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Environmental Classifications of Ships

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Environmental Classifications of Ships

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Abbreviations and glossary

ABS	American Bureau of Shipping
Ballast water	Water carried for stability of the ship
Bilge water	Water that collects in the bottom of the ship often contaminated with oil
Black water	Wastewater from toilets and medical facilities
BSR CCWG	Business for Social Responsibility - Clean Cargo Working Group
BWMC	Ballast Water Management Convention
CCS	China Classification Society
DNV	Det Norske Veritas
EEDI	Energy Efficiency Design Index
GHGs	Greenhouse gases
GL	Germanischer Lloyd
Grey water	Wastewater from showers, sink, galleys, laundry facilities etc.
GWP	Global Warming Potential
HCFCs	Hydro chlorofluorocarbon
IHM	Inventory of Hazardous Materials
IMO	International Maritime Organization
LNG	Liquefied Natural Gas
MARPOL 73/78	Maritime Pollution convention from 1973 with protocol in 1978.
MRV	Monitoring, reporting and verification
NO_X	Nitrogen oxide
ODP	Ozone depleting potential
ODS	Ozone depleting substances
PM	Particulate matter
RINA	Registro Italiano Navale (Classification society)
SCR	Selective Catalytic reduction
SECA	Sulphur Emission Control Area
SEEMP	Shipping Energy Efficiency Management Plan
SO_X	Sulphur oxides
TBT	Tributyltin
VOC	Volatile organic carbon

Dansk resumé

Der eksisterer en række standarder til at klassificere skibe med hensyn til deres miljø-og klimamæssige præstationer. Dette notat vurderer deres anvendelighed og giver et forslag til et sæt kriterier, som også kan være relevante globalt.

I det seneste årti , og især i de seneste år, er en lang række miljø- og klima resultatvurderingsstandarder for skibe kommet frem. Nogle er meget omfattende, mens andre er begrænset til en udvalgt gruppe af skibe, bestemte områder eller enkelte forureningskomponenter. De fleste standarder er frivillige og drives af virksomheder eller organisationer. Nogle få er i hænderne på statslige myndigheder, og nogle af dem er obligatoriske, f.eks. den norske NO_X-afgift, eller frivillige som Singapores Green Port program om SO_X-emissioner.

En række indekser for miljø som Clean Shipping Index eller Environmental Ship Index er udviklet, og de fleste klassifikationsselskaber tilbyder også deres kunder mulighed for at opnå forskellige "grønne standarder", f.eks. Lloyds Register, American Bureau of Shipping (ABS), China Classification Society, Germanischer Lloyd (GL) og Det Norske Veritas (DNV). De miljømæssige krav, der går ud over de eksisterende konventioner og regler er ofte ikke angivet med et kvantitativt kriterium. Kravet er typisk rettet mod eksistensen af en bestemt procedure eller udstyr.

Et system, der skal kunne fungere som en global standard, skal naturligvis være egnet til skibe, der opererer i et emissionskontrolområde, og dermed allerede opfylder strenge foranstaltninger vedrørende svovl, og formentlig indenfor en overskuelig fremtid også nitrogenoxider. I dette projekt er det valgt at gå ud over de eksisterende regelsæt ved f.eks. at kræve, at eksisterende skibe overholder reglerne for nye skibe og overholder grænser for emissioner tidligere, end hvad der er blevet vedtaget.

Den foreslåede standard består af et simpelt rangordningssystem på tre niveauer, som i vid udstrækning er baseret på informationer, der er let tilgængelige, og for de fleste verificerbare i skibets certifikater. Der kan være to forskellige måder at bruge dette system på: 1) at kræve at alle indikatorer skal overholde et vist niveau, før fartøjet kan godkendes til dette niveau, eller 2) at bedømme skibets klima- og miljøpræstationer ved at etablere en rangordning baseret på point. Det første giver skarpe adskillelser mellem niveauer og det andet en flydende overgang.

Summary in English

An overview of the existing mechanisms to classify ships with respect to their environmental and climate performance is provided. This note assesses the applicability and discusses a proposal for a set of criteria, which may also be applicable globally.

Over the last decade and in particular during the most recent years a great number of environmental and climate performance assessment standards have emerged for ships. Some are comprehensive, whilst others are limited to a select type of vessels or focusing on specific areas or performance parameters. The majority of the standards are voluntary and operated by companies or organisations. Others are in the hands of governmental authorities and some of those are mandatory, such as the Norwegian NO_X tax, or voluntary, such as Singapore's Green Port Programme on SO_X emissions.

A number of environmental performance indices such as Clean Shipping Index and the Environmental Ship Index have been developed and the majority of classification societies offer their clients an opportunity to obtain various "green standards", e.g. Lloyds Register, American Bureaus of Shipping (ABS), China Classification Society, Germanischer Lloyd (GL), Det Norske Veritas (DNV). The environmental requirements that go beyond the existing conventions and regulations do not often specify a quantitative criteria, but the requirement is directed at the existence of a certain procedure or equipment.

A performance system, which may be applied as a global standard must obviously be suited for ships operating in an emission control area and thus already complying with stringent measures on sulphur, and in a foreseeable future presumably nitrogen oxides as well. This study focuses on environmental requirements that go beyond the existing conventions, for example through demanding that existing ships comply with the rules for new ships or to implement limits of emissions earlier than what is planned.

The proposed standard consists of a simple three level ranking system, largely based on information readily available and for the most part verifiable in the ship's certificates. Two different ways of using this system are possible: 1) One way is to claim that all indicators have to comply with a certain level in order for the vessel to be certified for that level; 2) Another way is to rate the vessels' climate and environmental performance under the same system by a ranking score. The first option gives very stringent classes, and the second a more flexible transition between levels.

1. Introduction

This note provides an overview of the existing systems of classification of ships with respect to their environmental and climate performance. An assessment of their applicability is given and a proposal is advanced for a suitable set of criteria, which will also be applicable globally.

Over the last decade and in particular during the most recent years a great number of environmental and climate performance assessment standards have emerged for ships (for the purpose of this note termed "environmental ship performance indices". Some are ubiquitous and quite comprehensive, while others are limited to a selected group of vessels or focusing on specific areas or performance parameters. The majority of the standards are voluntary and operated by companies or organisations. A few are in the hands of governmental authorities where some of those are mandatory, such as the Norwegian NO_X (nitrogen oxides) tax, or voluntary, such as Singapore's Green Port Programme on SO_X (sulphur oxides) emissions. This study has its focus on environmental requirements that go beyond the existing conventions. However, it should be noted that many of the additional requirements in the available standards do not specify a quantitative value to aim for, but instead the approach can be procedural, e.g. relating to the existence of a garbage management plan, or the requirement can be "to do" or "not to do", e.g. no garbage overboard. It is emphasized that this note does not claim to be an exhaustive assessment of all available systems; the aim is to identify standards with general applicability regarding type of vessel, geographical area, and the range of pollutants included. Based on the assessed classification systems a proposal for a suitable Danish standard is given. This standard is created in such a manner that it will also be applicable globally in the long run.

2. The baseline of existing regulations

2.1 MARPOL 73/78

The member states of the International Maritime Organization (IMO) have over the years agreed to articles, protocols, annexes and unified interpretations of the International Convention for the Prevention of Pollution from Ships (MARPOL), originally from 1973 and modified by the Protocol of 1978, in short form MARPOL 73/78.The six Annexes cover following areas:

Annex I:	Regulations for the prevention of pollution by oil.
Annex II:	Regulations for the control of pollution by noxious liquid substances in bulk.
Annex III:	Regulations for the prevention of pollution by harmful substances carried by sea in packaged form.
Annex IV:	Regulations for the prevention of pollution by sewage from ships.
Annex V:	Regulations for the prevention of pollution by garbage from ships.
Annex VI:	Regulations for the prevention of air pollution from ships.

