voluntarily complying with such standards, a number of vessel operating companies demonstrate and document that they

- comply with environmental regulations, and
- take substantial steps in improving their environmental performance.

[47] WORLD BANK GROUP: Pollution Prevention and Abatement Handbook, Environmental Management Systems and ISO 14000

A list of vessel operating companies that have an EMS in operation is attached to this report as (Leif Höeg Environmental Statement). Due to its widespread acceptance, the majority of the companies are ISO 14001 registered. This goes in line with the global development of EMS (see fig. 8 below).

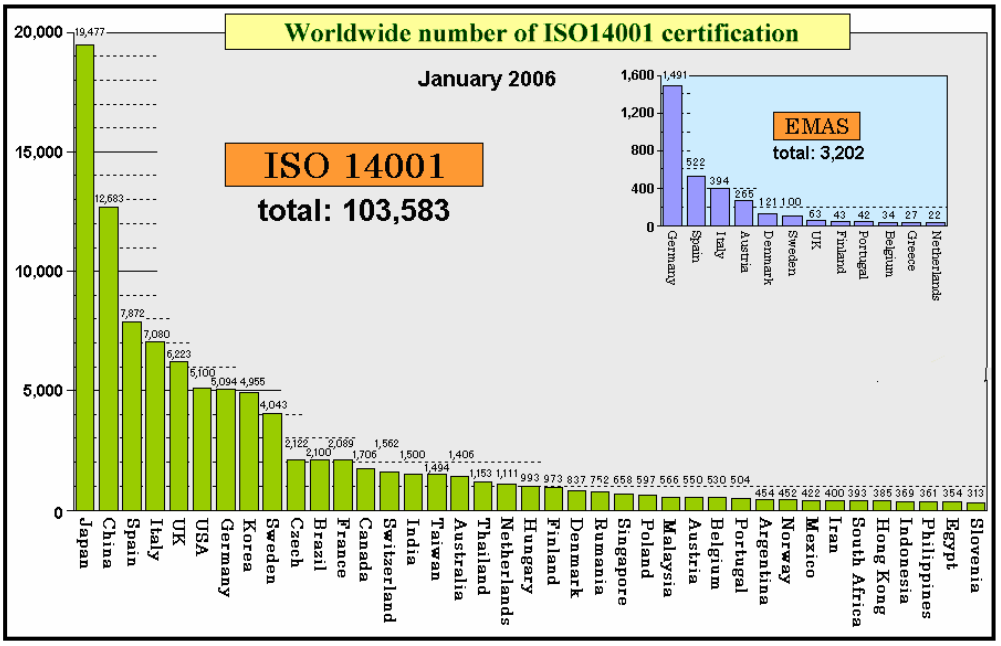


Figure 8: Worldwide number of ISO 14001 and EMAS certifications
Source: www.ecology.or.jp/isoworld/english/analy14k.htm

Both management systems are very similar, EMAS, however is slightly more comprehensive in its requirements, e.g. there are requirements for communication with the public, which is not part of ISO 14001.

In order to promote EMAS, a pilot project called "Shipping with EMAS" was launched in 2003. Shipping with EMAS has been approved and co-financed by the European Commission (LIFE ENVIRONMENT PROJECT). Until now, EMAS has not received particular attention by the shipping industry (see email "shipping with EMAS").

Potential benefits for the shipping industry are:

- Assurance of compliance with environmental laws and regulations.
- Assurance that the company meets, and will continue to meet, its legal and corporate policy requirements.
- Potentially less surveillance from regulatory agencies (e.g. PSC).
- Demonstration of environmental responsibility.

- Increasing competitiveness.
- Reduction of environmental liability.
- Reduction of costs as a result of potentially lower insurance rates.

However, currently there is no direct monetary benefit from possessing ISO14001 certification[48], though it does demonstrate the company's commitment to environmental protection and, whenever practicable, the reduction in waste and overall pollution.

Costs of the EMS:

It is difficult for the representatives of shipping lines to give information about the costs for starting and running a certified EMS. The main reason for this is the fact that the shipping lines pay a lump sum for certifying the whole company, including all vessels, and all offices on all locations[49].

Information has been obtained from one shipping company[50] (BW Shipping)

- "*Initial certification and training costs c. US$ 40K*
- *Ongoing certification / audit costs c. US$15K pa.*
- *Difficult to estimate the additional costs for support services (e.g. garbage collection in port) or specific hardware (e.g. improved waste oil purifiers) until we have had a full 12 months operation as the certification only commenced in Nov 2005).*
- *Costs minimized by advanced level already reached before certification process began"*

ISO 14001 Certification Renewal:

Once every three years the EMS is entirely reassessed, once per year an initial audit has to be carried out.

[48] Email information from BW Shipping Managers Pte Ltd, and:
Interview with Ship Management Hamburg-Sud, Hapag-Lloyd
[49] Interview with Ship Management Hamburg-Sud
[50] BW Shipping Management

Environmental benefits:

The specific environmental benefits related to an EMS like EMAS or ISO14001 (which go beyond MARPOL and legal requirements) are prescribed in the environmental targets the company voluntarily complies with. When defining these targets, each company can put the emphasis differently, according to their corporate environmental objectives.

Box 10: The requirements for full compliance with ISO 14001

- An environmental policy – including a commitment to continual improvement, prevention of pollution and compliance with relevant environmental legislation and regulations; the policy must be available to the public;
- Identification and evaluation of the environmental aspects or issues associated with an organisation's activities, products and services that may have a significant impact on the environment;
- Compliance with relevant legal and other regulatory requirements;
- Documented and, where possible, quantifiable environmental objectives and targets;
- The establishment and maintenance of an environmental management programme in order to achieve agreed objectives and targets;
- Evidence of the practical implementation of an environmental management system including the allocation of roles and responsibilities, training programmes, documentation, operational control procedures and emergency preparedness and response mechanisms;
- Monitoring and measuring of relevant operational and management activities, including record keeping;
- Procedures for periodic auditing of the environmental management system, to inform management of the findings and to ensure the system conforms with the standard (i.e. that the environmental management system is properly implemented and maintained);
- Management review of the environmental management system to ensure its suitability, adequacy and effectiveness in meeting the requirements of an organisation's environmental policy and commitment to continual improvement.

	ISO 14001	EMAS
Basis	International standard ISO 14001:1996	EU: Regulation (EEC) No. 1836/93 FRG: Environmental Audit Act of Dec. 7, 1995
Area of applicability	Worldwide	European Union
Scope of application	Organization related	Organization related
Verification via	Certification procedures (2-tier) by an accredited certification body	Review of the environmental management system and validation of the environmental declaration by an approved environmental verifier
Public information	Within the scope of the organizational communication procedures	Obligatory via publication of the validated environmental declaration
Registration	n.a.	Entry in the German and European Site Register by the Chamber of Industry and Commerce or the Chamber of Handicrafts

Table 7: Differences between ISO 14001 and EMAS
Source: "ISO 14001 and EMAS: A Pledge to Active Environmental Protection", TÜV Management Service GmbH, 2002

2.4 Inventory and Analysis of the Different Economic Incentives

Worldwide, there exists a variety of initiatives taking substantial steps in improving the environmental performance of the maritime industry. They comprise incentives for ship operators (like offering reduced port dues and other direct financial incentives, such as reduced pilotage fees, waste reception charges and insurance premiums to ships and shipping companies that meet certain criteria) and other initiatives as awarding systems without a direct pecuniary value, which give positive publicity for environmentally responsible shipping.

During the period of the study, 47 different systems and initiatives (not all of them being in operation) have been identified. They are listed in Annex 2.

From this list, specific widely known initiatives from Europe and the U.S. have been selected and described in the following chapters (2.4.1 – 3.2.4). These initiatives provide an insight into the wide range of possibilities in the sector, including a first appraisal of the pros and cons of the selected schemes.

It can be stated that during the last years the environmental concerns in shipping have shifted from oil pollution to air emissions. Today, emission-based initiatives are dominating the range of incentives and awarding schemes. This goes in line with the international climate policy, which has developed strongly during the last decades

and is nowadays one of the most important elements of national and international environmental policies.

This chapter provides a first evaluation of the different initiatives; the discussion is taken up in detail in chapter 3.1.

2.4.1 The GREEN AWARD

The most common award promoting environmental sound shipping is the GREEN AWARD (Rotterdam). It is the first incentive system with a global range. The Green Award Foundation was established in 1994 on the initiative of the Rotterdam Municipal Port Management and the Dutch Ministry of Transport in order to promote "quality shipping" by providing market incentives. Since January 2000, the organisation works entirely independent.

Participating vessels are crude oil tankers, product tankers and dry bulk carriers with a minimum size of 20,000 DWT. Before receiving the GREEN AWARD certificate, the vessel has to fulfil specific requirements:

a) Compliance with international and national legislation
b) Specific requirements for crew and management
c) Requirements of the technical equipment of the vessel

In the GREEN AWARD, the requirements of b) and c) are laid above national and international legislation. A complete list of the GREEN AWARD requirements is attached to this report as Annex 3.

This GREEN AWARD is not only based on the technical qualities of the ship, but also on the qualities of its crew and management. This is expressed, inter alia, in the Annual Report 2005, page 26: "*The aim of having less green in the logo is also to make clearer that the scope of Green Award is wider than protection of the environment only. Green Award looks at environment, safety and quality*." (green award annual report 2005)

Therefore the office of the owner / manager is audited as well prior to ship certification. The results of the office audit are valid for a period of three years; each ship applying for Green Award certification is surveyed annually. For both, office and ship, the inspection scheme consists of basic and ranking criteria.

Benefits for participating ship owners / managers:

- For participating vessels, there is a considerable discount of port fees at about 40 ports in eight different countries (see table 8 below). 196 vessels are certified up to now (12.12.2006, Green Award Ships), all of them are tankers[51]. This is only a very small percentage of operating vessels that fit into the categories for which in principle the GREEN AWARD is applicable, as worldwide there are about 1,500 tankers and 1,500 bulk carriers of this category operating[52].
- About 40 % of Green Award certified vessels never call at an incentive port. The main advantage of being certified lies in the fact that oil tanker charterer prefer Green Award vessels as they consider them to have a reduced risk ("additional class"), as the requirements for certification are above legal (national and international) requirements.

The "Green Award" is widely known and accepted, not only in Europe, but also in Australia, Canada and Japan. The level of requirements is continuously evaluated, and in praxis it is changes every two years, either by adapting the requirements or the scoring system to new regulations or new industrial developments.[53]

[51] Phone conversation with Mr Jan Fransen, Managing Director of the Green Award Bureau, 28 Dec. 2006
[52] www.greenaward.org
[53] Phone conversation with Mr Jan Fransen, Managing Director of the Green Award Bureau, 28 Dec. 2006

Table 9: The GREEN AWARD – participating ports and port states
Source: www.greenaward.com

Country	Port	Incentive
Belgium	Port of Ghent	6% premium on the port fees for Crude oil / Product Tankers and for Dry Bulk Carriers
Lithuania	Klaipeda State Seaport	5% premium on vessel dues for Crude oil / Product Tankers
New Zealand	Westgate Port Taranaki	5% discount on its marine tariff for any Green Award vessel
Portugal	Porto de Sines	5% premium on Tariff of port use (TUP) for Crude oil / Product Tankers
	Portos do Douro e Leixões	3% premium on Tariff of port use (TUP) for Crude oil / Product Tankers
	Porto da Lisboa	5% premium on Tariff of port use (TUP) for Crude oil / Product Tankers
	Porto de Setúbal	3% premium on Tariff of port use (TUP) for Crude oil / Product Tankers and for Dry Bulk Carriers
South Africa	National Ports Authority of South Africa, Ports of Richards Bay, Durban, East London, Port Elisabeth, Mossel Bay, Cape Town, Saldanha	5% port dues rebate in all South African national ports, if not enjoying already a 5% rebate in terms of double-hulled / SBT scheme.
Spain	Puertos del Estado (Bilbao, Santander, A Coruña, Huelva, Bahia de Cádiz, Bahía de Algeciras, Málaga, Cartagena, Valencia, Castellón, Tarragona, Barcelona, S.C. de Tenerife and other ports)	As from 1st January 2004 a new port law has become effective in Spain. The reimbursement for Green Award certified vessels has been postponed until after implementation of modifications to the new law. (clarification sought from ESPO)
The Netherlands	Port of Amsterdam	6% premium on the port fees for Crude oil / Product Tankers and for Dry Bulk Carriers
	Port of Rotterdam	6% premium on the port fees for Crude oil / Product Tankers
	Zeeland Seaports (Vlissingen, Terneuzen)	6% premium on the port fees for Crude oil / Product Tankers
United Kingdom	Port of Sullom Voe (Shetlands)	5% reduction on the payable harbour dues for Crude oil / Product Tankers

Advantages of the system:

- The GREEN AWARD criteria list is very comprehensive, a broad range of the different aspects of pollution is considered
- The GREEN AWARD is worldwide very well known and has set a certain environmental standard in the shipping industry

Disadvantages of the system

- The GREEN AWARD covers only a limited range of vessels. This incentive system presently only applies to tankers and bulk carriers of a minimum size of 20,000 DWT. Other vessels, as container vessels, cruise ships, general cargo vessels, etc. cannot participate in this system.
- Incentives awarded by ports are not the same throughout the scheme, even within one participating country the premium on port dues may vary (e.g. in table 8 - Portugal).
- This incentive system cannot be applied universally in all seaports, as the criteria for the GREEN AWARD are to a great extend designed for large tankers and bulk vessels only. Such vessels cannot be dispatched in every port .
- Ranking criteria – and thereby the criteria that provide the basis for incentives – are complicated.
- The system provides incentives for vessels calling at participating ports only. There will be no direct benefits for vessels calling at other ports.

2.4.2 The Bonus / Malus System

In Sweden, there are two independently operating incentive systems in place:

- Environmental Differentiated Fairway Dues
- Differentiated Harbour Dues

2.4.2.1 Environmental Differentiated Fairway Dues

Sweden has primarily taken the exhaust quality, especially with regard to ships' emissions of SO_x and NO_x, as criteria for establishing an incentive ("bonus / malus") system.

Box 11: Swedish Fairway Dues

Fairway dues are a national levy collected by the Swedish Government via the Swedish Maritime Administration (SMA). Fairway Dues enable provision of services to shipping, infrastructure investments, dredging, lighthouse and fairway maintenance, ice-breaking, hydrological surveys, etc. Dues are paid by ships of all flags visiting Swedish ports and calculated on the basis of their gross tonnage.

The incentive system is called "Environmental Differentiated Fairway Dues" and is based on an agreement between the Swedish Shipowners' Association, the Swedish Port and Stevedore Association and the Swedish Maritime Administration (SMA). It was introduced in 1998 with the aim of reducing emissions of sulphur oxides (SO_x) and nitrogen oxides (NO_x) by 75 per cent until 2010 (starting 01.01.1998)[54].

"Environmental Differentiation" means that the SMA offers reduced fairway dues, differentiated according to the ship-generated emissions of NO_x and SO_x. If the level of emitted NO_x, for example, is 12 g/kWh or more, the dues for tankers carrying a cargo of mineral oil products in bulk will be SEK 5.30 (~ € 0.56) per unit gross tonnage, and for other ships than tankers SEK 5.00 (~ € 0.53) ("malus"). If the level of emissions is lower, the dues will be rebated, so that a ship which has attained an emission level of a maximal 2 g/kWh will be billed SEK 3.70 (~ € 0,39) or SEK 3.40 (~ € 0.36) respectively ("bonus"). Dues for other degrees of cleansing are rebated according to a linear scale.

In order to encourage the installation of catalytic converters, which give the highest degree of purification, the SMA will reimburse the fairway dues being paid for a five-year period.

[54] HELCOM MARITIME 4/2005, Document 6/1

To reach the required SO_x-level, and thus be qualified for the system, Ro/Pax (combined Roro- and passenger ferries) and railroad ferries have to be continuously operated on fuel with a sulphur content of less than 0.5%. For cargo ships, this level was set to less than 1% , taking into account their traffic pattern and the availability of low sulphur fuel in Northern Europe.

Control of bunker receipts as well as fuel analyses are carried out by SMA inspectors. In order to reduce the NO_x emissions, ships have to install measures as described in box 11, page 62, which have to be controlled and certified by an independent accredited control laboratory. The results must be listed in a measurement report and in a NO_x attestation issued by that laboratory.

Benefits for participating ship owners / managers:

- There is a considerable economic incentive for complying vessel operators: An oil tanker, for example, having attained an emission level of nitrogen oxides of maximum 2 g/kWh, is charged a maximum amount of SEK 100,000 (~ € 10,605). Following a linear scale, with an increasing rate of SEK 6,000 (~ € 636) per g/kWh, the amount for an emission level exceeding 12 g/kWh is SEK 160,000 (~ € 16,967).

  For other vessels than tankers the amounts are SEK 60,000 (~ € 6,363) and SEK 100,000 (~ € 10,605) respectively with an increasing rate of SEK 4,000 (~ € 424) per g/kWh.

Environmental benefits:

- After eighteen months of operation of the scheme, already about 1200 vessels from a total number of 3500 ships calling at Swedish ports were registered for continuous low sulphur operation. Between 1998 and 2004, 38 vessels had installed NO_x reducing technology and had been qualified through certification and registration.
- A high reduction of the most serious air pollutants: The total annual reduction of SO_x and NO_x emissions of vessels participating in the system was calculated as 50,000 tonnes of SO_2 and 41,243 tonnes of NO_2 in the year 2004.

Advantages of the system:

- As the system is based on "bonus" ***and*** "malus" (polluters pay more), it can be considered cost neutral[55], as the system involves the imposition of an emissions charge ("malus") and relief from it according to a rebate method ("bonus").
- The system is very transparent, information can easily be obtained via Internet.

Disadvantages of the system:

- The system focuses on two different kinds of air pollutants (NO_x, SO_x) only. Other pollutants (oil, waste, etc.) and also other air pollutants (as CFC's and other ozone depleting substances) are not considered. (However, this can be explained due to the very sensitive Swedish ecosystem, which is at permanent threat of acidification and eutrophication.)
- The problem of low-sulphur fuels has been debated controversially, also from an environmental point of view, as desulphurising of fuel is extremely energy demanding; use of this fuel might therefore not provide the desired overall environmental benefit.
- Low-sulphur fuels are very expensive. According to a representative from Exxonmobil Marine Fuels Ltd., the additional costs are about 40 € per tonne[56]. This might render truck traffic more competitive – especially in the Baltic Region. Considering the rising costs of sea transport due to the higher fuel costs, it is possible that multi-modal transport will focus to a greater extent on truck traffic in future. (Especially after construction of the Great Belt Bridge (1997) and Oresund Bridge (1999) over the international waterway of the Danish Straits, which makes truck traffic more comfortable, and limits vessel traffic in the Baltic to middle-sized vessels).
- Availability of low-sulphur fuels for vessels can be problematic in some geographical areas. This might necessitate installing additional scrubbing technology (end-of-pipe application) on board.

[55] HELCOM HOD 18/2005
[56] Schiff & Hafen 5/2001: "Schonung der Umwelt und Erhöhung der Zuverlässigkeit des Schiffsbetriebes – Neue Anforderungen und Lösungen"

2.4.2.2 Differentiated Harbour Dues

In 1998, the system of differentiated harbour dues was introduced in Sweden. About 30 of the major Swedish ports are participating in this system[57].

The system of differentiated harbour dues is not influenced by the SMA; therefore, the conditions for application and implementation may vary from port to port. Nevertheless, the criteria for each port are transparent, as they are published and available for vessel operators via the Internet.

Box 12: Options available to reduce NOx from HFO and investment costs

NOx reduction method	Description	Potential reduction	Investment costs (base 1999) in EUR
Emulsification	The engine runs on an emulsion of water and fuel. This leads to a 10 % reduction of NOx per 10 % of water present in the emulsion. Fuel consumption can increase by 1 % for every 10 % of water content	20 – 40 %	~ 30,300 (for engines less than 3 MW)
Humidification (fumigation)	Cooled moist air added to the combustion exhaust can reduce NOx significantly	50 – 80 %	Unknown
Direct injection	Water or other liquids are injected directly into the combustion chamber	50 – 60 %	From 9,000 to 26,700
Selective catalytic reduction	Using a catalyst results in the highest reduction of NOx. Requires low sulphur fuel (< 2 %) and other consumables (urea and replacement of catalyst material).	85 – 90 %	36 to 61 per kW for engines over 1,000 kW; 61 to 182 per kW for engines under 1,000 kW; Running costs included
Engine tuning and injection retardation	Reducing the exhaust temperature and/or retarding the start of the oil fuel injection, NOx reductions can be achieved a very low costs – albeit with a fuel efficiency penalty	10 – 30 %	Low cost

Source: OECD Maritime Transport Committee, 2003: Cost Savings stemming from Non-Compliance with International Environmental Regulations in the Maritime Sector

NO_x and SO_x:

Discounts are given to ships that use low-sulphur bunker oil, as well as to ships that use catalytic exhaust emission control (SCR) or other environmentally sound technologies as humidification, water injection or water emulsion in order to encourage ship owners / managers to reduce their vessels' emission of sulphur and nitric oxide.

