Environmental Ship Index
field test

On the basis of a voluntary survey

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Preface

The author would like to express his gratitude to the representatives of the ports of Le Havre, Antwerp, Rotterdam, Amsterdam, Bremen and Hamburg and all interviewees who provided us with data and comments on the drafts.

In version 1.1 the correct Tier I NO_X limits were used, by correctly applying the IMO formula for engines under 130 rpm. This has a small influence on the ESI_NO_X scores and overall ESI scores.

The author

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Summary

The ports of Le Havre, Antwerp, Rotterdam, Amsterdam, Bremen and Hamburg are developing a uniform Environmental Ship Index (ESI) in the framework of the World Port Climate Initiative (WPCI). This voluntary index is to be applied from 2010 on worldwide by ports, to promote clean shipping.

The ESI formulas indicate the relative emission levels of air pollutants (NO_x and SO_x), taking into account all engines onboard and all fuel types. The emission level of a sea ship is set against the IMO regulations that apply to current ship operation. The baselines will be lowered in the future, following IMO regulations. The overall ESI score varies between 0 (meeting IMO regulations) and 100 (no emissions), as well as the partial scores for NO_x and SO_x.

The index has been designed in 2008 (CE, 2009). A next step after the development of the ESI, was testing of the formulas on a representative sample of ships. The report at hand presents the results of this field test. The goals of the field test were:

- To assess the applicability of the ESI.
- To learn about the ESI scores of different (kind of) ships.
- To assess whether the ESI is indeed a good indicator for air emission performance.

To answer the objectives of the study, a questionnaire was distributed by the ports involved in the development of the ESI. 48 questionnaires were returned that allow to draw first conclusions on ESI scores and the usability of the ESI formulas.

The main conclusions from the questionnaire analysis are that the ESI is a suitable indicator for the emissions of air pollutants of a ship. There appears to be no difficulties with data availability for calculating the ESI and the indicators are an appropriate measure for distinguishing ships with a different emission performance of air pollutants.

The data needed for the calculation of the ESI score are available from the EIAPP certificates[1] and bunker delivery notes, which are available onboard of ships. If no EIAPP certificate is available, the score for the NO_x part of the ESI is zero. This is generally the case for engines built before 2000. These unregulated engines generate, however, relatively high NO_x emissions on average. The time needed to gather all data needed to establish an ESI score is limited to less than 4 hours in general, as indicated by the respondents.

The results show that the ESI formulas can be used to discern between ships that perform close to the limits set by IMO and the best performing ships that are currently in use. From Table 1 it seems that the variation in ESI scores is significant, reflecting the difference in environmental performance of the ships in the sample. The analysis shows that ships in operation can differ significantly in their NO_x emissions and sulphur content of the fuel on board.

[1] EIAPP stands for Engine International Air Pollution Prevention. This certificate is obligatory for every engine onboard and part of the IMO Annex VI regulation (2000 and later).

Table 1 Overview of ESI scores

	Average	Best performing	Worst performing
ESI NO_X points (only Tier I ships included)	15	34	0
ESI SO_X points			
High sea	10	22	9
ECA	4	33	0
Berth	16	34	0
Overall ESI points (all ships included)	17	43	4

Note: See Figure 6 for a visual representation of the scores in the ship sample.

With the results of the field test available, next steps towards implementation can be made. Two effects may contribute to the reduction of air pollutants (increase of ESI points) of ships when ports promote clean shipping. Firstly, ship operators may change the *use* of their fleets, by the use of the cleanest ships in the ports that promote clean shipping. More research is, however, needed to underpin and quantify this effect. Secondly, *investment* in lower emission technologies (Tier III) and the purchase of low sulphur fuel may result in lower emissions and in overall ESI scores of around 75 points.

The fuel sulphur content of heavy fuel oil may be even reduced without significant investments, as a result of the variation in sulphur levels over the world[2]. Optimized fuel purchase may result in a lower average sulphur content, without significant investments. Additional research is also needed to clarify this.

This analysis is based on the current baselines and current operation. In 2010 the baselines for fuel sulphur content will change following the IMO and EU guidelines. The effect on the ESI SO_x scores of this is not known, since the availability of fuels on the market at that time is unknown. IMO Tier II will come into force in 2011 for new vessels. If the ESI would follow with a change of the baseline to IMO Tier II, many of the currently used engines would not meet the baseline.

[2] Figure 3 shows that the sulphur contents differ significantly over different bunkerings.

1 Introduction

1.1 Introduction

The ports of Le Havre, Antwerp, Rotterdam, Amsterdam, Bremen and Hamburg are developing a voluntary uniform Environmental Ship Index (ESI) in the framework of the World Port Climate Initiative (WPCI). The index is to be applied from 2010 on worldwide by ports, to promote clean shipping.

The index has been designed in 2008 (CE, 2009). After the development of the ESI in the first phase, the ESI formulas are to be tested on a representative sample of ships. This report discusses the ESI field test.

1.2 Project Framework

The goal of the project is to test the ESI formulas, as developed by the ESI working group, and to assess the practicability of the ESI in a voluntary index system. More specific, the goals are:

- To learn about the ESI scores of different (kind of) ships.
- Analyse the ESI scores of ships and assess whether the ESI is indeed a good indicator of environmental performance.
- Learn about the possibilities for ships to gather the data needed for ESI calculation.

To gather all the relevant data, a questionnaire has been developed and sent out by the ports involved in the development of the ESI. For reasons of time spending of the respondents, EEOI reporting has not been included in this questionnaire. There are however other initiatives that concentrate upon this.

1.3 Report structure

In chapter 2 we discuss the data that results from the questionnaires, and its availability. In chapter 3, we present the results of the ESI calculations. In chapter 4 we summarize the results and draw conclusions.

2 Data and data availability

2.1 Introduction

As an instrument to find answers to the goals of this study, a questionnaire was developed to gather the data needed to calculate the ESI scores for a sample of ships. The questionnaire is included in annex A.

48 questionnaires have been filled in by ship owners. Most of the vessels call at one of the participating ports. However, some ships were also contacted via personal contacts. There is therefore a limited number of ships that do not sail in the ECA or berth in an EU port.

On average, the quality of the filled in questionnaires was judged as good and therefore useful for making a first estimates of ESI scores.

All questionnaires were given a identification number, as to be able to retrieve details. These numbers are depicted in the various graphs.

All important ship types were represented in the ship sample (bulk, container, RoRo, general cargo, car carrier). All detailed data is included in annex B.

2.2 NO_x data used for calculations

The following information has been used to calculate the ESI NO_X:
- Tier I emission limit (based on rpm).
- Actual emission value of main and auxiliary engines.
- Nominal power of main and auxiliary engines.