There are a significant number of specific provisions relating to the area of applicability (e.g. within or outside of 12 nm offshore, in special areas, in ports etc.) and to the timing of the implementation as governed e.g. by the ship's year of built and size class.

2.2 Other relevant IMO conventions

There are other important conventions governing environmental issues including the International Convention on the Control of Harmful Anti-fouling Systems on Ships, the IMO Ballast Water management Convention (BWMC), the Hong Kong Convention for the Safe and Environmentally Sound Recycling of Ships and the International Convention on Oil Pollution Preparedness, Response and Co-operation including its Protocol on hazardous and noxious substances. These conventions are in general applicable to all ships above a certain tonnage except for the BWMC, which has a complicated schedule of implementation related to the vessel's year of construction and ballast water capacity. Neither the BWMC nor the Hong Kong Convention has entered into force as of June 2013.

3. Environmental Ship Performance Indices

It is the maritime authorities or the classification societies on their behalf that survey and certify that ships comply with regulations. It is also the classification societies and in some cases other third parties, who certify that ships meet the environmental ship performance indices, also where the standards go further than the current regulation with even stricter requirements. Many of these environmental ship performance indices are operated by the classification societies and are applicable to ships across types or categories. [1]

Some standards are delimited by pollutant or geographical area of applicability and others have been developed only to e.g. tankers and container vessels, such as the Green Award and the Environmental Performance Survey of Business for Social Responsibility Clean Cargo Working Group (BSR CCWG). The Green Award certification scheme is a voluntary option open to oil tankers, chemical tankers and dry bulk carriers from 20.000 DWT and upward, as well as liquefied natural gas (LNG) carriers and inland navigation vessels. There are 38 certificate holders World wide (from 16 nations), hereunder e.g. Maersk Tankers (Denmark), Knutsen OAS Shipping (Norway), NYK LNG Shipmanagement Ltd (Japan), MOL LNG Transport - Europe (United Kingdom) and Kuwait Oil Tanker Co. S.A.K. (Kuwait).

The BSR CCWG was developed as a global business-to-business initiative for leading cargo carriers and their customers dedicated to environmental performance improvement in maritime container transport. The BSR CCWG has a number of shipowners as members (>20) hereunder e.g. A.P. Moller Maersk, APL, CMA CGM, MOL and NYK LINE. Non-shipping company members, who have an environmental standard for transport of cargo, include e.g. DONG Energy, Novo Nordisk, Novozymes, NIKE, IKEA Services and Wal-Mart Stores.

Another widespread industry standard with applicability limited to a specified ship type is the Tanker Management Self Assessment scheme used in the crude oil trade, which was developed by the Oil Companies International Marine Forum. The majority of major tanker operators apply TMSA and the success of this standard is due to the requirement of the shippers (the oil majors) that only vessels adhering to this programme and vetted accordingly may transport their cargo.

Most members of the International Association of Classification Societies have developed “green notations”, of which the most comprehensive ones are presented here. The classification societies Registro Italiano Navale (RINA), China Classification Society, DNV, ABS and Lloyd’s Register EMEA have integrated the performance system with additional climate and environmental requirements for obtaining a “green” certificate. Table 1 provides an overview of some of the existing standards. The term “all inclusive environmental ship performance indices” are applicable to all vessels, all geographical areas and covers a broad range of pollutants while “delimited standards” concerns certain types of vessels, specific geographical areas or a limited range of pollutants. The requirements of some of the environmental ship performance indices that go

[1] It is emphasised that a number of other formal or informal indices for ships are available such as the Danish Ecocouncil or ”Der Blaue Engel: Umweltschonender Schiffsbetrieb”, but it was chosen to focus on systems already operated in shipping.

beyond the MARPOL 73/78 and other environmental conventions are specified in details in Appendix 1.

TABLE 1: OVERVIEW OF ENVIRONMENTAL SHIP PERFORMANCE INDICES AND THEIR DELIMITATIONS.

All inclusive Environmental Ship Performance Indices	**Delimited standards**		
All vessels, pollutants, areas	Vessel type	Pollutants	Area
"Green" notations by LR, DNV, GL, RINA, ABS etc. Clean Shipping Index (CSI) Environmental Ship Index (ESI)	BSR CCWG Green Award TMSA	EEDI NO_X tax Ports standards (typically SO_X)	Emission Control Areas Antarctica Treaty Ports standards

*LR: Loyd's Register, DNV: Det Norske Veritas, GL: Germanischer Lloyd, RINA: Registro Italiano Navale, ABS: American Bureaus of Shipping, CSI: Clean Shipping Index, ESI: Environmental Ship Index, TMSA: Tanker Management Self Assessment, EEDI: Energy Efficiency Design Index

Going beyond the regulatory requirements and voluntarily invoke more stringent standards may be due to one or more of the following reasons:

1. The shipping company has a "first mover" policy on additional stricter regulations in preparation of future demands.
2. The shipping company and its ships with a "green" certificate can gain access to transport buyers (shippers) that require the carrier to take environmental issues into account.
3. Obviously, economic incentives such as the saving on fuel or locally reduced port fees may exist as well.

Different environmental performance indices such as Clean Shipping Index and the Environmental Ship Index have been developed, making it possible for ships to obtain a "green" ranking. In principle, this makes it transparent for transport buyers when comparing vessels although the requirement of continuous improvement does present challenges for the ranking and comparison of ships. The mentioned indices are based on calculations concerning reductions of CO_2, NO_X and SO_X, and how water and chemicals are managed. Water in this context includes black water (sewage), grey water (bilge water) and ballast water, and chemicals refer to antifouling paints, cleaning agents, stern tube oils, etc. Table 2 provides an overview of what pollution parameters the different environmental ship performance indices touch upon.

Other notable standards:

- The Energy Efficiency Design Index (EEDI), mandatory for new ships
- Shipping Energy Efficiency Management Plan (SEEMP), mandatory existing and new ships

IMO has developed the EEDI as a technical measure to successively improve a new ship's efficiency and thereby a reduction in CO_2 emission. The index indicates the specific CO_2 emission per cargo capacity and distance sailed. The SEEMP and its company counterpart the Company Energy Efficiency Plan are meant to act as guides for developing ship specific initiatives to improve energy efficiency with one of the potential measures, e.g. the Energy Efficiency Operation Index. There are five major components of both SEEMP and Company Energy Efficiency Management Plan, which are: 1. Planning 2. Implementation 3. Monitoring 4. Self-evaluation 5. Improvement. The Company Energy Efficiency Management Plan is a broader management plan than SEEMP, incorporating all

environmental measures of energy efficiency through the supply chain, including onshore and offshore suppliers and subcontractors.

In June 2013 the European Commission set out a strategy to integrate maritime emissions into the EU's policy in June 2013. The first step of the strategy is a legislative proposal to establish a EU system for monitoring, reporting and verification (MRV) of CO_2 emissions from large ships on voyages to, from and between European ports. There is some debate on how the system should be implemented, but it is expected that the MRV system will apply to shipping activities carried out from 1 January 2018 (European Commission, 2013; Danmarks Rederiforening, 2013).