[57] Tomas Ljungström, Maritime Policy and Public Affairs: "Fairway dues in Sweden – presentation at the Ice Days in Kemi, 9 February 2006

Other Pollutants:

Apart from exhaust emission, other relevant environmental aspects can be considered in the differentiated harbour dues, too[58]:

- Tank vessels with SBT: deduction of harbour dues, reduced disposal charges for sludge and oily bilge water,
- Raised dues for tank vessels with single hull
- Discounts for vessels, which, through various measures, reduce onboard waste

Extra dues are paid, for example

- If the port does not receive notification of solvents or detergents contained in the sludge
- If containers with oil residues or dangerous waste are not correctly wrapped and marked
- If the water content in the sludge to be disposed off exceeds 50 % (Södertälje)

Advantages of the system:

- *As the system does not only consider air emission, but also other pollutants it gives incentive to a comprehensive ship environmental management system.*
- *By leveraging the costs for non-compliance, the system can be cost-neutral*

Resumen: Measures to Reduce NOx-Emissions[59]

There are two general approaches to NOx abatement:

- prevent NOx forming; and
- post combustion conversion back to N_2 and O_2.

(a) Low NOx Engine Design

Low NOx Engine Design as described in chapter 2.1.1.6 is currently the primary abatement approach assumed, for example, by MARPOL Annex VI.

[58] See Annex 4: "Port Tariffs for the Port of Göteborg" and "Harbour Dues for Ships" Port of Södertälje
[59] A SEaT Paper – Shipping Emissions Abatement and Trading, EmissionControlv051.doc. 13 January 2005

The standards are normally achieved by:

- Careful design of combustion by the shape of the combustion chambers and auxiliary chambers.
- Careful design of the gas flows into the cylinder to ensure appropriate mixing
- Careful design of valve timing; and
- Appropriate timing of fuel injection.

(b) Selective Catalytic Reduction (SCR)

The principle of SCR is that flue gas, when mixed with a reagent – ideally Ammonia (NH_4) – and passed over a catalyst will reduce the NOx components to N_2, water and O_2. In ideal circumstances NOx reductions of up to 95% and beyond can be achieved, but these ideal conditions tend not to apply when manoeuvring close to port, and realistic reductions are significantly lower. SCR is being used on a number of ships for NOx reductions, mainly for auxiliary engines. SCR can in principle be integrated with other abatement technologies, with, for example, the exhaust being further scrubbed to remove SOx.

Instead of ammonia it is more common to use urea – a readily available industrial chemical – which largely converts to ammonia when injected into the hot exhaust stream. The effectiveness of conversion depends on good control of the urea injection. Too much or too little for the exhaust flows damages efficiency and effectiveness. The catalysts, often embedded on ceramic substrates, create backpressures with adverse impacts on engine performance.

Disadvantages of the system:

- The catalysts are "poisoned" by sulphate salts, and so deteriorate faster the more sulphates are present. This can be countered in two ways: by having no sulphur compounds in the exhaust stream or by operating at temperatures high enough to prevent the sulphate salt formation.
- The catalysts have quite short life and need renewing every few years. It is not yet clear how the spent catalysts can best be disposed of safely.
- Ammonia escaping after SCR processes is dangerous, so rigorous controls are needed.
- Urea (or ammonia) is consumed, so a urea supply chain must exist and be paid for.

(links: http://www.jmcsd.com/se2.html, http://www.manbw.com/ Links report\Wärtsilä_SCR_technology.pdf)

(c) Fuel Additives for Nox-Reduction

Fuel additives have long promised significant benefits for NOx reduction, and there are sound theoretical foundations for believing that appropriate additives can modify combustion processes to reduce NOx formation. If the additive is water, and this is incorporated and distributed as small droplets within the fuel, these small droplets can "explode" when the fuel gets hot during injection to a cylinder, so ensuring better mixing of fuel and air, and so more controlled combustion

So far, there have been few large scale or commercial trials of such technologies in the marine context, but it is reasonable to expect that, with appropriate incentives, good, cost effective technologies will be marketed

Water and oil do not naturally mix, so to make "emulsion" fuels small quantities of other "emulsifiers" are added. These fuels are also known as emulsion fuels, with proportions of water up to about 20% of the fuel volume. Some fuel additive systems mix the oil and water just before injection. This can reduce the need for emulsifiers, but needs more complex mixing equipment on-board.

(d) Emulsions

Water itself appears to modify combustion processes in benign ways that reduce NOx formation. But the quantities of water needed are quite large, at around 30% of the volume of the fuel water mixture. Modified engines have been successfully run with such fuels, and have achieved NOx reductions of some 30%, and research continues to be pursued. However, emulsions are not easy to make stable, so there is a choice about whether to mix the emulsion at specialised plant, and carry higher volumes of fuel, or to mix the emulsion just before use, when specialist technology and fairly pure water is needed.

(e) Humid Air Motors (HAM system)

The benign impact of water on combustion processes raises the possibility of carrying the water into cylinders in the form of humid combustion air, and this is the concept of Humid Air Motors. They work by putting water vapour into the inlet air stream, and are effective at reducing NOx.

There are issues to be resolved:

- Quite high volumes of water need to be evaporated to create enough humid air to achieve the reductions sought, and are comparable with the fuel volumes. This requires heat input. The heat input is provided by heat exchange

from the hot compressed air after the engine turbocharger. This implies that at low load there may not be sufficient heat in which case the HAM system is not used.

- Under varying loads (when it is most difficult to achieve optimum combustion) it is also hard to control the humidity adequately.

(f) Fuel Cells

A good way to avoid NOx is to avoid combustion, and fuel cells deliver electricity from non combustion reactions moderated by catalysts. There are fuels cells which range from relatively cool to very high temperatures, liquid metal oxides
The ideal fuel cell configuration is to feed pure Hydrogen (H_2) and pure Oxygen (O_2) to a fuel cell, to obtain electricity and pure water (H_2O). Energy conversion efficiencies of up to 60% can be achieved, and this is now the preferred power source for submarines, as (unlike nuclear reactors) it minimises leakage of heat that might be detectable.

The technology is not yet suitable for commercial use in commercial shipping, but research and development is continuing. However, variations to the technology are possible and promising for shipping:

- Air can be used instead of pure O_2. But with the complication of needing to use 5 times the gas volumes;
- Methanol can be used instead of Hydrogen. But with the complication of needing to reform it first.
- Hydrocarbons can be used instead of methanol, but with the complication of higher temperature reactions and more difficult catalysts,

Hydrogen is a good energy carrier, with high energy densities for its weight, and it will work with fuel cells as well as internal combustion engines. It has to be solved how ships should be equipped best to carry hydrogen bunkers.

Table 8 below shows different measures for emission reduction and their efficiency:[60]

[60] Source: European Commission, Directorate General, Environment: Service Contract on Ship Emissions: Assignment, Abatement and Market-based Instruments. Task 2 – General, Entec UK Limited, August 2005

Measure	% Emissions reduction per vessel			
	SOx	NOx	PM	VOC
Shore-side electricity (cold ironing)*	0	97	89	94
Direct water injection	0	50	0	0
Humid air motors HAM	0	70	0	0
Selective catalytic reduction (2.7 % RO)	0	90	0	0
Selective catalytic reduction (1.5 % RO)	44	90	18	±
Selective catalytic reduction (0.1 % MD)	96	90	>63	±
Sea water scrubbing	75	0	25	±
* Compared to engines using 0.1 % sulphur fuel. This is based on the sulphur content corresponding to the future requirements under the Sulphur Content of Marine fuels Directive requiring ships a berths to use 0.1 % sulphur fuel.				

Table 8 : Measures for emission reduction

2.4.3 U.S. Coast Guard - Qualship 21

In 2001, the U.S. Coast Guard (USCG) implemented an initiative to identify high-quality ships and to provide incentives to encourage quality vessel operations. This initiative is called Qualship 21, "quality shipping for the 21st century".

By identifying the quality of a vessel, the USCG – by reversal reasoning – attempts to eliminate substandard shipping. All non-U.S. flagged vessels are examined at least once per year and scored according to a "targeting matrix". Vessels that are operated responsibly and found with few or no deficiencies are recognized and rewarded for their commitment to safety and quality.

Box 13: Qualship 21: Eligible Flag States (2004)

- Barbados
- Bermuda
- Denmark
- Germany
- Gibraltar
- Greece
- Hong Kong
- Isle of Man
- Luxembourg
- Netherlands
- Norway (NIS)
- Singapore
- Sweden
- United Kingdom
- Vanuatu

Precondition for obtaining the Qualship 21 Award is that the vessel is operated by a well-run company, is classed by a classification society with a quality track record, is registered with a Flag State with a superior Port State Control record, and has a Port State Control history without deficiencies in U.S. waters.

Box 14: Flag of Convenience FOC

All sea-faring ships must be registered in and fly the flag of one country (Flag State). For commercial reasons, ship-owners may register their ships in an inexpensive flag state (Flag of Convenience FOC). Just six Flag of Convenience states including Liberia, Panama, the Bahamas and the Marshall Islands (well known countries that provide this cheap service), make up 55 % of the world's shipping tonnage. These countries not only offer a favourable tax system, but they also have fewer requirements for the crew and do little to ensure ship safety or to enforce environmental laws.

In detail, the requirements for obtaining the Qualship 21 Award are[61]:

- The vessel must not have an IMO Detention in U.S. waters within the previous 36-months
- It may not have committed any marine violations (civil or criminal) and no more than one paid Notice of Violation (ticket) case, within the previous 36-month period
- The vessel may not have a reportable marine casualty that meets the criteria of a serious marine incident in U.S. waters within the previous 36-months
- It must have completed a successful U.S. Port State Control exam within the previous 12-month period
- It may not be classed by a targeted class society
- The vessel may not be owned or operated by any company that has been associated with a substandard vessel detention in U. S. waters within 24 months

[61] Source: European Quality Shipping Information System (EQUASIS) ww.equasis.org

- It may not be registered with a Flag State that has an overall U.S. IMO detention percentage of more than 1% over the previous three-year period
- The vessel's Flag State must have submitted their Self-Assessment of Flag State Performance to the IMO and provided a copy to the USCG.

Only approximately 10% of the non-U.S. flagged vessels that call at U.S. ports qualify for this initiative.

Box 15: U.S. Coast Guard – Targeted and Non-Targeted Classification Societies

Classification societies are assigned points, based on four separate performance levels starting at the baseline detention ratio of 0.5%, which indicates a minimum level of 'acceptable' performance. Class societies with a detention ratio of less than 0.5% will not be targeted. Societies with a detention ratio that exceeds 0.5% are assigned points in the risk based vessel targeting matrix as follows:

A detention ratio –
1. less than 0.5% = 0 points
2. equal to 0.5% or less than 1% = 3 points
3. equal to 1% or less than 2% = 5 points
4. equal to or greater than 2% = priority 1

The following points are at present assigned to each class society:

Priority 1	5 Points	3 Points	0 Points
• Hellenic Register of Shipping HRS • Honduras International Naval Surveying & Insp. Bureau HINSB • INCLAMAR • International Register of Shipping IROS • Isthmus Bureau of Shipping, S.A. IBS • Panama Maritime Documentation Services PMDS • Panama Register Corporation PRC • Panama Shipping Register PSR • Phoenix Register of Shipping PHRS	• Polski Rejestr Statkow PRS	• Russian Maritime Register of Shipping RS	• American Bureau of Shipping ABS • Bulgarski Koraben Registar BKR • Bureau Veritas BV • China Classification Society CCS • China Corporation Register of Shipping CR • Croatian Register of Shipping CRS • Det Norske Veritas DNV • Germanischer Lloyd GL • Indian Register of Shipping IRS • Lloyd's Register LR • Nippon Kaiji Kyokai NKK • Panama Bureau of Shipping PBS • Panama Maritime Surveyors Bureau, Inc. PMS • Registro Italiano Navale RINA • Romanian Naval Authority ANR • Korean Register of Shipping KRS

Benefits for participating ship operating companies:

The system is very uncomplicated for the vessel operators, as no application or nomination process is necessary. If the vessel meets the required criteria, it is issued with the Qualship 21 Certificate, which is meant as an acknowledgement of "day-in and day-out prudence and responsibility on compiling creditable safety and pollution prevention records", rather than a direct economic incentive. Approved vessels receive an initial 2-year certificate entitling them to a less rigorous inspection regime. Benefits can be summarised as follows:

- Having the name of the vessel posted on the U.S. Port State Control Website is a marketing tool, especially for passenger ships and cruise vessels
- Limited Port State Control examination frequency for all vessels (biannual examinations) except tank vessels and passenger ships
- For tank vessels: reduced scope of mid-period examinations

Unlike the Green Award, no reduction in fees is currently offered by Qualship 21, although discussions are ongoing with the American Association of Port Authorities.

Environmental benefits:

It is hardly possible to quantify the environmental benefits of Qualship 21. However, it can be definitely stated that elimination of substandard vessels and targeting of certain Flag States and classification societies will decrease the occurrence of marine accidents. Two devastating oil spills off the coast of Europe involving older single-hull tankers – the *Erika* in 1999 and the *Prestige* in 2002 – clearly demonstrate this (the 25-year old Erika was Maltese-flagged, the Prestige was Bahamas-flagged). One of the main problems associated with Flags on Convenience is that it can be an obscure system, which makes it hard to determine who is ultimately responsible for a ship (the Prestige, for example, sailing under the flag of the Bahamas, was registered in Panama, it's manager was Greek, it was chartered by a Russian oil company registered in Switzerland.).

The International Maritime Organization IMO also states[62]: "*There was a wide consensus that the Erika and other the recent accidents involving oil tankers pointed to a need for additional international measures to eradicate substandard vessels, particularly substandard oil tankers, given the catastrophic impact such ships may have on the marine environment in the case of an accident*".

[62] Tanker safety - preventing accidental pollution – www.imo.org

(This again shows the slow process of implementing international agreements: single hull oil tankers are to be phased out in 2015. This was decided by the IMO in 1999!).

Advantages of the system:

- Broad scope of control: Each foreign flagged vessel is controlled (compared to 25 % as required by the Paris MOU on Port State Control), therefore, there is hardly any possibility for substandard vessels to slip through the control net
- Not only the vessel itself, but also the Flag State and the Classification Society are included in the system. This will contribute to the development of a higher standard with certain ("targeted") classification societies and flag states.

Disadvantages of the system:

- As merely compliance with legal requirements is demanded, this system is not pro-active, it does not give incentives for installation of advanced or state-of-the-art technology or special environmental behaviour.

2.4.4 Project "Green Shipping" Hamburg

In order to promote higher environmental standards in the shipping industry, the Senate of the Hanseatic City of Hamburg introduced the bonus-system "Green Shipping" (initiated by the Environmental Authority in 1999) in the Port of Hamburg on the 1st of July 2001. This system granted harbour dues deductions to seagoing vessels as an incentive for certain environmental friendly behaviour that is above the standards of the IMO.

Criteria	Reduction of Port Dues by
vessels holding a GREEN AWARD certificate	6 %
vessels holding a ISO 14001 certificate	6 %
vessels operating at 15 % below the exhaust gas norms set in the new Annex VI of MARPOL	12 %
vessels operated exclusively with fuel with a sulphur content of less than 1.5 %	12 %
TBT-free hull coating	12 %

Table 10: "Green Shipping" Hamburg – criteria for incentives

It was decided to start with a few well-established criteria as listed in table 9 above. These criteria for reduction of port dues were meant to be expanded during the following years.

In the end, the project was thwarted by too many "windfall" benefits:
An experience report of the year 2003 showed that the biggest part of application for harbour due reduction was based on environmental friendly hull coating. As the EU member states proclaimed a Europe-wide ban of TBT-based ship paints from 1 January 2003, this incentive was pointless after that date[63].

All vessels trading in the Baltic area had to use fuel with a sulphur content of 1.5 % according to HELCOM. Vessels coming to Hamburg from the Baltic claimed the incentive for low sulphur operations, although they were just complying with HELCOM legal requirements.

In both cases, the incentives claimed did not result in improved environmental performance.

Therefore, the project was abandoned after a change of government in the City of Hamburg in June 2003, even though the project was planned for a time span of five years. It was considered not to be necessary any longer.

Benefits for the ships:

Incentives were given, depending on vessel size and number of calls: for example, a container vessel, of 35,000 GRT could save per call DM 754.- to DM 1,508.-(€ 380 to € 750), a tank vessel of 67,000 GRT DM 1,199.- to 2,398.- (€ 600 to € 1200).

According to a study of the Germanischer Lloyd[64], the rebates, which were given by the "Green Shipping" system, sufficed to fully offset the extra costs of a TBT-free hull coating.

[63] Verbal communication: Environmental Authority, City of Hamburg
[64] Wirkung eines differenzierten Hafengeldes auf Referenzschiffe (Gutachten GL) in: Green Shipping: Ermäßigung der Hafengebühren für umweltfreundliche Schiffe, Hamburger Anreize für hohe Umweltstandards im Schiffsverkehr, 11. Mai 2001

Advantages:

- The requirements of "Green Shipping" were based on already existing certification systems and could therefore easily be proven. This made the system very transparent for all persons involved, and it could be put into practice without further bureaucratic efforts.

Disadvantages:

- The rebates for "Green Shipping" were paid by the Environmental Authority, which means that the system had to be subsidised.
- It is problematic, if a system depends on the present political situation. There is always the risk that with a change of Government the main focus will be shifted to another topic.
- The system was not flexible; it was overtaking by actual developments: Incentives were given for TBT-free hull coating. However, during the project time a new international law banned TBT. Therefore, ships were awarded without making an additional positive environmental impact, contradicting the objective of the scheme.

2.4.5 The "Blue Angel"

In cooperation with the German Federal Minister for the Environment and the Federal Environmental Agency, the Environmental Label Jury has set up the criteria for the award of the environmental label for environment-conscious ship operation called "Blue Angel".

The requirements to be met for the award of the "Blue Angel environmental label for environment conscious ship operation" are split into three groups representing different aspects of environmental protection in maritime traffic:

- Ship owners' policy and shipping-company management
- Ship design and equipment
- Management of ship operation and ship technology.

Ship owners' policy and shipping-company management comprises systematized management instruments like the ISM-Code, ISO 9001, ISO 14001 as well as personnel management. While the ISM-Code is by now mandatory for all sea-going ships, the ISO 9001 and ISO 14001 standards are not

For **ship design and equipment**, a hull stress monitoring system has to be in place, which is necessary for the indication of stresses in ship structures in order to help avoiding dangerous overloading of bearing structures. Furthermore, an emergency towing equipment for quick towage of a ship in distress is required

Management of ship operation and ship technology applies to the reduction of SOx and NOx in the exhaust gases of the ship as well as to the usage of coolants and the reduction of respective emissions from cooling and refrigeration plant. Furthermore, reduction measures for soot and particle emissions have also been recognized as important, but limiting values have not been defined yet, because practicable proofing methods are still lacking.

Finally, emission of black and grey sewage waters, bilge waters, disposal of wastes on land are included in the Blue Angel awarding system.

The awarding criteria comprise 10 binding and 20 optional requirements (see link: Blue Angel Criteria). The 10 compulsory requirements are the most essential with regard to environmental protection. Out of the other 20 requirements aiming at additional desirable improvements the label user shall select at least three he commits himself to fulfil.

Award criteria apply to ships under the German flag, including the state service flag, and under foreign flags. They are not applicable to tank ships carrying products as defined in MARPOL Annex I and II (i.e. oil tankers and product carriers, chemical tankers, gas carriers), ships coming under the High Speed Craft Code, fishing vessels, recreational ships and navy ships.

Advantages of the system:

- The label awarding criteria are very flexile: besides ten binding requirements, as the vessel owner / operator can choose three from 20 optional requirements
- The criteria are applicable to existing and new ships as well as to different ship types.
- Management instruments as well as social conditions, operation and technology are covered

Disadvantages:

No incentives are given to the vessels. Up to now, only very few (four to six) vessels are certified. The requirements for the "Blue Angel" are recently discontinued and have to be updated[65].

Environmental benefits:

Each Blue Angel ship emits only half of its previous SOx-emissions (by obligation) or even about 85% less (optional). The NOx-share of international shipping in global emissions is estimated at 11 to 13 %, i.e. about 9.3 million tonnes NOx per year and thereof ca. 1.94 million tonnes in the Northeast Atlantic. Here individual emissions will be reduced by 20 % (obligatory) or by more than 50 % (optional)[66].

[65] Phone conversation with the Umweltbundesamt (Federal Environmental Agency), 27 Dec. 2006
[66] Implementation of Agenda 21 in European Ports at the example of Lübeck-Travemünde, Final report, Enclosure Band I, Stadtwerke Lübeck GmbH in cooperation with GAUSS, By order of the Federal Environmental Agency, December 2004 – page 182

2.5 Determining Compliance

2.5.1 Best Environmental Practice (BEP)

For the majority of BEP measures it is hardly possible to proof compliance, as they are based on environmental conscious behaviour of ship management and crew.

For some of these measures, however, compliance can be determined by presenting the respective documents, as for example:

BEP-Measure	Proof
Fuel Quality Management:	▪ Delivery notes for the fuel oil containing information on the sulphur content ▪ Receipt of fuel supplier ▪ Fuel analysis report
Biocide-free Hull Paint:	▪ Specifications by the manufacturer ▪ Documentary proof of application through the certificate issued in accordance with the AFS Convention (International Convention on the Control of Harmful Anti-fouling Systems on ships) and EU Regulation (EC) No 782/2003. The certificate is the same for TBT-free and biocide-free hull paints, but the type of paint is specifically mentioned in the certificate.
Waste Management	▪ Entries in Garbage Record Book ▪ Documentary proof of disposal on land

2.5.2 Environmental Management Systems (EMS)

The integrity of an EMS (EMAS or ISO 14001) depends on third-party audits to make sure that it is effective in operation, is meeting its specified goals, and the system continues to perform in accordance with relevant regulations and standards. Therefore, the environmental policy statement, the programme, the management system and internal audit cycles are reviewed and validated by an external accredited certification society, as for example ship inspection firms such as GL, DNV, Lloyd's Registry, Bureau Veritas, TÜV, and ABS, or financial accounting firms such as KPMG. The auditors must have requisite competence in environmental science, technology, environmental law and regulation, and systems auditing. The audit itself follows generally accepted auditing standards (e.g. ISO 14010, 14011, 19011).