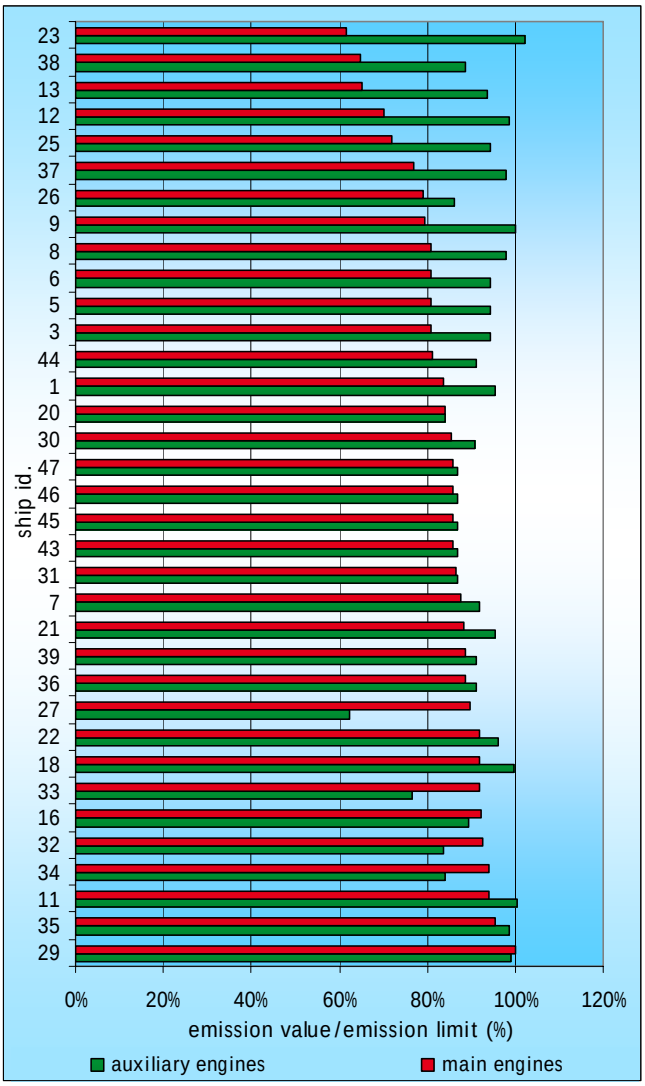
All this data is available on the EIAPP certificate, that need to be kept onboard a ship if its engines are build in 2000 or later.

From the data gathered, it seems that the weighted average emission level of auxiliary engines is closer to the Tier I limit than the emission level of main engines. The average emission level of the Tier I engines in the sample was 84% of the Tier I emission limit. For the auxiliary engines this was 92% of the Tier I emission limit.

The emission levels vary between 60% of the emission limit to 100% of the emission limit for the main engines, see Figure 1. For the auxiliary engines the variety is more limited.

In Figure 1 not the results of all 50 questionnaires are depicted, because a part of the ship engines was build before 2000. For these engines no EIAPP certificate was issued. For these ships no ESI NO_x score can be calculated.

Figure 1 **Emission values versus Tier I emission limits (g/kWh)**



2.3 SO_x data used for calculations

The following information has been used to calculate the ESI scores for SO_x:
- Amount of fuel bunkered per bunker delivery over 1 year time.
- Sulphur content per delivery.

All this information is available from the Bunker delivery notes (BDN's).

The weighted average sulphur levels of the fuels used are shown in Table 2. The fuel used at berth concerns EU ports. The fuel used at berth include both distillate fuel and heavy fuel oil. The latter has a higher sulphur content.

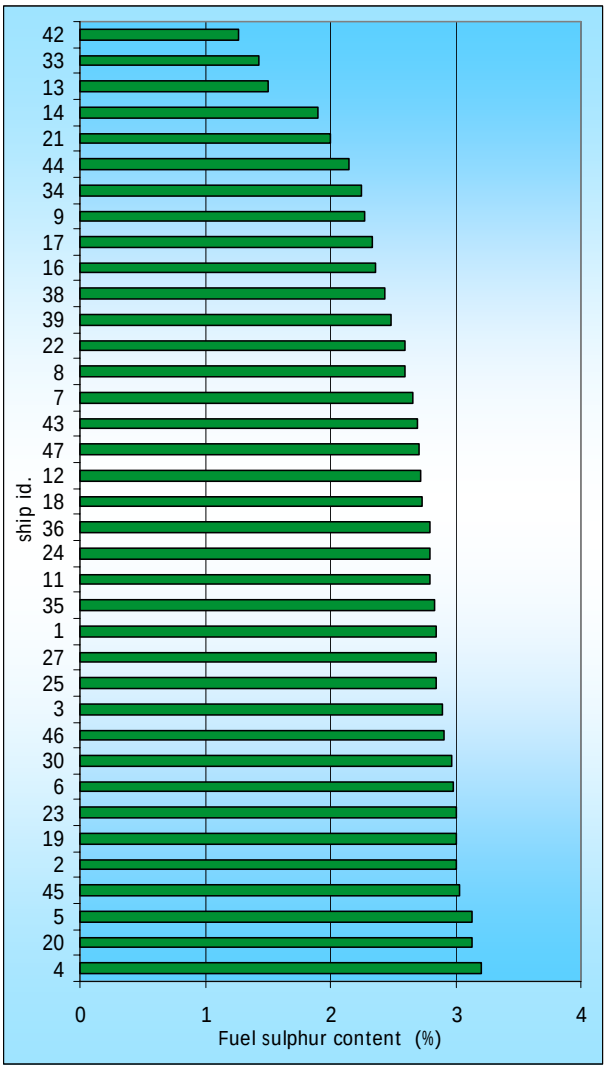
Table 2 **Average suplhur contents in the different regions**

Region	Sulphur level (%)
High sea	2.6
ECA	1.3
Berth	0.8

Note: The averages are calculated on the basis of the weighted average fuel sulphur content per ship.

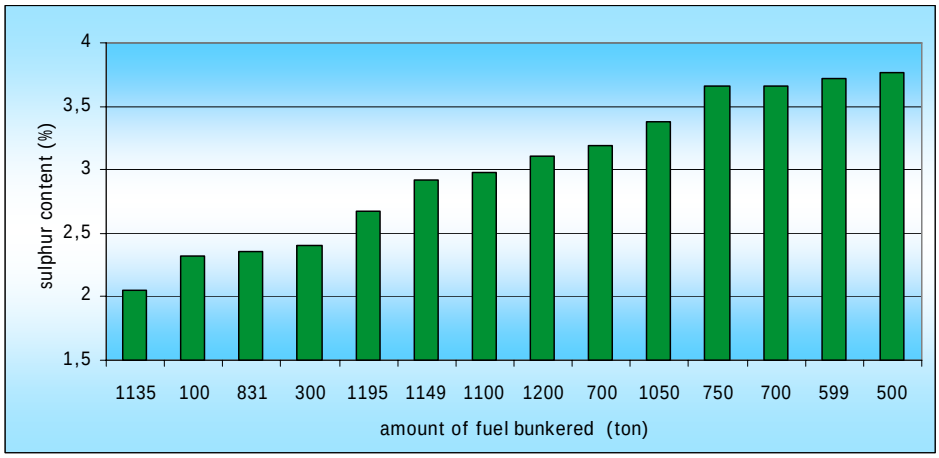
The variation of the average sulphur contents between the ships is significant, see Figure 2. As can be seen, some ships run low sulphur fuel continuously as part of the charter party.