TABLE 2: OVERVIEW OF MAIN SUPPLIERS OF ENVIRONMENTAL SHIP PERFORMANCE INDICES AND THE POLLUTION PARAMETERS INCLUDED.

Pollution parameter	Organisation							
	RINA Green Plus	CSI	LR	ABS	CCS	GL	BSR CCWG	DNV
Air pollution								
CO_2	+	+	+	+	+	+	+	+
SOx	+	+	+	+	+	+	+	+
NOx	+	+	+	+	+	+	+	+
PM[2]	+	+			+			
VOC[3]			+	+	+	+		+
ODS[4]	+		+	+		+		+
GWP[5] substances	+		+	+		+		+
Cold Ironing	+			+				
Incinerators				+			+	+
Sea pollution								
Black water	+	+	+	+	+		+	+
Grey water	+				+			
Bilge water	+	+	+	+			+	+
Ballast water	+	+	+	+	+	+	+	+
Sea discharge: NLS[6]			+	+	+	+		

[2] PM: Particulate matter
[3] VOC: Volatile Organic Carbon
[4] ODS: Ozone Depleting Substances
[5] GWP: Global Warming Potential
[6] NLS: Noxious Liquid Substances

Pollution parameter	Organisation							
	RINA Green Plus	CSI	LR	ABS	CCS	GL	BSR CCWG	DNV
Harmful substances in packed form	+				+			
Operational pollution by oil			+	+	+			
Accidental oil pollution					+			
Sludge oil handling		+						
Garbage	+	+	+	+	+		+	+
Non-toxic anti-fouling paints	+		+	+	+		+	+
Other measures								
Scrapping policy	+	+	+	+	+		+	
Crew awareness		+					+	
Ship design/construction				+	+	+		
Fuel oil changeover[7]					+			
Noise and vibration	+				+			
SEEMP[8]			+	+	+			
Company Energy Efficiency Management Plan				+			+	
Env. manager on board to prevent poll.	+			+				
EMS[9]							+	

* RINA: Registro Italiano Navale, CSI: Clean Shipping Index, LR: Loyd's Register, ABS: American Bureaus of Shipping, CCS: China Classification Society, GL: Germanischer Lloyd, BSR CCWG: Business for Social Responsibility Clean Cargo Working Group, DNV: Det Norske Veritas.

3.1 Ports and ship-owners focusing on environmental performance and differentiated fees in ports

3.1.1 The toolbox

One way of hastening the environmental performance of ships could be introduction of differentiated fees in ports. Ships with high environmental standards could foresee reduced ports fees, whereas ships with low environmental standards could foresee increased fees. The fees would have to be based on a number of accessible parameters and always on average values for the specific vessels, not on actual performance. Models like the Environmental Ship Index or Clean Shipping

[7] Fuel changeover to Low Sulphur Fuel
[8] SEEMP: Ship Energy Efficiency Management Plan
[9] EMS: Environmental Management System

Index could be used by ports and are in fact already applied in some.[10] In these models, environmental and climate performance are displayed in an easy accessible way. The ports can in this way decide whether the vessels are performing above or under a certain standard, and adjust the fees in accordance with this. It should be noted that the national industry association Danish Ports is not in a position to accept a mandatory system, which impose a differentiated fee based on environmental performance, as their members are independent ports with free price mechanisms.

3.1.2 The ship-owners' perspective

A crucial element is whether the ship-owners will be interested in taking part in such a system/classification. Based on findings regarding the earlier mentioned toolboxes, it seems that at a number of lo/lo operators are currently taking part in this.

The Danish Ship-owners Association do see a number of possibilities, but on the other hand, they express some reluctance with respect to introducing such measures. A high degree of transparency regarding the performance of the system is requested, in order to keep the competitive balance between partners.

On the other hand, the ship-owners find themselves in a rather critical position due to the introduction of Sulphur Emission Control Areas (SECAs) in a number of waters from 1 January 2015. The requirements of using low sulphur fuels or alternatively the introduction of technologies[11] which can offset the negative impact connected with the use of high sulphur fuel on the environment, will play an important role in the in the next 15 months or so.

Initiatives carried out at sea and in ports reducing emissions but possibly also reducing costs at sea and in ports will surely be in focus. Based on the findings in the report from Trafikanalys[12], the majority of ships in the Baltic Sulphur Emission Control Areas will switch to low sulphur fuel in 2015. This will result in an increase in actual cost with up to 64%[13], which will possibly lead to initiatives switching to other fuel types or installation of scrubbers. Such changes will have a positive impact on the emissions, both at sea and in ports. Regulation of port fees based on emission standards should therefore reflect these possible changes.

3.1.3 The perspective of ports

The Danish ports have different opinions on performance based differentiation of port fees and the ports and their organisation see both challenges and possibilities in introducing such a system. However, some disagreement exists with respect to whether the system should be compulsory for all ports (coordinated by the EU or IMO) and in which way it is to be controlled.

In contrast to this, Sweden has introduced a compulsory system as a part of their navigational fee system (Farledsavgift). The system is controlled and managed by the Swedish Authorities (http://www.sjofartsverket.se/sv/Om-oss/Ekonomi).[14] The system brings around the necessary information concerning each vessel, based on information from classification societies. Onsite inspections are therefore not part of the concept.

In Denmark a central system containing emission data for vessels does not exist making it more difficult to introduce such systems, without carrying out onsite inspections onboard the vessels. As part of the Clean Baltic Sea Shipping concept[15] initiatives applying schemes for environmentally differentiated port fees were investigated in a number of Swedish ports and their suggestion were to include emissions of NO_X, particulate matter (PM) noise and chemicals in a system.

In general, the reduction of port fees in Swedish ports is based on reduced emissions of NO_X and SO_X. The rebate is given based on the installation of e.g. scrubbers or SCR catalyst converters. Ships using LNG will also obtain a discount. As an example to this, one can look into the discounts given

[10] www.cleanshippingindex.com, http.//esi.wpci.nl
[11] Scrubbers as the most likely alternative.
[12] Trafikanalys: Konsekevnserna av skärpta krav for svavelhalten i maritimt bränsle- delredovisng , Juli 2013.
[13] Trafikanalys p 42.
[14] It should be noted, that this system only have focus on emissions to air.
[15] Cleanship Task 4.6.

by Port of Stockholm.[16] The sulphur rebate is up to 0.20 Sek/GT, when the sulphur content is less than 0.2 %. The nitric oxide rebate is 0.30 Sek/GT, when the content is less than 1 g/kWh. These values are listed in the official records[17] and are therefore directly applicable to the ship when it calls at the port. No additional control is necessary.
Port of Gothenburg has introduced an even more comprehensive system. The system is based on an additional fee for ships using bunker with a sulphur content exceeding 0.5% in combination with a reduction for vessels using bunker with a sulphur content less than 0.1%. On an annual basis, this shifts around 1 million. EUR between the two categories of vessels, and it has reduced the emissions of SO_X with approximately 100 tons in the Gothenburg area.[18] When SECAs is implemented in 2015, this system will be redundant, and new measures will have to be introduced.

3.1.4 Additional economic incentives

When looking at more incentives to reduce the emissions from ships, one could point to the use of power supply from land, soot particulate filters and similar measures. The EU funded project "Clean Air in Ports"[19] focus on a broad diversity of possibilities focusing on cleaning the air in the commercial ports. Although not yet actually on the agenda the treatment of ballast water is clearly an issue here as well, both with regards to the discharge directly to water and the increased use of energy and fuel whilst at berth.
However, even though many studies on emission reduction take place in the ports, it seems that most ports are currently awaiting the effects of the SECAs as well as the reactions from the ship-owners. Under the coming regulations ships operating in a SECA will already meet a 0.1% sulphur criterion. If the intention in a port is to voluntarily reduce even further and significantly beyond 0.1% sulphur cost related incentives may still be part of the port dues packages.