Updating: The minimum frequency for an EMS audit is at least once every three years.

2.5.3 Awarding / Incentive Systems

2.5.3.1 The GREEN AWARD

Awarding is based on office evaluation and a further vessel evaluation by visual inspection. Different basic and ranking lists are used for audit and inspection. (Seacure for Operations, Appendix Oil Tanker, Appendix Bulk Carrier). Basic criteria are those required by international regulations (e.g. ISM Code, MAPROL 73/78), ranking criteria are reflecting all aspects of the ship and ship operations, e.g. navigation/bridge operation, maintenance/surveys, crew and ISO 9001. With the help of survey lists, the visual inspections onboard of oil tankers or bulk vessels are carried out.

The surveyors/auditors have to pass through a four week training programme, furthermore they hold a masters' or chief engineers' qualification with five years survey experience or even ten years respectively for carrying out the initial company surveys.

The Green Award certificate is valid for a period of three years.

2.5.3.2 The Bonus / Malus System

SOx-Emission:
The installation of catalytic converters is controlled by SMA inspectors, who are also checking the bunker receipts for controlling the use of low-sulphur fuel. Furthermore, fuel analysis are carried out by different Swedish laboratories.

NOx-Emission:
Measures to reduce NOx-emissions are controlled and certified by an independent accredited control laboratory.

The certificate is renewed after three years.

2.5.3.3 U.S. Coast Guard – Qualship 21

For awarding the Qualship 21 certificate, the US Coast Guard checks all foreign vessels with regard to:

- The vessel's performance at complying with standards. The vessel may not have been detained and determined to be substandard in U.S. waters within the previous 36 months.
- The vessel's violation history. The vessel may not have had any marine violations, any reportable marine casualties that meet the definition of a serious marine incident, or any major marine casualties in U.S. waters within the previous 36 months. Also, the vessel may not have had more than one paid notice of violation case (ticket) during the same period.
- The vessel's recent inspection history. The vessel must have completed a successful U.S. Coast Guard Port State Control examination within the previous twelve months.
- The vessel's flag state. Although QUALSHIP 21 is a vessel-focused initiative, the flag state is a relevant factor in identifying quality ships. To qualify for a QUALSHIP 21 designation, a vessel may not be registered with a flag state that has a detention ratio that is greater than one third of the overall U.S. detention ratio, as determined on a three-year moving average
- The vessel's flag state must have submitted its self-assessment of flag state performance to the IMO and have provided a copy of the self-assessment to the United States

All Qualship 21 designated vessels will receive a Certificate, issued by the Office of Compliance staff. This certificate has a maximum 2-year period of validity.

2.5.3.4 The “Blue Angel”

As the requirements for awarding the "Blue Angel" are based on already existing certified systems, compliance can easily be demonstrated by presenting the respective documents.

Ten binding and 20 optional requirements are listed (Criteria for the award of the environmental label). Out of the 20 optional requirements, at least three have to be chosen to be awarded.

Examples:

Requirement / *proof*	**Obligatory**	**Optional**
Quality Management:	▪ ISM Code	▪ ISO 9001
proof:	▪ *ISM Certificate*	▪ *Certificate of ISO 9001 compliance*
Personnel Management	▪ ITF-tariff provision or equal standard	▪ language proficiency
proof	▪ *Blue Card or valid ITF contract document*	▪ *passed IMO language test*

2.5.4 Class Notation

Even though the fundamental objective of vessel classification is to promote safety, several classification societies have broadened their scope by offering a special class notation to vessels that comply with requirements for environmentally safe design, construction, and operation, which go beyond the requirements of MARPOL. Table 11 gives an overview about the environmental class notations discussed in this study.

Classification Society		Class Notation
American Bureau of Shipping	ABS	Environmental Safety (ES)
Det Norske Veritas	DNV	"Clean" "Clean Design"
Registro Italiano Navale	RINA	Green Star "Clean Air" Green Star "Clean Seas"
Lloyds Register	LR	Environmental Protection (EP)

Table 11: Environmental Class Notations

2.5.4.1 Lloyd's Register (LR)

The British classification society Lloyd's Register (LR) has offered the class notation Environmental Protection (EP) to vessels classed by any recognized classification society, if the vessel meets LR's environmental guidelines that comprise the full spectrum of international conventions, which relate to marine environmental quality, such as the International Convention for the Prevention of Pollution from Ships (MARPOL 73/79), along with relevant International Maritime Organization (IMO) standards. Furthermore, to obtain the EP designation, a ship must demonstrate compliance with certain standards that have not yet been ratified by the international community.

Procedure for obtaining EP Designation:

- Plan Review prior to construction to determine that the proposed design complies with the requirements.
- Initial Survey during construction to determine that hull, machinery, and equipment are in accordance with the plans and that all equipment is in working order.
- Provisional Notation granted on successful completion of initial survey, valid for six-month period, during which time the crew must demonstrate and document that all procedures have been implemented.
- Final Audit to examine the documentation developed during the provisional period.
- Full EP Notation assigned following successful audit.
- Follow-up Surveys and Audits include annual survey and yearly audit and a renewal survey every five years to maintain the EP notation.

General requirements for EP Notations

- Comply with all relevant adopted Annexes of MARPOL, whether ratified or not.
- Have a Safety Management Certificate in accordance with the ISM Code, issued by the Flag State of Registration.
- Sign up with LR's Ship Emergency Response Service (SERS).
- Sewage treatment systems and holding tanks must have adequate capacity. All sewage discharges ashore or at sea must be documented as to date, location, and quantity.
- Develop and implement procedures for use and maintenance of equipment required for emission control, such as catalytic converters.
- Develop procedures for collection, segregation, processing, and disposal of garbage
- Provide precautionary measures to minimize translocation of non-native organisms in ballast water.

- No application of TBT after January 2003.
- No use of refrigerants known to harm the environment, in accordance with the Montreal Protocol on Substances that Deplete the Ozone Layer.
- Control the loss, leakage, venting, and disposal of all refrigerants. (By taking the position that leakage of any refrigerant is potentially harmful, LR is actually more stringent than the Montreal Protocol.)
- Limit the sulphur content of oil fuels used onboard, consistent with the quality of fuel available in the area of operation.
- Development of an oil-fuel management system including testing and documenting the sulphur content of fuel taken aboard.
- No use of halon or halo-carbons in the fire fighting system.

2.5.4.2 Det Norske Veritas DNV

Det Norske Veritas DNV has developed two environmental protection class notations, namely "Clean Design", prepared for ships trading in coastal waters, and "Clean", primarily for ships engaged in deep sea trading.

The requirements to comply with the "Clean" classification are similar to LR's EP, a ship must limit emissions and discharges to air and sea. The requirements are in line with those of MARPOL, including annexes not yet ratified. Specifically limited are antifoulings containing TBT, the sulphur content of fuel oils, on-board refrigerants that contain global warming promoting CFCs such as Freon, engine NOx emissions, plus discharges of grey/black water, and contaminated ballast (see Annex 10).

2.5.4.3 The American Bureau of Shipping (ABS)

The American Bureau of Shipping (ABS) has offered a class notation called Environmental Safety (ES) to any ABS-classed vessel that meets its environmental guidelines (ABS class environmental safety).

2.5.4.4 Registro Italiano Navale (RINA)

The "Green Star" is the class notation promoted by the Registro Italiano Navale (RINA). The "Green Star" scheme has both, a Clean Sea and a Clean Air element. The Clean Sea notation requires bunker tanks to be installed over double bottoms, holding tanks for black and greywater, requirements to ensure that garbage is disposed off safely and ships must use TBT-free anti-fouling. The Clean Air notation

sets limits on SO_x and NO_x emissions, requirements for refrigeration gases, and controls for incineration plants (Green Star).

Initial take up of these schemes has been by cruise lines whose new ships incorporate low NO_x emission gas turbines, advanced waste management systems, fuel tanks in protected locations and the use of non-TBT anti-fouling hull coatings. The first Green Star issued to a chemical/product tanker was made in 2002.

All of these additional class notations are entirely voluntary.

Benefits:

- For the shipyard, to make reference to clear technical standards for the design and construction of onboard systems and plants.
- For the ship-owner, to show passenger, charterers, media, the commitment for the protection of the environment by documenting the higher standard of pollution prevention achieved on his ships.
- For the personnel on board, to develop procedures for proper management of polluting substances.
- For passengers, to assure them that the ship is not harming the environment.

2.5.5 Green Passport

Ship dismantling as such can be considered as the most environmentally friendly way of disposing of ships, as it is possible to re-use every part of the hull and the machinery. In the past it was carried out in Europe, but it has now moved mainly to Asian countries, where the costs of dismantling are far cheaper. However, there the dismantling is often carried out with minimal accident protection, with inadequate tools and machinery, without regards for environmental protection and with unskilled workers, who often do not know anything about the hazardous materials they are handling.

To make sure that the recycling of ships is carried out in an environmentally friendly manner, the IMO adopted "Guidelines on Ship Recycling" in 2003. In these guidelines, there is a paragraph that describes and defines the "Green Passport".

Box 16: Green Passport

Ships sold for scrapping may contain environmentally hazardous substances such as asbestos, heavy metals, hydrocarbons, and ozone depleting substances and others. Concerns have been raised about the working and environmental conditions at many of the world's ship scrapping locations.

The "Green Passport" for ships contains an inventory of all materials potentially hazardous to human health or the environment, used in the construction of a ship. It accompanies the ship throughout its working life, from the shipyard at the construction stage where it is passed to the purchaser of the vessel, to the recycling yard. Any subsequent changes in materials or equipment have to be recorded. Successive owners of the ship have to maintain the accuracy of the Green Passport and incorporate into it all relevant design and equipment changes. The final owner delivers it, with the vessel, to the recycling yard.

The Green Passport is a document that contains guidelines and details of all potentially hazardous and high-risk materials on board a vessel. It should accompany the ship throughout its whole operating life. New owners of the vessel are obliged to maintain the accuracy of the Green Passport and to incorporate it into any relevant design and equipment changes. At the end of the vessel's life, the final owner would present it to the scrapping yard.

The Green Passport distinguishes between new ships and existing ships. In the case of a new ship, the ship owner should try to minimise the use of hazardous materials already in the design and construction stage. For existing ships, the owner should prepare a Green Passport in accordance with the guidelines and also minimize the generation of hazardous waste during the operation of a ship. All potentially dangerous materials that would have an adverse effect on human health and / or the environment have to be listed.

In its Resolution A.962(23) of 4 March 2004, the IMO developed guidelines in order to

- give guidance to all stakeholders in the ship's operating life;
- minimising the use of potentially hazardous materials and waste generation during
- a ship's operating life;
- encourage all stakeholders to address the issue of ship recycling.

(ResShiprecycling962)

Examples of acceptance in the shipping industry:

Wallenius Marine introduced the Green Passport to the Wallenius fleet (new building DSME 4442, delivered in May 2006)

The Independent Tanker Owners' Association Intertanko endorsed the Green Passport concept in 2004, requiring all new ships to carry the passport.

Shell has obtained Green Passports for all 25 of the liquefied natural gas (LNG) carriers in its managed fleet (Shell's LNG carrier Granatina was the world's first vessel to be awarded this recognition).

Chapter 3: Appraisal and Recommendations

3.1 Evaluation of Results and Findings

Chapters 2.2, 2.3 and 2.4 provide a variety of initiatives and practices applied by the different stakeholders of the shipping industry in order to enhance their environmental performance.

In order to find conclusions and recommendations based on these measures and initiatives, their strong points and possible draw-backs are discussed hereunder.

Wherever possible, the environmental benefits gained by the respective measure have been quantified. It has to be emphasised, however, that for a number of cases it is very difficult, sometimes even impossible, to deliver substantiated figures. This refers to nearly all BEP and EMS-measures. In this case, the benefits are described qualitatively only, the pros and cons of each measure are emphasized.

3.1.1 Evaluation of BEP Measures

3.1.1.1 The "Poseidon Challenge" or "Zero Concept"

Because a great number of stakeholders of the oil and shipping industry are integrated in this concept, the "Poseidon Challenge" can be considered as a unique approach. The environmental and social benefits to be achieved will be the sum of all stakeholders' activities, and therefore it is not possible to quantify them.

Pros

- Concept sets clearly defined goals to be achieved within a definite time frame (within five years):
  - Zero fatalities
  - Zero pollution
  - Zero detentions
- Integrating and recognising the responsibility of all links of the chain as a new approach which makes – of course – sense: in order to improve the whole chain, each link of the chain has to be strengthened.
- Every stakeholder sets his own goals and gives his commitment in order to achieve the overall goal.
- Covering a broad variety of aspects, according to the respective "link", as for example:
  - Choosing the most appropriate technical equipment
  - Providing advanced professional education and training
  - Sharing information on substandard vessels, etc.

Cons

- As the concept is based on self-commitment, all participants can set their own goals. There is no objective control whether these goals "significantly" improve the environmental performance
- The fact that there are too many "players in the game" could result in allocation of responsibilities to others in case of failure of the concept

3.1.1.2 Optimum Speed

To run a vessel at the optimum speed provides a typical win-win-solution: it reduces the costs for the vessel owner / shipping company, and reduces the release of pollutant as well as waste generation at the same time.

Pros

- Immediate effect of reduction of air pollutants
- Immediate effect of reduced waste generation (sludge)
- No investments necessary, as there is no technical equipment involved

Cons

- The speed at which a vessel has to run often dictated by various factors from outside:
  - Schedule (liner service); going at lower speed means additional vessel requirement by the customer
- Mainly for new ships to be equipped according to their speed optimum. In General, it is not possible to operate ships' engines below 70 % of their maximum revolution/minute.

3.1.1.3 Speed reduction

The example given is a voluntary reduction of speed to 12 knots or less within a 20-mile radius while approaching the Ports of Los Angeles and Long Beach.

Pros

- Immediate effect of reduction of air pollutants
- No investments necessary, as there is no technical equipment involved

Cons

- Addresses port and coastal area only (20 mile limit), considering the whole voyage of the ship, the effects of emission reduction are negligible
- Low environmental effect, as the speed has to be reduced anyhow while the vessel is approaching the port
- The onboard NOx abatement technology, currently available, is generally most efficient at full load of the sip's engine but its efficiency drops significantly when the engine load decreases as the ship slows down. Net effect is questionable when engine is on reduced load[67].

[67] Revision of MARPOL Annex VI, The NOx Technical Code and Relevant Guidelines, submitted to IMO by INTERTANKO, 17 October 2006

3.1.1.4 Fuel Quality Management

For this measure, three different examples have been given:

a) Part-time fuel switch from bunker to low-sulphur distillate
b) Permanent fuel switch to MDO in a certain region
c) Permanent global fuel switch for the whole shipping industry, as proposed by INTERTANKO

a) Part-time fuel switch from bunker to low-sulphur distillate

The voluntary "fuel switch" from bunker fuel to low-sulphur distillate by approaching and before leaving 24 miles from the ports of Los Angeles and Oakland, which was carried out by Maersk Line, is projected to result in a considerable reduction of the key air pollutants, while the vessel is within the emission reduction zone (see list below).

It has to be kept in mind, however, that this project is initiated by the respective ports. The emission reduction, even though being high, is locally only. Considering the whole trip of the vessel, the reduction of pollutants will be of no consequence.

Pros	Cons
▪ Immediate effect of reduction of air pollutants in the vicinity of the ports: – 73 % reduction in particulate matter (PM) – 92 % reduction in SO_x – 10 % reduction in NO_x ▪ No investments necessary, neither for the ports, nor for the vessels	▪ Addresses port and coastal area only (24 mile limit), considering the whole voyage of the ship, the effects of emission reduction are negligible ▪ No reduction of other operational waste, as for example sludge, can be expected. ▪ Fuel switch cannot be exactly controlled

b) Permanent fuel switch to MDO in a certain region

The "MDO" project by Wallenius Lines, in which MDO has been used instead of low-sulphur HFO, has achieved a high reduction in emissions, and has also been beneficial in a number of other aspects as, as for example, less sludge generation, cleaner working environment and conditions on board, etc..

Pros

- 5 % less fuel consumption
- 5 % less CO_2 emission
- Reduced fuel consumption for the heating of fuel tanks – increased energy saving.
- Longer service intervals for engines and boilers
- Less use of lub oil
- Reduced sludge generation
- Reduced sludge handling and cleaning – reduced labour time
- Cleaner working environment – reduced labour time
- Less use of detergents
- Use of less strong, environmental friendly cleaners
- Less painting is necessary – reduced labour time
- Reduced Fairway Dues (in Sweden)

Cons

- Higher price for MDO can make the shipping line less competitive. This is partly compensated by lower labour costs, and reduced Fairway dues (e.g. in Sweden).

c) Permanent global fuel switch for the whole shipping industry, as proposed by INTERTANKO

The environmental and social effect of INTERTANKO's proposal to the IMO to use low-sulphur MDO globally would be the same as for the example b) (above); further beneficial effects of a permanent and global use of clean fuel are:

Pros

- Global approach would mean no competitive distortion or advantage
- No need for bunker treatment onboard ships
- Reduction of fuel waste to be stored onboard and treated on shore
- Reduction in number of pipes and tanks
- No fuel change on voyage (and associated safety implications)
- No human errors during fuel changeovers, no risk of incompatibility between two fuel qualities as a result of blending during changeover process
- No loss of power by blockage of filters
- Simplified monitoring and regulatory control mechanisms for fuel quality compliance
- No further technical equipment for exhaust treatment to be installed
- Less regulatory control requirements for emission
- Applicable for old and new ships

Cons

- Acceptance of the global shipping industry is questionable
- Availability of sufficient MDO – refinery capacity
- Possible opposition from fuel oil suppliers, for refineries have to dispose of crude oil sludge now on shore

3.1.1.5 Silicone-Based Antifouling

As a further measure for fuel reduction, a hull coating with silicone-based antifouling has been described. From an environmental perspective the most desirable approach to fouling control is one which does not rely on the release of biocides to achieve its effect. At present, silicone-based antifouling is regarded as such an antifouling control.

Pros

- Non-toxic, no exposure to unhealthy conditions for the workers
- No disposal of hazardous paint waste
- Biocide-free
- Remediation of polluted harbours
- Fuel savings up to 6 %*)
- Self-cleaning at cruising speeds greater than 15 knots
- Easily cleaned with high-pressure water while the vessel is in port
- Reductions in dry docking frequency, longer intervals for hull cleaning compared to conventional antifouling (3 full coats compared to 4 – 5 full coats over a 10 years period)[68], silicone bottom paints last 1.5 to 2 times longer than conventional antifouling paints[69]

Cons

- The price of TBT : Copper-based : silicone-based is 1 : 2 : 7[70]
- Dedicated spray lines are recommended for application in order to prevent contamination of the coating, resulting in higher costs
- Silicone is slowly biodegradable; due to its persistent properties it is used as tracer for anthropogenic influences, as it has been widely used since the 50ies. Generally, it is considered to be harmless. However, up to now tests on long-term influences on aquatic organisms are missing.[71]

*)some producer of silicone-paint state that this figure is a bit too optimistic. They mentioned a fuel reduction of 2 % by use of their product[72].

[68] HEMPASIL 77599 silicone-based fouling release by Hempel

[69] Pacific Northwest Pollution Prevention Resource Center 1999: Large Shipyards in Oregon: Coating Choice Drivers & P2 Opportunities, A Northwest Industry Roundtable Report

[70] "Öko-Problem TBT-Alternativen", HANSA – Schiffahrt – Schiffbau – Hafen Nr. 9, 2000

[71] "Öko-Problem TBT-Alternativen", HANSA – Schiffahrt – Schiffbau – Hafen Nr. 9, 2000

[72] Verbal communication during interviews with representatives of silicone-paint producers at the SMM Fair, Hamburg, September 2006

3.1.1.6 "Alternative" Fuel

In this study, "alternative fuels" are those which are not based on mineral oil. Use of these fuels, of course, could solve the problems related to HFO, and also mitigate many impacts caused by the use of MDO.

The use of
a) Biodiesel
b) "Dual Fuel" (Diesel and LNG)
c) LNG
has been described.

a) Biodiesel

Pros	Cons
▪ Pure biodiesel is non-toxic, readily biodegradable and essentially free of sulphur and aromatics ▪ Immediate effect of reduction of air pollutants: – 50 to 60 % reduction in particulate matter (PM) – 99 % reduction in SO_x – 78 % life-cycle reductions in CO_2[73] ▪ Higher lubricity, cleaner injectors ▪ No investments necessary, as diesel engines can run with biodiesel, no concerns with engine performance ▪ Renewable, domestic fuel, reduce dependence on fossil fuel	▪ If not subsidised (as it is for example in Germany), biodiesel is much more expensive than petroleum diesel ▪ Availability – it will not be possible to produce enough biodiesel to supply the commercial shipping industry – use of biodiesel can only be a "niche" solution ▪ There are no marine fuelling station, trucking is costly and could increase potential for spills ▪ Increase in NOx emission, which could be mitigated with additives ▪ 8 % lower efficiency

[73] West Coast Diesel Emissions Reductions Collaborative, Project Description: Marine Biodiesel Fueling Station Submitted by Teri Shore, Bluewater Network, December 10, 2004

b) Dual Fuel engines run on both: on diesel and on LNG

Pros

- Lower air emission while using MDO instead of HFO
- Immediate effect of reduction of air pollutants while switching to LNG:
  - 100 % reduction in SO_x
  - 20 % CO_2
  - 90 (or more) % NOx
- LNG is comprised of 90 to 99 % methane; the higher fuel purity allows greater engine optimisation
- On NLG Tanker: possible use of boil-off as fuel in gas engines

Cons

- Low availability of LNG
- Vessel needs additional large fuel tank

c) Liquified Natural Gas

Pros

- Immediate effect of reduction of air pollutants:
  - 100 % reduction in SO_x
  - 20 % CO_2
  - 90 (or more) % NOx
- LNG is comprised of 90 to 99 % methane; the higher fuel purity allows greater engine optimisation
- On LNG Tanker: possible use of boil-off as fuel in gas engines

Cons

- Low availability of LNG
- Vessel needs additional large fuel tank

3.1.1.7 "Cold Ironing"

While in port, ships are provided with electricity from the national grid instead of producing electricity by ship engines. This shore-side electricity for vessels ("cold ironing") is considered as one measure to reduce ship emissions while at berth. It is used in several ports world wide meanwhile (see chapter 2.2.2.7).