Figure 2 Weighted average fuel sulphur contents (high sea)



However, not only the average sulphur content between the ships differ significantly, but also the sulphur contents of different bunkerings of individual ships. This is illustrated in Figure 3. Available BDN's indicate that the sulphur content is influenced by the region of bunkering.

Figure 3 Sulphur contents of different bukerings of an individual ship



In the ECA the variation in sulphur contents is limited. The sulphur level of most low sulphur bunker deliveries is around 1.3–1.4%.

At EU berths, various types of fuel are used: IFO/HFO and MDO/MGO. The first is the same fuel as used in the ECA. The sulphur content of the latter is often around 0.1% S.

2.4 Noticeable issues

During the processing of the questionnaires, the following catched the eye:

- A part of the ships are older than 1990[3] and are not able to provide EIAPP data. These ships can not join the NO_x part of the ESI programme, apart from certifying the engines on board. Their engines generally do not meet Tier I.
- From one questionnaire filled in by a charterer it seemed that charterers do not have the needed information available, as the EIAPP certificate and the BDN's are kept on board.
- No ships from the sample are equipped with NO_x reduction technology installed, apart from internal engine measures to meet Tier I.
- The time needed to fill in is on average limited (less than 4 hours), apart from outliers. Generally, ships with up to date documentation can easily answer to the questions.
- A limited number of ships use low sulphur fuel as part of the contract between operator and charterer.
- There is no clear link between age and emissions level for Tier I ships. The actual emissions level of an engine is more dependent on the engine type and manufacturer.

[3] The share of ships build before 2000 is 63%. The share of pre-2000 engines in the NO_x emissions and propulsion power is 50% (GL, 2008).

3 ESI scores

3.1 Introduction

In this chapter we will calculate the score of the ships in the sample. We will calculate the ESI scores for NO_x, SO_x and the overall score.

The following formulas have been used to calculate the ESI scores (for more information, see (CE, 2009):

$$ESI\_NO_x = \frac{100}{\sum_{i=1}^{n} P_i} \times \sum_{i=1}^{n} \frac{(NO_x\,\text{limit\_value}_i - NO_x\text{rating}_i) \times P_i}{NO_x\_\text{limit\_value}_i}$$

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

With:
- a% stands for the reduction of the sulphur content at the high sea, b% and c% for the reduction at berth and in the ECA. All compared to the baseline.
- If a ship does not use fuel with a sulphur content under the baseline, no points can be earned.

$$ESI_{overall} = \frac{1}{3.1}\left(2 * ESI\_NO_x + ESI\_SO_x + RR\_CO_2\right)$$

The following baselines have been used for this analysis:
- NO_x: IMO Tier I.
- SO_x: IMO sulphur limits of 4.5% for the high sea and 1.5% in ECA and at berth).

In 2010, the baselines will be lowered according to the IMO and EU regulations to 1.0% in the ECA and 0.1% at berth. These baselines are also in line with the regulations that apply to North America.

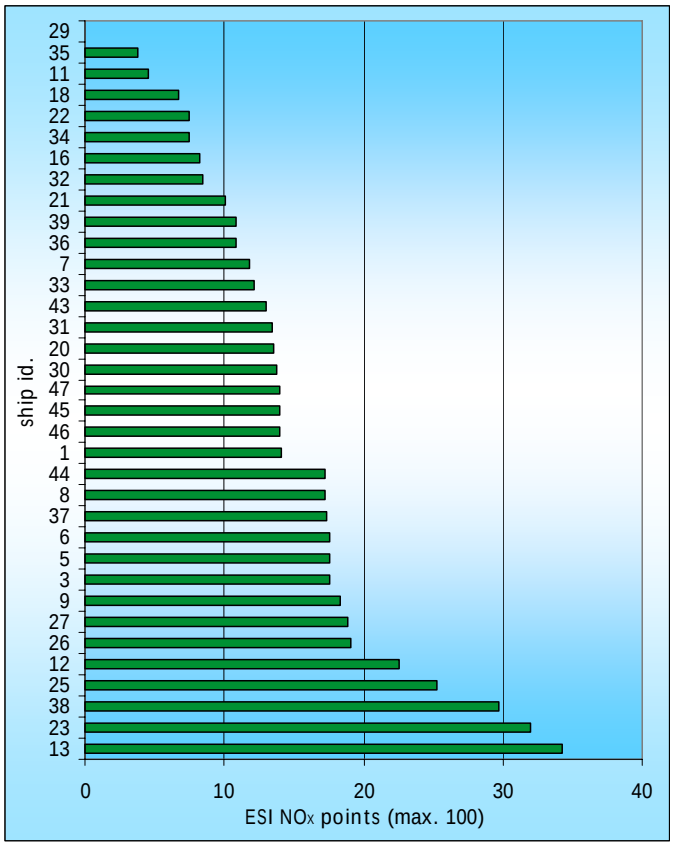
Only the BDN's are used for control. This implies that whenever a ship can demonstrate the use of a certain fuel, it will be settled against this. In the case of ships sailing between Asia and Europe that uses HFO fuel in Asia at berth, the ships can get points on the basis of the high sea limit at berth in Asia and on the basis of the low sulphur fuel used at berth and in the ECA in Europe.

As CO_2 is not part of the questionnaire, we kept the CO_2 part outside of this analysis and divided the total amount of points by 3.0 instead of 3.1.

3.2 Analysis ESI NO_x

The ESI NO_x scores are depicted in Figure 4. Out of a theoretical amount of 100 points, the best performing ships gets 34 points. The emission level of the worst performing ship is equal to the IMO limit value. Based on the sample, the average score is 15 points. The difference in emissions levels of Tier I engine propelled ships is however relatively big.

Figure 4 ESI NO_x scores of the different ships (max. 100)



If Tier II would be used as a baseline for the main engine instead of Tier I, the amount of ESI NO_x points to be earned would be on average 8-10% lower. If Tier II would be used for the auxiliary engines this would result in negative scores for the auxiliary engines, because their average emission level is higher than the Tier II emission level that will apply from 2011.