[16] www.stockholmshamnar.se.
[17] Via Farledsavgiften.
[18] Göteborgs hamn: Stöd till miljösatsande rederier. 2013.
[19] NABU: Clean Air in Ports. 2012 and ongoing.

4. Applicability of environmental ship performance indices

The classification systems available regarding ship's opportunities for environmental improvements beyond the regulations are often not directed at incremental improvements, but frequently utilize yes/no answers to assess the improved performance. This may include the existence of a company policy on a certain area with no actual assessment of a measurable performance indicator. In the following, focus is directed towards the incremental and quantitative indicators.

The implementation of pollution reduction is often governed by restrictions, which become effective at a certain date and in some cases for certain areas (ports, emission control areas etc.). Going beyond existing regulation may thus be done by constructing incremental improvements where the implementation dates are pushed forward and the rules only concerning specific areas are made effective in other areas. An incremental system makes it possible for all ships to make a difference even though their current stage of environmental performance is poor. An advantage is that for many of the pollution parameters the "values" or indicator levels, which may be used for an incremental standard, are already agreed amongst IMO members. In general, the environmental ship performance indices offered from classification societies rate or rank the vessel in a quantitative manner. A tool as the Clean Shipping Index is developed to all vessel types, but it should be noticed that the vessel score should not be compared across vessel types. The Clean Shipping Index system seems to be a reasonable tool to distinguish between vessels both for rewarding taxes and as help for transport buyers to choose company. BSR CCWG also provides a score but is only developed for container vessels. The use of a multi-indicator system for more than one matrix (air, water and chemicals), such as the Clean Shipping Index and Environmental Ship Index, does represent a complication with respect to the "value" associated with each indicator, as opposed to systems known from other sectors with relatively few indicators solely related to emissions to air. The indicators and their susceptibility to quantification will be assessed, since the use of an environmental ship performance index should be surveyed and certifiable.

It should be mentioned that several classification societies and other third parties are working on concepts for zero emission vessels. An example is the classification society GL, which is currently working on a zero emission technology based on hydrogen fuel cells. This means that no CO_2, NO_X, SO_X and very limited noise emissions will take place. This technology has been used since 2008 by a passenger ship "FCS Alsterwasser" in the river Alster in Hamburg's city in Germany (GL Group, 2008). However, the energy requirement of larger ferries, tugboats and port authority vessels is still too high and the use of fuel cells in marine navigation is mainly limited to auxiliary functions. The development of zero emission vessels may challenge the technologies and bring forward innovative solutions but are not included in the environmental ship performance index in this study. The technologies developed for the zero emission vessels will prevent air pollution, but still the environmental impacts from scrapping together with sea pollution from ballast water, sewage, garbage and chemicals should be managed.

4.1 Measures beyond mandatory requirements

As already mentioned, this study has its focus on environmental requirements that go beyond the existing conventions. In the following additional measures regarding prevention of air pollution and sea pollution will be described together with technical methods that may be used to achieve the targets.

4.1.1 Measures for prevention of air pollution

For prevention of air pollution, the environmental performance indices suggest different mechanisms or technologies to reduce the emissions and they set quantitative goals for obtaining a "green" notification or certification. A summary of the quantitative criteria is given below:

1. SO_X emissions should not exceed 0.5% and in SECAs not more than 0.1%
2. NO_X emissions should be in compliance with Tier II or III depending on vessel age
3. Refrigerant substances should have a global warming potential (GWP) < 1650 and an Ozone depleting potential (ODP) equal to zero. The monthly leakage should be under 3%.
4. Substances used for fire fighting should have a GWP<1650 and ODP=0
5. Hydrochlorofluorocarbon (CFCs and HCFCs) are prohibited

The technical methods listed below are included in the environmental ship performance indices and may be used to meet the listed quantitative targets:

1. Gas to liquids providing higher energy content than diesel
2. Blending fossil fuel with second-generation bio-fuels reducing CO_2 footprint
3. Dual-fuel engines running with Liquefied Natural Gas
4. Fossil fuel pre-treatment (e.g. water emulsions)
5. Modification in prime movers
6. Use of non-fossil fuels (e.g. sails, fuel cells, etc.)

"Gas to liquids" is a fuel type where natural gas has been converted to a liquid using a hydrocracking catalyst. It has higher energy content than diesel and therefore reduces the CO_2 emissions. Furthermore it reduces SO_X, NO_X and PM emissions. By blending fossil fuel with bio-fuels, the SO_X emission will also be reduced, but only second-generation bio-fuels are recommended. Another aspect is the CO_2 reduction potential, which will depend on the bio-fuel source, since not all biofuels necessarily have a net CO_2 benefit. The dual-fuel engines running with LNG and a small amount of fuel oil allow the ship to select the best option to meet local requirements regarding CO_2, SO_X, NO_X and PM emissions. Pre-engine or In-engine treatment with water to comply with Tier II requirements will reduce the NO_X emissions and the PM formation. To further reduce PM emissions, e.g. engine modifications and the common rail technology are in play. Other measures that will impact the air emissions are the restrictions in the use of GWP substances, shore based electricity, and supporting tools to assist the captain in keeping the most efficient sailing draft and trim. It should be emphasised that the chosen technology should not cause a significant rise in emissions of other pollutants or greenhouse gases (GHGs). This study has not included emissions of noise to air (or water). These issues have been on the agenda in the IMO, in particular related to protection of seafarers onboard and marine life in the sea. However, noise associated with ships in ports is an issue addressed frequently in a local and national settings or e.g. in the EU, but currently a lack of suitable and internationally recognised standards do not allow for inclusion in the present study.

4.1.2 Measures for prevention of sea pollution

For prevention of sea pollution no quantitative targets have been set, which complicates the actual improvements for the ships when a measure is taken into force. However, the measures should not be undervalued. In the following, items contributing to sea pollution are listed and the technologies

and suggestions to prevent the pollution are mentioned. Following measures for prevention of sea pollution are included in several of the environmental ship performance indices and are suggested for a common standard:

1. Black water:
    a. Advanced treatment plant on board as per Alaska Department of Environmental Conservation Title XIV (33 CFR Part 159 Subpart E)[20]
    b. Holding tank, high level alarms located at manned positions and sewage discharge recording book
2. Grey water:
    a. Advanced treatment plant on board as per Alaska Department of Environmental Conservation Title XIV (33 CFR Part 159 Subpart E)
    b. Holding tank and grey water record book
3. Bilge water:
    a. Bilge holding tank with facilities for delivery ashore
    b. High level alarms located at manned positions and automatic stopping device when oil content exceeds 5ppm
    c. Labels/colour codes in order to identify the different piping systems
    d. Biodegradable and low aquatic toxicity lube oil
4. Ballast water:
    a. Ballast Water Management system in accordance with resolution MEPC.174 (58)
    b. Ballast water exchange in mid-ocean
5. Garbage:
    a. Management Plan for hazardous wastes: lamp bulbs, batteries, printer cartridges etc.
    b. Separation into following categories: recyclables, non-recyclables, food waste, hazardous waste.
    c. Recycling of plastic, aluminium, glass, paper-cardboard
6. Antifouling:
    a. The hull antifouling paint should be without organotin compounds, i.e. existing tributyltin (TBT) containing paint not just coated.