Pros

- Immediate improvement of air quality in the port
- Reduction of 95 % in NO_x, SO_x, and PM10
- Once the equipment is installed on board, it is convenient for the ship, lower maintenance, no fuel changeover
- Reduced noise level in residential areas closest to the harbour, as well as for personnel working onboard or involved in loading operations around the quay
- No vibration, reduced noise result in better working condition especially for engineers working within the engine room environment, more convenient for cruise passengers and crew
- Reduced engine maintenance costs
- It must be assured that the shore-supplied electricity has not been generated by "dirtier" processes that shipboard energy

Cons

- Lack of shore power connections in current vessels, ships need to be retrofitted
- Additional costs for the vessels. Ships need to retain auxiliary engines, even if they were using shore-side electricity exclusively
- Port infrastructure must be in place to provide the additional electricity
- Lack of space at the quayside
- High costs: modifying a ship to accept cold ironing: > US$ 500,000 per vessel without an onboard transformer, and US$ 1.5 million per ship with transformer. The average cost for shore-side infrastructure, without additional shore-side transformer is US$ 3.5 million per terminal
- Currently there are no standards existing for shore-side electricity, different ports have access to different voltage levels
- Lack of shore power standardization: Electricity frequency produced by the grid (EU: 50 Hz) may not be compatible with the electricity required by ships (50 or 60 Hz)
- Transfer of pollution
- Doesn't address out-of-port running (3 mile limit)
- Power-generating capacity necessary to serve cold ironing is not everywhere available
- In a number of ports or countries the cold ironing is likely to cause significant impacts to the electricity system
- High costs for port terminals (example: for the Port of Hamburg for all terminals about 100 million €)

Cost Components:

Cost of installing a transformer to an existing ship is significantly higher than installing a transformer on a new ship.

For frequent callers, ferries, cruise vessels in very sensitive areas (e.g. Port of Juneau in Alaska) "cold ironing" can be considered a very sensible decision.

From a global point of view, the environmental benefit depends on the power generation for the AMP. The highest benefit can be expected, when regenerative power is used, as for example in the Port of Gothenburg, where the AMP is supplied by wind energy, and in Juneau, where hydropower is used exclusively.

Rotterdam is presently performing a feasibility study which will be available soon.

Box 17: Shore Side Electricity – EU Recommendation

Conclusion

The benefits and costs of shore-side electricity vary significantly depending on the existing configuration and location of the port, berth and ship. This means that its cost-effectiveness needs to be studied on a case-by-case basis, and that direct reduction of marine engine emissions should continue to be pursued.

In environmental terms, shore-side electricity achieves emission reductions well beyond those achieved from switching to 0,1 % sulphur fuel at berth (as Directive 2005/33/EC requires from 2010), particularly for NOx and PM. It therefore merits particular consideration in ports where ship NOx and PM emissions are contributing to local air quality problems, such as exceedances of ambient air quality limit values for ozone and particles.

In general the figures suggest that for ships with larger engines regularly visiting the same port, switching to shore-side electricity should be both environmentally and economically preferable to using 0,1 % sulphur fuel. In economic terms, shore-side electricity should generate savings compared to low sulphur fuel for new-build ships regularly visiting the same ports, especially, but not only, if electricity tax reductions are offered as allowed under Directive 2003/96/EC. Member States and local authorities might wish to consider other means to encourage ports to invest in shore-side electricity infrastructure and to ensure its use.

(source: L 125/42 EN Official Journal of the European Union 12.5.2006)

3.1.1.8 Waste Management (waste according to MARPOL Annex V)

As properly maintained waste management has beneficiary environmental impacts only, it is not necessary to discuss any pros and cons hereunder.

The special conditions on a vessel (higher waste production per person, not enough space to store waste) make onboard waste management a difficult task.

Therefore, the strategy of

1. source reduction
2. waste minimization
3. recycling, separate collection
4. processing (incineration)
5. discharge (ashore)

has a much higher significance than on land. This is of particular concern on cruise ships, as they are capable of generating massive volumes of waste. Other commercial vessels generate significantly lower amounts of waste, as the average crew is 19 compared to up to five thousand passengers plus crew onboard cruise ships.

Incineration:

Storage space is a crucial factor in any scheme to manage shipboard waste streams. Therefore, onboard incineration is still common praxis. According to MARPOL, the discharge to sea of incinerator ash from plastics which may contain toxic or heavy metal residues is forbidden[74]. This, of course, is extremely difficult to control. The use of incinerators poses further risks: A "cruise ship health risk assessment[75]" carried out in 2005 showed an elevated cancer risk of the crew attributed to the use of incinerators.

On other commercial vessels the health impacts are likely to be less than on cruise ships, as there are significantly lower amounts of waste generated and incinerated. A number of shipping lines have prohibitory company policies towards waste incineration, they collect and separate their waste and dispose it of on shore. At these shipping lines, new ships are generally ordered without incinerator[76]. Nowadays, approximately 45 % of the ocean-going ships do not have or use incinerators onboard.

However, the fact that in some ports it is not possible to handle the waste in an environmentally sound way has been used as an argument for onboard incineration[77]. It is considered more environmental friendly to incinerate the waste on board than to "export" it to countries without adequate waste handling facilities.

[74] MEPC 45/20, RESOLUTION MEPC.89(45), Amendments to Annex V of MARPOL 73/78, Adopted on 5 October 2000

[75] Presentation: Oceangoing Ship Onboard Incineration Public Workshop, Sacramento August 30, 2006, Air Resources Board, California Environmental Protection Agency

[76] Interview Ship Management Hamburg-Sud, Hapag-Lloyd

[77] Interview with a Captain of a vessel chartered by Maersk

Waste Segregation:

At a number of shipping lines, waste separation is carried out in an exemplary manner. In some ports (e.g. Stockholm, Helsinki), this is rewarded by reduced waste fees. In other ports, however, it is "frustrating to see how the separated waste is mixed again with other wastes for incineration"[78].

This, however, is due to the regulation in many ports that any waste according to MARPOL Annex V which is contaminated by food is considered to be quarantine waste and has to be incinerated for sanitation reasons[79].

3.1.2 Environmental Management System (EMS)

Participating in an internationally accepted EMS like EMAS or ISO 14001 is generally to be considered as being beneficial, as it signifies that the respective institution of the shipping industry is conforming to all the regulatory environmental standards, and additionally, sets targets for continuous improvement of its environmental performance.

Generally, an EMS according to EMAS or ISO 14001 provides the framework for meeting environmental targets defined by the company itself. Besides this, benefits can be realised focussing of five different categories:

- Environmental benefits:
  An EMS specifies the process for controlling and improving the company's environmental performance.

- Legal benefits:
  One benefit of implementing an EMS is that it ensures the company's compliance with environmental laws and regulations, thus avoiding charges or fines for non-compliance.

- Economic benefits:
  Companies which implement EMS often achieve improved efficiency and cost savings as benefits. By reducing any environmental impacts (e.g. reducing fuel consumption and waste generation), cost savings often follow.

[78] Interview with the Manager Environmental Compliance, Aida Cruises
[79] Interview with the Harbour Captain of the Port of Bremen, Mr Andreas Mai, 31.01.07

- Marketing benefits:
  An “enhanced corporate image” is a further benefit of an EMS which might lead to better competitiveness, and stronger customer satisfaction.

- Safety benefits:
  As operational procedures are included in an EMS, involving all people concerned (e.g. the crew of a ship), in-depth reviews of procedures for monitoring significant operations, including a review of emergency preparedness and response procedures, have to be carried out accordingly. Furthermore, an EMS should include awareness building and regular training. This will lead to significant safety improvements.

A number of shipping lines have adopted an internationally certified EMS (see Annex 3), most of them are certified according to ISO 14001.

Their publicly available Environmental Reports provide a clear and transparent picture of the environmental targets to be reached within a defined period of time. (Hanjin environmental plan 2005, Leif Höeg Environmental Statement, Nedlloyd Environmental Statement).

Normally, it should be expected that the companies have taken all these advantages into consideration before starting the EMS procedures and opted for a "green shipping philosophy".

Being asked for benefits gained by an EMS certification, however, the majority of interviewees stated that the driving forces behind participating in an EMS have been predominantly customers' requirements. According to the interviewees' experiences, potential monetary benefits like

- time saving by less surveillance from regulatory agencies (e.g. PSC).
- reduction of costs as a result of lower insurance rates.

did not occur. Any official reward has not been provided.

Furthermore, the requirement of EMAS and ISO 14001, that the backward and forward linkages should comply with the company's environmental policy, could not be confirmed: Contracted charterers which are linked to EMS-certified companies have usually not been asked for a special environmental compliance.[80]

[80] Interview with charter line representative

Pros	Cons
▪ Compliance with relevant environmental regulations ▪ Continuous improvement of environmental performance ▪ An Environmental Policy to be in existence within the organisation, fully supported by senior management, and outlining the policies of the company, not only to the staff but to the public ▪ Regular re-validation of the certificate by an internationally accredited auditor ▪ Competitive advantages ▪ EMSs are consistent with quality management principles as ISM and ISO 9001.	▪ EMS certification to compete in the global marketplace often overshadows the main reasons for environmental management: which is environmental protection ▪ EMS carried out primarily to meet growing demands from customers ▪ The extent of coverage of environmental targets to be reached is primarily decided by the company itself, target can be set too low in order not to risk a companies "over-commitment" ▪ In praxis, some requirements are not met, as for example: – Commitment from the top, the EMS is considered a "necessary evil" – Suppliers and chartered companies have do not comply with environmental policy ▪ EMS certification is expensive, some smaller companies might be unable to afford ISO 14001 registration

3.1.3 Awarding / Incentive Systems

In the following, the pros and cons of two different groups of incentive systems are discussed: monetary incentives, as the Green Award and the Bonus / Malus System, and non-monetary awarding systems, the U.S. Qualship 21 and the German Blue Angel.:

3.1.3.1 The GREEN AWARD

The Green Award is the only international certification and incentive scheme, as it is applied in roughly 40 ports in seven different countries. The Green Award is open to crude oil, product tankers and dry bulk carriers from 20,000 DWT and up. By rewarding high safety and environmental standards in shipping, Green Award makes "above standard ship" operation economically more attractive. In 2006, the 200th vessel has been certified (the current number of Green Award vessels is 196 as some have left the scheme again).

This award offers economic incentives in the form of reduced port dues/fees and reduced fees for related vessel services including waste reception, training courses and pilotage fees.

Pros	Cons
▪ Complex awarding criteria covering a broad range of different aspects of pollution ▪ Well known internationally ▪ Monetary incentives are provided	▪ Too complicated, surveyors need a special training before auditing ▪ Limited to tankers and bulk vessels only ▪ Limited geographical application: Certified vessels get discounts in participating ports only

3.1.3.2 The Bonus / Malus System

The Bonus / Malus system, which is offering reduced harbour and fairway dues, differentiated according to the ship-generated emissions of NOx and SOx, is intended to be revenue-neutral. Therefore, it results in higher dues for some ships and rebates for others; the rebates are intended to compensate ships for the higher operating costs resulting from their emission control measures.

This philosophy of differentiated dues does not find universal acceptance: The Australian Marine Environmental Protection Agency (AUSMEPA), for example, stated that "*Australian ports have consistently rejected the concept of reduced port fees for quality and environmentally conscious ships....Their view being that if port fees are discounted for some ships other ships will need to pay higher fees than the service provided is worth.*" (e-mail AUSMEPA)

Pros	Cons
▪ High environmental benefits with regard to reduction of air pollutants ▪ High monetary incentive for high standard vessels ▪ Very transparent system	▪ Limited to air pollution only ▪ Vessels of lower standard pay a "malus" thus paying more on fairway and in the port than the service provided is worth

3.1.3.3 U.S. Coast Guard – Qualship 21

The Qualship 21 Award does not promote above-standard vessels, rather it aims at eliminating sub-standard shipping.

Pros	Cons
▪ All foreign vessels are checked ▪ Classification societies' quality is included ▪ Flagstate's quality is included	▪ Only a reactive system, as merely existing international laws and regulations have to be complied with

3.1.3.4 The "Blue Angel"

The Blue Angel is an environmental label acknowledged by the United Nations. The aim for awarding the environmental label Blue Angel for environment-conscious ship operation is to acknowledge the compliance with clearly defined and high standards by an internationally accepted label. Ship-owners and charterers can show their commitment and use the label for the promotion of market and public relation.

As with every integrated system, environmental benefits are difficult to substantiate. Blue Angel publication (Criteria for the award of the environ label) provided estimated figures for air emission reduction only. They are listed below.

Pros

- The label awarding criteria are very flexile:
  There are 10 binding and 20 optional requirements listed.
- The 10 compulsory requirements are the most essential with regard to environmental protection.
- The other 20 requirements aim at additional desirable improvements, the label user shall select at least three he commits himself to fulfil.
- Criteria are applicable to existent and new ships as well as to different ship types.
- Management instruments as well as social conditions, operation and technology are covered
- Environmental benefits:
  Each Blue Angel ship emits only half of its previous SOx-emissions (by obligation) or even about 85% less (optional). The NOx-share of international shipping in global emissions is estimated at 11 to 13 %, i.e. about 9.3 million tonnes NOx per year and thereof ca. 1.94 million tonnes in the Northeast Atlantic. Here individual emissions will be reduced by 20 % (obligatory) or by more than 50 % (optional).

Cons

- The award criteria are not applicable to all ships: tank ships carrying products as defined in MARPOL Annex I and II (i.e. oil tankers and product carriers, chemical tankers, gas carriers), ships coming under the High Speed Craft Code, fishing vessels, recreational ships and navy ships are not included.

3.1.4 Class Notations

The environmental class notations provided by different classification societies for enhanced environmental and safety design, construction, and operation.

These classes are neither an incentive nor an award, in fact the vessel has to pay for class extention.

However, for a number of shipping lines it is of competitive advantage to show passenger, charterers and media the commitment for the protection of the environment.

Further advantages:

The classification societies can renew the certification and regular control of environmental performance of the ship during their annual surveys.

Because of the extensive experience in surveying and inspecting vessels, class societies' environmental notations can be regarded as respectable evidence.

3.2 Guidelines and Recommendations

3.2.1 Introduction

In the attempt to contribute to cleaner seas and especially to cleaner coastal and port waters, a number of ports have generated programmes to motivate shipping companies and crews for a more sustainable performance of vessels. The shortcomings of such incentive programmes, however, mainly are:

- Only a few programmes survived longer periods.
- No standardisation and hence a wide scope of requirements from port to port.
- Financing problems because e.g. a reduction in port dues results in smaller budgets of the port administration.
- Partly used to achieve an advantage in competition between ports.

As international rules and regulations to avoid or at least to reduce pollution by ships are only according to the minimum common denominator between IMO member states, much more could be done to enhance environmental sustainability of ship operation.

Under favourable regulative and operational conditions advanced technical solutions in connection with prudent onboard performance can already result in increased profitability. This is especially true in regions where environmental standards above minimum requirements are financially awarded by reduced fees (see e.g. the Swedish example). In general, however, such performance of above requirements does not yet pay off commercially.

Commercial benefits certainly are the most convincing argument for a shipping company to outperform minimum requirements and do not need additional incentives financed by public bodies, but could be fostered by easy to retrieve information and advice. Also indirect commercial benefits like a shipping company's image, which usually is part of the marketing strategy, are effective stimulators as shown by the cruise vessel industry.

Those solutions, which result in convincing commercial benefits, are only a few and not sufficient to significantly improve the situation. Basically, there are only two alternative strategies to achieve desired results, either to impose European normative rules stricter than international standards or to offer commercially interesting solutions. The first alternative would be mandatory for everyone and therefore will be most effective, the second one would be voluntarily and needs to be commercially convincing to achieve a significant participation.

In any case a thorough knowledge of the state of the art and of emerging technologies in all relevant areas is essential. The scope of technology relevant for green ships is extraordinary wide and developments in some areas are rather dynamic. In some areas additional research is required to better assess the environmental benefits of some solutions and to optimize those from the technological and operational point of view.

Thus, a catalogue of techniques, technologies and operations to qualify for incentive measures just specified once can only be valid for short time span. This fact is being taken into account within the recommendations and guidelines.

The following recommendations and guidelines are based on the findings of the study and provide aspects to be considered, when composing a European system to enhance environmental performance of ships.

3.2.2 Proposition: Development of a European "Clean Ship" Awarding System

Most of the award systems investigated and described in this report are rather specific and not comprehensive enough to span the entire spectrum of "clean ships" as desired. Either, they only concern part of the shipping fleet (Green Award) or they are concerned with only selected environmental problem areas (Bonus / Malus system) or they only reward compliance with legal requirements (Qualship 21).

A European "Clean Ship" Award should be comprehensive, meaning, embracing all types of vessels, complete, meaning addressing most factors that contribute to environment degradation, flexible, meaning being constantly adapted to technological advances and scientific developments, and give the participants tangible or intangible benefits.

To make an award system acceptable to the participants, it must offer some benefit to them. Mostly, this is seen as monetary benefit. For a Europe-wide monetary reward system everybody would expect cash payments from the European Union, which is hardly feasible. Another alternative would be prestige and positive public recognition. To achieve that, a system with high public visibility is required

In the following matrix, onboard measures to avoid or reduce the most important negative influences on the environment by shipping are listed. In the Column "Subject" the areas to consider are listed. Column "Rules/Regulations" lists the legal or regulatory requirements concerning the subject. In Column "Achievable Advance-

ment" it is noted what is today already technically and organisationally achievable. The items mentioned in this third column should form the basis of any award system.

Table 12: Onboard Measures to Reduce Emissions to the Sea and into the Air

Subject	Rule/Regulation	Achievable Advancement State of the Art	Remarks
Emissions to the Sea		▪	
Protection of Oil Fuel Tanks	Double hull protection of fuel tanks for defined oil fuel capacity resp. individual fuel tank size (MARPOL 73/78 Annex I, Regulation 12 A for building contracts placed on or after 1 August 2007)	▪ Existing vessels ▪ Smaller fuel capacity ▪ Smaller fuel tanks	
Discharge of Bilge Water	MARPOL 73/78 Annex I, Reg. 16 (5) Oil content =15 ppm	Oil content =5 ppm	
Sewage	MARPOL 73/78 Annex IV Reg. 9 or Reg. 11 for ships =400 GT or >15 persons International Sewage Pollution Prevention Certificate	▪ Sufficient sewage and grey water holding tank capacity and shore discharge connection to avoid any discharge into the sea ▪ Ships <400 GT ▪ Ships carrying <15 persons	
Ballast Water	IMO Resulution A.868 (20) IMO MEPC Res. 124 (53) Guidelines for ballast water exchange (G6) IMO MEPC res. 127 (53) Guidelines for ballast water management and the development of ballast water management plans (G4)	Certified system or treatment to prevent from any translocation of non-native organisms in ballast water and sediments	Treatment methods under development
Anti-Fouling Systems	IMO International Convention on the Control of Harmful Anti-Fouling Systems on Ships (not yet in force) Regulation (EC) No 782/2003 of the European Parliament and of the Council of 14 April on the prohibition of organotin compounds on ships	Compliance with requirements before regulations come into force	Biocide-free silicon based coating systems are meanwhile applied by a number of shipping companies like Maers-Sealand, Hapag-Lloyd and others

Garbage	MARPOL 73/78, Annex V	Onboard system to sort, minimize and store garbage but not incinerate	Sorting results are frequently being ignored by ports because garbage contaminated with food residues have to be incinerated in many ports e.g. in the EU. Thus even empty Coca Cola cans go the incinerator plants. Usually sorted garbage is being consolidated again ashore. Onboard sorting therefore needs to be discussed on IMO-EU-level
Propeller Shaft Stern Tube Sealing	Low amounts of environmentally critical constituents are discharged no international rule or regulation but some national requirements	Air-space stern tube sealing system avoiding any discharge into the sea	

Emissions into the Air			
NOx	MEPC 132 (53) Engine International Air Pollution Prevention Certificate (EIAPP) =17.0 g/kWh (n <130 rpm) =45.0 · $n^{-0.2}$ g/kWh (130 =n<2000 rpm) =9.8 g/kWh (n =2000 rpm) where n is the rated engine speed measured in crankshaft revolutions per minute. Usually this is achieved by electronically controlled engines.	▪ Exhaust gas cleaning/SCR system or ▪ water injection, emulsification or any other addition of water to the combustion process or ▪ other installation or method to reduce the exhaust gas emissions resulting in significantly (has to be specified) better values to be verified by a practicable system of onboard NOx verification procedures. Power provision in port from ashore ("Cold Ironing")	
SOx	Content of any sulphur in any onboard fuel =4.5% in general =1.5% SECA	Less than allowed SOx-content (limits must be specified). Power provision in port from ashore ("Cold Ironing")	Sweden provides a reduction in fairway dues if fuel of ferries contains <0.5% and of other ships <1.0%
Vapour Emission Control	IMO Standards for Vapour Emission Control Systems (MSC/Circ. 585)	Usage of a certified vapour emission control system during loading/discharging of tankers in port	
Refrigerants	Natural refrigerants such as NH_3, CO_2. No use of ozone-depleting refrigerants , however, exceptions to the HCFCs in existing ships until 1 January 2020	Abandonment of HCFC on ships which still may use it. Global warming potential (GWP) of refrigerants used aboard <3800. Refrigerant recovery system to avoid any release during maintenance or repair	
Fire Fighting	Environment –friendly fire-fighting substances	To be applied aboard	

An award system that comes close to the above mentioned requirements is the European "Blue Angel" award, an environmental label for environment-conscious ship operations. It is comprehensive, complete, flexible and, because there are other areas where the Blue Angel label is awarded, of high public visibility.