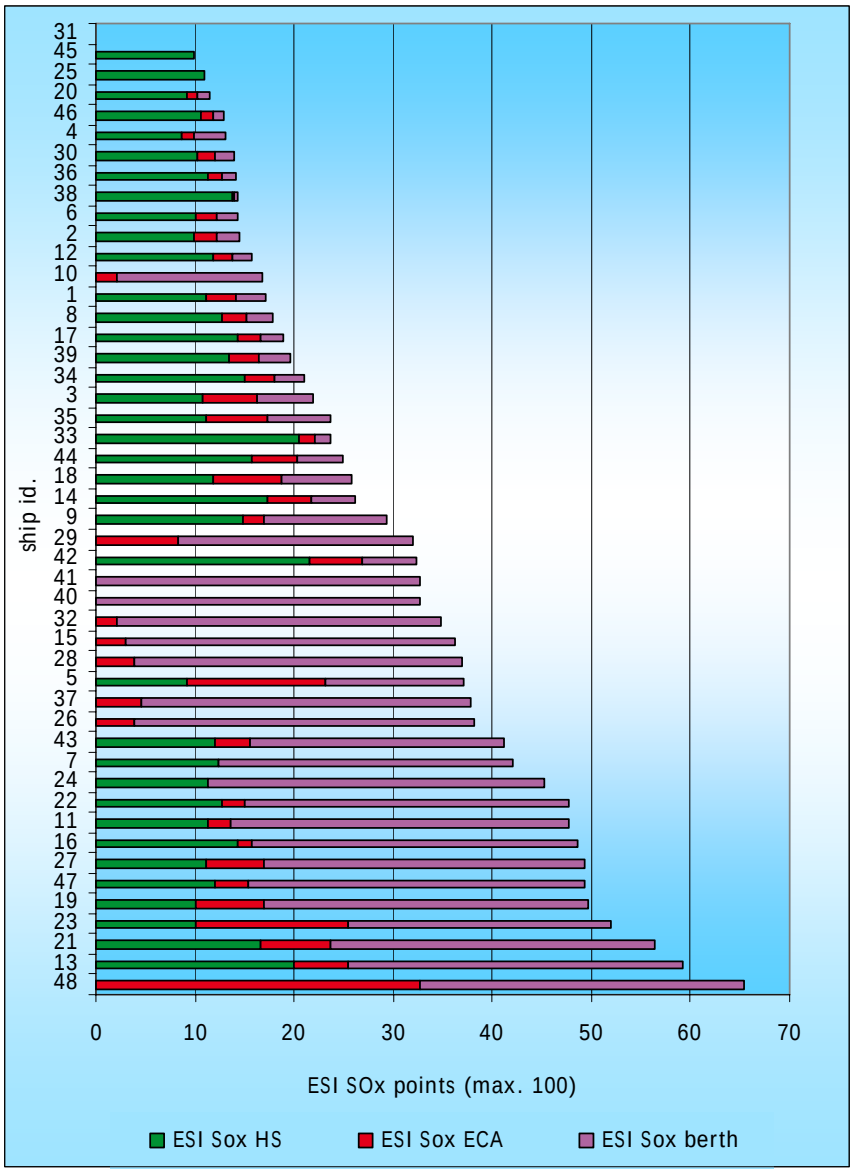
3.3 Analysis ESI SO_x

The ESI SO_x scores are depicted in Figure 5. The figure illustrates the relative big difference in ESI SO_x scores between ships, reflecting the difference in fuel sulphur content.

Figure 5 shows that the biggest amount of points are earned both at the high sea and at berth. The points earned for the ECA are relatively small, because the fuel sulphur content of low sulphur fuel oil is close to the limit in most cases.

Ships from the sample that do not call at EU ports and consequently do not enter the ECA, are at the lower end of the scores. The average overall ESI SO_x score is 30 points. The roughly 10 returning points result at the lower end of the graph result from the fact that the average sulphur concentration on the high sea is below the baseline of 4.5%.

Figure 5 ESI SO_x scores of the different ships (max. 100)