It should be noticed that in cases where the selected five classifications societies have different restrictions for the same item, the strictest measure has been recorded in the list above.

4.1.3 Other indicators of pollution prevention

Scrapping of vessels is another issue raised in the environmental ship performance indices and is linked to the policies on the identification, labelling and removal of hazardous materials on board during operation or on the final voyage. The actual environmental benefit is difficult to assess during the operational phase of the vessel, but this issue is typically included in the environmental ship performance indices. In some cases, awareness training and other programs to engage the crew in the environmental and climate performance are also awarded points or benefits in the “green” notations.

In order to develop a suitable global standard, a shortlist of measures beyond existing regulation is presented in Table 3 including the most important performance indicators regarding prevention of air and sea pollution and concerning scrapping and awareness building.

[20] This US regulation sets discharge standards for sewage and grey water from large cruise ships operating in the Alaska waters.

TABLE 3: SHORTLISTED MEASURES BEYOND EXISTING REGULATION.

Air pollution	
CO_2	EEDI: Phase 1, 2 and 3 reduction factors
NO_X	Tier II and Tier III for existing vessels (depending on vessel age)
SO_X	<0.5% and in SECAs <0.1% S
Ozone depleting substances	Not allowed (also HCFCs)
Global Warming Potential	Global Warming Potential <1,650 and have a leakage under 3% per year.
VOC/PM_{21}	Only for tankers: Vapour control systems
Green house gases	No further specific regulation, follows EEDI and SEEMP (Energy Efficiency Operation Index) for CO_2
Shipboard incineration	Not allowed
Sea pollution	
Black water	No discharge in certain areas and sewage treatment plant on board
Grey water	Advanced treatment plant installed
Bilge water	Biodegradable and low aquatic toxicity lube oil
Ballast water	Mid-ocean exchange, BWM system installed
Garbage	Management Plan for hazardous materials and recycling wastes
Antifouling	Paint without biocidal compounds, such as organotin
Other	
Scrapping policy	Inventory of Hazardous Materials onboard; policy on scrapping at approved non-beaching facilities
Crew awareness	Documented education in environmental policy, targets and procedures.

4.2 Principles for a possible global standard

Based on the assessed environmental ship performance indices, a proposal for a possible future global standard, which is also applicable in Denmark, is developed (Table 4). A performance system applicable in Denmark must obviously be suited for ships operating in an Emission Control Area and thus already complying with stringent measures on sulphur, and presumably nitrogen oxides as well, in a foreseeable future. A way to go beyond the existing regulation is to demand that existing ships comply with the rules for new ships and to implement limits of emissions earlier than what has been enacted. The proposed standard consists of a simple three level ranking system largely based on information readily available, and for the most part verifiable in the ship's certificates (Table 4). Two different ways of using this system are possible:

[21] VOC: Volatile organic carbon. PM: Particulate matter

One way is to claim that all indicators have to comply with a certain level in order for the vessel to be certified for that level. If all indicators meet the requirements for e.g. level 3, except from one indicator only complying with level 2, the ship can only be certified for level 2. Hence, a modern vessel that meets all air emission and water management indicators but not yet has an inventory of hazardous (IHM) materials will not benefit from lower port fees or relaxation of other levies, since it only complies with level 1. In order to comply with level 3 the ship has to achieve zero emission or discharge, except from CO_2. The disadvantage of this way of ranking is that the ship owners will not be encouraged to bring up few parameters to level 3, if the rest are only complying with level 2.

The other way to rate the vessels' climate and environmental performance is by a ranking score. A system that does allow for a more continuous rating like this is the Clean Shipping Index. In this study all indicators at each level are treated equally and the ship obtains a total score by adding the points obtained. All parameters complying with level 1 are given 1 point, parameters complying with level 2 are given 3 points, and parameters complying level 3 are given 5 points. This system is not as sensitive to one specific pollutant parameter not complying with a certain level as it provides a total ranking score for the vessel. If ship owners find it easier to reduce some pollutants rather than others, this way of ranking will ensure that they do their best to achieve most points for all parameters. It will still be beneficial for the ship owner to improve the reduction of one pollutant in order to comply with level 3, even though all other parameters only comply with level 2.

In the present study care was taken only to include standards that were already presented in the regulative context, be it for other ships, other areas or with a future implementation date. However, the voluntarily applied environmental standards will in some cases eventually have to be complied with for the vessels, e.g. after a voluntary early implementation of D-2 ballast water management for small and large ballast tank capacity ships (<1,500 or >5,000 m^3), and the points awarded will be forfeited once regulation applies. In other cases, such as the NO_X regulation older ships are permanently exempted and may retain points for voluntary applying stricter standards. Once a vessel must comply with the strictest regulations it cannot under the current proposal for standards earn additional points. Obviously, there are options for including even stricter future standards and such standards are discussed and some even applied locally.

4.3 Recommendations for next steps

The introduction of a performance standard applicable internationally and in Denmark may not be a simple feat. A voluntary system is always driven by the motivation and incentives of the participants and challenged if not considered fair, i.e. while it is fine to award those participating over those not, it is not conducive to appreciation if certain trades, ship types or abatement mechanisms receive unfair benefits. Since the current proposal is based on collecting existing indices without assessing further their application in the Danish shipping industry it is recommended to consider the following:

- Provide an assessment of the contribution of such a voluntary environmental standard for ships on Danish policy goals, particularly for the transport sector, and the possible contribution of a global standard to reductions of emissions from global shipping.
- Provide a measure of the impact on ships in the Danish Registry (Dansk Skibsregister) and in Danish International Ship Register (DIS).
- Analyse the consequences of continuously raising the bar as new regulations are implemented for larger areas, other ship types and/or newer ships.
- Propose additional top end standards for vessels that already comply with the strictest regulations, e.g. various "zero emission" designs.
- Improve on the awareness on sustainable transport and the availability of green standards.
- Propose a sustainable funding mechanism including vetting and administration, and assess the cost profile and consequences for ports, if environmentally differentiated fees are implemented via ports.

TABLE 4: PROPOSAL FOR AN APPLICABLE DANISH STANDARD.

Pollutant parameter	Level 1 (1 point)	Level 2 (3 points)	Level 3 (5 points)	Certifiable
CO_2 New ships/ Existing ships	Reduction 20% / Reduction 10%	Reduction 30% / Reduction 20%	Reduction >30% / Reduction 30%	Yes; MARPOL Annex VI
SO_X	0.5% outside Emission Control Area	0.1% outside Emission Control Area	No emission	Yes; MARPOL Annex VI
NO_X[22] New ships/ Existing ships	>Tier II*/Tier II	Tier III/Tier III	No emission	Yes; MARPOL Annex VI
ODS/ODP[23]	No use /ODP = 0	No use /ODP = 0	No use /ODP = 0	Yes; MARPOL Annex VI
PM[24]	0.4 g/kWh	0.15 g/kWh	0.1 g/kWh	Currently not
Refrigerants GWP[25]	<3500	<2500	<1890	Yes; MARPOL Annex VI
Black water	Advanced treatment	Holding tank	No discharge	Yes; MARPOL Annex VI
Grey water	Advanced treatment	Holding tank	No discharge	Yes; MARPOL Annex IV
Bilge water	< 5ppm	Holding tank	No discharge	Yes; MARPOL Annex IV
Ballast water	Comply with D-1	Comply with D-2	D-2 No chemicals system	Yes; Ballast Water Convention
Garbage	Shore delivery	Waste separation	Recycling	Yes; MARPOL Annex V
Hazardous waste	Separation	Reduction policy	No emission	Yes; Policy
Antifouling	No TBT[26] on hull	Non toxic paint	Biocide free paint	Yes; Antifouling Convention
Scrapping	IHM onboard	No beaching	Certified facility	Yes; Policy based on Hong Kong Convention

[22] 20%-80% reduction

[23] ODS: Ozone depleting substances. ODP: Ozone depleting potential

[24] No standard for particulate matter (PM) emissions is given in the assessed environmental ship performance indices. ISO 8178-1 is often used in shipping.