3.2.3 Proposition: Individual Port Incentives

Assumptions:

As experience shows individual port incentives do not result in a comprehensive improvement, but provide an opportunity to gather experience with both, the effectiveness of measures and the attitudes of involved parties.

Recommendation:

Any comprehensive European solution must allow individual ports to go even further. Individual ports' incentives provide excellent testbeds for further improvement of general European solutions.

Guidelines:

To establish a port environmental activities and measures reporting system on European level mandatory for all member states ports.

3.2.4 Proposition: Knowledge Pool

The essential basis of any effective scope of actions to foster environmental sustainability of ships is an excellent and up-to-date knowledge of normative rules, regulations, recommendations, techniques and technologies, commercial and other impacts and operational experiences. Currently there is no entity in Europe satisfactorily providing such knowledge comprehensively. However, the required competences and experiences are available on a widely dispersed basis.

To start from scratch would be very cumbersome and costly, resulting in redundancies to existing “entities of excellence”. Furthermore, the distinct areas of relevance require continuous efforts to understand the state of the art and to be able to draw appropriate conclusions. In almost all technical areas in question continuous research is required to assess the opportunities and limitations of the state of the art status and to advance developments. Frequently, claimed efficiency of technical solutions cannot be proven in reality and some solutions like e.g. the “Skysails” concept split experts into a school of believers and a school of opposers. Even more relevant is the Californian “Alternative Marine Power AMP” requirement, commonly known as “Cold Ironing”. It is foreseeable that European parliamentarians will pick up this idea and initiate a debate. It is important for relevant administrations to be prepared, which does not only include profound arguments, but also a wide knowledge of the possible implications.

In the past, the shipping world frequently experienced that the United States of America dashed forward to impose through IMO their ideas on the rest of the world. If Europe is starting late, it will be difficult to argue on best solutions on the same eye level with others.

A good example was the invention of Automated Identification Systems (AIS) where Europe only in the last moment succeeded to avoid the inappropriate Digital Selctive Call (DSC) solution proposed by the United States, based on their very restricted experience in the Port of Valdez region (technical measure after the grounding of the M/T EXXON VALDEZ).

Recommendations:

To establish a knowledge network administration entity (EMSA) identifies that relevant centres of excellence, associations and best practice operators and that links their competence to a virtual knowledge pool, providing technical and operational advise to EMSA and to the industry.

Within the National Transport Safety Board (NTSB) in the United States and also in Canada a similar approach to enhance transport safety has been proven very efficient, providing optimum benefits at low costs.

3.2.5 Proposition: Help Desk

Small and medium shipping companies are clearly overstrained by recognizing and realizing all relevant international rules and recommendations in connection with a wide variety of national laws, by continuously monitoring and assessing technical developments and by investigating best practice solutions most appropriate for their individual operation. Those companies can only follow others and copy their solutions once commercial success has been proven. This results in a delay of a few years to apply environmentally-friendly technology.

Recommendation:

To provide free of charge competent and comprehensive advice tailor-made for the individual company and/or vessel operation, ranging from a comprehensive and easy-to-understand information (printed, DVD, internet) to on-site visits by experts. At a certain stage costs need to be compensated by the "client".

How costs of such a help desk in general could be covered see further below.

3.2.6 Proposition: Awareness building and educational programmes

To motivate actors to search for improvements, where commercial benefits are small or even do not exist, respectively where additional costs of enhancement programmes are within an acceptable range, decision makers need to be convinced to do more than required or commercially viable. Experience from other industries like the logistics service provider domain shows that awareness building and educational programmes can achieve this. The peculiarity of shipping is that it is global and hence decision makers are difficult to address, however a comprehensive and well co-ordinated European programme would be already a good start.

An estimation[81] shows that cruise vessels cause about 75% of all sewage, not mentioning the enormous quantities of food leftovers dumped into the sea, the disturbance of sea and shore life by curious passengers taking thousands of snapshots during excursions etc. Even if cruise vessel operators demonstrate an increasing sensitivity to those problems, they finally are dependent on the wishes of their clients, the passengers. Thus an attempt must be made to adapt passengers' demands to environmental protection goals.

Recommendation:

Based on and in co-operation with already existing awareness building and education programmes from training entities, from shipping companies (e.g. INTERTANKO) and from ports (e.g. Ecoports, IPSEM) a certified European Course Programme should be established for port and ship managers and for crews. Onboard courses (e.g. Computer Based/Assisted Training CBT/CAT) and distant education programmes must be part of the programme.

A thorough inventory of existing courses will most probably show that after providing compatibility and consistency to existing ones there is already a wide range of appropriate programmes available.

It is advised to link such courses to other professional courses to avoid extra costs for travelling and to minimize off service time of participants.

For passenger vessels (cruise ships and ferries), an attractive special onboard awareness building programme, making optimum use of advanced media, should be developed and distributed.

[81] "Handelsblatt" No 202, 19 October 2006

3.2.7 Proposition: European "Clean Ship Award"

A European system must be fair, transparent and cost-efficient resulting in clearly measurable reductions of undesired environmental impacts. However, there exists a wide variety of combinations of all kind of measures, from technical and organisational measures to attitudes. Therefore, not individual measures should be assessed but the overall environmental balance of the vessel. Only if the overall environmental balance is being improved significantly, the vessel operator shall qualify for financial benefits. Such benefits should be reductions of port dues (see further below).

Such an approach, however, requires appropriate experts to provide advice to the shipping companies and evaluate the impacts of measures. The system also must motivate for continuous improvement within the range of feasible and reasonable measures.

Recommendations:

To identify a board of experts (e.g. from classification societies) to develop and continuously update a comprehensive catalogue of effective measures to better protect the marine environment. The same board must provide individual advice, determine the degree of improvement (environmental balance) and perform continuous audits always including support and advice actions.

EMSA then shall issue a European Clean Ship Award and administrate a data bank or contribute to the existing St. Malo data bank on Port State Control according to the Paris Memorandum where then ports and administrations can access the environmental status of those vessels.

3.2.8 Criteria for the Award of a European "Clean Ship" Label

After further research and discussion the following characteristics that a European "Clean Ship" Label should fulfil were identified:

1. It must be comprehensive.

Unlike other existing awarding schemes (e.g. the GREEN AWARD) it must not be restricted to certain vessel types. It must be possible to grant the future

"Clean Ship" award for all sea going ships, i.e. for **different ship types** as well as for **existing** and **new** ships.
Furthermore, the requirements must not be restricted to certain pollution types (e.g. air emissions) but to **all types of pollution** as represented by the Annexes I to VI of the Marpol Convention.

2. It must be complete.

The requirements to be achieved by the future "Clean Ship" awarding scheme have to be met by the **management** of shipping companies and ships, as well as by ship **design** and **technical equipment.** Also the **social** aspect (social conditions, training, language skills of seafarers) has to be included as well as the vessels' **safety** aspects.

3. It must be of high public visibility.

As it cannot be decided yet whether the future "Clean Ship" scheme will result in any **direct monetary** incentives for the vessels or not, it is of high importance that the award is of such a high public visibility that the awarded vessel can use the label for an environmentally oriented **marketing strategy**.

4. It must be flexible.

As technological innovations and ideas about environmental protection and pollution prevention are progressing fast, the criteria have to be continuously **modifiable** in order to incorporate changes. Criteria should be up-dated regularly (for instance every 2 years).

5. It must be result-oriented.

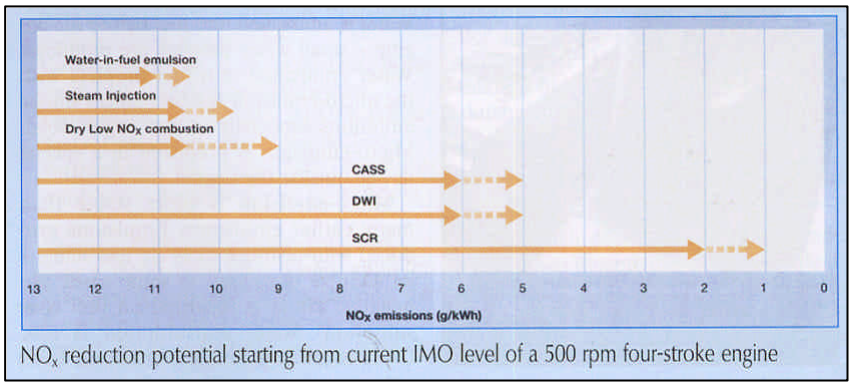
As the possibilities for improvement of environmental performance are numerous, the future "Clean Ship" awarding scheme should not be based on defined technologies or measures, but on **achievable results**.

Example:
According to Marpol Annex VI, the NOx emission is limited to 17 g/kW h for engines operating at 130 rpm, and to 9.8 g/kW h for 2000 rpm. Between these engine speeds the limit is designated by the equation:

$$45 * n(-0.2) \text{ g/kW h}$$

For an engine of 500 rpm this would mean that the NOx emission is not allowed to exceed 13 g/kW h.

A reduction of this value can be achieved by using different technical solutions:



Source: HANSA International Maritime Journal – 142 Jahrgang – 2005 – Nr. 8: "Exhaust emission control"

Precondition for the result-oriented approach is that the technology is approved, and the level of reduction is measurable and documented.

6. It must be easily verifiable.

Compliance with future "Clean Ship" schemes must be verifiable by any **Port State Control Officer** (trained according to recognised MOU-Standards) and/or **classification surveyor** (classification society acknowledged by IACS). No training for auditors above PSCO and Classification Society requirements should be necessary.

7. The scheme itself should be simple.

The future "Clean Ship" scheme should be based on already existing criteria, e.g. for environmental management: ISO 14001 etc. Instead of complicated ranking systems, a system of

- obligatory requirements (to be fulfilled by 100 %) plus
- optional requirements (to be fulfilled by a certain percentage)

should be introduced because too many and too ambitious criteria may lead to a lot of cumbersome paperwork.

Out of all incentive and awarding schemes discussed in this study, the "Blue Angel" label for environment-conscious ship operation is closest to meet the requirements listed above (see chapter 3.1.3.4) and could serve as a base for a European "Clean Ship" Label.

The "Blue Angel" is an environmental label acknowledged by the United Nations (adopted as an official logo in 1972). It is of high popularity in Germany and beyond, at present more than 17 % of this award is given to non-German companies. Since 2002, also ships can be "labelled" with the "Blue Angel".

The following table shows an example of the future "Clean Ship" awarding system based on the requirements of the "Blue Angel" scheme (written in blue). Further requirements or stricter (lower) emission values to be achieved are listed in black.

Table 13: Criteria for the Award of a European "Clean Ship" Label based on the "Blue Angel"

1.Shipping company's policy and management					
Criteria	**Obligatory Requirements**	**Proof**	**Optional**	**Proof**	achievable, already practiced
Quality Management	- ISM Code	- ISM Certificate	- ISO 9001	- ISO -Certificate [82]	
Environmental Protection Management	- ISM Code - SOLAS - MARPOL	- ISM Certificate - surveyor - surveyor, record books	- ISO 14001 (both: ship and company)	- ISO-Certificate	
Personnel Management	- ITF-tariff or national provisions of at least equal standard	- Blue Card or valid ITF contract document - Documented prove of training	- Language proficiency in accordance with SMCP [83]	- Passed IMO language test	
2. Vessel Construction					
Criteria	**Obligatory Requirements**	**Proof**	**Optional**	**Proof**	achievable, already practiced
Materials	- SOLAS	- Safety Construction Certificate	- Listing of materials used in consideration of the preliminary materials list in the "Industry Code of Practice on Ship Recycling of the International Chamber of Shipping" - Requirements of Green Passport	- Documentation of the materials in form of a materials register - Green Passport	
Collision protection and damage stability	- SOLAS Chapter II-1 - Classification	- Ship Safety Certificate - Class	- double hull for the protection of fuel tanks and cargo spaces - Voluntary acceptance of the Stockholm agreement regulations for the Ro/RO traffic in the Baltic Sea - Narrower framing or use of steel with bigger dimension or of higher quality than required - Improved collision protection, e.g. by keeping clearances between cargo spaces and hull and bottom, choosing watertight sections in the ship - other equally effective measures confirmed by he surveyor	- Documentation stating the compliance with optional requirements, or enhanced class notation	
Redundant Systems	- SOLAS Chapter II-1	- Safety Construction Certificate	- Measures to introduce redundancies in the ship propulsion system (emergency propulsion machinery) - Further measures [84]	- Document stating the fulfilment of optional requirements, or the enhanced class notation - Document stating the fulfilment of optional requirements, or the enhanced class notation	

[82] Advantage: Structured methods of operations, continuous improvements of operations, better precautionary measures and operational instructions
[83] Resolution A 918(22) "Standard of Marine Communication Phrases" (SMCP)
[84] Northorp Grumman Press Release (http://www.irconnect.com/noc/press/pages/news_releases.mhtml?d=26044) : From "Northrop Grumman to Christen Third Double-Hulled Tanker Polar Discovery" ... the tankers incorporate several redundant systems, such as double, independent engine rooms, and twin propellers, rudders and bow thrusters for greater manoeuvrability. The Endeavour-class vessels have all cargo, fuel and lubricating oils isolated from the ship's side by ballast tanks or void spaces. The ships also meet pending air emissions regulations for engines, and are painted with tin-free, antifouling paint in anticipation of proposed regulations. The crude-oil carriers are 894.7 feet (272.69M) long by 151.6 feet (46.2M) wide by 86.29 feet (25.3M) deep, and will hold just over one million barrels of cargo at full capacity.

3. Ship operation management and ship operation technique					
Criteria	**Obligatory Requirements**	**Proof**	**Optional**	**Proof**	achievable, already practiced
SOx-Emission	- Sulphur content in fuel oil is < 1,5% on average over the year	- Delivery notes for the fuel oil (or fuel analysis reports)	- Sulphur content in fuel oil is < 0.5% on average over the year	- Delivery notes for the fuel oil (or fuel analysis reports)	- use of MDO - use of LNG - Fuel Cell
NOx-Emission	- the limiting curve of MARPOL has to be undercut by at least 20%	- EIAPP Certificate or equivalent documents (measuring reports)	- the limiting curve of MARPOL has to be undercut by at least 50%	- EIAPP Certificate or equivalent documents (measuring reports)	- no NOx - Fuel Cell - 7-8 g/kW/h (Wallenium WetPac system)[85] - reduction to <0.2 g/kwh possible by SCR (Urea)[86]
Soot and Particle Emission	- none	-	- qualitative reduction of particle emissions by - operating with fuel-water-emulsions - additional systems for better combustion air supply - soot filters - other means		
Emissions from cooling and refrigeration plant	- ODP < 0.05 - GWP < 1650	- data sheets, records of usage	- ODP = 0 - GWP <1650	- data sheets, records of usage	
Waste disposal	- passenger vessels: as specified by Marpol V - cargo vessels: as specified by Marpol V, but no incineration unless in accordance with par. 3.3.6, disposal of ashes on land	- garbage record book - disposal: log book	- no incineration - no disposal of waste at sea		
Waste incineration	- passenger vessels: incineration in accordance with Marpol VI, disposal of ashes on land	- acceptance record for incinerator, garbage record book, documentary for disposal	- incineration according to a standard like for instance the German Federal Air Pollution Prevention Ordinance (Bundes Immisions Schutz Verordung BImSchVO)	- acceptance record for incinerator, garbage record book, documentary for disposal	
Black (sewage) water	- passenger vessels: no chlorinating, keeping to 50% of the limits set in Marpol IV: BOD < 25 mg/l, filterable solids < 25 mg/l, coliform bacteria < 125 / 100 ml - other vessels: limiting values set by Marpol IV	- design acceptance certificate for the plant	- collection, disposal on land or treatment technologies, e.g. membrane filter (coliforme bacteria < 30 / 100 ml)	- document of disposal	- membrane bio-reactors: BOD: 2 mg/l coliform: 13/100 ml[87] - membrane bio-reactors with uv: coliform: not detectable[88]
Grey water	-	-	- no chlorination, keeping 50 % of Marpol requirements, that is: BOD5 < 25 mg/l, filterable solids < 25 mg/l, coliforme bacteria < 125 / 100 ml	- acceptance certificate, documented proof of discharge	

[85] "Wallenius Marine AB signs WetPac agreement with Wärtsilä" - Wallenius Marine PRESS RELEASE September 15, 2006
[86] Clean solutions for ships – examples from the Port of Göteborg - Projekt Grön Kemi, Jan Ahlbom, Ulf Duus, May 2006
[87] The Naval Architect February 2003: Black and grey water treatment solutions using membrane bio-reactors
[88] Enhanced MARPOL IV Sewage and Graywater Pollution Prevention – Holland America Line Westours Case Study

Bilge Water	- oil content in discharge water < 5 ppm	- design acceptance certificate for bilge water separator	- exclusive and complete disposal of bilge waters on land	- oil record book	- 1 ppm oil content in effluent water[89] - chemo-physical treatment, oil content < 0.2 ppm
Antifouling Paint	- no organic tin	- specification by manufacturer, documentary proof of application	- organo-tin free self-polishing, but no so-called ablative or selferoding paints, where main biocides are not chemically bound to the matrix, - biocide-free antifouling paints	- specification by manufacturer, documented proof of application	- silicone paint
Ballast Water	- application of IMO Res. A 868 (20)	- documentation under the SMS, keeping of a Ballast Water Management Record Book	- application of IMO Res. A 868 (20) - ballast water treatment on board if complete exchange is not possible. When using biodegradable chemicals, it must be proved that their temporal effectiveness does not exceed the time the ballast is on board.	- documentation under the SMS, keeping of a Ballast Water Management Record Book	- chemical-free ballast water treatment system (Alfa Laval / AOT advanced oxidation technique, to be approved and certified mid 2007)[90]
Extinguishing Agents	- no use of halon	- specification of extinguishing agent on board	- use of a high-pressure water fog sprinkler system	- design acceptance certificate, documented proof on board	

[89] RWO Marine Water Technology: Oily Water Separator SKIT/S-DEB
[90] Alfa Laval Press Release, September 2004: Alfa Laval to meet the ballast water challenge

Recommendation:

Use criteria as described in the table above or as used for the "Blue Angel" Award as a basis for the European "Clean Ship" Award. The criteria should be revised and edited in accordance with latest technical developments.

Or:

Join the "Blue Angel" awarding scheme in elaborating further criteria.

Additional Suggestions:

Due to the fast developing nature of pollution prevention technology, it is recommended to elaborate a database for technical equipment, based on different criteria as:

- pollution category according to the six Annexes of MARPOL
- emission reduction potential
- implementation on existing / new ships
- costs.

An example of a data collection format is given below:

MARPOL 73/78 Waste Category	Discharge Parameter / Emission	Reduction Method / Technology	Reduction Potential	Cost		Practicability of Installation and Usage	
				Investment	Operation	Existing Ship	New Ship
Annex I: waste oil	fuel residues; bilge ..						
Annex II: chemicals	NLS residue/water mixture ...						
Annex IV: sewage	Grey Water Black Water ...						
Annex V: solid waste	Garbage Plastic Waste						
Annex VI: exhaust	NOx; SOx ...						

Table 14: Example for a spread-sheet for data collection

A database on environmental policies, guidelines and programmes of the shipping industry is presently being developed by The Shipping Federation of Canada. It is recommended to co-operate with The Shipping Federation of Canada in order to obtain a complete picture on the broad range of possibilities of environmental performance on board and in land based offices.

Recommendation:

To establish a database of new technical equipment and its pollution reduction potential.

This database could be combined with other international databases, as for example the database on environmental policies, guidelines and programmes developed by The Shipping Federation of Canada.

It has to be noted that better environmental performance does **not** in all cases mean less waste production!

Example:

- The use of sewage storage tanks and disposal of sewage to land-based treatment facilities should be preferred to sewage treatment on board. However, this means that a higher amount of sewage has to be discharged in the ports.
- The use of more effective bilge water treatment systems will result in a higher amount of waste oil (less oil is discharged to the sea).

3.2.9 Proposition: Financing of Measures

There must be a system to finance all costs for the a.m. measures equally within all EU member states and states associated to the programme. A solution distinct from port to port is not reasonable and will impede competition between ports. From the study results the Swedish approach to first impose dues (fairway dues) to all ships to then be able to reduce fees for the green ships appears to be the most favourable approach.

It is not within the scope of this study to solve legal problems when imposing European dues on ships, but this could be realized through the ports of call. Regrettably, there is currently no solution to include those vessels into the financing systems that are navigating through European waters but not calling at a European port.

The generated budgets then can serve to compensate port administrations' losses by port fee reductions, but also to finance all other recommended activities, assumed that administrations are able to establish an efficient and low cost system to collect the fees and transfer them to EMSA.