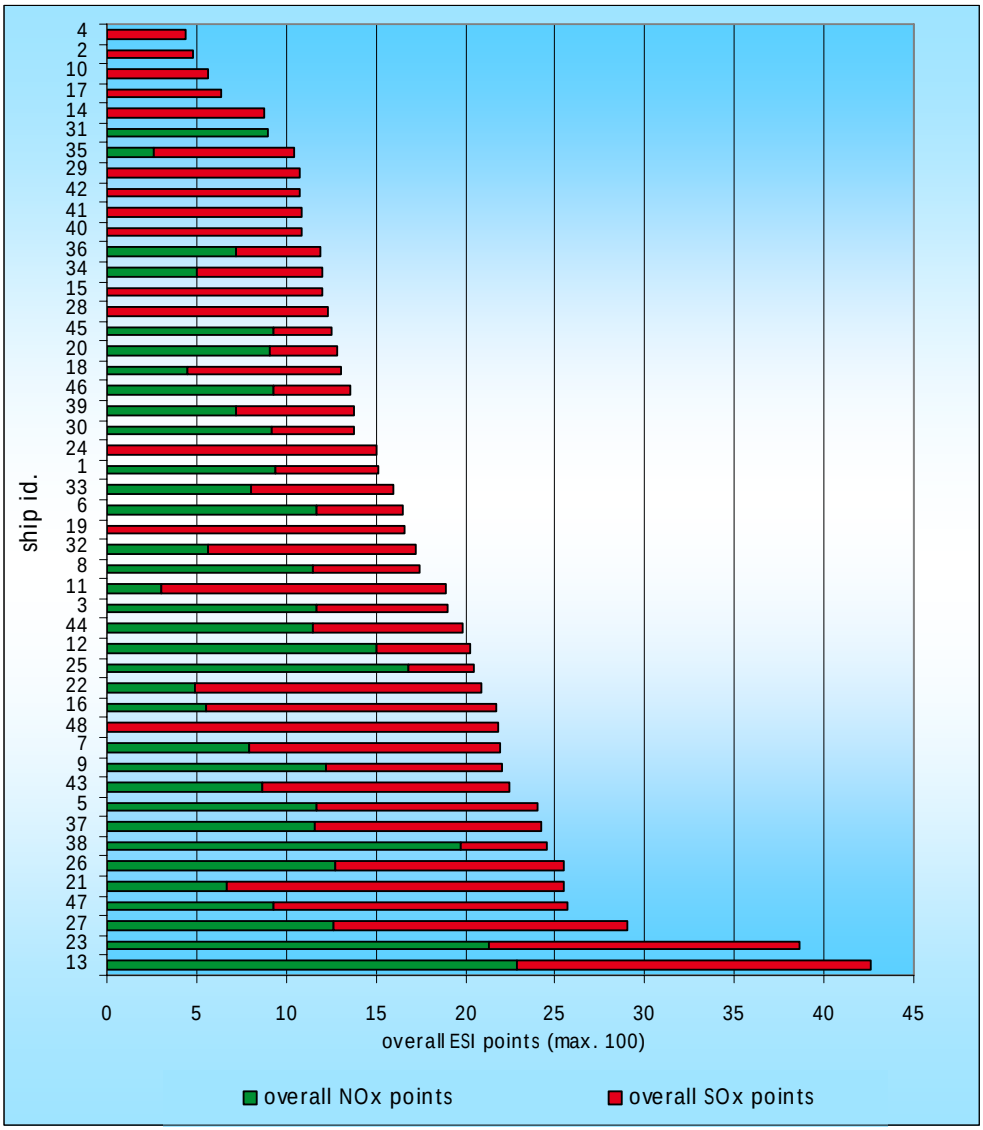


The ship with the highest number of ESI SO_x points is a ship that does not sail on the high sea, and uses 0.1% S fuel in the other regions. The ship that has a zero score does also not sail at the high sea and uses 1.5% S fuel in the other regions.

3.4 Analysis of overall ESI scores

The overall ESI scores of the ship sample range from 4 to 43 points. On average the score is 17 points, equally divided over NO_x and SO_x. As can be seen from Figure 4 the difference between ships is relatively big, reflecting the difference in NO_x emissions of the engines and fuel sulphur contents of the fuels used.

Figure 6 Overall ESI scores (max. 100)



3.5 Example of calculation

Below, we provide an example of ESI calculation for the ship with identification number 21 (for detailed data, see also annex B). The ship in the example has one main engine and three auxiliary engines. The ship uses all three types of fuel.

To calculate the ESI scores, we apply the formulas and baselines from section 3.1.

3.5.1 Sulphur

In the Table 3 below, the actual fuel sulphur contents and the baseline fuel sulphur contents are presented. With these data, ESI SO_X can be calculated.

Table 3 **Sulphur contents of different fuels used by example ship**

	Berth	ECA	High sea
Baseline sulphur %	1.5	1.5	4.5
Actual sulphur %	0.1	1.2	2

For the different regions, the relative improvement compared to the baselines is awarded, as presented in section 3.1:

$$\frac{(4.5-2)}{4.5}*30+\frac{(1.5-1.2)}{1.5}*35+\frac{(1.5-0.1)}{1.5}*35=56$$

3.5.2 Nitrogen oxides

In Table 4, all relevant data that is needed for the calculation of the ESI NO_x is presented. The formula from section 3.1 is used to calculate the ESI NO_x score.

Table 4 **NO_x emission data of main and auxiliary engines from the EIAPP certificate**

Baseline	Tier I				
Main engine			**Auxiliary engines**		
Allowed emission level (IMO Annex VI)	17	g/kWh	Allowed emission level (IMO Annex VI)	11,5	g/kWh
Actual emission level	15	g/kWh	Actual emission level	11	g/kWh
Power	9,480	kW	Power	970	kW
			Number	3	

$$\left\{\frac{17-15*9480}{17}+\frac{11.5-11*970*3}{11.5}\right\}*\frac{1}{9480+970*3}*100=10$$

3.5.3 Overall ESI calculation

For this example the overall ESI points[4] are as follows:

$$\frac{10*2}{3}+\frac{56}{3}+=26$$

If the ship would report its energy efficiency, the Reward for Reporting CO_2 would be included. The overall score in that case would be:

$$\frac{10*2}{3.1}+\frac{56}{3.1}+\frac{10}{3.1}=28$$

3.6 Ship owner reaction: the effect of low NO_x technology and low sulphur fuels on ESI

By promotion of the implementation of measures, two effects may occur:
1. Ship owner/charterers will change the use of their fleets, by the use of the cleanest ships in the ports with benefits and the reduction of the fuel sulphur contents without significant investments.
2. Invest in lower emission technologies and the buy of low sulphur fuel.

Firstly, we roughly indicate the effect op option 1 on the ESI scores. From the analysis of bunker delivery notes and EIAPP certificates, it seems that there is some variation within the ships (see Figure 1, Figure 2 and Figure 3). Below, we indicate the results that can be achieved by optimizing the use of the fleet (this is available to a limited extent) and only bunkering of fuel in areas where the sulphur content is naturally low.

Reducing the average high sea sulphur content from 3 to 2% and a reduction of the NO_x emissions of all engines with 10% will generate 11 points on the ESI NO_x and 7 points on ESI SO_x score. On the overall ESI, this will result in an increase of the ESI score of 10 points. A reduction of the fuel sulphur content of the ECA fuel from 1.5 to 1.3% will result in an increase of 2 overall ESI points.

Secondly, we provide an overview of the effect of installing low NO_x technologies and the use of low sulphur fuel. Based on the measures to promote clean shipping by ports and the willingness to invest by ship owners, ships will be equipped with emission reducing techniques and the use of low sulphur fuel will increase.

In Table 5 we illustrate the ESI points of a ship that meets the IMO Tier III emission level (80% below Tier I) and that uses fuel with a significant lower fuel content than currently prescribed by IMO regulations.

[4] Due to rounding off, limited differences can arise. Therefore, this score slightly deviates from the figures in Annex B.

Table 5 **ESI scores with an NO_x emission level of Tier III and the use of low sulphur fuel**

	NO_X	SO_X			
	Tier III	1.5% at high sea	1.0% in ECA	0.1% at berth	Total ESI score
ESI NO_X points	80				
ESI SO_X points		20	12	33	
Overall ESI points	53	7	4	11	75

From Table 5 it seems that a ship that is significantly cleaner that the current technology, achieves an ESI score of 75 points. Only the best performing ships sailing nowadays, achieve these scores.

3.7 ESI scores in the next years

In 2010, the limits for fuel sulphur content will be tightened both in the ECA and at berth in the EU, due to IMO and EU regulations. This will imply that the baselines will be adjusted downwards. The effect on the availability of fuel under the baseline is unknown at the moment.

From 2011, also the IMO Tier II standard will come into effect. By adjusting the NO_x baseline at that time, many of the current engines would not meet the baseline.

4 Conclusions and discussion

The following can be concluded from the ESI field test:

- The ESI formulas can be used to discern between ships that perform close to the limits set by IMO and the best performing ships that are currently in use. The analysis shows that ships in operation can differ significantly in their NO_x emissions and sulphur content of the fuel on board.
- The data for the calculation of the ESI scores is available onboard of ships. However, for engines build before 2000 EIAPP certificates are not obligatory. The absence of an EIAPP certificate implies a zero score. The emissions of these ships are, however, above the baseline set in most cases.
- In most cases the time needed to fill in the questionnaire is less than 4 hours. Because of the limited time needed, the questionnaire could be used as instrument to verify the ESI scores of participating ships.
- In Table 6, an overview is provided of the average, best and worst performing ships.