[25] GWP is a measure of how much heat a greenhouse gas traps in the atmosphere relative to the effect of CO_2; in this case over a time interval of 100 years. No chlorofluorocarbons are allowed at any level.

[26] Tributyltin (TBT)

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6. Appendix: Selected Classification Societies and Environmental Performance Indices

This appendix provides information on the assessment standards for environmental and climate performance. The different issues have been divided into following topics: Air pollution, sea pollution and other measures. Each organisation's system has been screened for their environmental- and climate classification rules and marked in the cells with a plus sign.
Four of the classification societies (Lloyd's Register, RINA, China Classification Society and DNV) and two environmental performance indices (Clean Shipping Index and BSR CCWG) have been selected for detailed listing and their environmental requirements have been specified in the following tables. Mandatory legislations according to MARPOL 73/78 have been excluded in this study, but the measures beyond MARPOL 73/78 and other regulations have been recorded. Furthermore, it should be noticed that generally the Clean Shipping Index is built in a way so that the carriers that fulfil all international regulations do not get any points in the Clean Shipping Index system, and only additional "green" measures will count. Another ship performance tool has been developed by BSR CCWG with the intention to have a transparent system for the transport buyers.

6.1 Registro Italiano Navale (RINA)

Ships can obtain two different Green passports according to RINA's classification rules. One called RINA GREEN PLUS, which comply with MARPOL 73/78, while RINA GREEN STAR contains additional measures, which are weighted in their environmental index. If each index criteria is complied with the ship gets the Green Passport Plus/Star. For each measure the score is higher in the environmental index. Examples of measures:

1. Gas to liquid fuels
2. Water injection into combustion chamber
3. Running with LNG
4. Exhaust gas treatment
5. NO_X monitoring and recording

The specifications for RINA GREEN STAR can be found in Table 5.

6.2 Lloyd's Register

Lloyd's Register has environmental classification rules for ships. If a ship fulfils additional requirements beyond the MARPOL 73/78 it can obtain an ECO notation. Requirements for obtaining the ECO notation can be found in Table 6. Furthermore, Lloyd's environmental classification rules are built up with supplementary characters to the ECO notation (Lloyd's, 2013), which can also be found in Table 6. This makes it easy for transport buyers to figure out in which

pollution areas the ships make a “green” performance, but for the uninformed it can be problematic to know how the items are weighted and therefore problematic to compare the vessels’ environmental performance.

6.3 China Classification Society

The China Classification Society divides the ships into three environmental classes: Green Ship I, Green Ship II and Green Ship III. The Green Ship I is the lowest class and applies to ships that fulfil the mandatory legislation and have a basic Shipping Energy Efficiency Management Plan (called SEEMP I). The criteria can be found in Table 7. The Green Ship II contains additional requirements to Green Ship I including an expanded SEEMP II, while Green Ship III comprises additional items to Green Ship II and a further expanded SEEMP III (CCS, 2013). The China Classification Society’s requirements to the different levels of SEEMP are:

SEEMP I notation: The ship is to have a SEEMP developed in accordance with the relevant IMO guidelines.

SEEMP II notation: In addition to compliance of the ship with the requirement of SEEMP I, a ship energy efficiency management system must be established by the company or the operator of the ship and certified by China Classification Society.

SEEMP III notation: In addition to compliance of the ship with the requirement of SEEMP II, the ship must have software for real time monitoring of e.g. route optimization and hull bio fouling in order to monitor relevant parameters affecting ship energy efficiency and/or adjust energy efficiency measures at any time.

6.4 Det Norske Veritas (DNV)

According to DNV’s environmental classification rules, ships that comply with mandatory requirements set by MARPOL 73/78 get the certification CLEAN, while CLEAN DESIGN indicates that the ship comply with additional measures. The additional measures are shown in Table 8.

6.5 Business for Social Responsibility Clean Cargo Working Group (BSR CCWG)

BSR CCWG has developed a Performance Metrics Tool, which should make it easy for transport buyers to distinguish between the vessels’ “green” performances. This scoring system consist of a comprehensive question list which covers air pollution, sea pollution and additional environmental issues as scrapping policy, the environmental impact through the supply chain in the company, etc. For instance, the scoring system requests additional descriptions of the environmental Management Program, the percentage of fleet covered by Green Passport for ship recycling, the strategy and practice to achieve targets, indicators used to evaluate environmental performance, etc. Furthermore, the CO_2, NO_X and SO_X emissions according to supply-chain are evaluated (BSR, 2013). Answering the questions gives a score calculated by the Metric Tool, which is based on a program in excel. Some of the questions require a simple “yes” or “no”, other questions require a description, while some items require a calculation. How the description issues are weighted in the system is not clarified but the final score makes it transparent for transport buyers to differentiate between the vessels environmental performance. In Table 9 the most relevant items used in the CCWG tool are shown.

6.6 Clean Shipping Index

The Clean Shipping Index is built up to give a vessel score when additional measures beyond the mandatory convention are performed. The pollution elements weighted and used in the Clean Shipping Index can be found in Table 10. Here the quantitative measures are listed:

For CO_2 improvement the Energy Efficiency Operation Index is calculated for existing ships and should be more than 40% lower than for the reference ship. For container ships the CO_2 emissions are calculated according to the CCWG. NO_X emission reduction can give a score if the vessel complies with Tier III requirements. SO_X emission reduction gives a score if fuel quality is under 0.1% S. Use of LNG or biogas will give a zero emission scenario, and thus the highest score. Furthermore, the change from diesel/heavy fuel oil to LPG (liquefied petroleum gas), LNG or biogas will also reduce the PM formation. It is required for container and cargo vessels that refrigerants substances may *not* have an ozone depleting potential (i.e. ODP=0) and that substances like HFCs should have a GWP not exceeding 3500. The score will be even higher when the used substances have a GWP<1850. Regarding bilge water a score is obtained when there is an active treatment and the oil in outgoing water is under 5ppm with an emission control box in place. Ballast water exchange is not optimal for the environment and thus provides a reduction in the Clean Shipping Index scoring system. To obtain a full score a Ballast Water Management system that has received Type Approval Certification following Final Approval by IMO should be implemented (Clean Shipping Index, 2013).

A number of other classification societies, organisations and public indices are briefly described below but not into further details.

6.7 American Bureau of Shipping (ABS)

ABS has an environmental classification standard that distinguishes between ENVIRO and ENVIRO+ notation (ABS, 2013). ENVIRO notation is based on compliance with the international conventions, while ENVIRO+ notation includes additional criteria for environmental protection related to design characteristics, management and support systems, sea discharges and air emissions. The specifications are not significantly different from other class systems and are not described into further details in this report.