4. Problems Encountered

4.1 Acquisition of Information

Within the first data collection phase it became already apparent that while the majority of general information was obtainable from the Internet without any problem, more detailed information was extremely difficult to acquire.

The problems in particular were:

- It was often difficult to find an address that was able to reply to the specific questions of this study
- Often it was nearly impossible to find the right contact person

Even though the above problems could be solved in the second phase of the project, the situation as such did not improve much. The topic "clean ship" is highly sensitive and seemed to be considered a "hot potato". Most shipping lines, maritime organisations, ports world wide and manufacturers run a highly restrictive information policy on this topic. Even some representatives from respectable institutions (classification society) were very reluctant to discuss this topic.

Therefore, in the second phase data acquisition was shifted to direct contacts with individuals. When written requests (letter and email) did not yield the anticipated and necessary information, interviewees were contacted by phone and in direct meetings at conferences and trade fairs.

When contacted personally, representatives of vessel operating companies, who were hesitant to give information in the first phase of the study, turned out to be very open with information.

In other instances where staff members of contacted organisations were very reluctant to give information, until a certain person was contacted first, this certain person turned out to be open in discussion and free in giving information. So, a trickling down of relevant information occurred towards the end of the project time

One problem, however, remained the manufacturers of technical equipment. Obtaining data on costs and benefits of the installed systems still remained problematic.

In general it can be stated that the quality of information given did not exceed what was publicly available anyhow (e.g. Internet, presentations, press release).

4.2 Evaluation of Results and Findings

The incentive and awarding systems are not directly and quantitatively comparable, as they are not consistent with each other. This is of course explainable by the fact that in different geographical locations different problems occur, which have to be tackled first: Sweden, for example, has big problems with acidification, therefore they tackle the problem of SO_x and NO_x first. An island state, as another example, dependent on tourism and clean beaches, will probably judge the problem of oil and garbage (MARPOL I and V) as more important.

Annexes

Annex 1

Inventory of technical equipment

Table 1a: State of the Art equipment
Table 1b: Prototypes and new equipment

MARPOL 73/78 Waste Category	Discharge Parameter / Emission	Reduction Method / Technology (Underlined text: please click for detailed information)	Reduction Potential	Costs in EUR		Practicability of Installation and Usage		Remarks
				Investment	Operation	Old Ship	New Ship	
Annex I: waste oil	fuel residues; bilge ..	RWO: combination of an open porous coalescer with an emulsion breaking oil and hydrocarbon absorber	1 ppm oil content in the effluent water	17.000		**x**	**x**	brochure
		EnSolve: petroliminator. Three stage oil water separator. First stage is a heavy phase separation of oil from water and enables collection of sludges. The second stage eliminates emulsified oil. The third stage removes remaining solids and water.	less than 15 ppm oil content. It is a bio-mechanical system which destroys oil and grease using naturally occurring bacteria.			**x**	**x**	smaller system
		Scanjet: wash tank cleaning machine	The permanent lubrication means an oil-free drive unit and the magnetic transmission allows an exchange of the drive unit without exposing the tank to the outside atmosphere.			**x**	**x**	smaller system
		WashTrac: wash tank cleaning monitoring system	Prewash procedure inspection can be eased through printed prewash reports stating total running time, starts and stops.			**x**	**x**	
		TankMaster: wash tank cleaning machine	The TankMater can be used in combination with a positioning system that is also suitable for use at rough sites.					
		AlfaLAval: wash tank cleaning solution	Full customizable system with single or dual nozzle tank cleaning device. Software determines the optimal cleaning method.			**x**	**x**	

MARPOL 73/78 Waste Category	Discharge Parameter / Emission	Reduction Method / Technology (Underlined text: please click for detailed information)	Reduction Potential	Costs in EUR		Practicability of Installation and Usage		Remarks
				Investment	Operation	Old Ship	New Ship	
Annex I: waste oil	fuel residues; bilge ..	CJC: Filter Separator. Purification systems for oil used in lubrication, hydraulic power systems, marine diesel fuel systems (diesel oil) for propulsion engines.	Combines fine filtration and water separation offline units with integral circulating pumps. They are designed for use in oil systems where water ingress is a constant or regular problem.	2400 - 4400 depends on the model	150-200 for filters (annually)	**x**	**x**	
		Alfa Laval: oily water cleaning system. Automated single stage centrifugal separation system for treatment of large bilge water volumes.	No filters are used which means less maintenance costs.			**x**	**x**	
		DELTA: oily water separator	3 ppm oil content in effluent water			**x**	**x**	
		Alfa Laval: sludge treatment system. Separation of oil, water and solids simultaneously from oil sludges of varying composition and density without adjustment.	High recovery of oil for direct use in boiler or incinerator. Intervals between service is high due to low sludge accumulation in the bowl.			**x**	**x**	
		NFV: bilge water deoiling. Two stage bilge water cleaning. Multi phase separation for water oil and solids and a second stage of emulsification or dispersion.	No use of chemicals, absorbers for emulsion and dispersion.			**x**	**x**	
		Westfalia: bilge water treatment. It a self cleaning centrifugal system which supervises the ppm in the cleaned water.	If the ppm exceeds 15 or 5 ppm the water is recirculated in the oily water tank.			**x**	**x**	
		Westfalia: sludge treatment. The sludge is pumped from the sludge tank by an eccentric screw pump and is fed via a heater to a centrifugal separator. The recovered oil and water is discharged under pressure.	Reduces the volume of sludge for disposal by up to 90%. Fuel oil is recovered for re-use and recovered lubricating oil can be used as boiler fuel.			**x**	**x**	

MARPOL 73/78 Waste Category	Discharge Parameter / Emission	Reduction Method / Technology (Underlined text: please click for detailed information)	Reduction Potential	Costs in EUR		Practicability of Installation and Usage		Remarks
				Investment	Operation	Old Ship	New Ship	
Annex I: waste oil	fuel residues; bilge ..	Westfalia: Combi (Bilge and Sludge) treatment. During the bilgewater separation process impurities accumulate in the sludge space. They are discharged into a sludge tank periodically by means of total bowl ejections. The result is highly compacted solids.	Combination of bilge and sludge treatment is normally less cost intensive.			x	x	
		DVZ Oil water separator				x	x	
		Hodge: Oil Water separator				x	x	
		Marinfloc: Emulsion Breaking Pre Treatment unit	Upgrading of existing OWS			x		
		Marinfloc: Emulsion Breaking Bilge Water Cleaning System	less than 5 ppm in the effluent water			x	x	
		Marinfloc: Sludge dewatering unit	Reduces water in sludge by up to 85%			x	x	
		Norsk Atlas: Bilge Water Separator	less than 5 ppm in the effluent water			x	x	
		SIT CD-SR System Sludge Reduction. Extension of flushing to the sludge tank of 180 minutes (8 flushes/day) instead of 30 min.	Sludge Reducing Efficiency up to 85%			x	x	
		JOWA: Oil Water Separator. The ows is a dual stage oily bilge water separation system utilizing differential specific gravity, coalescence plates and filtration to separate and remove free and emulsified oil.	The system does not require any chemicals.					
		JOWA: Oil Discharge Monitoring and Control System for Tankers. The system consists of a computer unit, a zener barrier unit and an analysing unit.				x	x	

MARPOL 73/78 Waste Category	Discharge Parameter / Emission	Reduction Method / Technology (Underlined text: please click for detailed information)	Reduction Potential	Costs in EUR		Practicability of Installation and Usage		Remarks
				Investment	Operation	Old Ship	New Ship	
Annex I: waste oil	fuel residues; bilge ..	JOWA: Emulsion Breaking Unit. It is designed to break apart water in oily water emulsions.	The unit separates up to 80% of the water in the emulsion.			**x**	**x**	
		Aquatek: bilge oily water separator	This technology has been recently developed and provides a superior method to separate oil and other hydrocarbons from water. The oils that are separated can usually be reclaimed and recycled to various other applications.	18.000				
Annex II: chemicals	NLS residue/water mixture …	Drew Marine: tank cleaning solution						
Annex IV: sewage	Grey Water Black Water ….	ACO Maripur: biological waste water treatment technology in combination with submerged micro-filtration units for black and grey water	Effluent values of coliform bacteria, total suspendid solids and BOD5 are better than the required by MARPOL IV			**x**	**x**	
		Scanship: Advanced Waste Water Purification Systems. Bio-chemical system.	Use of ultraviolet light reactor for final disinfection. This water can be reused for engineering purposes.			**x**	**x**	
		Evac: waste water treatment and sewage plants. Biological plants and advanced membrane bioreactor waste water treatment.	Biological: full biological odourless process / system, with no toxic gases. The membrane technology fulfils all existing treatment requirements.					

MARPOL 73/78 Waste Category	Discharge Parameter / Emission	Reduction Method / Technology (Underlined text: please click for detailed information)	Reduction Potential	Costs in EUR		Practicability of Installation and Usage		Remarks
				Investment	Operation	Old Ship	New Ship	
Annex IV: sewage	Grey Water Black Water ….	DELTA: Sewage treatment plants (biological and physical - chemical)				x	x	
		Rochem: Grey Water Treatment. Reverse osmosis plant.		267.500				cost details
		DVZ: sewage treatment plant						
		Navalis: Grey and Black Water Treatment. Separate treatment process of black and greywater.				x	x	
		Marinfloc: Grey and Black Water Treatment. A three stage grey and black water treatment system.	Oxidation and treatment of black and grey water.			x	x	
		Norsk Atlas: Sewage Treatment Plants. Biological and physical plants.				x	x	
		Jowa: Biological Sewage Treatment Plant. The STP is an aerated, submerged, fixed-film unit with a proprietary aeration system						
		RWO: Biological Sewage Treatment. Aerobic biological cleaning stage.		12.000		x	x	
		Bio Compact: Sewage treatment plant						
		Martin Systems: Si Claro, wastewater treatment concept	The system takes care: that water is free from pathogenic micro organisms; that there are no substances in it which are harmful to the environment; that turbidity reducing quality is removed; that the water can be reused in an ecologically-sensitive manner.					

MARPOL 73/78 Waste Category	Discharge Parameter / Emission	Reduction Method / Technology (Underlined text: please click for detailed information)	Reduction Potential	Costs in EUR		Practicability of Installation and Usage		Remarks
				Investment	Operation	Old Ship	New Ship	
Annex IV: sewage	Grey Water Black Water ….	Krueger-Wabag: MEMROD wastewater treatment	For process optimisation oil and grease contained in the galley water is removed before entering the biological treatment plant. The process is a combination of the low-pressure membrane technology and the activated sludge process that ensures permanent compliance with sewage discharge requirements.					
Annex V: solid waste	Garbage Plastic Waste ….	Delta: incinerators for solid waste only or for sludge and solid waste.				**x**	**x**	
		ATLAS: Incinerator. The incinerators are suitable for simultaneous burning of oil sludge and solid waste.		57.000	2.200	**x**	**x**	cost details
		TeamTec: Incinerator, liquid and solid waste; such as: sludge oil, sewages sludge, plastics, paper, cardboard, wood, rubber, cloth, oily rags, food waste and hospital waste. Sludge burning system with no filters/no strainers.			1.152 - 2.595	**x**	**x**	cost details
		Norsk Atlas: Incinerator for solid waste or solid waste/sludge	Solid waste and sludge can be burned simultaneously. Negative pressure in combustion chamber. Fully demountable for easy retrofitting.			**x**	**x**	

MARPOL 73/78 Waste Category	Discharge Parameter / Emission	Reduction Method / Technology (Underlined text: please click for detailed information)	Reduction Potential	Costs in EUR		Practicability of Installation and Usage		Remarks
				Investment	Operation	Old Ship	New Ship	
Annex VI: exhaust	NOx; SOx ….	Martek: Engine parameter check method						
		Blue Angel: requirements for ship operation	reduction of fees: Reederei Rörd Braaren		depends on the turn over of the enterprise	x	x	Explanation only GERMAN
		ACERT: Advanced Combustion and Emission Reduction Technology for Medium Speed Engines	Lowe Nox Emissions through Long Stroke Engine			x	x	
		Siemens: Recovery of Thermal Energy	8-11% Reduction on Fuel Consumption					
		Bio diesel for small crafts	Nox, Sox neutral					pages 6-9
		MarinNox: Emission Monitoring System. It is a NOx/CO2 & engine efficiency monitoring system.	The system provides monitoring of exhaust gases and engine / ambient parameters to calculate NOx emissions and enables continuous optimisation of engine performance to deliver fuel savings of up to 4%					
		Drew Marine: Fuel mill homogenizer	Asphaltene particles are sheared to 3-to-5 microns in size and blended. Smaller fuel droplets are injected. Fuel can be emulsified with injected fresh water.					
		Siemens: Siship. State of the Art Diesel Propulsion System						
		SIT: CD-Wide Homogenizer						
		SIT: CD-CI System. Combustion Improvement System						

MARPOL 73/78 Waste Category	Discharge Parameter / Emission	Reduction Method / Technology (Underlined text: please click for detailed information)	Reduction Potential	Costs in EUR		Practicability of Installation and Usage		Remarks
				Investment	Operation	Old Ship	New Ship	
		Wärtsila: Smokeless Engine	Smokeless Engine i.e. the engine equipped with Common Rail fuel injection system.	The target is to have the same investment and operational costs for the Common Rail as for conventional fuel injection system. For some engine types the Common Rail is in limited sales phase still which means limited manufacturing volumes and somewhat higher price for a limited period. There have been some additional maintenance costs during the development phase as well.			x	award

MARPOL 73/78 Waste Category	Discharge Parameter / Emission	Reduction Method / Technology (Underlined text: please click for detailed information)	Reduction Potential	Costs in EUR		Practicability of Installation and Usage		Remarks
				Investment	Operation	Old Ship	New Ship	
Annex I: waste oil	fuel residues; bilge ..	Marinfloc:White Box - Monitoring of Bilge Water. The system is designed as a fail-safe system for the discharge of water overboard.	The White Box offers assurance to operators that water with an oil content of >15 PPM or > 5 PPM cannot accidentally be pumped overboard.				x	
		SIT: CD-WOR Waste Oil - Sludge Regeneration. Its a pretreatment of remaining fuel oil sludges and ordinary waste oils.	The blend made by the equipment can be burned in boilers and incinerators like conventional fuel. The blend can also be transferred to the fuel oil settling tank to be consumed in the main engines or generators.				x	
Annex II: chemicals	NLS residue/water mixture …						x	
Annex IV: sewage	Grey Water Black Water ….	Waste Water Trends: Utilization of Advanced Ozone Reactors	smaller footprint than biological treatment, reuse of grey water				x	
		ITN: Nanotechnology	Ceramic flat membrane for wastewater treatment. Advantages: continuous cleaning during the filtration, stable long term process with high flow rates, no membrane fouling and extensive mechanical or chemical cleaning with filtration break-off.			x	x	

MARPOL 73/78 Waste Category	Discharge Parameter / Emission	Reduction Method / Technology (Underlined text: please click for detailed information)	Reduction Potential	Costs in EUR		Practicability of Installation and Usage		Remarks
				Investment	Operation	Old Ship	New Ship	
Annex V: solid waste	Garbage Plastic Waste ….	PyroGenesys: Plasma Arc Waste Destruction System	The system uses a simple mill to convert solid waste into lint. Afterwards this lint is burned in a plasma-assisted combustor. The waste pre-processing consists of a shredder, a storage conveyor and a mill. The milled waste is fed into an eductor and this forces the waste into a zone of high turbulence and high temperature (plasma), which results in fast gasification of the waste. Furthermore, air is added to the combustion chamber to combust the gases before cooling, cleaning and discharging it.				x	Food Waste Handling Alternatives
Annex VI: exhaust	NOx; SOx ….	Wärtsila: fuel cell power for ships	Fuel cell technology. The current research work focuses on Solid Oxide Fuel Cell (SOFC) systems using methanol together with natural gas (NG) and liquefied natural gas (LNG) as fuel.				x	
		SEAAT: pilot project shipping emissions abatement and trading from ship emissions.	compliance with SECA requirements					
		LNG power	Compared to Marine Gasoil Ferries, LNG Ferries have around 72% of fuel costs.				x	

MARPOL 73/78 Waste Category	Discharge Parameter / Emission	Reduction Method / Technology (Underlined text: please click for detailed information)	Reduction Potential	Costs in EUR		Practicability of Installation and Usage		Remarks
				Investment	Operation	Old Ship	New Ship	
Annex VI: exhaust	NOx; SOx ….	Shore Side Power / Cold Ironing	see report			**x**	**x**	
		Siemens: Siship Fuel Cell Air. Low temperature fuel cells. Zero emission energy production for passenger and cargo ships.	Fuel Cell Air installations produce electricity from hydrogen and air at zero emission. In the process, they achieve a higher degree of efficiency than comparable conventional internal combustion engines. The containerized installations are transportable and can be operated on land and on board. During energy production, only water and heat are generated.				**x**	
		Siemens: Innovation Power Generation onboard. Development of a small, light weight, high efficient synchronous generator with high-temperature superconducting (HTS) rotor windings.	Savings in terms of mass and volume compared with a diesel generator. The generator will be more compact and silent, will be a smaller source of vibration, capable for multiple overload and insensitive in case of load changes.				**x**	

MARPOL 73/78 Waste Category	Discharge Parameter / Emission	Reduction Method / Technology (Underlined text: please click for detailed information)	Reduction Potential	Costs in EUR		Practicability of Installation and Usage		Remarks
				Investment	Operation	Old Ship	New Ship	
Annex VI: exhaust	NOx; SOx ….	Wallenius Wilhelmsen: Solar Powered Ship.	The concept vessel does not release any emissions into the atmosphere or the ocean. It utilises the three main energy sources available at sea: wind, sun and waves.				**x**	
		Sky Sails: wind propulsion system for ships. This system consists of a towing kite propulsion and a wind-optimised routeing system.	Average fuel costs can be lowered between 10-35 % depending on the wind conditions.	337.000 - 1'900.000	35.350 - 157.520	**x**	**x**	cost comparison amortisation

Annex 2

Inventory of incentive / awarding systems

Table 2a: All incentive / awarding systems, labels, initiatives, etc.
Table 2b: Incentives vs. MARPOL

Explanation:
Black: systems which are presently practiced
Red: suggestions, proposals, recommendations

Annex 2: Inventory of incentive/awarding systems; Table 2A: All incentive/awarding systems, labels, initiatives, etc.

Name	Country / Port	Editor	Objectives	Issued in	Accepted in	Requirements	Vessel Type	Incentives	Remarks
Awards									
"Green Award"	Netherlands	Green Award Foundation, Rotterdam (Initiative of the Rotterdam Municipal Port Authority and the Dutch Ministry of Transport and Water Management	promotes save and environmental friendly behaviour of ships, crew and management	initiated in 1994, independent since 2000	at 45 participating ports in The Netherlands, Lithuania, Spain, Portugal, South Africa, Germany and on the Shetland Islands	bases on an internal "point system", certificate is given by the BGA. Focuses more on management than on technique	tanker and bulk carrier > 20.000 dwt (Stand 2000) container vessels and other types of ships are in planning (Stand 2004)	Incentives include a percentage discount of port fees. Additional discounts are received variously from pilot organizations, tug boat companies, chandlery services, port reception facilities and line handling.	see table incentive systems
Life Buoy Prize ("Life Buoy Award")	Port of Stockholm	Swedish Maritime association	Environmental prize for people, / companies / shipping lines who are engaged or have special ideas / behaviour in environmental friendly shipping especially in reduction of emissions						
"Thor Heyerdahl Maritime Environmental Award"		Thor Heyerdahl & the Norwegian Shipowners' Association	contribution to an improvement of the global environment serve as an inspiration for implementing new, specific environmental measures. Award for organizations / companies which contribute to an improvement of the global environment	launched in June 1999, first winner in 2001 "Green Award" foundation. Every two years a new winner				up to 100.000 US$ for the winner of the award	
"Clean Marine Award"	European Union		to support environmental friendly shipping especially by reducing SOx			proposed by a committee – green behaviour, other environmental certificate, green policy	all kinds of ships		sometimes called the "Environmental Oscar"
"Lloyds Register Awards"						Compliance with Lloyds Register's "Rules for environmental protection", published in 1998			
Certificates									
Environmental Passport" (see: http://www.gl-group.com/scripts/index_fs.html?content=http%3A//www.gl-group.com/maritime/fleet/3613.htm&top=/maritime/fleet/3407.htm		German Lloyd	promotes save and environmental friendly behaviour of ships, crew and management according to MARPOL regulations			MARPOL-certificate 1- 6 requirements, TBT-free coatings, ballast water management., location of fuel tanks	new and old ships, all kinds of ships	saving time at port state control (i.e. in some US ports) (Marketing instrument)	Marketing Instrument
"Clean" ("Environmental class notation")		De Norske Veritas	identifies the basic requirements for controlling and limiting operational emissions and discharges i.e. achievement of zero discharge for a number of pollution components			Compliance with DNV's rules for classification of ships (July 2005)	existing and newbuildings high sea going ships		Marketing Instrument
"Clean Design" ("Environmental class notation")		De Norske Veritas	identifies additionally requirements for controlling and limiting operational emissions and discharges. Additionally design requirements for protection against accidents and for limiting their consequences are specified			Compliance with DNV's rules for classification of ships (July 2005)	existing and newbuildings ships trading in costal waters and for passenger transport	"sometimes" reduced harbour fees – "clean Design" ships can get as equivalent the "Green Award"	
"Green Star Class Notation"		R.I.N.A. Royal Institution of Naval Architects	"Clean Sea" "Clean Air"	In 2000 maintenance and on-board responsibilities In 2004 extended to design of ships Only new ships		"Clean sea notation" requires bunker tanks over double bottoms, holding tanks for black and grey water, safely garbage disposal, TBT-free antifouling "Clean Air notation" sets limits on SOx and NOx emissions, requirements for refrigeration gases, controls for incineration plants. (i.e. low NOx emission gas turbines)	initially adapted by cruise ships in 2002 the first "Green Star" to a chemical/ product tanker		Marketing Instrument

Explanation:
Underlined text: Please click for detailed information
Black text: Systems which are presently practised; Red text: Suggestions, proposals, recommendations

Annex 2: Inventory of incentive/awarding systems; Table 2A: All incentive/awarding systems, labels, initiatives, etc.