Table 6 Overview of ESI scores

	Average	Best performing	Worst performing
ESI NO_x points (only Tier I ships included)	15	34	0
ESI SO_x points			
High sea	10	22	9
ECA	4	33	0
Berth	16	34	0
Overall ESI points (all ships included)	17	43	4

Note: See Figure 6 for a visual representation of the scores in the ship sample.

- The variation in ESI scores is significant, reflecting the difference in environmental performance of the ships in the sample.
- Two effects may have a positive effect on the ESI scores of ships when ports promote the use of clean ships. Firstly, ship owner/charterers will change the use of their fleets, by the use of the cleanest ships in the ports with benefits and the reduction of the fuel sulphur contents without significant investments. It seems that the fuel sulphur contents can be reduced without significant investments due to optimized purchase[5]. However, more research is needed to underpin and quantify this effect. Secondly, investment in lower emission technologies (Tier III) and the purchase of low sulphur fuel (1.5/1.0/0.1%) may result in lower emissions and in overall ESI scores of around 75 points.
- This analysis is based on the current baselines and current operation. In 2010 the baselines for fuel sulphur content will change following the IMO and EU guidelines. The effect on the ESI SO_x scores of this is not known, since the availability of fuels on the market at that time is unknown.
- IMO Tier II will come into force in 2011 for new vessels. If the ESI would change the baseline to IMO Tier II at that date, many of the current engines would not meet the baseline.

[5] Figure 3 shows that the sulphur contents differ significantly over different bunkerings.

Literature

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Annex A Questionnaire

Voluntary survey Environmental Ship Index (ESI)

Introduction
The environmental performance of the shipping industry is becoming increasingly important as a 'license to operate'. It is felt that individual ships can go well beyond the current standards, with advantages for ports, ship owners and shippers. With assistance of CE Delft consultancy, the ports of Le Havre, Antwerp, Rotterdam, Bremen and Hamburg are developing a voluntary uniform Environmental Ship Index (ESI). The index is to be applied potentially from 2010 on worldwide by ports, to promote the use of clean ships.

The proposed index ranges from 0 for a ship that meets the current environmental average performance to 100 for a ship that emits no **SO_X** and **NO_x** and reports its **IMO energy efficiency operational index (EEOI)**. Particulates are important from an air quality point of view, but can not be implemented at the moment because of the absence of IMO regulations. Because of the time constraints for the interviewees for gathering data to report the EEOI, this questionnaire only deals with NO_X and SO_X. Information on the feasibility of EEOI reporting is achieved in other projects.

In the Annex to this questionnaire, the ESI principles, including the formulas used are included and illustrated. For more information, please download the study "proposal for and Environmental Ship Index" at http://www.ce.nl/art/uploads/file/7848_finalreport.pdf.

The goal of this questionnaire is to:
a Test the ESI formulas (anonymous)
b Test the ability data of reporting for shipping companies

The questionnaire results will thus be used to test and improve the voluntary index before implementation. The results will only be used for improvement of the ESI and not for other purposes.

This questionnaire exists of 4 questions. We prefer completely filled in questionnaires, but also partly filled in questionnaires are welcome. Please attach the documents requested to the filled in questionnaire.

1. Vessel particulars (will not be reported)

VESSEL NAME:	
IMO Number:	
Year of build:	
DWT (ton):	
Ship type:	
Company name:	
Name Interviewee:	
Email:	
Telephone:	

2. NO_X emissions

For NO_X emissions, the average emission value of the ship, weighted over the total rated power, is set against the state-of-art (20% below IMO Tier-II limit.). The average emissions value is calculated from the main engine and the auxiliary engines.

Main engine data from EIAPP/technical file

ENGINE TYPE NO.	NUMBER OF ENGINES OF THIS TYPE ON BOARD	RATED POWER (KW)	RPM	NO_X EMISSION VALUE (G/KWH)	YEAR BUILD
1					
2					

Any NO_X reducing techniques installed on board?

□Internal engine □HAM □SCR □DWI □EGR □ other……

Would you be able to demonstrate the relevant documents from the technical file to underpin the reported figures above?:

Yes □

No □

Please attach the relevant documents from the Technical File.

Remarks

IMO Reg.VI.13 - Nitrogen oxides (NO_x) emissions from diesel engines applies to ships constructed (keel laid) after 1 January 2000 or to engines undergone a major revision. All diesel engines of 130 kW output or more installed must comply with the specified NO_X limits. The NO_x Technical Code establishes that a Technical File, containing the engine's specifications for compliance with the NOx regulation, must be available on board the ship.

Internal Engine Modifications (IEM, e.g. slide valves or injection timing) Direct Water Injection (DWI); Humid Air Motors (HAM) Exhaust Gas Recirculation (EGR); and Selective Catalytic Reduction (SCR).

Note: Please attach the relevant documents from the Technical File.

Auxiliary engines data (>130 kW) from EIAPP/technical file (excluding boiler, incinerator)

ENGINE TYPE NO.	NUMBER OF ENGINES OF THIS TYPE ON BOARD	RATED POWER (KW)	RPM	NO_X EMISSION VALUE (G/KWH)	YEAR BUILD
1					
2					
3					
4					
5					
Would you be able to demonstrate the relevant documents from the technical file to underpin the reported figures above?: Yes □ No □ **Please attach the relevant documents from the Technical File.**					
Remarks					

Note: Please attach the relevant documents from the Technical File.

3. SO_X emissions

For SO_X emissions, the fuel sulphur content is offset against the world average sulphur content (high sea) or against the maximum allowable sulphur content (ECA and at berth). Please provide per bunker delivery, the type, mass and fuel sulphur content over the last year.

BUNKERING NO.	DATE	FUEL TYPE (HFO/IFO/MO/MDO)	MASS (METRIC TONNES)	SULPHUR CONTENT (%S)

Is low sulphur fuel use part of contract between ship owner and charterer?

Yes □

No □

Please illustrate how?

Please provide fuel bunker notes over the last year

IMO Reg.VI.18 - The Bunker Delivery Note must be retained on board the receiving vessel for 3 years.

Note: Please provide fuel bunker notes over the last year

If low sulphur fuel use is part of the charter party (answer: yes), please answer question 3b.

If answered no, we assume that the fuel bunkered with a higher sulphur content than 1,5%S is used outside the ECA and fuel with 1,5%S or lower inside the ECA, according to the international regulations.

3b SO_X emissions (only when low sulphur fuel use is part of the Charter Party)

Please report the fuel consumption and average sulphur content over the last year.