6.8 Environmental Ship Index

The Environmental Ship Index identifies seagoing ships that perform better in reducing air emissions than required by the current emission standards of the IMO. The Environmental Ship Index evaluates the amount of NO_X and SO_X that is released by a ship and includes a reporting scheme on the greenhouse gas emission of the ship. It gives an indication of the environmental performance of ocean going vessels and assist in identifying cleaner ships in a general way while providing a total score based on each of its constituent parts separately. The Environmental Ship Index is an adaptable index where the weighting of the scores between the different constituents of the formula might change and the evaluation of the performance can be adjusted to be more in line with constituents as they are added and existing ones deleted. Deletions will be made if a measure has proven to be effective and the behavioural change has become widespread. Disadvantage: Due to the adaptability and adjustment of the index, the total score will *not* be comparable for the same ship from year to year, since improvement calculations is not possible. Therefore, the Environmental Ship Index is only comparable between ships within the same year.

6.9 IMO's Energy Efficiency Design Index (EEDI)

IMO has developed the EEDI as a technical measure to successively improve a ship's energy efficiency. The index indicates the specific CO_2 emission per cargo capacity and distance sailed. This

tool has been created for improvement in CO_2 reduction. The amendments to MARPOL Annex VI Regulations for the prevention of air pollution from ships, scheduled to enter into force on 1 January 2013, add a new chapter to Annex VI, where the EEDI is made mandatory for new ships.. EEDI, which is measured in g CO_2 per ton-miles, requires step-wise improvements to the energy efficiency of new build ships, starting at 10% reduction in CO_2 per tonne-mile from 2015, increasing to 20% and 30% in 2020 and 2025, respectively.

6.10 IMO's Ship Energy Efficiency Management Plan and Energy Efficiency Operational Indicator (SEEMP)

The SEEMP is an operational measure that establishes a mechanism to improve the energy efficiency of a ship in a cost-effective manner. The SEEMP also provides an approach for shipping companies to manage ship and fleet efficiency performance over time using, for example, the Energy Efficiency Operational Indicator as a monitoring tool. The guidance on the development of the SEEMP for new and existing ships incorporates best practices for fuel-efficient ship operation, as well as guidelines for voluntary use of the Energy Efficiency Operation Index for new and existing ships (MEPC.1/Circ.684). The Energy Efficiency Operation Index enables operators to measure the fuel efficiency of a ship in operation and to gauge the effect of any changes in operation, e.g. improved voyage planning or more frequent propeller cleaning, or introduction of technical measures such as waste heat recovery systems or a new propeller. The SEEMP urges the ship owner and operator at each stage of the plan to consider new technologies and practices when seeking to optimise the performance of the ship (IMO, 2013). SEEMP is mandatory for ships over 400 GT from the 1st of January 2013 (Lloyd's, 2013).

TABLE 5: ENVIRONMENTAL CLASSIFICATION RULES FROM RINA BEYOND MANDATORY REQUIREMENTS.

Pollution area	Additional measures which have impact on the Environmental Index in RINA
Air pollution	
CO_2	Gas to liquids, Blending fossil fuel with second-generation bio-fuels, Duel-fuel engines running with LNG, CO_2 emissions monitoring and recording
SO_X	Gas to liquids, Blending fossil fuel with second-generation bio-fuels, Dual-fuel engines running with LNG, SO_X emission monitoring and recording
NO_X	Gas to liquid, Fossil fuel pre-treatment, (e.g. water injection) Dual -fuel engines running with LNG, NO_X emissions monitoring and recording
PM	Gas to liquids, Fuel pre-treatment, Lower PM emission achieved by modifications in prime movers that do not increase other pollutants and GHGs emissions, Dual-fuel engines running with LNG
ODS	Restrictions in the use of GWP (global warming pot.) substances
GHG	Non fossil fuels (e.g. Sails, fuel cells, etc.), Second generation of bio-fuels partially or totally used on board, Cold ironing, Tool to monitoring and recording fuel supplies and consumption, Computerized system to monitor fuel consumption, Supporting tool to assist the Master in keeping most efficient sailing draft and trim
Sea pollution	
Black Water	Advanced treatment plant as per Alaska Department of Environmental Conservation Title XIV (33 CFR Part 159 Subpart E), High level alarm in manned position
Grey Water	Advanced treatment plant as per Alaska Department of Environmental Conservation Title XIV (33 CFR Part 159 Subpart E), Grey water record book, Holding tank
Bilge water	High level alarm in manned position, Dry bilge concept, Magnetic coupling on oil pumps, Biodegradable and low aquatic toxicity lube oil, Retention on board, Bilge water treatment with alarm, automatic stop and recorder
Ballast water	Using Ballast water exchange
Discharge of water	Limitation of hot water discharge: such as not to increase by more than 2°C in mixing zone
Garbage	Management plan for hazardous wastes: lamp bulbs, batteries, printer cartridges etc., Recycling of plastic, aluminium, glass, paper-cardboard
Other	
Ship recycling	Res. MEPC.179(59)
	Res. A.962(23)

TABLE 6: ENVIRONMENTAL CLASSIFICATION RULES FROM LLOYD'S REGISTER BEYOND MANDATORY REQUIREMENTS.

Pollution area	ECO notation	Supplementary characters to the ECO notation
Air pollution		
CO_2		EEDI: submitted and approved by LR, Energy Efficiency Operation Index: in acc. With IMO guidelines
NOx	Comply with MARPOL Annex VI	NO_X-1: <80% of Tier I NO_X emission limits NO_X-2: <80% of Tier II NO_X emission limits NO_X-3: meets the Tier III emission limits
SOx	S content in Oil fuel < 3.0% m/m	DIST: SO_X, fuel sulfur content less than 0.10% m/m
CFC	Prohibited	
HCFCs	In new prohibited, ODP=0, GWP<1950	
Refrigerants	Alarm system, and leakage <10-3%	R: Refrigeration systems, natural substances are to be used as the refrigerants in all main r. Systems (cargo systems, provision rooms and air conditioning)
VOC	VOC Management Plan	VECS: Vapor emission control systems in acc with IMO Standards for Vapor Emission Control Systems
Sea pollution		
Black water	Treatment system in accordance with MEPC Res. 159(55)	
Bilge	MARPOL, Annex I, <15 ppm alarm	OW: Oily Bilge water, discharge ashore
Oil-in-water	Content in water discharge 15 ppm	TC: Enhanced tank cleaning
Ballast water	Ballast water management plan In accordance with regulation B1 of the International Convention for the Control and Management of Ships' Ballast Water and Sediments.	BWT: if treatment system in acc. With MEPC 174(58)
Garbage	Management plan, IMO MEPC Res. 71(38)	
TBT	Prohibited	A: Anti-fouling system is to be non-biocidal

Noxious liquid substances		CRM: Cargo Residue minimization GW: Grey Water, treatment plant installed and/or tank for discharge ashore
Other		
SEEMP	SEEMP in accordance with the relevant IMO Guidelines	
Scrapping Policy		IHMs should be in compliance with Regulation 5 of the Hong Kong International Convention for the Safe and Environmentally sound Recycling of Ships

TABLE 7: ENVIRONMENTAL CLASSIFICATION RULES FROM CHINA CLASSIFICATION SOCIETY BEYOND MANDATORY REQUIREMENTS.