Name	Country / Port	Editor	Objectives	Issued in	Accepted in	Requirements	Vessel Type	Incentives	Remarks
"Green Passport"		IMO Marine Environmental Protection Committee	the "Green Passport" consists of a document listing an inventory of all potentially dangerous materials that would have an adverse effect on human health and / or the environment			the listed materials include all those used in the construction of the ship and the passport of this inventory will accompany the ship throughout its entire life span right through to decommissioning. The passport is produced at construction stage by the shipyard and is then passed onto the purchaser. The document is flexible enough to allow for changes to be recorded in the materials used. New owners of the vessel are obliged to maintain the accuracy of the Green Passport and to incorporate it into any relevant design and equipment changes. It is the duty of the final owner to deliver the vessel and the passport to the recycling yard where virtually the entire ship will be broken down and reused.	all kinds of ships only newbuid ships ?		Marketing Instrument
"Environmental Safety (ES) Class Notation"		American Bureau of Shipping, Huston, Texas	promoting environmental safe design, construction and operation of vessels and marine structures			fully compliance with IMO I - VI additionally with: NOx technical code, IMO Montreal Protocol on Substances that deplete the ozone layer, IMO Resolution MEPC 76 (Incinerator Specifications), Standard for Vapour Emission Control (IMO) MSC/Circ. 585, USCG Title 46 Ballast water Resolution, Anti-fouling Paints (IMO) Resolution MEPC 46 (30)	ships and marine structures which are classified by ABS		Marketing Instrument
Incentive Systems									
Life Buoy Diploma ("Life Buoy Award")	Port of Stockholm	Swedish Maritime association	in the beginning reduction of waste by separation, after two years NOx and SOx reduction was also taken into account. Since two years also bilge water is included	since 2000	Port of Stockholm	functioning waste sorting system, NOx and SOx reduction to be proved by certificates for the engine	cruise ships	reduction of harbour fees in the port of Stockholm	very good experience, standard of ships is increasing see table incentive systems
Bonus System for SBT's and double hull tankers		EU regulation according to IMO resolution A. 747 (18)	reducing the risk of pollution by accidents and by ballast water exchange		North Range and Suez Canal, Hamburg, Wilhelmshaven, Emden, Brunsbüttel, Bremen Ports, Nordenham, Antwerp, Rotterdam, Le Havre, Ports of Kaliningrad and Szczecin-Swinoujscie	segregated ballast tank, double hull	segregated ballast tank tankers, double hull tankers	Different incentives in different Ports	see table incentive systems
Swedish Incentive System for Differentiated Fairway dues	Sweden	Swedish Maritime Administration, Swedish Ship-owners Association, Swedish Ports and Stevedores Association	to reduce emissions of SOx and NOx by 75 % within a fife year period	initiated in April 1996 into force since 01.01.1998 since 01.01.2005 a restructured incentive system was introduced	Swedish waters	reduced NOx emissions reduced SOx emissions usage of low sulphur fuel for < 0,5 % passenger vessels and < 1,0 % other ships catalytic converters proved by an Emission-Certificate issued by different Swedish laboratories or GL. The Certificate needs to be renewed every three years.	oil tanker, ferries, passenger vessels, other ships	according to the NOx and SOx content respectively the sulphur content of the fuel different rebates on the fairway dues, referring to a linear scale. s	the level of the fair-way dues is such that it results in the same total costs for all ships travelling to and from Swedish ports as before 1998 (polluter pays principle). Generally the fairway dues were increased by SEK 1.40 per GRT see table incentive systems
Swedish Incentive System for differentiated harbour dues	Sweden	Swedish Maritime Administration, Swedish Ship-owners Association, Swedish Ports and Stevedores Association	to reduce emissions of SOx and NOx by 75 % within a five year period		approx. 30 different Swedish ports	emission reduction measures, proved by an Emission-Certificate issued by different Swedish laboratories or GL. The Certificate needs to be renewed every three years.	ferries and all other ships	discounts on harbour fees according to NOx and SOx emissions	see table incentive systems

Explanation:
Underlined text: Please click for detailed information
Black text: Systems which are presently practised; Red text: Suggestions, proposals, recommendations

Annex 2: Inventory of incentive/awarding systems; Table 2A: All incentive/awarding systems, labels, initiatives, etc.

Name	Country / Port	Editor	Objectives	Issued in	Accepted in	Requirements	Vessel Type	Incentives	Remarks
Finland I	Port of Helsinki	Port of Helsinki	to reduce SOx emissions		Port of Helsinki	usage of low sulphur fuel for passenger vessels < 1,0 % within the Finish territory	passenger vessels in regular public service	40 % discount on the port fees in the Port of Helsinki	see table incentive systems
Finland II	Finland		to reduce the risk of pollution by accident	introduced during the eighties	Finish territory	usage of double hull tankers	tankers	all oil companies must pay certain fees, double hull tankers pay half of single hull tankers	see table incentive systems
Finland III (The Aaland System")	Finish autonomous region of Aaland	Port of Mariehamn	to reduce emissions of SOx and NOx	since 01.01.2000	Port of Mariehamn	emission reduction measures, using of bunker oil with low sulphur content	all ships	rebate on harbour fees on a linear scale	see table incentive systems
Poland	Ports of Szczecin-Swinoujscie	Ports Szczecin-Swinoujscie	reduce pollution by sludge, sewage and oily waste	since 2004?	Ports Szczecin-Swinoujscie		all ships	rebate on tonnage fees (collection of sludge and bilge water for free)	see table incentive systems
Russia	Port of Kaliningrad	Port of Kaliningrad	reduce pollution by sludge, sewage, oily waste and other kind of ship's generated waste	since 2003?	Port of Kaliningrad	to have onboard environmental protection equipment in operation processing all kinds of vessel's waste/garbage and pollutants and hold international Certificates	all ships	rebate of 50 % on environmental fees	see table incentive systems
"Green Flag Incentive Programme" **Port of Long Beach**	Port of Long Beach, Part of the "Long Beach Green Port Programme"	Port of Long Beach together with U.S. Environmental Protection Agency, California Air Resources Board, South Coast Air Quality Management District, Pacific Merchant Shipping association and the Marine Exchange of southern California.	improve air quality cutting NOx emissions by reducing vessel's speed	introduced in 2001, at 01.01.2006 extended to another 3 years	Port of Long Beach	12 knot speed limit within 20 miles of the port during an entire year of voyages to and from Long Beach (control by radar observation)	all kinds of ships	Ocean carriers, who operate the individual ships will qualify for a 15 % "Green Flag"-discount on the dockage rate during the following 12 month if 90 % of their ships comply with the speed limit for a year	see table incentive systems
Ports of New York and New Jersey	Ports of New York and New Jersey	Ports of New York and New Jersey	reducing emissions from ferries		Ports of New York and New Jersey		private operated ferries	funds to provide incentives for private ferry operators	see table incentive systems
"Low sulphur subsidy program"	Port of San Francisco	Port of San Francisco CTEAC Cruise Terminal Environmental Advisory Committee	improve air quality	started 09 / 2005	Port of San Francisco	usage of low sulphur fuel of < 0,5 % sulphur content	Cruise ships calling San Francisco	subsidies program pays 50 % of the added costs for low sulphur fuel compared to conventional fuel, Grant from the Environmental Protection Agency	see table incentive systems
Carl Moyer Programme	Ports of California	State of California	reducing NOx emissions for compliance with California Air commitment State Implementation Plan	since 1998	Ports of California	investing in clean technology to emit less NOx then the legal limits	all marine ships, ferries, tug boats, fishing vessels, bulk carrier, passenger vessels	subsidies for "cleaner" engines and equipment, financed by a fund	see table incentive systems
"Cruise Ship Environmental Award"	Port of San Francisco	Port of San Francisco CTEAC Cruise Terminal Environmental Advisory Committee	reduction of air emission, waste-water treatment, recycling and disposal for solid waste	developed in 2005	Port of San Francisco		cruise ships calling San Francisco at least two times a year	incentive programme in planning stage	see table incentive systems
"Green shipping programme"	Port of Hamburg	Environmental Authority of Hamburg	promoting environmental friendly shipping	since 06 / 2001 - stopped in 06 / 2003	Port of Hamburg	i.e. ISO 14.001, "Green Award", high safety standards, use of low sulphur fuel (<1,5 %), no use of TBT	all ships	6 – 12 % less harbour fees - 6 % for ISO 14.001 & "Green Award" - 12 % for low sulphur fuel (<1,5 %), no use of TBT 15 % less emissions than in MARPOL VI	see table incentive systems
Korea "Green Ship System"	Korea		prevent marine pollution		accepted in Korean Ports	"requirements partly higher than MARPOL 73/78"		"providing administrative favours"	no further informations
Swedish recommendation	Sweden	Swedish Ship owner association	reducing SOx emissions	2002	Swedish waters	using of low sulphur fuel	all ships	tax rates should equalize the gap between the price for fuel with > 1% sulphur and < 1% sulphur indirect incentive to use low sulphur fuel	see table incentive systems
Swedish recommendation	Sweden	Swedish Ship owner association	reducing emissions	2002	Swedish waters	investing in reduction of emissions	all ships	EU board provides emission credits payback for investments by selling emission credits if they produce less emissions	see table incentive systems
Sweden	Port of Västeras	Port of Västeras	reducing NOx emissions	planned	Port of Västeras	catalytic converters	all ships	50 % rebate on port fees incentive programme in planning stage	see table incentive systems

Explanation:
Underlined text: Please click for detailed information
Black text: Systems which are presently practised; Red text: Suggestions, proposals, recommendations

Annex 2: Inventory of incentive/awarding systems; Table 2A: All incentive/awarding systems, labels, initiatives, etc.

Name	Country / Port	Editor	Objectives	Issued in	Accepted in	Requirements	Vessel Type	Incentives	Remarks
"Norwegian Green Ship Research Program"		Proposal of the "Norwegian Green Shi p Research Program"	reduce sea and airborne pollution	Proposal, started 1994 aimed on supporting standards higher than the IMO regulations by introducing environmental related indexing system for ships, including operational and accidentally pollution		getting a high score in an environmental related point system	five ship categories: oil tanker, chemical tanker, passenger vessels, reefers, other ships	50 % reduction of port fees	proposal!
Environmental related ton-nage tax		Proposal Norway - follow up of the proposal above (No 23)		1999, introducing a Point system from 1 to 10		increasing the tonnage tax about 50 %		reduction of the tax according to the points on the scale	proposal!
Incentive based ship related proposal for the Federal Implementation Plan for MARPOL VI 1994		U.S. EPA Environmental Protection Agency	reducing emissions exciding MARPOL VI requirements based on the Federal Implementation Plan for MARPOL VI 1994			newer, cleaner engines, speed limits, providing of "shore side power suppl y"	all kinds of ships	financed by introducing a fee - fee should be reduced for the compliance with MARPOL and no fee if MARPOL was excided	first plan 1994, alterna-tive plan 02/95, rejected by the congress 04/95 Proposal failed! 1998 new plans for emission reduction but not incentive based s
Initiatives									
"Qualship 21"	US ports	US Coast Guard	initiative to eliminate substandard shipping and to provide "targeting schemes" to identify poor quality vessels				non US ships freight ships, tanker and passenger vessels	Unlike the "Green Award" no reduction in fees is currently offered by "Qualship 21", although discussions are ongoing with the American Association of Port Authorities. Quality vessels should not be subject to the same annual inspec-tion as sub-standard vessels have to undergo. Freight ships - limited Port State Control Oversight (biannual examinations) Tank ships - annual examinations retained but discretion to reduce the scope of mid-period examinations Passenger ships - use as a marketing tool	
"Keep it Blue"	France	French initiative	to avoid dumping of ship generated waste		250 ports in Europe		all ships		
"Green Port Program"	Port of Long Beach	Port of Long Beach	reducing environmental impacts of port operations			the port is providing "shore side" power supply	all kinds of ships	Emission reduction for machines - funding & support for port- and loading vehicles	vessels with excessive smoke emission are cited and forced by AQMD for possible enforcement action
Congestion Mitigation and Air Quality Programme CMAQ	New York / New Jersey	New York	reducing traffic / traffic problems in ports and around ports		New York / New Jersey	reducing traffic		direct subsidies for measures to reduce traffic in ports and around ports (fund)	i.e. the new ferry for the Atlanta-Oakland service to substitute truck transport
Poseidon Challenge		INTERTAKO members	Continuous improvement of the tanker industry's performance in striving to achieve the goals of zero fatalities, zero pollution and zero detentions	INTERTANKO's council meeting in November 2005			whole tanker industry	The Chairman will personally sponsor a Poseidon Prize to be awarded annually to the member who has done the most to meet the Poseidon Challenge in the past year.	

Explanation:
Underlined text: Please click for detailed information
Black text: Systems which are presently practised; Red text: Suggestions, proposals, recommendations

Annex 2: Inventory of incentive/awarding systems; Table 2A: All incentive/awarding systems, labels, initiatives, etc.

Name	Country / Port	Editor	Objectives	Issued in	Accepted in	Requirements	Vessel Type	Incentives	Remarks
Labels									
"Blue Angel"		German Environmental Authority	to develop an integrated and internationally applicable incentive scheme for quality shipping	launched in 2002		like the Green Award the criteria include not only ship specification and equipment but also company operation and personnel management.	all types of seagoing vessels		Marketing Instrument represents the German version of the Green Award, the German Federal Environment Agency adopted a list of quality shipping criteria to give a rating for environmentally friendly ships, promoted as a Quality Shipping Initiative qualifying vessels are accredited with a Blue Angel 'Label'.
"Ecopro"		Washington State, Dept. Of Ecology	protect Washington's resources from damage caused by oil spill	since 1995		list of 31 criteria	tanker		Marketing Instrument
"Save the Waves"		RCI Royal Caribbean International (Cruise line)	company internal program to operate ships environmental friendly				Cruise ships of RCI		Marketing Instrument
"Earth Environmental Price"		Japan							no further information
AUSMEPA **Ship Membership**	Australian Ports	Australian Marine Environment Protection Association	To raise awareness among ship's crews and other members of the community about Australia's marine environment and the need to protect it.	beginning of 2006	Australian Ports	Application, costs 750 Aus$, certificate like Qualship 21, Green award, other international certificate providing evidence of ship's quality and safety record or two years free of detention under Australia's Port State Control regime.	all kind of vessels	none	Marketing Instrument
different "systems"									
"Safety Point System"		US Coast Guard							no further information
"OMS Screener"		Washington State Office of Marine Safety since 1997 "the Washington Dept. of Ecology has taken over OMS responsibilities (No .: 9)				funded by a tax on oil transported by tanker into Washington State			no further information
Indirect incentives in general	div countries		consumer is asking for more environmental friendly products and environmental friendly transport			i.e. Swedish forest industry reduced 70 % of SOx emission by using low-sulphur fuel voluntarily i.e.CDI Chemical Distribution Institute is inspecting vessels by independent inspectors. They are not chartered if they do not comply with the company's safety and environmental standards		inspections for environmental friendly and safety measures done by the chartering company before signing the contract	

Explanation:
Underlined text: Please click for detailed information
Black text: Systems which are presently practised; Red text: Suggestions, proposals, recommendations

Annex 2: Inventory of incentive/awarding systems; Table 2B: Incentives versus MARPOL

	Annex I Pollution by Oil	Annex IV Pollution by Sewage	Annex V Pollution by Garbage	Annex VI Pollution by NOx & SOx	To be proven by:	Other Incentives	Remarks
System / Port / Country							
Port of Stockholm **(as per: 2006)**	General charge for depositing sludge and oily bilge waters. Cruise Liners: general: 0,05 SEK/GT Water content > 25 %: => 25 < 50 % = surcharge of 0,2 SEK/GT =< 50 > 75 % = surcharge of 0,25 SEK/GT => 75 % = surcharge of 0,3 SEK/GT Vessels other than cruise liners: 0,5 SEK/GT		General charge for depositing waste. Cruise Liners: per passenger 15,0 SEK reduced by 5,0 SEK when waste is pre-sorted Vessels other than cruise liners: 0,5 SEK/GT Vessels minimising waste trough different actions – not contravene international or Swedish law – can get discount by special agreements with the port	**SOx** Passenger Ships, Ferries, Train Ferries: > 0,2% = surcharge of 0,2 SEK/GT > 0,2 < 0,5 % = surcharge of 0,1 SEK/GT Other Ships: > 1,0 % = surcharge of 0,2 SEK/GT extra certificate as proof of exemption from sulphur charges **NOx** All ships: < 10 g/kWh = reduction in harbour dues < 10 > 5 g = reduction of 0,15 SEK/GT =< 5 >1 g = reduction of 0,25 SEK/GT =< 1 g = r eduction of 0,30 SEK/GT	Nox and SOx reduction to be proved by certificates for the engine - including a function-ing waste sorting system the ship can get a "Life Buoy Diploma"	Vessels whose main engine is equipped with catalytic exhaust emission control or other equipment, which reduces the vessel's discharge of NOx by at least 50 %, receive a discount of SEK 400 per month	
Bonus System for SBT's and double hull tankers **(as per 01 / 2000)**	**Hamburg, Wilhelmshaven, Emden -** reduction of harbour fees by 17 % for SBT tankers and reduction by 25 % for double hull tankers **Brunsbüttel (as per 04 / 2006) -** reduction of harbour fees by: ca. 20 % for SBT tanker & double hull tankers **Bremen Ports and Nordenham**: Brutto measurement of ship reduced by the volume of b allast tanks = reduced port fees **Amsterdam:** 17 % for SBT tankers **Antwerpen and Rotterdam -** reduction of harbour fees by: 17 % for SBT tankers no reduction for double hull tankers **Le Havre -** no incentives but due to special measurement no disadvantage for SBT and double hull tankers **Suez Canal** - reduction of transit fees by: 2 % for SBT tankers 4 % for double hull tankers					different incentives in different ports	EU regulation according to IMO resolution A. 747 (18) to reduce the risk of pollution by accidents and by ballast water exchange
Swedish Incentive System for differentiated fairway dues **(as per 2006)**				**New System effective from 01.01.2005** **NOx & SOx:** **Reduction of fairway dues if:** NOx < 0,5 g/kWh & S < 0,2 weight-% Tanker: Fairway due: 7,21 €/GT (at most 2x/month) Possible reduction by 64 % Other cargo vessels: Fairway due: 6,82 €/GT (at most 2x/month) Possible reduction by 66 % Passenger vessels and railway ferries: Fairway due: 16,00 €/GT (at most 5x/month) Possible reduction by 75 %			**old s ystem till 31.12.2004** General fairway dues of 0,35 €/t and 0,09 €/t for goods of low value. Tanker (max. 12x/year): **NOx:** > 12 g/kWh = 0,47 €/GT **SOx:** > 1 Weight% S = 0,10 €/GT **NOx & SOx:** NOx < 2 g/kWh & S < 1,0 % = 0,30 €/GT Other Cargo vessels (max. 12x /year): **NOx:** > 12 g/kWh = 0,45 €/GT **SOx:** > 1 Weight% S = 0,10 €/GT **NOx & SOx:** NOx < 2 g/kWh & S < 1,0 % = 0,25 €/GT Passenger vessels and railway ferries (max. 18x/year): **NOx**: > 12 g/kWh = 0,45 €/GT **SOx**: > 1 Weight% S = 0,10 €/GT **NOx & SO x:** NOx < 2 g/kWh & S < 0,5 % = 0,27 €/GT
Port of Goteborg **(as per: 2006)** **Swedish Incentive System for differentiated harbour dues**	Charge for depositing sludge and oily bilge waters. Vessels from Europe and the North Sea: 0,15 SEK/GT Vessels from outside Europe and North Sea: 0,25 SEK/GT Tankers: additionally to the above mentioned: 0,08 SEK/GT Cruise liners: additionally to the above mentioned 0,15 SEK/GT		Charge for depositing other vessel generated solid waste. Tankers: 0,17 SEK/GT Other vessels: 0,10 SEK/GT Vessels minimising waste trough different actions – not contravene international or Swedish law – can get discount by special agreements with the port	**SOx** Passenger vessels, passenger ferries, railway ferries: > 0,5 weight-% = additional charge 0,2 SEK/GT Other ships: > 1,0 weight-% = additional charge 0,2 SEK/GT Tankers: > 1,0 weight-% = additional charge 0,2 SEK/GT (after reduction of the tonnage of the SBTs) **NOx** Possible reduction of harbour dues 11,99 - 6,01 g/kWh = reduction 0,05 SEK/GT 6,00 - 2,01 g/kWh = reduction 0,10 SEK/GT 2,00 or less = reduction 0,20 SEK/GT			

Explanation:
Underlined text: Please c lick for detailed information
Black text: Systems which are presently practised; Red text: Suggestions, proposals, recommendations; Green Background: Requirements exceed MARPOL

Annex 2: Inventory of incentive/awarding systems; Table 2B: Incentives versus MARPOL