	TONNES/YEAR
Fuel consumption at high sea, non ECA (tonnes/year)[1]	
Fuel consumption in ECA (tonnes/year) [1]	
Fuel consumption at berth (tonnes/year)	
	%S
Average fuel sulphur content of high sea fuel, non-ECA (%)	
Average fuel sulphur content of ECA fuel (%)	
Average fuel sulphur content at berth (%)	
Remarks	

1 Fuel consumption due to maneuvering and sailing in port area included.

Note: please approve the data in this table with underpinning data.

4 Data reporting and suggestions

IS THE DATA WE ASKED FOR TO CALCULATE THE ESI EASILY AVAILABLE AND CAN YOU VERIFY THE DATA?
How much time did it take to fill in this questionnaire?
Do you have any suggestions?

For questions and completed questionnaires:

Local port contact details

Annex B Data used for ESI calculation

In Table 7, Table 8, Table 9 and Table 10, all data used for the analysis is included. In Table 7 we present ship details and the details of the main and auxiliary engines. Most ships have several identical auxiliary engines on board, that are all categorized as type 1 auxiliary engines. If ship has different types of auxiliary engines onboard, engines other than type 1 are listed in Table 8 and Table 9.

In Table 10 we present the data on the sulphur content and the results from the calculations of ESI scores. ESI scores have been calculated for ships for which data was available. Overall ESI scores have been calculated for all ships. If data is not available, this is indicated with #N/A.

Due to rounding of, manual reproduction of the calculations may result in slight differences.

Table 7 Ship details, main engine and auxiliary engine type 1

Main engine									Auxiliary engine type 1								
No.	Type	DWT (ton)	Year of build	rpm	Power (kW)	NO_x value (g/kWh)	NO_x limit Tier I (g/kWh)	Actual/ limit value	No.	Year of build	rpm	Power	Number	No_x value (g/kWh)	No_x limit Tier II (g/kWh)	No_x limit Tier I (g/kWh)	Actual/limit value
1	Chemical tanker	44,044	2008	127	11,060	14.2	17	0,84		2008	900	1,400	2	11	8.3	11.5	0.95
2	Chemical tanker	36,896	1996	720	2,430	#N/A	12.1	#N/A		1996	720	3,645	3	#N/A	6.7	12.1	#N/A
3	Bulk	174,133	2005	91	16,860	13.7	17	0,81		2005	720	800	3	11.4	9.5	12.1	0.94
4	Container	24,355	1983	140	11,353	#N/A	16.7	#N/A		1983	720	782	3	#N/A	9.5	12.1	#N/A
5	Bulk	173,806	2004	91	16,860	13.7	17	0,81		2004	720	800	3	11.4	9.5	12.1	0.94
6	Bulk	173,799	2006	91	16,860	13.7	17	0,81		2006	720	800	3	11.4	9.5	12.1	0.94
7	Bulk	53,505	2002	127	9,480	14.9	17	0,88		2002	900	440	3	10.6	10.9	11.5	0.92
8	Bulk	174,133	2005	91	16,860	13.7	17	0,81		2005	720	745	3	11.8	9.6	12.1	0.98
9	General cargo	16,676	2004	333	12,060	11.2	14.1	0,80		2004	1,200	476	3	10.9	10.7	10.9	1.00
10	Ro Ro/passenger	5,455	1978	520	4,709	#N/A	12.9	#N/A		1978	720	760	2	11	9.6	12.1	0.91
11	#N/A	46,159	2008	121	8,170	16.0	17	0,94		2007	720	795	3	12.1	9.5	12.1	1.00
12	#N/A	39,842	2000	105	12,750	11.9	17	0,70		2000	720	1,500	3	11.9	8.2	12.1	0.99
13	Oil tanker	116,640	2003	105	135,560	11.1	17	0,65		2003	720	677	3	11.3	9.8	12.1	0.94
14	Tanker	16,655	2008	500	6,500	12.6	13.0	0,97		#N/A	#N/A	1,020	1	9.7	8.9	#N/A	#N/A
15	Ro Ro	5,638	2000	520	5,376	#N/A	12.9	#N/A		1999	900	870	2	#N/A	9.3	11.5	#N/A
16	Container	109,000	2002	100	63,000	15.7	17	0,92		2002	720	3,600	2	10.8	6.7	12.1	0.89
17	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A		#N/A		#N/A	#N/A	#N/A		#N/A	#N/A	#N/A	#N/A
18	Oil/chemical	39,819	2003	120	7,980	15.6	17	0,92		2003	900	660	3	11.5	9.9	11.5	1.00
19	Oil/chemical	32,490	1995	111	8,380	#N/A	17	#N/A		1995	750	925	3	#N/A	9.1	12.0	#N/A
20	Oil/chemical	44,999	2002	600	3,840	10.5	12.5	0,84		2002	600	3,840		10.5	6.6	12.5	0.84
21	Oil tankers	46,590	2008	127	9,480	15	17	0,88		2008	900	970	3	11	9.0	11.5	0.95
22	Oil/chemical	40,003	2006	120	7,980	15.6	17	0,92		2007	900	600	3	11.1	10.1	11.5	0.96
23	Oil tanker	74,296	2008	105	12,240	10.5	17	0,62		2008	900	745	3	11.8	9.6	11.5	1.02
24	#N/A		1985	520	5,376	#N/A	12.9	#N/A		#N/A	#N/A	#N/A		#N/A	#N/A	#N/A	#N/A
25	Bulk	75,765	2006	104	8,973	12.2	17	0,72		2006	900	455	3	10.9	10.8	11.5	0.94
26	Oil/chemical		2008	173	4,440	12.7	16.1	0,79		2008	1,200	512	3	9.4	10.5	10.9	0.86
27	Tanker	3,476	2004	800	2,040	10.6	11.8	0,90		2004	1,500	310	3	6.5	11.8	10.4	0.62
28	#N/A	3,817	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A		#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
29	Car carrier	3,414	1999	750	2,400	12	12.0	1,00	2	1999	1,200	440	2	10.8	10.9	10.9	0.99
30	Container	100,680	2006	94	68,640	14.5	17	0,85		2006	720	2,310	3	10.94	7.4	12.1	0.91