	Additional measures which have impact on the CSI Index		
Pollution area	**Green Ship I**	**Green Ship II**	**Green Ship III**
Air pollution			
SO_X	-	Not to exceed 3.0%	Not to exceed 0.5%
	-	In SECAs not to exceed 1.0%	In SECAs 0.1%
NO_X	-	-	Tier III
ODS	-	-	HCFCs prohibited
Sea pollution			
Black water	Sewage Pollution Prevention Certificate	Effective operational procedure for sewage treatment	
		Sewage treatment system in acc. With res. MEPC.159(55)	
		Holding tank	
		Alarms	
		Sewage discharge recording book	
Grey water		Holding tank	Sewage treatment system
		Alarm	or discharged more than 12 nautical miles from land
Bilge Water		Alarm and auto stop when oil content exceeds 15ppm	Not to exceed 5ppm

			Bilge water treatment system, IMO MEPC.1/Circ.642
Ballast water	BWM convention	Requirements adopted by res. MEPC.149(55)	BWM system in acc. with res. MEPC.174(58)
	BWM Certificate	Res. MEPC.140(54)	
Garbage		Procedures for garbage documented	
Antifouling	Anti Fouling Systems convention		without organotin compounds (act as biocides)
	Anti-fouling Certificate		
Chemicals			
Oil	Oil pollution Prevention Certificate		
Harmful substances carried by sea in packaged form	Certificate for Carriage of Noxious Liquid Substances	Drainage system for Noxious liquid substances	
Refrigerating systems		Isolated	Ozone depletion potential is to be zero
			GWP less than 2000
		Liquid receiver	
		Annual refrigerant leakage rate is to be less than 10% of its total charge	
		Alarm system	
Other			
SEEMP	SEEMP (I)	SEEMP (II)	SEEMP (III)
Scrapping policy	Hong Kong Convention		

TABLE 8: ENVIRONMENTAL CLASSIFICATION RULES BY DNV BEYOND THE MARPOL 73/78.

Pollution area	Additional measures to obtain CLEAN DESIGN
Air	
SO_X	Max. 2.5% in fuel oil carried on board
	As alternative: use of an electrical shore connection
ODP/GWP	GWP < 1890, and ODP=0. No chloroflourocarbons (CFCs and HCFCs) allowed.
Incinerators	Installed, unless enough capacity for 100% delivery to shore
Sea pollution	
Bilge water	Bilge holding tank with facilities for delivery ashore.
	Labels/colour codes in order to identify the different piping systems
	Alarm, set to 5ppm
	Bilge water separator with automatic stopping device
Garbage	Vessel shall be equipped and arranged for sorting, collecting, minimizing and storing garbage prior to incineration or delivery to shore.
	Separated into following categories: recyclable, non-recyclable waste, food waste, hazardous waste
Only for tankers	
VOC (cargo evaporation)	Vapor control systems CFR 46 Part 39

TABLE 9: SELECTED ELEMENTS FROM THE CCWG ENVIRONMENTAL PERFORMANCE SYSTEM.

Pollution Area	Measure
Air pollution	
CO_2	Calculated, Vessel speed reduction, weather routing, hull and propeller polishing/hull resistance reduction, optimal rudder adjustment
	Optimal trim, optimized vessel utilization
	Optimized vessel load through freight consolidation
	Ballast water reduction measures for a better CO_2 / TEU ratio
	Waste heat recovery systems
	Shaft generators
	Electronic engine controls
	High pressure fuel injection systems
NOx	Calculated
	Slide valve technologies
	Common rail technology
	Electronic engine controls
	Water-based technologies
	After treatment technologies (e.g. SCR)
SOx	Measured S content in fossil fuel
	Description of program to reduce SOx emissions
Alternative energy: wind, solar, etc.	Noticed
Sea pollution	
Oily discharge	Score depend on percentage.
Ballast water	Treatment, Minimization,
	Mid-ocean ballast water exchange when required by regulations
Hull	Which biocide used, Which coating used
Waste	"No-garbage-over-board" policy, No-incineration policy, Discharge food waste only at mid ocean, e.g. >25 nm off-shore, Waste disposal onboard ship/at ports
Other	
Environmental policy	Yes/no (if yes: Description)
Annual environmental performance report	Yes/no (if yes: Description)
Environmental Management System	Yes/no (if yes, is it certified?) (e.g. ISO 14001)

All certificates	Supplied, and each weighted
Environmental short-term (annual) and long-term goals	Description
Monitoring of environmental performance	Description
Recycling policy	Yes/no (if yes: Description)
Company Energy Efficiency Management Plan	Description
Crew awareness	In environmental policy, targets and procedures.
Container management	Operate reefers with low energy consumption potential
	Use of environmentally friendly technologies for application of paint
	Verification of legally and sustainable wood used for container floors.
Monitored facilities	Paper consumption
	Electricity consumption
	Water consumption

TABLE 10: MEASURES IN CLEAN SHIPPING INDEX THAT IMPACTS THE VESSEL SCORE.

Pollution area	Measures which have impact on the CSI Index
Air pollution	
CO_2	Energy Efficiency Operation Index compared with a similar reference ship: >40% below reference
	Reduction goal: CCWG: >40% below reference
	For container ships: CO_2 emissions calc. acc. to CCWG
NO_X	Calculation of NO_X emissions per transport work in grams/tonne-km.
	NO_X emissions calculated in grams/TEU-km, Tier III (80% reduction)
SO_X	Total yearly average of sulphur in all fuel used as percentage by weight: Quality up to < 0.1% S. SO_X emissions in grams/TEU-km. Fuel S content < 2.5 % as total yearly average.
PM	Connected to the SO_X emissions.
Refrigerants	Use of ODP substances should have ODP =0
	Use of GWP substances should have GWP <3,500 or even <1,850
Sea pollution	
Black water	Scoring based on how treatment is in Particularly Sensitive Sea Areas (PSSAs)
	No Sewage discharge in PSSAs
Sludge oil handling	No incinerator on board, Documented disposal of sludge oil to treatment on shore.
Bilge water	Active treatment equipment has to be installed, calibrated and documented emission of <5ppm oil in the disposed bilge water
	Installation of emission control box
Ballast water	Ballast water exchange (reduced score)
	BW Management systems which received Type Approval Certification following Final Approval by IMO (full score)
Garbage handling	No incinerator on board, no waste over board, separate garbage for handling for reuse, recycling and disposal.
Antifouling	Using SPC (self-polishing coating)
	Non-toxic coating, accepted according to EU Biocide Directive 98/8/EG Annex 1 (10)
Chemicals	
Stern tube oils	Biodegradable oil according to ISO 9439(11), ISO 10708 or ISO 9408 (13)
External hydraulic fluids	Biodegradable fluids, Electrical power instead of hydraulic power, External hydraulic power capped so leakage will not reach the sea

Gear oil for thruster or propellers	Biodegradable oil
Boiler-/cooling water treatment	Avoiding the use of chemicals classified as carcinogenic, mutagenic or toxic to reproduction, according to the EU Dangerous Substance Directive (14), Avoiding products classified as sensitizing, toxic or dangerous for the environment according to the DSD directive (exclusion of nitrite)
Cleaning agents	Avoiding the use of chemicals classified as carcinogenic, mutagenic or toxic to reproduction, according to the EU Dangerous Substance Directive (14). Avoiding detergents classified as dangerous for the environment according to the DSD directive. Detergents, surfactants that disturb the installed bilge water treatment should be avoided.
Other	
Scrapping policy	Breaking facility may not be located on intertidal coastal zone. They have to carry an updated IHM on board. They sign a Covenant with the new owner when selling the ship
Crew awareness	Documented education for all crew on board with special emphasis on engine room personnel and handling of heavy fuel oil

Environmental Classification of ships

The report provides an overview of the existing mechanisms to classify ships with respect to their environmental and climate performance. Further the reports accesses the applicability of the systems for ports, shipping companies and cargo owners and discusses a proposal for a set of criteria, which may also be applicable globally.

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