	Annex I Pollution by Oil	Annex IV Pollution by Sewage	Annex V Pollution by Garbage	Annex VI Pollution by NOx & SOx	To be proven by:	Other Incentives	Remarks
Mälarharmna(Ports of Köping and Västeras) **(as per 2004)** **Swedish Incentive System for differentiated harbour dues**	General charge of a special fee for receiving sludge and oily bilge water from vessels separate from the harbour fee. SEK 0,20 per vessel GT per call SEK 0,10 per vessel GT per call extra charge will be levied in case that the water content is over 40 %. Vessels that have fully discharged their sludge in a previous harbour in Europe, and can prove this by showing a receipt, will receive a 0,05 SEK/GT discount on the above charge.		General charge of a special fee for receiving waste from vessels separate from the harbour fee. SEK 0,15 per vessel GT per call Vessels which reduce waste onboard through various measures may sign a special agree-ment with Mälarhamnar AB, whereby a discount will be granted on the charge related to the nature of waste. This system for waste reduction must not be in conflict with interna-tional or Swedish rules and regulations.				
Port of Helsinki **(please see handbook p 18)** **(as per 2006)** **(Finland I)**				**SOx** Passenger vessels providing regular services **and** using fuel of < 1 weight-% S get a rebate of ca. 36 % of the vessel charges. 18,74 €/100 t net tonnage instead of 25,20 €/100 t			**Port recommendations:** Port of Helsinki advises to use catalytic converters Port of Helsinki advises to avoid unnecessary noise
Oil pollution fund for pollution in Finish waters **(Finland II)**	all oil companies must pay certain fees for there ships, double hull tankers pay half of the fees than single hull tankers						introduced during the eighties
Port of Mariehamn **(Aaland system)** **(as per: 2006)** **(Finland III)**				**SOx** All ships (in all bunkers): < 0,5 weight-% = 4 % discount on harbour fees < 0,1 % = 8 % discount on harbour fees **NOx** All ships: =< 10 g/kWh = 1 % reduction on harbour fees < 1,0 g/kWh = 8 % reduction on harbour fees (based on an rectilinear scale) **NOx & SOx** NOx < 1 g/kWh & SOx =< 0,5 % get extra bonus of 8 % on harbour fees			introduced: 01.01.2000
Ports of Szczecin and Swinou-jscie **(as per 03 / 2006)**	Sludge an oily waste not exceeding special volume limits is can be discharged free of charge if the ship pays the harbours tonnage fees. The amount of "free" waste is accord-ing to the previous port: Baltic Sea 2,0 m3 North West European Waters 5,0 m3 Other Areas 10,0 m3 Additional fees of 85 to 125 zl/m3 will be charged if the amount of waste exceeding the limit	Sewage not exceeding special volume limits is can be discharged free of charge if the ship pays the harbours tonnage fees. The amount of "free" waste is according to the previous port: Baltic Sea 2,0 m3 North West European Waters 3,0 m3 Other Areas 5,0 m3 Additional fees of 25 zl/m3 will be charged if the amount of waste exceed-ing the limit	Garbage not exceeding special volume limits is can be discharged free of charge if the ship pays the harbours tonnage fees. The amount of "free" waste is according to the previous port: Baltic Sea 0,4 m3 North West European Waters 0,5 m3 Other Areas 0,6 m3 Additional fees of 85 to 700 zl/m3 will be charged if the amount of waste exceeding the limit		Double-bottom tankers get a discount of ca. 20%, tankers with separate ballast tanks get a discount of ca. 17 % on the tonnage dues. E.g. PLN 1,78/GT or 2,43/GT (double bottom) and PLN 1,86/GT or 2,51/GT (SBT) instead of PLN 2,23/GT or 3,04/GT.	No special terms for "Green Award Ships", no incentives planned for reduction of NOx and SOx emissions. Special charges for "special events" e.g. Lack of garbage sorting, Lack of couplings as required by MARPOL, Lack of ship's readiness to deliver the waste and others. Special volumes of waste included in tonnage fees for ships which have an exemption from mandatory delivery of their waste.
Port of Kaliningrad **(as per 2003, ongoing)**	General charge for depositing sludge, oily bilge waters and other ship generated waste, to be disbursed from all ships calling the port (environmental or sanitary dues). Vessels which have onboard environmental protection equipment in operation process-ing all kinds of vessel's waste/garbage and pollutants and hold international Certificates, get a rebate of 50 % of the environmental dues.		General charge for depositing sludge, oily bilge waters and other ship generated waste, to be disbursed from all ships calling the port (environmental or sanitary dues). Vessels which have onboard environmental protection equipment in operation processing all kinds of vessel's waste/garbage and pollutants and hold international Certificates, get a rebate of 50 % of the environmental dues.			Tankers may apply for 50% rebate from the environmental (respective sanitary) due but double-hull construc-tion is a pre-requisite condition for granting the rebate (besides all other environmental soundness).	

Explanation:
Underlined text: Please click for detailed information
Black text: Systems which are presently practised; Red text: Suggestions, proposals, recommendations; Green Background: Requirements exceed MARPOL

Annex 2: Inventory of incentive/awarding systems; Table 2B: Incentives versus MARPOL

	Annex I Pollution by Oil	Annex IV Pollution by Sewage	Annex V Pollution by Garbage	Annex VI Pollution by NOx & SOx	To be proven by:	Other Incentives	Remarks
"Green Flag" incentive programme -Port of Long Beach **(as per 01 / 2006)**				15 % discount on dockage rate if the vessel is observed to keep the 12-knot speed limit within 20 miles of the port during an entire year of voyages. The vessel gets a green flag to recognize its contribution to improve air quality. The ocean carriers get the rebate during the following 12 month if 90 % of their vessels comply with the speed limit for a year.	control by radar surveillance		Introduced in 2001 at 01.01.2006 extended to another 3 years
Incentives for private ferry operators in the ports of New York and New Jersey				Fund for incentives provided for private ferry operators to reduce emissions.			
Port of San Francisco "Low sulphur subsidy programme" **CTEAC Cruise Terminal Environmental Advisory Committee** **(as per 09 / 2005)**				Subsidies program pays 50 % of the added costs for low sulphur fuel compared to conventional fuel if using fuel with less than 0,5 % sulphur content.			Grant from the environmental protection agency developed in 2005
Carl Moyer Programme for the ports of California (issued by the State of California)				Incentives are given as subsidies for cleaner engines and equipment. Programme to reduce NOx emissions for compliance with California Air Commitment State Implementation plan. Aim is to emit less NOx than the legal limits			Established 1998, valid for all marine ships, ferries, tug boats, fishing vessels, bulk carrier and passenger vessels
"Cruise ship Environmental Award" of the Port of San Francisco (CTEAC Cruise Terminal Environmental Advisory Committee)	Reduction of emissions, proper wastewater treatment, better recycling and disposal for solid waste - incentive programme in planning stage.	Reduction of emissions, proper wastewater treatment, better recycling and disposal for solid waste - incentive programme in planning stage.	Reduction of emissions, proper wastewater treatment, better recycling and disposal for solid waste - incentive programme in planning stage.	Reduction of emissions, proper wastewater treatment, better recycling and disposal for solid waste - incentive programme in planning stage.			Developed in 2005, valid for cruise ships calling the Ports of San Francisco at least two times a year
Green Shipping Programme of the Port of Hamburg (Environmental Authority of Hamburg)				12 % less harbour fees for the use of low sulphur fuel with a sulphur content < 1,5 % and for 15 % less emissions than in MARPOL VI including TBT free antifoulings		6 % less harbour fees for ISO 14000 & "Green Award" Certificates	Planned to promote environmental friendly shipping, established in 06/2001, stopped in 06/2003
Korean "Green Ship System"	"meeting requirements partly higher than in MARPOL 73/78"	meeting requirements partly higher than in MARPOL 73/78	meeting requirements partly higher than in MARPOL 73/78	meeting requirements partly higher than in MARPOL 73/78		"administrative favours"	Established to prevent "marine pollution", accepted in Korean Ports, no further information
Swedish recommendation of the Swedish Ship Owner Association in 2002				reducing SOx emissions in Swedish waters by using low sulphur fuel - for all ships proposal: tax rates should equalize the gap between the price of fuel with > 1% sulphur and < 1% sulphur (indirect incentive)			
Swedish recommendation of the Swedish Ship Owner Association in 2002				reducing emissions in Swedish waters in general - for all ships by investing in reduction technology. EU board provides low emission credits payback for investments by selling emission credits if they produce less emissions			
Port of Västeras / Sweden				50 % rebate on harbour fees for reducing Nox emissions by using catalytic converters			planned incentive programme for al ships to reduce NOx emissions
Proposal of the "Norwegian Green Ship Research Program" (please see chapter 3.3)	Proposal, started in 1994 aimed on supporting standards higher than the IMO Regulations by introducing environmental related indexing system for ships, including operational and accidental pollution. Proposal: 50 % rebate on port fees	Proposal, started in 1994 aimed on supporting standards higher than the IMO Regulations by introducing environmental related indexing system for ships, including operational and accidential pollution. Proposal: 50 % rebate on port fees	Proposal, started in 1994 aimed on supporting standards higher than the IMO Regulations by introducing environmental related indexing system for ships, including operational and accidental pollution. Proposal: 50 % rebate on port fees	Proposal, started in 1994 aimed on supporting standards higher than the IMO Regulations by introducing environmental related indexing system for ships, including operational and accidental pollution. Proposal: 50 % rebate on port fees			Proposal based on getting a high score on an environmental related point system - five ship categories: oil tanker, passenger vessels, reefers, other ships
Norwegian proposal for environmental related tonnage tax	Proposal: reduction of the tonnage tax according to the points on the scale	Proposal: reduction of the tonnage tax according to the points on the scale	Proposal: reduction of the tonnage tax according to the points on the scale	Proposal: reduction of the tonnage tax according to the poins on the scale			Proposal from 1999, based on the proposal above, implementing a point scale from 1 - 10 and increasing the tonnage tax about 50 %
Incentive based ship related proposal for the Federal implementation plan for MARPOL VI 1994 by the U.S. EPA Environmental Protection Agency				reducing emissions exciding MARPOL VI requirements based on the Federal Implementation Plan for MARPOL VI 1994 financed by introducing a fee - fee should be reduced for the compliance with MARPOL and no fee if MARPOL was excided	newer "cleaner" engines, speed limits, usage of shore side power supply		first plan in 1994, alternative plan 02/95, rejected by the Congress in 04/95 Proposal failed! 1998 new plans for emission reduction but not incentive based

Explanation:
Underlined text: Please click for detailed information
Black text: Systems which are presently practised; Red text: Suggestions, proposals, recommendations; Green Background: Requirements exceed MARPOL

Annex 2: Inventory of incentive/awarding systems; Table 2B: Incentives versus MARPOL

	Annex I Pollution by Oil	Annex IV Pollution by Sewage	Annex V Pollution by Garbage	Annex VI Pollution by NOx & SOx	To be proven by:	Other Incentives	Remarks
Incentives based on the "Green Award" in different ports:							
Port of Ghent					"Green Award" Certificate	6 % premium on the port fees for Crude Oil tankers and Cargo Bulk Carriers	
Port of Klaipeda	segregated ballast tanks, double hull				"Green Award" Certificate International Tonnage Certificate	5 % premium on vessel dues 20 % SBT+double hull	
Westgate Port Taranaki					"Green Award" Certificate	5 % premium on the port fees for Crude Oil tankers and Cargo Bulk Carriers	
Port of Sines					"Green Award" Certificate	5 % premium on Tariff of port use	
Ports of Douro and Leixoes					"Green Award" Certificate	3 % premium on Tariff of port use	
Port of Lisboa					"Green Award" Certificate	5 % premium on Tariff of port use	
Port of Setubal					"Green Award" Certificate	3 % premium on Tariff of port use	
Ports of South Africa (Durban, East London, Port Elisabeth, Mossel Bay, Cape Town, Saldanha)					"Green Award" Certificate	5 % port dues rebate in all South African national ports if not enjoying a 5 % rebate in terms of double hulled/SBT scheme	
Ports of Spain					"Green Award" Certificate	Reimbursement for "Green Award" certified vessels has been postponed	
Port of Amsterdam					"Green Award" Certificate	6 % premium on the port fees for Crude Oil Tankers and Cargo Bulk Carriers	
Port of Rotterdam					"Green Award" Certificate	6 % premium on the port fees	
Port of Dordrecht					"Green Award" Certificate	6 % premium on the port fees	
Port of Moerdijk					"Green Award" Certificate	6 % premium on the port fees	
Ports of Vlissingen and Terneuzen					"Green Award" Certificate	6 % premium on the port fees	
Port of Sullom Voe (Shetlands)					"Green Award" Certificate	5 % reduction on the payable harbour dues	
Other incentives in different ports							
Port of Antwerp				seagoing ship using MDO or gasoil		75% reduction	
Port of Copenhagen			correct source separation of waste			savings in waste handling charges	
Port of Goteborg	segregated ballast tanks		reduce onboard waste			discount related to nature of onboard waste reduction of harbour due for SBT	
Port of Marseilles							Generally French regulation has not yet published guidelines concerning the enforcement of any incentive system
Port of Montreal							offering no incentives or awarding systems for environmental ships and ship operations
Port of Oslo			garbage sorted by source			garbage sorted by source will prevent a 50% surcharge being levied on cruise ships	
Port of Södertälje				Sulphur: max sulphur content 0,5% by weight: 0,3SEK/GT exceeding sulphur content 0,5% by weight: add. 0,1 SEK/GT nitric oxide per kWh: below 2 grams per kWh: 0,2 SEK/GT between 2 -6 grams per kWh: 0,15 SEK/GT between 6 - 12 grams per kWh: 0,05 SEK/GT exceeding 12 grams per kWh: add. 0,1 SEK/GT			
Port of Tallinn	segregated ballast tanks in the interval of 60,000 - 80,000 GT					discount of 5% from tonnage due	
Port of Thessaloniki			ability of waste separation			10% for all reception facilities	
Port of Vancouver							studying possibilities of an incentive program based on differentiated harbour dues

Explanation:
Underlined text: Please click for detailed information
Black text: Systems which are presently practised; **Red text: Suggestions, proposals, recommendations;** **Green Background: Requirements exceed MARPOL**

Annex 3

Vessel operating companies with award / Environmental Management System

Annex 3: Vessel operating companies with award / Environmental Management System

Ship Operators	Nationality	Vessel Type	EMS	Award	Remark
Abu Dhabi National Tanker Company ADNATCO	UAE	Oil Tanker	ISO 14001		
Arab Maritime Petroleum Transport AMPTC		Crude Product LPG Tanker		GREEN AWARD	
Arcadia Shipmanagement Co. Ltd.	Greece	Oil Tanker		GREEN AWARD	
A/S Dampskibsselskabet Torm		Product Tanker Bulk Carrier		GREEN AWARD	
Atlantic Container Line ACL	S	Container	ISO 14000 Clean Cargo Participant		
Bergshav AS	N	various	ISO 14001	GREEN AWARD	
BP Shipping Limited	UK	Tanker	ISO 14001	GREEN AWARD	
BW Shipping	Singapore	Tanker Bulk Carrier	ISO 14000		
Cavadoro Shipping Corporation	Greece	Tanker		GREEN AWARD	
Celebrety Cruises		Cruise l	ISO 14000, DNV Clean Design		merged with Royal Caribbean to Royal Caribbean Cruises Ltd
Chandris (Hellas) Inc.	Greece	Tanker		GREEN AWARD	
COSCO	China	container, bulker	ISO 14000, ISO 9000 OHSA 18000		
Costa Crociere S.p.A.	Italia	Cruise ships,	ISO 14001, OHSAS 18001, RINA Green Star and Green Star Design		first green cruise line
CROWLEY	USA	container general cargo Ro/Ro	working towards ISO 14001 certification	William M Benkert Award, U.S. Coast Guard,	
Crystal Cruises		cruise ships	ISO 14000		
Deiulemar S.p.A	Italia		EMAS		
Dorchester Maritime Ltd. DML	Isle of Man	Ship management, container, tanker	ISO 14001		member of the Schulte Group
Eagle Shipmanagement PTE Ltd	Singapore	Ship mgt.		GREEN AWARD	
Eidesvik	Norway	Platform Supply Vessels(PSV), AHTS, Seismic vessels, subsea/IMR vessels and a vessel equipped for fiber optical cable-laying	ISO 14001		innovative, LNG vessel
Evergreen	Taiwan	container	ISO 14001 Clean Cargo Participant	Environmental Excellence (LA)	
Executive Ship Management Pte Ltd	Singapore		ISO 14001 OHSAS 18001 Business for Social Responsibility	GREEN AWARD	

Annex 3: Vessel operating companies with award / Environmental Management System

Ship Operators	Nationality	Vessel Type	EMS	Award	Remark
Expedo Ship Management	Canada	Tanker Bulk Carrier		GREEN AWARD Qualship 21	
Great White Fleet, Ltd.		Container Reefer	ISO 14001		
Grimaldi Group	Italy	various	ISO 14001	Ford's Q1 Award	
Hanjin Shipping	S Korea	Container Bulk Carrier	ISO 14001 OHSAS 18001		
Hapag-Lloyd	D	container	ISO 14001 Business for Social Responsibility		
Hatsu Marine Limited	UK		ISO 14001 OHSAS 18001		
Holland America Line	US	Cruise	ISO 14001 (Aug. 2006) Cert. confirmed 21.08.06		
Iino Marine Service Co., Ltd	Japan	Tanker		GREEN AWARD	
IMCA International Marine Contractors Association		Offshore drilling units	ISO 14001		Offshore, marine and underwater engineering
International Marine Transportation IMT	UK	Tanker		GREEN AWARD	
International Tanker Management Limited				GREEN AWARD	
ISP International Shipping Partners	DK USA?	Cruise, Ferries	ISO 9000, ISO 14001, ISM, ISMA		
Jan De Nul	Belgium	Dredging vessels	ISO 14001, OHSAS 18001		
K-Line	Japan	various	ISO 14001 Business for Social Responsibility		
Knutsen OAS Shipping AS	Norway			GREEN AWARD, European Clean Marine Award	
Kristen Navigation Inc.				GREEN AWARD	
Kuwait Oil Tankers Co. S.A.K.	Kuwait	tankers, crude, product, LPG	ISO 14001	GREEN AWARD	subsidiary of Kuwait Petroleum Company KPC
F. Laeisz	D	various	ISO 14001		
LHL Leif Höegh & Co. ASA	Norway	various	ISO 14001		
Maersk /	DK	container MAERSK ARIZONA	Green Passport		
A.P.Moller – Maersk A/S			ISO 14001 Business for Social Responsibility	GREEN AWARD	

Annex 3: Vessel operating companies with award / Environmental Management System

Ship Operators	Nationality	Vessel Type	EMS	Award	Remark
Mitsui OSK line	Japan		ISO 14001 MOL 21 EMS Clean Cargo Paritcipant		
National Iranian Tanker Company				GREEN AWARD	
Navios Maritime Holdings Inc.- Technical Ship Management	Greece		ISO 14001		
Neptune Shipmanagement Services (Pte) Ltd (NSSPL)	Singapore	Ship management, container, tanker	ISO 14001		wholly-owned subsidiary of NOL
Neste Oil Oyi				GREEN AWARD	
Northern Marine Ltd	Scotland, subsidiary of Swedish Stena AB	all kinds of ships and offshore installations	ISO 14001	GREEN AWARD	
Norwegian Cruise Line	Tochter der Asiatischen Star Cruises	Cruise Ship Norwegian Star	DNV Passenger Ship ECO CLEAN		
Novoship (UK) Ltd				GREEN AWARD	
NYK Line	Japan		ISO 14001 Business for Social Responsibility		
OOCL		container	ISO 14001,	Qualship 21	
OSM Ship Management AS				GREEN AWARD	
Petroship	(SE Asia)	Tanker	ISO 14001		
P&O Nedlloyd	GB	container	ISO 14001 Business for Social Responsibility		
Royal Caribbean Cruises Ltd		cruise vessels	ISO 14001	William M. Benkert Award for Environmental Excellence (U.S. Coast Guard)	Gas turbines, funding of environmental projects, joint ventures with universities, etc.
Shell International Trading and Shipping Co, Ltd.	UK NL	Tanker	ISO 14001	GREEN AWARD Green Passport	
Silver Fern Shipping Limited	NZ	Tanker		GREEN AWARD	
Sun Enterprises Ltd				GREEN AWARD	
Superfast	Greece UK	Passenger Ferries	ISO 14001		
Tanker Pacific Management	Singapore	Tanker		GREEN AWARD	
TESMA Singapore Pte Ltd				GREEN AWARD	
Thenamaris Ships Management	Greece			GREEN AWARD	
Toyofuji Shopping Co., Ltd	Japan	Car Carrier	ISO 14001		very innovative - solar, etc.

Annex 3: Vessel operating companies with award / Environmental Management System

Ship Operators	Nationality	Vessel Type	EMS	Award	Remark
Ugland Marine Services AS	N			GREEN AWARD	
Vista Ship Management AS	N	Tanker	ISO 14001	GREEN AWARD	
V.Ship Norway AS	N	Tanker Bulk Carrier	ISO 14001	GREEN AWARD	
Teekay Shipping (Canada) Ltd			ISO 14001	GREEN AWARD	
Unicom Management Services	Cyprus		ISO 14001	GREEN AWARD	
Wallem Shipmanagement Ltd			ISO 14001 OHSAS 18001	GREEN AWARD	
Wallenius Lines	S		ISO 14001	Green Passport	
Windstar Cruises			ISO 14001		
Yang Ming Marine Transport Corp	Taiwan	container, bulkies, tanker	ISO 14001, OHSAS 18001		
Zim	Israel	container	ISO 9001 EMS		