		Main engine							Auxiliary engine type 1								
No.	Type	DWT (ton)	Year of build	rpm	Power (kW)	NO_x value (g/kWh)	NO_x limit Tier I (g/kWh)	Actual/ limit value	No.	Year of build	rpm	Power	Number	No_x value (g/kWh)	No_x limit Tier II (g/kWh)	No_x limit Tier I (g/kWh)	Actual/limit value
31	Container	39,200	2006	104	25,270	14.7	17	0,86		2006	720	1,680	4	10.5	8.0	12.1	0.87
32	Bulk	9,342	2006	500	8,400	12	13.0	0,92		2005	1,800	465	2	8.4	10.7	10.0	0.84
33	#N/A	27,711	2004	500	7,300	11.95	13.0	0,92		2004	1,200	682	4	8.36	9.8	10.9	0.77
34	Multipurpose	30,270	2003	114	16,250	16	17	0,94		2002	900	1,020	3	9.7	8.9	11.5	0.84
35	Tanker	39,842	2000	105	12,750	3.4	17	0,95		2000	720	1,500	3	2.4	8.2	12.1	0.20
36	Container	111,792	2006	104	68,250	15.1	17	0,89		2006	720	2,882	4	10.99	7.0	12.1	0.91
37	Car carrier	7,808	2005	129	9,170	13.1	17	0,77		2005	900	1,110	3	11.3	8.8	11.5	0.98
38	Car carrier	27,227	2004	105	14,313	11	17	0,65		2004	720	1,470	3	10.7	8.2	12.1	0.89
39	#N/A	#N/A	#N/A	104	68,250	15.1	17	0,89		2006	720	2,882	4	10.99	7.0	12.1	0.91
40	Container feeder	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A		#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
41	Container feeder	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A		#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
42	General cargo	47,257	1999	720	4,441	#N/A	12.1	#N/A	2	1999	720	600	1	#N/A	10.1	12.1	#N/A
43	Container	89,097	2003	104	#N/A	14.6	17	0,86		2003	720	3,160	4	10.5	6.9	12.1	0.87
44	Container	47,828	2002	104	37,257	13.8	17	0,81		2002	720	2,400	3	11	7.3	12.1	0.91
45	Container	99,508	2003	104	68,520	14.6	17	0,86		2002	720	3,360	4	10.5	6.8	12.1	0.87
46	Container	99,614	2004	104	68,520	14.6	17	0,86		2004	720	3,000	4	10.5	7.0	12.1	0.87
47	Container	99,538	2004	104	68,520	14.6	17	0,86		2002	720	3,360	4	10.5	6.8	12.1	0.87
48	Chemical tanker	2,925	1991	#N/A	#N/A	#N/A	#N/A	#N/A		#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A

Table 8 Details for auxiliary engine type 2

Auxiliary engine type 2						
No.	Year of build	RPM	Power	Number	NO_x value (g/kWh)	NO_x limit Tier I (g/kWh)
14		900	680	2	9.7	11.5
16	2002	720	2,700	1	10.8	12.1
20	2003	720	682	2	11.3	12.1
30	2006	720	2,944	2	10.94	12.1

Table 9 Details for auxiliary engine type 3 and 4

Auxiliary engine type 3						
No.	Year of build	RPM	Power	Number	NO_x value (g/kWh)	NO_x limit Tier I (g/kWh)
16	2001	720	3,600	1	11.6	12.1
Auxiliary engine type 4						
	Year of build	RPM	Power	Number	NO_x value (g/kWh)	NO_x limit Tier I (g/kWh)
16	2002	1,800	1,424	1	7.03	10.0

Table 10 SO_X data and ESI scores

	HS	ECA	EU-berth	ESI NO_x	ESI SO_x HS	ESI SO_x ECA	ESI SO_x berth	ESI SO_x total	Overall ESI
No.	% S	% S	% S						
1	2.8	1.4	1.4	14	11	3	3	17	15
2	3.0	1.4	1.4	#N/A	10	2	2	14	#N/A
3	2.9	1.3	1.3	18	11	6	6	22	19
4	3.2	1.5	1.4	#N/A	9	1	3	13	#N/A
5	3.1	0.9	0.9	18	9	14	14	37	24
6	3.0	1.4	1.4	18	10	2	2	14	16
7	2.7	--	0.2	12	12	0	30	42	22
8	2.6	1.4	1.4	17	13	3	3	18	17
9	2.3	1.4	1.0	18	15	2	12	29	22
10	--	1.4	0.9	#N/A	0	3	21	24	#N/A
11	2.8	1.4	0.0	4	11	2	34	48	19
12	2.7	1.4	1.4	23	12	2	2	16	20

	HS	ECA	EU-berth	ESI NO_x	ESI SO_x HS	ESI SO_x ECA	ESI SO_x berth	ESI SO_x total	Overall ESI
13	1.5	1.3	0.1	34	20	5	34	59	43
14	1.9	1.3	1.3	#N/A	17	4	4	26	#N/A
15	--	1.4	0.1	#N/A	0	4	47	52	#N/A
16	2.4	1.4	0.1	8	14	1	33	49	22
17	2.3	1.4	1.4	#N/A	14	2	2	19	#N/A
18	2.7	1.2	1.2	7	12	7	7	26	13
19	3.0	1.2	0.1	#N/A	10	7	33	50	#N/A
20	3.1	1.5	1.5	14	9	1	1	11	13
21	2.0	1.2	0.1	10	17	7	33	56	26
22	2.6	1.4	0.1	7	13	2	33	48	21
23	3.0	0.8	0.4	32	10	15	26	52	39
24	2.8	1.5	0.1	#N/A	11	0	34	45	#N/A
25	2.9	--	1.5	25	11	0	0	11	20
26	--	1.3	0.0	19	0	6	49	55	25
27	2.8	1.2	0.1	19	11	6	32	49	29
28	--	1.3	0.1	#N/A	0	6	47	53	#N/A
29	4.5	1.1	0.5	0	0	12	34	46	11
30	3.0	1.4	1.4	14	10	2	2	14	14
31	#N/A	#N/A	#N/A	13	0	0	0	0	9
32	--	1.4	0.1	8	0	3	47	50	17
33	1.4	1.4	1.4	12	20	2	2	24	16
34	2.3	1.4	1.4	7	15	3	3	21	12
35	2.8	1.2	1.2	4	11	6	6	24	10
36	2.8	1.4	1.4	11	11	1	1	14	12
37	--	1.3	0.1	17	0	7	47	54	24
38	2.4	1.5	1.5	30	14	0	0	14	25
39	2.5	1.4	1.4	11	13	3	3	20	14
40	--	1.5	0.1	#N/A	0	0	47	47	#N/A
41	--	1.5	0.1	#N/A	0	0	47	47	#N/A
42	1.3	1.3	1.3	#N/A	22	5	5	32	#N/A
43	2.7	1.4	0.4	13	12	4	26	41	22
44	2.2	1.3	1.3	17	16	5	5	25	20
45	3.0	1.5	--	14	10	0	0	10	13
46	2.9	1.5	1.5	14	11	1	1	13	14

	HS	ECA	EU-berth	ESI NO_x	ESI SO_x HS	ESI SO_x ECA	ESI SO_x berth	ESI SO_x total	Overall ESI
47	2.7	1.4	0.1	14	12	4	34	49	26
48	--	0.1	0.1	#N/A	0	47	47	93	#N/A

Note: -- means fuel not used, no figure available.